THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ALBERTA INFRASTRUCTURE AND TRANSPORTATION LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

PEACE REGION (PEACE RIVER/HIGH LEVEL AREA)

SITE PH48: FORT VERMILION BRIDGE (BF74227)

LEGAL LOCATION:	**29-108-13-W5M**
NEAREST LANDMARK:	**8 KM WEST OF FORT VERMILION**
Highway Control Section:	**HWY 88:18 km 30**
Date of Initial Observation:	**1973**
Date of Last Inspection:	**2005**
Last Inspected By:	**Thurber Engineering Ltd. (Thurber)**
Instruments Installed:	**5 Slope Inclinometers (1978), 6 Slope Inclinometers (1984), 2 Pneumatic Piezometers (1984)**
Instruments Operational:	**1 Slope Inclinometer**
Last Updated:	October 2005 – Thurber Engineering Ltd.

1. LOCATION

The site is located along Hwy 88:18 over the Peace River at about 12 km south of the junction with Highway 58 and west of Fort Vermilion.

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

The bridge is a 5 span bridge of 513.7 m in length. According to AIT's bridge file data (Section G) the bridge deck is located 25.6 m above the river level. The bridge was constructed in 1972 and 1973 with a special design to resist extreme ice forces (about 7.1 MN per pier). The piers were founded on steel piling about 30 m long driven to the bedrock layer. According to bridge design data drawings (attached) the south end of the bridge is located at the north end of an island. A large culvert passes water beneath the highway at the south end of the island.

The site has had a long history of instability going back to 1973. During the construction of Pier 4, the cofferdam around the pier excavation began to exhibit signs of failing. However, it was concluded that Pier 4 was stable enough and construction was continued. Between June 13, 1974 to March 24, 1975, Pier 4 tilted to a total of about 44 mm (1 ¾"). Between September 1976 and January 1977 Pier 4 continued to tilt at a relatively constant rate up to a total movement of about 86 mm (3 3/8"). The movement was attributed to the asymmetry of the pier and to variability in soil conditions within the footprint of the pier. No further movement for Pier 4 was reported after that time. Five slope inclinometers were installed in 1978 to monitor the possible slide within the soil.

Between September 1976 and January 1977, the expansion assembly gap at Abutment 2 closed by about 35 mm (1 3/16"). Measurements on Abutment 2 in 1987 indicated that it had moved toward the river by about 51 mm (2") since it was built.

In 1985, the rocker bearings at Abutment 1 (south end of bridge) were repositioned by about 76 mm (3"). Thereafter, Abutment 1 continued to move toward the river at an approximate rate of 6 mm per year. Six slope inclinometers were installed in 1984 to monitor the possible slide within the soil at the south abutment.

Despite the relatively large movements, it was concluded that the bridge was structurally capable of sustaining the additional forces due to tilt and no further action was required.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Bedrock Geology: The bedrock geology at the site consists of cretaceous age marine bedrock of the Loon River Formation. The bedrock is a dark grey fossiliferous, silty shale and laminated siltstone containing nodules and thin beds of concretionary ironstone.

Surficial Geology: no information available

Hydrogeology: no information available

Stratigraphy: Two possible locations for the bridge were identified in R.M. Hardy's geotechnical report (1971), namely locations B and C, as are shown on Figure 1, Appendix G. Stratigraphic cross sections along the proposed locations of the Fort Vermilion bridge were shown on Figures 2 to 5, Appendix G. It appears that the bridge was constructed along line B.

Based on TH#1 through TH#6, it appears that the conditions on the north bank of the river consisted of silt, sand and/or silty clay overlying clay till (clay with stones) overlying highly weathered clay shale (dark grey shale) overlying clay shale bedrock. The depth to bedrock varied from 3 to 10.5 m.

On the north side of the island (south bank of the river) the subsurface conditions consisted of 24 to 36 m of sand overlying shale bedrock.

4. CHRONOLOGY

The history of the site is based on the following memos:

- A letter from R.M. Hardy and Associates Ltd. To Department of Highways and Transport dated September 24, 1973.
- A memo from Bill Peterson provided the following history from 1974 to 1977.
- A memo from D.H. Quapp on June 1987 provided the history from 1984 to 1987.

1973

During the construction of Pier 4, the cofferdam around the pier excavation began to exhibit signs of failing. This matter was handled in the field as a construction problem but the question was raised whether or not the failing of the cofferdam or the cause of failure would influence the bearing capacity of the pier. However, it was concluded that the movement of the cofferdam would not have affected the stability of the pier. The bearing capacity of the pier was shown to have a factor of safety of about 3 and the factor of safety against sliding was about 1.4.

June 13, 1974 to March 24, 1975

Pier 4 was tilted by about 44 mm (1 ¾"). The cause of tilt was identified as a result of asymmetry of the pier and due to variability in soil conditions.

April 1975 to September 1976

Pier 4 continued to tilt at a decreasing rate to the south with a tilt of about 12 mm (½").

September 1976 and January 1977

Abutment 2's expansion assembly gap closed by 35 mm (1 3/16"). The top of Pier 4 continued to tilt to a total movement of about 86 mm (3 3/8").

June 1978

Five slope inclinometers were installed (SI-1 to 5). Reading plots that were available in the background information are attached for inclusion in Section G of the binder.

1983

Arrangements were made with Tom McGreer, Regional Bridge Engineer, to obtain field measurements on a more regular and consistent basis on all piers and abutments. Thus measurements were taken on expansion gaps at the abutments, all rocker bearings, and on the tilt limit devices (TLD's) which existed on all of the piers except" fixed" Pier 3. As these readings were difficult to take and not very accurate, except for the expansion gap measurements, they were discontinued.

1984

Two pneumatic piezometers were installed in June 1984. Six slope inclinometers were installed in December 1984 (SI-1 to 6). Reading plots that were available in the background information are attached for inclusion in Section G of the binder.

1985

The rocker bearings at Abutment 1 (south end of the bridge) were repositioned by 76 mm (3").

1986

Electronic distance measurements (EDM's) were begun. These measurements were taken on targets mounted directly on the substructures. Four sets of data were obtained. Eight independent distances as follows were obtained: five distances between the substructures; the distance between the two abutments; and the two distances from each abutment to a stable hub on its approach some 300 m away.

1987

Abutment 1 continued to move toward the river at an approximate rate of 6 mm per year (¼" per year). Measurements taken on rocker tilt and the TLD's indicated a slight apparent movement southward for Pier 1 toward Abutment 1 at an annual rate of ¼ ". Pier 4 appeared to be relatively stable with pier top displacement unvarying at about 76 mm (3") since 1977. Abutment 2 had moved toward the river by about 51 mm (2") since it was built.

September 26, 1995

Slope Inclinometer SI-1 was last read.

April 29, 1996

Slope Inclinometer SI-3 was last read.

October, 2005

Thurber Engineering were requested by Alberta Infrastructure and Transportation to carry out readings on any operational instruments at the bridge site. Only one slope inclinometer, SI#3 was operational and could be read. Since electronic files were not available, the reading will act as the new baseline to which future readings may be compared. The field summary table, baseline reading and absolute position plot are attached.

REFERENCES

1. R.M. Hardy and Associates Ltd., September 24, 1973. "Influence of Movement of Cofferdam around Pier No. 4 on Stability of the Pier." File E-2120A.

2. Alberta Transportation. April 26, 1978. "Fort Vermilion Bridge Apparent Movements of North Abutment and Pier 4-Meorandum" File 74227.

3. Alberta Transportation. June 22, 1987. "Peace River Bridge at Fort Vermilion Substructure Movements" "Fort Vermilion Bridge Apparent Movements of North Abutment and Pier 4-Memorandum" File 74227.

4. R.M. Hardy and Associates Ltd., January 27, 1971. "Assessment of Soil Conditions Proposed Peace River Crossing Highway 58A, Near Fort Vermilion." File E-2120.