ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2022 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
SH003-1	North of Little Smoky River	Little Smoky River (North)	49:12	0.4-0.8
Legal Description		**UTM Co-ordinates**		
NW34-74-21-W5M		11U E 490,730	N 6,145,966	

	Date	PF	CF	Total
Previous Inspection:	28-Jun-2021	13	6	78
Current Inspection:	31-May-2022	13	6	78
Road AADT:	1450		**Year:**	2022
Inspected By:	Rishi Adhikari, TRANS Ed Szmata, TRANS Max Shannon, TRANS		Ken Froese, Thurber Mark Gallego, Thurber	
Report Attachments:	☑ Photographs ☑ Plans		☐ Maintenance Items	

Primary Site Issue:	Highway (aligned SW-NE) traverses WNW-oriented deep-seated (about 55 m), retrogressive landslide with ongoing creep movement over the entire valley slope due partly to erosion at toe by the Little Smoky River.	
Dimensions:	400 m length of highway affected by several intersecting scarps resulting in uneven riding surface. There is also a localized embankment failure on the north slope and erosion issues at specific locations. Approx. 1.5 km of the highway crosses this unstable east valley slope.	
Date of Remediation:	1990's: Draining and regrading of a sag pond adjacent to the highway. 2003: Slope flattening of the local instability failure. Fall 2020: Pavement overlay and guardrail replacement	
Maintenance:	2016: Grader-laid patch (350 t) 2018: $90,000 of milling on SH003 and SH004 Fall 2019: Milling both sides of valley for about 172,000 m^3 Spring 2022: Milling	
Observations:	**Description**	**Worsened?**
☑ Pavement Distress	Cracking and uneven roadway surface requires ongoing patching and milling.	☑
☑ Slope Movement	Overall slope movement continues and the localize failure at Sta. 0+640 to 0+680 continues to ravel.	☐
☑ Erosion	Gully at 0+460 culvert inlet continues to down cut and now encroaching toward highway. Surface erosion gully between Sta. 0+500 to 0+640 became somewhat deeper.	☑
☑ Seepage	Seepage observed at a few locations adjacent to the localized failure.	☐
☑ Bridge/Culvert Distress	Erosion bowl forming at outlet of culvert at 0+800 Slumping obstructing culvert inlet at Sta. 0+460	☑
☐ Other		☐

Instrumentation (Spring 2022):	
SI96-4, SI96-5, SI96-6	No discernable movement pattern (SI's may be too shallow)
SI31a	Sheared at 22.5 m; readings have continued above this depth after resetting in Spring 2017 and no discernable movement observed.
PZ01-1, PZ01-3, VW07-1, VW07-1A	Water levels at PZ01-1 and PZ01-3 generally stable over last decade with levels at 540 m and 515 m elevation, respectively. VW07-1 had been essentially stable since Fall 2016 at 14.3 m below ground but increased noticeably in Spring 2022 by 0.6 m; VW07-1A is currently stable at 18.2 m below ground.
Damaged/ Destroyed	SI01-3 (discontinued, main movement was at 48.7 m), VW07-1B

Assessment:

The overall valley slope is moving as several separate slide blocks resulting in numerous scarps, sag ponds, and differential movement zones and the highway is intersected at several locations by these features resulting in an uneven highway surface. The driving mechanism appears to be toe erosion by the Little Smoky River although stability analyses undertaken by others indicate that a high ground water table may also be contributing. Based on GPS survey of the inSAR points conducted by Alberta Geological Survey (AGS Open Report 2013-14), the central portion of the highway distress is situated on a faster-moving block (40 mm to 90 mm per year) compared to the rest of the east slope which is moving at 5 mm to 40 mm per year. Drawing 32121-SH003-1-1 shows some of the slide scarps and sag pond features that have been interpreted from the 2008 LiDAR imagery.

The ongoing movement of the valley slope results in continued deformation of the highway surface that requires frequent patching of the asphalt and required a recent overlay in the summer of 2020 to maintain the smoothness of the pavement. Cracks were started to reflect through the overlay by 2021 at various locations in between Sta. 0+570 and 0+770. Milling was required in Spring 2022 and most of the pre-overlay crack pattern has become re-established.

The localized embankment failure (Sta. 0+640 to 0+680) indicated potential movement at the west end in 2020, however, it appears to be relatively stable this year.

The erosion gully in the south ditch leading to the culvert inlet at Sta. 0+460 has noticeably deteriorated over the last three years resulting in the partial obstruction of flow to the culvert inlet. The erosion bowl at the nick point of this feature has widened and deepened leading to slumping which is eroding toward the highway.

Recommendations:

Short-term:

- Road maintenance should continue as necessary (once or twice annually) to maintain the roadway surface in a safe condition and may consist of milling, patching, and crack sealing of the ACP, even though an asphalt overlay was placed through the site in 2020.
- The gully from about Sta. 0+500 to 0+550 continues to downgrade. This could be repaired with minor excavation and replacement with pitrun gravel. Consideration could be given to topsoil and seed secured with an erosion control blanket.
- The erosion gully at the Sta. 0+460 culvert inlet is deteriorating and may affect the highway within a few years. Consideration should be given to regrading this section of the ditch and lining with erosion control measures (Class 1M riprap or concrete block blanket like Flexamat).
- The erosion bowl that has recently formed at the culvert outlet at about Sta. 0+800 should be repaired before it increases in size. This could consist of backfilling the bowl with pitrun gravel and adding riprap (there does not appear to have been riprap put around the outlet when the culvert was installed).

Medium-Term:
The localized embankment failure could be repaired using clay or pitrun backfill and regraded to match the surrounding slope. Alternatively, consideration could be given to using a geogrid-reinforced backfill to reduce the amount of fill, thus reducing the potential increase to the driving force on the slide block.

Long-Term:
The two alternatives for this location are: to realign the highway either using the existing bridge crossing or constructing a new one on more stable ground. Riprap could also be installed to control river erosion at the toe of the slope such that remedial measures above will have a longer effectiveness. It is understood that AMEC prepared a report under the High Water Related Mitigation Works program providing recommendations for erosion control at the toe and drainage measures on the slope to reduce the number and size of the sag ponds.

Ongoing Investigation:
- It is recommended that the annual Geohazard inspection and twice-annual instrumentation readings should continue as scheduled.
- At this time, additional test holes or slope inclinometers are not recommended at this site given the short life span of SIs. Consideration could be given to movement measurement methods that can tolerate higher displacements such as fibre optics or SAA.
- Consideration should be given to re-surveying the InSAR (interferometric synthetic aperture radar) targets, perhaps annually, to supplement the work done by the AGS as this will provide an overall view of ground movements.

A GPS real-time ground movement system (Geocube), that is less expensive than the current systems, may be an option worth considering at this site particularly for identifying lower-movement rate zones for potential realignment. Alternatively, a series of targets or pins would be surveyed twice a year to map out the slower-moving zones.

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.

Renato Clementino, Ph.D., P.Eng.
Principal | Senior Geotechnical Engineer

PROFESSIONAL ENGINEER ALBERTA
KENNETH E. FROESE
ID 80824
October 17, 2022

PROFESSIONAL ENGINEER ALBERTA
RENATO V. CLEMENTINO
ID 72376
October 17, 2022

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE:
RM APEGA ID #: 72376
DATE: October 17, 2022
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Ken Froese, P.Eng.
Geotechnical Engineer

THURBER

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LEGEND

- OPERATIONAL SLOPE INCLINOMETER
- SHEARED SLOPE INCLINOMETER WITH DIRECTION OF MOVEMENT (BY THURBER)
- OPERATIONAL PNEUMATIC PIEZOMETER
- ABANDONED / INOPERABLE PNEUMATIC PIEZOMETER
- DRAINAGE DITCH
- OBSERVED SLIDE CRACK
- POSSIBLE SCARPS INTERPRETED FROM LIDAR
- DIRECTION AND NUMBER OF PHOTO
- BUMP SIGN
- GUARDRAIL

N W E S

SAG POND
SAG POND
REVISED SLIDE SCARP LIMIT
RILLING ON SIDESLOPE
2019: SOFT AND DAMP
GULLY - 1.4m WIDE AT GUARDRAIL
SI 96.1
RIP RAP
DIP
SURFACE EROSION GULLY
2014: 0.3m - 0.6m DEEP
2016: 0.3 - 0.7m DEEP
2017-2018: 0.8m DEEP
2019-2021: 0.9m DEEP
DROP OF 1.0m DUE TO EROSION
0.8m DEEP (2022)
NO GRASS GROWTH
6.7m TO FOG LINE (2019);
6.3m TO FOG LINE (2020)
PP
WINDROW FROM RECENT MILLING
GULLY
SIGN
EROSION AND SLUMPING IN DITCH
0.45m DEEP AT NICKPOINT (2016)
0.9m DEEP (2019); 1.0m DEEP (2020)
1.0m DEEP, 2-3m WIDE (2022)
0.8m WIDE, 0.7m DEEP
0.9m WIDE, 0.3m DEEP
SURFACE EROSION GULLY
(2014): UP TO 0.8m DEEP
2016: UP TO 1.2m DEEP
EROSION CHANNEL
WET
BUMP WARNING SIGN
750mm Ø SWSP CULVERT
INLET CHANNEL PARTIALLY OBSTRUCTED
20-30mm WIDE, 50mm DIFF
SI 31A
SLOW RATE OF MOVEMENT AT 16 TO 19m
SI SHEARED BELOW 22.5m
SI 32
SI TO 45m
UPPER TOE PUSH
SI 35
35mm/yr @44.5m
24mm/yr @43.2m
SI TO 45m
SI 01-3
PZ 01-3
LOCALIZED EMBANKMENT FAILURE
SI 96.2
SI 31
DRAIN MARKER
GULLIES FORMING ON BACKSCARP
3m LONG, 10mm WIDE
20mm WIDE
MILLED
POSSIBLE HEADSCARP (AMEC)
GROUND CRACKS UP TO 10cm WIDE
ORANGE COLOR SEEPAGE
SI 01-2
SI TO 69m
WET
SI 34
SI TO 45m
WET AREA WITH SLIGHT SEEPAGE
COCONUT STRAW MATTING
SEEPAGE FROM SIDESLOPE ABOVE (2017-2018)
TELUS BOX
TELUS PEDESTAL
WET (2020, 2021)
SI 96.4
NO DISCERNABLE MOVEMENT SI TO 26m
DIP
SI 30 (SHEARED OFF)
NO DISCERNABLE MOVEMENT
SI TO 49.2m
PZ 01-1 SI 01-1
NO DISCERNABLE MOVEMENT (2006)
POSSIBLE HISTORICAL SCARP
STEEP VEGETATED DROP 5 TO 10cm HIGH
FRESH CRACKS (2021)
RUNOFF
SURFACE EROSION
TWO - TRACK WITH RUTTING
MAY BE GONE
300mm HIGH TOE ROLL
SI 96.6 (30m DEEP)
NO DISCERNABLE MOVEMENT
SI 33
SHEARED OFF
NO DISCERNABLE MOVEMENT
SI TO 45m
TOPSOIL PILES
20-30mm WIDE, 20-30 DIFF
POSSIBLE TOE BULGE
GULLY
HWY 49:12
WET
DIP
CRACK VISIBLE IN GRAVEL
20mm WIDE, 20mm DIFF
30mm WIDE, 20mm DIFF
CULVERT OUTLET HANGING 0.4m
CONCRETE APRON CRACKED
SCOUR BOWL 1.5m WIDE, 0.9m DEEP
750mmØ SMOOTH STEEL CULVERT
TO BRIDGE
RIGHT OF WAY
RIGHT OF WAY

0 10 20 30 40 50 60 70 m
SCALE 1:1250

NOTES
1. FEATURE LOCATIONS ARE APPROXIMATE.
2. PREVIOUS OBSERVATIONS SHOWN IN BLACK (2013-2015 FROM AMEC FIGURE 1, PROJECT EG10030, PROVIDED BY ALBERTA TRANSPORTATION).
3. ASPHALT OVERLAY PLACED THROUGH SITE IN SUMMER 2020
4. MAY 2022 OBSERVATIONS SHOWN IN RED.
5. CRACK PATTERN RESET BASED ON UAV IMAGERY FLOWN MAY 2022

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PEACE REGION (PEACE RIVER DISTRICT)

SH003-1: HWY 49:12
2022 SITE INSPECTION PLAN

DWG No. 32121-SH003-1-1

DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	1:1250
DATE	SEPTEMBER 2022
FILE No.	32121

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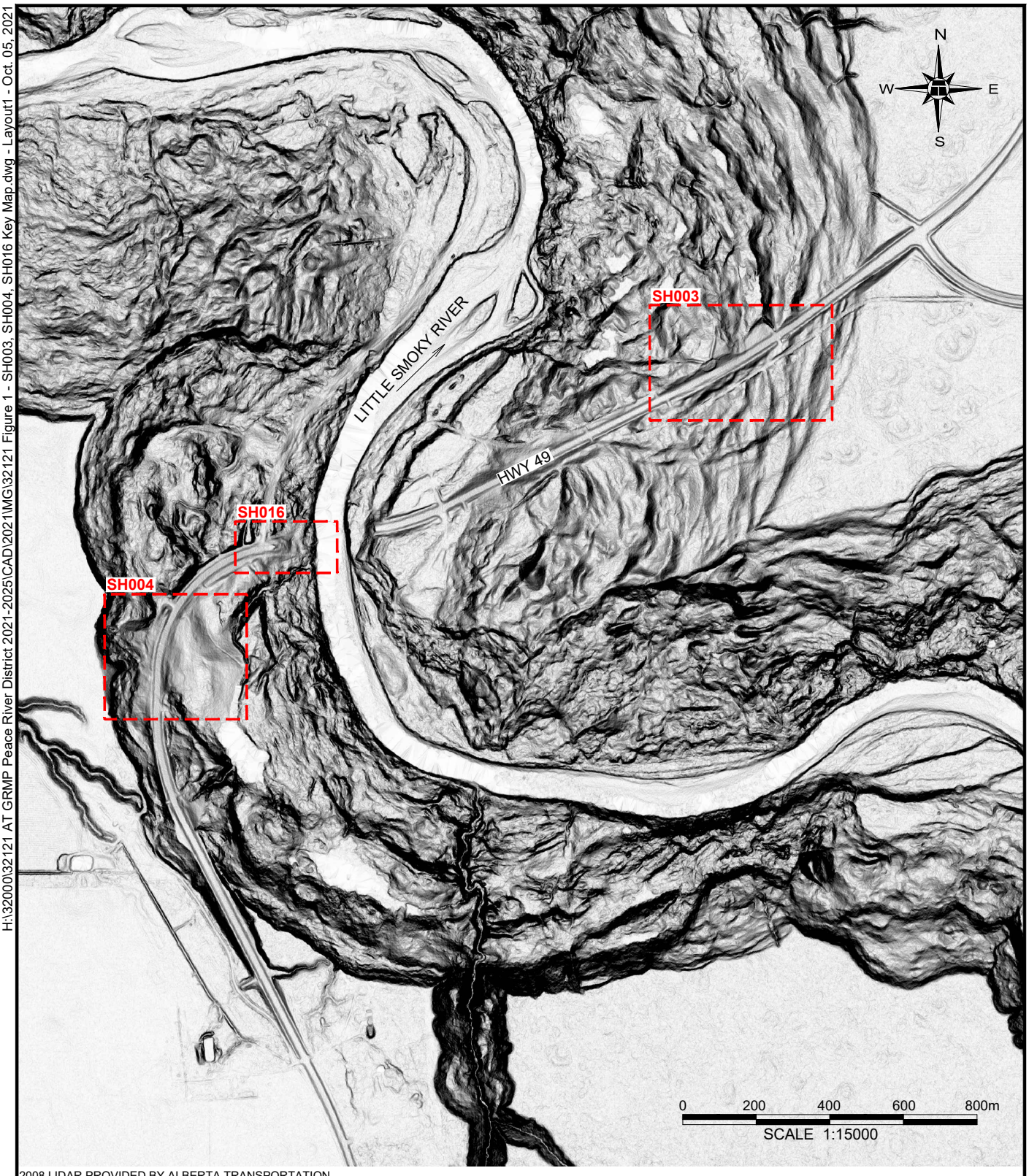
H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2021\MG\32121 Figure 1 - SH003, SH004, SH016 Key Map.dwg - Layout1 - Oct. 05, 2021



2008 LIDAR PROVIDED BY ALBERTA TRANSPORTATION.

PEACE REGION (PEACE RIVER DISTRICT)

SH003-1, SH004-1, SH016-1 KEY MAP

FIGURE 1

DRAWN BY	KLW
DESIGNED BY	MG
APPROVED BY	DWP
SCALE	1:15000
DATE	OCTOBER 2021
FILE No.	32121

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Photo 1 – Erosion gully at outlet of culvert at about Sta. 0+450.

Photo 2 – Looking southeast along erosion gully near Sta. 0+550.

Photo 3 – Looking southwest over the main sag (graben) area extending from Sta. 0+600 to 0+800.

Photo 4 – Looking north at the main graben at about Sta. 0+600 where dips in the highway surface are starting to become re-established.

Photo 5 – Looking southwest an area of frequent patching in the main graben block movement between Sta. 0+600 and 0+800.

Photo 6 – Looking south at cracks at northeast end of main graben block at Sta. 0+600.

Photo 7 – Looking east at the cracks on the southwest end of the main graben.

Photo 8 – Developing erosion bowl at outlet of culvert at about Sta. 0+800.

Photo 9: Erosion at the culvert inlet (left side) and scour bowl (right side) at Sta. 0+430 is starting to encroach towards the highway.

Photo 10: Scour bowl forming close to the edge of the highway at Sta 0+430.