

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



Site Number	Location	Name	Hwy	km
PH071	Daishowa West Hill	Daishowa West Hill Slide - Km 26.8	986:01	26.8
Legal Description		UTM Coordinates		
SE¼ 09-085-21 W5M		11V E 485015		N 6245524

		Date	PF	CF	Total
<b>Previous Inspection:</b>	Upslope of Wall	11-Jun-2020	3	4	12
	Downslope of Wall	11-Jun-2020	13	2	26
<b>Current Inspections:</b>	Upslope of Wall	5-July-2021	3	4	12
	Downslope of Wall	5-July-2021	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 checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items			

<b>Primary Site Issue:</b>	<p>Pavement distress and minor subsidence were first observed in 2012 within the Eastbound Lane (EBL) due to landslide movement to the south.</p> <p>The damage in the EBL worsened in 2013 and eventually progressed into a significant slope failure involving a segment of the highway that required the closure of the EBL and construction of a detour in the winter of 2013. Further landslide expansion and retrogression into one of the original Westbound Lanes (WBLs) required the construction of another detour in 2015. A pile wall and highway re-alignment were constructed between 2016 to 2018.</p>	
<b>Dimensions:</b>	<p>The highway at the site runs east to west on a sidehill cross-section. The road embankment is about 21.5 m high with side slopes in the order of 3H:1V. Originally the highway at the site area had 2 WBLs and 1 EBL each about 4 m wide. The EBL pavement damage observed in 2012 was 33 m long and included a drop up to 100 mm. In 2013 the damage developed into a slope failure 100 m long with a main scarp up to 6 m high. The landslide extents in 2015 expanded to affect a 130 m long segment of the highway with main scarp up to 6.5 m in height. A 140 m long reinforced concrete anchored tangent pile wall to mitigate landslide movement was completed in 2017.</p>	
<b>Maintenance:</b>		
<b>Observations:</b>	<b>Description</b>	<b>Worsened?</b>
<input checked="" type="checkbox"/> Pavement Distress	Minor reflective cracking observed at the top of the pile wall that follows the edge of the pile cap. No change from the 2020 condition. (Photo 71-10)	<input type="checkbox"/>

<input checked="" type="checkbox"/> Slope Movement	<p>Tension cracks and slide scarps with up to approximately 4 to 5 m of dropdown observed downslope of the pile wall along previously observed slide extents (Photos 71-7 and 71-8). Main slide scarp was offset approximately 5 m from SI16-3.</p> <p>A shallow earth slide with 0.4 m high scarp developed within the swale at the top of the granular backslope repair on north side of road near KM 26+350 that has displaced the riprap (Photo 71-1).</p>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	<p>Upslope ditch between 26+500 to 26+600 has ongoing scour and gulying within the invert (Photo 71-3) that is slightly worse from last year (1.3 m wide and 0.7 m deep). Repaired backslope area where granular fill washed out (first noted in 2019) had increased vegetation growth and did not appear significantly worse (Photo 71-3). Erosion gully from road runoff west of the wall flows above armored swale was slightly deeper but no major change (Photo 71-5). Road runoff had caused minor rill erosion between the armored swale and road edge at the east end of the pile wall near km 26+850 (Photo 71-11).</p>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	<p>At the downslope base of the wall on the east end, drain outlets were slowly dripping, oxidation staining was visible on the paving blocks, and area was wet at eastern side at base of wall (Photo 71-9).</p>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	<p>One of two culvert inlets in the north ditch near km 26+650 has been fully blocked and the other is about ¾ full due to silt buildup (Photo 71-4).</p>	<input checked="" type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>
<p><b>Instrumentation:</b></p> <p>Instrumentation installed as part of the geotechnical investigation has been sheared off and/or decommissioned.</p> <p>Instrumentation has been installed to monitor pile wall performance that includes:</p> <ul style="list-style-type: none"> <li>▪ Three shape-acceleration arrays (SAA) installed within concrete piles of the wall (<b>SAA-P022</b>, <b>SAA-P060</b>, and <b>SAA-P097</b>)</li> <li>▪ Nine vibrating wire load cells on the wall anchor plates (<b>VC1917</b> to <b>VC1925</b>)</li> <li>▪ Six vibrating wire (VW) piezometers (<b>VW16-1A</b>, <b>VW16-1B</b>, <b>VW16-1C</b>, <b>VW16-2A</b>, <b>VW16-2B</b> and <b>VW16-2C</b>)</li> <li>▪ Three test holes south (downslope) of the pile wall with one slope inclinometer (<b>SI16-3</b>) and six additional VW piezometers (<b>VW16-3A</b>, <b>VW16-3B</b>, <b>VW16-4A</b>, <b>VW16-4B</b>, <b>VW16-5A</b> and <b>VW16-5B</b>)</li> <li>▪ 28 VW strain gauges</li> </ul> <p><b>SAA-P022</b>, six of the 28 strain gauges <b>VW16-5B</b> stopped functioning before the end of construction. As of May 7, 2017, <b>VW16-4B</b> is no longer functional.</p> <p><b>SI16-3</b>: rates of movement have been steady since 2018 at approximately 4 to 6 mm/yr within the upper 4 m and with total resultant movement of approximately 20 mm. Creep measured in deeper zones.</p>		

**SAA-P060:** showed an average rate of movement of 0.1 mm/yr over the length of the pile and no discernible movement over the combined length of the pile and waler since the fall of 2020 readings. There has been cumulative pile head movement of 16.6 mm in the downslope direction to date. There has been an overall stable trend of movement since the end of construction.

**SAA-P097:** showed a rate of movement of 2.2 mm/yr over the length of the pile since the fall of 2020 readings. There has been a total pile head deflection of 17.3 mm in the downslope direction to date. There has been an overall trend of slow movement in the downhill direction since the end of construction, with peaks of higher downhill movement rates during the winter months.

**VW Strain Gauges:** Overall, the strain gauges showed relatively small changes in microstrain value since the previous readings in the fall of 2020, with the greatest changes in strain occurring in the strain gauges within the upper 7 m of the pile. Within this upper zone, the strain gauges in the upslope pile face generally showed increases in positive (tension) strain, while the strain gauges in the downslope pile face showed increases in negative (compression) strain. Six of the 28 strain gauges originally installed are no longer functional.

**VW Piezometers:** Groundwater level measurements vary between decrease up to 0.35 m to an increase of 0.48 m since the fall of 2020 readings. VW-1B, VW16-1C, VW16-2C and VW16-3A registered all-time high groundwater levels since the fall of 2020 readings. VW16-1C, VW16-2C and VW16-3A appear to show an overall trend of slowly increasing groundwater levels over time.

**Load Cells:** All the load cells showed increases in measured load compared the fall of 2020 readings, ranging from 1.99 kN in VC1920 (P060A) to 10.82 kN in VC1923 (P022B). All load cells, except for VC1917 (P097A) and VC1918 (P097B) registered all time high measured loads during a period between March 7, 2021, and July 1, 2021. Since the end of construction, the load cells have generally shown an overall trend of increasing load, with the highest seasonal loads measured towards the end of each winter. Overall, there is a trend of increasing anchor loads, which has been ongoing since the end of construction. The current loads measured in the upper two anchor rows at all three piles are above the design loads.

#### **Assessment:**

The landslide has been mitigated by the construction of a tangent concrete pile wall reinforced by three rows of anchors. The pile wall is designed to retain and support the road embankment and prevent further slide retrogression upslope into the highway.

Slope movement is expected to continue downslope of the pile wall, which has been observed to be active along previous slide extents since 2016. The pile wall is designed to accommodate approximately 6.5 m of slope subsidence or 'drop' below the second row of anchors downslope of the pile wall. Movement of the soil bench downslope of the wall should therefore be monitored on an annual basis to determine if/when another row of support anchors might be required.

The pile wall should have an ongoing assessment by site inspection (including to check for changing site conditions) and instrument monitoring to ensure it is performing as intended. In general, the instrument readings to date indicate that the wall is performing as intended and the strain and displacement measurements are within design tolerances; however, further assessment is recommended to track that performance is within expected limits. Consideration should be given to re-enabling the camera monitoring system that was setup for research to track downslope movement rates. This would require some maintenance of the visual survey markers.

Erosion damage and sediment buildup was observed in some areas in the backslope and upslope ditch through the site area. The culvert inlet at the west end of the site requires to be cleaned out. Where the surface runoff from the road is flowing around the armored inlet consideration should be

given to an asphalt berm at the edge of pavement to direct runoff or installing a swale with ECM along the road edge in this area to reduce further erosion rates.

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.

**Recommendations:**

**Cost**

Continue to visually inspect the repaired slide area regularly and read instruments to monitor pile wall performance (particularly after heavy and/or prolonged rain or rapid snowmelt). -

Maintenance should continue to check the ditch structures and culverts and cleanout as required. Water runoff near km 26+050 should be managed via an armored swale or asphalt berm to direct water to existing armored swale. Maintenance

A snow fence or equivalent barrier should be placed at either end of the pile wall to prevent and discourage public access by off-road vehicle into the slide area below the wall Maintenance

The slide in the granular backslope repair at KM 26+350 should be repaired by excavating the disturbed slide material, reducing the backslope angle, rebuilding with granular fill and relining with riprap. \$15k

**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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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

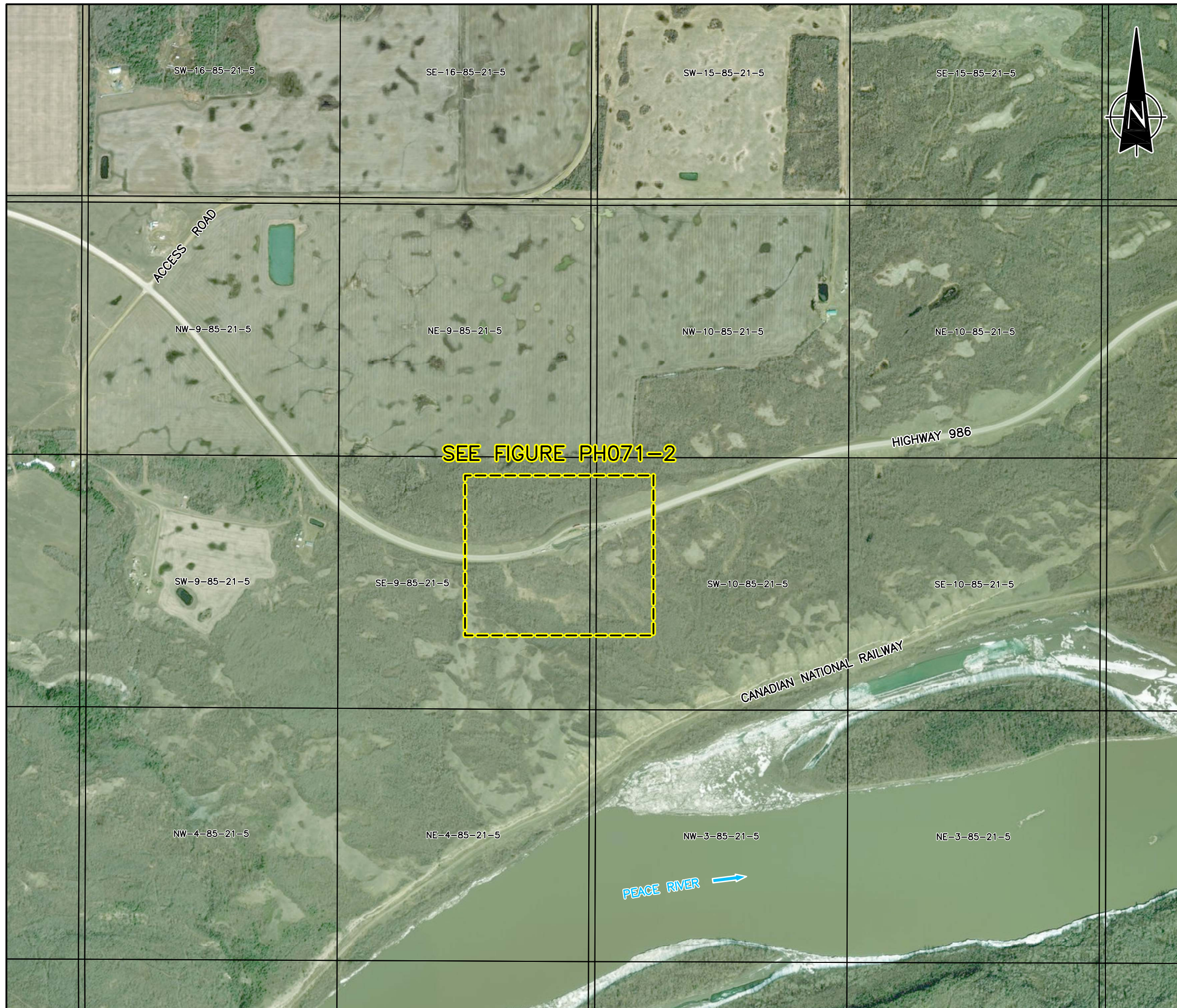
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification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

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**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 IMAGERY SERVICE (DIGITAL GLOBE, 2016).

*Alberta*  Transportation

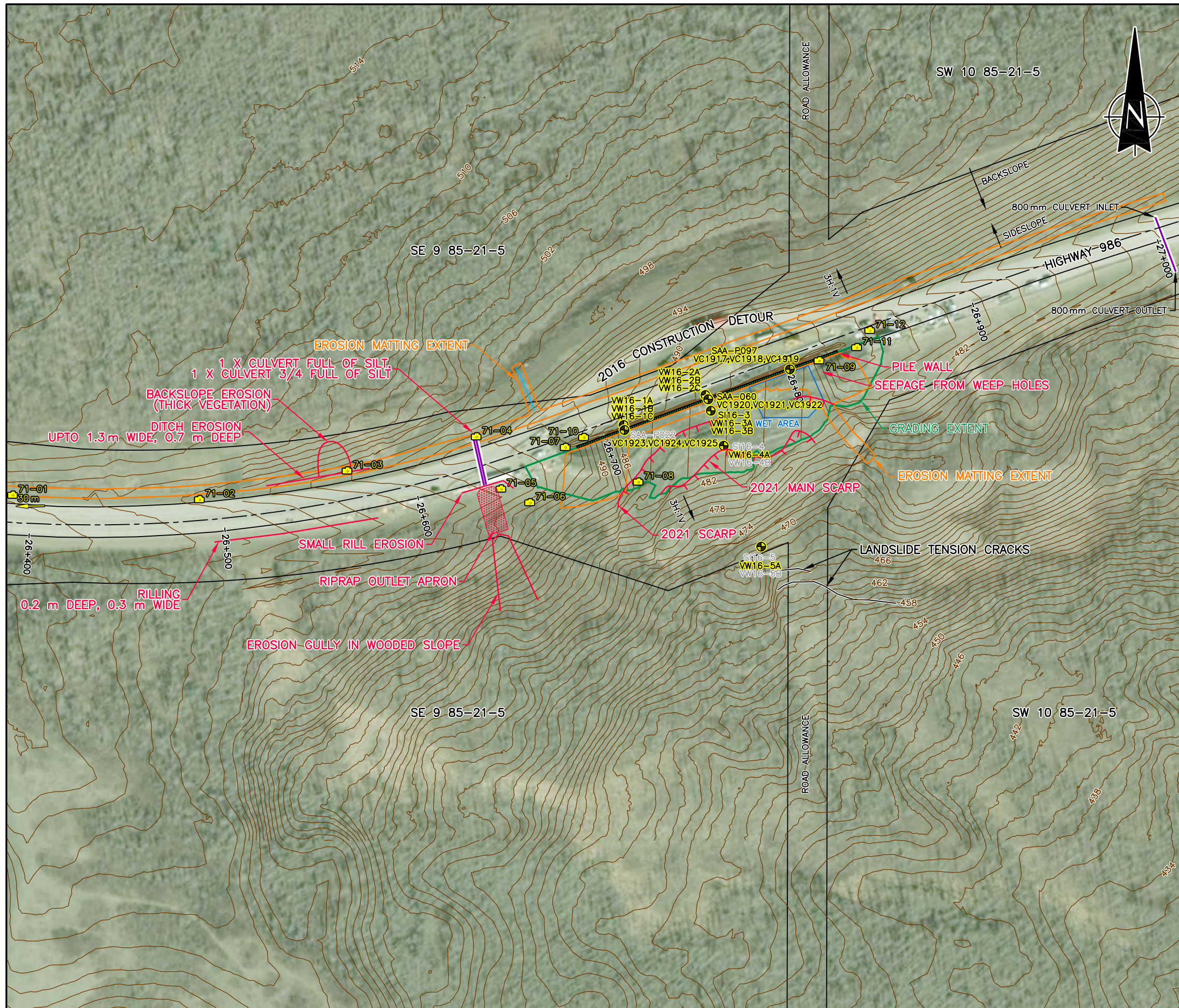
PEACE REGION (PEACE RIVER DISTRICT)

**DAISHOWA  
HWY 986:01 (PH071)  
KEY PLAN**

FIGURE PH071-1

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:12 500
DATE	OCTOBER 12, 2021
FILE No.	32121-A2B

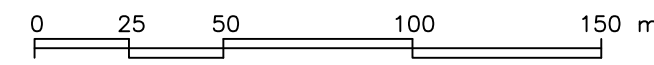




**LEGEND:**

TEST HOLE LOCATION	
SLOPE ACCELEROMETER ARRAY	SAA
SLOPE INCLINOMETER	SI
VIBRATING WIRE LOAD CELL	VC
VIBRATING WIRE PIEZOMETER	VW
PHOTOGRAPH LOCATION	71-01
CULVERT	
CONTOUR (1m INTERVAL)	

- NOTES:**
- 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.
  - BASE MAP FROM GENIVAR.
  - AIR PHOTO BASE FROM ESRI IMAGERY SERVICE (DIGITAL GLOBE, 2016).
  - STATIONING SUPPLIED BY GENIVAR PLAN # "19923-D01" DATED 2013-09.
  - EROSION MATTING EXTENT AND 2017 ROAD LIMITS SUPPLIED BY WSP FILE "2017 ASBUILT COMPILED AUG 23.dwg"



**Alberta** Transportation

PEACE REGION (PEACE RIVER DISTRICT)

**DAISHOWA  
HWY 986:01 (PH071)  
LOCATION PLAN**

FIGURE PH071-2

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:2000
DATE	OCTOBER 12, 2021
FILE No.	32121-A1B





**Photo 71-1.**  
A shallow earth slide developed within the swale at the top of the granular backslope repair on north side of road since the previous inspection (26+350). There was a slight toe bulge at the mid-slope under the riprap.



**Photo 71-2.**  
Second area of granular backslope repair on north side of road. Overall slope was in good condition and vegetation was filling in (26+500).





**Photo 71-3.**  
Backslope area upslope of the highway above the pile wall near the west end of the site looking towards the northwest (26+550). Granular fill had eroded and partially washed out but has since had increased vegetation growth. Ditch erosion is slightly worse. Georidge ditch barriers have been outflanked in some sections.



**Photo 71-4.**  
View toward the north ditch culvert inlets (26+650). One culvert has been fully blocked due to silt buildup and the other is about  $\frac{3}{4}$  full.



**Photo 71-5.**  
West of the wall on the south side of the road (26+650), water runoff from the road currently flows around the armored swale in an erosion rill. No major change from the 2020 condition.



**Photo 71-6.**  
View of the armored swale at the culvert outlets (26+650). No issues were noted at the time of inspection.



**Photo 71-7.**  
At the west end of the pile wall looking towards the east downslope of the wall. Vegetation is well established below the wall.



**Photo 71-8.**  
Looking towards the east at the downslope area below the wall at the main scarp where landslide movement has continued since the pile wall was constructed. Scarps have typically followed along previously observed slide extents prior to the regrading and wall construction.



**Photo 71-9.**  
Weep holes at the east end of the wall had active seepage and area was wet.



**Photo 71-10.**  
Looking east along the highway above the pile wall. Pavement was in good condition. Minor buildup of sand and gravel at the base of the guardrail along the top of the wall.



**Photo 71-11.**  
Looking towards the east at the east end of the pile wall at the armoured drainage swale. Minor rill erosion was observed between the swale and road edge in areas of poor vegetation. Some increased sediment buildup in the swale but no major change from 2020 condition.



**Photo 71-12.**  
Looking northeast towards the backslope area across from the pile wall (26+800). Slope had good vegetation coverage and no issues were observed.