Highway 940 – Km 14 Ditch Erosion Site

This site is located approximately 14 km northbound along Highway 940 from the intersection between Highway 940 and Highway 3, in Coleman, AB. The site location is shown on Figures B1 and B3 in Appendix B. The site coordinates are listed in Table B1 in Appendix B.

The site inspection was performed on September 27, 2008 by Mr. Andrew Bidwell, P.Eng. of AMEC.

Background

AMEC is not aware of any previously reported problems or repair work at this site. The September 2008 site inspection was performed as part of the Highway 940 geohazard corridor review.

A general description of the geological and climatic conditions in this area is presented in Section 5.2 of this report.

Site Observations

- The segment of the highway at this site is a two lane, gravel surface road oriented north/south as it crosses through a low pass between the Blairmore Creek watershed (to the south) and the Vicary Creek watershed (to the north). The treed, lower slopes of Grassy Mountain are east and upslope of the road, and the area immediately west of the road is relatively flat-lying between the road and the lower slopes of McGillivray Ridge further to the west.

- The attached site sketch shows the layout of the site and the relative locations of the site features described below.

- There is significant erosion and downcutting along an approximately 110 m segment of the west road ditch. The northern limit of the erosion is around the outlet of a 500 mm diameter culvert, as shown in Photos 940-1 and 940-2. The erosion extends southwards (downstream) along the ditch. The southern limit of the erosion is around the inlet of another culvert to the south that carries the west ditch drainage back over to the east ditch, as shown on the attached site sketch.

- The ditch erosion widens and deepens to approximately 2 m maximum depth starting around 40 m south from the outlet of the north culvert. Photo 940-2 shows this segment of the ditch. Fine grained, clayey soils are exposed in the ditch base and sidewalls in this area. There are numerous slump failures along the ditch sidewalls in this area. At the time of the inspection, the west edge of the road had not been directly undermined by the slumping in the ditch sidewalls.

- There is a minor, seasonal creek channel flowing down the treed slope above (east) of the road and the 500 mm diameter culvert is positioned to carry the flow from this channel across the road alignment. As shown on the attached site plan sketch, there is a fork in the creek channel a short distance upslope of the road. The main fork curves to the north and is intercepted by the east road ditch approximately 10 m north (upstream) of the culvert inlet (see Photo 940-4). The secondary fork continues downslope more or less flowing directly towards the culvert inlet (see Photo 940-5). It appears that the creek flows through the main (north) fork except during peak flow periods when a portion enters the secondary (south) fork.

- There was no flow in the creek channel, culvert or ditch at the time of the inspection. The culvert was open and clear of debris. The road surface was undamaged and there were no indications that peak flows along the creek or in the east ditch overflow from the ditch and go across the road surface.

Assessment

There is a risk that the west edge of the road will become directly undermined by the slumping in the sidewalls of the west road ditch if the erosion and downcutting along the ditch downstream of the culvert outlet continues and possibly worsens in the future. However, the road has not been damaged to date.

The existing 500 mm diameter culvert appears to be of sufficient size to carry the peak flows along the creek channel. It appears that the majority of the creek flow is intercepted by the east road ditch at the main (north) fork in the channel approximately 10 m north/upstream of the culvert inlet. It would be preferable to have the culvert inlet at the main (north) fork so that it would intercept the majority of the flow directly. However, it does not appear that there have been any problems to date with the east ditch overflowing and creek flow spilling onto the road surface.

Risk Level

The recommended Risk Level for this site, based on AT's general geohazard risk matrix, is as follows:

- Probability Factor of 6 because the slumping in the ditch sidewalls is active, but with an uncertain rate of movement and rate of retrogression towards undermining the west edge of the road.

- Consequence Factor of 2 based on the potential loss of a portion of the roadway if the west edge of the road becomes undermined by ongoing ditchwall instability, but not to the point where the highway would need to be closed pending repair work.

Therefore, the recommended Risk Level for this site is 12.

Recommendations

Maintenance and Short Term Measures

The maintenance contractor should visually monitor the site conditions as part of the routine maintenance along the highway. If the west edge of the road becomes undermined due to ongoing ditch erosion it may become necessary to place signage to warn motorists of the reduced road width until repairs are completed. It may also become necessary to place a line of jersey barriers to restrict traffic to the northbound side of the road.

Long Term Measures

The slumping along the west ditch sidewalls could be mitigated by one of the following:

1. Excavate the destabilized material along the ditch sidewalls and then reconstruct the ditch base and sidewalls with compacted backfill to a suitable cross-section (i.e. a suitable ditch depth relative to the road surface and sideslopes at inclinations that will remain stable over the long term). Line the reconstructed ditch with a geosynthetic product in order to protect from erosion under future peak flows.

Or

2. Reinforce and support the existing ditch sideslopes with launched soils nails, and then line the ditch and sidewalls with a geosynthetic product for surface erosion protection.

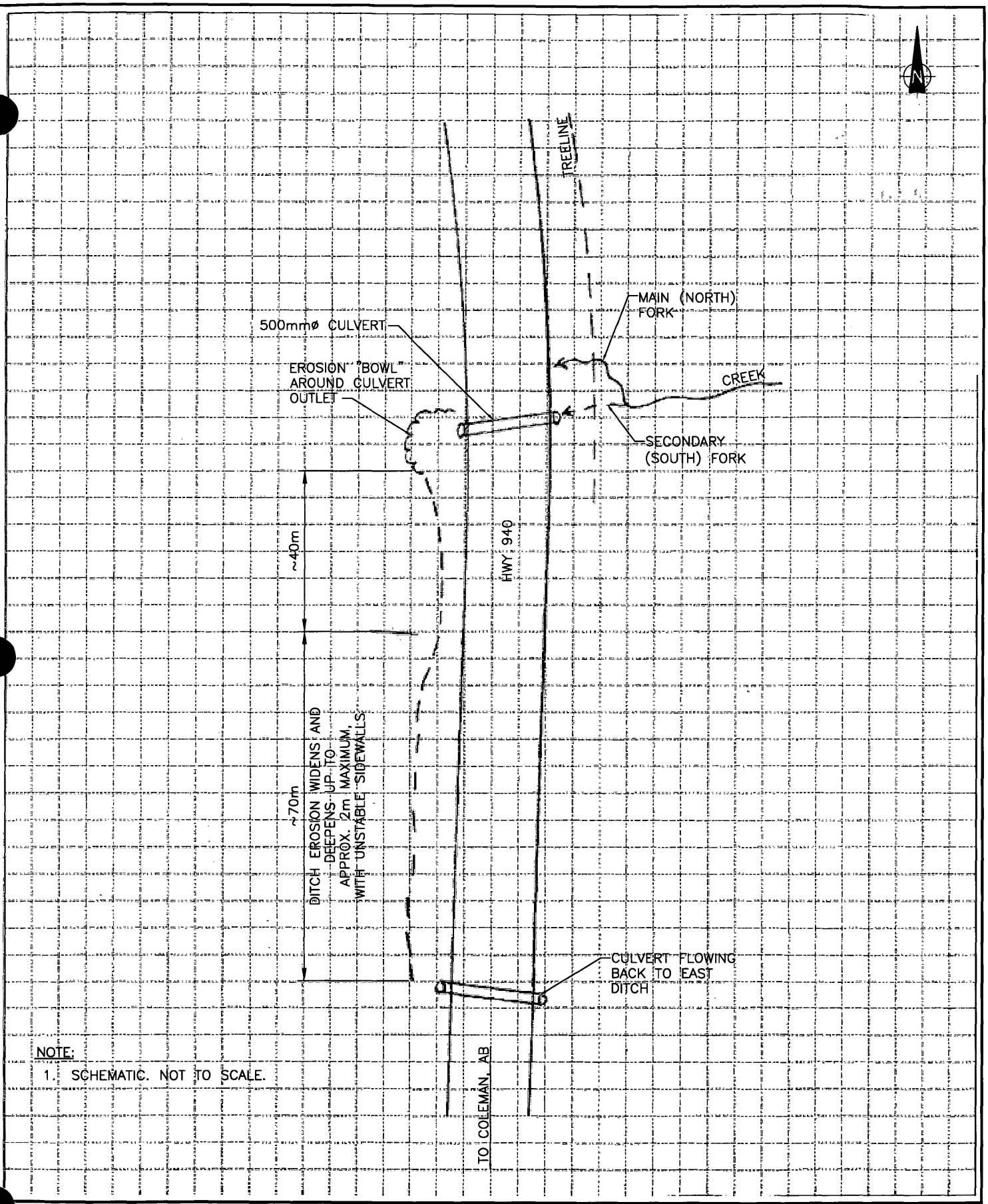
It is recommended that AT consider Option 1. Soil nailing (Option 2) may not be an effective repair method for this site due to the relatively shallow nature of the slumping. Furthermore, soil nailing would not mitigate the potential for further downcutting of the ditch base and at this site is likely cost-ineffective relative to Option 1.

A simpler version of Option 1 would be to dump coarse (i.e. cobble to boulder-sized) material into the west road ditch in order to create a shallower ditch that would buttress the oversteepened and unstable sidewalls. However, this option would likely not be as effective over the long term because it would not mitigate the oversteepening of the upper portion of the ditch sidewalls as effectively as a reconstruction of the ditch sidewall with compacted, erosion-protected backfill. In addition, migration of fine grained soils from the ditch sidewalls into the coarse rock fill would likely reduce the permeability of the fill over time.

In addition to the above, a second culvert could be installed approximately 10 m northbound of the existing culvert and aligned with the main (north) fork of the creek channel. This would distribute flow input to the west ditch between the two culverts and may help to mitigate the erosion "bowl" at the existing culvert outlet (as shown in Photo 940-1). However, this is not recommended because it does not appear that the east ditch has been overflowing during peak creek flows. Furthermore, the second culvert would not mitigate the erosion and downcutting of the west ditch downstream of the existing culvert outlet, because the total volume of flow in the west ditch would not change.

Investigation

No site investigation work is recommended at this time.



NOTE:

1. SCHEMATIC. NOT TO SCALE.

amec Earth & Environmental

CLIENT: Alberta Transportation

PROJECT: HWY 940 GEOHAZARDS REVIEW

TITLE: Km 14 DITCH EROSION SITE

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
JANUARY 2009	CG25262	25262Z06.dwg	.	A

Hwy 940 – Km 14 Ditch Erosion Site

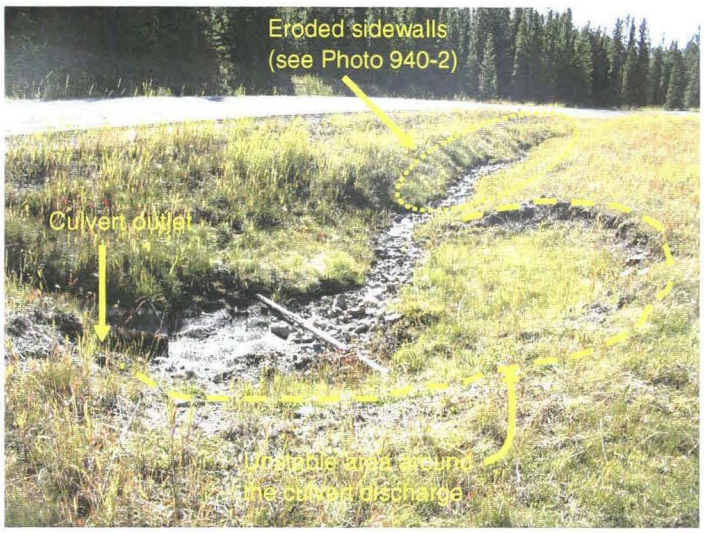


Photo 940-1 (top) – Facing southbound and downstream along the west ditch. The outlet of the existing 500 mm diameter culvert is in the left foreground. Note the "bowl" of destabilized ground around the area where the culvert discharges, and the erosion along the ditch sidewalls further downstream.

Photo 940-2 (middle) – Closer view of the erosion and downcutting along the segment of the west road ditch downstream of the culvert outlet. There are numerous slump failures along the ditch sidewalls in this area. The west edge of the road is at risk of becoming undermined if the slumping continues in the future, but has not been damaged to date.

Photo 940-3 (bottom) – Facing northbound and upstream along the west road ditch. The downcut and eroded segment of the ditch shown in Photo 940-2 is visible in the middle background of this photo.

Hwy 940 – Km 14 Ditch Erosion Site

Photo 940-4 (top) – Main (north) fork of the seasonal creek in the slope above the highway. The main fork discharges into the east road ditch approximately 10 m upstream/ northbound of the culvert inlet.

Photo 940-5 (bottom) – Secondary (south) fork of the seasonal creek in the slope above the highway, draining directly towards the culvert inlet.