



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 S3 – Cochrane, Highway 22:16
2010 Annual Inspection Report**

This letter documents the 2010 annual site inspection of Site S3 – Cochrane, on Highway 22:16, south of Cochrane, AB and approximately 1 km southbound from the Highway 22 bridge over the Bow River. This site is located on the upper portion of the south slope of the Bow River valley, and has been monitored under the Geohazard Assessment Program due to landsliding on the slope below/northeast of the highway that appears to be encroaching into the highway surface.

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 21, 2010 by Mr. Bryan Bale, P.Eng., and Mr. Andrew Bidwell, 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 general description of the geohazard conditions at this site along with the site geological setting and chronology of previous events, investigations, monitoring, and repair work were provided in the Geotechnical File Review (Section A of binder) and summarized in previous annual inspection reports¹.

The landsliding at this site has been monitored by AT and their consultants since the early 1990's. AMEC understands that no major repairs have been performed at this site to date, however some redirection of surface runoff and regrading/lining of the road side-slope and ditch

¹ AMEC report "Southern Region Geohazard Assessment, Annual Assessment Report, 2009", project number CG25309.B, submitted to AT on August 28, 2009.

has been done (no documentation of this found during the file review). During the summer of 2009, the portion of the northbound lane exhibiting damage to the road surface due to landsliding was excavated and rebuilt. The ditch directly below the damaged road area was also rebuilt to restore drainage through the site area.

SITE OBSERVATIONS

A summary of observations and discussions on site with the AT personnel from the June 2010 inspection is presented below. Please also refer to Figure S3-2 for a cross-section at the site, and to the Spring 2010 instrumentation monitoring report² for this site for a more detailed presentation and discussion of the instrument data.

- The cracking and settlement area along an approximately 30 m segment of the northeast shoulder and northbound lane of the highway that has had visible cracking since 2005 was most recently patched during the summer of 2009. An overlay was placed along the entire road surface near the site area shortly after in Summer 2009. The overlay remained intact in the area of past damage with no new cracks formed. The slope inclinometers (SI's) at the site have recorded ongoing movement at less than 3 m depth since the fall of 2009, at typical to slightly reduced rates with respect to the rates observed between Fall 2005 and Fall 2009. Figure S3-1 shows the location of the patch, and Photo S3-1 shows the condition of the overlay.
- The ditch berm through the site area that had been noted in past inspections to be too low in places was repaired in the summer of 2009. A new ditch liner was also installed during the repair work. The liner was incompletely buried and remained exposed at the time of the June 2010 inspection. The repaired ditch gradient is not uniform, but is likely functional to ensure positive ditch drainage away from the site. The ditch berm has settled since the repair work in 2009, either due to fill settlement or continued slope movement, and it is possible that water can overtop the ditch and flow into the site area. The fill placed in 2009 has not become vegetated, and although no significant erosion damage has yet occurred the fill should be revegetated to resist erosion. Photos S3-2 and S3-3 illustrate the condition of the ditch at the time of the inspection. As shown in Photo S3-3, a crack has reformed in the ditch berm, following the same pattern observed prior to the repair, and likely represents the flank of the slide that continues to be active.
- The visible tension cracks and slump blocks on the slope below the road did not appear to have changed significantly since the 2009 or earlier annual inspections. Refer to

² AMEC report "Southern Region Geohazard Assessment, Spring 2009 Instrumentation Monitoring Results, Site S3: Highway 22:16, COCHRANE", submitter to AT June 19, 2009.

Photo S3-4 and S3-5. As shown on the attached cross-section, tension cracks were visible as far upslope as SI 2007-1, which is the same position as noted in previous annual inspections. There were no discernable tension cracks or other landslide features between SI 2007-1 and the highway.

- Four SI's remain functional at the site, and should provide sufficient monitoring for retrogression of the shallow landsliding noted near SI 2007-1, and for identifying potential deeper landsliding that has yet to develop.

ASSESSMENT

There is a risk to the integrity of the northbound lane of the highway at this site based on the ongoing cracking and settlement of the road surface since 2005. This damage appears to be due to shallow movement (e.g. less than 3 m depth) of the slope below the highway but may also be linked to slightly deeper-seated movement in the slumping area downslope of SI 2007-1 (i.e. around and downslope of the fenceline on the slope below the highway). However, the instrument data up to the Spring 2010 readings does not show a definitive link between the damage to the road surface and the slumping area downslope of the fenceline. The June 2009 repairs to the ditch were intended to prevent peak ditch flow from leaving the ditch and draining into the landslide area around and downslope of SI 2007-1, however the ongoing settlement/slumping of the ditch berm has increased the likelihood that the ditch can still be overtopped despite the repairs.

In recent years the damage to the northbound lane of the highway has been managed as a maintenance issue and based on the instrument monitoring data and annual site inspections it does not appear that the rate and magnitude of damage to the northbound lane will increase significantly in the near-term. Also, the existing instrumentation at site provides monitoring for a link between the apparent shallow movement causing the damage to northbound lane and possibly deeper-seated movement occurring further downslope below the highway.

Repair work is not required at this time, and the site should continue to be treated as a maintenance issue. Continued monitoring to identify landslide retrogression or the formation of a deeper slide is warranted, and the landslide conditions should be considered during the planning of any future expansion or twinning projects for this highway.

RISK LEVEL

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

- Probability Factor of 9 in order to reflect the ongoing slope movement observed in the area around and downslope of SI 2007-1 as well as ongoing shallow movement in several of the other SI's.
- Consequence Factor of 3 based on the magnitude of damage to the northbound lane in recent years that has been managed as a maintenance issue.

Therefore, the current recommended Risk Level for this site is 27, which is unchanged since the 2005 assessment.

RECOMMENDATIONS

Maintenance and Short Term Measures

- Road surface patching and overlays as required to mitigate the settlement and cracking along the shoulder and in the northbound lane.
- The segment of the repaired ditch should be graded further to a more uniform ditch gradient, and the exposed portions of the new ditch liner should be buried. Fill should be added to the settled/slumped portion of the ditch berm to maintain the ditch capacity. Vegetation should be established on the recently graded fill. This work is not urgent, but should be performed if other work is planned for the area.

Long Term Measures

Previous annual assessment reports have noted that a pile wall should be considered as a repair option for this site, with a ballpark estimated cost in the range of \$500,000 to \$750,000. However, AT should consider the possible cost for such a repair vs. the ongoing maintenance cost and effort in the context of the recommended Risk Level of 27 for this site. It is also understood that this segment of the highway may be twinned in the future and that it may be preferable to install a pile wall in conjunction with the twinning work.

The semi-annual readings of the functioning instruments should be continued.

The annual inspections of this site should be discontinued. Future inspections should only be performed if a significant change in the site conditions is noted during the semi-annual



instrument readings (either in the instrument data or in visual observations by the AMEC field personnel while taking the instrument readings).

Investigation

No further investigation work for this site is recommended at this time.

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 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: Site Plan
Cross-Section
Photos S3-1 to S3-5