



THURBER ENGINEERING LTD.

September 19, 2022

File No.: 32121

Alberta Transportation
Provincial Building
9621 – 96 Avenue
Peace River, Alberta
T8S 1T4

Attention: Mr. Ed Szmata

**GEOHAZARD RISK MANAGEMENT PROGRAM (CON0022164)
PEACE REGION (PEACE RIVER DISTRICT)**

**SECTION D CALLOUT REPORT
CAUDRON: HWY 2:50 km 43.61 – 43.67**

Dear Mr. Szmata:

This report presents the results of a call-out for the above-noted site located on Hwy 2:50 between km 43.61 and 43.67. The legal description of this site is W10-74-14-W5M. The AADT (average annual daily traffic) on the highway is 2123 vehicles per day (verified in September 2022).

Mr. Ken Froese, P.Eng., and Mr. Mark Gallego, P.Eng., of Thurber Engineering Ltd. (Thurber) undertook a callout inspection on May 30, 2022, in the presence of Mr. Rishi Adhikari, P.Eng., Mr. Ed Szmata, Mr. Max Shannon, and Mr. Rodney Johnston (Maintenance Contractor Inspector, MCI), of Alberta Transportation (AT).

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

1. BACKGROUND

A slump occurred in the north side slope of Highway 2:50 just west of a culvert located at km 43.572. The culvert, BF76479-2 on a tributary to the Lesser Slave River, is a 4.61 m dia. by 49.99 m-long structural plate culvert installed in 2016. It appears that there was some minor grading work done for the highway embankment and the channel at the culvert outlet.

From AT correspondence, the slumping began in 2017. The shoulder of the highway apparently dropped fairly quickly after construction and, as of April 2022, was beginning to affect the road surface. There did not appear to be any distress to the bridge culvert, so the remediation is being considered by AT's Operational Section. That group is planning a patch in the area in the summer of 2022 but wanted an assessment by AT's Geohazard Risk Management Program (GRMP) team, so the site was inspected as part of the annual GRMP tour.

A brief review of publicly available mapping indicates that the bedrock at this site is in the order of 40 m deep (Alberta Geological Survey DIG 2020 0023) and consists of marine clay shale and



siltstone of the Puskwaskau Formation (Alberta Geological Survey Map 236). The bedrock surface slopes north (DIG 2020 0022) toward pre-glacial valley thalwegs that approximately underly the present-day Lesser Slave Lake valley. Surficial geology maps indicate that the creek lies in an organic deposit with glaciolacustrine (clay and silt) sediments to the west, moraine deposits (silt, sand, and trace gravel in a clay matrix) on the east side and south of the highway, and fluvial (sand and gravel with some silt and clay) on the east side to the north of the highway (Alberta Geological Survey Map 601, 2013).

2. OBSERVATIONS

Observations made during the site visit are illustrated on Figure 1, attached. Selected photographs of the site visit are also included at the end of this letter.

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” had not yet affected 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. 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.

There is an active east-west two-track in the ditch at the toe of the slope. The north sideslopes of the embankment outside of the slumped zone are about 3H:1V becoming about 5H:1V over the culvert outlet.

A brief review of the ground conditions around the culvert outlet determined that the culvert itself appears to be in good condition and no instability was observed. However, there appeared to be some slumping of the riprap on the west (left) bank just beyond the outlet and a larger slump (about 17 m wide) on the east (right) bank about 23 m downstream of the culvert. The drainage channel from the east ditch is starting to erode creating a shallow gully.

To the east of the culvert, at and further east of the end of the HTSC, there was another crack noted in the outside wheel path of the north lane. This crack was similar in appearance to the crack noted at the east end of the main slide and likely indicates impending movement at this second location. The embankment at this location was about 2 m high with a 4H:1V sideslope.

3. INSTRUMENTATION

There is no instrumentation at this site.



4. ASSESSMENT

Record drawings of the culvert installation were not reviewed during the preparation of this report; however, it would appear that the slumping observed at the site could be 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/or organics left in place during construction) 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.

5. RISK LEVEL

Based on the AT's Risk level rating system, the risk level for this site has been assessed as follows:

$$\text{Risk (44)} = \text{PF (11)} \times \text{CF (4)}$$

This risk level was based on a Probability Factor (PF) of 11 (active with moderate but increasing rate of movement) and a Consequence Factor (CF) of 4 (site "where partial closure of the road or significant detours would be a direct and unavoidable result of slide occurrence"). Given the relatively low height of the embankment, it is anticipated that the worst case would involve the closure of only the north lane and the culvert does not appear to be affected at this time.

6. RECOMMENDATIONS

Similar to the repairs undertaken for slumps of this nature in the area (such SH030, SH031, and East of Gunn's Creek) and recommended for others (like the East of Arcadia call-out also on Hwy 2:50), there are four typical options. Slope flattening or a toe berm would be suitable although the presence of an overhead power line, the creek, and culvert constrain the amount of land available for additional fill placement. A pile wall would be suitable but at a significant cost. Thus, gravel replacement is the recommended remedial option. The slumping at this site is active and impacting the roadway particularly the structural integrity of the HTSC system. It is recommended that preliminary engineering be undertaken, and a solution implemented as quickly as possible to prevent unexpected lane closures on this busy highway.

On a preliminary basis, the recommendations for the repair are:

- The excavation should extend at least 5 m beyond the edges of the slumped material and up to the highway centerline.
- A temporary excavation cut face of 1H:1V is usually acceptable for this low-height embankment.
- The base of the excavation should slope slightly towards the north to facilitate drainage of any water that accumulates in the backfill.



- Pit-run gravel is suitable for backfill except for the granular base course portion of the pavement surfacing.
- A deeper gravel shear key will likely be required within the base of the main gravel backfill zone.
- Non-woven geotextile should be placed along the base and three sides of the excavation.
- Three layers of uniaxial geogrid might need to be placed within the gravel: one at about 150 mm above the base, one at the 1/3 height, and one at the 2/3 height. The geogrid layers should extend from the back and sides of the excavation to the face of the fill.
- The material that is blocking drainage near the inlet of the culvert should be smoothed out to allow the ditch to drain freely into the culvert.

A geotechnical investigation is also recommended to confirm soil properties and groundwater levels. Four test holes are recommended: two in the north ditch, downslope of the slump, and two through the highway embankment. Stability analyses should be undertaken to confirm the depth of the repair and if a shear key will be necessary.

The above measures would replace the poor-quality embankment fill with stronger compacted granular fill. The estimated cost to complete the repair listed above will be in the order of \$400,000 (excluding engineering).

The second site on the east side of the culvert could be repaired pre-emptively using a similar methodology. This would add an estimated \$100,000 to the cost but would be less expensive as part of the other repair than as a stand-alone project if required at a later date.



7. CLOSURE

We trust that this information is sufficient for your present requirements. We would be pleased to answer any questions that you may have regarding this letter report.

Yours very truly,
Thurber Engineering Ltd.
Don Proudfoot, M.Eng., P. Eng.
Review Principal

Ken Froese, M.Eng., P. Eng.
Geotechnical Engineer
/sls

Attachments:

- Statement of Limitations and Conditions
- Figure 1
- Selected Photos



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

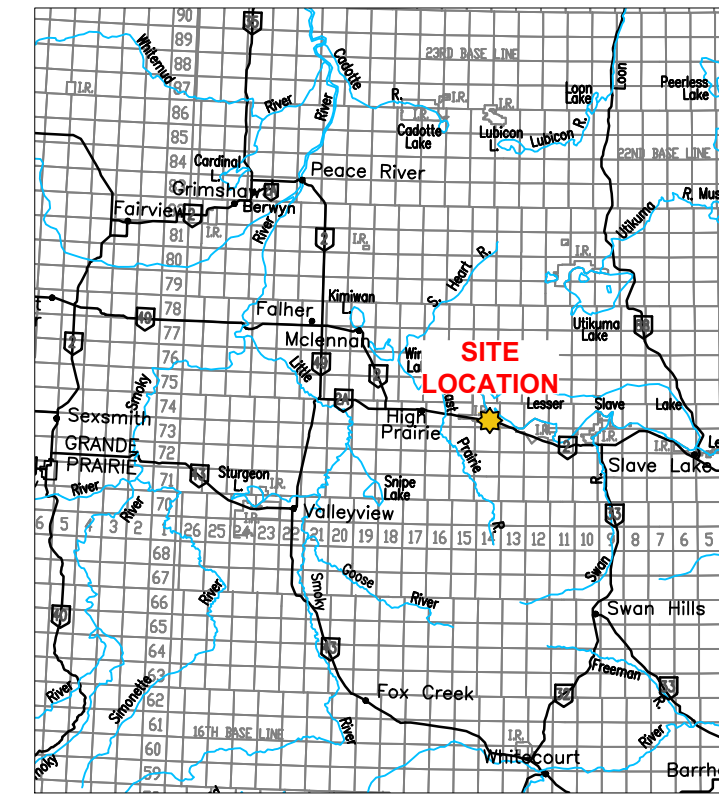
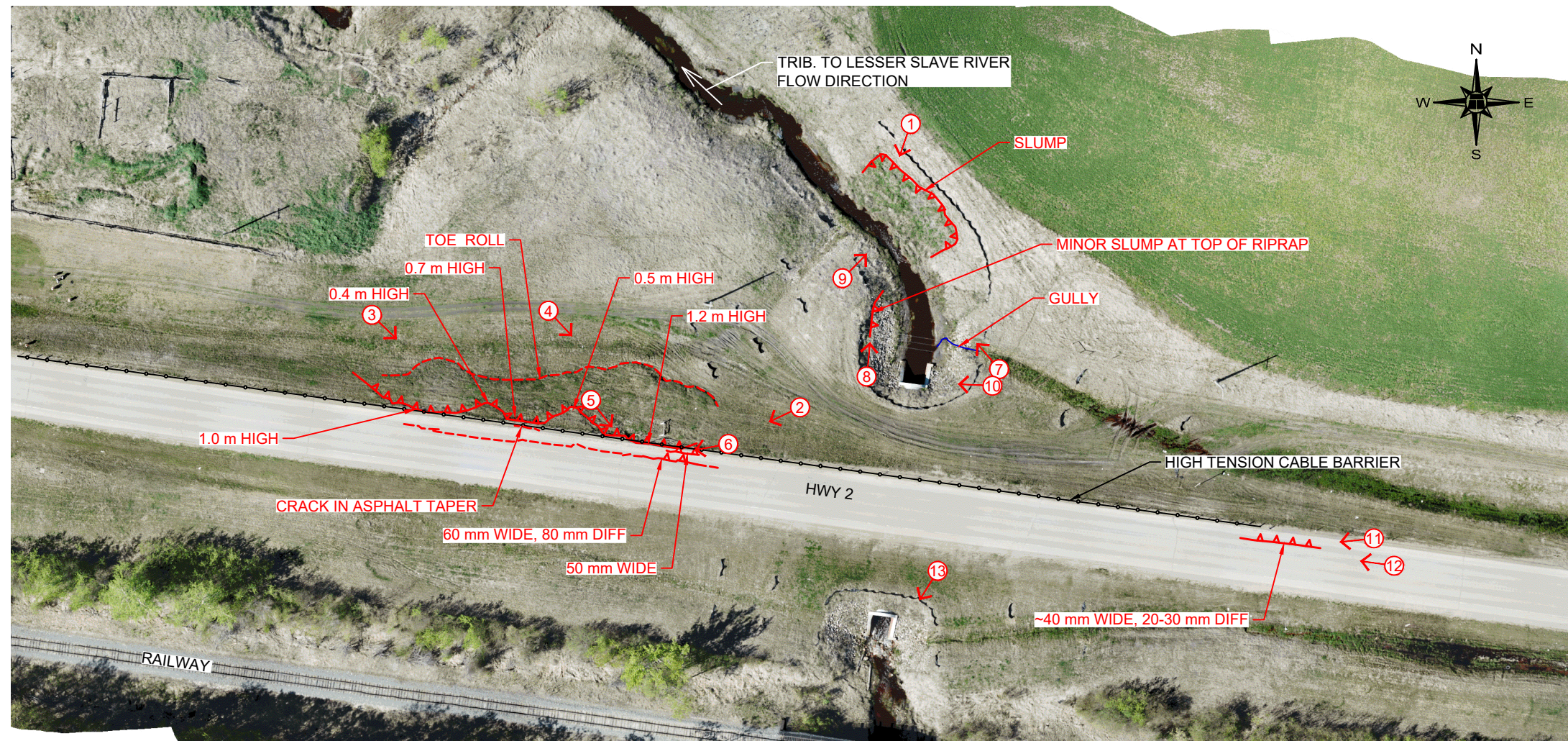
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification 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.

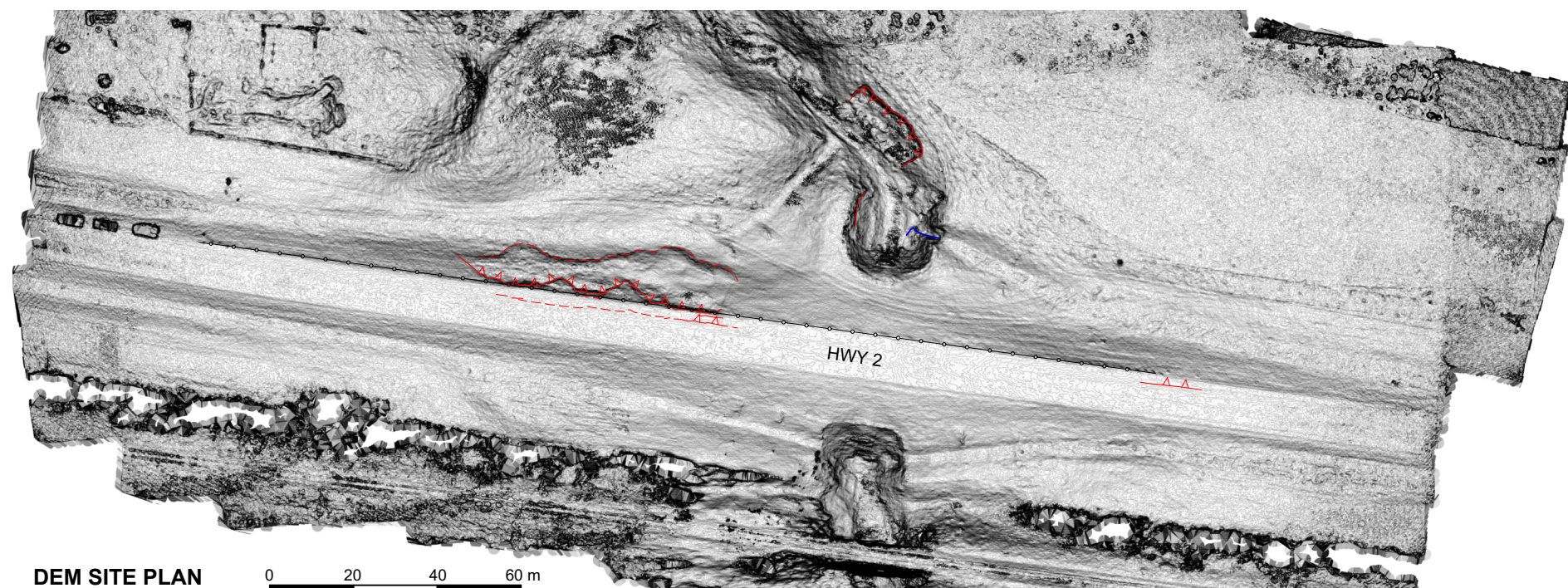


KEY MAP
SCALE 1:3 000 000

- LEGEND**
- SCARP
 - CRACK
 - DIRECTION AND NUMBER OF PHOTO

SITE PLAN
SCALE 1:1000

0 10 20 30 40 m
SCALE 1:1000



DEM SITE PLAN
SCALE 1:1500

0 20 40 60 m
SCALE 1:1500

ORTHOMIMAGE AND DIGITAL ELEVATION MODEL
DERIVED FROM UAV IMAGERY FLOWN BY THURBER ON MAY 30, 2022

PEACE REGION (PEACE RIVER DISTRICT)
HWY 2:50 KM 43.61 TO KM 43.67

CALL OUT SITE PLAN

FIGURE 1

DRAWN BY	KLW
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	SEPTEMBER 2022
FILE No.	32121

THURBER ENGINEERING LTD.



Photo 1 (AT, May 3, 2022) - Looking south across creek at slump in north shoulder.



Photo 2 – Looking west from east end of slump.



Photo 3 – Looking southeast at east end of slump.



Photo 4 – Looking southeast at east end of slump.



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



Photo 6 – Looking west at 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 southwest 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 west at the same crack shown in Photo 11 which may be related to separate movement zone.



Photo 13 – Looking south at culvert inlet and adjacent rail bridge.