

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – SWAN HILLS
2020 INSPECTION**



Site Number	Location	Name	Hwy	km
SH013-13	Little Smoky River	Little Smoky River Valley, North Hill – Site #13	744:02	21.36-21.49
Legal Description		UTM Co-ordinates		
SE28/SW27-76-22-W5M		11U E 478,608	N	6,162,922

	Date	PF	CF	Total
Previous Inspection:	12-Jun-2019	11	4	44
Current Inspection:	3-Jun-2020	11	4	44
Road AADT:	240		Year:	2020
Inspected By:	Rocky Wang, TRANS		Ken Froese, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items			

Primary Site Issue:	Highway traverses deep-seated, retrogressive landslides with ongoing creep movements due partly to erosion at toe by the Little Smoky River and Peavine Creek resulting in cracking and sagging of the pavement surface at numerous locations. Approx. 4 km of the highway crosses this unstable north valley slope. An active slump developed in Fall 2018 in the east embankment slope near the location of the previously-repaired 2002 slide. Site #13 is 55 m above and 310 m away from the Peavine Creek and 35 m above and 115 m away from the tributary gully.
Dimensions:	20 m wide active slide on east side of embankment.
Date of Remediation:	<u>1997:</u> Investigation and construction of gabion wall and surface pipe to direct culvert outflow. <u>2002:</u> Downslope slump excavated, subdrain installed, and backfilled with imported clay. <u>2014:</u> Repair of upslope side of embankment <u>2017:</u> Installed new 760mm SWSP culvert, placed fill on upslope side, new riprap apron on downslope, and grouted old culvert.
Maintenance:	Routine ACP crack sealing, milling, and patching, when required. <u>2017 (post-inspection):</u> Overlay through Sites 13, 15, and 14 2020: Line painting

Observations:	Description	Worsened?
<input checked="" type="checkbox"/> Pavement Distress	Crack pattern predominantly in the SBL with differential settlement.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Ongoing creep movement toward Peavine Creek. North portion of embankment slid in September 2019 removing part of the gabion wall	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Loss of vegetation and change in flow patterns due to Sept. 2018 slide is causing erosion at several locations including loss of material into the valley below. Gully forming in NW quadrant from ditch flow.	<input checked="" type="checkbox"/>

<input checked="" type="checkbox"/> Seepage	Some seepage noted at location where old culvert was cut off.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	Riprap apron deteriorating due to high flows in spring and lower portion lost or covered due to slide.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Other	Gabion basket wall north half lost due to Sept. 2018 slide and south half deformed by erosion and scarps.	<input checked="" type="checkbox"/>
Instrumentation:		
None.		
Assessment:		
<p>The overall valley slope is moving as several separate slide blocks in response to the toe erosion and downcutting of two different rivers resulting in numerous scarps, sag ponds, and differential movement zones going in slightly different directions. The highway intersects the scarps of these blocks at several locations resulting in an uneven highway surface and cracking.</p> <p>This site may be affected by the deep-seated valley movements; however, localized movements are the primary concern. The formation of an erosion gully below the culvert outlet led to the requirement for the initial repair in 1997. Subsequent replacement of a slumped portion of the downslope embankment was required in 2002. In 2008, a failure developed on the west side of the embankment (upslope) which continued to retrogress toward the road. A temporary repair undertaken in 2014 had not slowed movements which obstructed the culvert inlet resulting in ponding of water in the upslope ditch. In spring of 2017, the Maintenance Contractor pushed a 760 mm smooth-wall steel pipe (SWSP) through the embankment. The inlet is approximately 1.2 m higher than the old culvert and some of the softened material was left in place. Approximately 300 m³ of pitrun was placed on the embankment sideslope. The riprap apron at the outlet was extended about 10 m past the gabion wall. The old culvert was grouted (approximately 35 m³ of grout required) and the damaged surface pipe removed. The soils immediately above the new culvert and in the ditch, bottom were soft and wet with standing water. Settlement cracks are present in the sideslope and highway surface which may continue to worsen until settlement is complete. The ditch bottom was improved during the summer of 2017.</p> <p>Heavy spring runoff in 2018 has led to erosion and undermining of the riprap apron below the culvert outlet particularly immediately below the outlet where the discharge flow impacted the top of the apron. There was also erosion, displacement of riprap, and damage to the gabion basket wall further down-channel. In Fall 2018, a portion of the east embankment slope failed at the approximate location of the 2002 slump. By 2019, the scarp was approximately 20 m in width up to the north tree line and extended through the gabion wall removing the north half of it. The scarp was approximately 12 m from the highway at the closest point. In 2020, the scarp had widened to 22 m and about 11 m from the highway. Three of the five stakes placed in 2019 had to be relocated away from the encroaching scarp. The remaining south half of the gabion wall has displaced further and the retrogressive slumping below it is affecting the riprap apron including the erosion bowl forming below the culvert outlet. The UAV flight taken over the site in 2020 was used to refine the site drawing. Also observed on the UAV imagery is a potential scarp about 25 m north which is likely related to slumping of the downcutting ravine to the east and will be verified during the next site inspection.</p> <p>There is significant risk of undermining of the east embankment due to the continued erosion of the slide mass and retrogression of the gully.</p>		

Recommendations:

Short-Term:

- Road maintenance should continue as necessary to maintain a safe roadway surface and may consist of milling, patching, and crack sealing of the ACP.
- Routine observation of the site, particularly following periods of heavy precipitation, to ensure that the slide mass has not retrogressed closer to the highway.
- Preliminary engineering design should be undertaken so that there are developed options available should there be rapid deterioration of the site.

Medium-Term:

- A pile wall could be constructed across the narrower downslope end of the sideslope near the outlet of the old culvert to buttress the slope. The slump in the east embankment could then be reconstructed with geogrid-reinforced fill after over-excavating the slide material.
- A surface pipe should be installed from the new culvert extending further down the gully to where it meets the tributary coming down from Site #14.
- The ditches coming down the east embankment (once the north portion has been rebuilt) should be lined with riprap or other erosion protection and the flow directed to the gully where it should be discharged in a controlled manner.

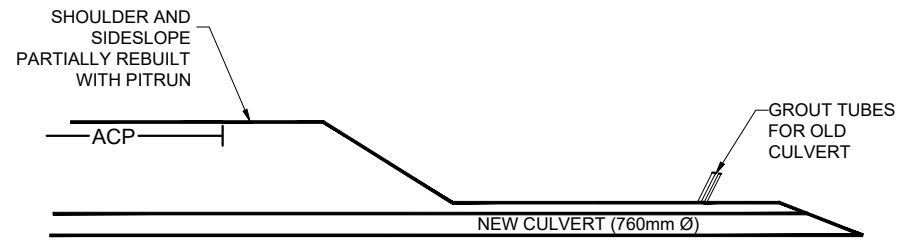
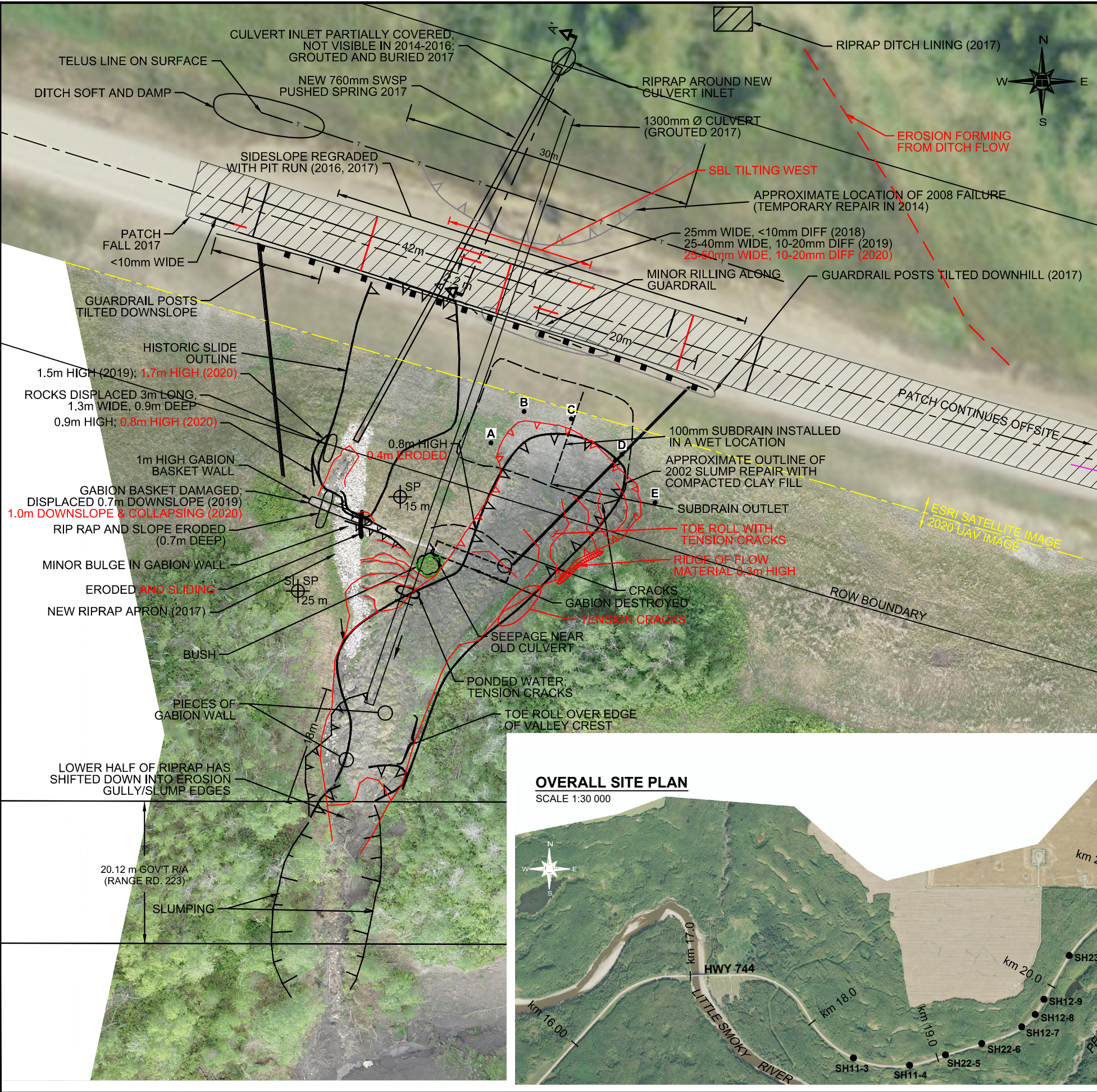
Long-Term:

It is understood that, at this time, the only long-term remediation option under consideration is realignment of the entire north hill section of Highway 744. However, given the high cost of this option and as it is a low volume highway, it is unlikely that realignment will be undertaken in the near future.

Ongoing Investigation:

- It is recommended that the annual GeoHazard inspection should continue as scheduled.
- At least one deep slope inclinometer installed on the downslope side between the highway and the gabion basket should be installed to confirm the stratigraphy at the site and provide an indication of the depth and rate of movement. Additional test holes should be drilled if a pile wall is to be designed.

H:\13000\13355 Geohazard Assessment - Swan Hills (CON0017604)\Drafting\2020\KEF13355 SH013-13.dwg - 13 - Nov. 09, 2020



CROSS - SECTION A - A'
APPROX. SCALE: 1:300 (HAND MEASURED)

STAKE	SCARP (HEIGHT)	
	2019	2020
A	3.1m (1.5m HIGH)	? (1.8m HIGH)*
B	1.5m DOWNSLOPE 1.7m LATERAL	0.3m / 2.0m** (0.5m HIGH)
C	1.3m 11.6m TO GUARDRAIL	0m / 2.0m**
D	0.6m	FELL / 2.0m**
E	0.6m TO CRACK 1.9m TO SCARP (0.5m HIGH)	0.6m TO CRACK 1.9m TO SCARP (0.5m HIGH)

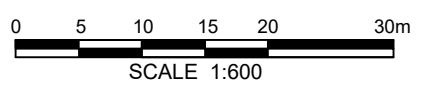
* STAKE MISSING; SCARP HEIGHT MEASURED AT APPROXIMATE LOCATION
** OFFSET FROM SCARP BEFORE/AFTER STAKE RELOCATED

NOTES

1. PREVIOUS OBSERVATIONS SHOWN IN BLACK
2. JUNE 2020 OBSERVATIONS SHOWN IN RED
3. THIS DRAWING TAKEN FROM EXH ENGINEERING SERVICES LTD. PROJ. NO. 1202177 WITH 2013-2015 OBSERVATIONS FROM AMEC FIGURE 1, PROJECT EG10030 (PROVIDED BY AT)
4. DUE TO SIGNIFICANT CHANGES OBSERVED IN 2019, NUMEROUS HISTORICAL FEATURES AND OBSERVATIONS WERE REMOVED FROM THIS DRAWING
5. SCARP EXTENTS UPDATED IN 2020 USING UAV PHOTOGRAMMETRY

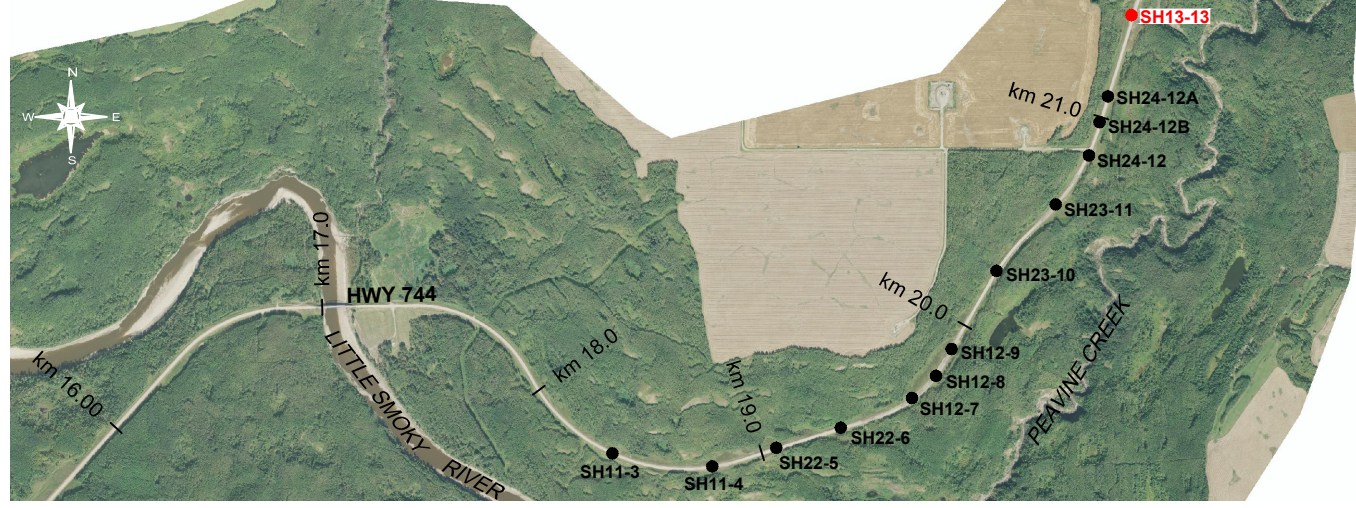
LEGEND

DIRECTION AND NUMBER OF PHOTO



SATELLITE IMAGE FROM VALTUS IMAGERY (DATED 2014)
UAV IMAGE ACQUIRED BY THURBER (2020)

OVERALL SITE PLAN
SCALE 1:30 000



PEACE REGION (SWAN HILLS)

**SH013-13: HWY 744:02 LITTLE SMOKY RIVER VALLEY
2020 SITE INSPECTION PLAN**

DWG No. 13355-SH013-13

DRAWN BY	KLW
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:600
DATE	NOVEMBER 2020
FILE No.	13355





Photo 1 – Looking south at reconstructed upslope shoulder - note tension crack forming in roadway with differential settlement.



Photo 2 – Looking north at reconstructed sideslope above culvert inlet.



Photo 3: Looking northwest at new culvert inlet.



Photo 4: Looking northwest at new culvert outlet. Erosion on left-hand side (south) is significantly worse and may be part of a retrogressive tension crack from the slide further down the slope.



Photo 5 – Looking south at gabion wall on downslope side of embankment. Note eroded south face of new riprap apron from culvert outlet. September 2018 slide has removed about half of the gabion wall.



Photo 6 – Scarps above and below the gabion wall at the riprap apron.



Photo 7 – Looking north at top of September 2019 slide block.



Photo 8 – Looking west at slide in the north half of the embankment with tension cracks extending into the south half at and below the gabion wall.



UAV Photo 1: Landslide on east side of highway embankment



UAV Photo 2: Potential scarp forming north of the main slide