THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION

SITE NC48: FRED CREEK

LEGAL LOCATION:	SE28-51-1-W6M
NEAREST LANDMARK:	48.8 km North of Hinton
HIGHWAY CONTROL SECTION	HWY 40:30 km 48.79
DATE OF INITIAL OBSERVATION:	2005
DATE OF LAST INSPECTION:	June 2008
LAST INSPECTED BY:	Thurber Engineering Ltd.
INSTRUMENTS INSTALLED:	4 Pneumatic Piezometers (2006) 3 Slope Inclinometers (2006)
INSTRUMENTS OPERATIONAL:	4 Pneumatic Piezometers 3 Slope Inclinometer
RISK ASSESSMENT:	PF(12) CF(3) = **36** (2008)
LAST UPDATED:	April 2009, Thurber Engineering Ltd.

1. LOCATION

The site is located on Highway 40:30 about 48.8 km north of Highway 16 at Hinton. There are two areas of distress. The first is a shallow slump impacting the highway at km 48.80 where instrumentation (SI's and PN's) are installed. The second is where transverse cracking exists over a pair of culverts (BF76754, Fred Creek crossing) about 130 m east of the slump. The main culvert is 1800 mm diameter corrugated steel pipe (CSP) and the overflow culvert is 1500 mm diameter CSP.

2. GENERAL DESCRIPTION OF DISTRESS

The distress at km 48.80 affects both lanes of the highway in an area constructed over peat on a gentle sidehill cut/fill in organic terrain. The distress at this location began sometime in the 1970's. In 1979, three 229 mm diameter perforated pipes were installed transverse to the highway through the distressed area with outlets to the south sideslope. A 91 m long perforated pipe of the same diameter was installed below the north ditch draining beneath the access road to the north of the highway. Design drawings show a gravel berm was proposed for the south side of the highway at the same time; however, it is not clear that it was constructed and there is no evidence of it in the field at this time. By August of 1980, the movement pattern had re-established with settlements up to 150 mm and repeated patching required. In November of 1980, the scope was outlined for a geotechnical investigation program which was to include six test holes, two dynamic cones, muskeg probing, in-situ vane testing, and block sampling of the muskeg. This investigation appears to have taken place in December 1980 and July 1981. Based on this work, a September 1981 memorandum recommended three potential remediation measures: excavate and rebuild the affected portion of the highway, realign the highway to higher ground, or increase the bearing capacity of the foundation soils. The third option was preferred and the construction recommendations were to:

- strip roadway structure and subcut to a depth of 600 mm,
- install stone columns at 1.5 m centre-to-center spacing with 610 mm diameter holes to about 10.7 m depth,
- backfill the stone columns with woven socks and vibratory-compacted, clean, crushed gravel,
- place a 150 mm lift of gravel to connect the columns, and
- rebuild the subgrade with 150 mm lifts of gravel with 100 mm by 100 mm wire mesh placed between each lift.

It is not known if this repair was undertaken as proposed. However, in 1982, there were references in the file to cracks appearing in new pavement which would

indicate that some work had been undertaken as does the absence of any evidence of the 1979 gravel toe berm.

In 2005, the ongoing movement had accelerated in mid-July and required a 42.4 tonne patch. A call-out was requested and was undertaken by Thurber. At that time, two patches had been placed: one over the culverts at the Fred Creek crossing and the other on the distressed area at km 48.8. At the culverts, it was observed that the inlet section of the overflow culvert had detached causing a sinkhole in the sideslope and settlement cracking in the sideslope and paved highway. There was also some scour and sloughing around the outlets of both culverts. Arc-shaped cracking was observed over a length of about 60 m that had reflected through the recently-placed 70 m long patch. The crack widths were up to 40 mm.

The assessment at the time of the call-out was that the cracks in the highway were the backscarp of a re-activated landslide which may have been triggered by creek erosion and/or a high water table. However, the toe of the slip surface could not be determined due to the uneven natural topography.

A geotechnical investigation was undertaken by Jacques Whitford (JW) in 2006 and 2007 to develop conceptual designs for repair of the highway. Four sets of test holes were drilled in a north-south cross-section and instrumentation (slope inclinometers and pneumatic piezometers) were installed. Thurber also undertook a geotechnical assessment of the slide at km 48.8 as part of a grade-widening project including test pitting along the highway and test holes at the culverts.

The recommended method to stabilize the slide was to reduce the pore water pressures in the slide zone by installing wick drains at 1.5 m spacing (equilateral triangular pattern) to refusal in the clay shale bedrock at approximately 10 m below ground surface. A pad is required to allow access for the installation equipment consisting of well-graded free-draining gravel placed on a woven geotextile.

At the time of the 2008 annual GeoHazard Assessment site visit, the crack pattern at the main site had extended to 130 m in length. The sinkhole at the culvert inlet had been repaired; however, there was additional transverse cracking noted along both sides of the culverts.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: Rocky Mountain Foothills (1969, Atlas of Alberta, University and Government of Alberta).

Bedrock Geology: The bedrock at the site is non-marine, thickly bedded sandstone and mudstone, with some tuff and thin coal beds, of the Brazeau

Formation (Hamilton 1999). No published bedrock topographic information is available for this site. However, test holes drilled for instrumentation installation encountered clay shale bedrock between 4.6 m and 8.3 m depth below ground surface (Jacques Whitford 2007)

Surficial Geology: Larger-scale (1:250,000) surficial geology map indicates that terrain is generally clay till but this particular site is located on the boundary with an area of organic terrain through which Fred Creek flows (Bayrock 1980).

Hydrogeology: The sandstone and mudstone of the Brazeau Formation bedrock have an estimated yield of 0.1 L/s to 0.4 L/s groundwater flow. Regional groundwater table contouring was not been completed for this area given the complexity of flow in the folded bedrock of the foothills. However, flowing wells are noted at many location in the region. The regional groundwater flow pattern is downward to bedrock aquifers (Barnes, 1976). Local flow, in near-surface sediments above the bedrock, at the site is from high ground to low ground toward Fred Creek. A spring was noted about 80 m from the highway near Fred Creek.

Stratigraphy: Test holes were drilled at four locations during the 2005 geotechnical investigation (Jacques Whitford, 2007, previously included in Section G). The locations are situated along a north-south cross-section with one pneumatic piezometer installed to the north of the highway and the remaining instruments to the south. The stratigraphy generally consisted of peat overlying clay and clay shale. A thin clay till layer was encountered at one location about 20 m south of the embankment (SI2). Test holes drilled through the highway embankment encountered clay fill at the surface which overlaid peat on the south sideslope. The bedrock was relatively shallow and sloped from 1363.8 m elevation at the north side of the highway to 1357.9 m to the south near Fred Creek.

4. CHRONOLOGY

It should be noted that in many cases, the files were unclear as to whether proposed work was actually completed and how it may have deviated from that proposed.

1975

The culverts were installed at the Fred Creek crossing.

1979

Reference to continual settlement at this location and the large quantities of fill required to maintain the shape of the roadway.

Perforated pipes were placed through the failing area at km 48.8 and a ditch drain was installed in the north ditch. At the same time, a gravel berm was constructed on the south sideslope.

1980

Settlement of completed road resumed in August with up to 150 mm of vertical movement. By September, some portions had been patched twice. The affected length was about 60 m and movement is downward without toe movement observed.

In November, a request was made for a subsurface investigation at the site as the repairs undertaken to date had not stabilized the site. The investigation was to consist of 6 test holes to very stiff soil or bedrock, in-situ vane testing, and block sampling of the muskeg. The investigation was initiated in December.

1981

Additional field testing was undertaken in July. A September assessment concluded movements were due to compressive subgrade, variable depth to bedrock, and sloping bedrock compounded by a high groundwater table. Several solutions were presented with the recommended treatment being to reinforce the subgrade with stone columns at 1.5 m spacing.

1982

New pavement placed. Surface crack photographed in October.

1991

Additional riprap placed at the culvert outlets.

2005

Call-out undertaken by Thurber on July 17 in response to increased movement in the previous week which had necessitated patching work. The culvert inlet sinkhole was observed during the call-out.

2006

Instrumentation was installed as part of a geotechnical investigation undertaken by Jacques Whitford.

A 50 mm asphalt overlay was placed in the fall.

A site reconnaissance was undertaken in October by Thurber as part of the geotechnical investigation for the proposed grade widening of Highway 40:30. Two test holes were drilled at the Fred Creek culverts (BF76754).

2007

The Thurber geotechnical investigation initiated in 2006 was completed in May including a series of test pits in both ditches of Hwy 40:30.

The site becomes part of the annual GeoHazard inspection and instrumentation monitoring program. The first routine assessment was conducted in July.

In October, Thurber submitted a report to ARA Engineering Ltd. providing geotechnical recommendations for repair of the slide.

The culvert inlet was re-sealed and the sinkhole in the sideslope was repaired.

5. REFERENCES

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

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

3. Bayrock, L.A. and Reimchen, T.H.F. 1980. Surficial Geology, Alberta Foothills and Rocky Mountains. Alberta Research Council, Map 150.

4. Barnes, R. 1976. "Hydrogeological Map, Mount Robson – Wapiti, Alberta, NTS 83E-83L". Alberta Research Council, Map 115, Report 76-5.

5. Survey and Mapping Branch, Department of Energy, Mines, and Resources, 1981. NTS 1:50,000 Topographic Map, 83 E/9: Moberly Creek, Alberta.

6. Alberta Transportation, Geotechnical Files.

7. Jacques Whitford, January 31, 2007 report to Alberta Infrastructure and Transportation: Geotechnical Investigation and Conceptual Design, NC-48: Highway 40:30 48.7 km north Hinton, Alberta, North of Fred Creek. Job No. 1012822.14. Contract No. CE401/2005.

8. Thurber Engineering Ltd., September 20, 2007 report to ARA Engineering Ltd: Highway 40:30 Grade Widening, Project A3 (km 36.19 to km 53.91), Geotechnical Investigation. File 19-2831-38.

9. Thurber Engineering, October 22, 2007 report to ARA Engineering Ltd: Fred Creek Slide on Highway 40:30, North of Hinton, Alberta, Geotechnical Recommendations. File 19-2831-38.