

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



Site Number	Location	Name	Hwy	km
PH026	Eureka River North Hill	Sites #3, #5 and #6	726:02	10.1
Legal Description		UTM Co-ordinates (NAD83)		
SW13/SE14-86-8-W6		11 N 6258740	E 368408	

	Date	PF	CF	Total
<b>Previous Inspection:</b>	May 16, 2022	13	4	52 (Site 3)
		9	5	45 (Sites 5 and 6)
<b>Current Inspection:</b>	June 1, 2023	13	4	52 (Site 3)
		9	5	45 (Sites 5 and 6)
<b>Road AADT:</b>	400	<b>Year:</b>	2022	
<b>Inspected By:</b>	Barry Meays, Don Proudfoot (Thurber) Rishi Adhikari, Max Shannon (TEC)			
<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>	Slide scarp at Site #3 crossing highway at 2 locations was repaired in 2013. Two other slide areas (Site #5 & #6) developing further north, likely linked as one larger slide. A new landslide occurred in 2017 (Site #3) in the west sideslope between the upper pile wall and the bridge culvert.	
<b>Dimensions:</b>	Main slide at Site 3 was about 60 m long by 100 m wide. Slide Sites 5/6 are in the order of 200 m wide (along the highway) by 200 m long. The new slide at Site 3 is about 20 m wide along the highway and 35 m (avg. toward the river) in a 12 m high embankment slope.	
<b>Date of any remediation:</b>	Main Slide Site 3 was remediated in 2013 with 2 pile walls and riprap.	
<b>Maintenance:</b>	Semi-continuous patching and crack sealing at all three sites. The north end of the guardrail and impact attenuator at Site 3 were repaired/replaced in 2021.	
<b>Observations:</b>	<b>Description</b>	<b>Worse?</b>
<input checked="" type="checkbox"/> Pavement Distress	Cracks, differential settlement, subsidence, and dips in the pavement and shoulders at Sites 5/6. Also, at Site 3, alligator cracked area at the south end of the lightweight fill along with a hump near the north end, and map cracking is occurring over the majority of area where lightweight fill was placed. The new slide at Site 3 has extended into the paved shoulder of the highway.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Slides at Sites 5 and 6 continue to creep, which requires periodic pavement maintenance. Also, the newer slide south of the upper pile wall at Site 3 is actively moving.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	At Site 3: There are some erosion rills on the sparsely vegetated area between the highway and the upper pile wall, and another on the east hwy. embankment.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	A seepage area exists (emanating from the highway GBC) 12m south of the south end of the upper pile wall in the highway embankment (which contributed to the 2017 slide). There is also a seepage area in the east ditch even with the north end of the upper pile wall.	<input type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>

<input checked="" type="checkbox"/> Other	Maintenance issues require attention: loose gutter grate and silt filled concrete gutter. Also, the exposed concrete on the top of the upper pile wall is spalling.	<input type="checkbox"/>
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**Instrumentation:** Last Read on June 21, 2023

SI08-1: Sheared off at 4.9m depth in 2009 (Prev. movement zones at 5m & 7m). SI08-2: Sheared off at 9.8m depth in 2008 (Prev. move zones at 9 & 13m). SI08-3: Sheared off at 7.9m depth in 2009 (Prev. move zones at 8 & 13m). SI11-5: Sheared off at 8.7m depth in 2014 (Prev. move zone at 9m). SI11-6: Sheared off at 17.1m depth in 2014 (Prev. move zone at 18m). SI11-7: Sheared off at 16.7m depth in 2013 (Prev. move zone at 18.5m). SI11-3 showed no significant movement above 5 m depth since the fall of 2021 reading; and no significant movement between the time of 2018 to 2020; but had previously moved at an average rate of ~5 mm/year at a depth above 5 m since the spring of 2014. SI11-4 showed no significant movement above a 10m depth since spring 2017, and has averaged <1mm/yr since spring, 2014.

**Upper Wall:** SI12-P9U (North end), SI12-P17U (center), and SI12-P26U (South end), all showed negligible movements over both the length of waler & pile, and the length of pile only. The 6 anchor load cells indicated continued load stabilization with loads that vary between 175 kN to 225 kN per anchor (fluctuations varying between a loss of 0 to 2 kN/anchor since the fall of 2022), compared to the initial peak load stressing of about 250 to 260 kN per anchor. The design load was 300 kN/anchor, but the anchor lock-off load was 240 kN.

**Lower Wall** over the length of the piles: SI12-P3L (North end), SI12-P9L (center), and SI12-P14L (South end), all showed negligible (ie. <1 mm/yr) movement over this most recent reading cycle. Historically since installation in the fall of 2012, SI12-P3L and SI12-P9L have averaged about 1.5 mm/yr movement, while SI12-P14L has averaged about <0.5 mm/yr, all downslope towards the river.

Water levels (all BGS) in: PN11-3 at 13.2m; and VW11-7 at 16.0m.

**Assessment:**

At Site #3, construction to repair a series of translational slide blocks along a common deep-seated slip plane was completed in 2013. This featured: a 120 m long tied-back pile wall along the west side of the existing highway but included excavation of soil and incorporation of lightweight fill along the existing highway alignment; an additional 60 m long lower cantilever pile wall located nearer the River below Site 3 to keep the soil from eroding into the river and remain intact below the tied back pile wall; and armoring the toe of the River with Class 2 Riprap.

In the upper wall at Site #3, the 3 SI's have generally indicated negligible movement over the last 3 years. Over the last few years, there appears to be some oscillating fluctuations in the movements between spring and fall, which temporarily reverse the short-term directional movements in SI12-P9U and SI12-P17U, and to some extent in SI12-P26U. The load cells indicate the latest anchor load readings fluctuated between about 0% and -1%, but the anchor loads are showing the general relaxation trend is slowing or possibly even reversing the last few years. This indicates that, in general (since 2017 and excluding oscillating fluctuations), the piles ceased being pulled upslope and are beginning to reach a state of equilibrium with the soil. In the lower cantilever wall, all 3 SI's indicate negligible movements towards the river over the last 3 years and appear to be stabilizing. Based on these readings and site observations, the two walls, sheet piles, and riprap have effectively stabilized the original large landslide at Site 3.

The seepage from the pavement GBC observed in 2016 south of the upper pile wall and ongoing weathering of the fill are the likely causes of the slide that occurred south of the upper pile wall in 2017. The seepage likely saturated the GBC and embankment fill with time, which created a weak soil mass that eventually failed, carrying the material down into the river.

Pavement deflections and alligator cracks have showed up in both lanes (southbound lane worse) near each end of the upper pile wall where the lightweight (Geofoam) fill ends. The southbound lane ACP is in poor shape from the south end of the slide area to about 11 m north of the south end of the wall. Also, map cracking exists quite extensively over the pavement adjacent to the upper pile wall. This is surmised

to be due to flexing of the pavement structure overtop of the Geofoam in response to heavy truck traffic, and different thermal characteristics from freeze-thaw compared to total soil bedding. Some of the pavement distress was remediated by placing asphalt patches at the north end of the wall in 2020 and 2021.

The exposed concrete along the top of the upper pile wall is spalling. This was attributed to weaker than design strengths on this material, for which the contractor was penalized for low strengths at that time.

Slide features at/between Sites 5 and 6 have not changed significantly over the last few years. The inclinometers installed in 2011 (SI's 11-5, -6 and -7, which were previously showing movements in the order of 15 to 25 mm/year, had all sheared off by 2015), while SI's 11-3 and 11-4 which are located very near the top of the slide scarp show negligible movement. This indicates movements are occurring at both Sites 5 and 6, in addition to between them, at depths as deep as 18.5 m below ground surface. This more closely defines the slide boundary between Sites 5 and 6 and outlines the edge of a single larger slide moving towards the river.

## **Recommendations:**

### **Maintenance**

Consider covering the slope in between the pavement and the upper wall with hand placed asphalt, as there is sparse grass growth here and some rilling has formed.

It was understood that the Site 3 pile wall should be added to the Bridge File yearly maintenance program, which would include gutter (concrete swale) cleaning at the same time as bridge deck cleaning occurs.

- 1) Clean the gutter of soil/debris buildup under the handrail adjacent to the west side of the highway, and securely fasten the loose gutter grate.
- 2) The spalled concrete on the surface of the upper pile wall should be repaired by placing a proper concrete sealant over the entire exposed surface to prevent any further degradation.
- 3) A steel sleeve could be installed over the gap in the handrail.

### **Short Term**

Paving Contract #21542 is ongoing in 2023, which involves a pavement overlay to be applied to the highway throughout the valley crossing section. It was recommended that prior to placing the overlay, consideration be given to doing a full depth subgrade repair to improve the strength of the pavement and better bridge over the softer geofoam zone, by: Excavating the majority of the 0.7 m of clay subgrade to near the surface of the geofoam; Replacing the clay subgrade to compaction specifications; Installing geogrid in the compacted GBC; then repaving these areas, however, this was not included in the contract.

At Site 3, the slide that occurred between the upper pile wall and bridge culvert is currently being repaired as part of the above noted contract, as follows:

- Excavated the slumped material in the west highway embankment, and disposed of the material outside and away from the valley crests. Installed a drainage geosynthetic and a subdrain system along the base of the excavated slump. Sheet piles were installed along the slide toe and adjacent to the arch culvert, to minimize river inflow and to provide support for excavation adjacent to it, while temporary sheet piles were installed adjacent to the highway/pile wall for excavation support and removed after backfilling. The subdrains were extended through the lower portion of the re-built slope to outlet on the riprap adjacent to the river. Additional Class 2 riprap was installed along the toe of the repaired area adjacent to the river to prevent future toe erosion. The new highway embankment was re-built using compacted gravel to re-establish the existing slope and to surround the subdrains.

**Approximate Cost \$900,000 (Excl. engineering and contingencies).**

## **Long Term**

Thurber performed a preliminary geotechnical investigation and design (see Report dated July 17, 2009), which outlined various remediation alternatives/costs consisting of three major highway re-alignment options (two of which utilize the existing crossing), a minor highway re-alignment, or constructing pile walls at each site individually. TEC is considering which alternative to pursue in respect of costs and future planning. A functional planning study was completed by Morrison Hershfield Ltd. in 2012, which recommended Option #1B be adopted – i.e., a major re-alignment which utilizes the existing crossing but is perpendicular to the river and raises the crossing grade elevation but passes through the farmyard. A separate recommendation for armouring the river along the downstream toe of Slide Site 3 for the minor re-alignment and individual site repairs was also provided in Thurber's report, but this was already performed as extra work for the Site 3 slide repair contract.

The major highway re-alignment is still considered the best long-term recommendation, since the slip surfaces at Sites 5 and 6 are too deep to stabilize with a cost-effective pile wall.

## **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.

Renato Clementino, Ph.D., P.Eng.  
Principal | Senior Geotechnical Engineer

Barry Meays, P.Eng.  
Senior 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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### 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. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

### 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

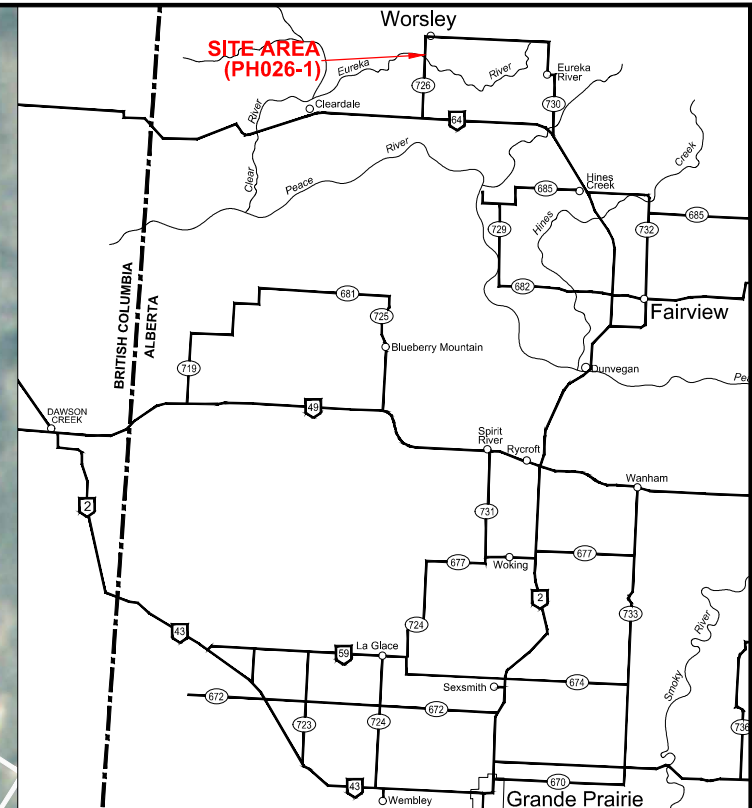
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, 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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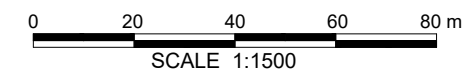
KEY MAP - SCALE 1:1,500,000

**NOTE**

1. SLIDE FEATURES RECORDED USING A HAND HELD GPS.
2. SITE 5 AND SITE 6 MAY OUTLINE THE EDGE OF A SINGLE SLIDE SPANNING BETWEEN THE TWO AREAS.
3. FOR UPDATED CRACKS / PATCHES, SEE DWG No. 32123-PH026-1-2 AND 32123-PH026-1-3.

**LEGEND**

- SLIDE MOVEMENT DIRECTION
- TEST HOLE LOCATIONS
- 9m DEPTH BELOW GROUND OF SHEAR ZONE IN SLOPE INCLINOMETER



PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH026-1 HWY 726:02 SOUTH OF WORSLEY,  
SITES #3, #5 & #6

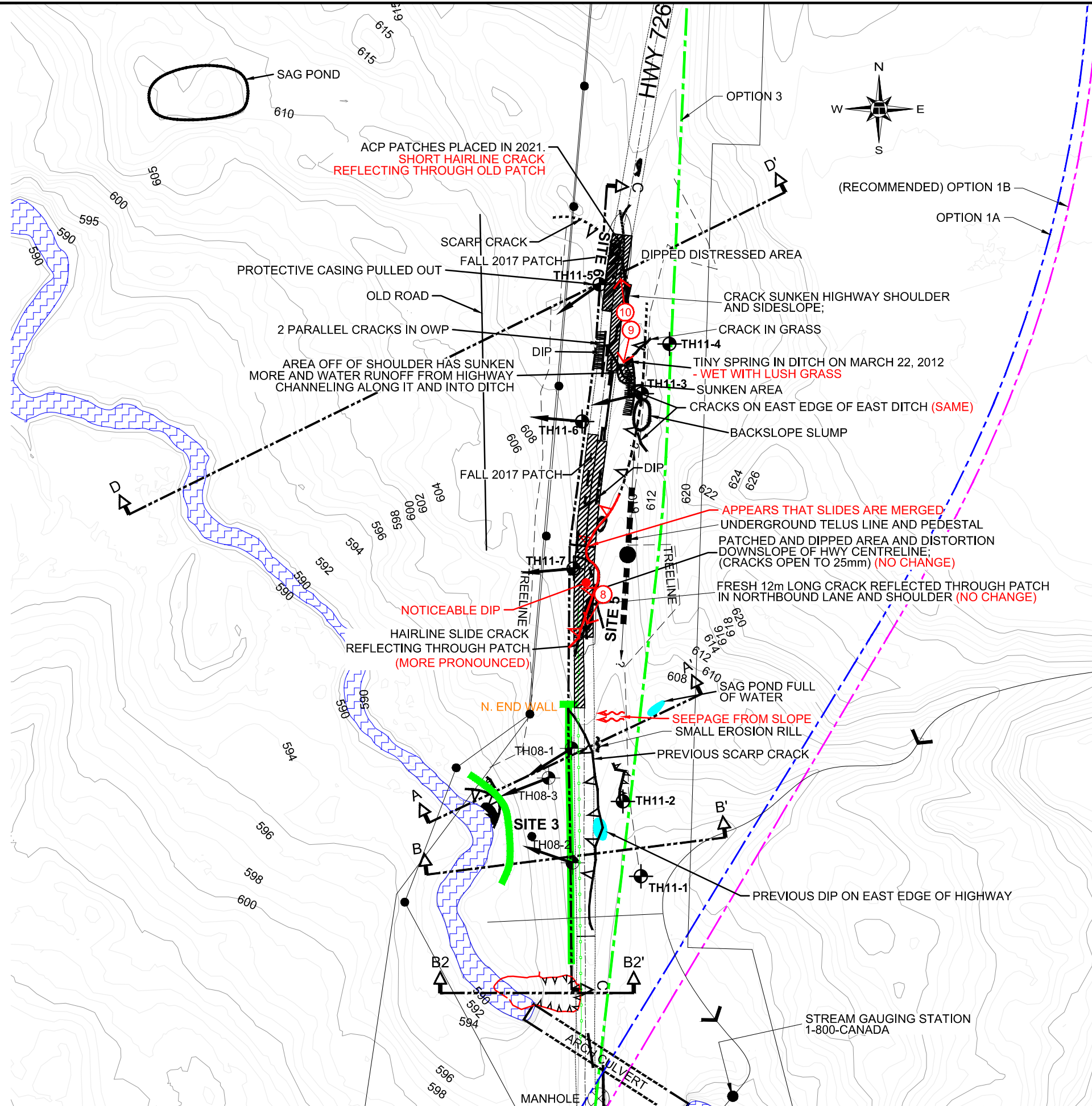
2023 PH026-1 INSPECTION PLAN

DWG No. 32123-PH026-1-1

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:1500
DATE	JUNE 1, 2023
FILE No.	32123



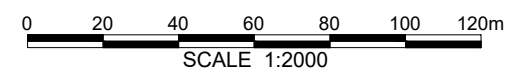





**LEGEND**

	APPROXIMATE TEST HOLE LOCATIONS
	CRACKS
	SLIDE SCARP / CRACK
	PHOTO AND DIRECTION
	PONDED WATER
	OVERHEAD POWER LINE
	DRAINAGE
	MOVEMENT VECTOR
	GUARDRAIL
	ACP PATCHES

- NOTES**
1. SLIDE SITE FEATURES RECORDED USING A HAND HELD GPS.
  2. EXISTING PILE WALLS
  3. GROUND SURFACE CONDITIONS WERE DEVELOPED BASED ON LIDAR DATA.
  4. CONDITIONS ON JUNE 1, 2023 SHOWN IN RED.
  5. SITE 5 AND SITE 6 MAY OUTLINE THE EDGE OF SINGLE SLIDE SPANNING BETWEEN THE TWO AREAS. NEGLIGIBLE MOVEMENT AT BOTH SITES 5 & 6 IN 2023.
  6. SEE DWG No. 32123-PH026-1-3 FOR SITE 3 NOTES.






**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH026-1 HWY 726:02 SOUTH OF WORSLEY,  
SITES #3, #5 & #6**

**2023 PH026-1 INSPECTION PLAN**

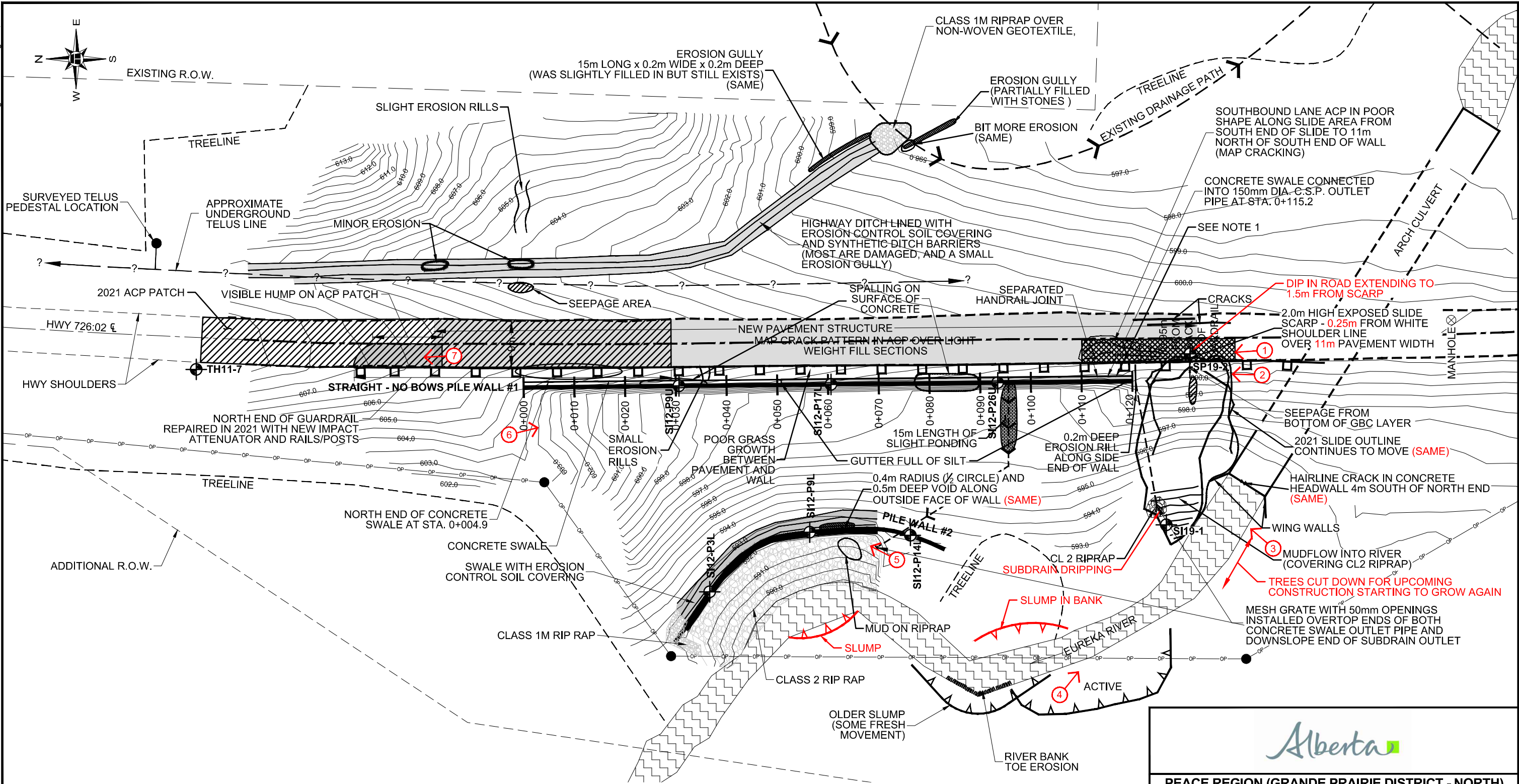
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DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:2000
DATE	JUNE 1, 2023
FILE No.	32123









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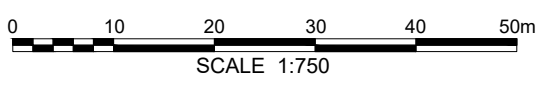
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- NOTES:**
- 1. GUTTER GRATE IS LOOSE AND GUTTER IS FULL OF DIRT AND NEEDS CLEANING (AT MAINTENANCE).
  - 2. CONDITIONS ON JUNE 1, 2023 SHOWN IN RED.
  - 3. REFER TO DWG NO. 32123 PH026-1-7 AND -PH026-1-8 FOR LATEST SLIDE DETAILS.

**LEGEND**

-  NEW GUARDRAIL
-  POWER POLE AND GUY WIRES
-  2012 INSTRUMENTS LOCATED IN THE PILE WALLS
-  PHOTO AND DIRECTION
-  SLIDE SCARP / CRACK
-  ACP PATCH






**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH026-1 HWY 726:02 SOUTH OF WORSLEY,  
SITES #3, #5 & #6**

**2023 INSPECTION PLAN**

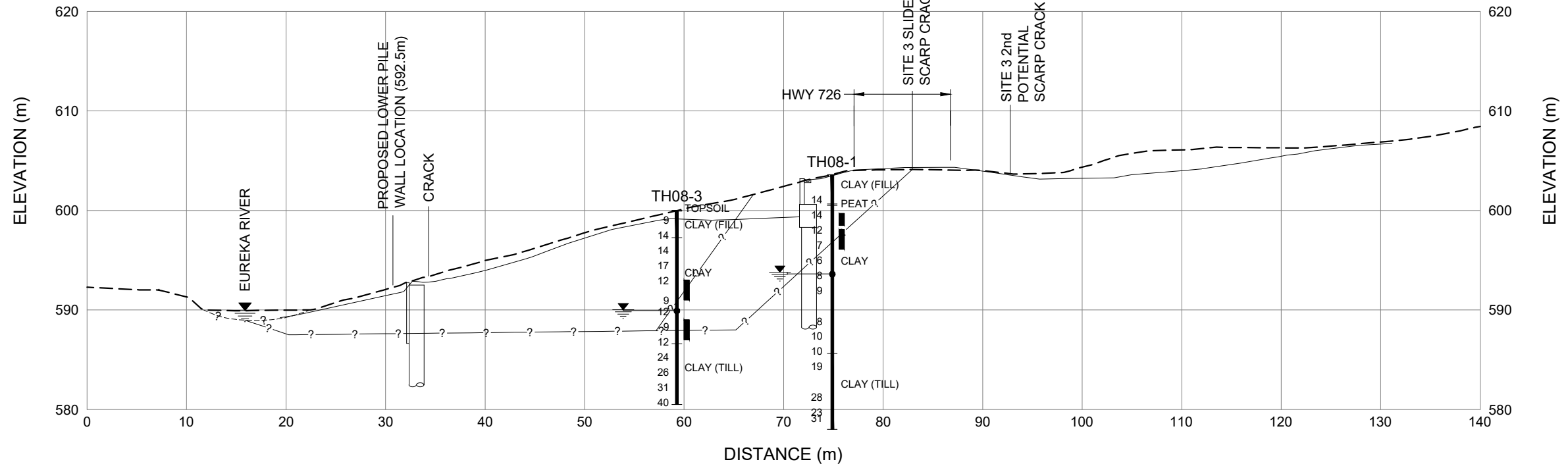
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DESIGNED BY	BDM
APPROVED BY	DWP
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DATE	JUNE 1, 2023
FILE No.	32123

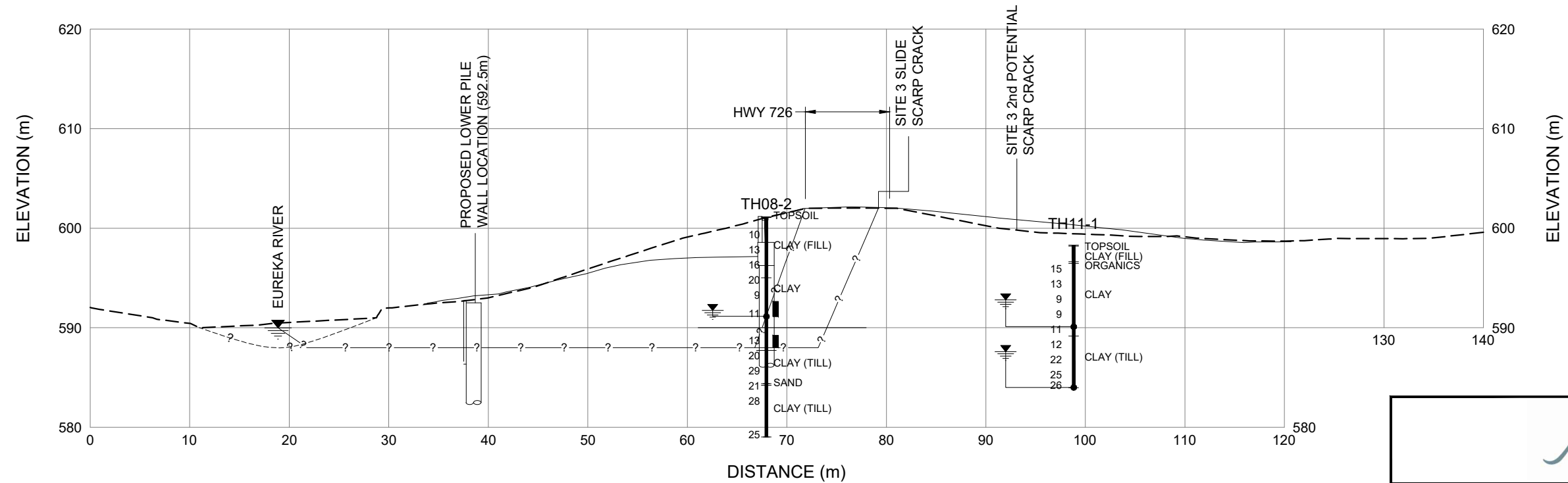


**THURBER ENGINEERING LTD.**





SECTION A-A'



SECTION B-B'

LEGEND

- SPT N VALUE
- WATER LEVEL IN PIEZOMETER, JUNE 4, 2011
- INFERRED SLIDE SURFACE
- INFERRED GROUND SURFACE BELOW RIVER
- PIEZOMETER TIP LOCATION IN TEST HOLES
- MOVEMENT ZONE IN INCLINOMETERS
- ORIGINAL GROUND SURFACE (LIDAR)
- AS - BUILT GROUND SURFACE (SURVEY)

NOTES

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.
2. THE CROSS SECTIONS ARE BASED ON OCTOBER 2007 LIDAR & 2013 SURVEY INFORMATION. THE TEST HOLE ELEVATIONS WERE CONVERTED FROM GENIVAR'S SURVEY INFO.



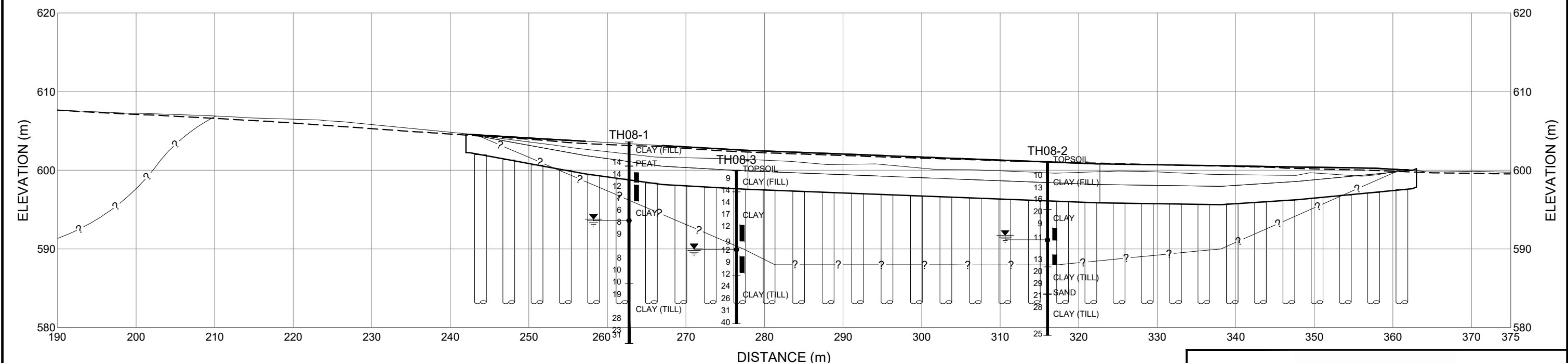
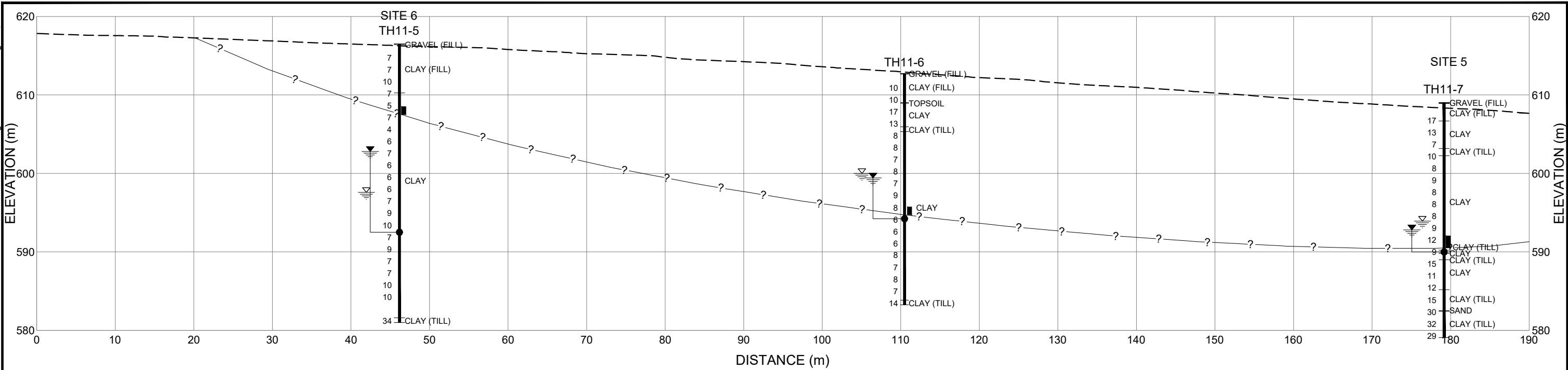
PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH026-1 HWY 726:02 SOUTH OF WORSLEY,  
SITES #3, #5 & #6

CROSS-SECTIONS A-A' & B-B'

DWG No. 32123-PH026-1-4

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





**LEGEND**

- SPT N VALUE
- WATER LEVEL IN PIEZOMETER, JUNE 4, 2011
- WATER LEVEL IN PIEZOMETER, SEPTEMBER 20, 2014
- INFERRED SLIDE SURFACE
- PIEZOMETER TIP LOCATION IN TEST HOLES
- MOVEMENT ZONE IN INCLINOMETERS
- ORIGINAL GROUND SURFACE (LIDAR)
- AS - BUILT GROUND SURFACE (SURVEY)

**NOTES**

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PH026-1 HWY 726:02 SOUTH OF WORSLEY,  
SITES #3, #5 & #6**

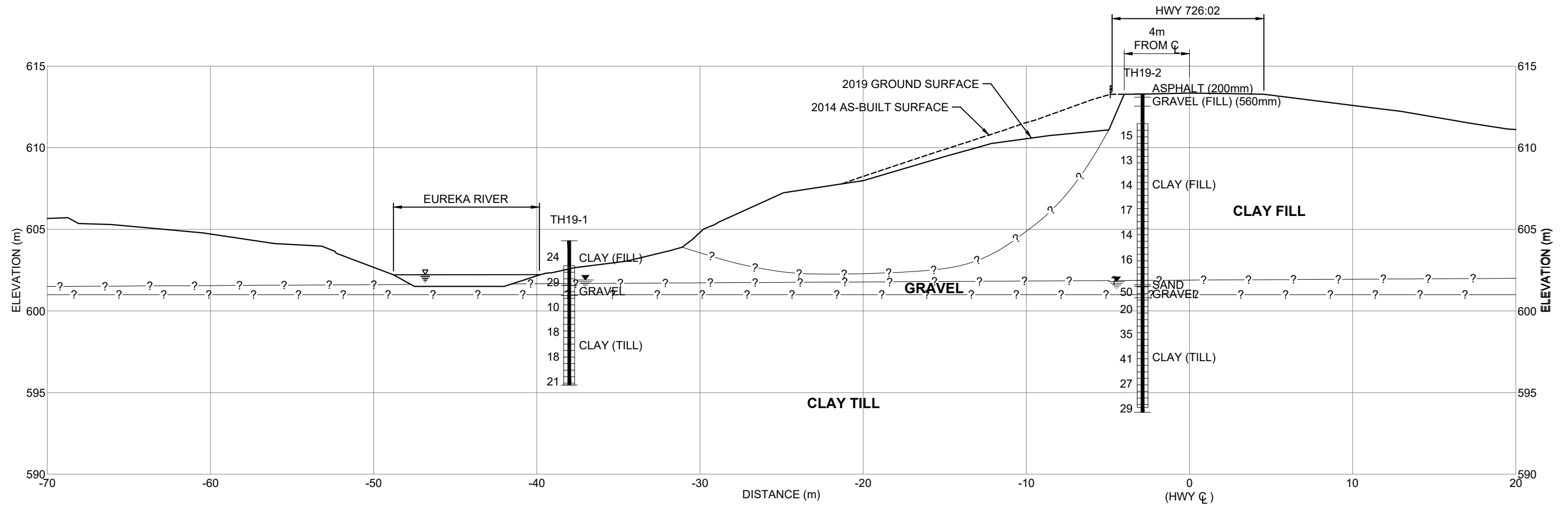
**CROSS-SECTION C-C'**

**DWG No. 32123-PH026-1-5**

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DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:500
DATE	JUNE 1, 2023
FILE No.	32123







**LEGEND**

- 15 SPT N VALUE
- WATER LEVEL IN PIEZOMETER
- STANDPIPE PIEZOMETER SCREENED INTERVAL
- ? ASSUMED MOVEMENT ZONE

**NOTE**

OLD ELEVATIONS CORRELATED TO THIS SURVEY GRID BY +12.5m



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH026-1 HWY 726:02 SOUTH OF WORSLEY,  
SITES #3, #5 & #6**

**CROSS-SECTION B2-B2' (PH026)**

**DWG No. 32123-PH026-1-7**

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:250
DATE	JUNE 1, 2023
FILE No.	32123







Photo 1 – Looking north along the highway south of the upper pile wall at the landslide that developed at Site 3.



Photo 2 – Looking north at the slide scarp that has extended into the SB shoulder to within 0.25 m of the white line beyond the south end of the upper pile wall at Site 3.





Photo 3 – Looking northeast at the slide that pushed debris against and around the arch culvert outlet headwall at Site 3. Note the cut trees growing again on the south side of the arch culvert.



Photo 4 – Looking east at the body and scarp face of the slide between the south end of the pile wall and the arch culvert at Site 3.





Photo 5 – Looking north at the lower pile wall area and riprap behind it at Site 3.



Photo 6 - Looking south along the upper pile wall and downslope embankment at Site 3.





Photo 7 – Looking north along the highway at the north end of the guardrail and former patching at Site 5.



Photo 8 - Looking south along the highway from the south end of the scarp of Site 5.





Photo 9 - Looking south along the highway at the subsidence in the NB driving lane and shoulder at Site 5.



Photo 10 - Looking north along the east highway edge at where the slide scarp crosses the highway at Site 6.