THURBER ENGINEERING LTD.

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION - ATHABASCA

SITE NC71: HWY 633:04 LITTLE PINE CREEK SLIDE (km 6.98)

Highway Control Section:	**HWY 663:04**
Nearest Landmark	**1 KM EAST OF COLINTON**
Legal Location:	**SE-15-65-22-W4M** **SW-14-65-22-W4M** **NE-10-65-22-W4M**
Date of Initial Observation:	**November 1979**
Date of Last Inspection:	**June 2012**
Last Inspected By:	**Thurber Engineering Ltd. (Thurber)**
Instruments Installed:	**2 Slope Inclinometers (January 1980),** **3 Standpipe Piezometers (November 1979)** **5 Slope Inclinometers, 12 Pneumatic Piezometers and 3 Standpipe Piezometers (2012)**
Instruments Operational:	**5 Slope Inclinometers, 12 Pneumatic Piezometers and 5 Standpipe Piezometers**
Risk Assessment:	PF(7) x CF(4) = **28 (for highway)**
Last Updated:	**N/A**
Previous Update:	**N/A**

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1. LOCATION

The subject site is located along Highway 663:04 at km 6.98, and is about 1 km to the east of Colinton in Alberta.

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

The highway at this site was constructed as a side-hill cut and fill section and is oriented in an east to west direction. The highway embankment to the south of the highway is about 9 m high and is inclined at 3H:1V.

The landslide is about 150 m wide (parallel to highway surface) and 300 m long (to the south of the highway alignment). Details of the slide main features are presented on Figure NC71-1. Figure NC71-2 shows a cross-section based on available test hole information provided by Alberta Transportation prior to the installation of new instruments in 2012.

The continued landslide creep movement resulted in the development of 10 mm to 15 mm wide longitudinal and diagonal cracks, and pavement distress along the highway surface. The pavement distress was noted to be more severe along the flanks of the landslide, bounded by the open diagonal cracks. Frequent patching of the highway surface (every few years) has been undertaken at the flanks of the landslide to provide a smooth ride to travelers.

The site has had a history of instability going back to the 1970's when the highway was upgraded and raised about 2 m (refer to section G of the binder). Prior to 1978, a landslide had occurred and extended from the uphill (north) ditch to the existing bridge over the Little Pine Creek, located at the bottom of the hill. Instruments installed at that time indicated that the subsurface conditions mainly consisted of a weak high plastic clay shale formation underlain by a water bearing sand (extremely weathered sandstone). Ground water levels measured in the standpipe piezometers indicated that ground water was within the upper 2 m below ground surface. In addition, slope inclinometers indicated that the landslide slip surface was situated between 9.5 m and 12 m below ground surface near the interface of the clay shale / sandstone formations. Implemented remedial measures in 1980 included the installation of drainage pipes to reduce ground water levels within the landslide mass. The remedial measures appeared to have reduced the landslide movement rates at that time.

In 2010, 1 m of stagnant water was noted along the north ditch and about 600 m^3 of material was brought to site to contour the ditch and improve surface drainage.

In 2012, the bridge over the Little Pine Creek was damaged due to the continued landslide movement and the progressive erosion of the creek banks.

Additional geotechnical instruments consisting of slope inclinometers, pneumatic and standpipe piezometers were installed by Thurber in late 2012 to determine soil and groundwater conditions, and landslide movement rates and depth.

Site observations between 2011 and 2012 indicated that a deep-seated translational landslide occurred at this location. In addition, available LIDAR information revealed that the highway was constructed on an ancient landslide terrain.

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Presence of high ground water levels and weak clay shale formation, placement of fill near the crest of the unstable hill slope, and progressive undercutting of the toe of the ancient landslide due to the erosion action by the creek are probably the main contributing factors for the accelerated landslide movement rate.

It is anticipated that the landslide creep movement will continue to progressively deteriorate the highway condition.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: Located in the Tawatinaw Plain (Atkinson, N. and Lyster, S., 2010).

Bedrock Geology: The bedrock at the site is of the Labiche Formation, dark grey shale and silty shale; ironstone partings and concretions; silty fish-scale bearing beds in lower part; marine. (Geological Map of Alberta, AGS, AEUB, 1999).

Surficial Geology: Surficial deposits in the area consist of fine grained glaciolacustrine silt and clay with occasional stones (Surficial Materials of Canada, GSC, 1995).

Hydrogeology: Local groundwater and surface water flow is expected to be south toward the Little Pine Creek. Regional groundwater flow is towards the Athabasca River, located approximately 12 km to the northwest of the site (Hydrogeological Map Tawatinaw Alberta, ARC, 1972).

Stratigraphy: The five test holes drilled in November 1979 and January 1980 indicated the presence of brown sandy clay overlying grey clay shale over water bearing weathered sandstone (sand).

4. CHRONOLOGY

1979

A letter from November 9, 1979, indicated a slide problem at the site requiring immediate investigation as the bridge structure south of Highway 663 was affected by the slide activity.

An inspection of the site was performed on November 15, 1979. Up to 150 mm wide cracks were observed on the highway surface and the existing access road to the north of the highway. The guardrail at the bridge on R.R. 221, located to the south of the highway, appeared to have buckled and the wooden abutment appeared to be in roll position. Trees were observed to be leaning near the creek by up to 5 or 10 degrees. Seepage was also observed to the southeast of the slide near the access road leading to the bridge. It was recommended to seal the cracks to prevent surface water from entering the subgrade and to drill three test holes complete with standpipes.

Three test holes were drilled by Alberta Transportation on November 20 and 21, 1979. Standpipe piezometers were installed in all of the test holes (SP1 to SP3). The test hole logs are attached in Section G.

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1980

Two additional test holes complete with slope inclinometers (SI1 and SI2) were drilled by Alberta Transportation on January 15 and 16, 1980. The test hole logs are attached in Section G. Slope inclinometers SI1 and SI2 sheared off at 12.0 m and 9.5 m, respectively.

Drain pipes were installed in May 1980 to reduce the groundwater levels. Installation records or locations could not be found.

2011

Call-Out inspection performed by Thurber in May 2011. A 10 mm to 15 mm dip was noticed along the highway lanes. 5 mm to 10 mm longitudinal and diagonal open cracks were visible on the highway surface. Ponded water was visible in the north ditch. A 1 m to 2 m scour was observed at the 600 mm diameter CSP culvert below the highway lanes. The 900 mm CSP culvert below the highway lanes had a plugged inlet and a broken outlet. The north abutment wall and supports of the wooden bridge were noted to be tilted.

2012

The site was added to the North Central Annual GeoHazard Assessment program and a site inspection visit was carried out by Thurber in June 2012. The width of the cracks in the highway surface increased by 5 mm to 10 mm. The north abutment wall and pile supports failed. A drop developed on the top of the bridge behind the abutment wall due to the failure. The bridge was out of service during the 2012 inspection visit.

Thurber drilled holes between November 30 and December 11, 2012. Five (5) slope inclinometers, twelve (12) pneumatic piezometers and three (3) standpipe piezometers were installed to monitor the slide activity. Approximate instrument locations are shown on Figure NC71-1.

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REFERENCES

1. Atkinson, N. and Lyster, S., 2010. "Bedrock Topography of Alberta, Canada," ERCB/AGS Map 50, scale 1:1,500,000.

2. Alberta Geological Survey, Alberta Energy and Utilities Board, 1999. "Geological Map of Alberta." Map No. 236, scale 1:1,000,000, compiled by Hamilton, W.N., Price, M.C. and Langenberg, C.W..

3. Geological Survey of Canada, 1995. "Surficial Materials of Canada," Map 1880A, scale 1:500,000, compiled by Fulton, R.J..

4. Alberta Research Council, 1972. "Hydrogeological Map Tawatinaw Alberta."