PUBLIC WORKS CANADA
HYDROLOGY AND HYDRAULICS
MUSKEG RIVER BRIDGE
KILOMETRE 207.9, LIARD HIGHWAY
DECEMBER, 1978
PREPARED BY BOLTER PARISH TRIMBLE LTD.

PUBLIC WORKS CANADA

HYDROLOGY AND HYDRAULICS
MUSKEG RIVER BRIDGE

KILOMETRE 207.9, LIARD HIGHWAY

December 1978

Bolter Parish Trimble Ltd.
CONSULTING ENGINEERS

11805 - 149 STREET
EDMONTON, ALBERTA
T5L 2J1
TELEPHONE 452-7810

December 11, 1978

File 115-19

Public Works, Canada,
9925 - 109 Street,
EDMONTON, Alberta

Attention: Mr. N. Huculak, P. Eng.
Regional Highways Engineer

Dear Sir:

Re: Liard Highway - Muskeg River Bridge,
Kilometre 207.9

We have carried out a preliminary engineering investigation of the proposed bridge over the Muskeg River, and have prepared Drawings 115-19-1 and 115-19-2 which presents our recommended design data. Public Works Canada requested that we investigate the hydrologic and hydraulic conditions at the Muskeg River and prepare a report on our findings and make recommendations concerning the most appropriate location of a bridge and outline the mitigating measures required to protect the structure and approach fills from bed scour, ice forces and required foundations. Authorization for this investigation was received in October 1978 and a site investigation was made on October 30, 1978.

GEOMORPHOLOGY AND HYDROLOGY

The proposed crossing of the Muskeg River is located approximately fifteen kilometres north of Fort Liard, and is situated approximately 4,000 metres upstream of the Liard River. The Muskeg River drains approximately 6,320 square kilometres to the proposed crossing. The river has a sinuous meander pattern in this region and is situated in a broad valley, although in its lower reaches the river tends to occupy only the northern half of the valley bottom. Numerous oxbow lakes exist along the valley bottom, with the majority of these features being located on the southern half of the valley floor.

Continued....

The river has a coarse sand bed with cobbles and boulders situated on the riffles. Large point bar deposits and channel bars are visible on the aerial photographs during low water periods.

The Muskeg River drains basically gently undulating terrain and lacks any major high relief features. The highest part of the basin is approximately 500 metres above the proposed crossing. There are no major influences of lake control on the trunk streams, although numerous small lakes will exert some control on the hydrology of the smaller tributary streams draining to the trunk streams.

The proximity of the Liard Range, immediately west of the Liard River, may influence the hydrology of the lower reaches of the Muskeg River, as the orographic influence of the mountains may extend some distance eastward and increase precipitation intensities during summer rainfall events. It is not believed that this potential orographic influence would affect the majority of the basin, however.

The design discharge for the river is the 1 in 50 year flood event and has been estimated to be 1,600 m^3/s.

CHOICE OF CROSSING LOCATION

Several crossing locations have been considered at various times during the last eight years. The four crossing locations considered are presented on Figure 1. The usual choice for a crossing on a meandering river would be at a straight reach or at a crossover. A suitable straight reach did not exist within the limits of investigation (see Figure 1) and a stable crossover was also unavailable. As such, the crossing chosen is on a meander bend.

The following are the pertinent factors which affected the choice of the 1978 A line as the one that is recommended.

1970 LINE

This line was previously eliminated by P.W.C. personnel due to the poor vertical alignment provided at the north end of the river valley.

1977 LINE

This line is similar to the 1978 A line, but it crosses through an oxbow south of the river, which is considered a negative environmental factor. In addition, poor soil conditions apparently were noted by P.W.C. personnel along the south valley wall.

Continued.....

1978 B LINE

This crossing takes place at a riffle in the river where a sand and gravel bar has formed at the outside of a bend. Deposition of bed load material on the outside of a bend is not normal, and may be caused by local erosion along the south bank which has produced an exceptional bed load. This situation has created a fairly stable section, which could be classed as a crossover at the outside of a bend, an unusual but not unknown feature. It is feared that this situation might only be a temporary one, however, and the danger exists that someday the local factor causing the bar may be eliminated, causing a sudden great scour at the outside of the bend, which might not have been allowed for. In addition, the structure required here is on a large skew, which would make the bridge long and expensive.

RECOMMENDED LOCATION

The recommended location is the 1978 A line (Figure 1, Drawing 115-19-1, Photographs 1 to 4). This crossing is on a moderate bend in the river and the outside of the bend, the south bank, is gradually receding. An examination of the 1947, 1968, 1973 and 1978 aerial photographs and 1970 on-the-ground photographs confirms that the bank is receding, but the actual rate of recession is difficult to assess owing to scale problems and the clarity of the photographs. However, we estimate that the total bank recession at the proposed crossing location is less than four metres since 1949.

HYDRAULIC ASSESSMENT

From our hydrologic assessment we have estimated that the 1 in 50 year design discharge will be 1,600 m^3/s. Assuming there is no backwater from a high Liard River stage, we have estimated that this discharge will occur at elevation 207.6 prior to placement of the bridge fills. The mean velocity in the main channel would be approximately 3.0 m/s. With the proposed bridge fills in place (Drawing 115-19-2) the mean velocity will be increased slightly to approximately 3.2 m^3/s. Afflux created by the bridge fills will raise the upstream water level slightly, to elevation 207.8. The higher velocity has been used to estimate general bed scour and to determine the size of riprap required.

The crossing site periodically will be influenced by water and ice levels in the Liard River downstream. This backwater has been taken into account in the assessment of high ice and high water levels. The design high water and high ice level as determined by backwater is elevation 208.4. Therefore, it is recommended that the minimum bottom flange elevation be 210.0, to provide adequate clearance for drift and expected ice pan thicknesses of up to 1.2 m.

Continued....

As an environmental consideration, it is recommended that piers not be located within the low water channel, as this may create excessive scour. Pier scour has not been estimated at this time as it is dependent on the pier shape and the required geotechnical drilling information is unavailable. However, location of the pier as far from the deepest part of the low water channel as is structurally and economically feasible will minimize the additional effects of pier scour.

SLOPE PROTECTION

It is proposed that the south bank near the bridge be protected with heavy rock riprap of gradation specified as Class II R.T.A.C. An apron toe of riprap will be required at the base of the south bank slope with the top elevation at the current low water level, elevation 203.4. The apron toe should extend out from the edge of water 1.5 metres and the existing bank should be cut back an additional 1.5 metres, yielding a 3.0 metre wide apron toe. The apron toe would contain approximately 6.0 m^3 of rock per metre of length along the bank. A layer of rock riprap 0.6 metres thick would extend up the south bank at a slope of 2:1 to elevation 209.4, which is 1.0 metre above the highest water level anticipated.

Although the bank will be protected, as an added safety factor it is recommended that the bridge abutment be set slightly further back than required.

At the upstream and downstream ends of the slope protection a 3 m x 3 m cutoff and end return, transitioned smoothly into the natural bank, will be required.

The north approach fill will also require riprap along the fill slope and a launching apron and these requirements are shown on the plans.

The toe of fill along the north bank is recommended to be at Station 207 + 820, which is positioned just within the permanent tree line. This will limit any main channel flow constriction to only very high flow events.

The south bank toe of fill should be situated a few metres back from the top of bank, and be positioned approximately at Station 207 + 958.

Pier and abutment foundations should be on driven piles.

Continued.....

A grade line has not been set at this stage of investigation; therefore, the recommended out to out of fills can only be approximated. If the grade line were set at elevation 212.5, however, the out to out would be approximately 152 metres.

We trust this report is adequate for your needs at the present time and we would be pleased to discuss any aspect of the report with you at your convenience.

Yours very truly,

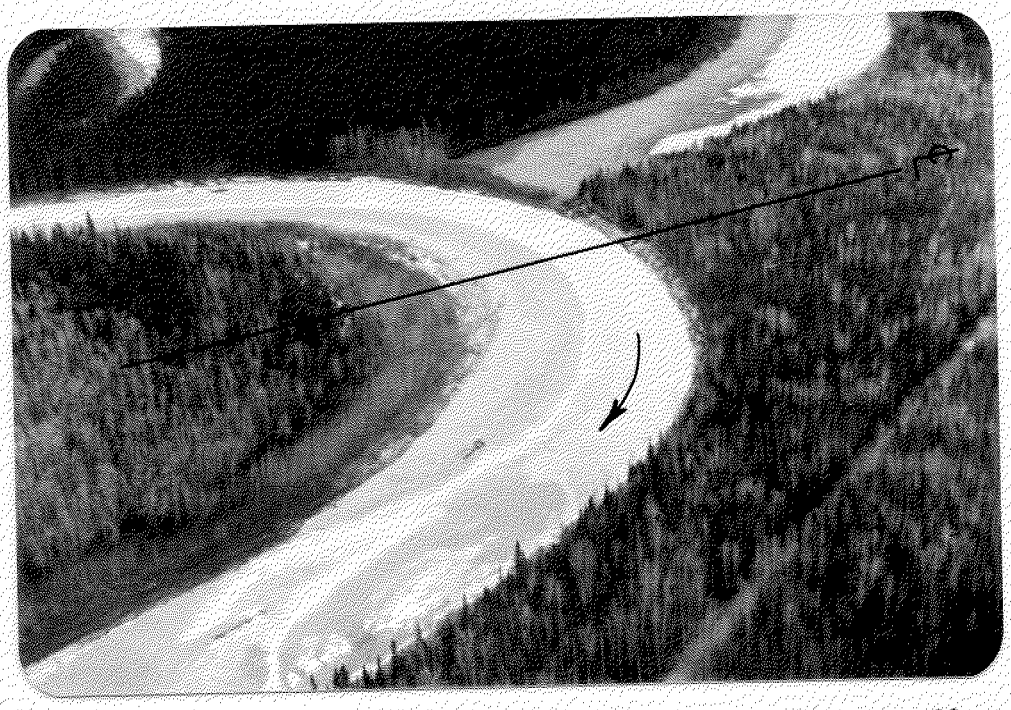
BOLTER PARISH TRIMBLE LTD.

R.P. Parish

RCF:nlb

R.P. Parish, P. Eng.

PHOTOGRAPH 1. Muskeg River - looking northeast. Flow is right to left. October 30, 1978.

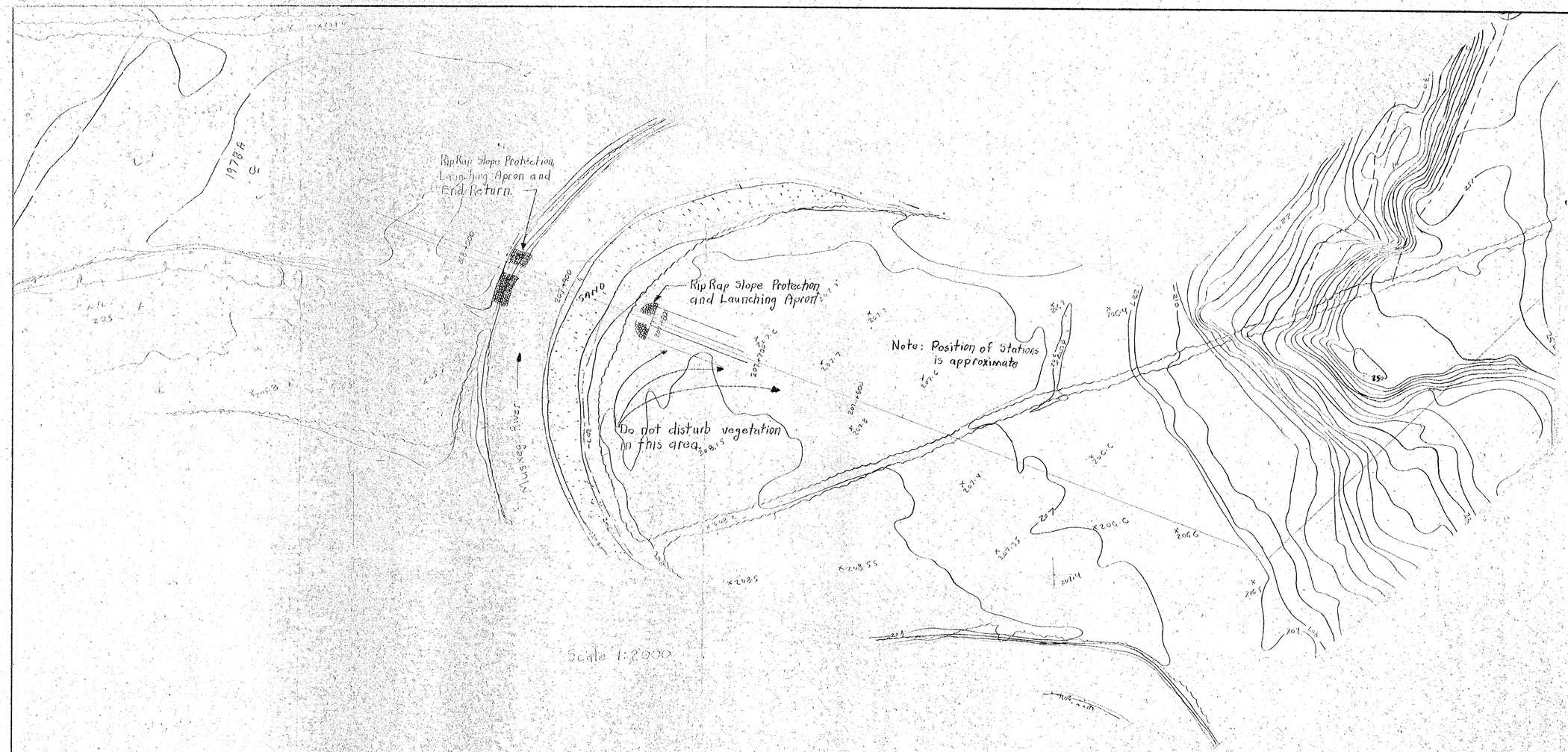


PHOTOGRAPH 2. Muskeg River - looking upstream. October 30, 1978.

PHOTOGRAPH 3. Muskeg River - looking at high south bank. Flow is left to right. October 30, 1978.

PHOTOGRAPH 4. Muskeg River - looking south to high bank on centre line. October 30, 1978.

PHOTOGRAPH 5. Muskeg River - looking at high south bank approximately 30 metres upstream of centre line. October 30, 1978.



NO.	DATE	DESCRIPTION	BY

REVISIONS

Bolter Parish Trimble Ltd.
CONSULTING ENGINEERS

DATE	FILE	DWN. BY
NOV., 1978	115-19	B.C.F.

PUBLIC WORKS CANADA

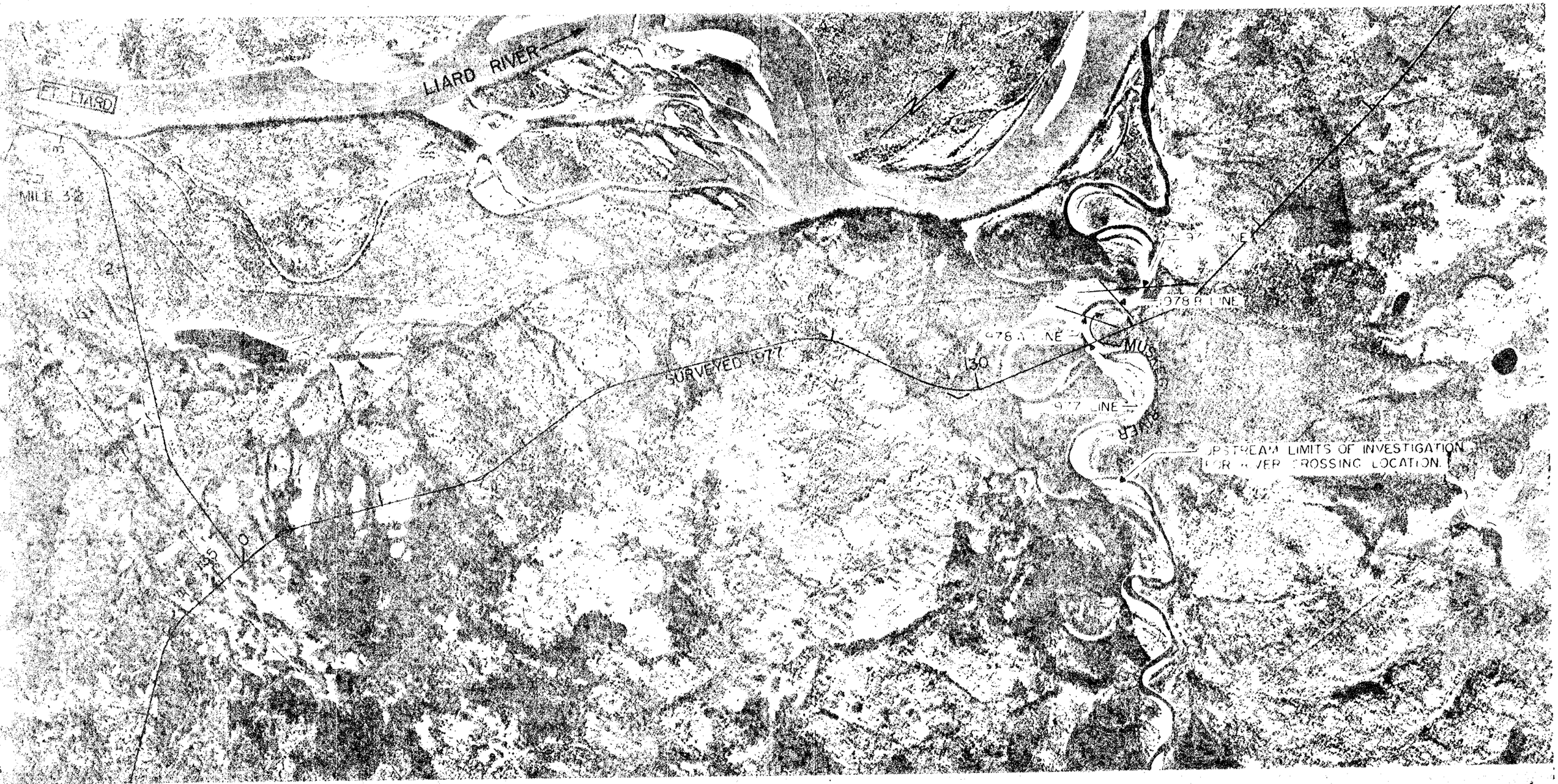
FORT LIARD HIGHWAY

MUSKEG RIVER BRIDGE CONTOUR PLAN

SHEET NO.

DWG. NO. 115-19-1

MUSKEG RIVER
ALTERNATIVE CROSSING LOCATIONS



1973 AERIAL PHOTOGRAPH

SCALE 1:36,000

FIGURE 1.

MUSKEG RIVER

22'

Out to Out of Fills ≈ 152 meters

EL. 220

EL. 215

EL. 210

EL. 205

EL. 200

TO FORT LIARD

TO FORT SIMPSON

NOTE: POSITION OF BOREHOLE IS APPROXIMATE

TENTATIVE GRADE LINE, ELEV. 212.5

ELEV. 209.4, TOP OF RIP RAP

SANDY SILT

SANDY SILTY CLAY

GRAVELLY SAND

GRAVEL

SANDY SILTY CLAY TO CLAYEY SILT

4.1

4.6

6.3

8.2

ELEV 207.8, DESIGN H.W. FOR VELOCITY AND SCOUR

ELEV 208.4, DESIGN H.W. FROM LIARD RIVER BACKWATER

ICE ELEV 203.4, OCT 6, 1978

ELEV 199.0, GENERAL BED SCOUR ALONG THALWEG

DO NOT LOCATE PIER IN THIS AREA

MINIMUM BOTTOM FLANGE, ELEV. 210.0

NOTE: POSITION OF BOREHOLE IS APPROXIMATE

GRAVELLY SAND

2.7

SILTY, CLAYEY SILT

8.2

ELEV. 209.4, TOP OF RIP RAP

2:1

TOE OF FILL, STA. 207+820

TOE OF FILL, STA. 207+980

207+900

207+850

207+800

207+750

NOTE:

PENETRATION READINGS AVAILABLE FROM P.W.C.

℄ PROFILE

SCALE 1:250

DRAWING No. 115-19-2