October 14, 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 S32 – Bow River Upstream of Crowfoot Ferry, Highway 56
2010 Annual Inspection Report

This letter documents the 2010 annual site inspection of Site S32 – Bow River Upstream of Crowfoot Ferry, along Highway 56 and approximately 4.4 km southbound from the intersection between Highway 56 and Highway 1.

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 23, 2010 by Mr. Bryan Bale, P.Eng., of AMEC in the company of Mr. Roger Skirrow, P.Eng., Mr. Neil Kjelland, P.Eng., and Mr. Ross Dickson of AT.

BACKGROUND

This site was inspected for the first time under AT's Geohazard Risk Management Program in June 2008 after AT personnel noted active erosion and slope instability along the left (east) bank of the Bow River adjacent to the highway. Please refer to the report on the June 2008 inspection[1] for a description of the site layout and landslide conditions.

The assessment from the June 2009 inspection recommended:

- A hydrotechnical review of the site (airphotos, river flow data, 2008 and 2009 inspection information) to assess if the current pattern and intensity of erosion along the east bank will continue or change in the near future, and from that interpret whether or not the

[1] AMEC report "Southern Region Geohazard Assessment Program, Site S32 – Bow River Upstream Of Crowfoot Ferry, Highway 56, 2008 Annual Inspection Report", submitted to AT on September 8, 2008, AT consulting services agreement no. CE061/08, AMEC project no. CG25277.B.

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active landsliding will continue or possibly worsen (or become less active). Such a review should also provide a basis to confirm the length of the highway segment that may become undermined due to future river bank erosion.

- Continuation of the annual or bi-annual inspections in 2009 in order to check the site conditions and the position of the landslide headscarp relative to the fenceline west of the highway.

SITE OBSERVATIONS

Key observations from the June 2010 inspection were as follows:

- The river level was high at the time of the inspection, as compared to the level observed in 2008 and 2009.

- There has been very little change in the visual appearance of the site or the landslide conditions along the left (east) bank of the river since the June 2008 and June 2009 inspections. Photo S32-1 shows a general view of the landslide area, and Figures S32-1 and S32-2 present plan views of the site area.

- The minimum offset between the scarp of the landsliding and the fenceline along the west side of the road was approximately 1.7 m at the time of the June 2010 inspection, which is the same as was measured in 2008 and 2009 (Photo S32-2). A cross-section through the slope at this minimum offset location is shown on Figure S32-3.

- Landsliding remains active in some areas of the site, with fresh slumps observed. Refer to Photo S32-2.

- The lateral extent of the landsliding along the left (east) river bank did not appear to have increased significantly in the past year. The downstream extent of the landsliding and bank instability is still more than 100 m away from the ferry ramp on the left bank of the river.

ASSESSMENT

The site conditions have not changed significantly since the June 2009 inspection. The landsliding adjacent to the highway continues due to ongoing erosion along the east bank of the river. The headscarp of the landsliding has not retrogressed across the west fenceline and into the highway right-of-way to date. The June 2010 observations of the slope crest position in the landslide area as well as the over-steepened and unstable slope downstream of the south flank of the landslide area (i.e. between the landslide area and the east ramp at the ferry) show that

eastwards slope crest retrogression from June 2008 to June 2010 has been in the order of 0.1 m within the landslide area.

It remains possible that over the long term (i.e. at least several years), the over-steepened upper portion of the landslide area will retrogress back to a 15 to 20° inclination similar to the existing slope in the lower portion of the landslide area. If this happens over time, then an approximately 50 to 70 m long segment of the highway may become directly undermined by the landsliding. The risk of this occurring over the short term is judged to be low and it will likely not occur more rapidly than annual site inspections can provide warning of.

The landslide risk to the highway could be mitigated with one of the following strategies discussed in the 2008 annual inspection report:

- Establish erosion protection along the east bank of the river and stabilize the existing slope in the upper portion of the landslide area.

- Install a pile wall or equivalent measures to support the road surface adjacent to the landslide area.

- Eastward relocation of the highway, likely by 10 to 15 m, to a sufficient setback from the landslide area.

Significant erosion protection measures would likely be required for a river channel of this magnitude and the design of such measures would need to take into account the Crowfoot Ferry crossing a short distance downriver. Furthermore, the regulatory and environmental permitting process for significant bank protection work along the Bow River could be relatively onerous. For the expected low volume of traffic along this segment of the highway (and presumably local traffic only during the winter months when the ferry does not operate), the most cost-effective approach may be to shift the road to the east. The site appears to be located within the Blackfoot Indian Reserve, the right-of-way acquisition aspects of which will need to be considered if contemplating shifting the highway alignment.

RISK LEVEL

The recommended Risk Level for this site, based on AT's general geohazard risk matrix, is as follows:

- Probability Factor of 6 based on the active but slow rate of slope crest retrogression towards the highway. This is the same value recommended in 2009.

- Consequence Factor of 4 to account for the potential for at least a partial closure of the existing road could be required if an increment of landslide movement in the near-future retrogresses eastwards through the fenceline and undermines the west shoulder of the road.

Therefore, the recommended Risk Level is 24, which remains unchanged from the 2009 assessment.

RECOMMENDATIONS

The hydrotechnical review of this site recommended in the 2008 and 2009 annual inspection reports should be performed in order to clarify the risk level for this site. The scope of a hydrotechnical review would include:

- A review of site airphotos, available river flow data and the information from the June 2008 inspection should be performed by a hydrotechnical engineer.

- Assess if the current pattern and intensity of erosion along the east bank will continue or change in the near future, and from that interpret whether or not the active landsliding will continue or possibly worsen (or become less active).

- Such a review should also provide a basis to confirm the length of the highway segment that should be shifted eastward, if necessary.

- Such a review could also consider potential long-term issues at the ferry crossing downstream of the landslide area due to bank erosion/channel shifting.

AMEC can provide a proposed scope and cost estimate for this task to AT upon request.

If the hydrotechnical review confirms that the landsliding will continue then AT should review the concept of an eastwards relocation of the highway by 10 to 15 m. The cost and issues associated with right-of-way acquisition vs. bank protection and/or slope stabilization measures to preserve the existing highway could then be considered well in advance of needing to do either.

This site should be inspected again in the future in order to check the site conditions and the position of the landslide headscarp relative to the fenceline west of the highway. The frequency of inspections of this site could be reduced from annual to bi-annual with the timing of subsequent inspections adjusted if necessary due to reduced offset of the slope crest from the edge of the highway.

CLOSURE

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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 14, 2010

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

APEGGA Permit to Practice No. P-04546

Reviewed by:

Andrew Bidwell, M.Eng., P.Eng.
Associate Geological Engineer

Attachments: Figures S32-1 to S32-3
Photos