

**ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS  
GEOHAZARD ASSESSMENT PROGRAM  
NORTH CENTRAL REGION – ATHABASCA &  
FORT MCMURRAY DISTRICTS  
2023 SITE INSPECTION**



**THURBER ENGINEERING LTD.**

Site Number	Location	Name	Hwy	km
NC103-2	Approximately 7.9 km north of Hwy 29 (North of Elk Point)	<b>KEHIWIN LAKE</b>	41:23	7.9
<b>Legal Description</b>		<b>UTM Co-ordinates (NAD 83)</b>		
9-25-58-07 W4		12 N 5988463.22	E	506745.73

	Date	PF	CF	Total
<b>Previous Inspection:</b>	June 8, 2022	11	4	44
<b>Current Inspection:</b>	May 18, 2023	11	4	44
<b>Road WAADT:</b>	1,220	<b>Year:</b>		2022
<b>Inspected By:</b>	José Pineda, Tarek Abdelaziz (Thurber) Arthur Kavulok, Amy Driessen, Kristen Tappenden (TEC)			
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items			

<b>Primary Site Issue</b>	<p>A slump on the west side of the highway downslope of the NC103-1 pile wall location. The slump occurred above an existing 600 mm CSP centre line culvert.</p> <p>A sinkhole developed on the east side of the highway above the 600 mm CSP centre line culvert inlet.</p>
<b>Dimensions:</b>	<p>The slump on the west side of the highway is approximately 5.5 m wide, 20 m long, and about 1.6 m deep below the original ground surface.</p> <p>The sinkhole on the east side of the highway is about 3.3 m wide 2 m deep.</p>
<b>Site History/Maintenance:</b>	<p>The slump occurred in a section of the highway that is known for multiple landslides that have been repaired by TEC using various configurations of pile walls on the west side of the highway. At the location of the west slump failure, a tied-back concrete pile wall was constructed in 2011 under TEC contract No. 11165. The pile wall consisted of 15 m deep, 1.8 m diameter concrete piles, connected at the top using a 1.8 m deep concrete waler. Two rows of 200 mm diameter grouted anchors, 22 m long, were installed within the waler to further restrain the wall movement.</p> <p>At the location of the side slope failure, a centre line culvert was present prior to the construction of the pie wall. Hydrovac excavation was completed prior to the installation of the pile wall to expose the 600 mm CSP culvert. The top of the culvert was at an approximate elevation of 547.3 m (~6 m below the top of waler). The pile spacing at the culvert location was 3 m (i.e., 1.2 m clear space between concrete piles).</p> <p>TEC noted that the slope failure occurred in 2019. The maintenance contractor attempted to expose the centre line culvert downslope of the</p>

	<p>pile wall locations in 2020. However, the hydrovac excavation was not advanced deep enough to expose the culvert.</p> <p>In May 2022 a hydrovac excavation and a CCTV inspection were conducted from the outlet of the centre line culvert under Thurber's supervision. The CCTV inspection revealed that the top of the culvert had collapsed and separated approximately 16 m from the outlet side. However, the condition and actual orientation of the culvert under the highway, between the identified break point and the inlet was unable to be inspected. Attempts were made to perform the CCTV inspection from the inlet side, but it was not possible due to a blockage in the culvert near the inlet.</p> <p>In May 2023, after the inlet was made accessible by TEC, a second CCTV inspection was completed by CAM-TRAC. This later CCTV inspection revealed that an obstruction was present at about 24.8 m from the culvert separation near the inlet which corresponds with the general location of the obstruction measured in 2022 from the outlet (i.e., the rupture is located on the west side of pile wall).</p>	
<b>Observations:</b>	<b>Description</b>	<b>Worse?</b>
<input type="checkbox"/> Pavement Distress		<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Ongoing movement of the slump located on the west side of the highway caused the snow fence to collapse. The slump is about 1.6 m deep and 5 m wide.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	The slump located near the culvert inlet is about 4.3 m wide, 5 m long, and 3.2 m deep	<input checked="" type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	Culvert separated at about 3 m from the inlet. Centre line culvert is completely blocked at about 24.8 m from the culvert separation based on the 2023 CCTV inspection	<input checked="" type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>
<b>Instrumentation Readings (1 Slope Inclinator and 2 Piezometers):</b>		
SI11-4 installed in Pile 60 adjacent to the slump on the west side of the highway did not show discernable movement in the spring 2023.		
The maximum groundwater level recorded at PB10-1 and PB10-3 was 3.6 m and 0.5 m, respectively.		
<b>Assessment:</b>		
The failure of the culvert is the main cause of the slump developed downslope of the pile wall location.		
In general, the existing culvert is old, rusted and may have surpassed its design life span. The 2022 and 2023 CCTV inspections of the culvert confirmed that (a) the culvert has collapsed approximately 16 m from the outlet location (i.e., the rupture is located on the west side of the pile wall) and (b) there are no elbows present along this culvert.		
Based on site observations and instrumentation results, the west side slope failure has not yet impacted the highway pavement surface condition, or the performance of the NC103-1 pile wall. The performance of the wall is not expected to be impacted since the design assumed complete loss of the downslope soil mass. However, the slump may become larger and deeper in the future, resulting in soil loss and formation of voids between the piles, and accordingly a dip or a sink hole on the highway surface.		
The drop in ground surface downslope of the wall represents a significant hazard to motorists in this zone.		

The upstream flow will continue to saturate the slump mass downslope of the wall location and the highway embankment fills. This may have an adverse impact on the overall stability of the highway, but it all depends on the discharge volume from the gully located on the east side of the highway.

The sinkhole located on the east side of the highway also appears to have developed in response to the culvert separation at the inlet location. The back scarp of the slump, located above the culvert inlet location, is currently located about 7 m from the edge of the road and could eventually retrogress back and impact the highway condition.

### **Recommendations:**

This site should be visited again in 2024.

In the short term, the roadway surface should be monitored for the development of new cracks or extension of existing cracks. Any open cracks should be sealed to prevent further rise in ground water levels. Sharp shoulder signs should be erected to warn motorists of the hazard. If TEC is not planning to remediate this site soon, consideration should be given to placing guardrail to protect runaway vehicles from the existing hazard. The guardrail should extend a sufficient distance beyond the limits of the slump.

The depth of the waler is 1.8 m and the current drop in the ground surface along the face of the waler is about 1.6 m below the ground surface. The local MCI should frequently measure the drop along the face of the waler, and add minimal gravel wedge, as needed, to avoid exposure of the piles/gap below the underside of the waler.

Based on the results of the CCTV inspections, a feasible repair measure would consist of the following:

- excavate the west side slope to remove wet slump material and expose the broken section of the pipe; the use of a trench box or an alternative supporting excavation method is highly suggested to minimize the size of excavation and to avoid disturbing the soil below the underside of the waler,
- remove the damaged pipe section between the break point and the outlet location,
- notify TELUS of the proposed work to temporarily relocate the existing line on the east side of the highway,
- excavate existing slump above the inlet location to remove damaged/corroded section of the pipe,
- install a liner from the inlet location (if feasible) to the break point location. Weld a piece of SWSP to the exposed end of the liner pipe, and extend the welded pipe section to the outlet location of the old culvert,
- dispose of common excavation material and stockpile select clay to provide a clay cap at final ground surface,
- backfill the excavation downslope of the wall with granular material and install a subdrain pipe within the gravel backfill replacement zone; use a light compactor to backfill against the concrete waler,
- backfill the east side slope with granular fill,
- place riprap at the at the culvert inlet and outlet locations; daylight the subdrain pipe at the culvert outlet riprap location, and
- place a clay cap above the gravel replacement zone(s), and topsoil and seed all disturbed areas.

The feasibility of installing a liner should be confirmed by a contractor specialized in culverts installation and rehabilitation. If it is not feasible to line the existing culvert, the less robust solution would consist of (a) excavate the damaged section of the pipe, located downslope of the pile wall, as described above and attach a new CSP pipe to the undamaged section of the existing CSP pipe, and (b) replace the damaged section of the CSP pipe inlet with a new CSP pipe.

The ballpark cost to complete the repair measure listed above will be in the order of \$300,000 (excluding engineering).

**Closure:**

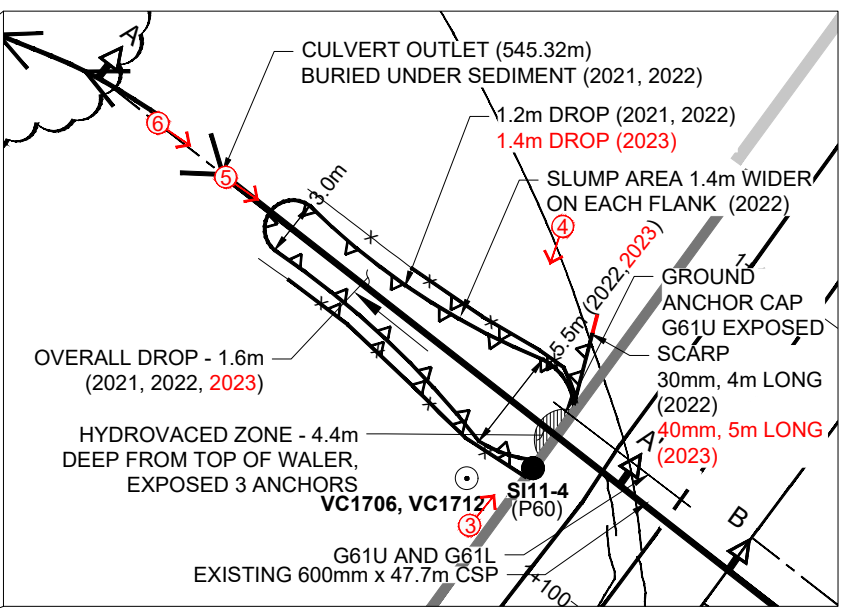
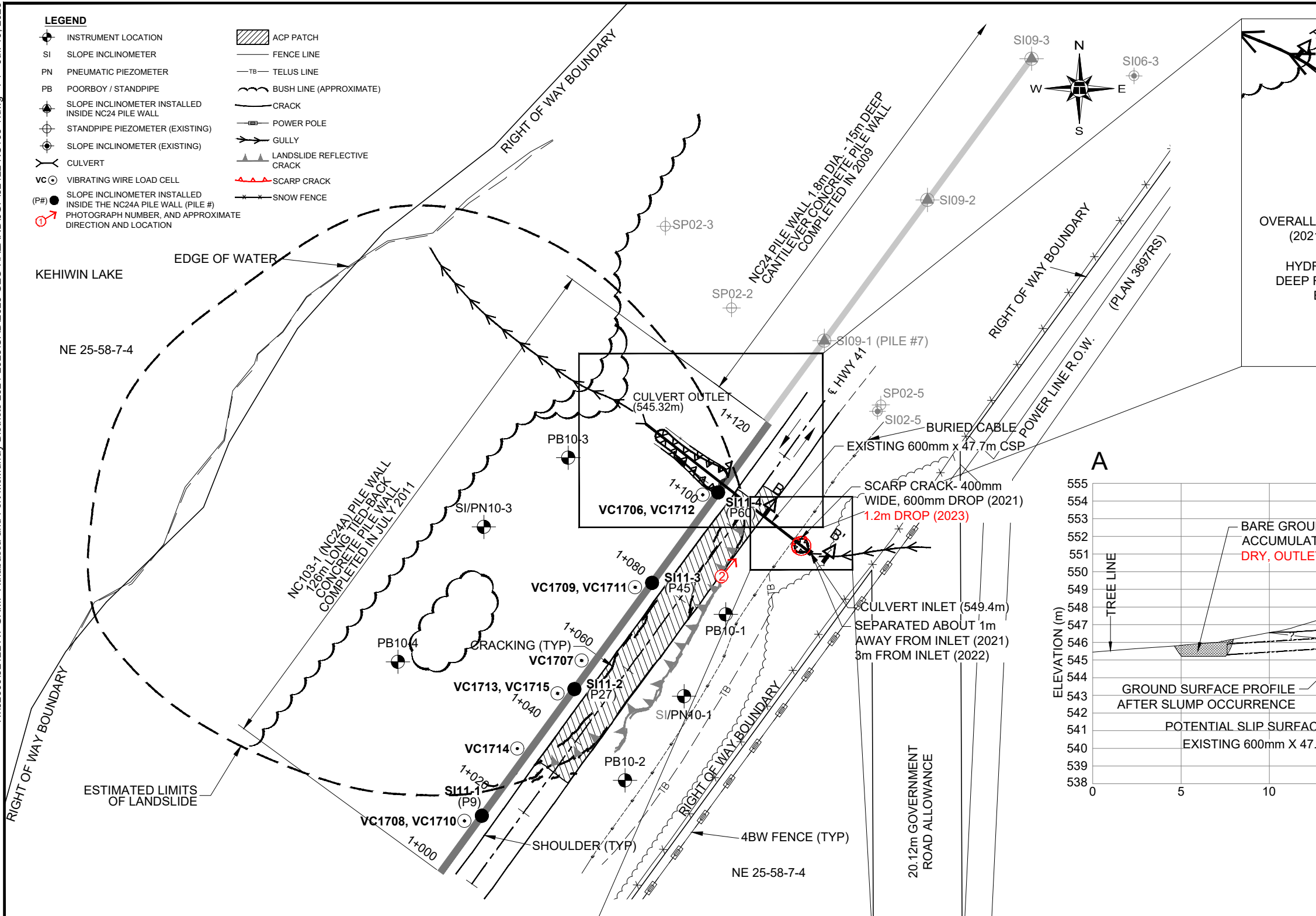
It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Yours very truly,  
Thurber Engineering Ltd.  
Tarek Abdelaziz, Ph.D., P.Eng.  
Principal | Geotechnical Review Engineer

José Pineda, M.Eng., P.Eng.  
Associate | Senior Geotechnical Engineer

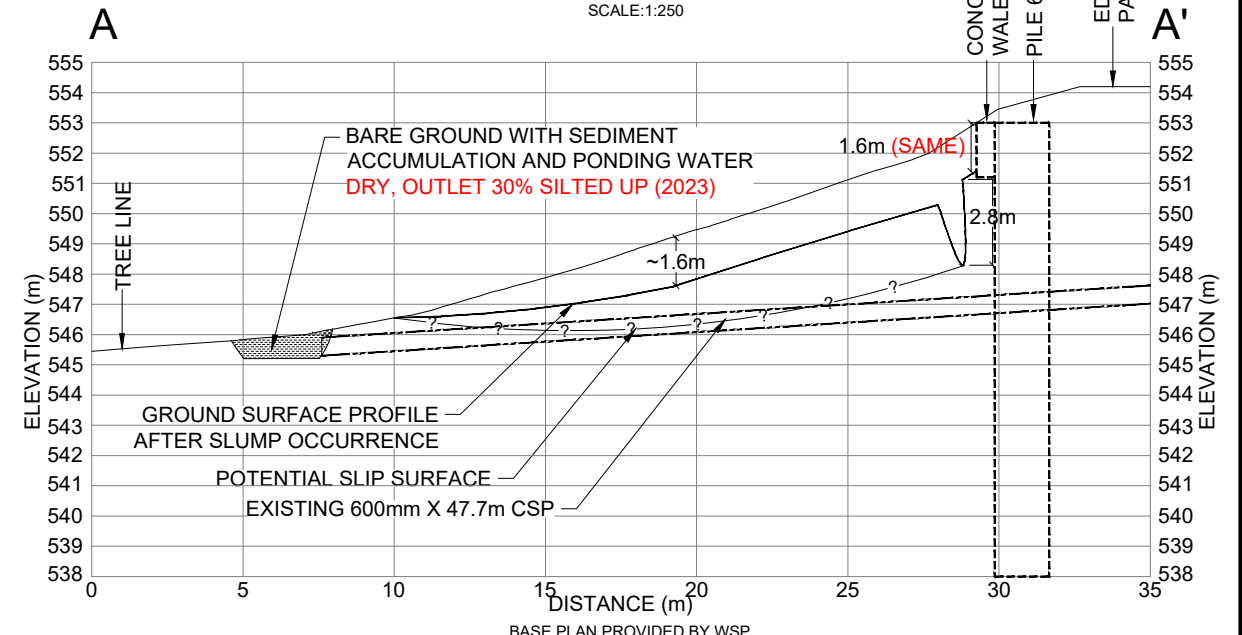
**LEGEND**

⊕	INSTRUMENT LOCATION	▨	ACP PATCH
SI	SLOPE INCLINOMETER	—	FENCE LINE
PN	PNEUMATIC PIEZOMETER	—TB—	TELUS LINE
PB	POORBOY / STANDPIPE	~	BUSH LINE (APPROXIMATE)
⊕	SLOPE INCLINOMETER INSTALLED INSIDE NC24 PILE WALL	—	CRACK
⊕	STANDPIPE PIEZOMETER (EXISTING)	—	POWER POLE
⊕	SLOPE INCLINOMETER (EXISTING)	—	GULLY
⊕	CULVERT	▲	LANDSLIDE REFLECTIVE CRACK
VC	VIBRATING WIRE LOAD CELL	—	SCARP CRACK
(P#)	SLOPE INCLINOMETER INSTALLED INSIDE THE NC24 PILE WALL (PILE #)	—	SNOW FENCE
①	PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION		

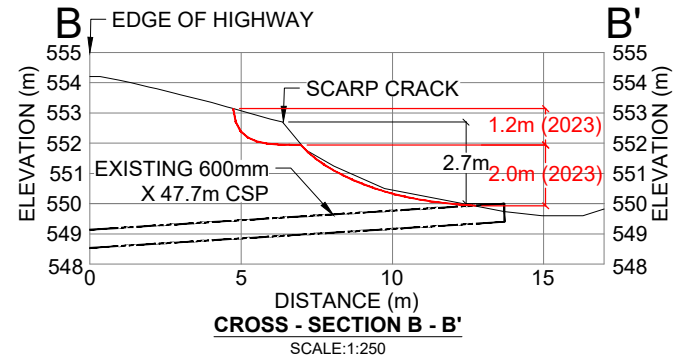


**SITE PLAN SHOWING SLUMP ABOVE THE 600mm CSP**  
SCALE:1:400

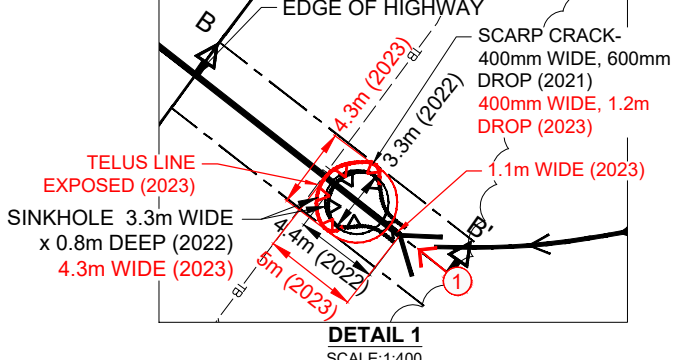
**CROSS - SECTION A - A'**  
SCALE:1:250



BASE PLAN PROVIDED BY WSP

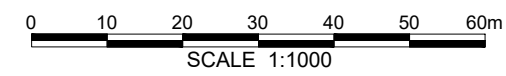



**CROSS - SECTION B - B'**  
SCALE:1:250



**DETAIL 1**  
SCALE:1:400

- NOTES:**
- MAY 18, 2023 OBSERVATIONS ARE SHOWN IN RED.
  - CROSS - SECTION A - A' IS BASED ON APPROXIMATE FIELD MEASUREMENTS, MAY NOT REPRESENT THE ACTUAL PROFILE.
  - CULVERT IS LOCATED BETWEEN PILES P60 AND P61. THE CENTER TO CENTER SPACING BETWEEN THE CULVERT AND EACH OF THE PILES IS 1.5m.






**NORTH CENTRAL REGION  
(ATHABASCA AND FORT McMURRAY DISTRICTS)  
2023 GEOHAZARD ASSESSMENT**

**NC103-2: HWY41:23 KEHIWIN LAKE WEST SIDE  
SLOPE SLUMP (km 7.9)**

**FIGURE 1**

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:1000
DATE	JUNE 2023
FILE No.	32122



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**Photo No. 1 – 600 mm CSP culvert inlet got separated, resulting in a sinkhole and a slump at the bottom of the highway side slope.**



**Photo No. 2 – Looking at the highway southeast side slope upslope of the 600 mm CSP culvert inlet location**



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**Photo No. 3 – Looking northeast at the slump downslope of the pile wall location**



**Photo No. 4 – Looking south at the slump downslope of the pile wall location**

Client: Alberta Transportation

File No.: 32122 NC 103-2



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**Photo No. 5 – Looking southeast at the head scarp crack of the slump; the slump exposed the waler and a couple of anchor caps.**



**Photo No. 6 – Culvert outlet partially filled with sediment. No flow observed in 2023.**