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 S4 – Willow Creek, Highway 2:08
2010 Annual Inspection Report

This letter documents the 2010 annual site inspection of Site S4 – Willow Creek, along Highway 2:08, south of Claresholm, AB and approximately 4.7 km north of the Highway 2 bridge over the Oldman River. This site is located on a segment of the west slope of the Willow Creek valley where ongoing landsliding driven by creek erosion along the toe of the slope is causing the slope crest to retrogress westwards towards the northbound lanes of Highway 2.

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. Bryan Bale, P.Eng. and Mr. Andrew Bidwell, P.Eng., of AMEC in the company of Mr. Ross Dickson, Mr. Neil Kjelland, P.Eng., and Mr. Roger Skirrow, P.Eng., 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 the site binder) and summarized in the annual inspection reports up to 2007[1].

The landsliding at this site has been monitored by AT and their consultants since 1993. This site has been under greater scrutiny since the summer of 2005 when a relatively large increment of slope crest retrogression occurred.

[1] AMEC report "Southern Region Geohazard Assessment, Annual Assessment Report, 2007", project number CG25263, submitted to AT on November 6, 2007.

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A repair was performed in late 2008 and consisted of:

- Longitudinal peak stone toe protection (LPSTP) and vanes along the right creek bank along with bioengineering treatments to reduce creek erosion along the toe of the slope in the landslide area.

- Regrading and the installation of launched soil nails to stabilize the segment of the slope crest that had retrogressed towards the highway and westwards of the fenceline.

- Trial applications of numerous bioengineering and erosion control treatments on the exposed soils on the slope in the landslide area as part of a field workshop hosted by AT.

Please refer to Figures 1 and 2, attached, which are adapted from the as-constructed drawings for the 2008 repair and show the type and layout of the various repair measures at this site.

SITE OBSERVATIONS

Key observations from the June 2010 inspection were as follows:

- The slopes were wet at the time of the inspection, with groundwater observed seeping from the slopes to within 2 m from the crest. Only trace amounts of groundwater seepage, if any, had been noted during previous site inspections. In general, the steep upper slopes throughout the site area had been recently damaged by seepage-driven, shallow earth flows and blocks of earth toppling from the scarps.

- The soil nailed area along the crest of the slope was in poor condition, with additional slump blocks forming at the crest, and nails sticking out of the slope by up to 2 m. It appears that seepage has caused shallow soil flows around the nails and down the slope, displacing the vegetative cover, and slumping of the slide mass has continued. There was no vegetative cover in the soil nailed area despite the hydroseeding and other measures applied during the 2008 repair work. The scarp was at the fenceline at the time of the inspection, and had retrogressed by approximately 1 m from its position in 2009. Refer to Photos S4-1 to S4-3, and S4-11.

- Dry slopes in the area appear stable while slopes with visible groundwater discharge were subject to shallow earth flow and block toppling (Photo S4-2).

- The benched areas along the mid to lower slope were in very good condition and were covered with vegetation. This area had been treated with compost blanket and containerized plantings. Gullies formed in the slopes were diminished upon reaching the benches.

- The LPSTP along the right creek bank and the rock vanes angled into the channel to protect the bank from stream erosion were in good condition. The creek flow at the time of the inspection was high, with the water level above the vanes, but not overtop of the LPSTP. Sediment was observed on top of the LPSTP, indicating that the water level had been higher in the past. The live siltation/brush layering (willows) installed along the LPSTP had not taken root, with only a small fraction (perhaps less than 10%) of the willows alive as of June 2010. Refer to Photos S4-6 to S4-8.

- The various bioengineering treatments that were applied across the site are described below and illustrated on Figure 2.

    - The soil nailed area had very poor vegetative cover and had earth flow debris and gullies. This area had been treated with fiber rolls, flexible growth medium, and broadcast seed and fertilizer. Shallow earth flows have apparently displaced any vegetation and disrupted growth. Refer to Photos S4-1 to S4-3.

    - The regraded slope face below the soil nailed area had fair vegetative cover, and minor earth flows. This area had been reclaimed with broadcast seeding and fertilizer.

    - The soil disposal area to the south of the soil nailed area had poor vegetative cover. Earth flows were noted throughout the area. During the 2009 inspection it had been noted that the fiber rolls had detached from the slope face slid down the slope due to slope wash effects, and the area had not revegetated well. This area had been treated with straw hydromulch and broadcast seed and fertilizer. Refer to Photo S4-3.

    - The soil disposal area to the south end of the site near the gully had good vegetative cover, and some signs of earth flows (Photo S4-5). This area had been treated with fiber rolls, flexible growth medium, and broadcast seed and fertilizer.

    - The lower cut slope that had been treated with a compost blanket and containerized plantings had good vegetative cover, minor gullies, and few earth flows. Most of the containerized plantings were obscured beneath the grasses, but appeared to be growing well.

    - The live staking and blown compost used on the gully sidewalls at the south end of the site was generally unsuccessful as of the June 2010 site inspection (Photo S4-9).

ASSESSMENT

The groundwater seepage conditions observed during the 2010 inspection was higher than had been observed in the past, and seems to be a key factor in the slope instability causing shallow earth flows and block toppling along the crest. The steep upper slopes, including the soil nailed area, have been the most affected, and vegetative cover in these areas has been damaged. The soil nails have been effective to date in stopping large increments of headscarp retrogression; however they have not been successful in preventing the shallow earth flows and localized slope crest retrogression to the fenceline.

The success of the trial bioengineering techniques applied at the site has varied. The flexible growth medium has generally worked well, as long as earth flows do not occur displacing the vegetation. Benching of the slope has also worked well, and serves to catch any earth flows and disrupt the formation of gullies. Drainage by rock channels along the slope, where present, has reduced the gully formation. The bank armouring has been very effective, and has withstood the 2009 and 2010 spring runoff flows without any problems. These techniques should be applied at other sites with similar conditions.

Some remediation is required at the site to establish vegetative cover in some areas, and to revegetate/stabilize the slope crest in the soil nailed area.

RISK LEVEL

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

- Probability Factor of 6. This is an increase from the value of 5 assigned in 2008 after the remediation was completed to reflect that the soil nailed area may be less stable due to shallow earth flows. The current Probability Factor is less than the pre-remediation level of 9 since the river channel protection and other reclamation measures remain functional.

- Consequence Factor of 2 for the present location of the landslide relative to the northbound lanes of the highway. This is unchanged from the 2008 assessment.

Therefore, the current recommended Risk Level for this site is 12, which is an increase from the 2009 level of 10 but lower than the pre-repair Risk Level 18.

RECOMMENDATIONS

Maintenance and Short Term Measures

- Vegetation should be established in areas where it has not grown properly or has been disturbed by earth flows. The flexible growth medium with broadcast seed and fertilizer, in combination with fiber rolls is recommended, however it will be necessary to apply the flexible growth medium without restoring truck access to the lower slope areas. Fiber rolls should be installed with longer stakes than were used in 2008.

Long Term Measures

- The risk of the upper scarp retrogressing further towards the highway is somewhat mitigated by the soil nails, however the nails are less effective now following the shallow earth flows at the scarp and localized slope crest retrogression has occurred since the 2008 repair. High groundwater seems to be the cause of these earthflows, and it is expected that they may occur every several years during periods of peak precipitation or snowmelt. This risk could be mitigated by installing a drainage trench along the scarp to intercept high groundwater levels and lower the groundwater level at the slope face. The drainage trench should include an outlet pipe to an area midway down the slope. Alternatively, perforated soil nails could be installed at the head scarp to attempt to provide drainage outlets from within the slope. The slope face would need to be protected against erosion with either vegetative cover or erosion resistant matting (attached to the nails). AMEC could provide design details for either of these options if requested.

- The annual site inspections by AT and AMEC personnel should be continued in 2011.

- It would also be of interest to perform a bathymetric survey of the creek channel (including the thalweg position and profile) after a few years in order to compare to the 2007 channel survey and assess changes in the channel cross-section and profile as a result of the installation of the bank armouring and rock vanes in late 2008. This would be of interest in further assessing and documenting this case history of the use of rock vanes and their effect on channel conditions, and could be cross-referenced to post-construction creek flow records for further interpretation.

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: Figures 1 and 2
Photos S4-1 to S4-11