August 28, 2009

CG25309.B

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

Attn: Mr. Ross Dickson

Re: Southern Region Geohazard Assessment Program
Site S33 – Highway 774, Beaver Mines/"Limber Pine Creek" Site
2009 Annual Inspection Report

This letter documents the 2009 annual inspection of the Beaver Mines/"Limber Pine Creek" site located approximately 4.2 km southbound along Highway 774 from Beaver Mines, AB.

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 9, 2009 by Mr. Andrew Bidwell, P.Eng. of AMEC in the company of Mr. Neil Kjelland, P.Eng. and Mr. Ross Dickson of AT.

BACKGROUND

The first work related to this site under AT's Southern Region Geohazard Management Program was a call-out site inspection by AMEC in June 2008. AT's request for the call-out inspection was due to reports by AT operations and/or maintenance contractor personnel of significant erosion of the downstream face of the large road fill embankment earlier in 2008. Please refer to the report on June 2008 call-out site inspection[1] for a site description along with the initial assessment and recommendations at that time.

[1] "Report On June 26, 2008 Site Inspection, Site S33 – Highway 774 "Limber Pine Creek", South Of Beaver Mines, Alberta", AMEC report submitted to AT, September 8, 2008, AT Consulting Services Agreement CE061/08, AMEC project no. CG25277.D.

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SITE OBSERVATIONS

The June 9, 2009 site inspection was the first inspection by AMEC since the initial inspection in June 2008.

Please refer to Figures 1 and 2, attached, for a site plan and cross-section of the highway embankment.

The key observations from the June 2009 inspection are summarized as follows:

- No repair work has been performed at the site since the June 2008 inspection.
- The road embankment fill erosion around the culvert outlet has continued since the June 2008 inspection, however the size of the eroded area does not appear to have increased significantly since June 2008. Photos 1 and 2, attached, show comparative views of the erosion area from the June 2008 and June 2009 inspections. The offset distance between the upslope extent of the erosion area and the downslope edge of the highway was in the order of 10 m or more at the time for both inspections.
- The secondary erosion area on the downstream embankment face and to the northeast of the culvert area did not look significantly worse than in June 2008. A trickle flow of seepage was discharging from the rock-filled area near the head of the secondary erosion area.
- The possibly tertiary erosion gullies on the mid to lower downstream face of the road embankment and further northeast from the culvert had not changed significantly since the June 2008 inspection. No seepage was noted in these areas, however they continue to have the appearance of having carried water flow at times in recent years.
- The road surface continues to show no signs of damage due to the embankment fill erosion around the culvert outlet.
- As shown in Photos 1 and 3, since the June 2008 inspection an additional 2.8 m length of the culvert outlet has broken away.
- The inlet and length of the culvert pipe were clear of sediment at the time of the inspection. It was possible to see through the entire length of the culvert (same condition as in June 2008) and the dent that was visible in the crown of the culvert during the last inspection did not appear to have changed. As before, the dent appeared to be within roughly the middle portion of the culvert length, however not possible to confirm when viewed from the outlet end of the culvert.

- Clear groundwater seepage was daylighting from several areas in the eroded embankment face within a few metres of either side of the culvert outlet. The seepage was daylighting at elevations around the crown of the culvert and below. Photo 3, attached, shows the distribution of seepage discharge around the culvert outlet. The seepage discharge was widespread and it was not possible to get even an approximate measurement of the seepage rate. Subjectively, the seepage rate appeared to be less than noted during the June 2008 inspection, however the rate of creek flow in June 2009 also appeared to be proportionally less than during the June 2008 inspection.

- Photos 4 and 5 show the area around and upstream of the culvert inlet as they appeared at the time of the June 2009 inspection. There were no significant changes in this area since the June 2008 inspection. The culvert inlet elevation remains slightly higher than it should be relative to the channel elevation (Photo 5).

- The slump in the natural ridge sideslope above the right creek bank immediately downstream of the culvert outlet had not changed significantly since the June 2008 inspection.

ASSESSMENT

The assessment of this site has not changed from the June 2008 inspection. Please refer to the report on the June 2008 inspection for further details. In summary:

- The failure of the culvert outlet and erosion of the embankment slope from around the culvert outlet appears to be due to the embankment backfill being eroded by groundwater seepage through the base of the embankment along with high exit gradients for the seepage around the culvert outlet. It is also possible that the seepage through the base of the embankment and around the culvert is causing piping erosion within the embankment. The groundwater seepage appears to be creek flow that bypasses the culvert due to the inlet being too high along with the broad, distributed nature of the creek flow in the area upstream of the highway (i.e. not a single, defined channel flowing directly into the culvert). There is also the possibility that there is leakage from the culvert into the base of the embankment that is contributing to the seepage around the culvert.

- The erosion area on the downstream embankment face has still not started to undermine the road surface. However, the oversteepened upper portion of the erosion area will not be stable over the longer term and it will eventually retrogress further upslope. This will eventually begin to destabilize the road surface.

- The visible dent in the crown of the culvert also raises the possibility of a breach in the top of the culvert and a void in the overlying embankment fill. There is no sign of

settlement or damage to the road surface from such a void. However, the experience with the culvert replacement during the repair at the S16 – Chain Lakes site on Highway 22, where such a void above an existing culvert collapsed and damage the overlying road surface during the trenchless installation of an adjacent culvert, showed that significant voids can develop above breaches in the culvert with no indication at the road surface due to arching or mobilization of shear strength of the backfill over the culvert.

RISK LEVEL

Based on AT's Risk Level Criteria, the recommended Risk Level for this site is as follows:

- Probability Factor of 11 to reflect the likelihood that ongoing seepage through the embankment will continue to erode the downstream face of the embankment. The embankment is also vulnerable to future peak flows along the creek channel which may result in a short term increase in the seepage volume and exit gradient through the embankment, and advance the erosion.

- Consequence Factor of 4 to reflect the size of fill embankment involved and the potential for loss of service of the southbound lane if the erosion area retrogresses further upslope.

Therefore, the recommended Risk Level is 44, which is the same value as recommended after the June 2008 inspection.

RECOMMENDATIONS

The 2008 recommendation that the site should be repaired as soon as practical remains valid.

Please refer to the report on the 2008 site call-out site inspection for a discussion of a number of repair options for this site. The 2008 recommendations for culvert and erosion area repair remain valid, as follows:

> *[It is recommended to] install a new, smaller diameter culvert/HDPE pipe through the existing culvert and grout the annular space between the two pipes. This option should be less expensive than a trenchless installation of a replacement culvert. However, it may not be possible to install a new culvert/pipe through the existing one due to the dent visible in the existing culvert and a smaller diameter culvert may not have sufficient flow capacity for this site. Also, this option would not mitigate the possible voids in the embankment around the original culvert aside from possibly at least partially filling some voids with grout that leaks outwards through any holes in the existing culvert.*

It should be noted that a replacement culvert installed in this way may not have sufficient flow capacity. The design basis for the sizing of the original culvert should be checked prior to confirming this report method, in order to see if a larger culvert is actually required, or would be prudent in any case to buffer against short term peak flows along the creek due to localized, high intensity rainstorms in this foothills area.

In addition to a culvert replacement, the 2008 report also recommended:

1. *Trimming back the oversteepened headwall areas of the erosion area to a gentler slope.*

2. *Placing a layer of geotextile on the erosion area face, then backfilling the erosion area with granular material. The geotextile will prevent fine-grained material from the embankment fill from piping out into the granular backfill. The granular backfill material will need to be suitably graded to prevent groundwater flow through the lower portion of the embankment from eroding it away.*

3. *Spreading topsoil across the backfilled area and revegetating the slope.*

A fall-back option of abandoning and sealing off the existing culvert and the trenchless installation of a replacement culvert is still available.

AMEC understands that AT's Bridge Group has also inspected this site and is contemplating this type of repair, supplemented with "flares" around both the inlet and outlet of the new culvert in order to direct flow into the replacement culvert and promptly away from the culvert outlet upon discharge. The scheduling for any such repair is not known at the time of writing.

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

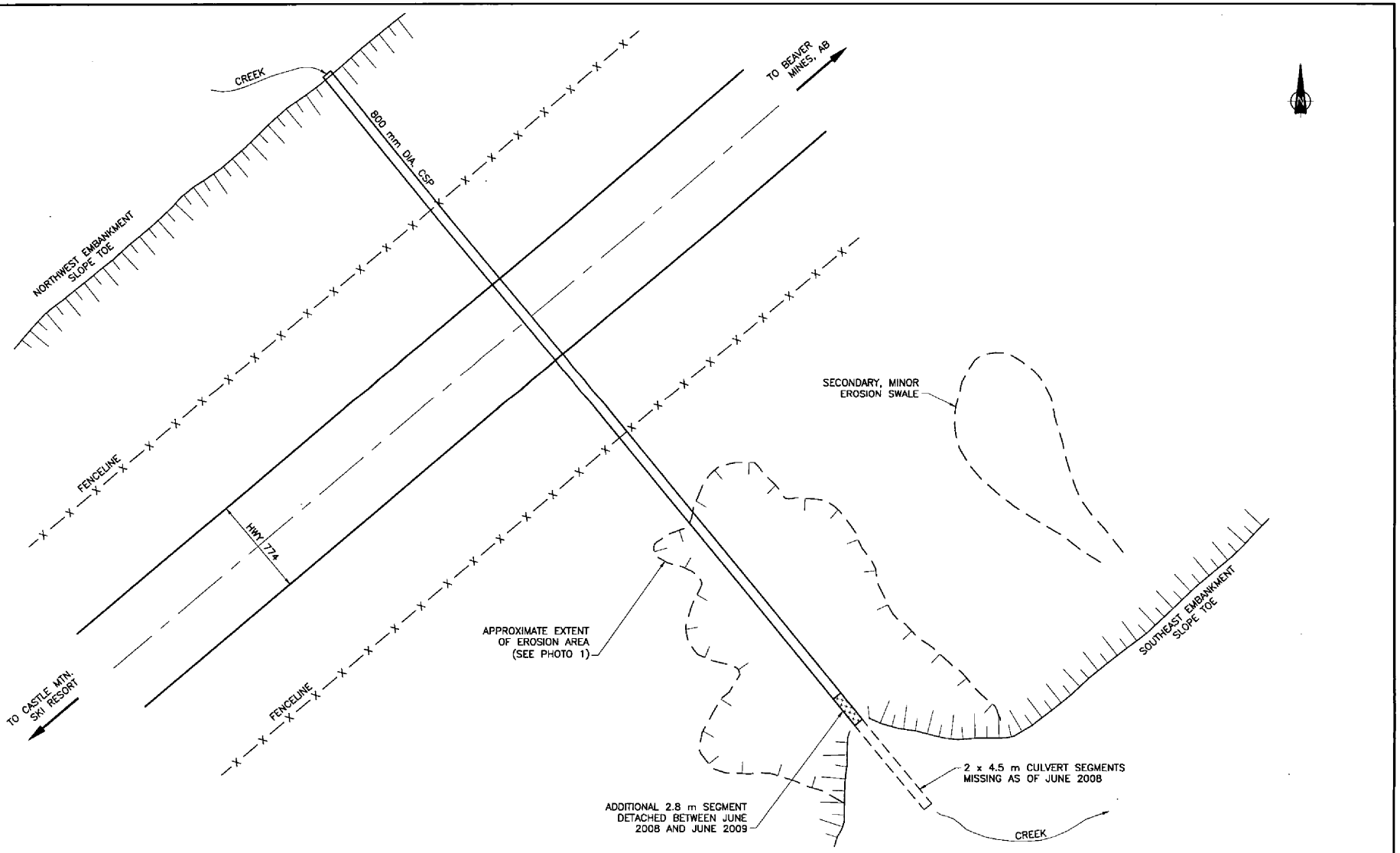
Andrew Bidwell, M.Eng., P.Eng.
Associate Geological Engineer

APEGGA Permit to Practice No. P-04546

Reviewed by:

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

Attachments: Figures 1 and 2
Photos 1 to 5



APPROXIMATE SCALE
1:300
0 2 4 6 m

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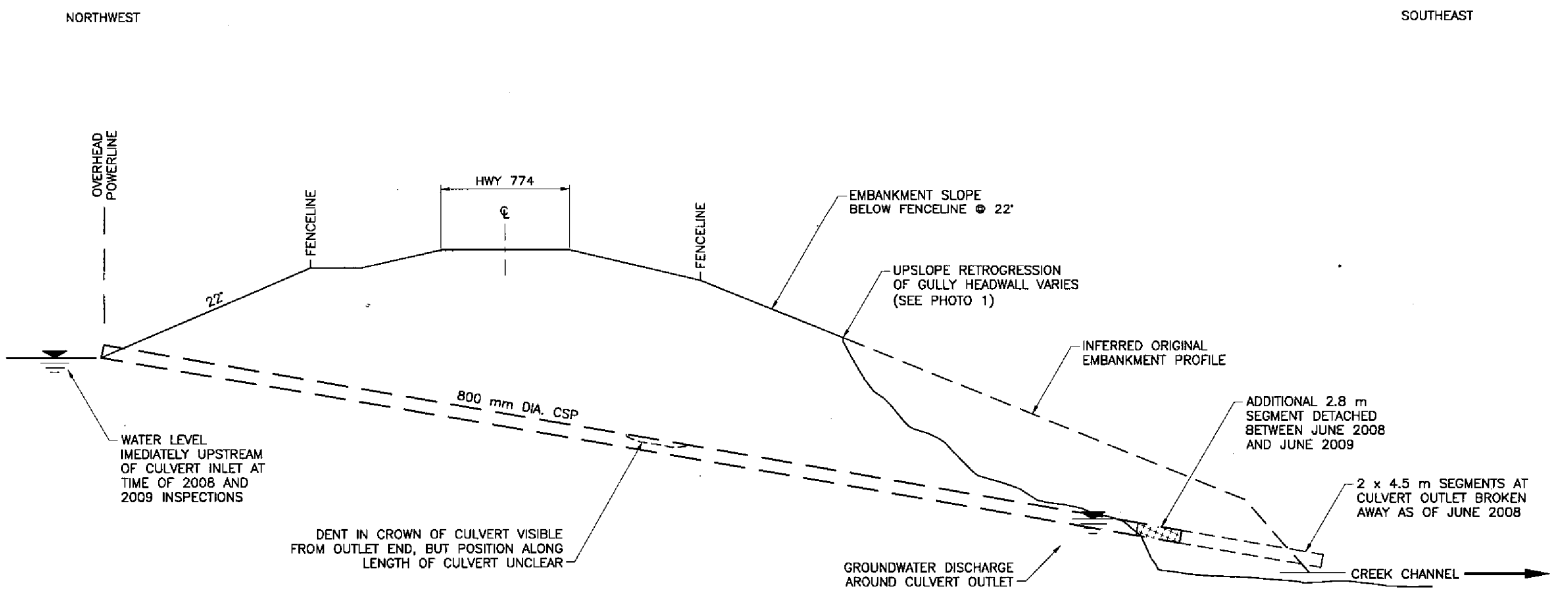
CLIENT: ALBERTA TRANSPORTATION

PROJECT: SITE S33 - BEAVER MINES / "LIMBER PINE CREEK"

TITLE: SCHEMATIC SITE PLAN

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2009	CG25309.B	25309B01.dwg	FIGURE 1	A



NOTES:

1. ALL DIMENSIONS APPROXIMATE.
2. CROSS-SECTION ALONG BEARING 135/315°.

APPROXIMATE SCALE
1:300
0 2 4 6 m

amec Earth & Environmental

CLIENT: ALBERTA TRANSPORTATION

PROJECT: SITE S33 - BEAVER MINES / "LIMBER PINE CREEK"

TITLE: CROSS-SECTION ALONG CULVERT ALIGNMENT

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2009	CG25309.B	25309B01.dwg	FIGURE 2	A

Photo 1 – June 2009 (top)
Facing upstream towards the southeast embankment slope. Note the failure of the culvert outlet and the erosion around the outlet that has retrogressed up the embankment slope towards the highway. Compare the extent of erosion with Photo 2, taken in June 2008.

Photo 2 (bottom)
June 26, 2008 photo.

Photo 3 – June 2009 (top)
Culvert outlet within the erosion area on the downstream face of the embankment. Note the 2.8 m long segment of culver that has become detached since the June 2008 inspection. Note also the sloughed areas in the erosion slope around the outlet – these area delineate the groundwater seepage discharge around the culvert outlet.

Photo 4 – June 2009 (bottom)
Facing upstream from the highway, with the culvert inlet visible in the middle foreground.

Photo 5 – June 2009 (bottom)
Close-up view of the culvert inlet. Note how the inlet is slightly higher than the base of the creek channel.