



January 2015

CG25399

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

Attention: Mr. Ross Dickson

Dear Ross:

**Re: Southern Region Geohazard Assessment
2014 Annual Inspection Report
Site S46: Highway 840:02, Rosebud Slides**

This report documents the 2014 annual site inspection of Site S46 – Rosebud Slides, on Highway 840:02, approximately 1 km northwest of Rosebud, Alberta. At the site location, Highway 840 is a paved, two lane undivided roadway that is oriented roughly northwest to southeast. The area is mainly comprised of farmland with gentle topography and shallow valleys to the west of the highway, likely remnants of river tributaries that drained towards the valley to the southeast. The sites (herein referred to as the Northern and Southern Slide) are approximately 270 m apart and both site areas can be considered to involve less than a 50 m section of the highway. The highway is a fill section in both of the site areas. The legal description for the site area is 12-18-027-21 W4.

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 Bryan Bale, P.Eng., and Tyler Clay, E.I.T., of AMEC; Roger Skirrow, P.Eng., and Ross Dickson of AT during the 2014 Annual Tour.

1.0 SUMMARY

The slides at both the North and South sites show ongoing movement within the previously observed landslide extents and retrogression towards the west road shoulder. The minimum offsets of the landslide headscarps from the road edge is approximately 1.8 m and 2.0 m for the North and South slides respectively. The failure at the North slide is expected to be within a previously observed failure area that was inspected in 2007. The Risk Levels are 9 and 18 for the North and South slides respectively. This is a slight increase from the 2013 risk levels due to the observation of active and ongoing slide movement and retrogression. Both sites should be repaired. AMEC can provide detailed design recommendations if required. The sites should be inspected in 2015.

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2.0 BACKGROUND

AMEC performed a call-out inspection to two slide areas on Highway 840 near Rosebud during October 2007. At the time the slides were referred to as the “North Site” (approximately 1.3 km north of Rosebud) and the “South Site” (approximately 4.4 km south of Rosebud). It was understood the landslides first occurred at these sites in June 2007 after a period of heavy rainfall. The sites were regraded shortly afterwards to restore the embankment slope angles to that which existed prior to the slide events. It also appears that pavement overlays were placed along segments of the highway at the North Site as part of the repair work. It was reported that further landslide movement occurred at the sites following the initial repairs. The damage was assessed by AMEC in 2007 to be shallow circular type landslide failures within native, clay soils of the road embankment driven by high groundwater and rainfall seepage. Soil nails were recommended for the South Site and regular maintenance was suggested for the North Site if no further damage was observed. Refer to AMEC’s 2007 call-out report¹ for further details on the site observations, risk assessment and recommendations.

In June 2013, AMEC inspected two slide areas (referred to as the Northern Slide and Southern Slide) north of Rosebud as part of a call-out inspection requested by AT. Based on the information provided during the inspection by AT’s maintenance contract inspector (MCI) for this area (Doug Goodine), the west embankment around the Northern Slide had experienced slide failures in the past. These were relatively small slumps that were repaired by pushing the displaced soil back upslope and did not impact the road directly. It was mentioned that soil nail repairs had been done in the past, although not in the current affected areas. The embankment failure at the Southern Slide was unprecedented and the largest the MCI had seen in the area. The slide area identified as the Northern Slide in AMEC’s 2013 inspection report corresponded closely to the area where a landslide was observed in 2007 and referred to as the North Site. The landslide referred to as the Southern Slide in AMEC’s 2013 report does not correspond to the same slide area observed at the South Site during the 2007 inspection. It is suspected that the 2007 South Site underwent the soil nail repairs referred to by the MCI. Therefore, the 2013 Southern Slide appeared to be a new landslide development that was not observed prior to 2013. Refer to AMEC’s 2013 call-out report² for further details on the site observations, risk assessment and recommendations.

¹ AMEC Earth & Environmental, 2007. *Southern Region Geohazard Assessment Program, Call-Out Request – Highway 840:02, Near Rosebud, AB, North and South Sites*, Project Number CG25263, Report submitted to AT October 29, 2007.

² AMEC Environment & Infrastructure, 2013. *Southern Region Geohazard Assessment Program, Highway 840:02 – Rosebud Slides Site, Call-Out Report*, Project Number CG25399.400, Report submitted to AT September 2013.

3.0 SITE OBSERVATIONS

Key observations regarding changes in the site conditions since the 2013 inspection are summarized as follows, and illustrated on Photos S46-1 to S46-6:

Northern Slide:

- The slide area had significant downslope movement relative to the 2013 inspection with the headscarp expanding from 0.5 m thick to approximately 1.0 m. The slide expanded laterally from 10 m to approximately 12 m. Refer to Photos S46-1 to Photos S46-3 for a comparison of the conditions between 2007, 2013 and the 2014 inspections respectively.
- The slide appeared to be occurring in gravelly fill and was estimated to be 1 to 2 m deep.
- The headscarp was offset by 1.8 m from the west road shoulder indicating approximately 0.1 m of retrogression since the 2013 inspection.
- The headscarp was staked at a 0.2 m offset to measure potential retrogression during future inspections.

Southern Slide:

- The exposed soils in the headscarp widened up to approximately 2.5 to 3 m in width, increasing by approximately 0.5 to 1.0 m since the 2013 observations, due to continued downslope movement of the failed soil mass. Overall the shape and extents of the headscarp and flanks of the slide remained comparable to 2013 conditions. Refer to Photos S46-4 and S46-5 to compare the 2013 and 2014 conditions near the headscarp respectively. Refer to Photo S46-6 for an overall view of the site.
- The minimum offset from main headscarp from the west guardrail decreased by approximately 0.5 m to 2.0 m since the 2013 inspection.
- Cracking was noted offset approximately 0.3 m from the west edge of the pavement; however, no damage to the road was observed.
- The dropdown along the crack running adjacent to the guardrail north of the slide was similar 2013 conditions with the adjacent embankment 100 to 200 mm lower than the road surface.
- The culvert appeared to be operating normally and no significant changes were noted from the 2013 observations.

4.0 ASSESSMENT

AMEC's 2013 assessment of the overall landslide conditions at the site remain valid and is summarized as follows:

The landslides at both site areas likely occurred due to excess pore pressures in saturated, medium to high plastic, clayey soils near the surface; likely following one or more heavy rain events. The MCI's reported observation of the slide damage following large rain storms supports this assessment.

The Northern Slide occurred in an area where relatively shallow landslide failures have been observed previously and been repaired by grading the disturbed soils back upslope. The soils in this area are therefore susceptible to ongoing movement along old failure planes once they become saturated. The headscarp is expected to worsen if left untreated and potentially retrogress closer to the highway.

The rotational type failure at the Southern Slide site incorporates a larger area along the embankment, has a deeper slide plane and has less offset relative to the North Site slide. The slide at this site poses a larger risk to the highway for these reasons. The conditions are expected to worsen at this site if it is not repaired. The soils in the failure will likely continue to settle and are susceptible to erosion. The upper embankment has lost support and will likely continue to settle and potentially move downslope in larger block failures. If this were to occur, the west road shoulder and, potentially, the southbound lane could become affected. The slope here is expected to continually fail under periods of heavy precipitation if some form of subgrade drainage is not incorporated into the repair to help mitigate excess pore pressure. The embankment further north and south of the failure area have reduced fill height or toe support that may reduce their risk of failure relative to the subject embankment area.

Based on the 2014 observations, both slides show continued movement and retrogression towards the highway. The Northern Slide area showed the largest increase in downslope movement along similar extents to that observed in 2013. The headscarp at the Southern Slide had retrogressed closer towards the highway due to mostly erosion and localized slumping at the headscarp; it did not appear to be expanding further into the road surface.

As discussed in AMEC's 2013 report, a geotechnical investigation is not considered to be warranted for either landslide areas as the mechanism and origin of the failure is considered to be sufficiently understood to provide effective repair recommendations. It is understood that AT wishes to repair both sites with regional labor. AMEC's 2013 repair recommendations remain valid and include AT considering the cost effectiveness of performing regular repair work for the Northern Slide (likely involving minor earthwork and grading) compared to a more involved "Excavate and Replace" type repair. At the Southern Slide it is recommended that a form of subgrade drainage be incorporated into the repair to help mitigate excess pore pressure. Consideration could also be given to slope flattening or support from a toe berm based on the apparent stability of the adjacent slopes.

5.0 RISK LEVEL

AMEC recommends the following Risk Levels based on AT's general geohazard risk matrix:

Northern Slide:

- Probability Factor of 9 based on the current, active failure at a moderate steady rate. There is a history of a previous failure in the area which affected the southbound lane and high probability of remobilization or other failures to occur in the surrounding area during large rain events.
- Consequence Factor of 1 reflecting that the current slump is relatively shallow and does not impact the road surface and is still offset almost 2 m. There was minor retrogression of the headscarp since 2013. The current damage to the embankment is treatable as a routine maintenance issue. If the slump is left unrepaired and it retrogresses to the highway shoulder, the consequence factor would increase.

Therefore, the recommended Risk Level for the Northern Slide is 9 (i.e. 9 x 1). This is increased from the 2013 Risk Level of 7 due to observed movement in the failed soil mass since the previous inspection and potential for ongoing retrogression. In 2007 the site area was assigned a Risk Level of 36 (i.e. 9 x 4) due to a larger consequence rating based on the potential of slide movement within the road itself requiring closure or retrogression of landslide failures. The reduction in Risk Level is considered to be justified based on the lack damage observed in the road since 2007 and apparent shallower depth of the current landslide failure.

Southern Slide:

- Probability Factor of 9 based on the current failure that has an active, moderate steady movement rate within a defined zone. There is high probability of continued movement and erosion within the disturbed soils. There is potential for retrogression into the surrounding area although at an unknown rate. Activity is expected to be intermittent and increase during large rain events.
- Consequence Factor of 2 reflecting the close proximity of slide induced cracking to the road shoulder which may compromise the integrity of the guardrail and road surface if retrogression and settlement continues.

Therefore, the recommended Risk Level for the Southern Slide is 18 (i.e. 9 x 2). This is an increase from the Risk Level of 14 assigned in 2013 due to the ongoing movement measured and observed within the failed soil mass and headscarp retrogression since the previous inspection.



6.0 RECOMMENDATIONS

6.1 Maintenance and Short Term Measures

AT's maintenance contractor personnel should continue to patch and regrade the settlement along the north edge of the highway as required.

The site should be inspected during the 2015 Annual Tour to check site conditions and potential expansion of the landslide scarps into the highway.

6.2 Long Term Measures

It is understood that AT would like to repair the slides with regional labour. AMEC can provide a detailed design if required.

AMEC's concept repair recommendations from the 2013 call-out report remain valid and are provided below for reference.

At the Northern Slide, the MCI should implement a repair that involves excavating below the slide material to 1 m depth and placing a gravel blanket drain (or perforated pipe) that daylight on the lower slope. The excavated clay should be replaced (as long as it is free of organics) and track packed. If the displaced slump material is pushed back upslope, it is likely that the embankment will become unstable again without sub-drainage. AT should consider the cost-effectiveness of reducing routine embankment grading maintenance by incorporating more robust sub-drainage controls.

At the Southern Slide, the MCI should implement a similar repair as recommended for the Northern Slide. The repair here however, may involve excavation up to 2 m deep within the disturbed area. This kind of repair is expected to be the most cost effective relative to other slope support options, as the high pore pressures are assessed to be the major factor of the embankment slides.

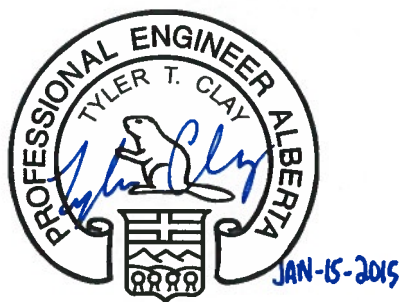
7.0 CLOSURE

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



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