

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2023 INSPECTION**



Site Number	Location	Name	Hwy	km
SH035-1	Southeast of High Prairie	Caudron Bridge	2:50	43.61 – 43.67
Legal Description		UTM Co-ordinates		
W10-74-14-W5M		11U E 558,678		N 6,139,283

	Date	PF	CF	Total
Previous Inspection:	30-May-2022	11	4	44 (Call-out)
Current Inspection:	5-Jun-2023	11	4	44
Road AADT:	1998		Year:	2023
Inspected By:	Kristen Tappenden, TEC Max Shannon, TEC		Ken Froese, Thurber Mark Gallego, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items			

Primary Site Issue:	Landslide on the north embankment with three scarp lobes encroaching into the pavement.		
Dimensions:	65 m long and embankment height of 4 m.		
Date of Remediation:			
Maintenance:	Spring 2023: Highway patched		
Observations:	Description	Worsened?	
<input checked="" type="checkbox"/> Pavement Distress	Landslide-related cracks in the outer wheel path of the WBL adjacent to scarp requiring patching. Secondary cracks forming in outer wheel path of WBL at east end of site.	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/> Slope Movement	Landslide scarp at highway edge with toe roll at ditch level approximately 65 m in length. Displacement causing distress at pavement edge and retrogressive scarps in pavement surface. Two of the high-tension steel cable (HTSC) guardrail posts are exposed at the scarp closest to and west of the culvert.	<input checked="" type="checkbox"/>	
<input type="checkbox"/> Erosion		<input type="checkbox"/>	
<input type="checkbox"/> Seepage		<input type="checkbox"/>	
<input checked="" type="checkbox"/> Bridge/Culvert Distress	BF 76479-2 appears to be in a good condition with no signs of distress. Slumping of the riprap on the west and east banks was observed downstream of the culvert.	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/> Other	The east end of the HTSC barrier was damaged, east of the culvert.	<input type="checkbox"/>	
Instrumentation:			
Standpipe Piezometer TH23-1 TH23-2 TH23-3	Short term groundwater monitoring indicated that the groundwater table varies between 1.5 m and 5.6 m below the existing ground surface.		
Assessment:			

A call-out inspection was conducted on May 30, 2022 for a slump in the north side slope of Highway 2:50 just west of a structural plate bridge culvert (BF76479-2) located at km 43.572. The culvert conveys the flow of a tributary to the Lesser Slave River across the highway. The culvert is 4.61 m in diameter, 49.99 m-long, and it was installed in 2016. Some minor grading work appeared to have taken place for the highway embankment and the channel at the culvert outlet location.

Based on AT correspondence, the slumping was first noted in 2017. The shoulder of the highway apparently dropped quickly after construction of the culvert. In April 2022, the slumping started to affect the outer wheel path of the north lane. A call-out inspection was requested by AT in May 2022 prior to undertaking patching of the cracks on the road.

At the time of the call-out inspection, the main slump on the west side of the culvert was approximately 65 m in length and had three "arcs" encroaching near the pavement edge. There was a visible toe roll over most of the length which was between 0.5 m and 0.7 m in height. The embankment increased in height from about 3.5 m at the west end to 4.5 m at the east. The west-most "arc" did not affect the highway and had approximately 1.0 m of vertical displacement. The second arc, with approximately 0.7 m of vertical displacement, was roughly parallel to the highway and there was a crack forming in the asphalt taper just south of the high-tension steel cable (HTSC) guardrail. The third arc, closest to the culvert, was the largest and had undermined one post of the HTSC which had increased to two posts in 2023. This scarp was about 9 m in width (measured at the edge of asphalt), about 1.2 m of vertical displacement, and was about 350 mm into the asphalt although still within the shoulder of the road. There appeared to be at least two layers of asphalt exposed in the scarp. In addition, there were parallel cracks in the outer wheel path of the north lane. The crack furthest into the highway was 60 mm wide with 80 mm of height differential. The north sideslopes of the embankment outside of the slumped zone are about 3H:1V becoming about 5H:1V over the culvert outlet.

In early 2023, the site was drilled for a preliminary engineering assessment (see Thurber Project 35964). The test holes drilled through the highway WBL, and the north ditch (locations shown on the drawing) encountered about 1.2 m to 3.5 m of clay fill overlying firm to stiff, high plastic native clay that extended to depths 2.7 m to 6.9 m below ground surface. The clay was underlain by clay till that extended to the bottom of the test holes.

During the 2023 geohazard inspections, the cracks on the highway upslope of the three "arcs" had been covered with the recent patch and had not yet reflected through. The west-most and middle arc did not appear to have indications of further displacement. For the third (east-most) arc, west of the culvert, the vertical displacement had increased by 0.1 m to a total height of 1.3 m. Three layers of asphalt were exposed and the granular base course (GBC) was also visible. Additional tension cracks were observed downslope of the third arc. Ponded water was also observed in the "bowl" areas of the west-most and middle arcs.

The culvert outlet itself continues to have no signs of instability. However, the slumping of the riprap on the west bank showed minor increases in displacement compared to the conditions observed during the call-out. The toe of the slump on the east bank north of the culvert outlet (about 17 m wide) appears to be constricting the channel. The gully created from the drainage channel from the east ditch widened since the call-out inspection.

The crack observed at and further east of the end of the HTSC, extended further west. The HTSC barrier was also damaged at this location. The embankment below is about 2 m high with a 4H:1V sideslope.

Record drawings of the culvert installation have not been reviewed; however, it appears that the slumping observed at the site is outside of the likely excavation and fill envelope of the culvert. Thus, the likely mechanisms of failure at this site may be similar to that observed at many other locations in this region: high groundwater table over the last few years combined with poor foundation soils (high plastic clays) and potential long-term loss of cohesion in the fill. Creek erosion at the toe of this slope is likely not a contributing factor to the current landslide condition as the creek angles away from the highway and area of distress.

Recommendations:**Short-Term:**

- Road maintenance should continue as necessary to maintain a safe roadway surface and may consist of patching and crack sealing of the ACP. It may be beneficial to place a small wedge of gravel or sand bags against the exposed face of edge of pavement to provide lateral support and potentially reduce the ravelling rate of GBC (if the scarp drops significantly to expose the GBC below the road).

Medium/Long-Term:

A geotechnical investigation was carried out during the preliminary engineering phase and the report provided two options for remedial measures:

- Excavate and replace the landslide mass with granular fill along with the construction of a gravel shear key
- Excavate the upper part of the slide and replace it with granular fill along with the construction of a clay toe berm

Based on the review meeting with TEC, the selected remedial option was Option 2 which includes excavating the upper portion of the failed landslide, replacing it with gravel and using suitable clay from the excavation for to construct a toe berm. Construction is scheduled for 2024.

Inspection:

- It is recommended that the Geohazard inspection should continue as scheduled (every other year).

Closure

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Tarek Abdelaziz, Ph.D., P.Eng.
Partner | Senior Geotechnical Engineer

Mark Gallego, M.Eng., P.Eng.
Geotechnical Engineer



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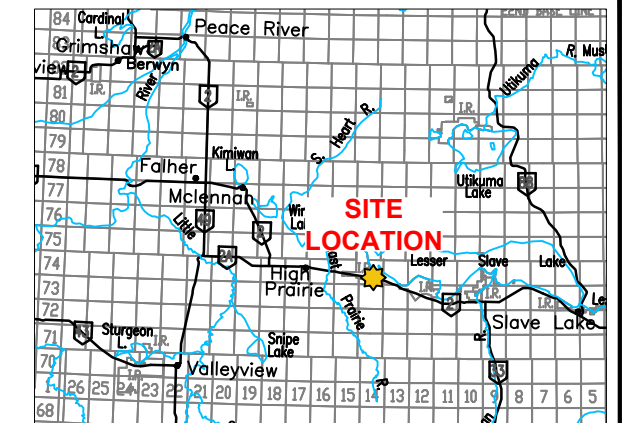
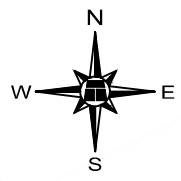
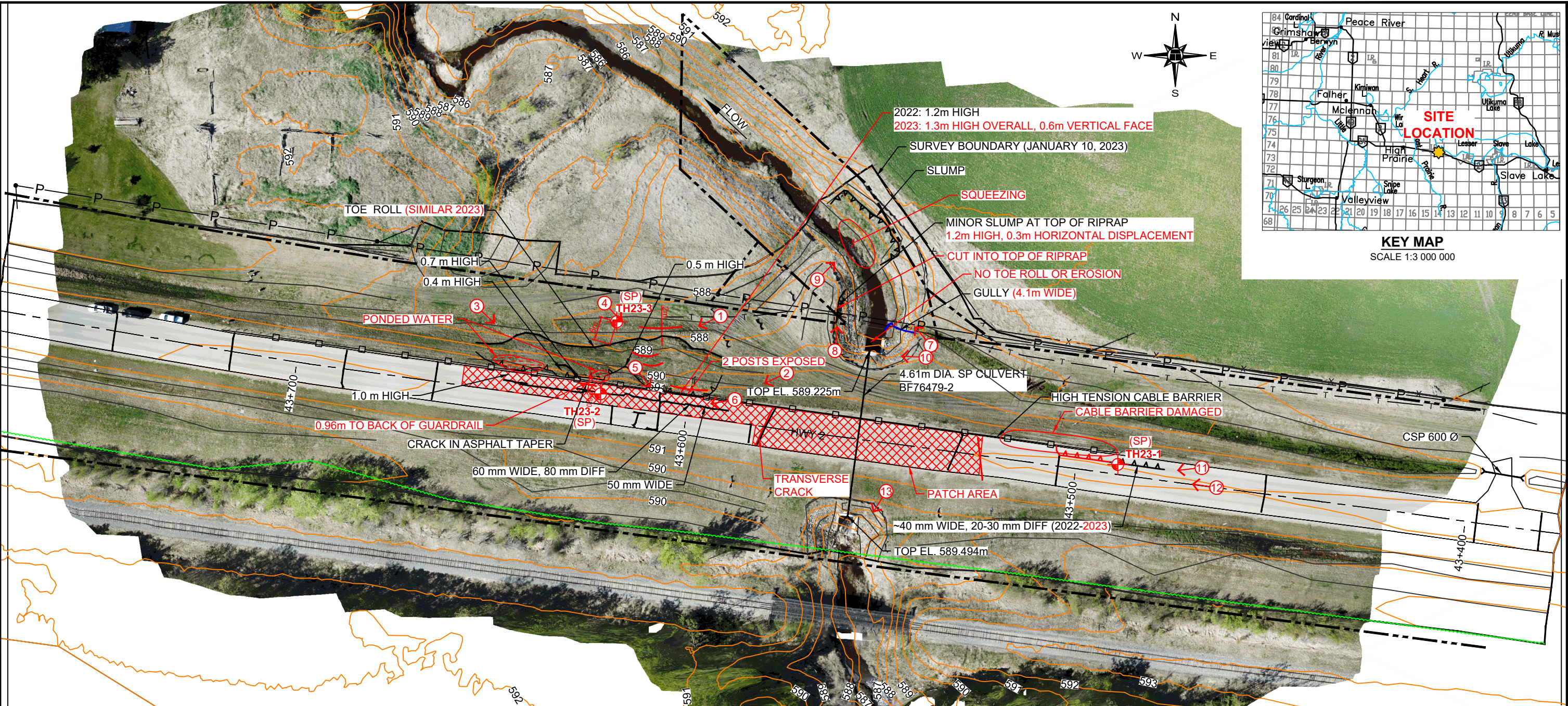
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KEY MAP
SCALE 1:3 000 000

LEGEND	
	CRACK (APPROXIMATE)
	LANDSLIDE SCARP CRACK
	APPROXIMATE TEST HOLE LOCATION
	STANDPIPE PIEZOMETER
	GROUND SURFACE CONTOUR (CONTOUR INTERVAL = 1m)
	GUARDRAIL
	POWER POST
	TELUS LINE
	FENCE LINE
	POWER LINE
	TREE LINE
	RIGHT - OF - WAY

NOTES
 1. FEATURE LOCATIONS ARE APPROXIMATE.
 2. JUNE 2023 OBSERVATIONS SHOWN IN RED.

SCALE 1:1000

ORTHOMOSAIC DERIVED FROM UAV IMAGERY FLOWN BY THURBER ON MAY 30, 2022
 GROUND SURFACE CONTOURS ARE FROM MCINTOSH PERRY SURVEYED JANUARY 10, 2023
 CONTOURS OUTSIDE SURVEY ARE FROM LIDAR

PEACE REGION (PEACE RIVER DISTRICT)

**SH035: HWY 2:50 km 43.4 TO km 43.7
2023 INSPECTION PLAN**

DWG NO. 32121-SH035-1

DRAWN BY	ML
DESIGNED BY	MG
APPROVED BY	TSA
SCALE	1:1000
DATE	OCTOBER 2023
FILE No.	35964

THURBER ENGINEERING LTD.



Photo 1 – Looking southwest at slump in north shoulder.



Photo 2 – Looking west from the east end of slump.



Photo 3 - Looking southeast at the slump.



Photo 4: Looking southeast at the east end of the slump; note the presence of a well-defined toe roll.



Photo 5 - Looking southeast at undermined guardrail and exposed pavement structure.



Photo 6 - Looking west at location of previous cracks and subsidence in highway above scarp shown in Photo 5.



Photo 7 – Looking north (downstream) along the creek. There is minor slumping at the top of the riprap on the west (left) side and a larger slump further downstream on the right (east) side.



Photo 8 – Looking at slumping above west riprap (somewhat obscured by grass).



Photo 9 – Looking northeast at slump on east side of channel.



Photo 10 – Looking west at culvert outlet, with slump beyond, and riprap with minor movement.



Photo 11 – Looking west at crack near east end of guardrail which is on the other side of the culvert from the main area of movement.



Photo 12 – Looking south at culvert inlet and adjacent rail bridge.