October 28, 2011

CG25352.200

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
2011 Annual Inspection Report

This letter documents the 2011 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 Environment and Infrastructure (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 20, 2011 by Mr. Bryan Bale, P.Eng., and Mr. Tyler Clay, E.I.T., of AMEC in the company of Mr. Ross Dickson and Mr. Neil Kjelland, P.Eng., 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 and/or compressible foundation materials below the road embankment were postulated as the cause. 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 significant rains of 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-

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flood level runoff during the June 2005 rains. An approximately 1.3 m wide and 1 m deep sinkhole was noted for the first time in the west embankment slope above the culvert inlet during the 2007 inspection.

SITE OBSERVATIONS

Key observations from the June 2011 inspection are listed below. Please also refer to the attached Figure S10(C)-1 for a site plan.

- The sinkhole in the west embankment slope and above the culvert inlet that was first noted during the 2007 inspection has continued to increase in size, and is now up to 4.2 m wide and 1.2 m deep. The sinkhole is apparently linked to a gap or puncture in the culvert, causing ongoing erosion of soil as it slumps into the sinkhole and washes into the culvert. Photo S10(C)-1 shows the sinkhole location relative to the culvert inlet.

- Some soil debris was faintly visible within the culvert in 2009, several metres downstream from the culvert inlet. As shown in Photo S10(C)-2, it appeared that the soil was entering the culvert through a breach in the crown of the culvert pipe; however, it was not possible to get close enough to the debris to inspect in more detail. The water level was too high during the 2011 inspection to view the breach location.

- Minor cracking has formed in the road surface upslope of the sinkhole location.

- Cracking and settlement of the northbound lane approximately 30 to 50 m north of the culvert was noted, following the same pattern that was observed during the 2009 inspection. The extent of the crack aperture (20 mm) and vertical settlement (50 mm) was greater than has been observed in the past. There is also a steep drop from the edge of the pavement at this location. Please refer to Photo S10(C)-3.

- The slumping along the creek banks downstream of the culvert outlet does not appear to have worsened significantly since the 2008 and 2009 inspections (Photo S10(C)-4).

- A possible slump headscarp or tension crack was noted just upslope (less than 1 m) of the fenceline on the east road embankment slope above the culvert outlet during the June 2009 inspection. The crack was just visible through the grass cover, and had negligible aperture and down-drop at the time of the June 2009 inspection. No change was noted during the 2011 inspection.

- Erosion along the west ditch upstream and south of the culvert inlet has worsened since the June 2009 inspection. The rock armour repair constructed here in the past has been displaced exposing the geotextile fabric. Erosion has continued to the south beyond the repaired area. (Photo S10(C)-5).

- Erosion damage was noted in the east ditch, immediately south of the culvert outlet during the June 2009 inspection. There was no significant change in the condition of the ditch noted during the June 2011 inspection.

ASSESSMENT

As noted in the previous assessments, there are several geotechnical issues at this site:

- The ditch to the southwest of the site is becoming increasingly damaged by erosion.

- The sinkhole above the culvert inlet has become larger, and will likely start to undermine the west shoulder of the road in the future.

- Problems with the culvert.

    - Deformation and possible breaching of the culvert is the likely cause of the sinkhole in the road embankment slope above the culvert inlet. Slope instability around the sinkhole is worsening as the sinkhole becomes enlarged.

    - The culvert outlet is too low which causes standing water to back up in the culvert. This may be due to the settlement and deformation of the culvert pipe.

    - The east/west alignment of the culvert is skewed from the overall northeast/southwest alignment of the creek channel, and may be a factor causing the slumping in the creek banks downstream of the culvert outlet. This is of little to no consequence to the road surface, but is an off right-of-way impact from the highway culvert.

- Cracking and settlement of the road surface, north of the culvert.

    - 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. The damage has worsened since the 2009 inspection, possibly triggered by creek erosion of the toe of the slope and/or groundwater pressure.

    - The accumulated thickness of the multiple overlays has resulted in a steep slope (greater than 45°) along the east shoulder in the cracking area, with slope heights up to approximately 1.3 m. A guardrail is required as per AT’s highway design requirements.

The above-noted issues have not directly threatened the highway to date beyond creating an ongoing maintenance issue. The more significant vertical settlement of the road surface observed this year may warrant a speed reduction through the site area until the road is repaired. The sinkhole in the west road embankment slope is also a hazard to the public and perhaps during cattle drives across the site.

RISK LEVEL

The recommended Risk Level for the cracking and settlement of the road surface north of the culvert 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 4 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.

The current Risk Level associated with the problems with the culvert and the sinkhole over the culvert is judged to be lower than the Risk Level for the ongoing damage to the road surface.

RECOMMENDATIONS

Maintenance and Short Term Measures

- AT's maintenance contractor 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.

- The sinkhole in the west road embankment slope should be backfilled with coarse rock fill. See the recommendations below regarding a culvert repair for further details.

- The eroded segment of the west ditch should be graded out and lined with a geosynthetic product in order to minimize erosion of the exposed soils and promote vegetation growth. This could be supplemented with a series of check dams along the ditch to limit the velocity of the ditch flow, similar in concept to rock check dams as per AT's Best Management Practice #7 for Erosion and Sediment Control along highways.

Long Term Measures

- The apparent breach in the existing culvert should be mitigated by one of the following:
    - Clearing the soil debris from the culvert, installing a smaller diameter culvert through the existing 900 mm diameter culvert, and grouting up the annulus between the two culverts. This option is contingent upon it being practical to clear the debris and insert a new culvert along with a smaller diameter culvert being of sufficient size to pass the creek flows at this site. Also, this option would not resolve the issue of the existing culvert outlet being too low or the culvert alignment being skewed from the overall creek alignment.
    - Installing a new culvert immediately adjacent to the existing culvert, preferably using trenchless methods, and sealing/abandoning the existing culvert. The new culvert should be installed along a northeast/southwest bearing to more closely align with the overall creek channel alignment.
    - If possible, the new culvert should be designed to accommodate possible continued deformation of the road embankment.
- The annual site inspections should be discontinued unless repairs are implemented or the condition of the road surface is noted to have worsened considerably.

Investigation

The damage to the road surface north of the culvert appears to be due to a landslide. Past inspection reports had recommended treating this damage as a maintenance issue with patching and overlays to repair the damage. The increased damage observed in June 2011 may indicate that the landslide is becoming increasingly active, or that larger increments of movement that could be a hazard to vehicle traffic are possible. It is recommended that a borehole be drilled in order to check the fill and native soil profile/conditions and that a slope inclinometer be installed to establish monitoring for the depth of landslide movement. This should provide sufficient information for a repair design if the need arises. AMEC can submit a proposal for the borehole drilling and instrument installation, along with a subsequent repair design, at AT's request.

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
OCTOBER 28, 2011

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APEGGA Permit to Practice No. P-04546

Reviewed by:

Andrew Bidwell, M.Eng., P.Eng.
Associate Geological Engineer

Attachments: Figure S10(C)-1
Photos S10(C)-1 to S10(C)-5