October 28, 2010

CG25332.200

Alberta Transportation
2nd Floor, 803 Manning Road NE
Calgary, AB T2E 7M8

Attn: Mr. Ross Dickson

Re: Southern Region Geohazard Assessment Program
Site S36 - Highway 800:02, Belly River Erosion Site
2010 Annual Inspection Report

This letter documents the 2010 annual inspection of the S36 - Belly River site located in 18-3-27 W4M, around Km 9 northbound along Highway 800 from the junction of Highway 5 and Highway 800 and approximately 17 km westbound along Highway 5 from Cardston, AB. The site is located within the boundaries of the Blood Indian Reserve 148.

AMEC Earth & Environmental (AMEC), a division of AMEC Americas Limited, performed this inspection in partial fulfillment of the scope of work for the supply of geotechnical services for Alberta Transportation's (AT's) Southern Region (AT contract CE061/08).

The site inspection was performed on June 22, 2010 by Mr. Andrew Bidwell, P.Eng., and Mr. Bryan Bale, P.Eng., of AMEC in the company of Mr. Neil Kjelland, P.Eng., Mr. Roger Skirrow, P.Eng., and Mr. Ross Dickson of AT.

BACKGROUND

A call-out inspection[1] was performed at this site in June 2009 by AMEC after AT reported that the riverbank above the Belly River had retrogressed rapidly towards Hwy 800 and was of possible threat to the highway right-of-way. The inspection noted that landsliding was occurring on the outside bank of a meander of the Belly River, and that the nearly vertical upper scarp would likely continue to retrogress into the highway ditch and road shoulder. At the time, the headscarp was offset 3 to 4 m from the fenceline, and approximately 12 m from the paved road surface. Repair work was recommended to stabilize the upper scarps while a more permanent repair could be planned to address the stability of the entire slope. Such a repair would likely

[1] AMEC report "Highway 800:02 – Belly River Erosion Site, Report on June 26, 2009 Site Inspection", submitted to Ross Dickson of AT, July 2, 2009, AMEC File No. CG25309.D.

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consist of river bank erosion protection works along with grading and drainage measures for the slope.

AMEC inspected the site again on May 12, 2010 after AT reported that the headscarp of the landslide had retrogressed further towards the highway. It was noted that the headscarp was 2 to 3 m upslope of the fenceline, at the ditch invert, and 5 to 6 m from the road surface. An approximately 15 m long segment of the fence had been undermined. The overall condition of the site area remained similar to that noted in June 2009, and the retrogression was expected due to the over-steepened headscarp.

AT proceeded with temporary repair work at the site in late May and early June 2010, with geotechnical input provided by AMEC. The upper scarp in the area of the right-of-way was excavated back to a 1H:1V slope, and 6 m long launched soil nails were installed. The approximate area of the repair work is shown on Figure 1. Nails were installed on a 1 m grid, with 2 to 3 rows of nails installed across an approximately 40 to 50 m long area.

SITE OBSERVATIONS

The June 22, 2010 site inspection was the first annual inspection of the site as part of the Geohazard Assessment program. Please refer to Figures 1 and 2, attached, for a site plan and cross-section of the site area.

The key observations from the June 2010 inspection and a summary of observations from the June 2009 call-out inspection are as follows:

- The site is located in the area where the highway begins to descend to the south approach to the bridge over the Belly River, which is approximately 500 m northbound from the site. The highway is located on the upland area east of the Belly River channel, with an approximately 15 to 20 m high valley slope above the right (east) bank of the river between the highway right-of-way and the river channel. Figure 1, attached, shows the overall site layout and the relative location of the highway and the river channel.

- A comparison of the 2006 videolog to the June 2010 site observations shows that the slope crest retrogressed eastwards towards the highway in the order of 15 to 20 m or possibly even more from 2006 to 2010. At the time of the inspection, the minimum offset from the toe of the road embankment to the edge of the pavement was approximately 5 to 6 m. Photo 2 shows the headscarp encroachment in June 2009, and Photo 3 shows the same area in 2010.

- The mode of movement appears to be slumping in the lower and mid-slope and toppling soil blocks in the upper slope (refer to Photo 1). The slumping may be driven by river erosion, high groundwater pressure, and/or loading from toppled blocks. The height of

the near-vertical scarp above the colluvial mass on the slope varies from around 2 m near the highway to over 5 m in other areas at greater offset from the highway.

- The near-vertical scarps expose a variable thickness (typically 1 m or less) of sandy, low plastic silt with fine gravel inclusions underlain by till consisting of sandy silt with trace amounts of sub-rounded to sub-angular, fine gravel inclusions and of low to medium plasticity. The colluvium slope below the scarp consists of metre-scale blocks of the silt till (some with intact turf covers still in place), transitioning to completely re-worked and broken-up till blocks further downslope. The lowermost portions of the landslide area consist of colluvium derived from the till with a slight “flowed” appearance and numerous toe thrusts/bulges into the river channel.

- Groundwater seepage was observed at roughly 2 m below the slope crest elevation, and the colluvium mass was wet at the time of the inspection. Groundwater seepage discharging on the upper slope may be a key trigger for block toppling from the upper scarp, and slumping/flowing on the mid and lower slopes.

- Water was flowing along the ditch and into the slide area because the headscarp intercepts the ditch invert and directs the ditch flow onto the slide mass. Photos 4 and 5 provide a comparison of the site area in 2009 and 2010 (Photo 8).

- Landsliding extends for approximately 200 to 300 m upstream from the point of minimum offset between the slope crest and the highway (Photo 6). Due to the curvature of the river upstream of the site, these areas are at approximately 20 m or greater offset from the fenceline (see Figure 1) and therefore present less risk to the highway.

- The Belly River flow was very high at the time of the inspection and based on data from Alberta Environment (measured at Belly River near Mountainview), was flowing at approximately 75 m^3/s, and was near the peak level for 2010.

- The temporary repair work performed in June 2010 was in good condition, and should be effective at strengthening the scarp pending permanent repairs. Some evidence of recent slide activity was noted, including fresh blocks that had toppled from the scarp throughout the site area and a flowed appearance to the slide mass. Refer to Photos 7 and 9.

ASSESSMENT

In general, the landsliding appeared to be more active at the time of the June 22, 2010 inspection as compared to the June 2009 inspection. The increased activity, consisting of recent

block toppling and earth flows, was likely due to the high groundwater level observed seeping from the slope, the ditch flow entering the slide area from the south, and the high river flow level. It is expected that erosion of the toe of the slope during periods of high river flow is a driving factor for the slope instability; however the contribution of high groundwater flow is thought to be equally important.

Based on the size of the toppled blocks on the slope, which were up to 2 to 3 m wide, it appears that the slide retrogresses incrementally as blocks are shed from the scarp. The recent movement rate does not indicate accelerated movement, but a continuation of the periods of incremental retrogression.

Retrogression of the crest of the slide has cut off the ditch flow, and diverted the ditch drainage onto the slide mass. The ditch water that flows into the slide area may cause an increase in movement in the future, as the additional water will saturate the upper slide mass and may trigger movement.

As described in previous reports, based on the post-failure slope angle in the lower portion of the landslide area it is expected that without repair measures the headscarp of the landsliding will eventually undermine the highway surface. The typical year-over-year rate of crest retrogression is not certain, however the amount of retrogression between 2009 and 2010 indicates that the road may become undermined in the near future (i.e. the next 1 to 3 years).

RISK LEVEL

AMEC recommends the following Risk Level for this site, based on AT's general geohazard risk matrix:

- Probability Factor of 13, based on a high rate of movement that is steady or increasing based on the continued retrogression of the headscarp in 2009 and 2010.

- Consequence Factor of 3, reflecting the potential for loss of service of a portion of the roadway and potentially partial closure of the road (e.g. closure of the southbound lane).

Therefore, the recommended Risk Level is 39 (i.e. 13 x 3).

RECOMMENDATIONS

AMEC recommends that mitigative works to stabilize the slide area be undertaken as soon as possible to reduce the risk of the highway becoming undermined. At the time of writing, AT has issued a request for proposal for the design of repair measures for this site, which calls for the completion of repair construction by the fall of 2011.

CLOSURE

This report has been prepared for the exclusive use of Alberta Transportation for the specific project described herein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. AMEC Earth & Environmental, a division of AMEC Americas Limited, cannot accept responsibility for such damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report has been prepared in accordance with accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

We trust that this meets your needs at this time. Please contact the undersigned if you have any questions or require any further information.

Respectfully Submitted,

AMEC Earth & Environmental,
a division of AMEC Americas Limited

ORIGINAL SIGNED
OCTOBER 28, 2010

Bryan Bale, M.Sc., P.Eng.
Geotechnical Engineer

APEGGA Permit to Practice No. P-04546

Reviewed by:

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Associate Geological Engineer

Attachments: Figures 1 and 2
Photos