

**ALBERTA TRANSPORTATION GEOHAZARD  
ASSESSMENT PROGRAM  
PEACE REGION (PEACE RIVER DISTRICT)  
2021 INSPECTION**



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

	<b>Date</b>	<b>PF</b>	<b>CF</b>	<b>Total</b>
<b>Previous Inspection:</b>	11-Jun-2020	3	6	18
<b>Current Inspection:</b>	05-Jul-2021 (Highway)	3	6	18
	05-Jul-2021 (South Ditch)	13	2	26
<b>Road WAADT:</b>	840		<b>Year:</b>	2020
<b>Inspected By:</b>	Ed Szmata, TRANS Kristen Tappenden, TRANS Max Shannon, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs		<input type="checkbox"/> Maintenance Items	
	<input checked="" type="checkbox"/> Plans			

<b>Primary Site Issue:</b>	<p>Roadway and embankment have history of active landsliding. Headscarp 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.</p> <p>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.</p> <p>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.</p>		
<b>Dimensions:</b>	<p>The original Landslide is 100 m wide and extends from east bound driving lane to (presumably) creek approximately 150 m downslope of roadway.</p> <p>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 ditch.</p>		
<b>Maintenance:</b>	Road overlaid in 2017.		
<b>Observations:</b>	<b>Description</b>	<b>Worsened?</b>	
<input checked="" type="checkbox"/> 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).	<input type="checkbox"/>	
<input checked="" type="checkbox"/> Slope Movement	No observations of slope movement were evident at the road surface or below the pile wall	<input checked="" type="checkbox"/>	

	along or outside the previous landslide extents (Photos 42-02). Backslope failure that occurred in 2020 near 33+125 has ongoing movement. The toe roll has lifted and deformed approximately 75 m of the gabion mattress in the south ditch, with vertical displacement up to 1.1 m (Photo 42-06).	
<input checked="" type="checkbox"/> Erosion	Previous gully erosion in the south ditch was repaired and ditch has been armored with a gabion mattress. Minor rill erosion was noted between the road edge and edge of the gabion but has not significantly changed since the previous inspection. (Photo 42-05 and 42-06).	<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	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)	<input type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>
<input checked="" type="checkbox"/> Other	Battery was stolen from the datalogger that records continuous instrument readings.	<input type="checkbox"/>

**Instrumentation:**

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

New 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. Battery issues at the datalogger resulted in data collection gaps for the SAA's.

SI18-1 (installed in the bench downslope of the pile wall) has not shown any discernible movement since it was reinitialized during Spring 2019.

Wall deflections have been measured in SAA17-P20 and SAA17-P40 over the length of the piles between 2 to 4 mm/yr with a maximum total resultant pile head movement in the downslope direction up to between 23 to 54 mm respectively. These deflections are within expected design limits.

SAA18-1 (installed in the bench downslope of the pile wall) showed an average rate of movement of 0.5 mm/yr over 0.5 m to 12.5 m depth since July 2020 with a total cumulative movement of 8.1 mm. SAA17-P40 has shown a total cumulative movement of 7.0 mm over the same depth zone since June 2018, indicating that the bench below the pile wall has moved 1.1 mm in the downslope direction relative to the pile wall during this time span. On this basis, the soil bench is still providing support to the wall.

**Strain Gauge Summary:** Collection of strain gauge data was interrupted following July 2020 as a result of the battery for the datalogger being stolen.

**VW Summary (at pile wall):** The vibrating wire piezometers in the pile wall were not able to be read during the current readings cycle due to the datalogger issues. The piezometers near the pile wall have shown an overall trend of gradually increasing groundwater levels since the end of construction.

**VW Summary (at upslope ditch):** VW18-1, VW18-2, and VW18-3, installed in the south highway ditch to the east of the pile wall, showed increases in groundwater level of 0.39 m, 0.38 m, and 0.37 m, respectively, since the fall of 2020 readings.

**Load Cell Summary:** Collection of strain gauge data was interrupted following July 2020 as a result of the battery for the datalogger being stolen. The data up to July 2020 generally followed previous load trends to slightly higher load cycles, with higher measured loads during the winter months in response to frost heave pressures.

**Assessment:**

The anchored retaining wall is designed to support the roadway and relies on passive support of the downslope bench. Future readings should be done to 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.

It is recommended to create a post-construction monitoring and design performance review plan (i.e., Asset Management Plan) to provide recommendations for ongoing monitoring and for future pass-off from construction / design to operations.

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 last few years (up to 2020) have triggered the recent new 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 ditch lining, which could hamper ditch drainage and possibly lead to overflowing of water onto the highway and erosion of the edge of the highway under high runoff conditions.

**Recommendations:**

**Cost**

Continue to visually monitor as part of annual inspections. Instrumentation should have bi-annual readings / data collected regularly to monitor the mitigation performance. -

**South Ditch Repairs:**

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.

\$75,000

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:

- 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.

\$250,000  
to  
\$400,000

**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.

### 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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### 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.

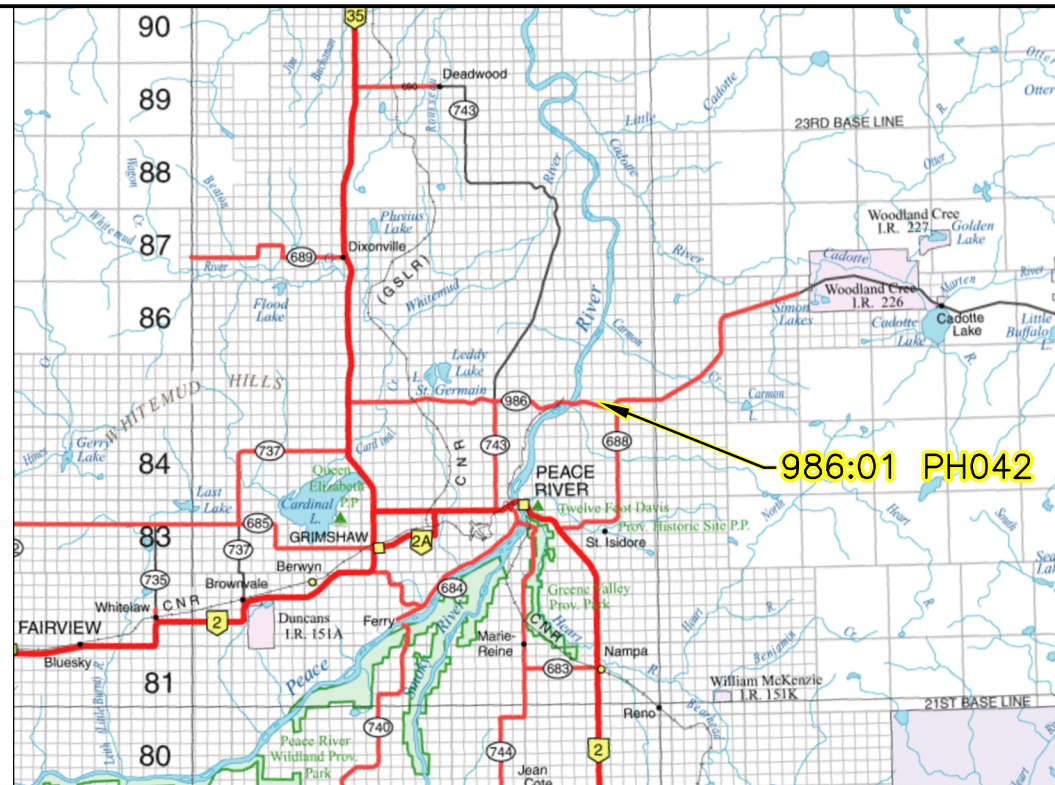
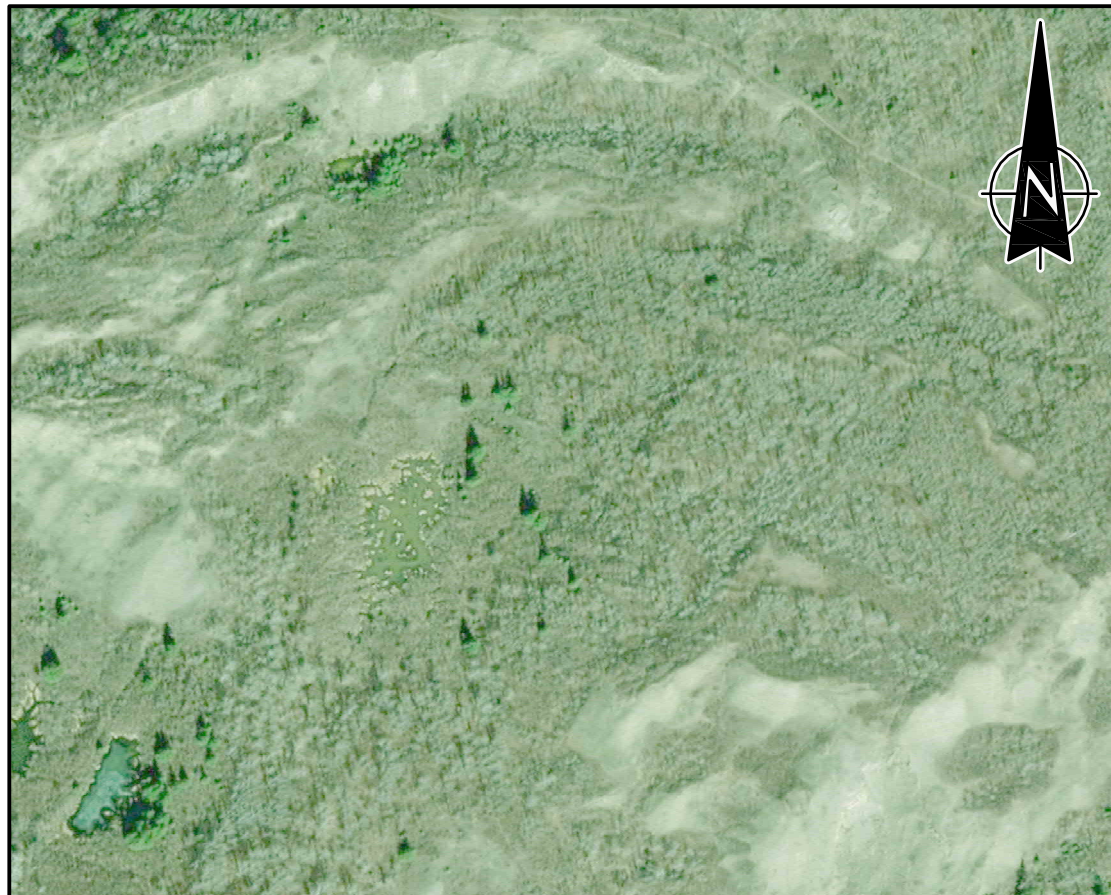
### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

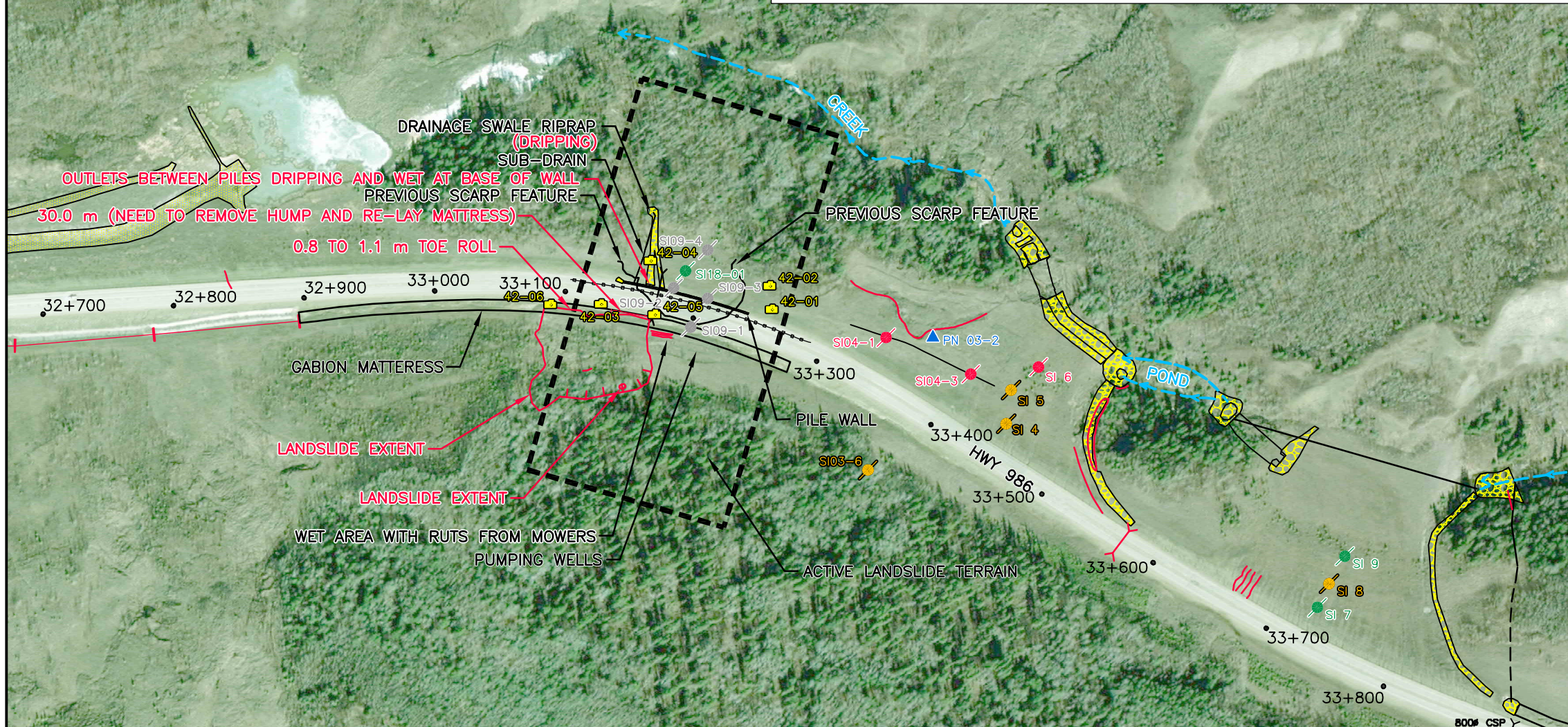
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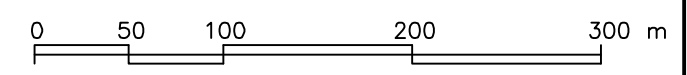


KEY MAP  
SCALE 1:1 000 000

- LEGEND:
- HORIZONTAL CHAINAGE ● 32+100
  - PHOTOGRAPH LOCATION 📷 42-01
  - SLOPE INCLINOMETER
    - NO MOVEMENT
    - CREEP
    - MEASURABLE MOVEMENT (OR RECENTLY SHEARED)
    - NON OPERATIONAL
  - PIEZOMETER
    - SI 64
    - SI 62
    - SI 82
    - SI 82
    - ▲ PN 004
  - PH41 BOUNDARY - - - - -
  - ARMOURD CHANNEL [Yellow Box]



- NOTES:
- 1 DRAWING MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 32121 DATED OCTOBER 2021 AND IS SUBJECT TO THE STATEMENT OF LIMITATIONS AND CONDITIONS INCLUDED IN THE REPORT.
  - 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 JULY 5, 2021.



Alberta Transportation

PEACE REGION (PEACE RIVER DISTRICT)

DAISHOWA  
HWY 986:01 (PH042)  
LOCATION PLAN

FIGURE PH042-1

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:4 000
DATE	OCTOBER 12, 2021
FILE No.	32121-A3D







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



**Photo 42-02.**  
Looking west at the new pile wall and regraded slope below. No significant change since 2020.



**Photo 42-03.**  
Looking east at the replaced highway segment that previously had cracking and settlement across the roadway due to landslide movement (33+210). Road surface was in good condition at time of inspection.



**Photo 42-04.**  
Looking south, upslope at one of two drainage swale branches at 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 change within the area east of 33+175 since 2020.



**Photo 42-06.**  
View looking east at the gabion mattress installed in the south ditch near 33+125. The toe roll of a landslide that occurred in 2020 has encompassed and deformed the gabion pushing it upwards and towards the highway. The length of gabion affected is approximately 85 m.