

**ALBERTA TRANSPORTATION AND
ECONOMIC CORRIDORS
GEOHAZARD RISK MANAGEMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2025 INSPECTION**



Site Number	Location	Name	Hwy	km
SH016-1	Little Smoky River	West Bridge Abutment	49:12	1.90
Legal Description		UTM Co-ordinates		
NE33-74-21-W5M		11 E 489,573	N 6,145,499	

	Date	PF	CF	Total
Previous Inspection:	3-Jun-2024	14	4	56
Current Inspection:	26-May-2025	14	4	56
Road AADT:	1460		Year:	2024
Inspected By:	Kristen Tappenden, TEC		Mark Gallego, Thurber Roger Skirrow, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs		<input checked="" type="checkbox"/> Plans	<input checked="" type="checkbox"/> Maintenance items

Primary Site Issue:	West abutment and land-based piers are located on various slide blocks of a large deep-seated slide complex affecting the entire west valley slope. The rate of slide movement, about 50-70 mm/year, requires frequent operational structural interventions to maintain the bridge support system as the foundation elements move laterally and vertically in response to the valley slope movements.
Dimensions:	The west abutment, Abutment 1, and Pier 1 are affected by landslide movement which is about 125 m from the river measured along the bridge axis. Refer to the GRMP Inspection Report for SH004 for a description of the overall valley slope instability.
Date of Remediation:	1999: Geotechnical investigation by Thurber including SI99-1 through SI99-5 installation. 2000: Major bridge rehabilitation project completed that consisted of a set of structural modifications to accommodate anticipated long-term movements of the bridge foundations on the west valley slope. 2017: Slump and erosion above Pier 2 repaired with stone columns, granular fill, and riprap. Riprap placed along the riverbank to the upstream and downstream of the bridge. 2021: Geotechnical investigation by Thurber to support MOST Engineer's design and implementation of structural repairs. 2022-2024: Bridge rehabilitation work including new I-beam at West Abutment, removal of concrete between West Abutment and Abutment 1, and new slider plates at Pier 1 (2024)
Maintenance:	2015: Bridge superstructure painted 2019: Pier 1 adjusted with new shims and slider plates Fall 2020: Pavement overlay and guardrail replacement.

Observations:	Description	Worsened?
<input checked="" type="checkbox"/> Pavement Distress	Previously observed sag in pavement profile just west of the bridge abutment has not been noticeable in last few years.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	There is ongoing slope movement along a slip plane the extends underneath the foundations; the localized failure upslope of Pier 2 has been repaired and appears to be stable.	<input checked="" type="checkbox"/>

<input checked="" type="checkbox"/> Erosion	Ongoing erosion of valley toe at river's edge (repaired 2017) – south end of riprap over-steepened and north end displaced. Erosion gullies forming on south side of West Abutment, Abutment #1, and Pier #1 repaired in 2024. Erosion gully formed along buried Telus cable trench west of the West Abutment.	<input checked="" type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert	The West Abutment, Abutment #1, and Pier 1 are routinely adjusted to compensate for ongoing slope movement.	<input checked="" type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>

Instrumentation (Spring 2025):	
2021 Instruments	<p>In 2022, the inclinometers were found to have sheared off – the final readings were taken in October 2021.</p> <p>On the south side of Pier 1, SI21-07 had a distinct zone at 479.5 m elevation with a cumulative movement of 7.2 mm (average 21.8 mm/year) and sheared off at 479.0 m. On the north side of Pier 1, SI21-08 had a distinct zone at 483.4 m elevation with a cumulative movement of 7.5 mm (average 22.7 mm/year) and sheared off at 482.9 m. These two were moving nearly due east. For comparison, the riverbed elevation near Pier 2 is estimated to be at 478 m elevation.</p> <p>Near Abutment 1, SI21-09 had a distinct zone at 484.4 m elevation with a cumulative movement of 9.3 mm (average 28.8 mm/year) and sheared off at 483.9 m. This SI was moving slightly north of east.</p> <p>Fibre optic cables were installed with the 2021 inclinometers and, as of Fall 2023, still had continuity so further readings could be taken if deformation measurements were of importance despite the loss of the inclinometers.</p> <p>In March 2023, dataloggers were added to the six vibrating wire piezometers installed in 2021. Water levels in the VW piezometers had been relatively stable since installation; the increased data collection frequency shows only slight seasonal variations though more pronounced at VW21-8A. The pattern at VW21-8B is an exception and has steadily increased since installation and has risen more than 2 m. The flow pattern at TH21-07 is nearly hydrostatic with only a small downward gradient; TH21-08 is strongly downward; and TH21-09 is downward as well.</p>
Assessment:	
<p>The overall valley slope is moving as several separate slide blocks resulting in numerous scarps, sag ponds, and differential movement zones all coalescing on a common base failure plane in the base of a disturbed clay shale unit immediately above an underlying gravel layer. This gravel layer daylight in the river near Pier #2. The movements have three components: a persistent creep movement; movement related to seasonal pore pressure variations and the level of the Little Smoky River, and; movement related to erosion of the toe of the slope by the Little Smoky River.</p> <p>Based on GPS survey of the InSAR points conducted by Alberta Geological Survey (AGS Open Report 2013-14), the west abutment of the bridge is situated on a faster-moving block (greater than 90 mm per year) compared to the rest of the west slope which is moving at 5 mm to 40 mm per year. Figure 1 shows a high-level view of the LiDAR (flown in 2008 and provided by Alberta Transportation and Economic Corridors) for the overall west slope where slide scarps and sag pond features can be readily identified.</p> <p>Pier #1 is likely situated on, or near, the intersection of two different slide blocks. The deformation at Pier #1 is further complicated by the presence of additional, near-surface movements (likely creep) zones in the upper 4 m. The dominant driving mechanism appears to be toe erosion by the Little Smoky River; an assessment of precipitation levels and antecedent stability analyses indicates that a high ground water table may also be a contributing factor.</p> <p>The West Abutment, Abutment 1, and Pier 1 were designed to compensate for movement of the landslide and foundation below the bridge. The West Abutment compensation is done by adjusting the location of the west half of the finger joints along with adjustment of the length of the approach slab by removing steel I-beams (see photos). Since 2000, three of the five beams have been removed. As each beam is</p>	

approximately 368 mm in width, there has been 1104 mm of horizontal displacement in 20 years for an annualized rate of 55 mm/year. Based on measurements between the bridge deck and wingwall, there has been 220 mm of displacement in the last three years which is 73 mm/year. In late 2022 or early 2023, the West Abutment was reset with 5 new beams added (366 mm wide for a total width of 1.83 m). A sixth beam (371 mm wide) was placed below the finger joints. A sixth beam was added recently excluding the beam below the finger joints. The gap measured between the bridge deck and abutment changed by 4 cm between June 7, 2023, and June 3, 2024, giving an annualized rate of approximately 40 mm/year.

The Teflon bearing pads at Abutment 1 move laterally over stainless-steel slide plates and are adjusted vertically using shim plates above the bearing pads, and like Pier 1, require frequent adjustment. When additional shim plates are added, the contractor also jacks the bridge transversely to correct the alignment. Measurements taken at the south-most bearing pad indicate 110 mm of movement between October 28, 2020, and May 29, 2021, for an annualized rate of 264 mm per year.

The bearing pad and sliding plate arrangement at Pier 1 was replaced in 2024. Previous measurements were summarized in the 2021 and 2023 Geohazard reports: 2.97 m of vertical settlement (approximately 48 mm/year) since 1957 and 1.18 m horizontal since 2000 (74 mm/year). The new configuration consists of four sets of galvanized steel I-beam pairs bolted to the concrete pier foundation and supporting a stainless-steel plate thus elevating the sliding surface to the bottom of the bent eliminating the tipping risk of the previous configuration. As noted on the Drawings, the outside corners of the slider plates were measured to the outside corners of the stainless-steel plates for future comparison. The lateral restraint has been shifted to vertical steel piles bolted to the exterior of the concrete foundations as the existing bolt holes in the wingwalls were too low. It should be noted that the TEC Bridge Department has been monitoring the movement of the slider plates in Abutment 1 and Pier 1.

The cracking and accelerating movements and tilting observed in the concrete foundation at Pier 1 might be related to a change in foundation support conditions. The older downstream part of the foundation was supported on deep steel piles; however, the landslide has moved the foundation to the transition point with the south part of the concrete slab which has no piles. The change in loading condition might be causing the slab to tilt and the side walls to crack as noted on the north side of Pier 1.

The 2017 repair of the slope below Pier 1 is still effective. This repair has only a limited effect on the overall valley movements. River erosion had over-steepened a portion of the south section of the riprap apron resulting in the loss of some material which worsened in 2020. This was also observed in 2021. At the lower water levels in October 2020, it was also noted that there is some erosion and slumping cutting into the apron north (downstream) of the bridge. The slumping at the river toe, both in and adjacent to the riprap did not appear significantly worse in 2022 and seems to have stabilized since 2023.

Recommendations:

Short-Term:

- Vertical and horizontal adjustment of the bridge superstructure should be undertaken as required. Should cracking form on the highway to the west of the abutment, crack sealing should be undertaken to minimize water infiltration.
- Milling and patching of the pavement surface at the west end of the bridge should be carried out on a periodic basis as required to maintain a safe riding surface (if needed).
- Log jams between the toe of the valley slope and Pier 2 can create eddies in the river flow and otherwise alter the river velocity at the bridge locations. Log jams should be removed as soon as practical to limit the potential for these log jams to erode the toe of the bridge headslope.

Long-Term:

- There are potential realignment options that have been considered for this valley crossing maintaining the same bridge which could be implemented to reduce maintenance for the highway approaches on either side. A long-term plan for this crossing includes a new bridge about 8 km away but there is no plan to implement this large realignment as the bridge has many years of service life left.
- It is understood that AMEC's High Water Related Mitigation Works reports for SH003 and SH004 recommended erosion control at the toe of the slope to limit river erosion which would also benefit this site. Reduction in the severity of toe erosion which is a contributor to the overall slope movement triggers, may not be sufficient to arrest the slope movements entirely. The rip rap at

SH016 helps to control toe erosion at the bridge headslope which is beneficial for management of local instabilities but would have limited effect on the adjacent extensive landslide complex.

Ongoing Investigation:

- It is recommended that the annual Geohazard inspection and twice-annual instrumentation readings should continue as scheduled.
- The TEC Bridge Department has been monitoring the movement of the slider plates in Abutment 1 and Pier 1 which involves an ingenious yet simple movement monitoring system consisting of felt pen markings directly on the sliding pads. This system could be formalized to ensure there is no confusion in the interpretation of movement measurements.
- A routine robust and detailed terrestrial survey of points on the bridge and the ground surface would also help track ground movement rates at a relatively low cost. It is understood that is being considered. The InSAR (interferometric synthetic aperture radar) targets could also be included in this terrestrial survey to build on the work done by AGS to provide an overall interpretation of the valley-scale ground movements.
- A Geocube GPS ground surface movement monitoring system has been installed at SH016 and SH004, It is recommended that this system be monitored for at least two years to acquire more data. Additional GPS real-time ground movement systems (SparkFun or Geocube based) may be an option worth considering at this site particularly for identifying lower-movement rate zones for potential monitoring of the bridge substructure.

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.

Roger Skirrow, P.Eng.
Senior Geotechnical Engineer

Mark Gallego, P.Eng.
Geotechnical Engineer



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 TO THE 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.

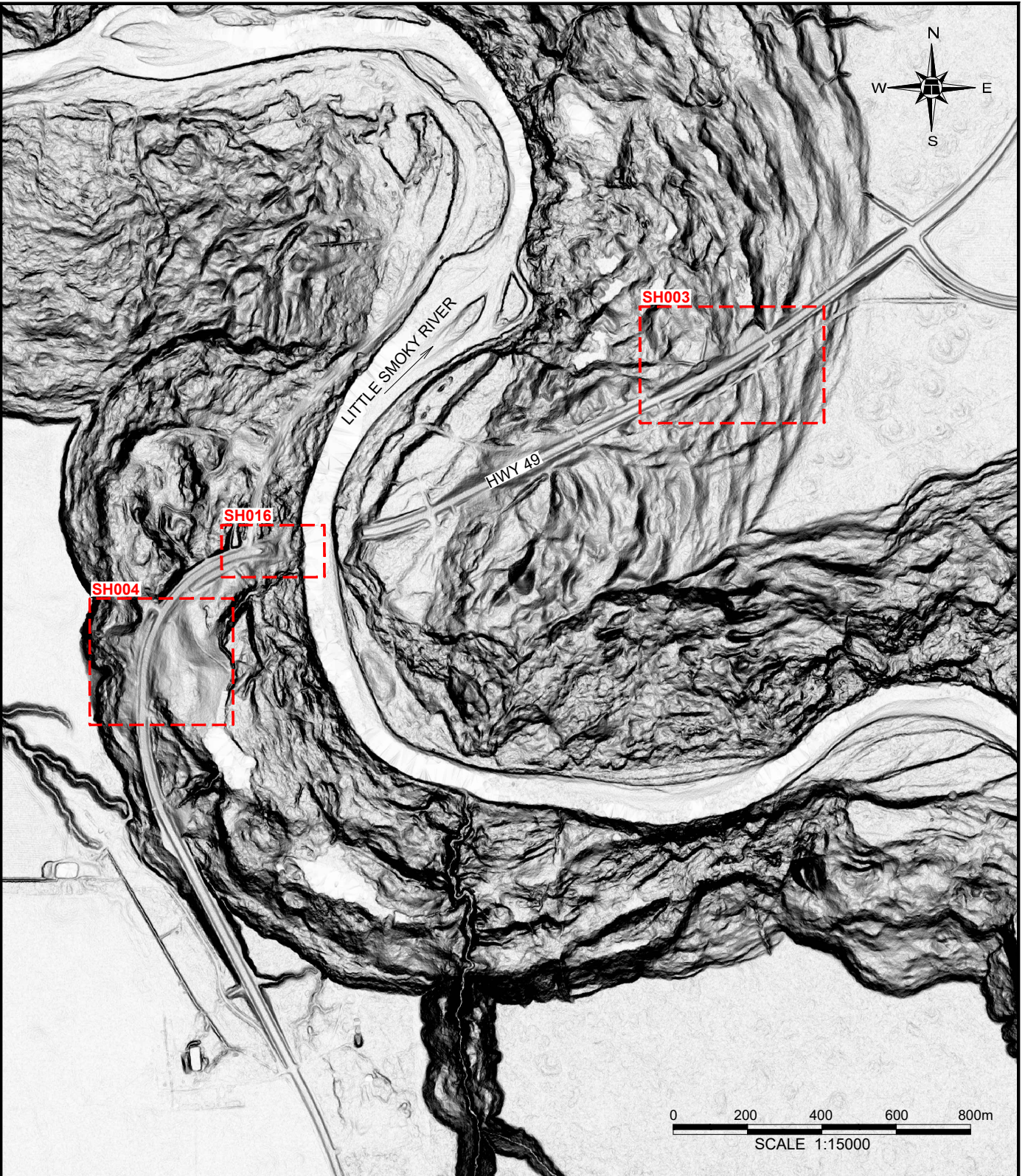
5. INTERPRETATION OF THE REPORT

- 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.

G:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2025 GEOHAZARD\MG\32121 Figure 1 - SH003, SH004, SH016 Key Map.dwg - 1 - Oct. 09, 2025



2008 LIDAR PROVIDED BY ALBERTA TRANSPORTATION.

PEACE REGION (PEACE RIVER DISTRICT)

SH003-1, SH004-1, SH016-1 KEY MAP

FIGURE 1



DRAWN BY	ML
DESIGNED BY	MG
APPROVED BY	RKS
SCALE	1:15000
DATE	OCTOBER 2025
FILE No.	32121





Photo 1 – Looking northeast at new finger joints and repaved approach (done since 2023 inspection).



Photo 2 – Looking north at west bridge abutment. New I-beam added in 2025 (6 total) plus one below the finger joints. The tarps were added in 2024.



Photo 3 – Looking towards the West Abutment where portions of the old foundation concrete was removed to allow movement of the girders between the West Abutment and Abutment 1.



Photo 4 - Void underneath the northeast corner of the old Abutment 1.



Photo 5 - Looking west at headslope below Abutment 1. Erosion control measures installed in 2023.



Photo 6 – New slide plates installed at Pier 1. TEC Bridge Department has been monitoring the movement of the slider plates.



Photo 7 – Looking north at Pier 1 where sliding plates and lateral restraints were installed in 2023.



Photo 8 – Looking south at Pier 1 wingwall at arc-shaped compression crack pattern in foundation. Left-hand portion of foundation is pile supported; right-hand is on-grade.



Photo 9 – Looking west at Pier 1 foundation which is tilted downward to the south. The angle from horizontal was 4° at the top and 7° at the bottom stage. Concrete has started to crack and spall.



Photo 10 – Looking west toward Pier 1 at rutting and installed erosion control measures. Some of the area has vegetated since.



Photo 11 – Looking north at accumulated tree debris against Pier 2.



Photo 12 – Looking south at erosion along toe of riprap and riverbank.



Photo 13 – Looking east at erosion gully formed along buried Telus cable trench.