ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2021 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:	2-Jun-2020	13	6	78
Current Inspection:	28-Jun-2021	13	6	78
Road AADT:	1230		**Year:**	2020
Inspected By:	Rocky Wang, TRANS Ed Szmata, TRANS Max Shannon, TRANS Chase Milligen, TRANS		Barry Meays, 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:	Asphalt milling and patching once to twice a year (~$70,000 each time) 2016: Grader 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

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 continues to down cut and now encroaching toward highway. Surface erosion gully between Sta. 0+525 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 (as of Spring 2021):

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 and after resetting from Spring 2017. 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 very slight decreasing trend over last few years with levels at 540 m and 515 m elevation, respectively. VW07-1 has been essentially stable since Fall 2016 at 14.3 m below ground; VW07-1A has slight increasing trend over the last three years at is currently 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 starting to form through the overlay at various locations in between Sta. 0+570 and 0+770.

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. Consideration should be given to regrading of the sideslope in this area and controlling the erosion through redirection of surface water flow from the highway or additional erosion control measures on the slope.

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 6.3 m of the fog line of 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 of this section of 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 for 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.

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.

Don Proudfoot, P.Eng.
Principal | Senior Geotechnical Engineer

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October 13, 2021

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October 13, 2021

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The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Mark Gallego, P.Eng.
Geotechnical Engineer

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

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This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

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All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

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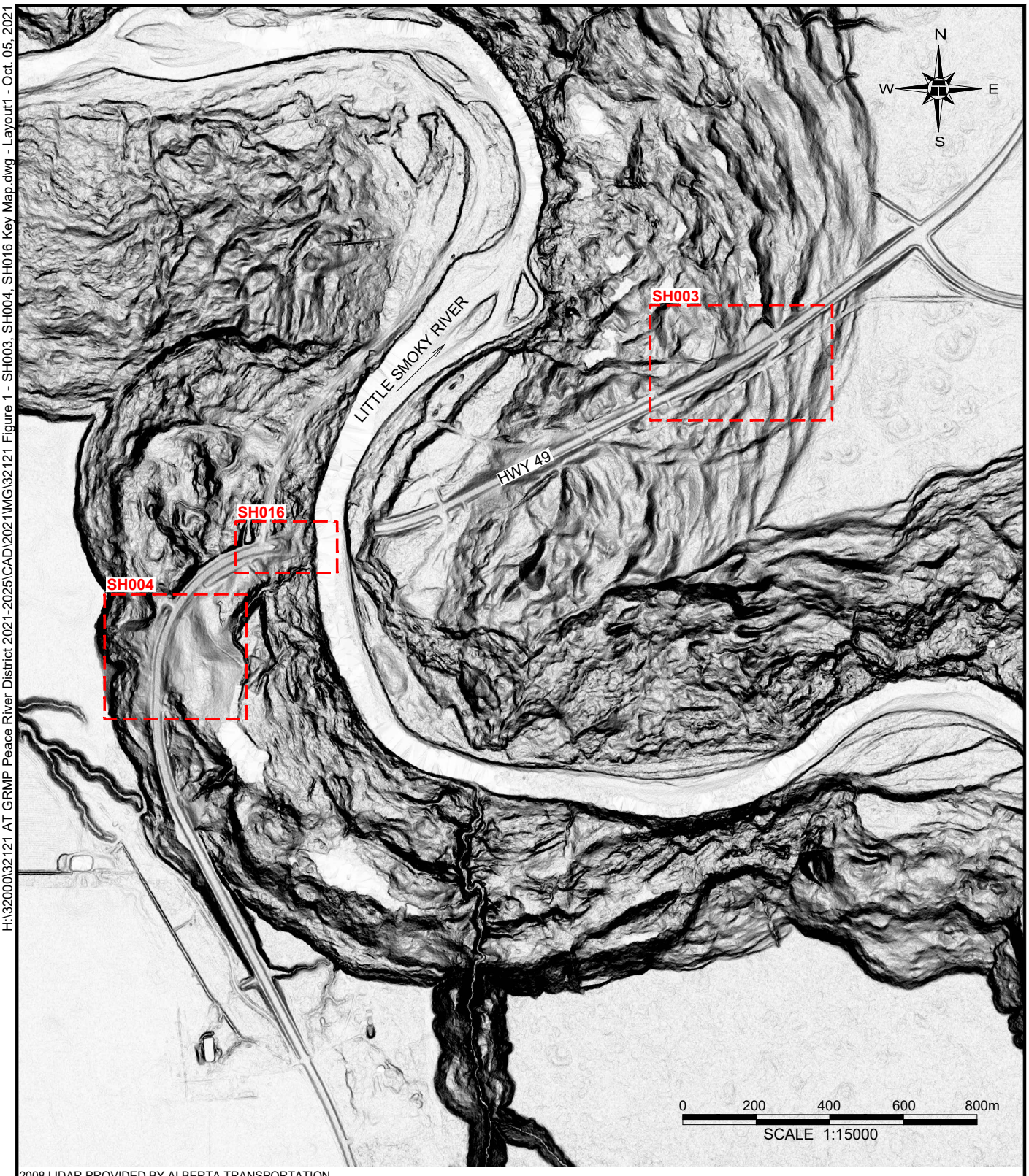
H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2021\MG\32121 Figure 1 - SH003, SH004, SH016 Key Map.dwg - Layout1 - Oct. 05, 2021



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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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

SAG POND
SAG POND
EROSION ON EMBANKMENT (UP TO 0.6m DEEP) (SAME IN 2016 & 2017) 2017 & 2019: 1.7m FROM GUARDRAIL
GUARDRAIL
2019: SOFT AND DAMP
SI 96.1
OLD MILLING MARKS
EROSION GULLY ADDITIONAL DOWNCUTTING OBSERVED ON EAST BANK (2018) UP TO 4m DEEP, 6m WIDE, 20m LONG NEAR VERTICAL GULLY (2016); MORE EROSION IN 2017; SLIGHTLY WORSE IN 2018 TENSION CRACKS FORMING ALONG THE EDGES (2019)
REVISED SLIDE SCARP LIMIT
POTHOLE
400mm - 900mm WIDE OVERALL
RIP RAP
DROP OF 1.0m DUE TO EROSION
4m WIDE
GULLY
CRACKING AND DEFORMATION; NOT VISIBLE IN 2021
2017: 10-20mm WIDE, 10mm DIFF
2018: 75mm WIDE, 20mm DIFF; BRAIDED WITH DIP ON WEST SIDE
SURFACE EROSION GULLY
2014: 0.5m - 0.6m DEEP
2016: 0.3 - 0.7m DEEP
2017-2018: 0.8m DEEP
2019-2021: 0.9m DEEP
NO GRASS GROWTH
SAG
40mm WIDE (2016)
EROSION GULLIES
2019: 0.4m DEEP
6.7m TO FOG LINE (2019); 6.3m TO FOG LINE (2020)
0.9m Ø SINKHOLE - RIPRAP EXPOSED (2016)
WINDROW FROM RECENT MILLING
SURFACE EROSION GULLY (2014): UP TO 0.8m DEEP
2016: UP TO 1.2m DEEP
EROSION AND SLUMPING IN DITCH
0.45m DEEP AT NICKPOINT (2016)
0.9m DEEP (2019); 1.0m DEEP (2020)
WET
EROSION CHANNEL
750mm Ø SWSP CULVERT
INLET CHANNEL OBSTRUCTED
BUMP WARNING SIGN
EROSION GULLIES UP TO 0.6m DEEP EXTENDING INTO FAILURE
2016: FORMING SMALL (LESS THAN 1m WIDE) SCARPS ABOUT 600mm FROM GUARDRAIL
RIGHT OF WAY
SI 32
SI TO 45m
REGRADED SLOPE SLUMPED RESULTING IN 1m HIGH BACKSCARP
UPPER TOE PUSH
SI 35
35mm/yr @44.5m
24mm/yr @43.2m
SI TO 45m
RILLS FORMING
SI 31A
SLOW RATE OF MOVEMENT AT 16 TO 19m
SI SHEARED BELOW 22.5m
BRAIDED CRACKS WITH POP-OUTS
2016 PATCH
30mm WIDE
MILLED (2016)
2 CRACKS (5-7m APART) WITH LESS THAN 10mm DROP
POSSIBLE HEADSCARP (AMEC) GROUND CRACKS UP TO 10cm WIDE
SI 01-3
PZ 01-3
SI 96.2
SI 31
LOCALIZED EMBANKMENT FAILURE
10-20mm WIDE
10mm WIDE HAIRLINE CRACKS
10-20mm WIDE (2017);15-25mm WIDE (2018); 80mm WIDE, 90mm DIFF (2019); 500mm WIDE (BRAIDED), 120mm DIFF (2020); FRESH CRACKS (2021)
10-20mm WIDE, <5mm DIFF (2017)
40mm WIDE, 30mm DIFF, 150mm DEEP (2018)
60mm WIDE, INFILLED (2019)
ORANGE COLOR SEEPAGE
SI 01-2
SI TO 69m
SI 34
SI TO 45m
DROPPED 600mm AT 3.4m FROM GUARDRAIL
20-40mm WIDE (2016)
20mm WIDE , 10mm DIFF (2017-2018)
10-20mm WIDE
WET AREA WITH SLIGHT SEEPAGE
20-40mm WIDE (2016); COVERED (2017)
40mm WIDE (2018); 60-70mm WIDE, 70mm DIFF (2019)
CRACKS VISIBLE IN GRAVEL
COCONUT STRAW MATTING
SEEPAGE FROM SIDESLOPE ABOVE (2017-2018)
TELUS BOX
TELUS PEDESTAL
WET (2020, 2021)
SEEPAGE (2016, 2018)
VOIDS
20-30mm WIDE
SI 30 (SHEARED OFF) NO DISCERNABLE MOVEMENT SI TO 49.2m
SI 96.4
NO DISCERNABLE MOVEMENT SI TO 26m
BRAIDED 200mm WIDE, 90mm DIFF
CRACK
DIP
POSSIBLE HISTORICAL SCARP, STEEP VEGETATED DROP 5 TO 10cm HIGH
PZ 01-1 SI 01-1
NO DISCERNABLE MOVEMENT (2006)
SURFACE EROSION
TWO - TRACK WITH RUTTING
DIP
FRESH CRACKS (2021)
EROSION BOWL (2016-2018): 3m LONG, 1m WIDE, 0.5m DEEP; 0.4m DEEP (2019) 0.5m DEEP, 1.6m WIDE (2020); WET (2021)
GUARDRAIL
WINDROW FROM RECENT MILLING
300mm HIGH TOE ROLL
SI 33
SHEARED OFF
NO DISCERNABLE MOVEMENT
SI TO 45m
SI 96.6 (30m DEEP)
NO DISCERNABLE MOVEMENT
300mm WIDE 90mm DEEP
RIDGE
MAY BE GONE
TOPSOIL PILES
NOT FOUND IN 2016
750mmØ SMOOTH STEEL CULVERT
WET CRACK VISIBLE IN GRAVEL
UP TO 100mm WIDE
20mm GAP AND A DROP OF 20mm ON NORTH SIDE OF CRACK
DIP: 30mm WIDE, 10mm DIFF; 70mm DIFF DOWN TOWARD UPSLOPE SIDE
OLDER PATCH 10-20mm WIDE
FRESH CRACKS (2021)
CRACK PATCHES
BECOMING BRAIDED WITH CRACKS 30mm WIDE
BRAIDED 0.8m WIDE WITH 150mm DEPRESSION
SCARP CRACK 10-20mm WIDE
POSSIBLE REVISION EXTENSION OF SLIDE LIMITS BASE ON SI33 READINGS
TO BRIDGE
WINDROW FROM RECENT MILLING
MILLED
BRAIDED 300-400mm WIDE (OVERALL), 70mm DIFF IN CENTER
BRAIDED 1m WIDE WITH 50-100mm WIDE CRACKS
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. JUNE 2021 OBSERVATIONS SHOWN IN RED.
4. PORTIONS OF SITE MILLED IN FALL 2019
5. ASPHALT OVERLAY PLACED THROUGH SITE IN SUMMER 2020

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PEACE REGION (PEACE RIVER DISTRICT)

SH003-1: HWY 49:12
2021 SITE INSPECTION PLAN

DWG No. 32121-SH003-1-1

DRAWN BY	KLW
DESIGNED BY	MG
APPROVED BY	DWP
SCALE	1:1250
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. Note windrow of milled materials on sideslope of highway.

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

Photo 4 – Looking northeast at fresh cracks which are part of the main graben block movement between Sta. 0+600 and 0+800.

Photo 5 – Looking south at cracks at northeast end of main graben block at Sta. 0+600.

Photo 6 – Looking east where previous cracks were paved over on the southwest end around Sta. 0+800.

Photo 7 – Developing erosion bowl at outlet of culvert at about Sta. 0+800.