September 8, 2008

CG25277.B

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

Attn: Mr. Ross Dickson

Re: Southern Region Geohazard Assessment Program
Site S31 – "Mystery Culvert", Highway 762:02
2008 Annual Inspection Report

This letter documents the 2008 annual site inspection of Site S31 – "Mystery Culvert" along Highway 762:02, south of Bragg Creek, AB, approximately 4.1 km southbound from the junction between Highway 22 and Highway 762, and roughly 50 to 100 m southbound from the 184 Avenue West turnoff from Highway 762.

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 19, 2008 by Mr. Andrew Bidwell, P.Eng. and Mr. Bryan Bale of AMEC in the company of Mr. Ross Dickson and Mr. Roger Skirrow of AT.

BACKGROUND

The June 2008 site inspection by AT and AMEC personnel was the first inspection of this site under the Southern Region Geohazard Assessment Program. The site was added to the 2008 inspection list because AT personnel had recently noted ongoing settlement and cracking of the road surface at this site.

Subsequent to the site inspection, AMEC reviewed the available files on this site from AT's archives. A summary of the relevant information from the files is as follows:

- A rotational/translational landslide in shale exposed in the backslope above the highway was reported in June 1987, however it appears that the landslide was 100 to 200 m north of the specific location inspected in June 2008. The files included a recommendation to excavate and replace the slide mass with competent backfill, however no documentation of any repair work was found.

AMEC Earth & Environmental
A division of AMEC Americas Limited
221 – 18th Street SE
Calgary, AB, CANADA T2E 6J5
Tel +1 (403) 248-4331
Fax +1 (403) 248-2188 www.amec.com

- Additional documentation from late June 1987 refers to a "failure in the road" between Sta. 17+680 and 17+760. The failure was attributed to water migrating into a native organic layer at the base of the road subgrade with sliding occurring along the weak, saturated organic material. The file included recommendations for:

    - Regrading the ditch to the existing culvert.
    - Installing subsurface drains in the ditch and across the road.
    - Removing the upper 1.5 m of the road embankment and rebuilding with compacted pit run.

- The repair was completed in early July 1987 by MD of Foothills personnel and equipment working with AT. The documentation of the repair work stated that groundwater springs were noted discharging from the backslope while regrading the ditch, and that the ditch was excavated to 3.5 m depth and a trench drain installed with a 0.5 m thick clay seal placed on top. It appears that a perforated pipe draining the trench drain was also trenched in across the road, along with a 600 mm culvert. The excavated area of the road was backfilled with "pitrun", however the depth and extent of the excavation and backfilling was not noted. The culvert inlet elevation (i.e. at ground surface, or buried within the trench drain) was not noted specifically.

SITE OBSERVATIONS

Key observations from the June 2008 inspection were as follows:

- Multiple overlays were visible along an approximately 70 to 90 m long segment of the highway and roughly centered around a 600 mm diameter culvert outlet in the slope face below the road. The attached site plan shows the approximate extent of the overlays relative to the culvert outlet. Photos S31-1 and S31-2 show the extent of the overlays.

- Minor cracking was visible in the road surface, as illustrated on the attached site plan and shown in Photos S31-3 and S31-4. The cracking was discontinuous and typically in 1 to 2 m segments with less than 10 mm aperture and negligible associated settlement at the time of the inspection. The overall pattern of the cracking was circular in plan view, roughly centered around the culvert outlet.

- The culvert outlet visible on the embankment slope face below the highway had negligible flow at the time of the inspection, however it appeared that the culvert had recently been carrying water. The culvert inlet was not visible in the upslope ditch.

- There was a minor (e.g. in the order of 5 L/min or less) southwards flow of clear water in the upslope ditch at the time of the inspection. The water appeared to flow southwards past the site, however it was difficult to confirm this amongst the dense grass cover and

pockets of standing water within the ditch. Photo S31-5 shows a typical view of the upslope ditch.

- A cross-section of the site is attached. The lower portion of the backslope is at approximately 23° inclination and is grass covered. There were numerous small toe rolls and small lobes indicating shallow soil creep in this area. The middle and upper portions of the backslope are at approximately 32° inclination and typically expose gravelly clay soil that is judged to be weathered shale bedrock. There were no visual signs of active landsliding visible in the middle and upper portions of the backslope. No groundwater springs were noted on the slope at the time of the inspection. The forested, undisturbed slope above the crest of the backslope appeared stable.

ASSESSMENT

The multiple overlays and pattern of visible cracking in the road surface suggest that there is ongoing settlement and possibly rotational landsliding in the road fill embankment and roughly centered around the culvert. The 1987 assessment documented in AT's files – that native organic and compressible soils underlying the embankment and groundwater seepage into and through the embankment are the driving forces for the settlement and/or landsliding – remains valid. The apparent instability and settlement in the road embankment does not appear to extend into the backslope.

It appears that the damage to the road surface has been easily manageable as a maintenance issue in recent years. It is possible that the drainage measures installed in 1987 are becoming less effective over time, resulting in increased cracking and settlement of the road surface in recent years.

It is understood that a segment of the road embankment was excavated and reconstructed with pitrun in 1987. However, the extent and depth of the excavation and backfilling was not documented and it is also not known if the reported native organic layer underlying the embankment fill was removed during the 1987 repair. Furthermore, the extent and/or locations of the trench drain outlet, perforated drain pipe and culvert inlet from the 1987 repairs are unconfirmed and it is not clear if the drainage measures installed in 1987 continue to be completely effective. The flowing water and standing water in the upslope ditch suggest that additional drainage measures, or at lest "refreshing" the existing drainage measures to try to restore their full effectiveness, would be beneficial.

RISK LEVEL

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

- Probability Factor of 5 based on the apparently active movement but with an indeterminate movement pattern or rate.

- Consequence Factor of 1 because it appears that the damage to the road surface is easily manageable as a maintenance issue.

Therefore, the recommended Risk Level is 5. This is based solely on the 2008 site inspection along with the information from AT's files on the 1987 repair work. Future observations will help to clarify the Probability Factor for this site, but overall it is judged that the Risk Level at this site is currently very low.

RECOMMENDATIONS

Maintenance and Short Term Measures

- AT's maintenance contractor should continue to crack-seal and apply patches/overlays as required to maintain a smooth running surface.

Investigation and Long Term Measures

- The culvert inlet should be located and exposed (if possible, presuming it is not at depth within the trench drain along the upslope ditch) in order to try to improve the current drainage from the upslope ditch. Alternatively, at least one or two new trench drains or even culverts could be installed to drain the upslope ditch and try to reduce the amount of water available to percolate into the road embankment. The consequence of not doing this would be ongoing maintenance, likely similar amounts as in the past 2 to 3 years.

- Boreholes or test pits to check for weak, organic soils beneath the road embankment are not recommended at this time. If the above-noted drainage measures turn out to be insufficient, then re-excavation of the road embankment, removal of any remaining organics, and re-backfilling with competent fill could be performed however this would essentially be a repeat of the 1987 repair. The cost for and traffic disruption during such work should also be compared to the cost of ongoing maintenance for this site.

- The annual site inspections by AT and AMEC personnel should be continued, at least for 2009. The decision on whether or not further annual inspections are necessary can be based on observations from the 2009 site inspection.

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

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

APEGGA Permit to Practice No. P-04546

Reviewed by:

Paul Cavanagh, M.Eng., P.Eng.
Associate Geotechnical Engineer

Attachments: Site Plan
Cross-Section
Photos