November 2012

CG25399

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

Attention: Mr. Ross Dickson

Dear Ross:

Re: Southern Region Geohazard Assessment
2012 Annual Inspection Report
Site S41: Highway 564:10, East Coulee Slide

This report documents the 2012 annual site inspection of Site S41 (formerly C24) – East Coulee Slide, on Highway 564:10, approximately 22.5 km southeast of Drumheller, Alberta, along Highway 564, 500 m from the junction of Highway 564 and Highway 569, south of the Red Deer River. This segment of Highway 564:10 is a gravel, two lane undivided roadway along a bearing of approximately 050° (northeast/southwest) built on a fill embankment that traverses a tributary valley slope that drains towards the Red Deer River.

AMEC Environment & Infrastructure (AMEC), a division of AMEC Americas Limited, performed this inspection in partial fulfilment of the scope of work for the supply of geotechnical services for Alberta Transportation's (AT's) Southern Region (AT contract CON0013506).

The site inspection was performed by Georgina Griffin, P.Eng., Bryan Bale, P.Eng., and Tyler Clay, E.I.T., of AMEC; and Roger Skirrow, P.Eng., Ross Dickson, and Nathan Madigan, E.I.T., of AT during the 2012 Annual Tour.

1.0 BACKGROUND

A general description of the geohazard conditions at this site is provided in the call-out report[1] from AMEC's November 21, 2011 inspection of the site, including a history of the previous monitoring and repair measures prior to 2007. Figure 1, attached, shows the overall site layout and the relative location of the highway to the landslide features

A landslide damaged the roadway in August 2007 when a 70 m long section dropped 1 m, effectively closing half the highway. It was thought that heavy rains caused reactivation of the existing slide on which the highway was built.

A variety of mitigation work/repair work was carried out between the fall of 2007 and spring of 2008 that included protecting the upslope ditch with gravel-filled geo-cell, re-grading the slope below the slide area, excavating along a portion of the road adjacent to the scarp, soil nailing on exposed scarp/excavation faces and constructing a geo-synthetic reinforced soil (GRS) wall to

[1] AMEC Environment & Infrastructure, *Southern Region Geohazard Assessment Program, C24 –Highway 564:10 – East Coulee Slide – Report on November 21, 2011 Site Inspection*, CG25352.400, May 7, 2012.

restore the highway grade. Further cracking and settlement was observed while the repair work was being carried out.

The site was monitored at least twice a year from 2008 to 2011. Cracking and settlement had formed again at the time of the May 2011 site inspection, and the GRS wall had some minor tilting. No signs of movement were noted beyond the 70 m long zone of previous damage within the highway. A relatively deep slide in weak bedrock material reactivated by ground saturation was identified as the probable cause of the movement. Ongoing movement was expected to continue but a rapid failure was considered to be a low probability.

AMEC performed a call-out inspection at the site in November 2011 and incorporated the site into the Southern Region geohazard database at that time. Observations were consistent with previous inspections. It was thought that the current mitigation repairs were effective in their role of providing temporary support for the road embankment and delaying the erosion of exposed scarp faces but did not provide any global stabilization for the overall landsliding that affects the road. The largest expected risk to the highway is the retrogression of the headscarp currently within the closed southbound highway lane.

2.0 SITE OBSERVATIONS

Key observations from the June 2012 site inspection are outlined below and shown in the attached photographs:

- The overall landslide conditions and status of the current mitigation repairs remain mostly unchanged from the 2011 inspection. Refer to Photo S41-1 and Figure S41-1.
- The 70 m long segment of highway lane previously damaged by landslide movement had increased settlement, with up to 500 mm of total settlement along the guardrail where the headscarp is located. The road settlement allows surface water to flow into the slide mass. No new cracks or settlement areas within the road surface were noted. Refer to Photos S41-2 and S41-3.
- No significant changes were noted to the condition of the mitigation. The geo-cell in the upslope ditch was working effectively at reducing erosion. The ditch width has been reduced to accommodate the upslope expansion of the undamaged highway lane.
- The slope above the highway appeared stable.
- The slope below the highway continues to show evidence of ongoing deep-seated landslide movement.

3.0 ASSESSMENT

The assessment regarding the landslide conditions and hazard at this site remains unchanged from AMEC's November 2011 inspection and is summarized as follows:

- Damage has been caused by settlement in the fill embankment from the underlying natural landslide below the highway.
- The landslide movement is likely a combination of ground saturation and high groundwater table contributing to ongoing movement along ancient slide surfaces in weak bedrock.
- The retrogression of the current headscarp into the remaining highway lane presents the largest risk to this site; however, sudden failure is considered unlikely.
- Temporary repairs already implemented should be maintained.
- A list of potential, more permanent repairs was presented in the 2011 call-out report. In general it was determined that a landslide of this scale would be difficult and expensive to repair. Highway re-alignment or grade lowering were judged to be the most practical options.
- Based on current observations, it appears that the landslide toe may be located on a bench at approximately mid-slope. The previous monitoring data would need to be reviewed to confirm this assumption. A buttress may help stabilize the slide if this is the case.
- Due to the slow moving nature of this slide, ongoing maintenance including construction of a GRS wall, may be a practical method to keep the road operable.

4.0 RISK LEVEL

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

- Probability Factor of 7, based on the active movement along defined zones of movement.
- Consequence Factor of 5, which reflects that a partial or full closure of the road would be required following a significant increment of slide activity.

Therefore, the recommended Risk Level is 35, which is increased from the 2011 Risk Level of 22.

5.0 RECOMMENDATIONS

5.1 Maintenance and Short Term Measures

- Perform a file review for this site (Task A unit rate under CE061/08). A Level A (site binder) should be compiled to gather data from the previous region. This will be important to find the instrument readings, surveys, etc.
- Regular grading to maintain a trafficable road surface adjacent to the landslide headscarp. The grade of the road through the landslide area should drain towards the upslope to prevent runoff into the headscarp of the slide mass.
- As recommended previously, the highway width should be increased by placing compacted gravel in the upslope ditch. This ditch should be completed with drainage pipe to

accommodate any ditch flow. The current ditch width does not meet AT specification and should also be widened.

- Maintenance personnel should frequently check and maintain the current mitigation. This work will involve periodic rebuilding of the road embankment/base using geo-grid reinforcement.
- Continue to perform annual site assessments.
- The southbound lane should remain closed until reduced rates of settlement are observed and ongoing scarp re-grading can be carried out.
- If the height of the unsupported headscarp along the south shoulder increases due to continued landslide movement below the highway, then long term options should be considered. In the meantime exposed soil faces should be treated to reduce erosion and retrogression of the road embankment.

5.2 Long Term Measures

It is probable that the effort and cost to maintain the current embankment at its present state will continually rise. If AT determines the cost of ongoing maintenance is no longer sustainable, a long term repair option should be considered. Depending on the depth of slide movement, there are various repair options:

- Upslope Lane Shift – To date no instability has been noted upslope of the highway. Moving the current highway alignment upslope would effectively move it outside of the affected landslide area. This would require a significant cut into the slope above the current highway and may create potential back-slope instabilities depending on the length of the re-alignment and change in highway grade. Once these factors are considered the re-alignment would likely be costly relative to other options. This option has been studied in the past for this site and it was concluded then that ongoing highway maintenance was a more economical option.
- Toe Berm – It was noted during the latest inspection that the toe of the landslide may daylight along a flat bench area at approximately mid-slope between the highway and gully area. If this is the case it may be possible to place a fill berm along this flat bench area to stabilize the slide.
- Pile Wall – A pile wall could be constructed to support the segment of the road adjacent to the landslide area. This option could provide a high level of assurance that the highway would not be undermined by landslide movement; however, the cost for the length and depth of pile wall necessary would probably be too expensive relative to the low volume of traffic on this road.
- Lightweight Fill – Rebuilding the current highway embankment with a lightweight fill and internal structural support. This would create an embankment less susceptible to deformation from downslope movement and at the same time reduce the total weight at the head of the slide that is a driving force of ongoing movement.

6.0 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 Environment & Infrastructure, 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 Environment & Infrastructure,
a division of AMEC Americas Limited

ORIGINAL SIGNED AND STAMPED NOVEMBER 20, 2012

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APEGA Permit to Practice No. P-04546

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