



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 S10(C) – Highway 762:02
2008 Annual Inspection Report**

This letter documents the 2008 annual site inspection of Site S10(C) on Highway 762:02, approximately 22 km south of the junction with Highway 22 and approximately 550 m north of the junction with Highway 549. The highway crosses over a small, unnamed creek at this site with the creek flow conveyed by a 900 mm diameter culvert.

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

There is limited background information available regarding this site prior to the 2000 inspection. Minor settlement and cracking of the road surface was noted at this site during the 2000 to 2004 annual inspections and weak foundation materials below the road embankment were postulated as the cause. An overlay was placed at this site in July 2003. It was also noted that the west ditch would pond water during wetter times of the year and required regrading to re-establish drainage towards the culvert at the creek crossing.

During the 2005 inspection more significant cracking and settlement of the road surface was noted along an approximately 15 m long segment of the northbound lane roughly 45 m north of the culvert. It appeared that the cracking had developed during or following the heavy rains during late June 2005. The road surface had not been critically damaged at that point, however further settlement would likely have necessitated a reduced speed limit. Some significant erosion was also noted in the west ditch, south (up gradient) of the culvert inlet and was attributed to flash-flood level runoff during the June 2005 rains.

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An overlay was placed over the cracked segment of the northbound lane at some point after the 2005 inspection, and again prior to the 2007 inspection (the site was not inspected in 2006). An approximately 1.3 m wide and 1 m deep sinkhole was also noted for the first time in the west embankment slope above the culvert inlet during the 2007 inspection.

SITE OBSERVATIONS

Key observations regarding changes in the site conditions since the 2007 inspection are summarized as follows:

- The sinkhole in the west embankment slope and above the culvert inlet has increased in size since the 2007 inspection:
 - 2007 dimensions – approximately 1 to 1.3 m wide at surface, roughly 0.75 to 1 m deep.
 - 2008 dimensions – approximately 2.1 m wide at surface and roughly 1.7 m deep.
- Photo S10(C)-1 shows the location of the sinkhole on the embankment slope above the culvert inlet. The location of the sinkhole along with visible deformation of the culvert pipe near the inlet suggests that the sinkhole has formed due to a breach in the culvert with overlying soil eroding down into the culvert.
- There was visible cracking across the northbound lane and extending slightly into the southbound lane in the same area north of the culvert where cracking and settlement has been noted in previous inspections. Photo S10(C)-5 shows a view of this cracking, along with lateral displacement visible in the white line along the east shoulder.
- Two slumps were visible in the creek banks a short distance downstream of the culvert outlet.
 - Photo S10(C)-3 shows the slump in the right bank immediately downstream of the culvert outlet that appears to have been triggered by toe erosion from culvert flow concentrated towards the right bank.
 - Photo S10(C)-4 shows a slump further downstream on the left bank. This slumping has been noted in previous annual inspections and does not currently appear to be a threat to the road embankment, however it bears watching.

ASSESSMENT

There appear to be two geotechnical issues at this site:

- Problems with the culvert:
 - Apparent settlement/deformation of the culvert that seems to have led to a breach in the culvert pipe near the inlet and caused the sinkhole to form in the west embankment slope.
 - The culvert outlet is too low, as evidenced by the standing water backing up into the culvert under the relatively low creek flow levels at the time of the 2008 inspection (Photo S10(C)-2). This is possibly a result of settlement and deformation of the culvert pipe.
 - The east/west alignment of the culvert relative to the northeast/southwest alignment of the creek channel – this appears to have contributed to the slump on the right creek bank immediately downstream of the culvert outlet.

- Ongoing cracking and settlement of the road surface, north of the culvert location:
 - The pattern of the cracking suggests that it is the north flank of an east-moving slumping/circular failure of the road fill embankment over the creek. It does not appear to be linked to the slumping in the left creek bank, downstream of the culvert (Photo S10(C)-4). It could also be due to settlement of the fill embankment (possibly over organics that were not removed prior to embankment construction) with minor eastwards lateral movement towards the creek channel.
 - The cracking has re-formed through several overlays in recent years. The magnitude of settlement has varied over the years. In past annual inspections it has been noted that at times the settlement has almost been large enough to warrant a reduced speed limit at the site (until repaired).
 - The accumulated thickness of the multiple overlays have created a steep slope (greater than 45°) along the east shoulder in the cracking area, with slope heights up to approximately 1.3 m.

The apparent settlement of the culvert and the ongoing cracking in the road surface north of the culvert may be linked with a root cause of ongoing settlement of the road fill embankment and/or the underlying native soils.

To date, the above-noted issues have not directly threatened the highway beyond creating an ongoing maintenance issue. However, if the size of the sinkhole in the west embankment slope continues to increase it may begin to directly undermine the west shoulder of the 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 based on the ongoing cracking and settlement of the road surface north of the culvert location.
- Consequence Factor of 3 based on a judgment that continued settlement of the northbound lane can be treated as a maintenance issue without requiring partial closure of the highway.

Therefore, the current recommended Risk Level for this site is 27, which is unchanged since the 2005 assessment. However, if the settlement worsens in the future, and/or if the sinkhole in the slope above the culvert inlet continues to increase in size, then the Risk Level will increase.

RECOMMENDATIONS

Maintenance and Short Term Measures

- AT's maintenance contractor personnel should continue to patch and place overlays at the cracking/settlement area north of the culvert location as required to maintain a suitable running surface.
- Overall, it is recommended that the cracking and settlement continue to be treated as a maintenance issue. If the root cause of the damage to the road surface is embankment or foundation settlement then a repair consisting of excavation and replacement of the road embankment is likely cost-ineffective relative to ongoing maintenance as required.

Long Term Measures

- A new culvert should be installed along a northeast/southwest bearing to more closely align with the overall creek channel alignment. The existing culvert should then be grouted/abandoned. The new culvert should be designed to accommodate possible continued settlement of the road fill embankment, if practical and cost-effective in comparison to a complete excavation and reconstruction of the road fill embankment to mitigate settlement.
- The annual site inspections should be continued.

Investigation

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

Further investigation work to check for fill embankment and/or foundation instability or settlement as the root cause of the apparent culvert deformation and damage and cracking in the road surface could be performed. However, the data from such an investigation would almost certainly confirm the current recommendation to replace the existing culvert and to continue to treat the road surface cracking as a maintenance issue.



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 Earth & Environmental,
a division of AMEC Americas Limited**

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Associate Geological Engineer

APEGGA Permit to Practice No. P-04546

Reviewed by:

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

Attachments: Site Plan
Photos