Bruce F

Report

GR-999-039

FOUNDATION INVESTIGATION

PROPOSED BRIDGE

UPPER FRANCES RIVER

NAHANNI RANGE ROAD, km 8.4

YUKON TERRITORY

Western Region
Department of Public Works

(ORIGINAL DOCUMENT
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Submitted by:

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Public Works Canada
Western Region

October, 1979

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APPENDICES

I INTRODUCTION

Work on this project was undertaken at the request of Mr. J.Y.C. Quong, Manager, Bridges and Special Projects, Public Works Canada, Whitehorse, Yukon Territory. On-site investigation was carried out by Public Works, Whitehorse in May, 1979, with data forwarded to P.W.C., Edmonton for preparation of a foundation report.

II PROPOSED CONSTRUCTION

The proposed new bridge will be located immediately upstream of the existing bridge and will be skewed at an angle of roughly 17° to the present channel. Design details for the new construction have not been finalized as yet, however, two conceptual designs are currently under review and cost comparisons - a three span continuous structure with a 50 m central span and two 27 m endspans; and a 92 m single span steel truss. Both designs will avoid a mid-span pier, however, piers for the three-span structure will be well within the present stream channel. Steel piling have tentatively been proposed for the foundations.

III EXISTING BRIDGE AND HISTORY

The original bridge at this site was constructed by the Royal Canadian Engineers in 1961 as a four-span Bailey Bridge. Piers and abutments were founded upon spruce piling driven to a maximum penetration of 3.5 to 4.5 metres (12 - 15') below ground line. Pile driving records indicate variable and difficult driving - some piles reached design penetration (15') without difficulty whereas adjacent piles encountered hard driving (probably boulders) at shallow depths and underwent brooming and splitting. Rockfilled timber cribworks were constructed upstream of each pier for protection against ice damage and driftwood, however, during high water in June, 1962, driftwood and/or scour resulted in overturning of the center pier and dropping of the two central spans into the river. Repair work in autumn, 1962 consisted of construction of a long central span and elimination of the mid-span pier. Configuration at present is a 49 m (160') central span with two end spans of 21 m (70').

IV STREAM CHARACTERISTICS

The Frances River channel at the proposed bridge site is some 82 m (270') wide and 6.4 m (21') in its deepest section at the average water elevation. Highwater occurs during the mountain snowmelt in June and July and water levels rise up to 3 m in a few days. Frances Lake located roughly 30 kilometres upstream of the crossing site provides a stabilizing effect on flows, controlling to some extent short-term fluctuations common to mountain streams. Maximum discharge has been estimated at 950 m^3/s (33,550 c.f.s.). Early spring run-off is temporary from localized melting and does not reach high water peaks, apparently with little ice drift or damming problems. June and July highwater carries large amounts of driftwood. There is reported shifting and scour of the river bottom at high water including movement of large size boulders, although no obvious bank scour is reported near the bridge site.

V EVALUATION OF SUBSOIL CONDITIONS

A. General

The Frances River is part of the Liard River system that drains the southern Yukon and Northern B.C. Headwaters of the Frances River are in the Pelly Plateau and the Pelly and Logan Mountains, with drainage southerly to the Liard. The valley of the Frances including Frances Lake is confined between the Pelly Mountains on the west and the Logan Mountains on the east. The entire Pelly Plateau was covered by Pleistocene ice with ice movement southward down the present Frances River valley. Surficial deposits within the valley are unconsolidated glacial, fluvioglacial, and alluvium.

B. Subsoil Profile

Borehole locations are shown on Drawing 1 in Appendix B, and borehole logs summarizing field and laboratory data are included in Appendix A. Boreholes were limited to the edges of the stream channel due to the lack of river ice for drill access.

The subsoil in all four holes is variable, layered, granular deposits. In the upper 10 - 11 m the material is primarily a silty sandy gravel with numerous cobbles and boulders. This stratum is thought to be dense to very dense and is expected to provide difficulty for pile driving. Below approximately 11 m is a 2 - 3 m stratum that is largely a clay-silt (possibly glacial till) that is also in a dense state. Underlying the clay-silt is a further stratum of coarse granular deposits - sandy gravel with cobbles and boulders.

VI FOUNDATION SUPPORT

A. General

The granular deposits at this site will provide adequate support for the proposed bridge foundations - the problem lies in selecting the most practical and economical foundation method. Because of the variable and coarse nature of the granular subsoil, pile installation will be difficult and unpredictable. The piers for the present bridge have remained stable since 1962 on a very shallow pile foundation, however, the possibility of significant scour is apparently real (at least within the channel) and piers will have to be protected accordingly. Based upon subsoil information available at present, either spread footings or steel friction piling could be utilized for piers or abutments near the channel edge.

B. Spread Footings

Spread footings are considered to be a good practical foundation for the subsoil conditions at this site and will avoid the problems and uncertainties of pile installation in the heavy granular subsoil. Footings may be designed on the basis of an allowable bearing pressure of 350 kPa and the base of footing is recommended at about 3 m below the present stream-bed channel for piers, and about 1.5 m below present ground line at abutments. The granular subsoil is highly pervious and sheet pile coffer dams and pumping will be required for footing construction.

C. Pile Foundations

The test borings to date do not adequately define the density and boulder content of the granular subsoil, however, based upon the difficulty in pile driving at the existing bridge, a steel H-pile section not less than 12 HP 53 is recommended to facilitate pile penetration. Steel pipe piles are not recommended due to anticipated driving problems. Bearing capacity for piles can only be guessed at from available subsoil information - I would suggest one of three avenues be taken for pile design at this site:

1) additional drilling with Standard Penetration Tests and detailed logging and subsequent re-evaluation;
2) driving a test pile to assess driveability, penetration and load capacity (preferably by load test but pile driving

formulae would suffice);

3) rely upon pile driving formulae at construction to ensure design pile capacity is attained.

Tips of the H-piles should be protected by using cast steel drill shoes, or by welding steel plates to reinforce the toe. The rated energy of the drive hammer should be limited to 630 J/cm^2 (3000 ft. lb./sq. in.) of cross-sectional area. Since piles driven at this site will essentially be friction piles, a final set in the order of 10 blows per inch (2.5 cm) will be adequate, and can probably be attained within about 12 - 13 m.

D. Approach Embankments

Free draining granular backfill is recommended adjacent to the abutments. The heavy granular subsoil encountered at the abutment locations is expected to extend well back from the river channel, hence embankment stability or settlements should not be a concern. Negative friction loadings on piling due to embankment settlements should be minimal.

R.D. Cook, P. Eng.
Head
Geotechnical Services
Western Region

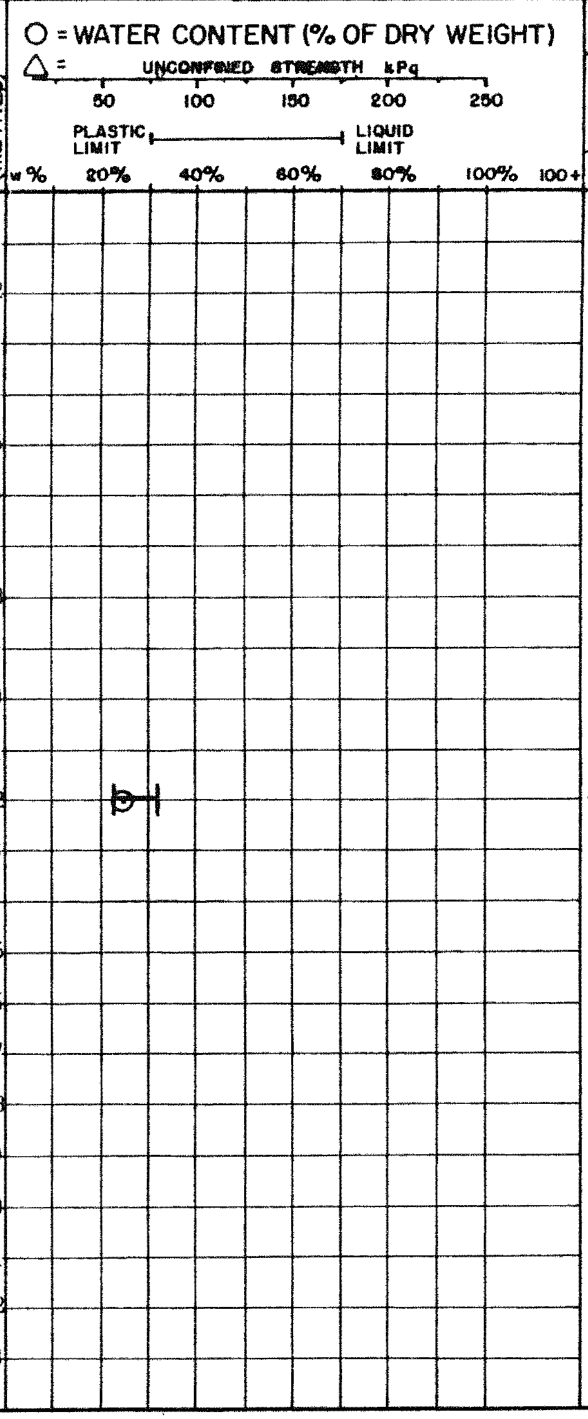
APPENDIX “A”

PUBLIC WORKS CANADA | **DRILL HOLE REPORT** | UPPER FRANCES RIVER BRIDGE

TECH. C.B.	RIG B 40L	DATE 79-05-18	km	B.P. No.	HOLE No. 1

CHAINAGE	OFFSET

DEPTH (FEET)	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	PENETRATION RESISTANCE	ICE DESCRIPTION	DEPTH (METRES)	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE MOISTURE CONTENT	REMARKS
		TOPSOIL — 0.3m.									
4		SILT, SAND, GRAVEL, COBBLES - SOME BOULDERS — 2.1m.			1						
8		GRAVELLY TILL (?) - SILT, SAND, GRAVEL - COARSE - COBBLES			2						
12					3						
16					4						
20					5						
24					6						
28					7						
32					8						
36		— 11.6m.			9						
					10						
					11						
40		SILTY TILL - GREY-BLUE - OCCASIONAL COBBLE. - VERY STIFF OR DENSE. — 13.2m	50		12	-97.5		2.5	0		
44		GRAVEL & COBBLES.			13						
48		— 15.2m			14						
					15						
52		BOTTOM OF HOLE 15.2m.			16						
56		NOTE. HOLE DIAMOND DRILLED.			17						
60					18						
					19						
					20						
					21						
					22						
					23						



PUBLIC WORKS CANADA — DRILL HOLE REPORT

Upper Frances River Bridge

TECH. C.B.
RIG B40L
DATE 79-05-15
km
B.P. No.
HOLE No. 2

CHAINAGE	OFFSET

DEPTH (FEET)	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	PENETRATION RESISTANCE	ICE DESCRIPTION	DEPTH (METRES)	○ = WATER CONTENT (% OF DRY WEIGHT)	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE MOISTURE CONTENT	REMARKS
		TOPSOIL — 0.3m										
		SILT-SAND-GRAVEL			1							
4												
		— 1.8m			2							
8		SAND, GRAVEL, COBBLES BOULDERS			3							
		— 3.5m										
12		SILT-SAND-GRAVEL MIX			4							
16		- OCCASIONAL COBBLE			5							
20		- EASY ADVANCE WITH NX CASING.			6							
24		- POOR WATER RETURN			7							
28					8							
					9							
32					10							
36					11							
		— 11.6m										
40		CLAY-SILT - BLUE GREY. - SOME SAND			12							
44		- MINOR GRAVEL. - GOOD WATER RETURN			13							
		— 14.0m			14							
48		SILT-SAND-GRAVEL			15							
52		-COBBLES AND BOULDERS THROUGHOUT			16							
56					17							
60					18							
					19							
64					20							
68		— 20.7m			21							
		Bottom of Hole - 20.7 m.										
72		NOTE. HOLE DIAMOND DRILLED			22							
					23							

GRAIN-SIZE ANALYSIS

△ = UNCONFINED STRENGTH kPa: 50, 100, 150, 200, 250

PLASTIC LIMIT ├──┤ LIQUID LIMIT

w %: 20%, 40%, 60%, 80%, 100%, 100+

PUBLIC WORKS CANADA | **DRILL HOLE REPORT** | Upper Frances River Bridge.

TECH. C.B.
RIG B 40L
DATE 79-04-27
km
B.P. No.
HOLE No. 3

DEPTH (FEET)	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	PENETRATION RESISTANCE	ICE DESCRIPTION	DEPTH (METRES)
		TOPSOIL — 0.3m			
4		SILT-SAND-GRAVEL. - BLACK. - ORGANICS ? — 1.5m			1
8		SAND, GRAVEL, COBBLES, BOULDERS.			2
12		- VERY HARD DRILLING.			3
16					4 5
20					6
24		— 7.6m			7
28		Bottom of hole 7.6m.			8 9
32		NOTE. HOLE DIAMOND DRILLED			10
36					11
40					12
44					13
48					14 15
52					16
56					17
60					18
64					19 20
68					21 22 23

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = UNCONFINED STRENGTH kPa: 50, 100, 150, 200, 250
PLASTIC LIMIT |———| LIQUID LIMIT
w % 20% 40% 60% 80% 100% 100+

GRAIN-SIZE ANALYSIS				RELATIVE MOISTURE CONTENT
CLAY	SILT	SAND	GRAVEL	
%	%	%	%	

CHAINAGE	OFFSET

REMARKS

PUBLIC WORKS CANADA | **DRILL HOLE REPORT** | Upper Frances River Bridge

TECH. C.B.

RIG B-40L

DATE 79-05-09

km

B.P. No.

HOLE No. 4

CHAINAGE

OFFSET

○ = WATER CONTENT (% OF DRY WEIGHT)

△ = UNCONFINED STRENGTH kPa 50 100 150 200 250

PLASTIC LIMIT ├──┤ LIQUID LIMIT

w % 20% 40% 60% 80% 100% 100+

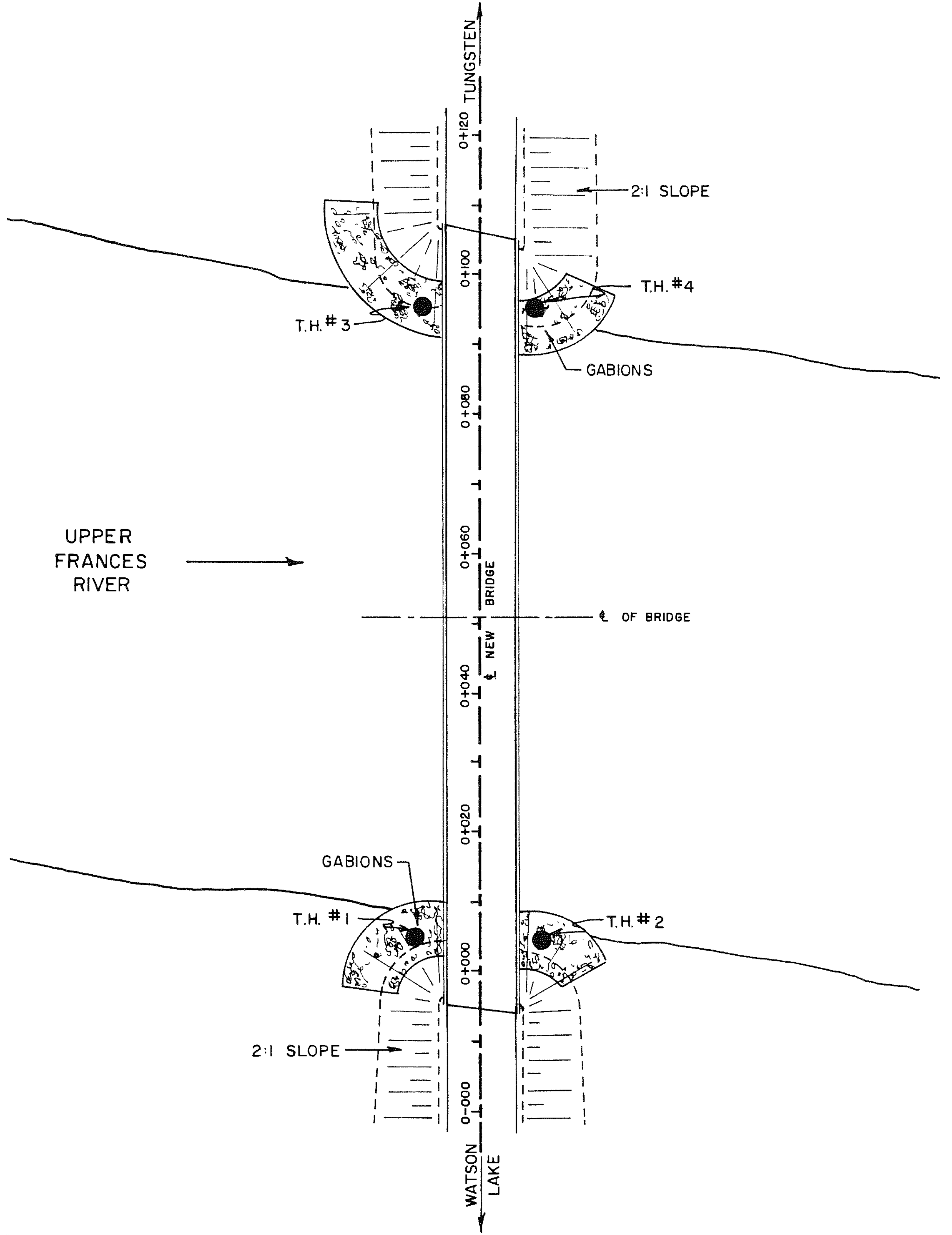
GRAIN-SIZE ANALYSIS: CLAY % SILT % SAND % GRAVEL %

RELATIVE MOISTURE CONTENT

REMARKS

DEPTH (FEET)	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	PENETRATION RESISTANCE	ICE DESCRIPTION	DEPTH (METRES)
		TOPSOIL — 0.3m			
4		SILTY, SANDY, GRAVEL. – BLACK – ORGANICS? — 1.8m			1
8		SAND, GRAVEL, COBBLES, BOULDERS.			2
12					3
16		– DIFFICULT DRILL ADVANCE.			4
20					5
24					6
28					7
32					8
36					9
40		— 12.2m			10
44		CLAY-SAND-SILT – BLUE-GREY – GRAVEL AND COBBLES			11
48		– POSSIBLY GLACIAL TILL.			12
52					13
56		— 17.7m			14
60		BOTTOM OF HOLE – 17.7m.			15
		NOTE. HOLE DIAMOND DRILLED.			16
					17
					18
					19
					20
					21
					22
					23

APPENDIX "B"



Drawing title:
Titre du dessin:

UPPER FRANCES RIVER BRIDGE

scale:
échelle:

date:

revisions:

BORE HOLE LOCATIONS

designed by:
conçu par:

date:

drawn by:
dessiné par:

reviewed by:
examiné par:

approved by:
approuvé par:

project no.:
no. du projet:

dwg. no.
dessin no.

Public Works Canada **Travaux publics Canada**

DPW 700A