THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION

SITE NC4: BF75118, Hwy 55:10 & 813:02 Overpass)

LEGAL LOCATION:	SW21-66-22-W4M
NEAREST LANDMARK:	in Athabasca
HIGHWAY CONTROL SECTION	HWY 55:10 km 0.7 HWY 813:02 km 0.1
DATE OF INITIAL OBSERVATION:	NA
DATE OF LAST INSPECTION:	May 2008 (Instrumentation only)
LAST INSPECTED BY:	Thurber Engineering Ltd. (TEL)
INSTRUMENTS INSTALLED:	2 Standpipe Piezometers (2004) 2 Pneumatic Piezometers (2004) 4 Slope Inclinometers (1996) 2 Slope Inclinometers (2004)
INSTRUMENTS OPERATIONAL:	2 Standpipe Piezometers 2 Pneumatic Piezometers 4 Slope Inclinometers
RISK ASSESSMENT:	Not Determined
LAST UPDATED:	Thurber Engineering Ltd., March 2009

1. LOCATION

The site is an overpass structure (BF75118) carrying Highway 55:10 over the north bound lane of Hwy 813:02 on the east side of the town of Athabasca, Alberta. The Athabasca River is about 100 m to the north of the bridge crossing. The site is located just east of NC3 which is the Hwy 55:10 bridge over the Tawatinaw River (BF1517).

Currently, only the instrumentation is monitored at this site. Annual site inspections have not been required.

2. GENERAL DESCRIPTION OF DISTRESS

The site is located at the overpass bridge structure and, as it is located within the greater Athabasca River valley, it is subjected to large-scale movement of the overall valley slope toward the river. Current plans are to replace this bridge with an at-grade intersection to be located on the west bank of the current Tawatinaw River (the river will be aligned further west). A pedestrian culvert is proposed for this location as part of the intersection relocation project.

The existing single-span bridge was constructed in 1959 on driven timber piles bearing on clay shale bedrock at about 7 m depth. However, slope inclinometer readings show the slide plane between 4 m to 5 m below ground level which implies that the piles may have been sheared off.

One of the four slope inclinometers installed in 1996 sheared off in 1998 with 51 mm of cumulative movement. A second (SI22) was found to be plugged in 2005 and discontinued; the cumulative movement measured at this location was 74 mm. As of 2008, the remaining two 1996 slope inclinometers (SI23 and 24) had cumulative movements of about 51 mm with current movement rates between 1.4 mm/year and 2.6 mm/year. The new slope inclinometers installed in 2004 were located further up the slope and showed cumulative movements of about 18 mm. The movement rates were 4.6 mm/year and 10.1 mm/year. In general, movement rates have fluctuated over the monitoring period and currently show slow, steady movement.

A geotechnical investigation was undertaken by Thurber in 2004 for the proposed intersection relocation. Only one test hole was drilled in the vicinity of this structure as the long-term plan is to remove the structure. The deeper test holes drilled for slope inclinometer installation were undertaken to determine overall valley conditions.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: Eastern Alberta Plains of the Interior Plains (1969, Atlas of Alberta, University and Government of Alberta).

Bedrock Geology: The bedrock at the site is marine shale, sandstone, and siltstone of the Upper Cretaceous Smoky Group (2948f). Bedrock topographic mapping shows that the Athabasca River valley lies in a bedrock low (dipping toward the east) and the bedrock surface rises to the north and south. The bedrock elevation at the site lies below about the 520 m contour (Map 62). Based on the drilling undertaken by Thurber in the general area in 2004, the depth to bedrock ranges significantly between 3.8 m and 25.6 m below ground surface. As the ground surface slopes significantly down toward the river valleys, the equivalent elevations had an even greater range: 486.7 m and 533.1 m. Based on the logs from the 1996 slope inclinometer installations, the intact bedrock at the bridge site was between about 519.7 m and 525.9 m elevation. The bedrock encountered at these 1994 test holes was predominantly clay shale, with a reworked or weakened zone at the contact, interbedded with sandstone and siltstone layers. On the south side of the bridge, test holes drilled 1983 encountered bedrock at 518.7 m elevation on the west side of Hwy 813 and at 526.2 m on the east side. On the north side of the bridge, the measured bedrock elevations were between 516 m and 517 m again confirming that the bedrock dips quite steeply toward the Athabasca River.

A bedrock assessment reported in an Alberta Transportation memorandum noted that the valley is underlain by overconsolidated bentonitic clay shales weakened by glaciation and subsequent valley rebound. Two sets of movements were identified: one moving toward the Athabasca River and the second toward the Tawatinaw River. These slide masses are subdivided with variations in localized movement directions and depth. While the slide masses appear to be creeping, there is the potential for short-term increases.

Surficial Geology: Large-scale surficial geology maps show that the Tawatinaw and Athabasca River valleys are bounded by escarpments from old higher river valleys with valley slopes covered by a thin layer of alluvial or colluvial material with the potential for local bedrock exposure. At the east side of this historical slope (top of the uplands), the mapping indicate a large failure in the bedrock or overlying colluvium. This historic slide is about 0.3 km from the site. Immediately east of the bridge, within the Town of Athabasca, there is an area of alluvial sediments on the flood plain that have not been modified by landslide activity (Map 9-1986).

Based on a review of several sets of test hole logs from the general valley area and airphoto interpretation (done during the intersection realignment study for Stantec), the presence of discontinuous layers of organic materials at depth indicate that the valley sediments were likely placed or disturbed by slumping which confirms previous assessments. Nearer the toe of the river valleys, the sediments are alluvial in nature so will typically consist of interbedded and layered sand, silt, and clay.

Hydrogeology: The surficial sediments overlying the bedrock at this site have an estimated yield of 0.3 L/s to 1.6 L/s with significantly lower flows expected from the underlying predominantly clay shale bedrock. The elevation of the regional water table is about 580 m in the upland areas outside of the river valleys (roughly 15 m to 20 m below ground surface). The groundwater flow directions are generally toward the Athabasca River except were modified locally due to proximity to tributaries such as the Tawatinaw River. The hydrogeological mapping did not indicate any artesian conditions in the local area (Borneuf 1972).

From the pneumatic and standpipe piezometers installed in 2004 at the slope inclinometer locations, the groundwater level is between 1.3 m and 3.1 m below ground surface. The water level measured in the standpipe installed along Hwy 813 beside the overpass was about 2 m below ground elevation.

Stratigraphy: From the test hole drilled along Hwy 813 at the overpass structure in 2004, the native soils consisted of a layer of intermixed sand and clay overlying till-like clay, sand, and clay. This is in agreement with the test holes drilled in 1983 and 1996. The relevant test hole logs and drawings are included in Section G.

4. CHRONOLOGY

1959

Hwy 55:10 and 813:02 Overpass Bridge (BF75118) was constructed. It was already known that massive landslide movements affected the area.

1976

Consultant report suggested the most economical remedial measure was periodic maintenance of the bridge structure as it would be difficult to restrain the massive landslide movements in the area.

1977 and 1979

Alberta Transportation's geotechnical section undertook an investigation of the area and observed a movement plane at the contact between the clay till and underlying clay shale bedrock. In addition, the groundwater table along Hwy 813:02 was noted to be about 1.5 m below the backslope ditch level.

1983

Four slope inclinometers were installed at the bridge location by Alberta Transportation. This work included tie-in of horizontal drains. The slope inclinometers were installed to depths between 19.8 m and 25.9 m below ground surface. No reference was made to these instruments in subsequent reports and investigations so it is presumed that they were destroyed.

1985

Internal Alberta Transportation memorandum acknowledge that the bridge had been affected by landslide movements and approximately 600 m of Hwy 813:02 from the bridge north was also affected. Reference was made to horizontal drains installed in the area to control groundwater as the slide activity along Hwy 813:02 was felt to originate with softening of the underlying clay shale material due to groundwater.

1995

An internal Alberta Transportation memorandums discussed the general valley conditions as part of an alignment study for Hwys 55 and 813. It was noted again that a permanent solution to the landslide problems was not feasible and that valley movements should be accommodated in the design. It was recommended to install additional instrumentation in the area and to undertaken site-specific drilling at the bridge for replacement with a proposed box culvert structure.

1996

Four slope inclinometers were installed by Thurber in conjunction with four installed at the nearby Tawatinaw River bridge.

2001

Functional Planning Study undertaken by Stantec with geotechnical input by Thurber.

2004

Geotechnical investigation undertaken by Thurber as part of the intersection relocation study lead by Stantec.

5. REFERENCES

1. University and Government of Alberta, 1969. "Atlas of Alberta".

2. Borneuf, D. 1972. "Hydrogeological Map, Tawatinaw, Alberta, NTS 83I". Alberta Research Council, Map 104, Report 72-11.

3. Journeay, J.M., Williams, S.P., and Wheeler, J.O. 2000. "Tectonic Assemblage Map, Edmonton, Alberta". Geological Survey of Canada, Open File 2948g.

4. Alberta Research Council, 1977. Map No. 62. "Bedrock Topography of the Tawatinaw Map Area, NTS 83I, Alberta".

5. Richard, S.H. 1987. "Surficial Geology, Cross Lake, Alberta". Geological Survey of Canada, Map 9-1986.

6. Canadian Centre for Mapping, Department of Energy, Mines, and Resources, 1991. NTS 1:50,000 Topographic Map, 83 J/4: Athabasca, Athabasca County, Alberta.

7. Alberta Transportation, Geotechnical Files.

8. Thurber Engineering Ltd., Project Files.

ALBERTA TRANSPORTATION
NORTH CENTRAL REGION
INSTRUMENTATION MONITORING RESULTS

SPRING 2011

SECTION C

SITE NC4: OVERPASS HWY55 / HWY813 (ATHABASCA)

1. OBSERVATIONS

1.1 Field Program and Instrumentation Status

A total of four slope inclinometers (SI23, 24, 04-1 and 04-2), two pneumatic piezometers (PN04-1 and 04-2) and one standpipe piezometer (SP04-1) were read at the Overpass HWY55/HWY813 (Athabasca) site on May 24, 2011 by Mr. Justin Sousa, C.E.T. and Ms. Ada Lao, E.I.T. of Thurber Engineering Ltd. (Thurber).

The SIs were read using a RST Digital Inclinometer probe with 2 ft wheelbase and a RST Pocket PC readout. Inclinometer reading depths were defined as per cable markings with respect to the top of the inclinometer casing.

The pneumatic piezometers were read using a RST C108 pneumatic piezometer reader. The standpipe piezometers were read using a SINCO dipmeter.

2. INTERPRETATION

2.1 General

SI plots for A and B directions are presented in Section D and are summarized below. Where movement has been recorded the resultant plot (X direction) and rate of movement have also been provided.

2.2 Zones of Movement

Zones of new movement were not observed since the last set of readings in the spring of 2010.

Zones of movement are summarized on Table NC4-1 at the end of this report. Table NC4-1 also provides a historical account of the total movement, the depth of movement, and the maximum rate of movement that has occurred at this site since the initialization of the slope inclinometers.

2.3 Interpretation of Monitoring Results

Slope inclinometer SI23 showed a decrease in rate of movement of 1.5 mm/yr corresponding to a current rate of movement of 3.0 mm/yr. SI24, SI04-1 and SI04-2 showed an increase in rate of movement of 9.2 mm/yr, 3.1 mm/yr and 1.4 mm/yr, respectively, since the last set of readings in spring 2010. Their rates of movement are now 14.4 mm/yr, 4.7 mm/yr and 5.3 mm/yr, respectively. Table NC4-1 summarizes the SI readings.

The water level increased in PN04-1, PN04-2 and SP04-1 by 0.13 m, 0.26 m, and 0.05 m, respectively, since the spring 2010 readings. Table NC4-2 summarizes the piezometers readings.

3. RECOMMENDATIONS

3.1 Future Work

The instruments should be read again in spring 2012.

3.2 Instrumentation Repairs

No Instruments need to be repaired at this time.