

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT - NORTH
2023 INSPECTION**



Site Number	Location	Name	Hwy	km
PH077-1 and 77-2	West of Fairview	Sites E of Hines Creek Bridge	682:02	12.5-12.8
Legal Description		UTM Co-ordinates (NAD 83)		
NE35-81-5-W6		11V N 6215000	E 396650	

	Date	PF	CF	Total
Previous Inspection:	May 18, 2022	13	4	52 (PH077-1)
		9	4	36 (PH077-2)
Current Inspection:	May 30, 2023	12	4	48 (PH077-1)
		9	4	36 (PH077-2)
Road AADT:	160	Year:		2022
Inspected By:	Don Proudfoot, Nicole Wilder (Thurber)			
	Max Shannon, Rishi Adhikari, Ken Szmata, (TEC)			
Report Prepared By:	Nicole Wilder, Don Proudfoot (Review)			
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items			

Primary Site Issue:	<p>PH077-1: Creek bank slumping caused by creek erosion continues to retrogress and has caused cracks to appear in the highway about 150 m east of the bridge. A shallow sideslope slide also exists at the east end. A newer 35 m wide slump has formed in the south embankment slope and below it a large area has slumped into the creek.</p> <p>PH077-2: Settlement and cracking in the highway and an active landslide through the south embankment are causing distress to the BF culvert and pavement. Channel and ditch erosion on the north embankment have created a slide around the culvert inlet which has remained in similar condition since 2021. Additional riverbank slumping was observed.</p>		
Dimensions:	<p>PH077-1: Slide dimensions ~110 m wide along the riverbank parallel to the highway x ~30m long. New slump is ~ 35 m wide and ~20 m long.</p> <p>PH077-2: South embankment slide ~40 m wide x 75 m long extending to river which appeared somewhat grown over. North embankment slope slide ~40 m wide x ~40 m also appeared somewhat grown over. New 10 m long erosion gully formed upslope of the northeast crotch ditch.</p>		
Date of any remediation:	<p>PH077-2 was repaired in the fall of 2014 with a new 1.8m dia. SWSP (WSP = Consultant, In-Line = Contractor). Landslide movements occurring since construction have required strutting and patching/sealing of the culvert. In 2021, rip rap was added on one of the north crotch ditches, and to the upper portion of the south crotch ditch, where erosion was noted previously at PH077-2. It appeared that the trash rack had been cleaned out of debris in 2022.</p>		
Maintenance:	Crack sealing, ongoing repairs to the culvert pipe at PH077-2	Worsened?	
Observations:	Description	Yes	No
<input checked="" type="checkbox"/> Pavement Distress	At PH077-1, a 40 m long (30 to 80mm wide) crack and a 15m long crack (near the east end) exist in the highway. A noticeable dip exists across a 45 m length of the highway where the larger cracks are this appeared the same in 2023.	<input type="checkbox"/>	<input checked="" type="checkbox"/>

	At PH077-2, cracks and a noticeable dip exists across a 40 m length of the highway overtop the SWSP culvert, with another dip existing further east. Same condition in 2023.		
<input checked="" type="checkbox"/> Slope Movement	<p>At PH077-1: Towards the east a shallow 35 m wide side slope slide developed and the backscarp is 6.2 m away from the guardrail. Just east of this slide, there is an overgrown 15 m wide shallow side slope slide with a 0.4 m high scarp, 0.6 m high toe push that is 3.6 m away from the guardrail.</p> <p>The Creek has eroded the toe of the south embankment, and continued creek bank slumping is evident, with a 20 m wide area that slumped into the creek south of the 35 m wide slide.</p> <p>At PH077-2: A landslide has developed through the south embankment and has deformed the culvert. There is a 0.4 m high scarp located 4.6 m from the white shoulder line which appeared more overgrown in 2023. North of the highway, a 1.5 m wide graben crack with a 0.2 m drop has developed above the erosion near the culvert inlet, and which has developed into a slide that previously retrogressed back towards the highway; this was unchanged in 2023. The riverbank is also locally slumping upstream and downstream of the culvert outlet</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	<p>At PH077-1, active erosion caused by the creek is occurring at the toe of the slope along the creek's edge.</p> <p>At PH077-2, the TRM south of the highway along the east runoff ditch where previously erosion was observed had been repaired with rip rap lining this ditch and as well as placing riprap on the downstream end of the gabions near the culvert outlet; however, some of this riprap at the base was washed away by the creek.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	At PH077-1 the soil within the tension crack within the 35 m wide slide was moist to wet.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	The upstream end of the 1.8 m diameter SWSP (BF75380) at PH077-2 was about 0.5 m buried with silt and debris at the drift catcher and the outlet did not appear to be visibly damaged at the time of our inspection but was somewhat buried in silt. The 2022 bridge inspection noted that there were distortions and cracks/separations within the culvert (along with low ratings) and that drift and silt should be removed from pipe and drift catcher.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>	<input type="checkbox"/>
Instrumentation: None			
Background/Assessment (Refer to Figures PH077-1, -2, -1/2):			
<p>At PH077-1, the slide roughly paralleling the creek and highway is a direct result of erosion by Hines Creek and resulting soil loss along the toe of the embankment. The slope will tend to flatten with time due to loss of cohesion in the clay fill embankment material. Therefore, the slide could also gradually enlarge into the driving lanes of the highway surface, and there are already indications of this presumably starting to occur based on the existing cracks and dips in the highway. The smaller 15 m wide and larger 35 m</p>			

wide slide near the east end of this site may have also been triggered by east ditch runoff erosion, and/or having a slope that is too steep for the composition material of the embankment. Ditch or surface erosion of the slope could also contribute to more rapid slope movements.

At PH077-2, the existing bridge file management system records indicate that BF75380 at PH077-2 consisted of a 1.8 m diameter SWSP having an in-service date of 2014.

PH077-2 was repaired in 2012 with a new culvert pipe installed in 2014, and there was some mention of a slide at the site at that time. The soil conditions identified from 2 test holes drilled through the highway as part of the 2012 design indicated a predominant clay fill embankment, overlying a stratified predominant clay deposit, overlying glacial clay till near Creek level. The submitted As-Built drawings indicated that the new pipe was a 157 m long x 1.8 m dia. SWSP spanning beneath the highway, containing horizontal and vertical elbows, and which also contained a 1.2 m diameter vertical access manhole located 34 m downslope of the highway centerline. A drawing note described the installation methodology as "Installed SWSP by augering and jacking through the existing road fill, backfill of culvert ends and other typical details in accordance with Std Drawing S-1418-03". Another drawing note indicated "Organic, and soft/yielding materials removed from existing slope failures prior to backfilling."

The 2022 Bridge Inspection Report indicated several gaps, along with a 100mm gap in the floor ~93 m from the upstream end with a plate welded over the gap, holes in the side walls due to baffles tearing off ~18 m from the downstream end, a 23 mm crack 67 m from upstream end that was partially repaired, 5 – 30 mm gap between plates with exposed fill between the pipe sections ~93 mm from the upstream end. It is also understood that steel struts have been installed within the culvert to deal with barrel distortions.

The cracks and subsidence in the south embankment slope are evidence that a landslide has formed in the slope at this location. This is supported by 2015 reports from AT that the culvert barrel had become distorted and separated, which indicate that the landslide is deep seated. The slide appeared somewhat grown over in 2023 and movement may have slowed.

Similarly, cracks in the north embankment slope which previously retrogressed to near the highway also suggest a landslide has developed. This is also supported by a documented crack in the culvert. This landslide was likely triggered by loss of toe support due to erosion caused by the tributary creek. Highway ditch runoff erosion (at the TRM/gabion intersections) may have also been contributing factors. The scarp on the north side of the highway appeared slightly grown over as well.

Settlement observed ovetop of the culvert at Site 2, in the form of dips and cracks in the highway could be the result of embankment fill settlement but might also be an indication that the slide movement will eventually retrogress towards the highway or has already.

Recommendations:

In the short term, regular monitoring of these sites should be undertaken for enlargement. If any of the slides encroach into the shoulders of the highway, barricades should be erected and enhanced with warning signage until highway repairs are undertaken. A temporary detour upslope (to the north of the highway) may also be required depending on the extent of the highway affected.

PH077-1:

Medium to Long Term: A short highway re-alignment around the affected highway may be feasible. In order to meet the existing bridge (~100 m to the west), it would not be able to be a significant detour but could work if only a small portion of the highway was affected by a slide. The eroded slope should be cut back to a flatter inclination. Riprap should also be installed along the toe of the existing south embankment to mitigate future creek erosion. Additionally a minor creek realignment and/or rock vanes could be considered in conjunction with riprap to reduce the quantity of riprap required. Environmental approvals (DFO, AEP) for working within the confines of Hines Creek would first need to be authorized for any realignment considerations and rock or riprap placement.

Ballpark Cost \$3 to \$4 Million

Long Term: Alternatively, due to the anticipated slide depth extending down to creek level and the embankment height (~13 m), a pile wall is feasible at this site. It would need to be a tied back pile wall (multiple anchors/pile), and a detour would be required to the north of the highway during construction.

Perhaps other measures may be required in addition to the tied back pile wall, such as offloading a portion of the downstream embankment, and/or lightweight fill replacement of soil. A minimum length of 100 m of pile wall would be required to span the slide length at this site. Riprap should also be installed to mitigate creek erosion for this option.

Ballpark Cost \$6 Million

If environmental approvals could be obtained, consideration could also be given to re-aligning the river further away from the highway to allow a soil buttress and riprap to be placed along the toe of the eroded slope.

PH077-2:

Short Term: The breaks in the joints of the culvert should be sealed by installing a thin sleeve at each joint that is welded on the upstream side and shingles in the downstream direction over the gap, or by sealing the gap with ethafoam on an annual basis until more permanent repairs can be completed. In 2021, it appeared that the bridge group performed some minor remedial work at this site including welding plates over gaps; however additional repairs are required.

Long Term: A potential long-term solution is a highway re-alignment to the north, done in conjunction with the re-alignment for Site 1, before meeting the existing bridge over Hines Creek. A re-alignment could allow some flattening of the south slope leading down to the creek. For this option, the top section of the culvert might need to be re-profiled to remain within the embankment fill and the inlet end of the pipe would need to be extended to allow a shift and flattening of the north embankment slope. The damaged pieces of the pipe will need to be repaired. Some shear piles might also be needed in the south slope. It is understood that AT are also considering replacing the culvert with a shorter pipe that exits the upper part of the slope and then bringing the discharge down the slope in an armoured drop structure. The costs of the drop structure would need to be weighed against the costs of repairing/replacing the longer SWSP culvert.

\$6 Million

Investigation: As a minimum recommendation, at least 2 or 3 test holes drilled at each site complete with vibrating wire piezometers and slope inclinometer installations to establish the soil and groundwater conditions, is required. At PH077-1, 2 holes should be located along the south edge of the highway. At PH077-2, 1 hole should be along the north side of the highway, 1 along the south edge of the highway, and 1 further downslope on the south embankment.

\$175,000

Additional test hole drilling would be required if a highway realignment or a pile wall is considered. The culvert pipe should also be re-inspected for further signs of distress, and the locations of any distress should be surveyed. A topographic survey, detailed design and tender package will also be required prior to carrying out the remedial measures.

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

Nicole Wilder, P.Eng.
Geotechnical 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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- 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.

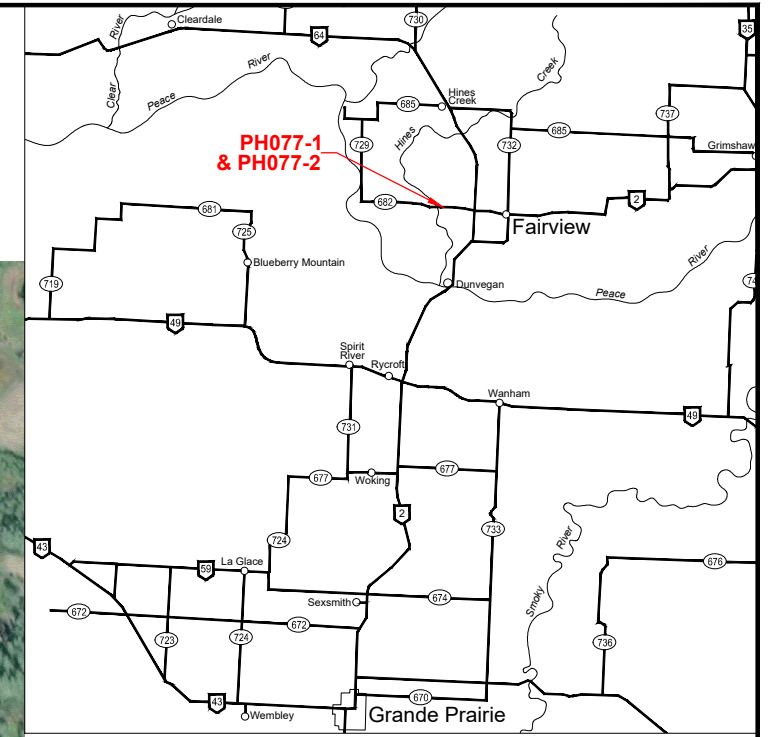
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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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H:\32000\32123 AT GRMP Grande Prairie District North 2021-2025\CAD\2023\NPW\32123 PH077-1-1&-2.dwg - OVERALL - Sep. 01, 2023



KEY PLAN
SCALE 1:1 500 000

LEGEND

 PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

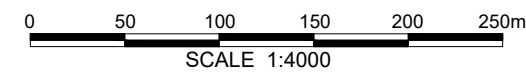
AIR PHOTO FROM ESRI WORLD IMAGERY EXPORTED ON OCTOBER 7, 2022



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH077-1 & PH077-2 EAST SIDE OF HINES CREEK BRIDGE
HWY 682:02, km 12.6-12.7**

SITE LOCATION PLAN

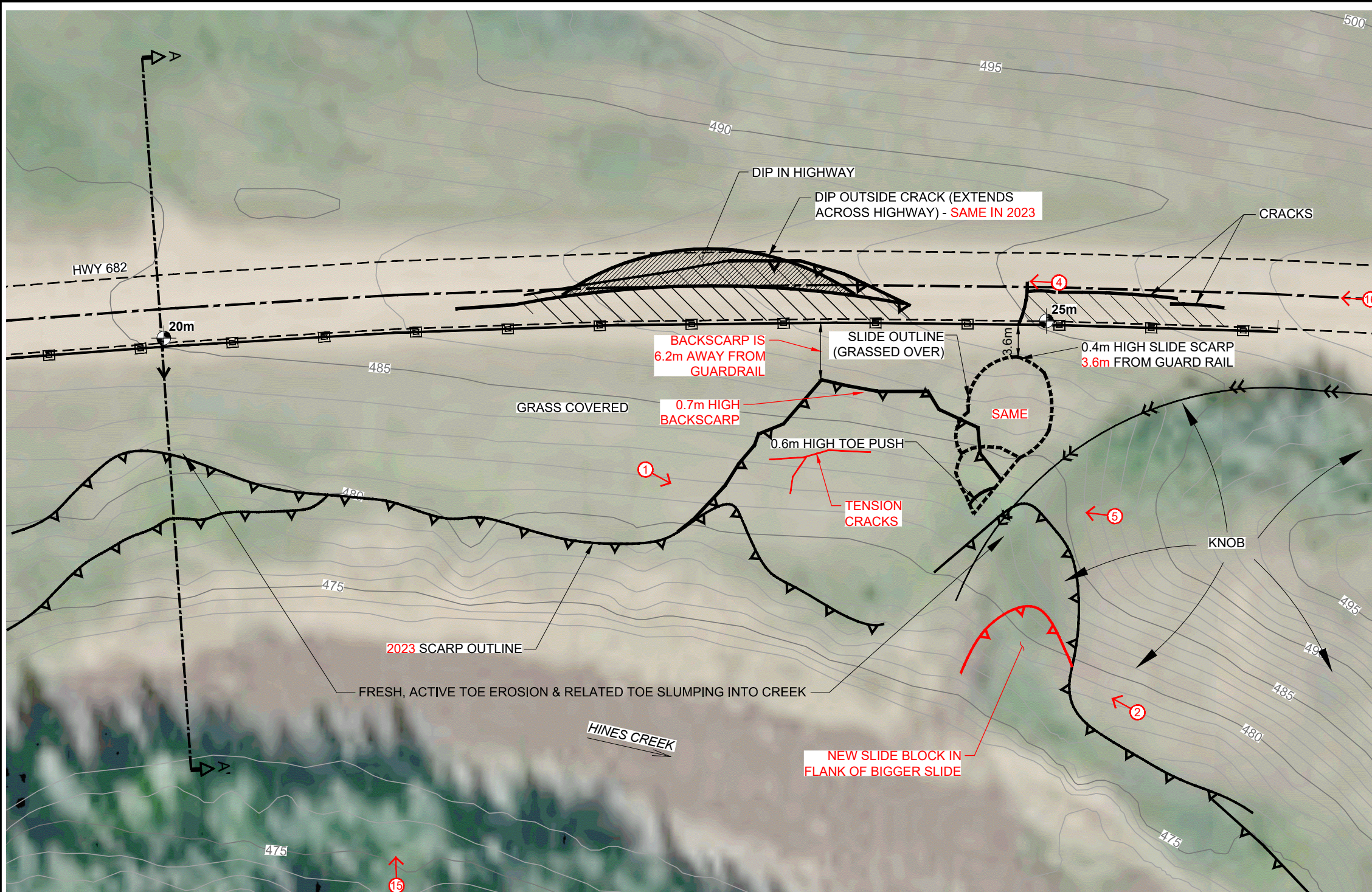
DWG No. 32123-PH077



DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:4000
DATE	SEPTEMBER 2023
FILE No.	32123



H:\32000\32123 AT GRMP Grande Prairie District North 2021-2025\CAD\2023\NPW\32123 PH077-1-1 & -2.dwg - PH077-1-1 - Sep. 01. 2023

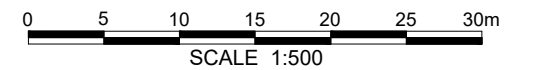


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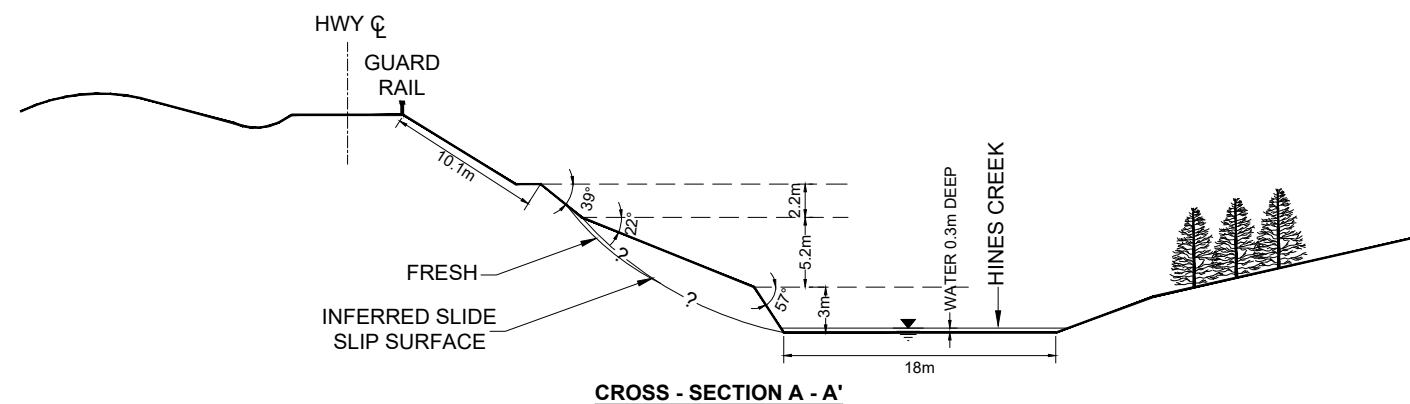
- APPROXIMATE GUARD RAIL LOCATION
- DITCH
- DIRECTION AND NUMBER OF PHOTO
- SLIDE SCARP
- PROPOSED SI / PIEZOMETER LOCATION
- 25m** DEPTH OF THE TEST HOLE IN METRES

NOTES

1. MAY 30, 2023 OBSERVATIONS SHOWN IN RED.
2. LOCATIONS ESTIMATED WITH HANDHELD GPS.



AIR PHOTO FROM ESRI WORLD IMAGERY EXPORTED ON OCTOBER 7, 2022



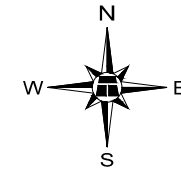
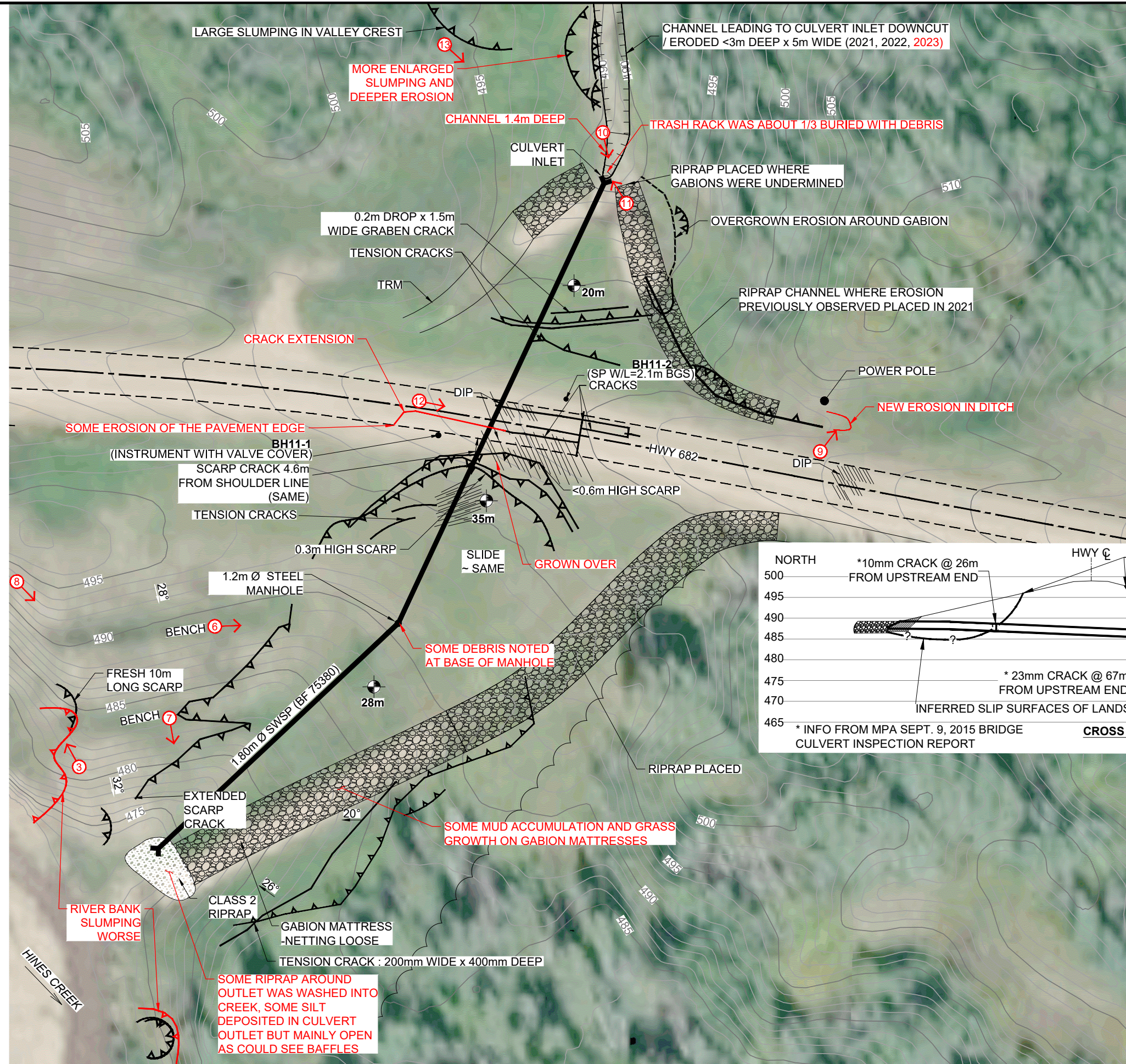
PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH077-1: EAST SIDE OF HINES CREEK BRIDGE
HWY 682:02, km 12.6-12.7

INSPECTION PLAN - SITE 1

DWG No. 32123-PH077-1-1

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:500
DATE	SEPTEMBER 2023
FILE No.	32123

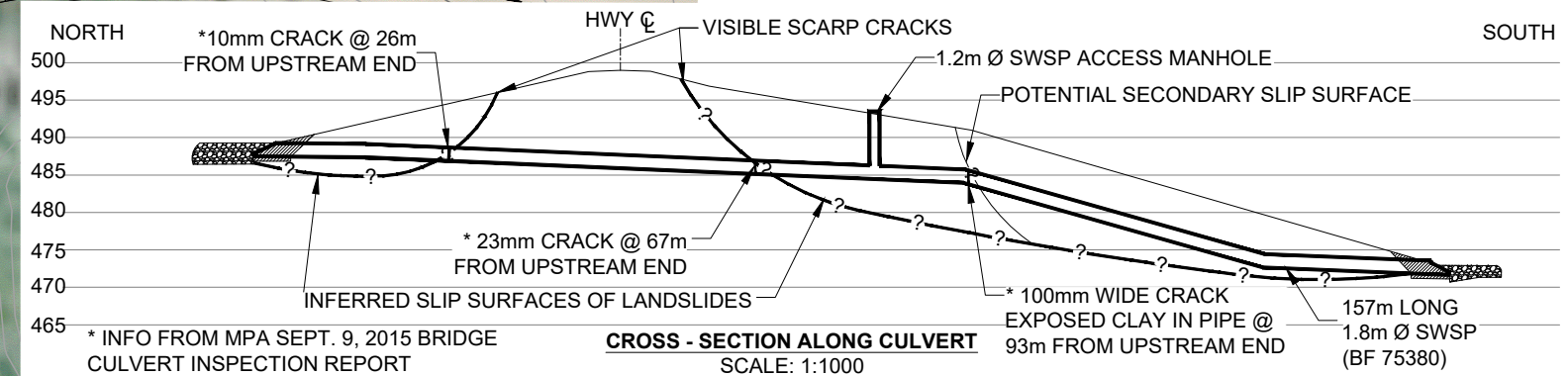




LEGEND

- SLIDE SCARP
- APPROXIMATE TREE LINE
- APPROXIMATE GUARD RAIL LOCATIONS
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION
- GABION MATTRESS
- SETTLEMENT AREAS
- PROPOSED SI / PIEZOMETER LOCATION
- 25m** DEPTH OF THE TEST HOLE IN METRES

- NOTES**
1. SITE RELATIVELY UNCHANGED.
 2. GABIONS LACKING INTERMEDIATE BAFFLES AND LIDS NOT ADEQUATELY TIED.
 3. MAY 30, 2023 OBSERVATIONS SHOWN IN RED.



AIR PHOTO FROM ESRI WORLD IMAGERY EXPORTED ON OCTOBER 7, 2022



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH077-2: EAST SIDE OF HINES CREEK BRIDGE
HWY 682:02, km 12.6-12.7**

INSPECTION PLAN - SITE 2

DWG No. 32123-PH077-2-1

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:750
DATE	SEPTEMBER 2023
FILE No.	32123





Photo 1. Looking east at Slide PH077-1 at the erosion along the north side of the Creek. Photo credit: Nicole Wilder.



Photo 2. Looking west at the fresh toe slumping above the creek at PH077-1 in the south highway embankment. Photo credit: Nicole Wilder.



Photo 3. Looking west at area that sloughed into the creek. Photo credit: Don Proudfoot.



Photo 4. Looking west along the highway at the crack/dip in the highway above the Slide at PH077-1. Photo credit: Nicole Wilder.



Photo 5. Looking west at new slump that developed west of the knob hill. Photo Credit: Don Proudfoot.



Photo 6. Looking east at riprap swale into the gabion mattress channel of PH077-2. Photo Credit: Nicole Wilder.



Photo 7. Looking east at the southeast ditch drainage channel of PH077-2, Hines Creek. Photo Credit: Nicole Wilder.



Photo 8. Looking southeast at the river bank slumping near the culvert outlet area of PH077-2. Photo Credit: Nicole Wilder.



Photo 9. Looking north at new erosion noted upslope from the riprap. Photo Credit: Nicole Wilder.



Photo 10. Looking south at the culvert inlet area at PH077-2, the trash rack appeared slightly less full of debris. Photo Credit: Nicole Wilder.



Photo 11. Looking north along the infilled channel leading into the culvert inlet north of the highway at PH077-2. Photo Credit: Nicole Wilder.



Photo 12. Looking east at the dip in the highway. Photo credit: Don Proudfoot.



Photo 13. Looking southeast at north sideslope of highway at culvert inlet at PH077-2. Drone Photo Credit: Don Proudfoot.



Photo 14. Looking north at Slumping riverbank at PH077-1/2. Drone Photo Credit: Don Proudfoot.



Photo 15. Looking north at slumping riverbank at PH077-1. Drone Photo Credit: Don Proudfoot.



Photo 16. Looking northwest at PH077-2. Drone Photo Credit: Don Proudfoot.