ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION

SITE NC6: MITSUE RECREATION AREA

LEGAL LOCATION:	NW7-72-4-W5M
NEAREST LANDMARK:	11 KM EAST OF SLAVE LAKE
Highway Control Section:	HWY 2:46 km ~~47.5~~ 47.329
Date of Initial Observation:	1977
Date of Last Inspection:	2009
Last Inspected By:	Thurber Engineering Ltd. (Thurber)
Instruments Installed:	3 Slope Inclinometers (1993), 3 Pneumatic Piezometers (1993), 4 standpipe piezometers (2005)
Instruments Operational:	2 Slope Inclinometers (2003), 4 Standpipe Piezometers (2005)
Risk Assessment:	PF (6)·CF (2) = 16
Last Updated:	January, 2009 – Thurber Engineering Ltd.

1. LOCATION

The site is located along Hwy 2:46 about 11 km east of the junction with Highway 88 and west of the Mitsue Recreation Area.

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

An approximately 100 m long section of the highway, oriented approximately in an east to west direction has been affected by landslide movements. The landslide continued to cause cracking and pavement distress of the westbound lane of the highway.

This section of the highway was constructed as a sidehill fill. The downhill side of the highway to the north was sloped at an average angle of 16.7 degree (3.3H:1V) for a distance of 40 m. Within this distance, the sideslope had two approximately 10 m wide benches, one at about 1/3 of the slope height and one at about 2/3 of the slope height. Beyond the toe of the lower fill bench the natural ground surface continued to dip at a gentler slope of 7.6 degree (7.4H:1V) to a distance of approximately 90 to 100 m from the north guardrail. The overall height of the slope is approximately 20 m. Further to the north, the ground sloped at an even gentler angle towards Mistue Lake, which is located several hundred metres from the highway. A centreline culvert crosses the highway through the middle of the distressed area and drains into a natural wooded ravine.

The site has had a long history of instability going back to 1977. Ongoing instability of the backslope and highway fill at this site was treated over the period from 1977 to 1983 by the installation of sub-horizontal drains in the slippage zone. Based on previous discussions with Mr. Fred Bickle, of AT, prior to 1989, the highway was cracked at the centreline and the north side was dropping up to 0.3 m/day. The second set of sub-horizontal drains were installed from the base of slope in 1989. The highway was maintained using cold mix patching until the site stabilized. The second set of drains plugged up and was replaced by weeping tile on the south side of the highway in 1995/1996.

During the site inspection by AT personnel in 1992 cracking in the pavement surface was noticed from the shoulder edge to the centreline. Three slope inclinometers (SI1 to 3) and pneumatic piezometers (PZ 1 to 3) were installed in 1993 to determine the slip surface and subsequent movement rate. Deflection plots for the destroyed SI and the last readings for the destroyed piezometers are included in Section G. The highest rate of movement noted in the operational SIs, SI1 and 3, installed in 1993 were 33 (over 0.3 m to 4.6 m depth) and 60 mm/yr (over 7.9 m and 9.8 m depth) between May and October 2004, respectively.

Additional geotechnical investigation was undertaken in 2005 by Thurber as a sub-consultant to Morrison Hershfield Ltd. (MHL) and included drilling six test holes complete with standpipe piezometers (TH05-1 to 05-4) and six test pits (TP05-1 to TP05-6). The locations of the instruments installed in 1993 and 2005 are shown on Figure NC6-1, Section F. The test hole/pit logs and installation records are shown in Section G of the binder.

The site observations and instrument readings indicated that the main cause of instability in the side slope of the highway was the presence of high ground water levels coupled with relatively steep downhill slopes. The groundwater levels fluctuated seasonally and possibly rose to its highest position during the west spring seasons when the slope movement accelerated. During dry seasons, there was little movement noted in the slope.

AT selected one of the remedial measures proposed by Thurber in 2006 to remediate the slide. The remedial option was implemented in fall 2007 by E-Construction, with In-Line contracting Ltd. as their sub-contractor, and consisted of slope flattening and drainage improvements consisting of installation of sub-drains, construction of a riprap lined swale and flushing and tying of the existing sub-horizontal drains to a drainage collection manhole at the bottom of the slope. The as built drawings are included in Section G of the binder.

The 2003-2009 annual inspection reports are provided in Section B and the instrumentation readings are included in Sections C and D of the binder.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: The site is located on the boundary between the Swan Hills Upland to the south and Lesser Slave Lowland to the north. The site is located north of the Athabasca River and east of Lesser Slave Lake.

Bedrock Geology: The bedrock at the site is nonmarine clayey sandstone, bentonitic mudstone, and bentonite of the Cretaceous Wapiti Formation containing scattered coal beds. The bedrock is approximately 15 m below ground level with a northerly slope toward a bedrock low located approximately at the present-day Lesser Slave River. Immediately to the north of the site, the bedrock consists of Lea Park Formation marine shales with ironstone concretions.

Surficial Geology: The surficial geology map indicates that the surficial materials are sand and gravel and locally diamicton: undifferentiated ice contact stratified drift and outwash; locally includes till and rock (Surficial Materials of Canada, AGS, 1995).

Hydrogeology: Upper bedrock formations in the vicinity of the site may be able to provide up to 2 L/s of groundwater flow; however, near-surface glacial drift would have reduced flow. Further to the north adjacent to the Lesser Slave River, groundwater flows in the upper bedrock may be as high as 38 L/s. Groundwater flow directions are mostly downward with possible discharge areas and contact springs along slopes.

Stratigraphy: The test holes for the slope inclinometers, standpipes, and test pit holes indicate that the soil units typically consisted of alternating layers of clay and gravel/sand fill overlying high plastic firm to hard clay/clay shale, weathered to intact bentonitic sandstone, and underlain by interbedded clayshale and sandstone. Cross-sections of the site are shown in Section F of the binder.

The water levels, recorded in October 2009, in the operational piezometers ranged from 8 and 13 m below ground surface.

4. CHRONOLOGY

A memo in the file from Karl Li, reproduced in Thurber's SI installation summary report of January 27, 1993, provided the following history from 1977 to 1992. The remaining information was taken from Thurber's SI installation summary report, geotechnical report for MHL, ongoing monitoring reports, and conversations with AT personnel.

1977

Installation of 2 horizontal drains into the sideslope at the centre of the slippage zone approximately 5.5 m below the highway pavement surface elevation. The groundwater outflow was recorded to vary from 0.5 to 1 gallon/minute (1.9 to 3.8 litres/minute).

1979

Installation of 9 horizontal drains installed into the sideslope at the centre of the slippage zone and 12 m to either side approximately 8 m below highway pavement surface elevation. The groundwater outflow was 0.25 gal/min (0.9 L/min) at the centre and a trickle to the west.

1983

Installation of 8 horizontal drains at the centre of the slippage zone at two separate elevations: 15.5 m and 18 m below the existing highway pavement surface.

1989

Installation of a series of horizontal drains at the base of slope which eventually plugged and were replaced.

1992

Inspection in October by Karl Li and Vishnu Diyaljee of AT to observe cracking on the north half of the highway. Cracking was observed approximately 50 m in length from sideslope shoulder edge to near the centreline of the highway. Seepage was observed in the lower set of 1983 horizontal drains of 1 gal/min (3.8L/min) during a second site visit by B. Leicht.

1993

Installation of 3 SIs and 3 pneumatic piezometers by Thurber as requested by AT following the October 1992 site visit.

1995/1996

Weeping tile was installed on the south side (upslope) of the highway. Cracks on the surface were routed and sealed.

1998

A forest fire destroyed a significant amount of trees and vegetation in the area.

2001/2002

New guardrail installed.

2000 – 2003

Ongoing instrumentation monitoring by Thurber. Only minor cracking on the highway and near SI#1 and creep movements were observed during this period. Vandalism to SI#1 was reported in spring 2000 and was repaired prior to Spring 2001. Damage to SI#2 and PI#1 due to grass maintenance equipment occurred between the fall and spring 2000 monitoring events. Additional cracking of the pavement surface was observed during the spring 2003 monitoring event. The 2003 annual inspection report suggested long-term stabilization measures and recommended that a file and historical aerial photograph review to provide further assessment of the slide. A file review was completed in 2004.

2004-2010

A geotechnical investigation was implemented by Thurber between March 9 and 11, 2005 and presented in a report to MHL dated January, 2006. The detailed design for the selected remedial measure, which consisted of building out the slope to a flatter inclination and drainage improvement, was completed by Thurber in 2006 as a sub-consultant to MHL. The repair was completed by In-line Contracting Ltd. as a sub-contractor to E-Construction in the fall of 2007.

The results of October 16, 2008 interim inspection and June 6, 2009 final inspection undertaken by Thurber were documented in a letter sent to MHL, dated July 23, 2009.

The 2009 annual inspection and instrumentation monitoring program indicated that the remedial measure has been working appropriately. Therefore, the site was removed from the Geo-hazard Assessment Program in 2009. On the other hand, it was decided to continue reading the instruments on an annual basis to assess the effectiveness of the remedial measures.

The file review was updated in January, 2010.

REFERENCES

1. Thurber Engineering Ltd., September 12, 2003. "North Central Region Landslide Assessment – Hwy 2:46 (NC6, Mitsue Lake), 2003 Annual Inspection Report." File 15-16-167.

2. Thurber Engineering Ltd., January 27, 1993. "Highway 2:46 & 48 Canyon Creek, Widewater and Mitsue Embankment Slippage – Slope Indicator Installations." File 15-16-68.

3. Alberta Research Council, 1978. "Hydrogeological Map, Lesser Slave Lake, Alberta (83-O)."

4. Alberta Research Council, 1976. "Bedrock Topography of the Lesser Slave Lake Map Area, NTS 83 O, Alberta."

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

6. Fulton, R.J., 1995. "Surficial Materials of Canada," Alberta Geological Survey, Map 1880A, Scale 1:500,000.

7. Thurber Engineering Ltd., January 25, 2006." Mitsue Lake Slide (Nc6) on Highway 2:46 (km 47.5) East of Slave Lake, Alberta. Geotechnical engineering Assessment.

8. Thurber Engineering Ltd., July 23, 2009." Mitsue Lake Slide (Nc6) on Highway 2:46 (km 47.5) East of Slave Lake, Alberta. Geotechnical service During Construction Summary Report.