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

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
PH044-1 (A) PH044-2 (B)	North of Manning, AB	Meikle River Slides A and B	35:08	26.14 25.82
Legal Description		**UTM Co-ordinates**		
Slide A: SW7-94-22-W5M		11U E 467,665	N 6,333,024	

	Date	PF	CF	Total
Previous Inspection:	4-June-2020	Slide A: 11 Slide B: 11	3 2	33 22
Current Inspection:	3-June-2022	Slide A: 11 Slide B: 11	3 2	33 22
Road AADT:	1330		**Year:**	2022
Inspected By:	Rishi Adhikari, TRANS Ed Szmata, TRANS Max Shannon, TRANS Erwin Kurz, TRANS		Ken Froese, Thurber Mark Gallego, Thurber	
Report Attachments:	☑ Photographs	☑ Plans	☐ Maintenance Items	

Primary Site Issue:	Sideslope slumping of high embankment into oxbow of the Meikle River.	
Dimensions:	Slide A: 34 m length of highway, 18 m high embankment Slide B: 65 m length of highway, 24 m high embankment	
Date of Remediation:	1993, Slide B: Pile wall installed	
Maintenance:	2008: spray-patch of cracks. 2016: Overlay and chip seal of Highway 35 including these sites. High tension steel cable barrier (HTSC) installed. 2019: HTSC replaced with W-Beam guardrail	
Observations (Slide A):	**Description**	**Worsened?**
☑ Pavement Distress	No distress observed since overlay in 2016.	☐
☑ Slope Movement	Continued retrogressive movement. The backscarp is 5.8 m from the highway; the landslide mass continues to expand, move, and break up.	☑
☑ Erosion	Increased erosion around the culvert outlet. A gully is forming north of the outlet.	☑
☑ Seepage	Salt-staining observed in face of highest scarp in 2015 not visible.	☐
☑ Bridge/Culvert Distress	Culvert outlet became obstructed by toe roll in 2017 but exposed again in 2019. Concrete lining downslope entirely destroyed. Slumping causing outlet to be undermined.	☑
☐ Other		☐
Observations (Slide B):	**Description**	**Worsened?**
☐ Pavement Distress		☐

☑ Slope Movement	The backscarp is about 0.8 m from the back of the post of the new W beam guardrail. Landslide is expanding to the north.	☑
☑ Erosion	Erosion rills between the highway shoulder and the backscarp; newer erosion rill south of the pile wall was not present in 2018. Gully has formed on north side of landslide bowl.	☐
☐ Seepage		☐
☐ Bridge/Culvert Distress	Gully forming below abandoned culvert south of landslide resulting in one segment detaching.	☑
☐ Other		☐

Instrumentation (as of Spring 2022):

Slide A	Two slope inclinometers (SI-27 and -45) remain operational and SI-23 sheared off 27.4 m depth. Continued slow deep-seated creep movement (annual movement rates of less than 1.0 mm) has been detected in the inclinometers between 31.5 m and 37.8 m depth.
Slide B	One slope inclinometer (SI-42 installed to a depth of 44 m) remains operational and has registered no discernible movement since installation in 1996.

Note: The instruments at these two sites are located outside the limits of the active landslide zones.

Assessment:

SLIDE A (km 26.14, was STATION 0+650) – See Drawing 32121-PH044-1-1:

The landslide movement consists of a rotational landslide with two blocks occurring on an 18 m high embankment inclined at an overall angle of 18°. The ravelling of the headscarp has become relatively stable since 2019. However, the lower slope continues to be active with new tension cracks observed on the east side, active movement on the west half, further development of an erosion gully, and fresh movement beside and below the hanging culvert outlet. The dip in the pavement surface, which was first observed in 2015 directly above the landslide, was overlaid in 2016 and has not yet reappeared. It is believed that the landslide has occurred due to a gradual loss of cohesion of the clay embankment fill due to surface weathering (similar at Slide B). The crest of the landslide has retrogressed about 0.5 m from 2015 to 2016 (a total regression of 1.7 m since 2009) and evidence of seepage (salt staining) was noted in the backscarp about 1 m below the crest in 2015 (covered with colluvium in 2016). A high-tension steel cable guardrail was installed in 2016 and measurement of the crest were reset to this new reference (consult 2016 drawings for list of previous measurements). The measurements were reset again in 2019 as the HTSC was replaced with w-beam guardrail. There was some further movement toward the highway between 2017 and 2018 including a tension crack that opened up about 5.3 m from the HTSC barrier. The tension crack was covered over with debris in 2019 and 2020; however, the main scarp does not appear to have regressed from 5.8 m from the guardrail measured in 2020. There is a significant erosion channel developing below the culvert out which is causing continued slumping at the toe of the slope which is regressing up and above the culvert.

In 2022, there was a new silt deposit on the southeast side of the upslope culvert outlet. The source of this material is not known. As it was still wet and soft, it is assumed to be a recent deposition.

SLIDE B (km 25.82 was STATION 0+500): - See Drawing 13351-PH044-2-1
The landslide movement consists of a rotational landslide located downslope of the pile wall. Although the wall appears to be protecting the highway, there is increasing raveling and eroding of the slope adjacent to the highway. After being relatively stable for the previous few years, the new movement observed in 2020 continued to deteriorate in 2022: tension cracks are forming near the headscarp, an intermediate scarp formed in the main scarp, and the skin landslide extension to the north has extended further.

Downcutting in the gully below the abandoned culvert south of the landslide, which resulted in a segment of the culvert becoming detached, has not yet stabilized despite that the inlet was blocked off in 2016. The gully may be concentrating surface water or groundwater flow from the adjacent area.

It is believed that the landslide has occurred due to a gradual loss of cohesion of the clay embankment fill due to surface weathering. Ongoing slope movement could eventually reduce the support to the back of the pile wall and result in distress to the wall and highway.

Recommendations:

Medium-Term:

- Slide A: Consideration should be given to lining the culvert and welding a downpipe to the outlet to direct culvert flow to the bottom of the slope into a dissipation bowl. This could reduce some of the driving force on the landslide and minimize issues that may arise from the reduced culvert flow due to the covered outlet.
- Slide B: Drainage water should be prevented from running onto the landslide area. An asphalt curb could be used to direct surface runoff away from the landslide, which will also reduce the ravelling of the embankment between the highway and pile wall.

Long-Term:

- Slide A: the landslide material (predominantly clay till) could be removed, and the slope reconstructed at a flatter angle with well-compacted, moisture-conditioned clay benched into the intact fill slope. The culvert should be replaced or repaired following excavation of the slumped material and extended to a flatter area downslope where a dissipation bowl should be constructed. Extending the outlet may allow sufficient room for a small toe berm so the slope could be flattened somewhat. In addition, the area surrounding the culvert inlet should be regraded and protected with a high-flow soil covering.
- Slide A: alternatively, a pile wall could be constructed at the shoulder to protect the highway similar to the approach taken at Slide B.
- Slide B: Consideration could be given to excavating and replacing the landslide material below the wall and reconstructing the slope at a flatter angle with well-compacted, moisture-conditioned clay benched into the intact fill. Soil nailing could be considered as an alternative to stabilize the upper portion of the landslide.
- Slide B: The concrete ditch liner at the north end of the landslide is cracked and could be repaired with fillcrete, which would prolong the useful life or replaced. Consideration should be given to installing a half-culvert to convey the water to the toe of the slope rather than spilling onto the fresh movement area.

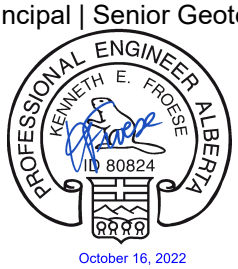
Ongoing Investigation:

- It is recommended that the twice-per-contract Geohazard inspection should continue as scheduled (2024).
- If a drill rig is in the area on other work, it is suggested that one or two additional inclinometers be installed at each of these sites as the existing instrumentation is outside active movement areas.

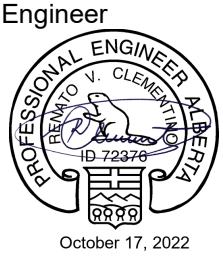
Closure

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



October 16, 2022



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.
Associate | Senior Geotechnical Engineer

THURBER

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.

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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

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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.

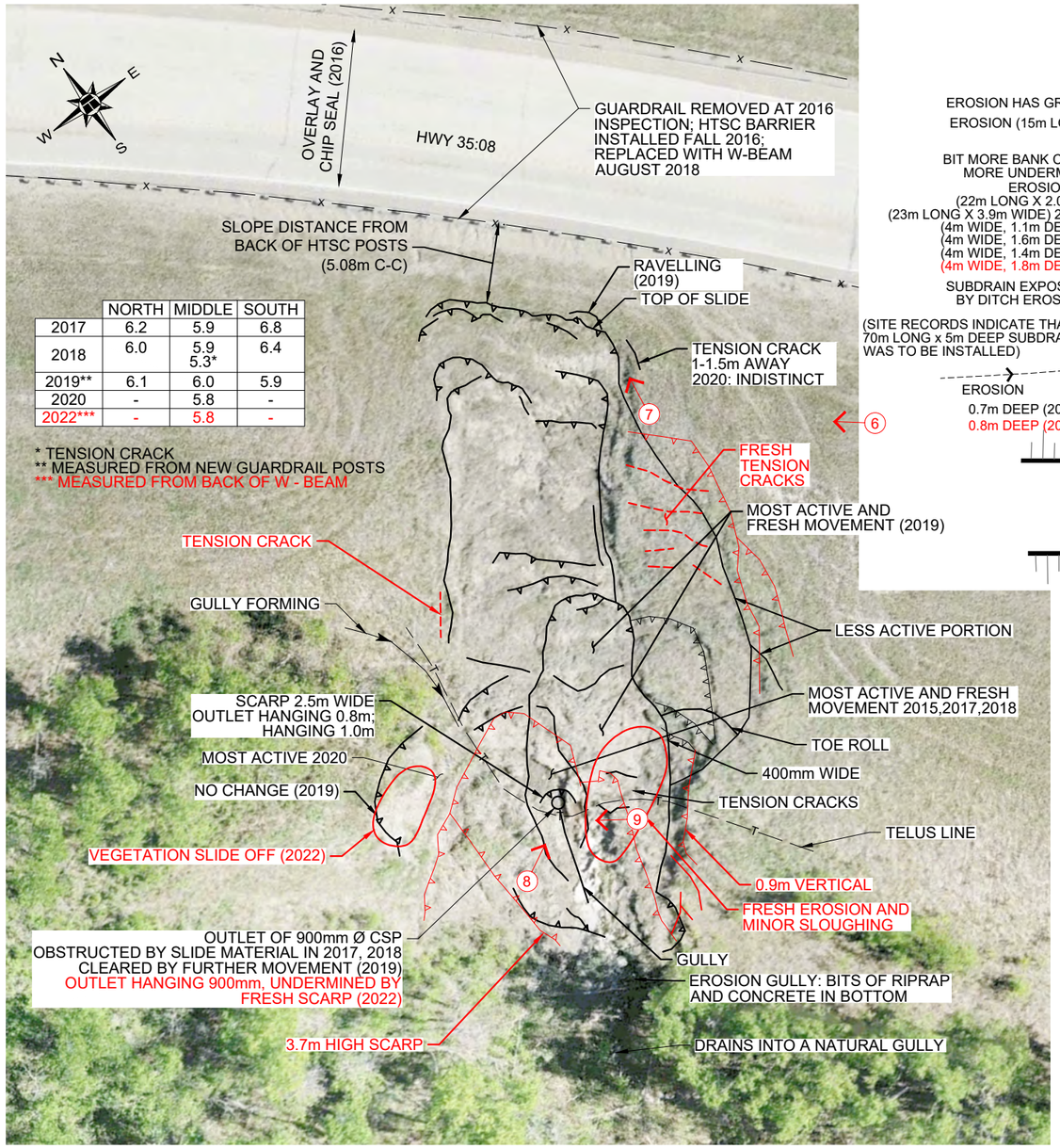
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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.

H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2022 GEOHAZARD\KEF\32121 PH044-1-1.dwg - PH44-2 - September 11, 2012



	NORTH	MIDDLE	SOUTH
2017	6.2	5.9	6.8
2018	6.0	5.9 5.3*	6.4
2019**	6.1	6.0	5.9
2020	-	5.8	-
2022***	-	5.8	-

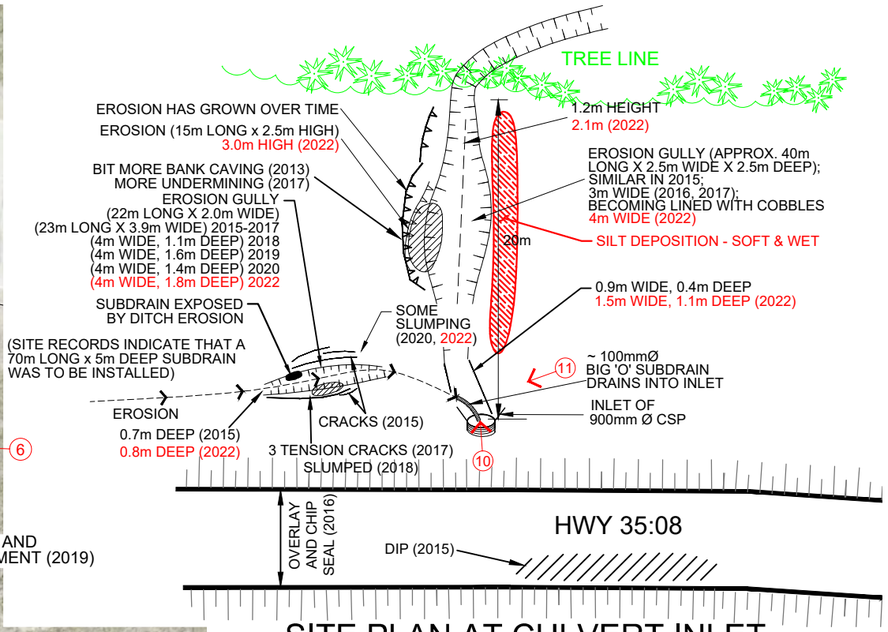
* TENSION CRACK
** MEASURED FROM NEW GUARDRAIL POSTS
*** MEASURED FROM BACK OF W - BEAM

SITE PLAN AT CULVERT OUTLET

1:400

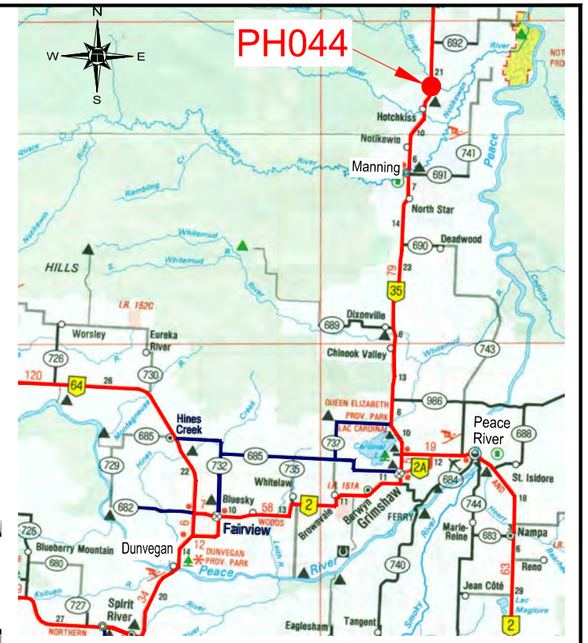
0 5 10 15 20 25m

SCALE 1:400



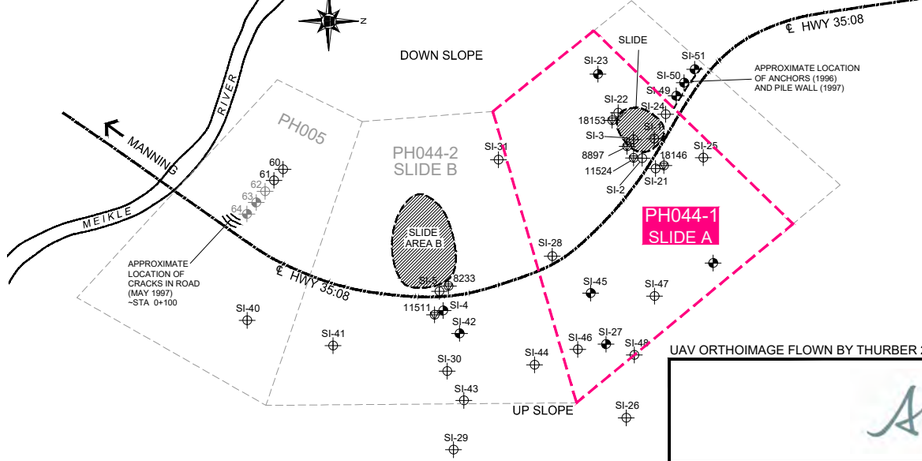
SITE PLAN AT CULVERT INLET

N.T.S.



SITE MAP

NOT TO SCALE



SITE PLAN

N.T.S.

UAV ORTHOIMAGE FLOWN BY THURBER 2022

LEGEND

- SLOPE INCLINOMETER *(currently using)*
- SLOPE INCLINOMETER *(not in use)*
- PIEZOMETER *(not in use)*
- SLIDE BACKSCARP
- PHOTO AND DIRECTION

NOTES

1. BASE PLAN COPIED FROM GAEA ENGINEERING DRAWING DATED MAY 1997
2. SI's 40-48 INSTALLED JULY 1996
3. SI's 49-51 INSTALLED DEC. 1997
4. FEATURE LOCATIONS ARE APPROXIMATE.
5. PREVIOUS OBSERVATIONS SHOWN IN BLACK AND RESET IN 2018
6. JUNE 2022 OBSERVATIONS SHOWN IN RED

Alberta

PEACE REGION (PEACE RIVER / HIGH LEVEL)

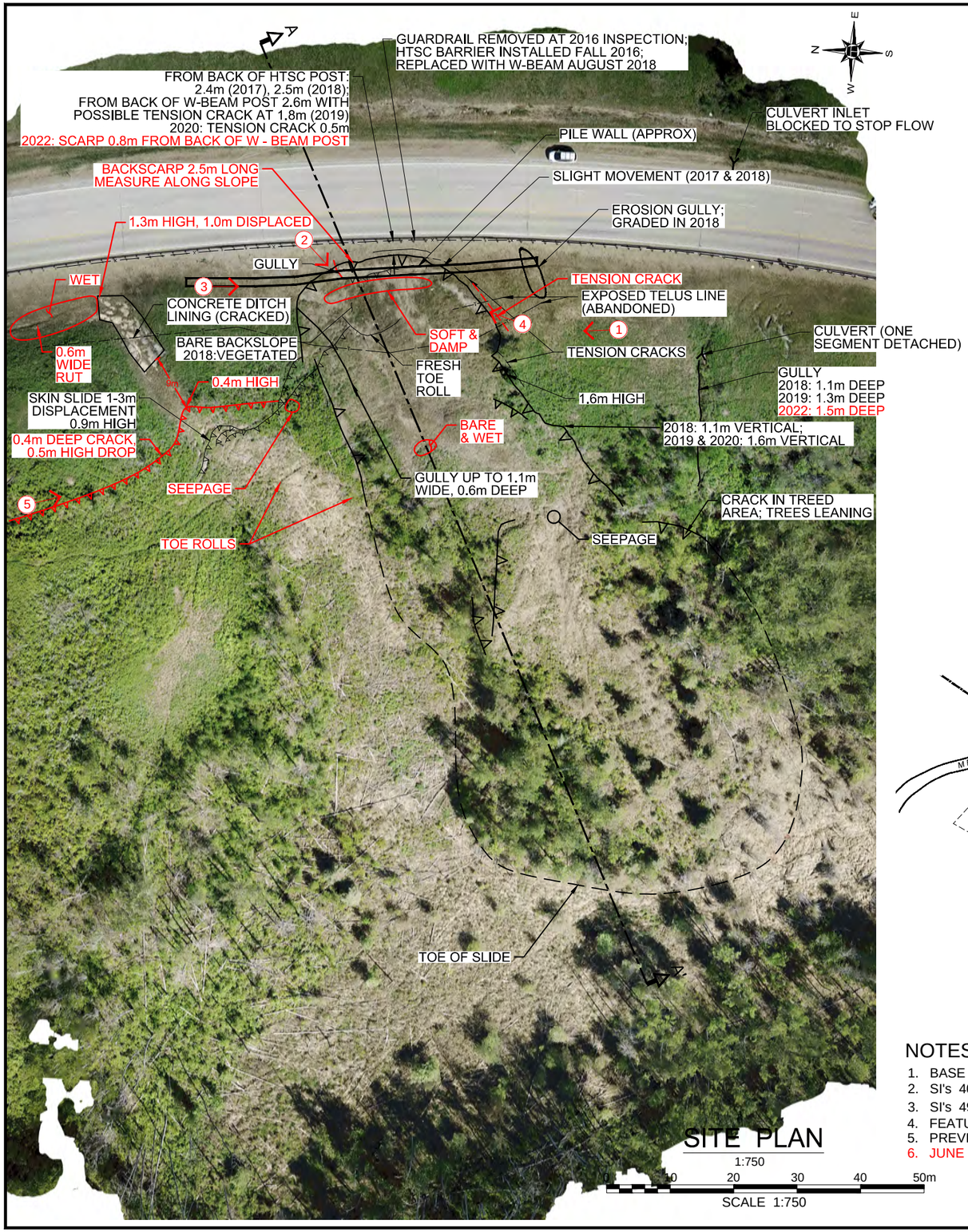
PH044-1: HWY 35:08 - MEIKLE RIVER km 26.14, SLIDE AREA A
2022 GEOHAZARD ASSESSMENT

DWG No. 32121-PH044-1-1

DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	AS SHOWN
DATE	SEPTEMBER 2022
FILE No.	32121

THURBER ENGINEERING LTD.

H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2022 GEOHAZARD\KEF\32121 PH044-2-1.dwg - PH44-1 - Jun. 15, 2010

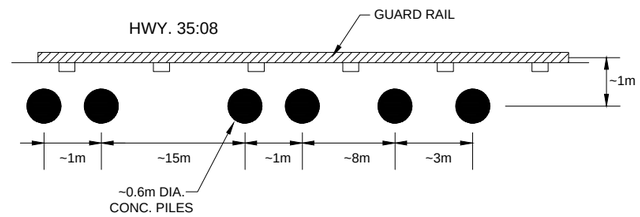


SITE PLAN

1:750

0 10 20 30 40 50m

SCALE 1:750

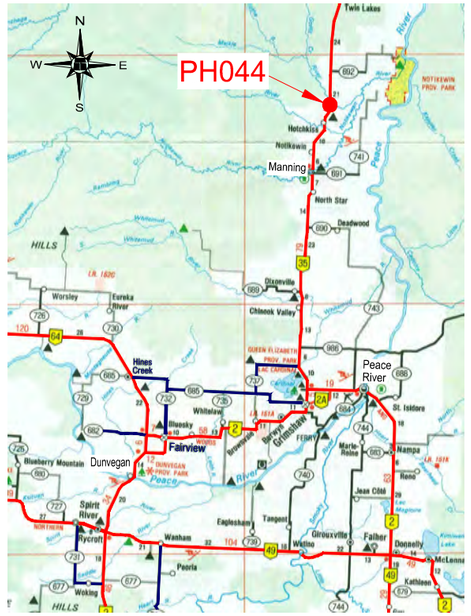


PILE WALL

N.T.S.

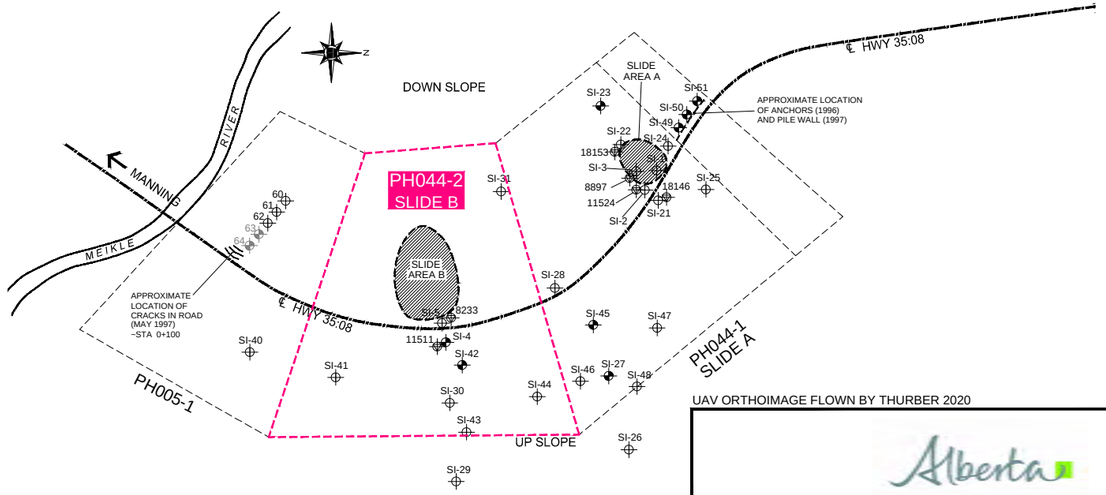
LEGEND :

- SLOPE INCLINOMETER *(currently using)*
- SLOPE INCLINOMETER *(not in use)*
- PIEZOMETER *(not in use)*
- SLIDE BACKSCARP
- (1) PHOTO AND DIRECTION



SITE MAP

NOT TO SCALE



SITE PLAN

N.T.S.

UAV ORTHOIMAGE FLOWN BY THURBER 2020

NOTES :

1. BASE PLAN COPIED FROM GAEA ENGINEERING DRAWING DATED MAY' 97
2. SI's 40-48 INSTALLED JULY 1996
3. SI's 49-51 INSTALLED DEC. 1997
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Alberta

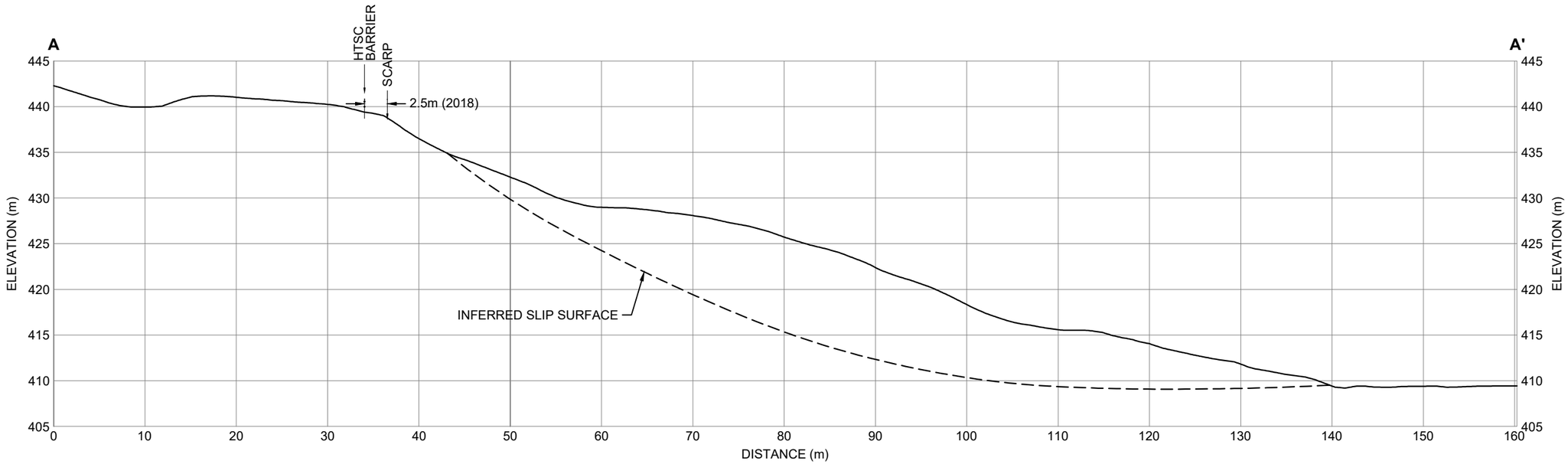
PEACE REGION (PEACE RIVER / HIGH LEVEL)

PH044-2: HWY 35:08 - MEIKLE RIVER km 25.82, SLIDE AREA B 2022 GEOHAZARD ASSESSMENT

DWG No. 32121-PH044-2-1

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

THURBER ENGINEERING LTD.



NOTE:
1. GROUND PROFILE FROM LIDAR DATA (DATE UNKNOWN) PROVIDED BY ALBERTA TRANSPORTATION

PEACE REGION (PEACE RIVER / HIGH LEVEL)

PH044-2: HWY 35:08 - MEIKLE RIVER km 25.82, SLIDE AREA B
2018 GEOHAZARD ASSESSMENT

DWG No. 13351-PH044-2-2

DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:500
DATE	DECEMBER 2018
FILE No.	13351

THURBER ENGINEERING LTD.

H:\13000\13351 Geohazard Assessment - Peace River\High Level (CON0017602)\Drafting\2020\KEF\13351 PH044-2-1.dwg - PH44-1 (2) - Jun. 15, 2010

Photo 1 – Slide B: Backscarp and highway, looking north.

Photo 2 – Slide B: View of slope failure and landslide block, looking southwest.

Photo 3 – Slide B: Backscarp and highway, looking south.

Photo 4 – Slide B: View of backscarp looking north.

Photo 5 – Slide B: Looking south at the developing extension on the north side of the landslide.

Photo 6 – Slide A: Embankment sideslope, looking north.

Photo 7 – Slide A: Embankment sideslope, looking northeast.

Photo 8 – Slide A: Slope movement near the toe of the slope, looking east. Recent movement has occurred below and to the left of the culvert outlet.

Photo 9 – Slide A: Downslope view, looking west. Some vegetation has slumped off the face on the left hand side. A former grass-covered access route is located on the left side of the small hill in the center of the photo.

Photo 10 – Slide A: Erosion gully outside culvert inlet, looking northeast. Note fresh silt deposit on the right-hand side.

Photo 11 – Slide A: Erosion gully in sideslope draining towards culvert inlet, looking north.

Slide A: 2020 UAV photo of landslide.

Slide A: 2022 UAV photo of landslide.