ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2025 INSPECTION

THURBER

Site Number	Location	Name	Hwy	km
PH042	Daishowa East Hill	Pumping Well	986:01	33.2
Legal Description		**UTM Co-ordinates**		
NE7-85-20 W5M		11V E 491155	N 6246175	

	Date	PF	CF	Total
Previous Inspection:	18-May-2023	3 13	6 2	18 (Highway) 26 (South Ditch)
Current Inspection:	14-May-2025	3 13	6 2	18 (Highway) 26 (South Ditch)
Road AADT:	1020		**Year:**	2024
Inspected By:	Rocky Wang, TEC		Tyler Clay, Thurber Don Proudfoot, Thurber	
Report Attachments:	☒ Photographs	☒ Plans	☒ Maintenance Items	

Primary Site Issue:	Roadway and embankment have a history of active landslide movement. Head scarp extended across both driving lanes. Site was remediated once (successfully in short-term) with a series of pumping wells installed on upslope side of roadway. The pumps required ongoing maintenance that was impractical to sustain and eventually the pumps were no longer effective at reducing the rate of landslide movement. Mitigation work was completed between the fall of 2016 to the summer of 2018 involving construction of a 98 m long, tied-back tangent pile wall to mitigate a landslide affecting the highway. A callout in August 2020 was requested due to a rapid landslide that developed in the valley slope uphill/south of the highway whose toe had heaved the gabion mattress in the south ditch.
Dimensions:	The original landslide is 100 m wide and extends from east bound driving lane to (presumably) creek approximately 150 m downslope of roadway. Recent valley slope slide on south side of highway is approximately 85 m wide parallel to highway, extends 70 m uphill from the ditch and toe roll extends into middle of south ditch. .
Date of Remediation:	2018: Pile wall
Maintenance:	Road overlaid in 2017

Observations:	Description	Worsened?
☒ Pavement Distress	ACP was in good condition at the time of the inspection with no signs of cracking or subsidence along previously observed extents of pavement damage due to landslide movement (Photos 42-01 and 42-03).	☐
☒ Slope Movement	No observations of slope movement were evident at the road surface or below the pile wall along or outside the previous landslide extents (Photo 42-02). Backslope failure that occurred in 2020 near 33+125 had no major visible change. The gabion was slightly more heaved at the slide toe (up to 1.1 m in height) but there was no significant change from the 2023 condition (Photo 42-06).	☐
☒ Erosion	Minor rill erosion was noted between the road edge and the edge of the gabion mattress but has not significantly changed since the previous inspection. An erosion gully (up to 0.5 m deep, 1.1 m wide, 17 m long) has formed near km 33+150 between the south road shoulder and heaved gabion mattress and had become worse since 2023. (Photo 42-06)	☒
☐ Seepage		☐
☐ Bridge/Culvert		☐
☒ Other	Drain outlets between the piles were dripping at the west end of the wall and area at the base of the wall was wet. Subdrain outlet at the end of the riprap swale was dripping. (Photo 42-04) PVC conduit along the top of the wall for instrument cables had become disconnected from the junction box and tie-down clamps were broken.	☐

Instrumentation (Spring 2025):	
Legacy SI instrumentation (installed in 2009)	SI09-1 - Upslope of roadway; sheared at 2.6 m after September 2013 SI09-2 - Downslope of roadway; sheared at 16.8 m after June 2011 SI09-3 - Downslope of roadway; sheared at 11.0 m after May 2010 SI09-4 - Downslope of roadway; sheared at 9.8 m after September 2010
Pile Wall	Instrumentation has been installed to monitor performance of the pile wall and includes the following: 9 vibrating wire (VW) piezometers,1 slope inclinometer (SI), 3 shape accelerometer arrays (SAA), 14 vibrating wire strain gauges (SG), and 9 load cells. After the spring of 2020 readings, the batteries for both dataloggers were stolen. Prior to the spring of 2022 readings, batteries were replaced, and several upgrades were completed by Thurber to the pile wall datalogger station to allow for automated readings of the pile wall instruments. **SAA Summary**: Wall deflections have been measured in SAA17-P20 and SAA17-P40 over the length of the piles. The rate of movement ranges from 0 to 2 mm/yr with a maximum total resultant pile head movement in the downslope direction of 25 mm to 60 mm. These deflections are within expected design limits. Both of the SAAs installed in the pile wall have shown an overall trend of downslope movement since they were installed, with higher deflections (in the order of 8 mm to 12 mm) during the winter months under frost loads, which rebound once the ground thaws.

	Strain Gauge Summary: The strain gauges showed changes in strain ranging from an increase in positive (tension) strain of 0.3 at 10.5 m depth on the upslope pile face to 13.9 at 2.5 m depth on the downslope pile face. Since 2023 maximum strain gauge values at 18.5 m depth on the upslope and downslope side have shown a stable trend. **Load Cell Summary**: The load cells showed relatively minor increases in load compared to the spring of 2024 readings, ranging from 0.74 kN to 3.45 kN. One anchor is measuring a load that above its design load. However, this is still safely below the ultimate bond strength confirmed during anchor testing activities. Overall, the load cells have shown relatively steady anchor loads over the last two years with a trend of higher loads measured in late winter to early spring due to freeze/thaw effects. **VW Summary**: The piezometers at the pile wall show relatively stable groundwater levels, apart from one instrument (VW17-3B), which is showing a trend of slowly increasing groundwater level over time.
Bench downslope of pile wall	SI18-1 has not shown any discernible movement since it was reinitialized in the spring of 2019. SAA18-1 showed an average rate of movement of approximately 2.3 mm/yr over 0.5 m to 12.5 m depth since spring of 2024 with a total cumulative movement of 18.1 mm.
Upslope Ditch	The three vibrating wire piezometers installed in the south highway ditch to the east of the pile wall, showed decreases in groundwater level between 0.06 m to 0.17 m since the spring of 2024 readings.

Assessment:

The anchored retaining wall is designed to support the roadway and relies on passive support of the downslope bench. SAA18-1 in the downslope bench has shown a total cumulative movement of approximately 18 mm vs 8 mm at SAA17-P40 in the pile within the upper 12.5 m, indicating that the bench has moved approximately 10 mm in the downslope direction relative to the pile wall during this time span. Future readings should check if the bench exhibits faster downslope movement relative to the pile wall. The wall relies on lateral support from the bench and if significant downslope movement is measured another row of tie-back soil anchors would be required below the existing anchors. Based on observations since construction completion the wall appears effective in supporting the highway and the risk of embankment failure due to landslide movement at this site is expected to be significantly reduced. The site should be monitored to assess the wall performance and potential expansion of the slide area laterally and upslope of the wall.

The hillside upslope/south of the highway has been affected by historic landslide movements and has always appeared hummocky during previous inspections. However, higher than usual precipitation and groundwater levels over the few years up to 2020 triggered more aggressive movements. The toe roll of the landslide is clearly marked by the near-vertical heaving of the gabion mattress lining in the ditch. The west flank is also clearly marked by shearing and displacement of the bush covered ground surface. However, the uphill backscarp and east flank were not as well defined. The toe heave has impacted the gabion mattress ditch lining and constricted ditch drainage causing erosion near the shoulder. The ditch restriction could result in overflowing of water onto the highway under high runoff conditions.

Recommendations:

Short-Term:

- Maintenance: Repairs are required along the top of the wall to the PVC conduit and junction box for instrumentation cables.
- Maintenance: The south ditch erosion gully due to the heaved gabion mattress near 33+150 should be filled with Class 1M riprap over non-woven geotextile.
- Short term remedial measures could consist of removing the eastmost 30 m of gabion mattress (and salvaging the stones), excavating the heaved ground back to the pre-disturbance level and replacing a new gabion mattress over this section. The risk with this method is that further ground movements might heave the mattress again. ($75k)

Medium and Long-Term:

- Longer term remedial measures could consist of removing the gabion mattress (and salvaging the stones) over the disturbed zone, strengthening the subsurface foundation soil, trimming the ditch smooth and then relaying new gabion mattress. The subsurface strengthening could consist of either of the following methods ($250k to $400k):
  - Sub-excavating the slide material under the ditch to a depth below the slip surface and constructing a well compacted granular shear key zone to force the slip surface to toe out uphill of the ditch. The shear key would likely need to be at least 2.5 m deep and 5 m wide; or
  - Installing spaced H-piles parallel to, and offset about 1 m south, of the uphill edge of the ditch lining. The piles would likely need to be at about 6 m long/deep.

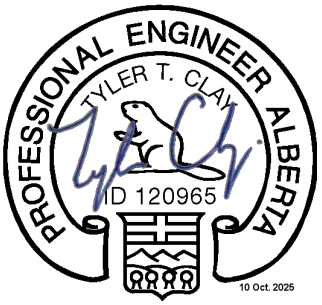
Ongoing Investigation/Monitoring:

- Continue to visually monitor every two years. Instrumentation should have bi-annual readings / data collected regularly to monitor the mitigation performance.

Closure

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement for Use and Interpretation of Report.

Don Proudfoot, M.Eng., P.Eng.
Partner | Senior Geotechnical Engineer



PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: Don Proudfoot
RM APEGA ID #: 51674
DATE: October 10, 2025
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Tyler Clay, P.Eng.
Geological Engineer

THURBER

STATEMENT FOR USE AND INTERPRETATION OF REPORT

1. STANDARD OF CARE

This Report has been prepared in a manner consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under similar circumstances at the same time and in the same or similar locality and in compliance with all applicable laws.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment, including this Statement For Use and Interpretation of Report, 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, AS DESCRIBED ABOVE. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TOTHE WHOLE OF THE 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 for the development, design objectives, and/or purposes described to Thurber by the Client. **NO OTHER PARTY MAY USE OR RELY ON THE REPORT OR ANY PORTION THEREOF FOR OTHER THAN THE CLIENT'S BENEFIT IN CONNECTION WITH THE PURPOSES DESCRIBED IN THE REPORT**. Any use which a third party makes of the Report is the sole responsibility of such third party and is always subject to this Statement for Use and Interpretation of Report. Thurber accepts no liability or responsibility for damages suffered by any third party resulting from use of the Report for purposes outside the reasonable contemplation of Thurber at the time it was prepared or in any manner unintended by Thurber.

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 is inherently judgement-based. 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 parties making use of such documents or records with or without our express written consent need to 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 parties. Some conditions are subject to change over time and those making use of the Report need to be aware of this possibility and understand that the Report only presents the interpreted conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client must 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.

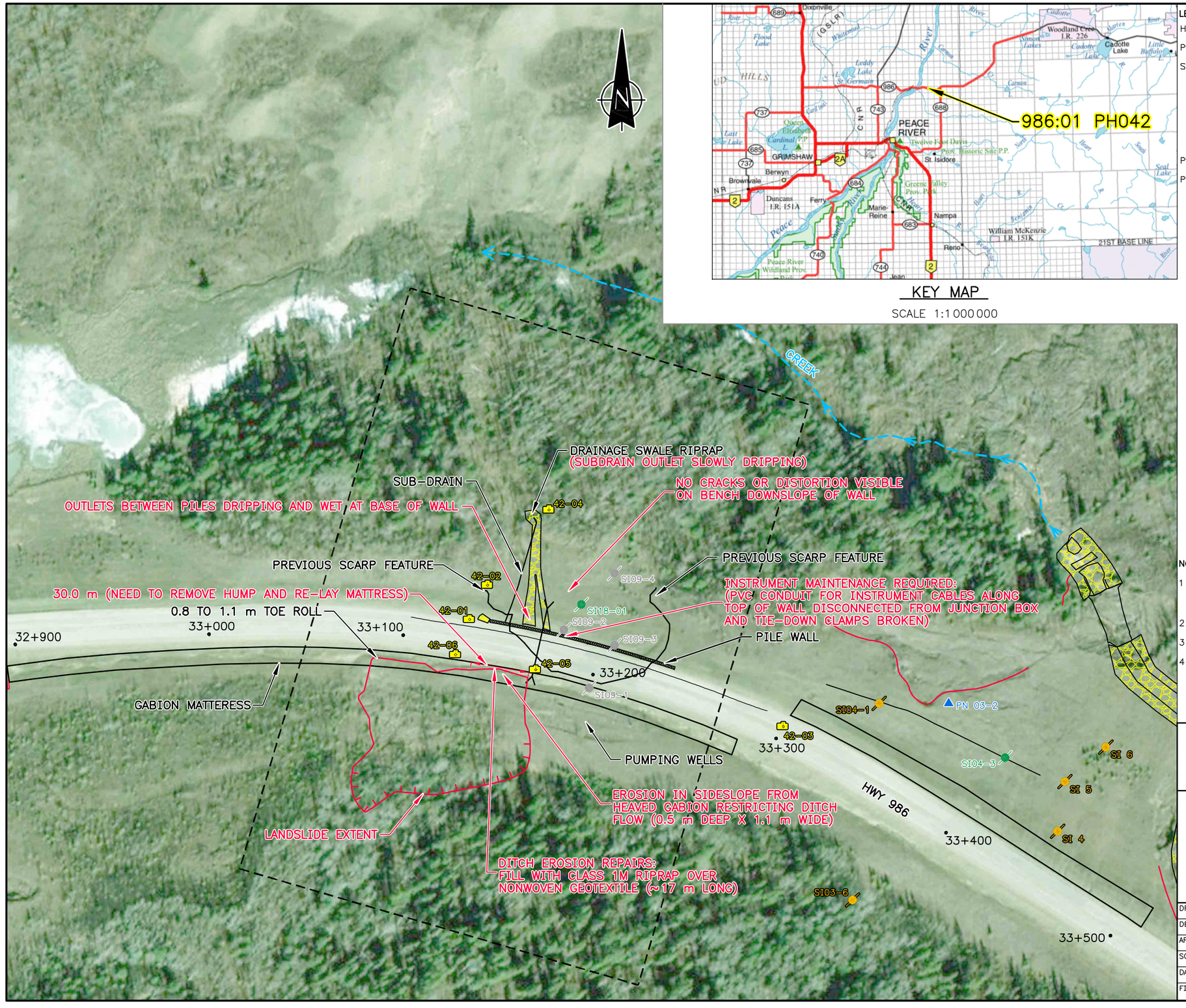
b) **Reliance on Provided Information:** The evaluation and conclusions contained in the Report have been prepared based on conditions in evidence at the time of site inspections and based on information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions 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 resulting from misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other parties 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 is recommended to 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 need to 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 to confirm and document that the site conditions do not materially differ from those 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. 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 other parties 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, unless such decisions expressly form part of the stated purpose of the Report as described in Paragraph 3.



KEY MAP

SCALE 1:1 000 000

LEGEND:

HORIZONTAL CHAINAGE — 32+100

PHOTOGRAPH LOCATION — 42-01

SLOPE INCLINOMETER

- NO MOVEMENT — SI 64
- CREEP — SI 82
- MEASURABLE MOVEMENT (OR RECENTLY SHEARED) — SI 82
- NON OPERATIONAL — SI 82

PIEZOMETER — PN 004

PH042 BOUNDARY

NOTES:

1 FIGURE MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 32121 DATED OCTOBER 2025 AND IS SUBJECT TO ANY LIMITATIONS DESCRIBED THEREIN.

2 AIR PHOTO BASE FROM ESRI (DIGITAL GLOBE, 2016).

3 SLIDE FEATURES, PHOTOGRAPHS AND CHAINAGE ARE SHOWN APPROXIMATE ONLY.

4 BASED ON FIELD OBSERVATIONS ON MAY 14, 2025.

0 25 50 100 150 m

UTM 11N NAD83

Alberta Transportation

PEACE REGION (PEACE RIVER DISTRICT)

DAISHOWA
HWY 986:01 (PH042)
SITE PLAN

FIGURE PH042-1

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:2 000
DATE	OCTOBER 10, 2025
FILE No.	32121-A5C

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Photo 42-01.: Looking east across the repaired slide area. Guardrail and pavement surface in good condition with no major change since previous inspection.

Photo 42-02.: Looking east at the pile wall and regraded slope below. Wall appears in a good condition and there has been no observable changes in the slope below since 2023.

Photo 42-03.: Looking west at the replaced highway segment that previously had cracking and settlement across the roadway due to landslide movement (33+300). Road surface was in a good condition at time of inspection and had no observable change from the 2023 condition.

Photo 42-04.:. Looking at subdrain pipe outlet that was slowly dripping within the end of the armoured drainage swale from the west side of the wall.

Photo 42-05.: View looking east at the gabion mattress installed in the south ditch across the entire site extents to repair previous erosion damage. Minor rill erosion was noted between the road edge and edge of the gabion. No major visible changes within the area east of 33+175 since 2023.

Photo 42-06.:. Looking west at the gabion mattress installed in the south ditch near 33+125 deformed by the toe roll of an upslope landslide that occurred in 2020. Gabion was slightly more heaved but had no significant change since previous inspection. Some increased erosion in ditch sideslope due to restricted flow from gabion heave.