

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT
2018 INSPECTION**



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 30, 2017	13	4	52
Current Inspection:	May 23, 2018	13	4	52
Road AADT:	1,160	Year:	2016	
Inspected By:	Don Proudfoot, Nicole Wilder (Thurber) Ed Szmata, Rocky Wang, Dwayne Lowen (AT)			
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> 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?
<input checked="" type="checkbox"/> 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 70mm 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.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Movement of the embankment fill has re-activated in recent years.	<input checked="" type="checkbox"/>
<input type="checkbox"/> Erosion		<input type="checkbox"/>
<input checked="" type="checkbox"/> 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.	<input checked="" type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>
Instrumentation June 21, 2018: Inclinometers SI17-2 = 2 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 = 36 mm/yr @ 5-7 m depth. Piezometers (All BGS): PN17-1A = 1.2 m; PN17-1B = 5.2 m; PN17-2A = 7.5 m; PN17-2B = 7.7 m; PN17-3A = 3.7 m; PN17-3B = 9.1 m; PN17-4A = 2.8 m; PN17-4B = 2.6 m, (4A/4B = 0.6 & 0.3 m decrease in W/L since fall 2017); PN17-5A = 10.1 m; PN17-5B = 12.1 m; PN17-6A = 1.6 m; PN17-6B = 9.8 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 23, 2018 and were found to be between 0.7 m to 3.6 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 June 2018) showed that SI 17-5 had sheared off at 7.3 m and SI 17-6 showed movement of 36 mm/yr (showed on attached section B-B'), while much slower rates of 1 to 2 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 June 2018. The high rates of movement in SI17-5 and SI17-6 coincide with the large crack observed in the pavement during the 2018 inspection date and indicate movements 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.

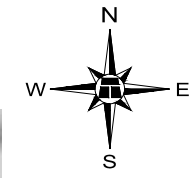
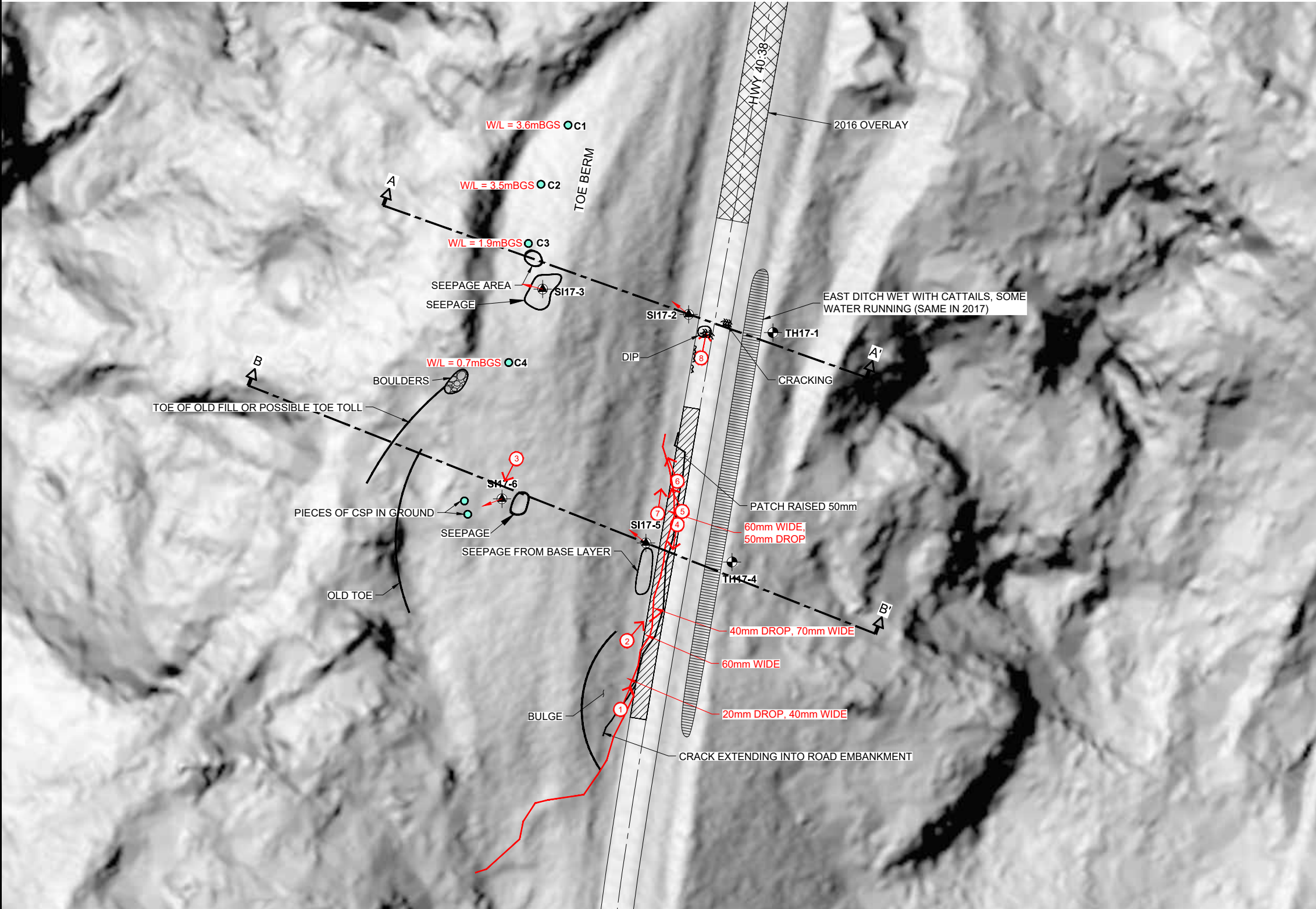
Short Term:

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. 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

Consideration could be given to installing a subdrain to further lower the water table in the east ditch and through the slide area. 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 will be further discussed in a preliminary engineering report that is being prepared by Thurber.

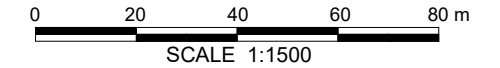


LEGEND

- 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 23, 2018 FEATURES SHOWN IN RED



LIDAR PROVIDED BY ALBERTA TRANSPORTATION



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

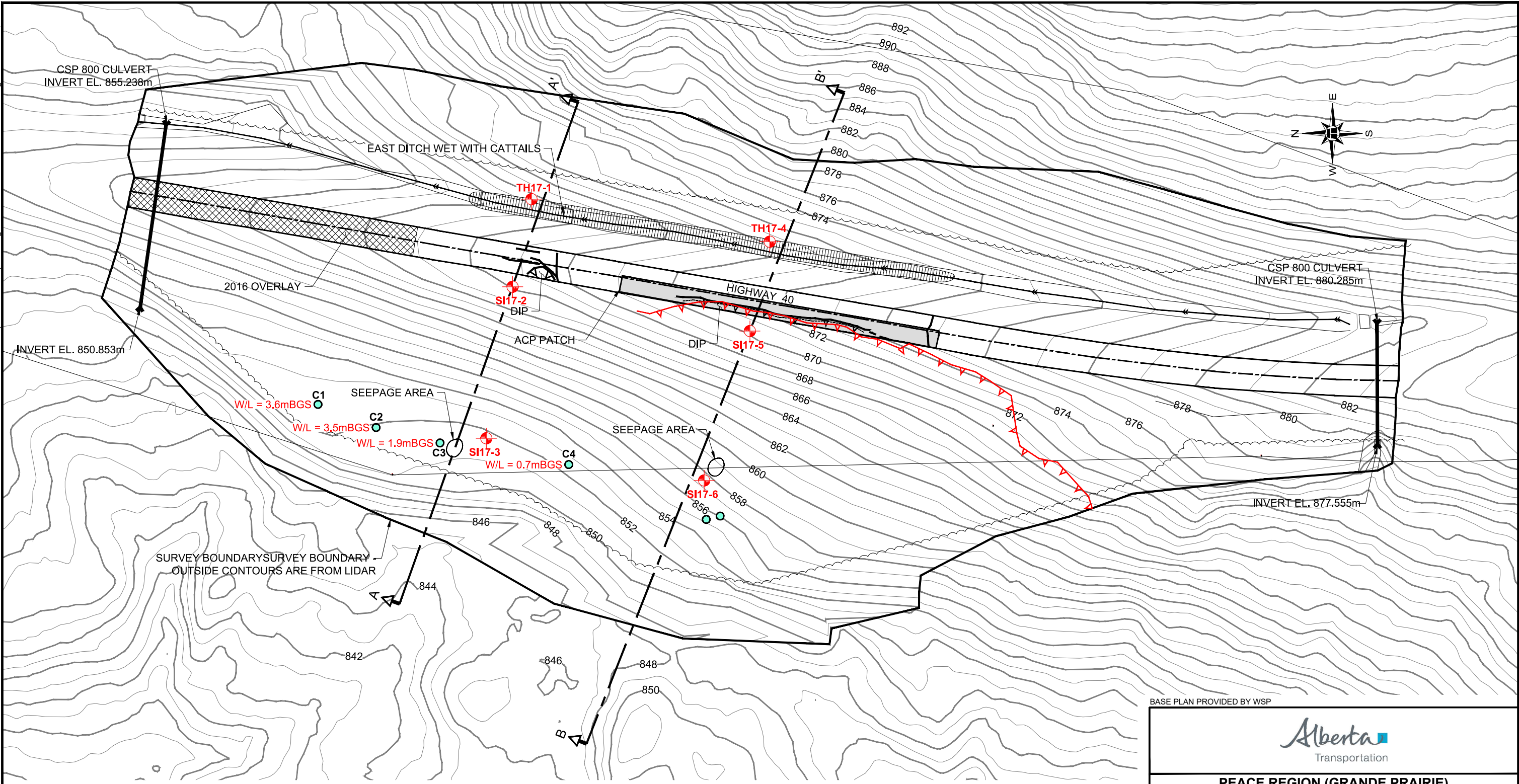
2018 INSPECTION PLAN

DWG No. 13353-GP34-1-1







DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1500
DATE	NOVEMBER 2018
FILE No.	13353



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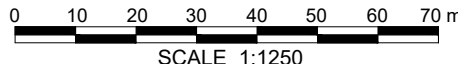


LEGEND

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

NOTES :

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3. MAY 23, 2018 FEATURES SHOWN IN RED



BASE PLAN PROVIDED BY WSP

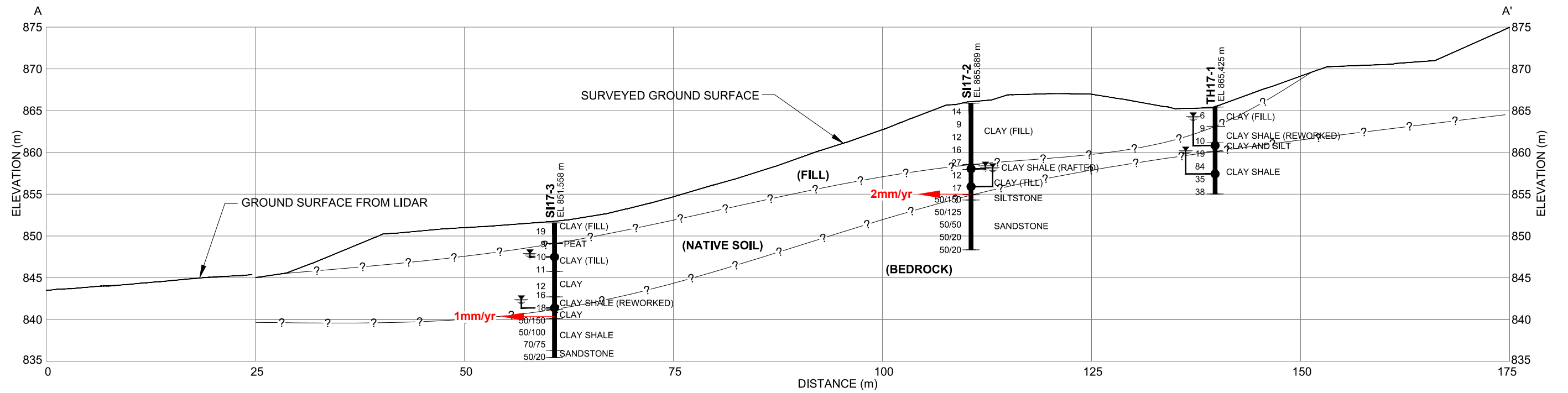



**PEACE REGION (GRANDE PRAIRIE)
GP34-1: HWY 40:38, 2.9km SOUTH OF
KAKWA RIVER BRIDGE
2018 INSPECTION PLAN**

DWG No. 13353-GP34-1-2

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1250
DATE	NOVEMBER 2018
FILE No.	13353




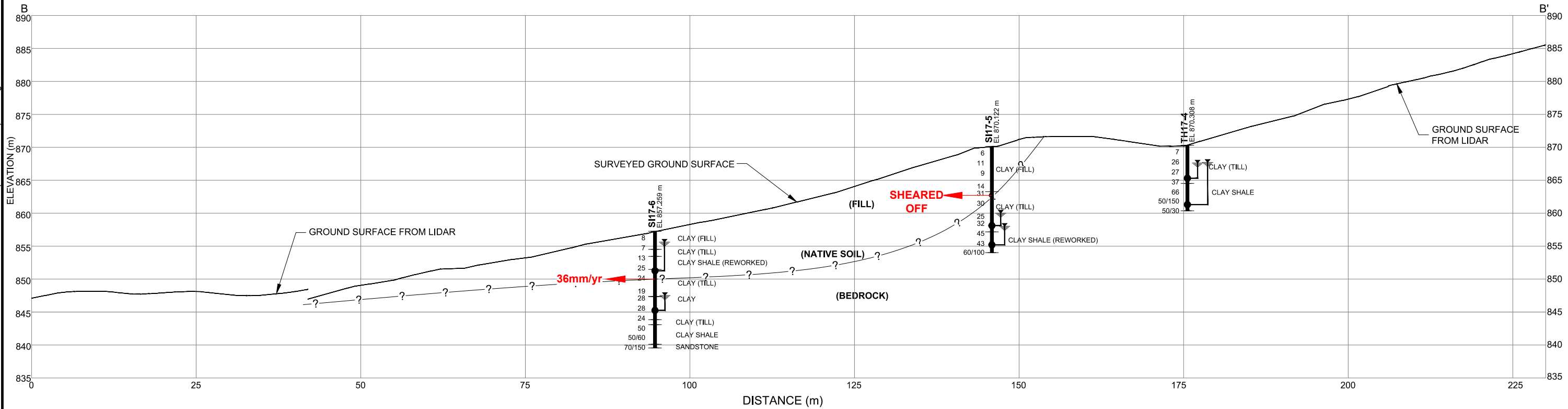



PEACE REGION (GRANDE PRAIRIE)
GP34-1: HWY 40:38, 2.9km SOUTH OF
KAKWA RIVER BRIDGE
CROSS-SECTION A - A'





DWG No. 13353-GP34-1-3

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:500
DATE	NOVEMBER 2018
FILE No.	13353


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LEGEND

-  SPT N VALUE
-  PNEUMATIC PIEZOMETER TIP
-  WATER LEVEL IN PNEUMATIC PIEZOMETER (JUNE 21, 2018)
-  MOVEMENT IN SLOPE INCLINOMETER (JUNE 21, 2018)

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.



**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 2018
FILE No.	13353



THURBER ENGINEERING LTD.



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.



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.



Photo 5.
Looking north at
the north end of the
scarp crack.

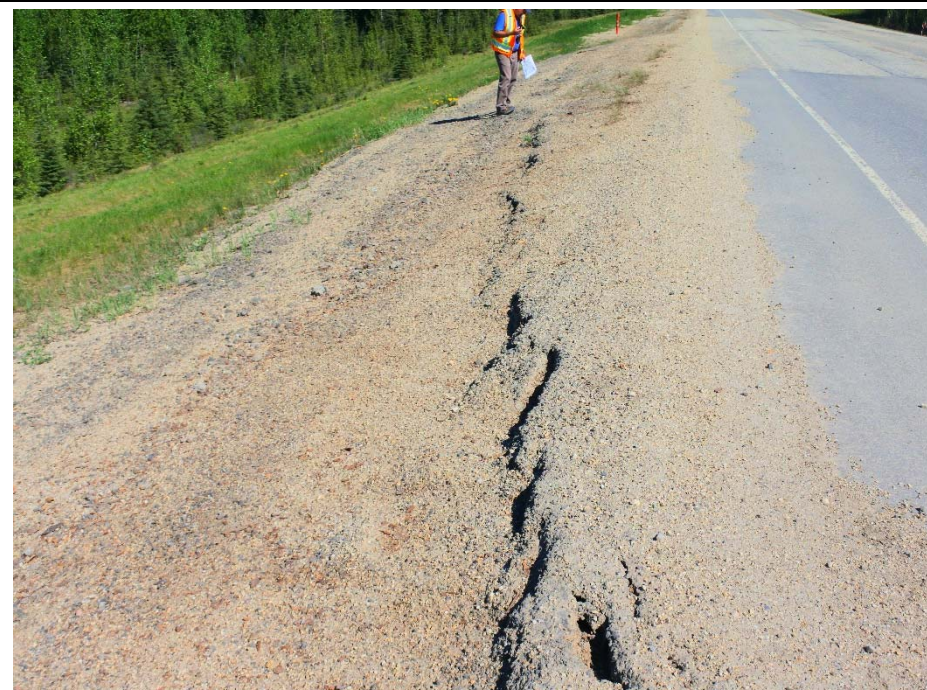


Photo 6.
Looking north at
where the scarp
crack extends off of
the shoulder and
into the
embankment.



Photo 7.
Looking north towards the north end of the scarp crack and patch, with SI17-2 in the background.



Photo 8.
Looking north at dip in the SBL.