ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT
2019 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
GP34	NW of Grande Cache	2.9 km S of Kakwa River Bridge	40:38	21.0
Legal Description		**UTM Co-ordinates (NAD 83)**		
NW28-62-4-W6		11U N 6,028,660	E 399,845	

	Date	PF	CF	Total
Previous Inspection:	May 23, 2018	13	4	52
Current Inspection:	May 28, 2019	13	4	52
Road AADT:	920		**Year:**	2018
Inspected By:	Don Proudfoot, Nicole Wilder (Thurber) Ed Szmata, Rocky Wang, Austin Dillman (AT)			
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items			

Primary Site Issue:	Landslide in a ~25 m high sidehill highway embankment fill	
Dimensions:	About 100 m long by ~200 m wide	
Date of any remediation:	Within a couple years after construction initiation (early 1980's), dewatering measures consisting of vertical wells (and possibly horizontal drains) were installed, along with a 6 m high toe berm.	
Maintenance:	A full SB lane/shoulder acp patch was placed over the cracked area in June 2015. In summer 2016, 50 mm was milled out of the S.B. lane and was overlaid over the cracked area. An area north of the site was also overlaid over both lanes.	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	A headscarp crack is affecting an approximate 80 m length of pavement along the southbound lane/shoulder. The crack got worst after the milling/overlay and the pavement has dropped up to 50 mm and is now up 150 mm wide near the middle. The main scarp has extended further into the embankment on either side. A dip and crack extension was also observed 25 m north of this area.	☑
☑ Slope Movement	Movement of the embankment fill has re-activated in recent years and continues at a steady rate.	☑
☐ Erosion		☐
☑ Seepage	Seepage was observed near both of the lower SI's (SI17-3 and SI17-6), where ponding of water and softer ground was observed in these areas.	☑
☐ Bridge/Culvert Distress		☐
☐ Other		☐

Instrumentation October 10, 2019: Inclinometers SI17-2 = -1.0 mm/yr @ 9-11 m depth; **SI17-3** = 1 mm/yr @ 10-11 m depth; **SI17-5** sheared off at 7.3 m depth; **SI17-6** = sheared off at 6.7 m depth. **Piezometers (All BGS): PN17-1A** = 1.0 m; **PN17-1B** = 5.2 m; **PN17-2A** = 7.4 m; **PN17-2B** = 9.1 m; **PN17-3A** = 0.8 m; **PN17-3B** = 3.1 m; **PN17-4A** = 5.9 m; **PN17-4B** = 6.6 m, **PN17-5A**= Broken; **PN17-5B** = Broken; **PN17-6A** = Broken; **PN17-6B** = 9.4 m.

Assessment:

The highway was constructed in the early 1980's, which included a 20 to 30 m high embankment fill at this site location. During construction of the embankment fill, difficulties with wet ground and then slide movements were documented. Remediation consisting of dewatering measures (horizontal drains and a series of vertical wells), and a 6 m high by 40 m wide toe berm near the base of the embankment fill, were undertaken within the following couple of years.

The water levels in four of the vertical wells (300 mm diameter CSP pipes sticking up above ground) near the central to north end of the site were measured on May 28, 2019 and were found to be between 0.7 m to 3.4 m below the ground surface. There were two other's CSP pipes near the south end that were found to be crushed during a previous inspection.

A geotechnical investigation consisting of 6 test holes (containing 4 inclinometers and 12 pneumatic piezometers) was performed in early winter 2017. The soil conditions were found to consist of a clay fill highway embankment, overlying glacial clay till, over predominantly clay shale bedrock with interbedded sandstone.

The last set of inclinometer monitoring (from October 2019) showed that SI 17-5 had sheared off at 7.3 m and SI 17-6 had sheared off at 6.7 m while much slower rates of 1 mm/yr were measured in SI's 17-2 and 17-3 (shown on attached section A-A').

These are similar rates indicated for SI17-2/17-3 prior to October 2019. The high rates of movement in SI17-5 and SI17-6 coincide with the large crack observed in the pavement during the 2018 inspection and subsequent worsening of the cracks in 2019 which have re-activated in the former slide area.

It is anticipated that gradual clogging of the dewatering system, and/or elevated groundwater levels, may be one of the causes of the renewed movements. Depending on details of the dewatering system installed, on-going slope movements may also be affecting the functionality of the system.

The diagonal crack (see Photo 6), and the movement rates suggest the start of movements further to the north.

Recommendations:

Maintenance:
Continue to patch and possibly mill the highway that is affected by the slide scarp area. The dip and crack further north may also require similar maintenance in the future.

Short Term:
In the short term, the slide should be regularly monitored for progression of slide movements. Landslide warning signs should be installed, a contingency made to implement traffic control for a one driving lane closure if a sudden movement closes the SB lane. A temporary detour could also be constructed in the east ditch of the highway. The instruments should continue to be read biannually to monitor movement rates and pore pressures to help confirm what remedial measure would be favorable at this site.

Medium to Long Term

From discussions with AT, it was mentioned that 7 Generations plan to relocate their highway access further south to the top of the hill and will likely add 1700 to 2000 vehicles per day from Hammerhead Road. This might warrant a climbing lane. If this is to be constructed, it should be built into the upslope ditch after installing a deep subdrain. AT also mentioned that an overlay has been delayed a few years and that the slide repair may be completed as part of the paving project.

Consideration could be given to installing a subdrain to further lower the water table in the east ditch and through the slide area. Based on the latest results of the instrument readings, it might be appropriate to also increase the size of the toe berm. However, since the slide movements could extend below the berm and further downslope, shear piles might also be required at the toe berm location.

Alternatively, a tied-back pile wall could be considered along the shoulder of the highway, the highway could be shifted into the hillside, using a retaining wall to support the toe of the south steeper portion of the backslope, or the slide could be offloaded by reconstructing the highway with light weight fill, supporting the downslope edge with a retaining wall and cutting to flatten the slope between the wall and the existing toe berm. These options are further discussed in a preliminary engineering report that was prepared by Thurber.

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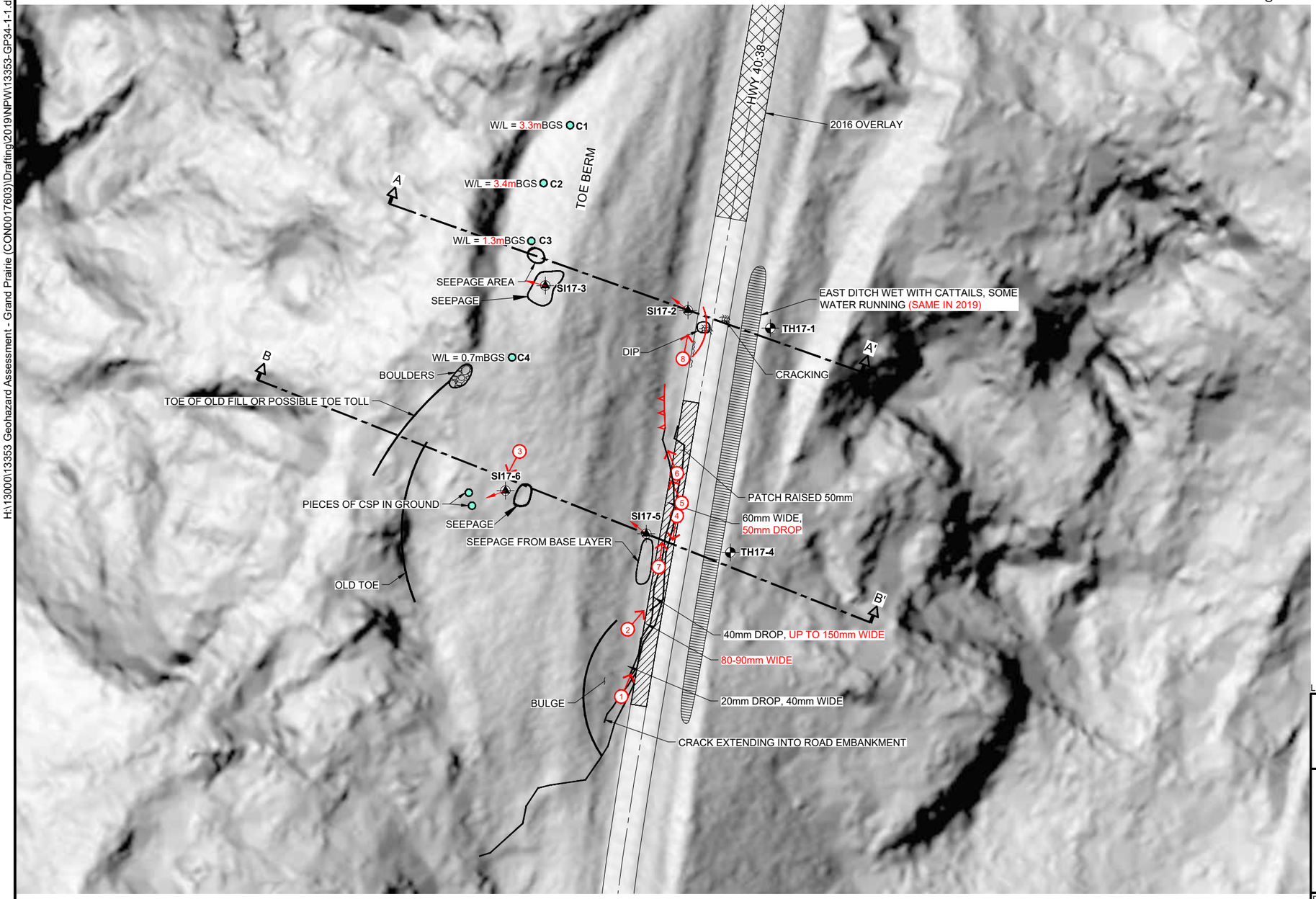

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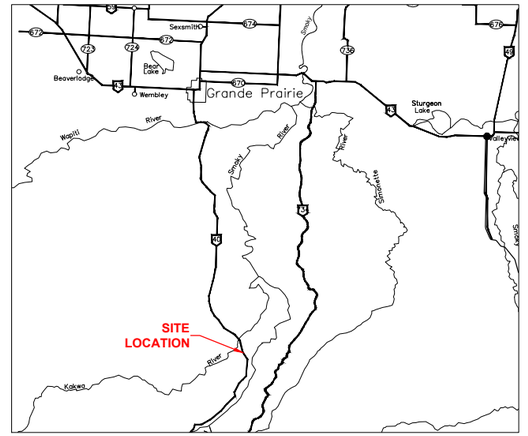

KEY PLAN
SCALE: 1:200 000

LEGEND

- SCARP CRACK
- ACP PATCHED IN 2016
- VERTICAL WELL LOCATION (300mm Ø CSP) WATER LEVELS MEASURED MAY 23, 2018
- SLOPE INCLINOMETER AND VIBRATING WIRE PIEZOMETER
- TEST HOLE WITH STANDPIPE
- DIRECTION AND NUMBER OF PHOTO
- WET DITCH
- DIRECTION OF MOVEMENT IN SLOPE INCLINOMETER

NOTES :

1. FEATURE LOCATIONS ARE APPROXIMATE
2. PREVIOUS OBSERVATIONS SHOWN IN BLACK
3. MAY 28, 2019 FEATURES SHOWN IN RED

0 20 40 60 80 m
SCALE 1:1500

LIDAR PROVIDED BY ALBERTA TRANSPORTATION

Alberta Transportation

PEACE REGION (GRANDE PRAIRIE)
GP34-1: HWY 40:38, 2.9km SOUTH OF KAKWA RIVER BRIDGE

2019 INSPECTION PLAN

DWG No. 13353-GP34-1-1

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1500
DATE	NOVEMBER 2019
FILE No.	13353

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CSP 800 CULVERT
INVERT EL. 855.238m

EAST DITCH WET WITH CATTAILS

TH17-1

TH17-4

2016 OVERLAY

SI17-2
DIP

ACP PATCH

HIGHWAY 40

DIP
SI17-5

CSP 800 CULVERT
INVERT EL. 880.285m

INVERT EL. 850.853m

INVERT EL. 877.555m

C1
W/L = 3.3mBGS

C2
W/L = 3.4mBGS

W/L = 1.3mBGS
C3

SI17-3

C4
W/L = 0.7mBGS

SEEPAGE AREA

GROUND IS WET

SEEPAGE AREA

WET

SI17-6

SURVEY BOUNDARYSURVEY BOUNDARY
OUTSIDE CONTOURS ARE FROM LIDAR

892 890 888 886 884 882 880 878 876 874 872 870 868 866 864 862 860 858 856 854 852 850 848 846 844 842

A A'

B B'

N E S W

BASE PLAN PROVIDED BY WSP

LEGEND

- APPROXIMATE TEST HOLE LOCATION
- SCARP CRACK
- TREE LINE
- HIGHWAY
- DRAINAGE DITCH
- VERTICAL WELL LOCATION (300mm Ø CSP)

NOTES :

1. FEATURE LOCATIONS ARE APPROXIMATE
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0 10 20 30 40 50 60 70 m
SCALE 1:1250

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PEACE REGION (GRANDE PRAIRIE)
GP34-1: HWY 40:38, 2.9km SOUTH OF KAKWA RIVER BRIDGE

2019 INSPECTION PLAN

DWG No. 13353-GP34-1-2

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1250
DATE	NOVEMBER 2019
FILE No.	13353

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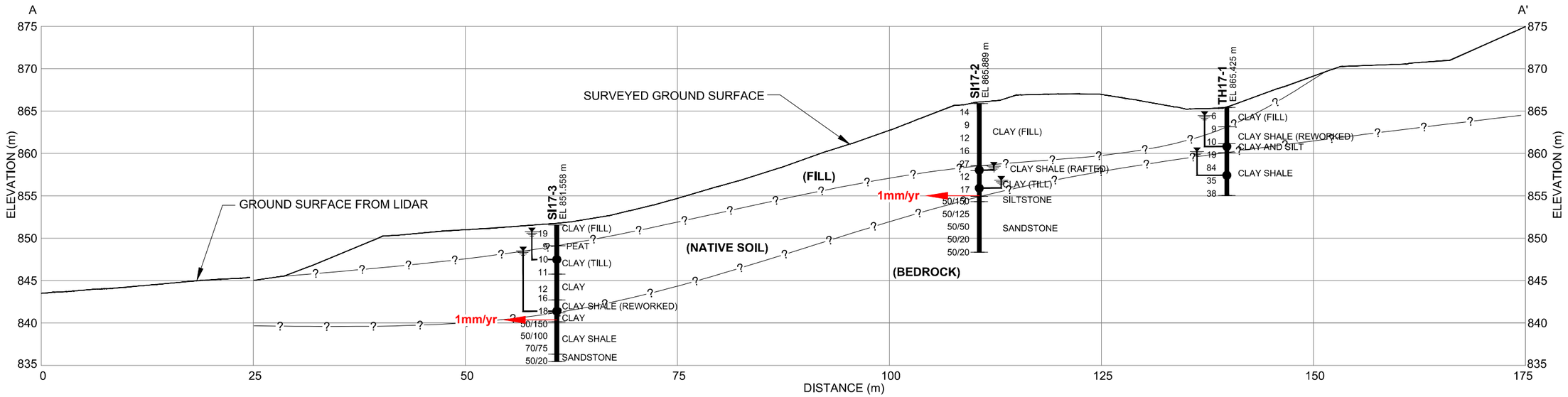

LEGEND

15 SPT N VALUE

PNEUMATIC PIEZOMETER TIP

WATER LEVEL IN PNEUMATIC PIEZOMETER (OCTOBER 10, 2019)

MOVEMENT IN SLOPE INCLINOMETER (OCTOBER 10, 2019)

NOTE

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.

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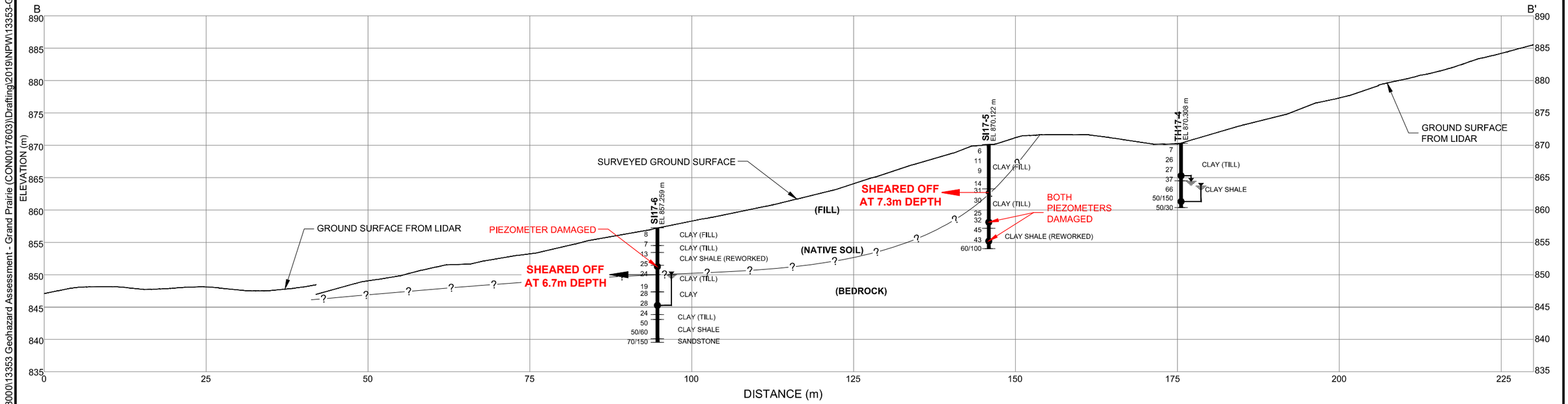
PEACE REGION (GRANDE PRAIRIE)
GP34-1: HWY 40:38, 2.9km SOUTH OF KAKWA RIVER BRIDGE

CROSS-SECTION A - A'

DWG No. 13353-GP34-1-3

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:500
DATE	NOVEMBER 2019
FILE No.	13353

THURBER ENGINEERING LTD.



LEGEND

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PEACE REGION (GRANDE PRAIRIE)
GP34-1: HWY 40:38, 2.9km SOUTH OF KAKWA RIVER BRIDGE

CROSS-SECTION B - B'

DWG No. 13353-GP34-1-4

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:600
DATE	NOVEMBER 2019
FILE No.	13353

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THURBER

	**Photo 1.** Looking north at the patched southbound lane and reflective scarp crack from the south end of the patch.
	**Photo 2.** Looking north at scarp crack from the south end of the patch.

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	**Photo 3.** Looking at SI17-6 at the toe of the west embankment where the ground was wet.
	**Photo 4.** Looking south at scarp crack where the deepest drop exists.

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	**Photo 5.** Looking north at the north end of the scarp crack.
	**Photo 6.** Looking north at where the scarp crack extends off of the shoulder and into the embankment.

	**Photo 7.** Looking north towards the north end of the scarp crack and patch, with SI17-5 on the left
	**Photo 8.** Looking north at dip in the SBL.