

**ALBERTA TRANSPORTATION AND
ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2024 INSPECTION**



Site Number	Location	Name	Hwy	km
PH059	East Hill	34+770 to 35+680 Site 2	2:60	35.2
Legal Description		UTM Co-ordinates (NAD 83)		
S28-083-21 W5M		11V E 484105	N 6231090	

	Date	PF	CF	Total
Previous Inspection:	May 25, 2022 Site 2 Downslope	10	5	50 (Slide Risk Rating)
	Shallow slide 34+850	9	4	36 (Slide Risk Rating)
Current Inspection:	May 27, 2024 Site 2 Downslope	10	5	50 (Slide Risk Rating)
	Shallow slide 34+850	9	4	36 (Slide Risk Rating)
Road WAADT:	3760	Year:	2023	
Inspected By:	Don Proudfoot, Tyler Clay, Cole Szakacs (Thurber). Rocky Wang, Robert Senior (TEC)			
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance			

Primary Site Issue:	Large landslide referred to as Site 2 (35+250) previously encompassed highway in the 1980s. The upslope area was mitigated by major crest unloading. The area below the road was mitigated by the construction of large berms. The area still has ongoing shallow and deep-seated movements as well as two active erosion gullies. A shallow slide up to the guardrail occurred in 2007 at 34+850.		
Dimensions:	Site 2 is 750 m wide; extends 300 m upslope of roadway to crest of valley and 350 m downslope of roadway to North Heart and Heart Rivers. Shallow slide at 34+850 is approximately 25 m wide and extends 40 m downslope.		
Date of any remediation:	None		
Maintenance:	2022 – Highway was repaved and there were numerous ditch and culvert repairs.		
Observations:	Description:	Worsened?	
		Yes	No
<input type="checkbox"/> Pavement		<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Shallow slump at 34+850 appears to have additional downslope movement within the displaced slide mass but no major retrogression of the main scarp or lateral expansion with a minimum offset of approximately 0.8 m from the guardrail (unchanged from 2022). A new tension crack was observed	<input checked="" type="checkbox"/>	<input type="checkbox"/>

	<p>above the main scarp, there was some rill erosion in the upper scarp and reduced vegetation growth (likely a result of winter salt and sanding). (Photos 59-01 and 59-02)</p> <p>No surficial signs of instability in embankment below highway between 35+100 to 35+350. Flank of scarp near 35+300 has no change from 2022 condition. (Photo 59-04)</p> <p>Potential new slide scarps or tension cracks appeared to be forming within the disturbed slide toe deposits approximately 75 m to 100 m upslope from the highway ditch near 35+250. (Photo 59-05)</p> <p>Active landslide area occurring at the base of the valley below the erosion gully at KM 35+500 as well as ongoing slide movements in the gully flanks further up the valley slope and downstream from the gabion culvert outlet (Photo 59-11).</p>		
<input checked="" type="checkbox"/> Erosion	<p>Erosion gully is active near 35+450, approximately 125 m downslope from highway. There was increased erosion/sliding within the vertical sidewalls and some minor expansion relative to the 2022 condition but no major headwall retrogression. (Photo 59-06)</p> <p>Erosion gully downstream of gabion culvert outlet near 35+500 had increased erosion/expansion along the sidewalls but no major headwall retrogression since previous inspection (Photos 59-10 and 59-11).</p> <p>As part of the Fall 2022 repair work, ditches were repaired, lined with ECM and gabion check dams were installed on both sides of the highway between approximately 35+200 to 35+350. At the downstream end of the 2022 north ditch repair section (near 35+350) water flow has been directed outside the gabion ditch armouring and eroded along the edge of the pavement shoulder due to a silt fence. The erosion channel was up to 0.3 m wide and 0.2 m deep. (Photos 59-07 and 59-08)</p> <p>Silt buildup and minor erosion was noted within ditch on the north side of the highway near 35+650 (Photo 59-02).</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert	Culvert at 35+100 was repaired in Fall 2022.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Other	The slope above the road between 35+200 and 34+700 that was used as a borrow source area has been graded back and reclaimed. Slope was well vegetated with minor track erosion from off-highway vehicles. No stability issues were apparent. (Photo 59-03).	<input type="checkbox"/>	<input checked="" type="checkbox"/>

	<p>Outlet drain pipe blocked in gabion discharge structure at 35+480. Slumping and erosion downslope of discharge structure is ongoing. Structure is in similar condition to previous inspection. (Photo 59-09).</p>		
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Instrumentation:

Instruments were read on May 19, 2024 and the results are summarized below:

- SI75 (located downslope of highway) – 3.8 mm/yr over 0.0 m to 5.4 m depth since the fall of 2023 readings. An overall accelerated movement rate has been present since the spring of 2023 readings (average rate of 7 mm/yr after spring 2023 versus average rate of 2 mm/yr between 2007 to 2023).
- SI81 (located downslope of highway) – 0.6 mm/yr and 3.0 mm/yr over 1.9 m to 6.1 m depth and 6.1 m to 9.2 m depth, respectively, since the fall of 2023 readings.
- SI67 (located upslope of highway)– No discernible movement.
- SI69 (located downslope of highway) – No discernible movement.
- SI82 – Sheared at 11.7 m below ground surface since Fall 2012 reading.
- Standpipe piezometers SP-003 and SP-004 showed decreases in groundwater level of 0.16 m and 0.17 m, respectively, since the fall of 2023 readings. Groundwater levels have shown a steady trend in both standpipes since 2002, with groundwater depth at approximately 11 m for SP-003 and 5 m for SP-004.

Assessment (Refer to Drawings PH060-2):

Small deep-seated movements are occurring within fill embankment downslope of roadway (35+250) indicating low Factors of Safety. Measured rates of movement within two of the instruments below the road (SI 81 and S I75) have averaged around approximately 2 mm/yr to 6 mm/yr since 2007; however, an acceleration trend has been observed since Spring 2023 (average of 7 mm/yr at SI 75). These rates of movement are still well below measured historic rates (prior to 2000) of up to 30 mm/yr. No visible indications of slope movement have been observed along the slope near these SI's.

No movement has been measured within the SI upslope of the road at 35+200. Shallow slumping upslope of roadway may potentially have increased activity but has limited potential to affect roadway at this time.

The shallow slump at 34+850 appears to have recent activity and may retrogress closer to the road in the next several years based on tension crack development and increase vegetation disturbance within the upper scarp.

Erosion is very active within the two major gullies south of the highway, forming localized slides within the vertical sidewalls. Current gullies do not present an immediate risk to the highway but adding a trunk drain to this section should be considered to reduce rate of retrogression and loss of embankment toe berm support.

The unloading of the upslope area above the highway between 35+200 to 34+700 is expected to help reduce the potential reactivation of the old landslide plane from the 1980s.

Recommendations:**Monitoring:**

Biennial inspections should continue with the next inspection occurring in the Spring of 2026.

Continue to monitor instruments twice a year.

Updated aerial imagery or drone photogrammetry survey completed every 2 to 4 years would be beneficial for tracking the rate of erosion, gully expansion and overall slide activity within the lower valley slope.

Maintenance:

- The drain pipe outlet needs to be cleared in gabion discharge structure at 35+480. Slope regrading or fill placement at 34+850 may be required in the future if the guardrail becomes undermined due to erosion or movement at the slide scarp.
- The silt fence in the north ditch near 35+350 should be removed and the ditch graded to ensure there is a smooth transition into the rock armored ditch section. ECM and synthetic check dams should be installed upstream of the rock armoured section. The erosion channel along the pavement edge should be backfilled with nominally compacted clay, ECM and seeded.

Short-term Measures:

- Anchored (Duckbill anchors or equivalent) TRM could be installed between the road and upper slide area for the shallow slump at 34+850 to reduce rates of erosion/retrogression of the oversteepened scarp face and limit undermining of the pavement edge and guardrail (\$50k - \$100k), or the shallow slide could be stabilized by placing a toe berm against the lower part of the slope or digging out the slide material and rebuilding the slope with a gravel over a gravel shear key (\$300k to \$800k).

Long-term Measures:

- Installation of one or two trunk drains to convey water drainage past the gullies. (\$1M - 2M)

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

Tyler Clay, P.Eng.
Geological 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.

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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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5. INTERPRETATION OF THE REPORT

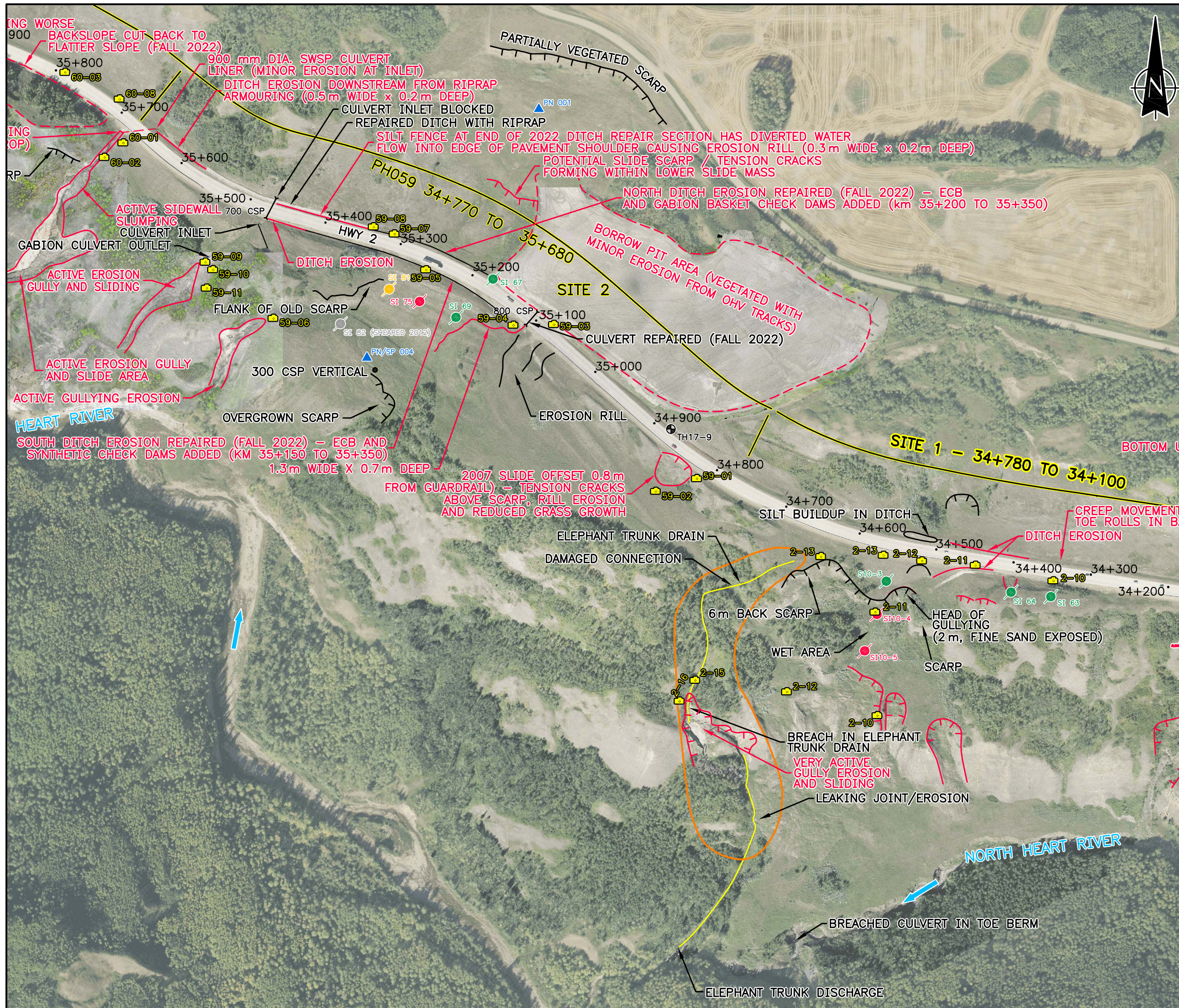
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification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

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LEGEND:

- HORIZONTAL CHAINAGE (37+130 GROUARD BRIDGE) ● 34+900
- PHOTOGRAPH LOCATION 📷 41-01
- TEST HOLE LOCATION ⊕
- SLOPE INCLINOMETER
- NO MOVEMENT ● SI 64
- CREEP 📏 SI 82
- MEASURABLE MOVEMENT (OR RECENTLY SHEARED) ● SI 82
- PIEZOMETER ▲ PN 004
- PH059 EXTENT —
- SLIDE —
- DRAIN BOUNDARY —

- NOTES:**
- FIGURE MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 32121 DATED MAY 2024 AND IS SUBJECT TO ANY LIMITATIONS DESCRIBED THEREIN.
 - PHOTO BASE IMAGE COMBINED FROM 2012 AIR PHOTO (TARIN RESOURCES SERVICES LTD.), THURBER DRONE IMAGERY (2022), MACINTOSH PERRY DRONE SURVEY (2022).
 - SLIDE FEATURES, PHOTOGRAPHS AND CHAINANGE ARE SHOWN APPROXIMATE ONLY.
 - MAY 28, 2024 OBSERVATIONS SHOWN IN RED.

Alberta Transportation

PEACE REGION (PEACE RIVER DISTRICT)

**PEACE RIVER EAST HILL
HWY 2:60 (PH059) STA. 34+770 TO 35+680
LOCATION PLAN**

FIGURE PH059-2

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:5000
DATE	OCTOBER 10, 2024
FILE No.	32121-A7E



THURBER ENGINEERING LTD.



Photo 59-01.
 Looking northwest at headscarp area of shallow landslide on downslope side of roadway first observed in 2007 (34+850). There was additional downslope movement of the slide mass, a new tension crack was observed above the main scarp, there was some rill erosion in the upper scarp and reduced vegetation growth (likely a result of winter salt and sanding).



Photo 59-02.
 Looking north (upslope) from the base of the slide area near 34+850. Increased downslope movement of the slide mass relative to the 2022 condition. Rill erosion visible in the backscarp. Scarp is still offset 0.8 m from the guardrail (unchanged since 2022).



Photo 59-03.
Looking northeast at the borrow area upslope of the highway between approximately 34+700 and 35+200. Slope was well vegetated with minor track erosion from off-highway vehicles. No stability issues were apparent.

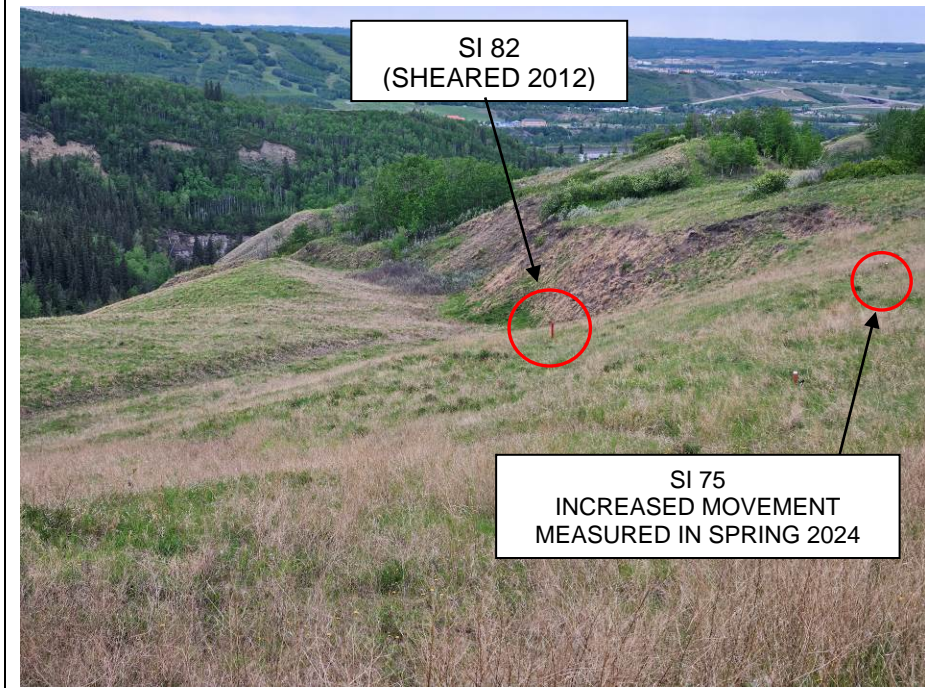


Photo 59-04.
Looking west at old slide flank near KM 35+300. Area is vegetated with no visible signs of major change or slope movement. SI indicated with trend of increased movement since Spring 2023. No change to the overgrown slide flank near 35+300.



Photo 59-05.
Looking at backslope north of the highway near KM 35+250 within historic slide terrain. Potential new slide scarps and tension cracks appeared to be forming within the disturbed slide toe deposits approximately 75 m to 100 m upslope from the highway ditch near 35+250.



Photo 59-06.
Looking west at headwall area of an erosion gully approximately 125 m downslope (south) from the highway (35+450). Ongoing erosion and sliding of the vertical sidewalls and some minor expansion relative to the 2022 condition but no major headwall retrogression.



Photo 59-07.
Looking east towards the Fall 2022 north ditch repair section (35+200 to 35+350) with gabion basket check dams. Similar repairs were also completed within this section in the south ditch.



Photo 59-08.
Looking west at north ditch erosion damage starting at the downstream end of the 2022 repair section near 35+350. Water flow has been directed outside the gabion ditch armouring and eroded along the edge of the pavement shoulder due to the silt fence. Erosion channel was up to 0.3 m wide and 0.2 m deep.



Photo 59-09.
View northeast downslope from the gabion culvert outlet structure (35+500). There was a 0.5 m scour drop below the downslope row of gabion baskets that drains towards a much large erosion gully.



Photo 59-10.
Looking southwest at the erosion gully downstream of the gabion culvert outlet (35+500). Ongoing erosion and flank expansion relative to the 2022 condition.



Photo 59-11.
Looking southwest at the erosion gully / slide area downstream of the erosion gully near KM 35+500. Ongoing erosion and slide movement but no significant retrogression towards the highway (main headwall offset approximately 115 m from the highway). More trees have fallen into gully due to the collapse of the gully sidewalls.