

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



Site Number	Location	Name	Hwy	km
SH004-1	South of Little Smoky River	Little Smoky River (South of Bridge)	49:12	2.3-2.6
Legal Description		UTM Co-ordinates		
W33-074-21-W5M		11U E 489,224	N 6,145,128	

	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:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items			

Primary Site Issue:	Highway traverses deep-seated (about 35 m), retrogressive landslide with ongoing creep movement over the entire valley slope due partly to erosion at toe by the Little Smoky River.
Dimensions:	300 m length of highway affected by several intersecting scarps resulting in uneven riding surface. Approx. 1.3 km of the highway crosses this unstable west valley slope.
Date of Remediation:	1987: Subdrain installed in backslope ditch. 1998: Overlay including building up downslope shoulder with gravel fill buttress and raising of the guardrail. 2006: Repair of erosion damage and installation of surface drains to nearby sag pond.
Maintenance:	Routine annual or bi-annual asphalt patching and milling 2016: Patch placed in August, milled in late September 2017: Patch and milled in August/September 2018: Milling removed up to about 60 mm of asphalt Fall 2019: Milling both sides of valley for about 172,000 m ³ 2020: Pavement overlay and guardrail replacement

Observations:	Description	Worsened?
<input checked="" type="checkbox"/> Pavement Distress	Cracking and uneven roadway surface requires ongoing patching and milling especially at the landslide scarp cracks and the south end of the bridge.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Overall slope movement continues resulting in cracks at scarps and sags in the graben blocks.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Rilling between riprap channel and beyond P01-6. Lesser riling near north end of patch.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	Evidence of seepage observed near culvert outlet at north end of site.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	Separation of plastic culvert.	<input type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>

Instrumentation (Spring 2022):	
VW07-2, VW07-2A, VW07-3, VW07-3A	Relatively stable and slightly decreasing over the last two years.
Destroyed/Lost	VW07-2B and -3B (damaged Fall 2014); SI4A, SI01-6, SI01-7, SI01-2, SI07-3B, SI01-9, SI07-2B, PZ01-6, PZ01-2 (discontinued)
Assessment:	
<p>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), this portion of the highway is located on landslide blocks moving relatively slower (5 mm to 40 mm per year) as compared to the north side (SH003) or the bridge site (SH016). Drawing 32121-SH004-1-1 shows some of the local slide features that have been interpreted from the 2008 LiDAR imagery. Regrading of the slopes at this site has obscured the scarps of the larger slide blocks that are likely present beneath the highway alignment.</p> <p>The ongoing movement of the valley slope results in continued deformation of the highway surface that requires frequent patching. An overlay was placed in the summer of 2020 to maintain the smoothness of the highway. Reportedly, the crack pattern in the highway started reflecting through the overlay in less than 24 hours. As the crack pattern became fully established, the increasing differential across the cracks required additional milling in 2021 and 2022. As shown on the Drawings, the crack pattern is similar to previous years.</p> <p>The rilling in the bare area on the downslope side of the highway to the north of the riprap apron appears to in a state similar to the previous inspection. These rill and gully areas should be repaired to prevent further degradation. There is a second area of rilling toward the north which is not quite as deep also appears to be in a state similar to the previous inspection.</p> <p>There is a break in the plastic culvert that handles downslope ditch flow from the south that creating a sinkhole up to the ground surface. The sinkhole has not changed in size significantly in the last few years. A second gap at a culvert joint was observed in 2019 about 25 m further north.</p> <p>The slope below approach at the south end of the site has started to deteriorate since about 2019. There is increasing displacement and extension of the tension and scarp cracks on this slope. The gully in the centre of the feature continues to deepen.</p>	
Recommendations:	
Short-term:	
<ul style="list-style-type: none"> ▪ Road maintenance should continue as necessary to maintain an even, safe roadway surface and may consist of milling, patching, and crack sealing of the pavement. An asphalt overlay was placed through the site in Summer 2020, but rapid slide movements have already cracked and distorted it requiring additional milling. ▪ The bare areas on the downslope side of the highway to the north of the riprap apron have the potential to deteriorate further. This area should be regraded and covered with topsoil and seed secured with an erosion control blanket or seed-impregnated compost blanket. The second rilling area near the north end of the site could be repaired at the same time with the same methodology. ▪ The break in the culvert should be excavated and repaired to limit infiltration into the slope which could potentially result in slope movement or significant erosion. 	
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; or 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. In a previous study, Thurber identified a more-stable road alignment option going up a deep cut in the valley slope straight west off the end of the bridge.

Ongoing Investigation:

- It is recommended that the annual Geohazard inspection and twice-annual instrumentation readings should continue as scheduled.
- Since there are no longer any operable SI's on site, consideration should be given to adding two to three slope inclinometers if there are other investigation projects in the area such that drilling costs could be shared so that the rate of creep can be monitored.
- Consideration should also 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.

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

Ken Froese, P.Eng.
Associate | Senior Geotechnical Engineer



STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

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.

2. COMPLETE REPORT

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.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

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.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- 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.

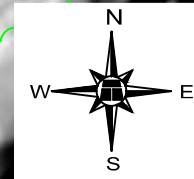
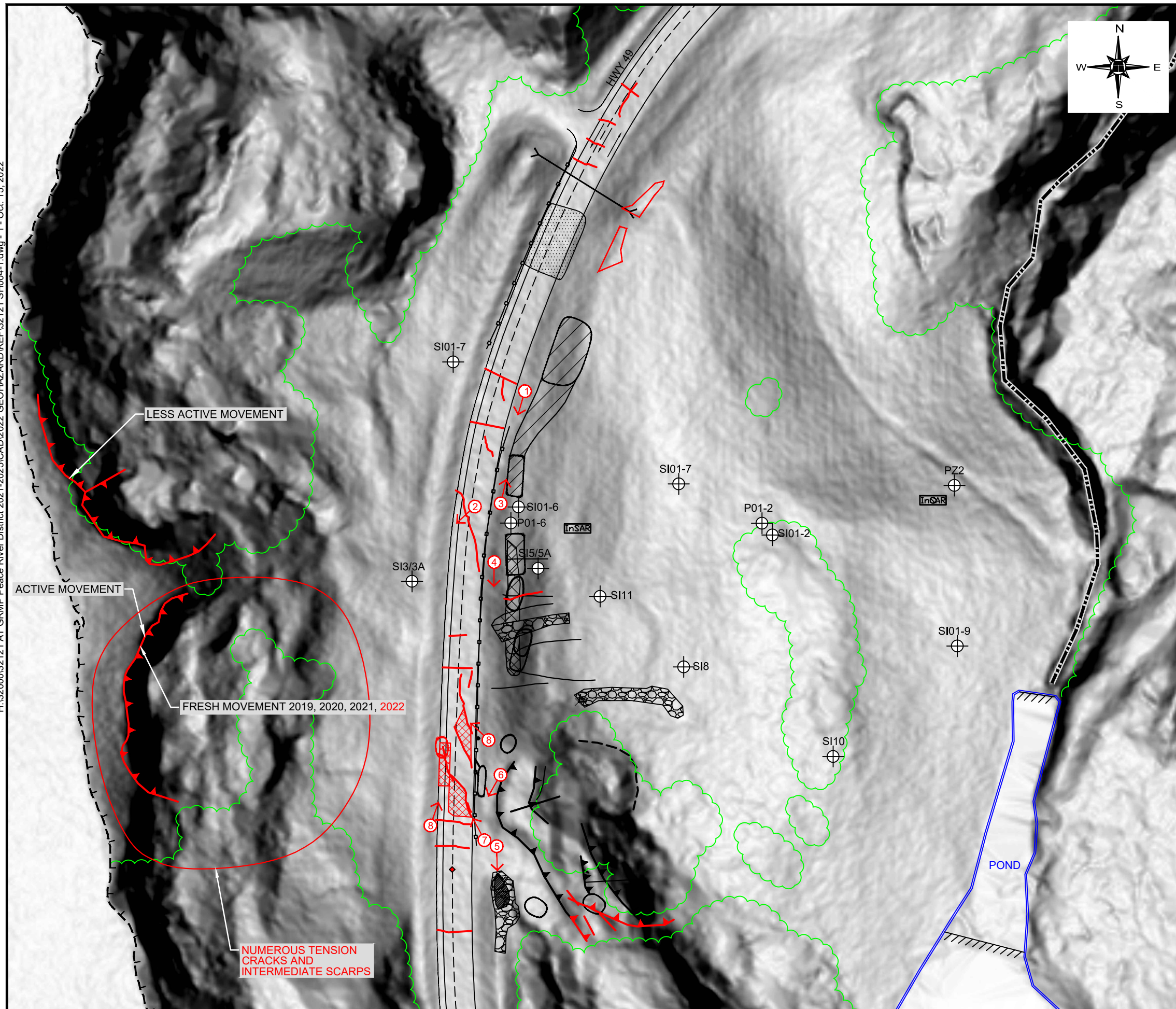
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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LEGEND

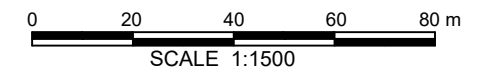
- APPROXIMATE INSTRUMENT LOCATION
- SI SLOPE INCLINOMETER
- P PNEUMATIC PIEZOMETER
- INSAR INSAR CORNER REFLECTOR
- MAJOR SCARP
- VALLEY CREST
- TREE LINE
- GUARDRAIL
- LANDSLIDE SCARP CRACKS
- RIPRAP APRON
- PAVEMENT OR TENSION CRACK
- MILLING AREA
- RED TEMPORARY HAZARD SIGN
- DIRECTION AND NUMBER OF PHOTO

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. MAY 2022 OBSERVATIONS SHOWN IN RED.
4. SITE OVERLAID IN 2020. CRACK PATTERN REDRAWN USING UAV IMAGERY ACQUIRED BY THURBER IN MAY 2022.

REFERENCE

1. 2008 LIDAR PROVIDED BY ALBERTA TRANSPORTATION. SHADED BY SLOPE ANGLE FROM WHITE AT 0° TO BLACK AT ≥30°.



Transportation

PEACE REGION (PEACE RIVER DISTRICT)

**SH004-1: HWY 49:12 LITTLE SMOKY RIVER
SOUTH OF BRIDGE
2022 SITE INSPECTION PLAN - OVERALL**

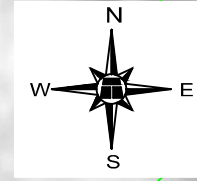
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DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	1:1500
DATE	SEPTEMBER 2022
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1/4 PLUGGED (2019-2020)
2022: 1/4 PLUGGED PLUS TREE
DEBRIS UP TO CROWN

1200mm Ø CULVERT OUTLET (2/3 PLUGGED) 2021, 2022

RUST-STAINED WATER AND SOFT GROUND;
PONDED WATER (2020, 2021, 2022)

BARE SPOT WITH SEEPAGE

SAG IN PAVEMENT NOTICEABLE (2014-2019)
SIMILAR BUT FRESHLY PATCHED (2021, 2022)

RILLING UP TO 0.2m TO 0.3m DEEP (2022)

SI01-7

10-20mm WIDE

10mm WIDE

10-20mm WIDE, <5mm DIFF

40mm WIDE, 50mm DIFF AT
CRACK, 100mm DIFF OVERALL

100mm DIFF AT ACP EDGE

SI3/3A

RILLS

SI01-6

P01-6

InSAR

SI5/5A

GULLY: 0.5m-0.7m DEEP; 2022: 0.9m DEEP WITH SEEPAGE

DAMP WITH SEEPAGE (2019, 2020)

RILLED AREA 28m WIDE, RILLS UP TO 0.6m DEEP (2014-2016, 2022)

GULLY: 0.5-0.7m DEEP (2017); ~0.8m DEEP (2018, 2020); 2022: 0.9m DEEP WITH SEEPAGE

SI11

SI01-7

P01-2

SI01-2

LEGEND

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PEACE REGION (PEACE RIVER DISTRICT)

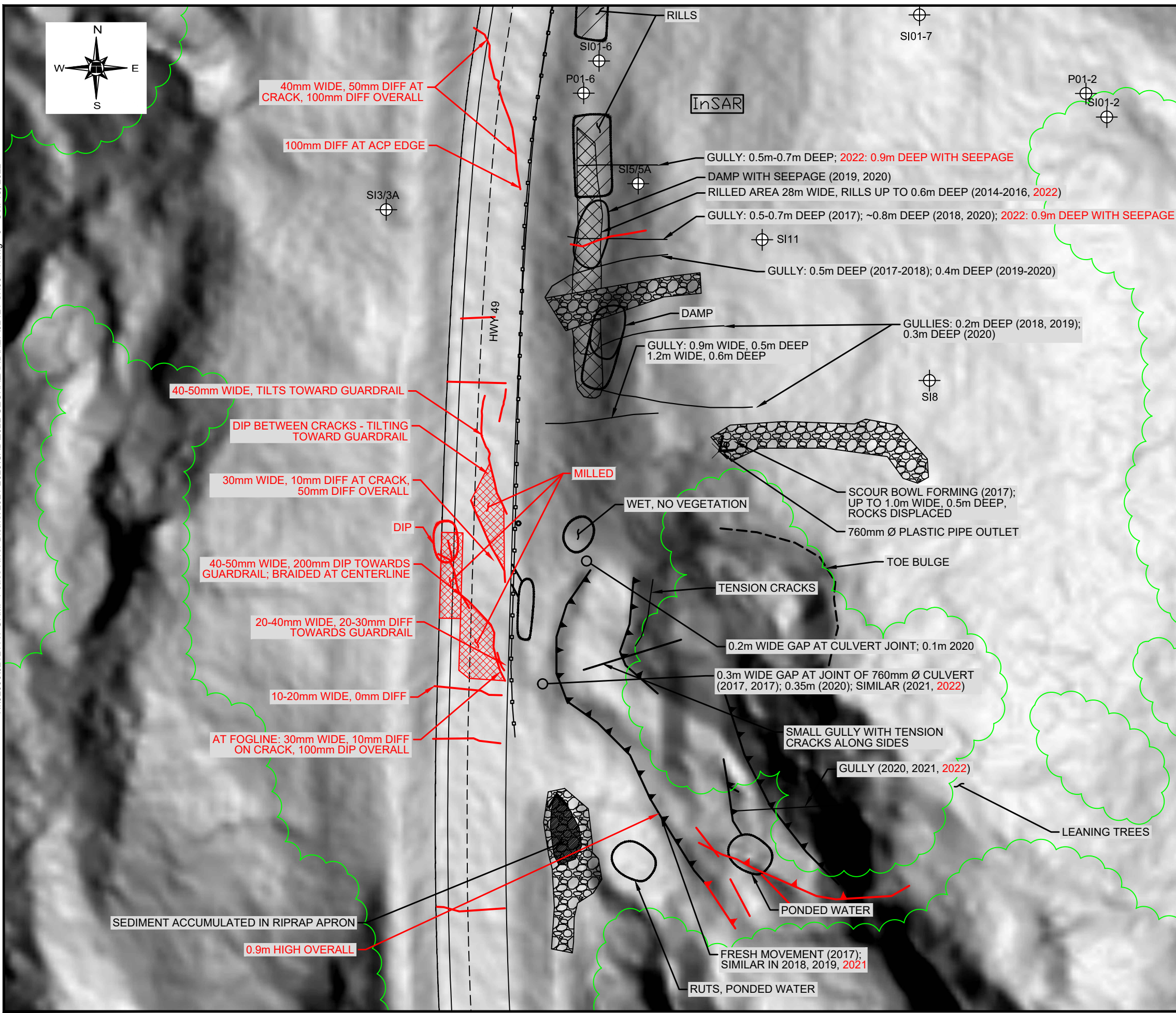
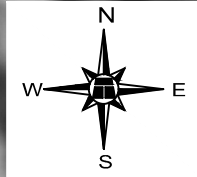
SH004-1: HWY 49:12 LITTLE SMOKY RIVER
SOUTH OF BRIDGE
2022 SITE INSPECTION PLAN - NORTH PORTION

DWG No. 32121-SH004-1-2

DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	1:750
DATE	SEPTEMBER 2022
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LEGEND

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- SLOPE INCLINOMETER
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PEACE REGION (PEACE RIVER DISTRICT)

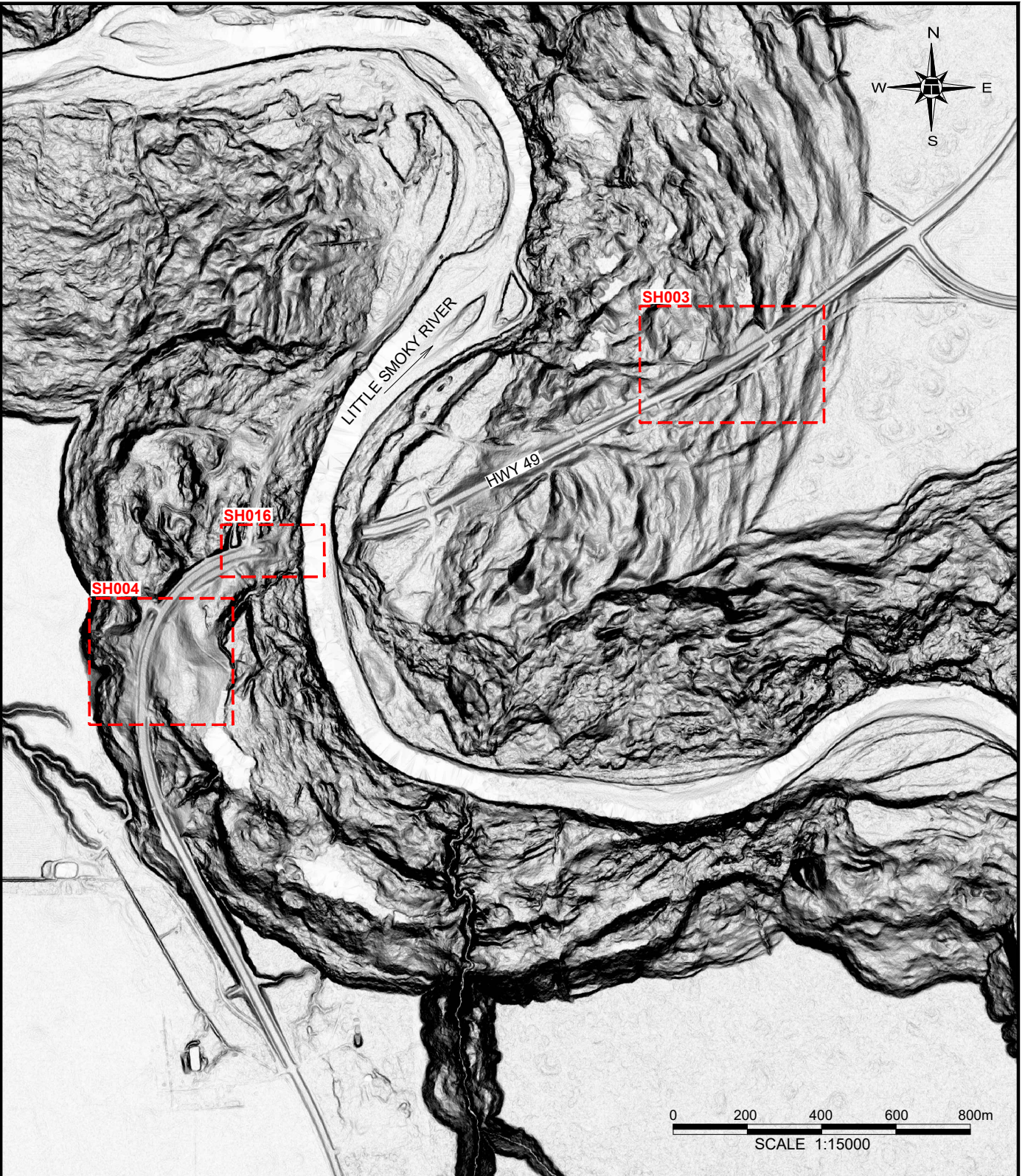
**SH004-1: HWY 49:12 LITTLE SMOKY RIVER
SOUTH OF BRIDGE
2022 SITE INSPECTION PLAN - SOUTH PORTION**

DWG No. 32121-SH004-1-3

DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	1:750
DATE	SEPTEMBER 2022
FILE No.	32121



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



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Photo 1 – Looking south at downslope side of highway at the north end of the site.



Photo 2 – Looking southwest slide movement in the backslope above the highway.



Photo 3 – Looking northeast at rilling below the guardrail.



Photo 4 – Looking southwest at guardrail at south end of site. There was a significant sag at this location before the work in 2020.



Photo 5 – Looking south along downslope ditch at sedimentation at inlet of 760 mm plastic culvert.



Photo 6 – Looking at 760 mm culvert joint separation.



Photo 7 – Looking north at crack just north of the downslope guardrail.



Photo 8 – Cracks across highway at south end of site.