

## **SECTION B – SITE VISIT AND ASSESSMENT**

### **2007 SITE INSPECTION**

#### **Eastbound Lane Site**

##### **Site Description and Background**

This site is located on Highway 507, west of Pincher Creek, AB and approximately 4 km west of the junction between Highway 6 and Highway 507. Please refer to Figures S24-1 to S24-3 in Appendix S24 for an illustration of the site location, the site layout and a typical cross-section.

The highway is located approximately 500 m north of the channel of Pincher Creek and along the crest of the north Pincher Creek valley slope. This valley is a broad, relatively flat-bottomed valley incised approximately 30 m into a flat upland plain to the west of the town of Pincher Creek, AB. The local segment of the highway is straight along an east/northeast bearing of 074/254 and is approximately tangent to the curving crest of the north valley slope as shown on the plan view of the site, attached as Figure S24-2 in Appendix S24.

AMEC had previously inspected this site as a call-out request by AIT in September 2006. The purpose of the call-out request was to inspect cracking and settlement areas on the road surface at the site and develop geotechnical recommendations to mitigate the damage to the highway. A summary of the observations from the September 2006 site inspection is as follows:

- The settlement and cracking area is along an approximately 52 m long segment of the highway and encompasses the entire eastbound lane. This segment consists of a fill embankment approximately 3 to 4 m high that was placed to maintain the road grade across an area where the highway alignment crosses below the crest of the north valley slope and is across the uppermost portion of the valley slope.
- Figure S24-3 in Appendix S24 shows a cross-section through the damaged portion of the highway.
- Based on the road surface appearance at the time of the September 2006 site inspection, it appeared that the maximum vertical settlement prior to patching could have been in the order of 100 mm.

The report on the September 2006 site inspection concluded that the damage to the road surface was due to settlement of and/or shallow sliding/shearing in the embankment fill. This was supported by the location of the damage to the road as well as the semi-circular pattern of the boundary of the cracking and settlement.

The June 2007 site inspection by AMEC and AIT personnel was the first since September 2006 and the first annual inspection as part of the Southern Region GRMP.

### **Site Assessment**

The site assessment was performed on June 20, 2007. The weather at the time of the site assessment was clear and warm.

The site assessment consisted of a visual review of the highway surface at the site as well as the slope to the south of the highway.

### **Observations**

The cracking and settlement area on the road surface had been repaved in the spring/early summer of 2007 and the cracking had not re-formed as of the time of the site inspection. Therefore, it was not possible to make any detailed observations of the pattern and magnitude of damage to the road surface. Photos S24-1 to S24-4 in Appendix S24 show comparative views of the site from the September 2006 and June 2007 inspections.

The appearance of the slope face below the highway had not changed significantly since the September 2006 site inspection. There continued to be no signs of toe bulging or other deformation of the slope face adjacent to the settlement and cracking area on the road surface.

### **Assessment and Risk Level**

The assessment of the risk to the highway at this site is unchanged from the September 2006 site inspection. In summary:

- Based on the location of the damage as well as the semi-circular pattern of the boundary of the cracking and settlement as seen during the September 2006 site inspection, it appears that the damage to the road surface at this site has been due to settlement of and/or shallow sliding/shearing in the embankment fill.
- The lack of a toe bulge or other signs of deformation in the fill embankment downslope of the damaged area on the road surface suggests that the settlement of the road surface is due to insufficiently compacted and/or compressible fill material underlying the road. Any such settlement would be expected to continue to something in the order of 5 to 10 years after construction and attenuate thereafter. The construction date for this segment of the highway is not known.
- Periods of significant precipitation would likely trigger additional settlement via water entering open cracks in the road surface, which would explain the apparent link between damage to the road surface and wetter than average summers as reported by AIT personnel. This would be consistent with experience with similar damage to other AIT sites in the Southern Region, e.g. the Highway 762 sites at Square Butte and Fisher Creek where poor quality fill material (poorly graded and including organic matter) was identified as the cause of similar damage to the road surface.

The recommended Risk Level for this site remains the same as listed in the report on the September 2006 site inspection:

- Probability Factor of 9 to reflect the active settlement and cracking during the past year.
- Consequence Factor of 2 to reflect the minor damage to the road surface to date, where it has been necessary to place marker signs to warn motorists.

Therefore, the recommended Risk Level is 18.

### **Recommendations**

AMEC recommends that any future cracking and settlement of the road surface be treated as a maintenance issue with regrading and patching of the road surface as necessary. The weight of additional patches to the road surface are not likely to further destabilize the fill embankment. It is possible that after further settlement the fill embankment will eventually stabilize but this is not certain.

It is also recommended that the annual inspections of this site under the Southern Region GRMP be discontinued unless AIT or maintenance contractor personnel report a change in the pattern or magnitude of damage to the highway at this site. Future inspections by AIT and geotechnical consultant personnel will likely provide little value unless a longer-term repair is to be implemented and follow-up inspections to check on the effectiveness of the repairs are required.

It may be possible to make a longer-term repair of the cracking and settlement by using launched soil nails to strengthen the fill embankment and reduce the potential for future settlement and shallow slope movement in the embankment. Another option would be to remove the existing fill embankment along the damaged segment of the highway and reconstruct it with engineered and compacted backfill (possibly including geogrid reinforcement) that will not experience significant post-construction settlement. If AIT wishes to investigate either of these options, it is recommended that a series of probe holes be drilled at the site to confirm the composition and condition of the backfill and the underlying native soil. The information from these boreholes can be used to confirm or revise the assessment that the damage to the highway is due to settlement and deformation within the fill embankment and provide a basis to proceed with either of these repair options.

### **Westbound Lane Site**

#### **Site Description and Background**

This site is located on Highway 507, west of Pincher Creek, AB and approximately 10.5 km west of the junction between Highway 6 and Highway 507. Please refer to Figures S24-1 and S24-4 in Appendix S24 for an illustration of the site location, the site layout and a typical cross-section.

At this site the highway is oriented along a bearing of 060/240 and crosses the approximately 8 to 10 m deep valley of an unnamed, seasonal creek that drains north towards the Castle River. The creek valley is relatively flat-bottomed with a marshy base to the south (upstream) of the highway. The seasonal creek flow is carried across the highway alignment by a 1000 mm diameter corrugated metal culvert at the base of the embankment. The road fill embankment at the damaged segment of the westbound lane is approximately 10 m high. The embankment sideslopes are at approximately 15° (3.7H:1V) inclination.

AMEC had previously inspected this site as a call-out request by AIT in September 2006. The purpose of the call-out request was to inspect cracking and settlement areas on the road surface at the site and develop geotechnical recommendations to mitigate the damage to the highway. A summary of the observations from the September 2006 site inspection is as follows:

- The settlement and cracking area in the westbound lane was approximately 38 m long and extended between the north edge of the pavement and the middle of the westbound lane.
- The northeast limit of the damaged segment of the highway was approximately 13 m southwest of the culvert alignment, as illustrated on Figure S24-4.
- At the time of the September 2006 inspection, the aperture of the open cracks in the road surface was up to approximately 25 mm and the vertical settlement at the cracks was typically around 50 to 75 mm.
- There was no visible deformation or bulging of the northwest embankment slope below the damaged segment of the westbound lane.
- There was a slump failure at the toe of the northwest embankment slope around the culvert outlet. Photo S24-8 in Appendix S24 shows the slump failure and its position relative to the culvert outlet. The headscarp of the slump is approximately 5 m above the toe of the embankment slope. Aside from this slump, the embankment slopes appeared to be stable and there were no visible areas of seepage discharge at the time of the inspection.
- The culvert appeared to be clear of debris but was visibly deformed (out of round) when viewed lengthwise from the outlet. It appeared that the central portion of the culvert was bowed towards the southwest, however it was too dark within the culvert to be sure of the pattern of deformation and to see if the culvert pipe was split or broken.

The report on the September 2006 site inspection concluded that the pattern of the settlement and cracking of the westbound lane could indicate a rotational slump failure in the northwest embankment slope. However, given the magnitude of the settlement observed at the road surface, a toe bulge/embankment slope deformation downslope of the damaged segment of the

road would be expected but was not observed. It is possible that the damage to the road is due to settlement of and/or shallow sliding in the embankment fill without the development of a toe bulge. The possibility of a break or opening along the culvert leading to internal erosion of the embankment fill and subsequent settlement of the overlying road surface was also noted, however considered less likely due to the offset of the damaged segment of the road surface from the culvert alignment.

The June 2007 site inspection by AMEC and AIT personnel was the first since September 2006 and the first annual inspection as part of the Southern Region GRMP.

### **Site Assessment**

The site assessment was performed on June 20, 2007. The weather at the time of the site assessment was clear and warm.

The site assessment consisted of a visual review of the highway surface at the site as well as a traverse of the west embankment slope and around the culvert outlet.

### **Observations**

As for the Eastbound Lane site, the cracking and settlement area on the road surface at the Westbound Lane site had been repaved in the spring/early summer of 2007 and the cracking had not re-formed as of the time of the June 2007 site inspection. Therefore, it was not possible to make any detailed observations of the pattern and magnitude of damage to the road surface. Photos S24-5 to S24-8 in Appendix S24 show comparative views of the site from the September 2006 and June 2007 inspections.

The appearance of the west embankment slope and the slump around the culvert outlet at the toe of the west embankment slope had not changed significantly since the September 2006 site inspection.

### **Assessment and Risk Level**

The assessment of the risk to the highway at this site is unchanged from the September 2006 site inspection. In summary:

- The pattern of the settlement and cracking of the westbound lane could indicate a rotational slump failure in the northwest embankment slope. It is possible that the damage to the road is due to settlement of and/or shallow sliding in the embankment fill.
- The apparent deformation of the culvert at the base of the embankment raises the possibility that internal erosion of the embankment is occurring via a break in the culvert. This could have led to the development of voids within the embankment possibly resulted in settlement of the overlying road surface. This scenario is not considered to be the likely cause of the damage to the road surface because settlement due to internal embankment erosion near the culvert would likely occur directly above or close to the culvert location, whereas at this site the boundary of the visible cracking in the

road surface is offset approximately 13 m from the culvert. However, the possibility of internal erosion in the embankment cannot be ruled out on this basis. It is worth noting that during landslide repair work at the Chain Lakes site along Highway 22, a large void (metres in dimension) was discovered in the fill embankment above a pair of deformed and breached culverts. This void had developed due to internal erosion of the embankment with little to no indication in the overlying road surface.

The recommended Risk Level for this site remains the same as listed in the report on the September 2006 site inspection:

- Probability Factor of 9 to reflect the active settlement and cracking during the past year.
- Consequence Factor of 3 to reflect the minor damage to the road surface to date, however with the uncertainty regarding the potential for void formation within the embankment due to internal erosion into a breach in the culvert pipe. This value is higher than the recommended value for the Eastbound Lane site, but that is considered reasonable because the Westbound Lane site involves a fill embankment with less options for a temporary detour lane if required due to future road damage.

Therefore, the recommended Risk Level is 27.

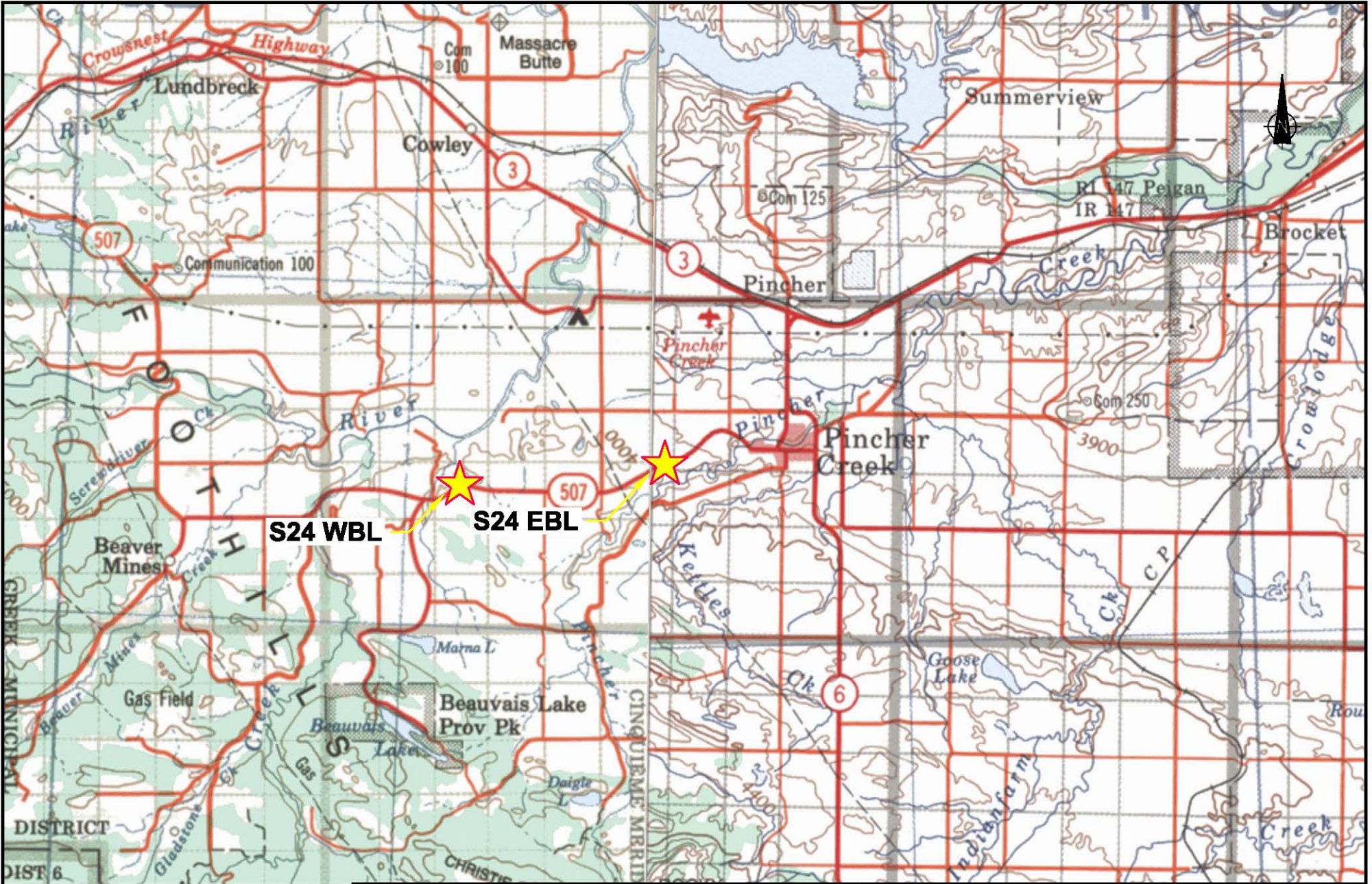
### **Recommendations**

AMEC recommends that any future cracking and settlement of the road surface be treated as a maintenance issue with regrading and patching of the road surface as necessary. In parallel to this, AMEC recommends the following path forward to clarify the Risk Level at this site and determine the best option for repairing the settlement and cracking of the road surface if required.

1. Drill a series of boreholes in the road within the settlement and cracking area as well as adjacent areas including around the culvert. These boreholes can be used to determine the composition and condition of the fill material both within and adjacent to the damaged area as well as to check for voids within the embankment. This information will help to confirm the cause of the damage to the road surface and provide a basis to select and design repair measures.
2. If the boreholes do not reveal any signs of voids or internal embankment erosion, then the options for repairing the damage to the road surface could be:
  - a. Continue treating the settlement and cracking of the road surface as a maintenance issue.
  - b. Excavate the affected segment of the road and reconstruct with engineered backfill, possibly including geogrid reinforcement.
  - c. Use soil nail reinforcement to strengthen the portion of the embankment around the settlement and cracking area.

If significant voids due to internal embankment erosion are encountered in the boreholes, then the existing culvert should be repaired/replaced and the eroded portion of the embankment reconstructed.

It is also recommended that the annual inspections of this site under the Southern Region GRMP be discontinued unless AIT or maintenance contractor personnel report a change in the pattern or magnitude of damage to the highway at this site. Future inspections by AIT and geotechnical consultant personnel will likely provide little value unless a longer-term repair is to be implemented and follow-up inspections to check on the effectiveness of the repairs are required.



SCALE



**amec** Earth & Environmental

CLIENT:



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TITLE: LOCATION PLAN  
S24 - HIGHWAY 507 SITES

DATE: AUGUST 2007

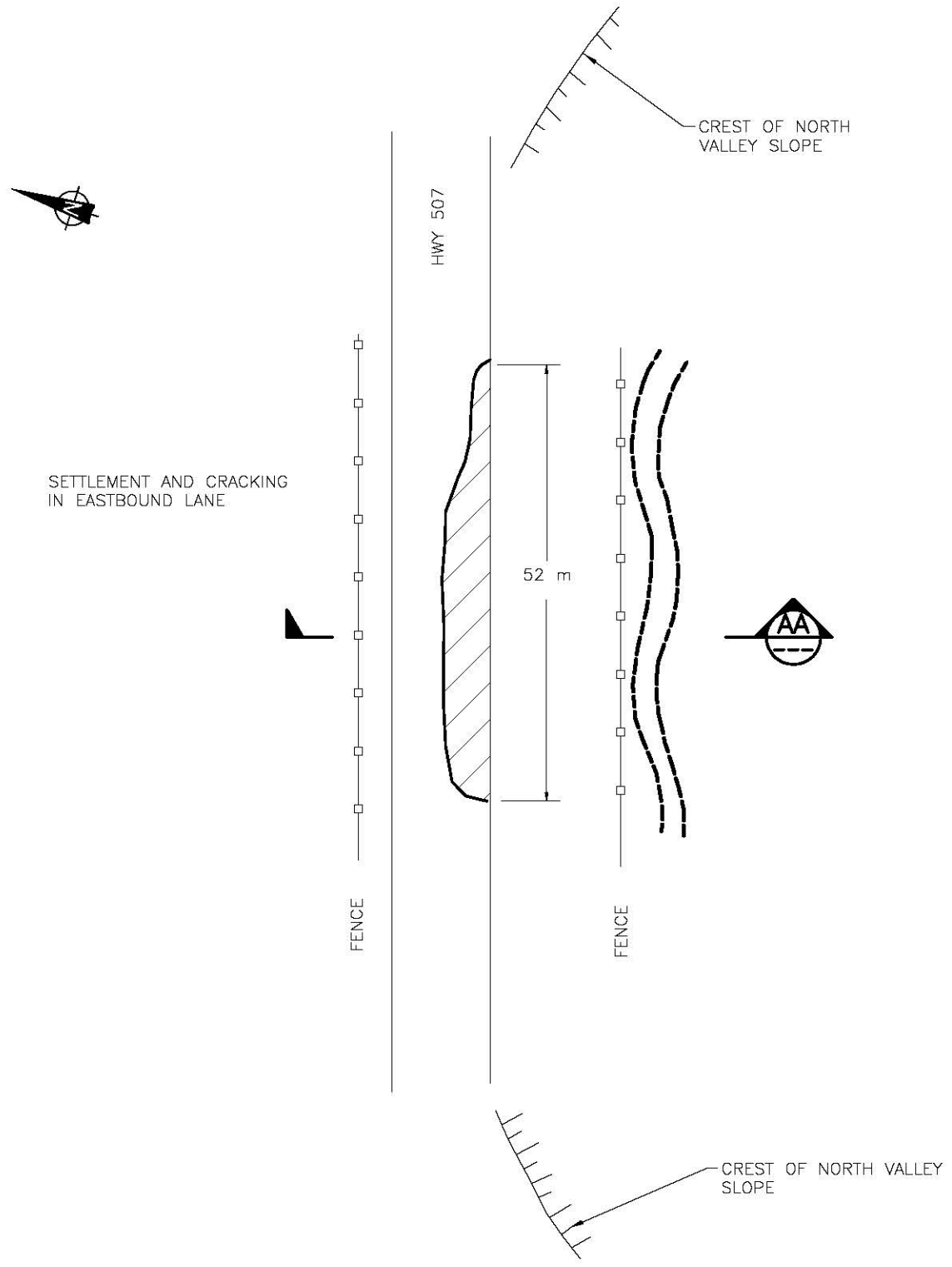
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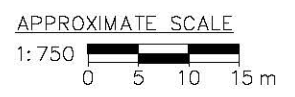
FIGURE No.: S24-1

REV. A

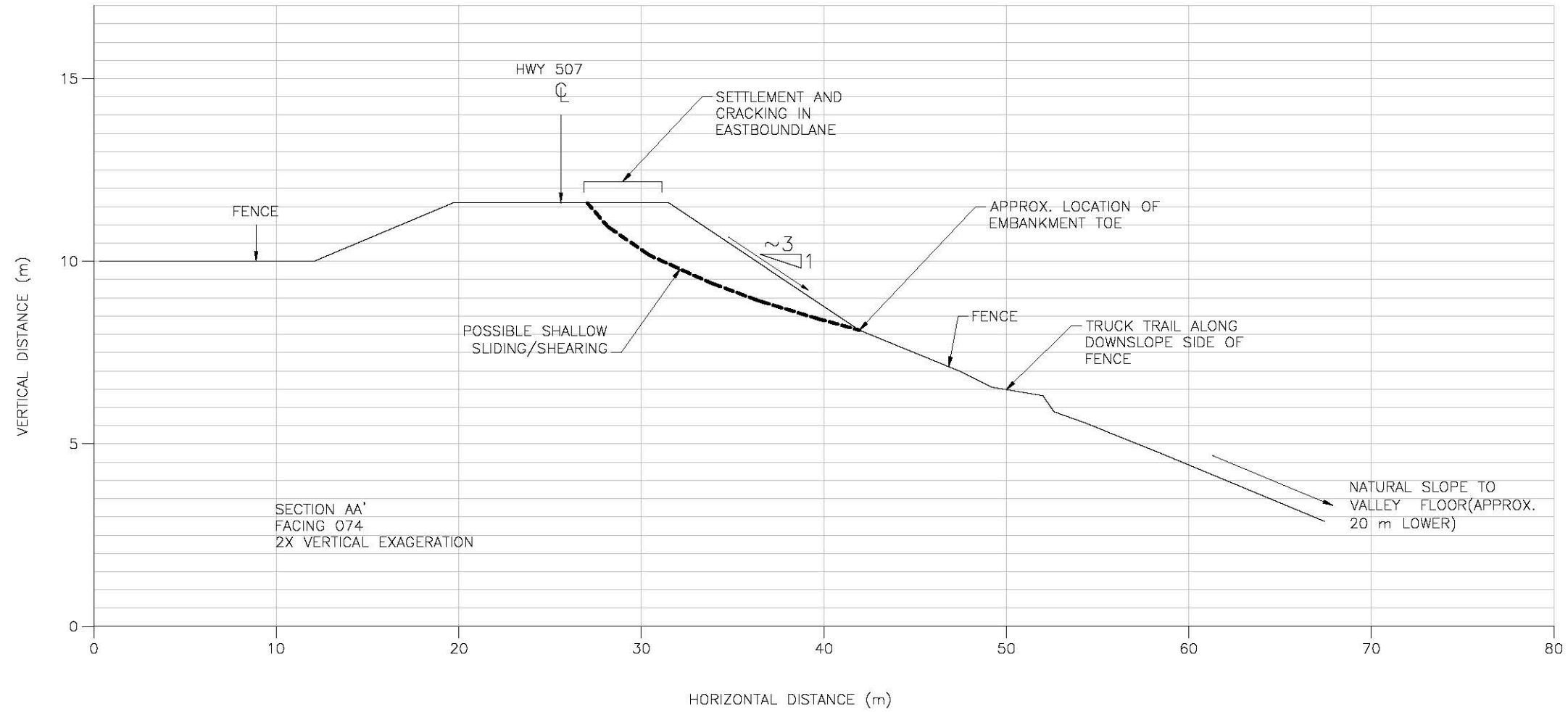




**PLAN VIEW**  
SCALE 1:750

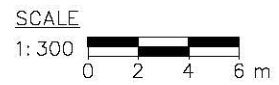


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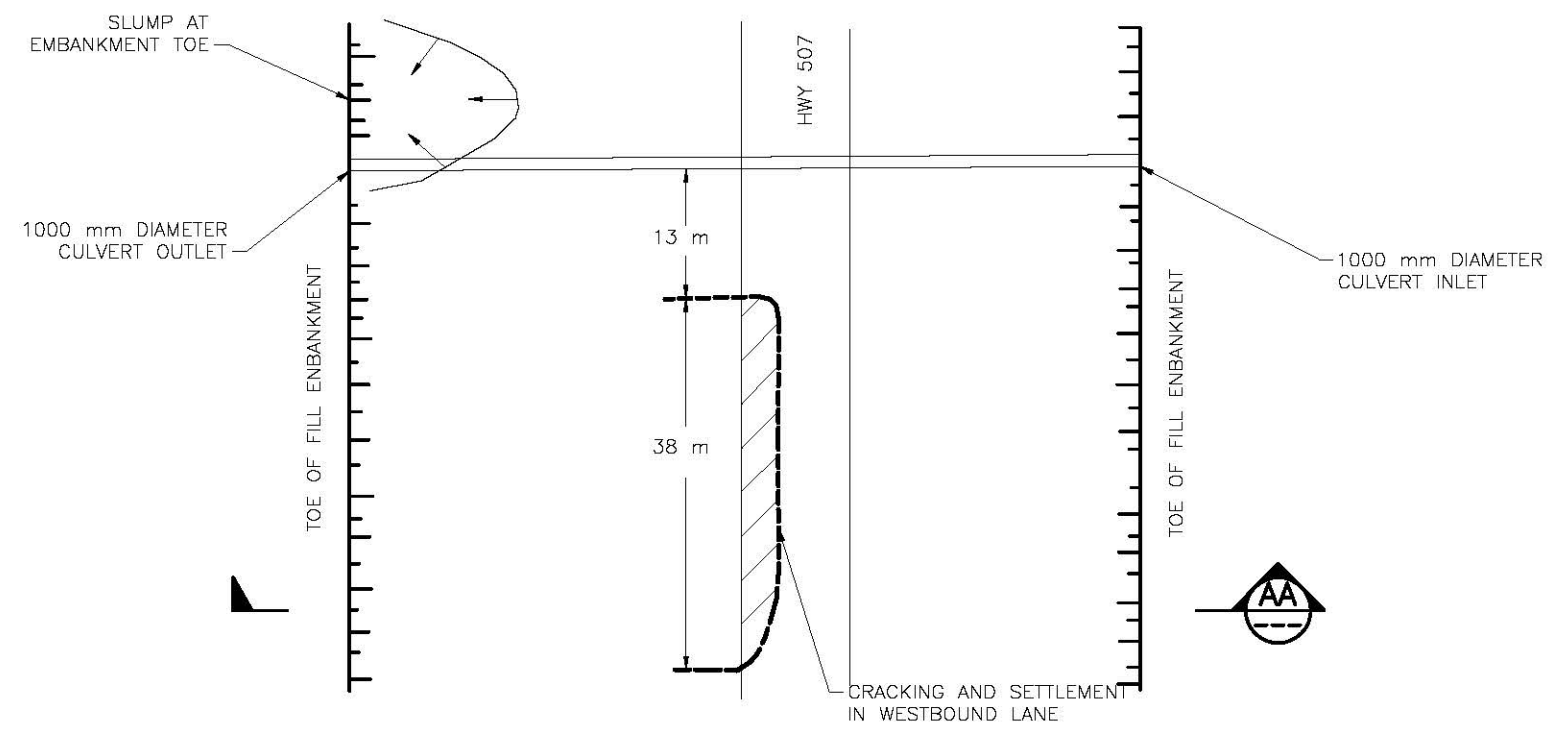
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**A PROFILE**  
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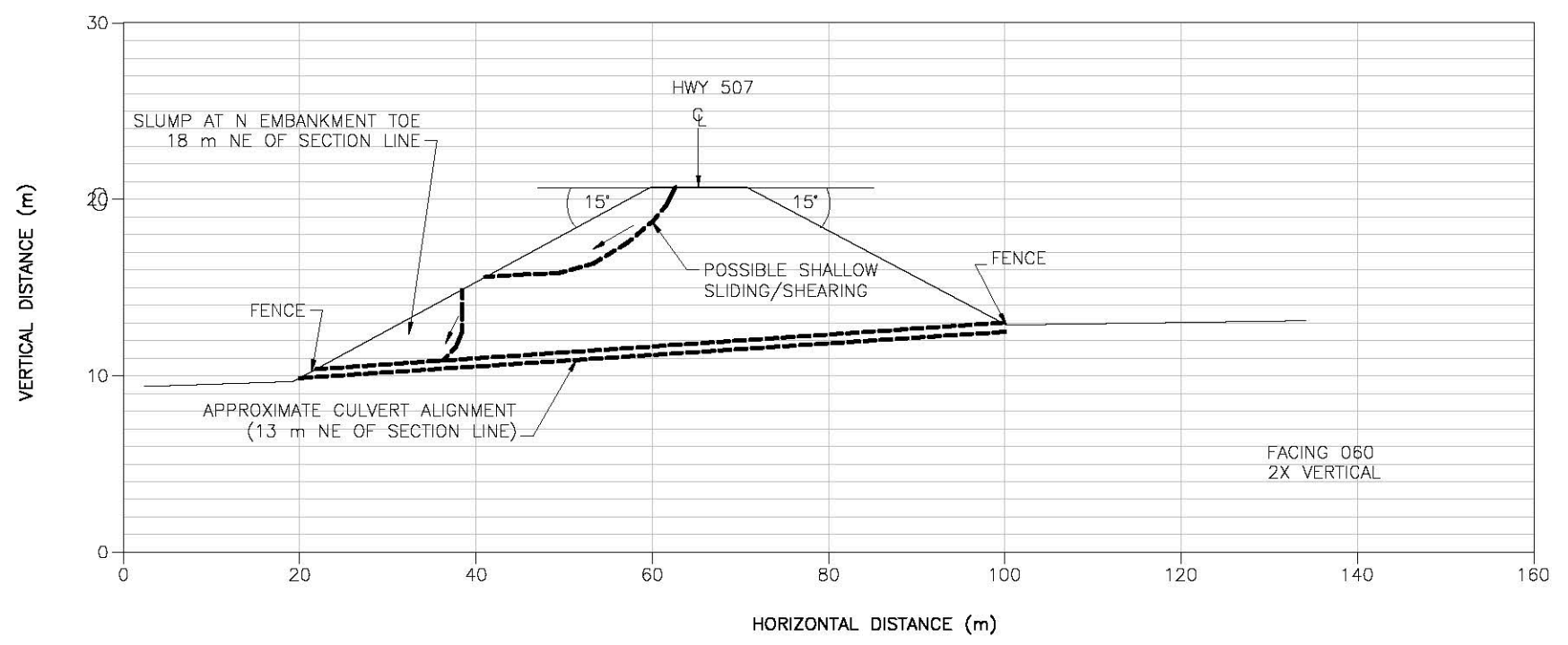


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					REV. A

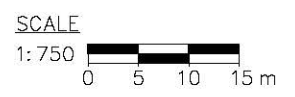
I:\CO\25263\25263\00.dwg - FIGURE S24-4 - Aug. 23, 2007 2:32pm - scott.leathers  
 PLOT 1:1=B (L)



**PLAN VIEW**  
SCALE 1:750



**AA SECTION**  
SCALE 1:750



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		TITLE: S24 - HWY 507 - CROSS - SECTION OF EASTBOUND LANE SITE			
CLIENT:		DATE: AUGUST 2007	JOB No.: CG25263	CAD FILE: 25263X00.dwg	FIGURE No.: S24-4
				REV. A	



**Photo S24-1– Eastbound Lane Site – June 2007**

(upper left)

Facing west across the recently repaved settlement and cracking area at the Eastbound Lane site. The north slope of the Pincher Creek valley is to the left of this photo. Compare with Photo S24-2 which shows the damage in this area as it appeared in September 2006 before the recent paving.



**Photo S24-2– Eastbound Lane Site –**

**September 2006** (upper right)

Same area as shown in Photo S24-1, with visible damage to the road surface



**Photo S24-3– Eastbound Lane Site –**

**September 2006** (lower left)

Facing east across the recently repaved settlement and cracking area at the Eastbound Lane site. The north slope of the Pincher Creek valley is to the right of this photo. Compare with Photo S24-4 which shows the damage in this area as it appeared in September 2006 before the recent paving.



**Photo S24-4 – Eastbound Lane Site –**

**September 2006** (lower right)

Same area as shown in Photo S24-3, with visible damage to the road surface. The damaged segment of the highway appears to be limited to the area where the road was built atop a 3 to 4 m high fill embankment on the upper portion of the north valley slope.



**Photo S24-5 – Westbound Lane Site –September 2006**  
(upper left)  
Facing southwest across the recently repaved settlement and cracking area in the westbound lane. Compare with Photo S24-6 which shows the damage to this area as it appeared in September 2006 before the recent paving.



**Photo S24-6 – Westbound Lane Site –September 2006**  
(upper right)  
Facing southwest across the settlement and cracking area in the westbound lane with visible damage as it appeared in September 2006.



**Photo S24-7 – Westbound Lane Site –September 2006**  
(lower left)  
Facing northeast across the settlement and cracking area in the westbound lane, as it appeared in September 2006. The semi-circular pattern of the cracking is consistent with a rotational slump failure in the northwest embankment slope (left side of photo), however a corresponding toe bulge below the road was not observed. The linear cracks in the eastbound lane (right hand side of photo) are judged to be unrelated to the circular cracking pattern in the westbound lane.



**Photo S24-8 – Westbound Lane Site –September 2006**  
(lower right)  
Slump failure along the toe of the northwest embankment slope, near the culvert outlet.