GEOHAZARD ASSESSMENT PROGRAM

NORTH CENTRAL REGION – ATHABASCA

2020 INSPECTION

Site Number	Location	Name	Hwy	km
NC077-1	Approximately 25 km west of Slave lake and 15.5 km east from the junction of Highways 2 and 33	West of Canyon Creek	2:48	26
Legal Description		**UTM Co-ordinates (NAD 83)**		
SE-34-73-8-W5M		11 N 6136974 E 617878		

	Date	PF	CF	Total
Previous Inspection:	May 18, 2016	11	3	33
Current Inspection:	June 5, 2020	11	3	33
Road AADT:	2310		**Year:**	2019
Inspected By:	Tarek Abdelaziz, José Pineda (Thurber) Roger Skirrow, Arthur Kavulok, Gordon Wolters (TRANS)			
Report Attachments:	☑ Photographs ☑ Plans ☑ Maintenance Items			

Primary Site Issue:	A landslide affecting the highway north side slope; head scarp crack is located within the highway clear zone	
Dimensions:	About 30 m wide along the highway alignment and 33 m long along the slope direction.	
Site History	The landslide's head scarp was first noticed in the spring of 2012.	
Date of any remediation:	N/A	
Maintenance:	N/A	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	10–130 mm wide longitudinal cracks on highway surface; 2 m long x 200 mm wide x 100 mm deep pothole on the highway EBL	☑
☑ Slope Movement	0.3 m to 1.4 m drop across the landslide head scarp cracks; most southern head scarp crack is at 4 m from white line; drop across the western and eastern flank cracks by 0.8 m and 0.9 m, respectively; well-defined toe roll at the bottom of the slope; tilting and falling trees within the bottom of the slope	☑
☐ Erosion		☐
☑ Seepage	Ponding water within slide mass; seepage near the bottom of the slope; ponding water within the highway south ditch above landslide location	☑
☑ Bridge/Culvert Distress	Existing culvert located further east of the site has been noticed to be distorted and water flows from below the outlet of the pipe; accumulated sediments at the inlet of the culvert partially blocked surface water flow into the culvert	☐
☑ Other	A culvert was auger bored to the west of the site location in 2014 to enhance surface drainage in the south ditch	☐
Instrumentation: (none)		

Assessment (Refer to attached Figure)**:**

Further retrogression of landslide head scarp crack towards the highway, additional drops across landslide crack surfaces, and presence of a more distinct toe roll indicate that the landslide has been active since the 2016 inspection.

The existing cracks and pothole on the highway lanes may reflect poor/soft subgrade condition due to high ground water levels in this area, but do not appear to be landslide-related cracks.

The presence of seepage and wet surface conditions within the slide mass suggests that the landslide movement occurred in response to a rise in ground water conditions. Poor surface drainage in south ditch, as noted in previous years, could have aggravated the situation.

The absence of signs of pavement distress in the highway surface indicates that the highway condition has not yet been impacted by the landslide movement. However, accelerated landslide movements may occur in the future in response to further rise in groundwater levels (e.g. due to heavy rainfall events). Accelerated landslide movement could result in the head scarp retrogression into the highway driving surface and/or appearance of landside-related cracks in the highway driving lane(s) due to partial loss of lateral support from the moving mass.

The existing drop within the highway north side slope constitutes a potential hazard for runaway vehicles.

Recommendations:

In the short term, the local MCI should watch closely for any cracking on the highway surface and periodically measure the distance between the landslide head scarp crack and the edge of the highway (at least twice a year between the spring and fall seasons). The existing pothole should be filled with ACP and open cracks on the highway surface should be sealed to prevent surface water infiltration into the landslide mass, which would result in further landslide movement and retrogression into the highway surface. A sharp shoulder warning sign should be placed to warn motorists of the present hazard. Consideration should also be given to install a guard rail along the edge of the highway to protect runaway vehicles.

The south ditch should be slightly re-graded in the short term to drain the surface water into the existing culvert, located to the east of the site. The area surrounding the inlet of the culvert should also be cleaned of sediments to enhance surface water flow into the culvert. Consideration should also be given to digging narrow shallow trenches (perpendicular to the highway alignment and not exceeding 0.5 m wide x 0.5 m deep) within the landslide mass using a long reach excavator to drain ponded water and promote drainage within the slide area.

An intermediate-term repair option might include reinforcing the side slope area above existing headscarp. In this option, 6 m long soil nails installed in 1x1 m^2 grid pattern should reduce the risk/rate of headscarp retrogression into the highway shoulder and lanes. The ballpark cost of this option would be in the range of $100,000. The estimated cost might become lower if the mobilization of the equipment could be shared with other sites.

The following options may be considered in the long-term to remediate the landslide.

1. Excavate and replace the landslide mass with gravel: In this option, sub-drains should be included within the gravel replacement zone to prevent future rise in ground water levels. This option will require negotiations with utility companies and land acquisition. The ballpark cost of this option would be in the range of $650,000.

2. Construct an earth-fill toe berm to buttress the landslide mass: In this option, it will be required to locate a borrow source and construct a riprap-lined swale to divert the drainage gully around the edges of the toe berm. This option will also require negotiations with utility companies and land acquisition. The ballpark cost of this option would be in the range of $450,000.

Prior to the design and implementation of the preferred remedial measure, it is recommended to drill test holes within the landslide mass, complete with piezometers, to determine soil and groundwater conditions.

S

BURNT SPRUCE

WET DITCH

℄ HWY 2:48

WHITE LINE

NEW SCARP (300mm DEEP)

HEAD SCARP

WET LOW AREA (2012)
GROUND SURFACE PROFILE (2012)

APROXIMATE GROUND SURFACE PROFILE (2013)

WET IN 2020

WELL DEFINED TOE ROLL (2020)

TILTING TREES

DRAINAGE GULLY

BURNT FOREST

N

4.6m
4.0m
1.4m
21m
9m
~8m
1.6m
0.9m (2015)
0.8m (2014)
0.7m (2013)
0.3m (2012, 2020)
3.2m
1.4m
5 - 6m
~0.6m
? 3m

GRABEN COUNTER SCARP
CRACK - 100mm DROP

INFERRED SLIP SURFACE

TOE ROLL
MORE DISTINCT (2014)

APPROX. GROUND SURFACE PROFILE (2015, 2016)

CROSS SECTION A -A'
APPROX. SCALE: 1:500

NEW CULVERT AUGER BORED IN 2014

CRACK 50mm WIDE, NO DROP
50-70mm WIDE, NO DROP
60-80mm WIDE, NO DROP (2016)
50 - 130mm WIDE, NO DROP (2020)

CRACK 15-25mm, NO DROP
SAME IN 2015
25-50mm WIDE, NO DROP (2016)

POTHOLE
0.7m LONG X 0.13m WIDE X 0.05m DEEP (2016)
2m LONG X 0.2m WIDE X 0.1m DEEP (2020)

WATER PONDING IN DITCH (2015)
DRY (2016)
PONDING WATER (2020)

BURNT SPRUCE

WET DITCH

CRACK 10mm WIDE (2016)
10 - 60mm WIDE, NO DROP (2020)
50 - 100mm WIDE, NO DROP (2020)

SHOULDER LINE
EDGE OF PAVEMENT

300mm DROP (2012)
700mm DROP, SLIGHT RETROGRESSION (2013)
800mm DROP, SLIGHT RETROGRESSION (2014)
900mm DROP, RETROGRESSED MORE (2015)
900mm DROP, NO RETROGRESSION (2016)
1.4m DROP, RETROGRESSED MORE IN 2020

KNOLL

400mm DROP (2013), 600mm DROP (2014)
700mm DROP, 240mm WIDE (2015)
SAME IN 2016
900mm DROP, 500mm WIDE (2020)

GRABEN COUNTER SCARP
CRACK (100mm DROP)

FENCE LINE (DISTORTED)

PONDING WATER (2020)

5mm WIDE CRACK, NO DROP
SAME IN 2016

130mm WIDE, 300mm DROP (2020)

APPROXIMATE LIMITS OF LANDSLIDE

SEEPAGE/ WET LOW AREA (2012)
SAME IN 2013
DRIER IN 2014
WET (2015)
WET (2016)

MORE DISTINCT
- 300mm DROP (2015)
SAME IN 2016
0.8m DROP (2020)

TOE ROLL AND TILTING/FALLING TREES
BECAME MORE DISTINCT IN 2014
MOVED MORE (2015)
MORE DISTINCT (2020)

DRAINAGE GULLY

BURNT FOREST

WATER FLOWS SLOWLY INTO CULVERT (2014)
SAME IN 2015

WATER PONDING AT INLET OF CULVERT
SAME IN 2014
SAME IN 2015

~4H : 1V
(APPROX.)

TO SLAVE LAKE

900mm DIAMETER CSP CULVERT

DISTORTED/SEPERATED OUTLET - WATER FLOWING FROM BELOW CULVERT OUTLET
SAME IN 2014
SAME IN 2015

0 5 10 15 20 25 30m
APPROX. SCALE 1:500

NOTES:

1. THE DIMENSIONS SHOWN ON THE SITE PLAN AND CROSS SECTION ARE BASED ON SIMPLE FIELD MEASUREMENTS AND MAY DEVIATE FROM THE ACTUAL CONDITIONS.
2. JUNE 5, 2020 OBSERVATIONS ARE SHOWN IN RED.

LEGEND

- ACTIVE SCARP
- WET/LOW AREA
- FENCE LINE
- TREE LINE
- OVER HEAD POWER LINE
- TELUS LINE
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION
- POWER POLE

NORTH CENTRAL REGION (ATHABASCA AREA)
- 2020 GEOHAZARD ASSESSMENT

NC077-1: HWY 2:48 (km 26)
WEST OF CANYON CREEK LANDSLIDE
SKETCH SITE PLAN & CROSS SECTION A-A'

DWG NO. NC077-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	APPROX. 1:500
DATE	AUGUST 2020
FILE No.	13357

THURBER ENGINEERING LTD.

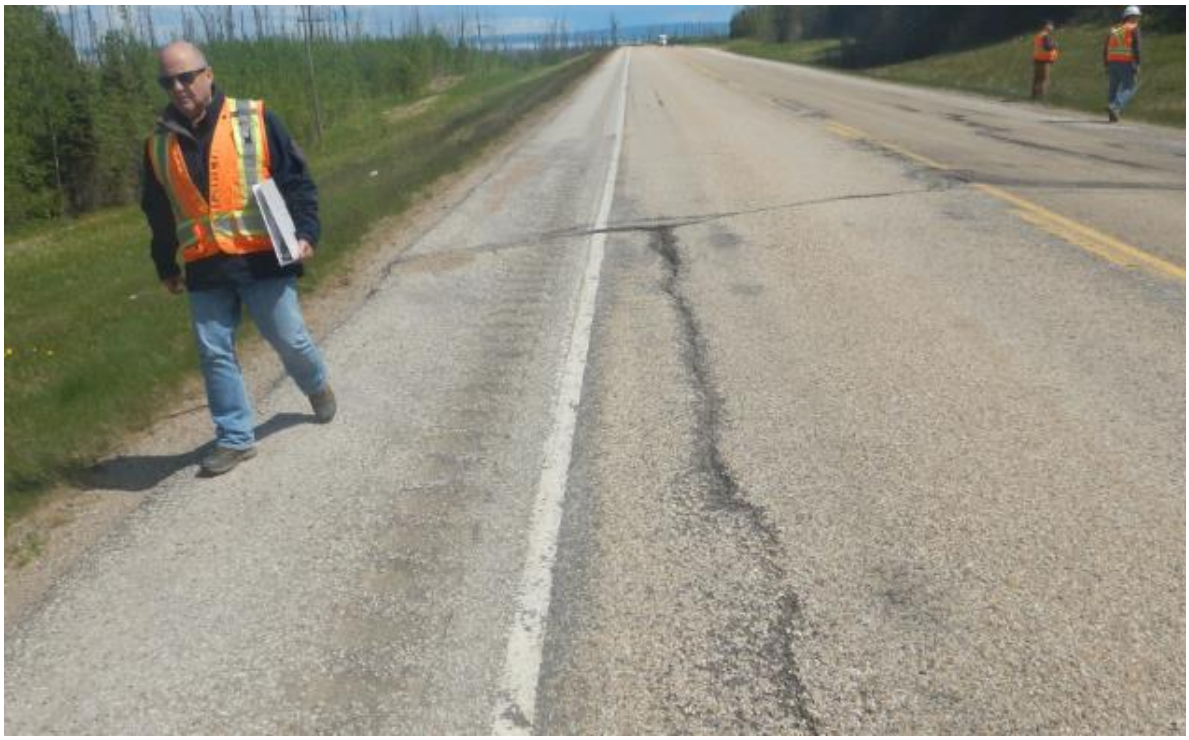

Photo No.1 – Looking east at a longitudinal crack on the highway WBL to the east of the landslide location

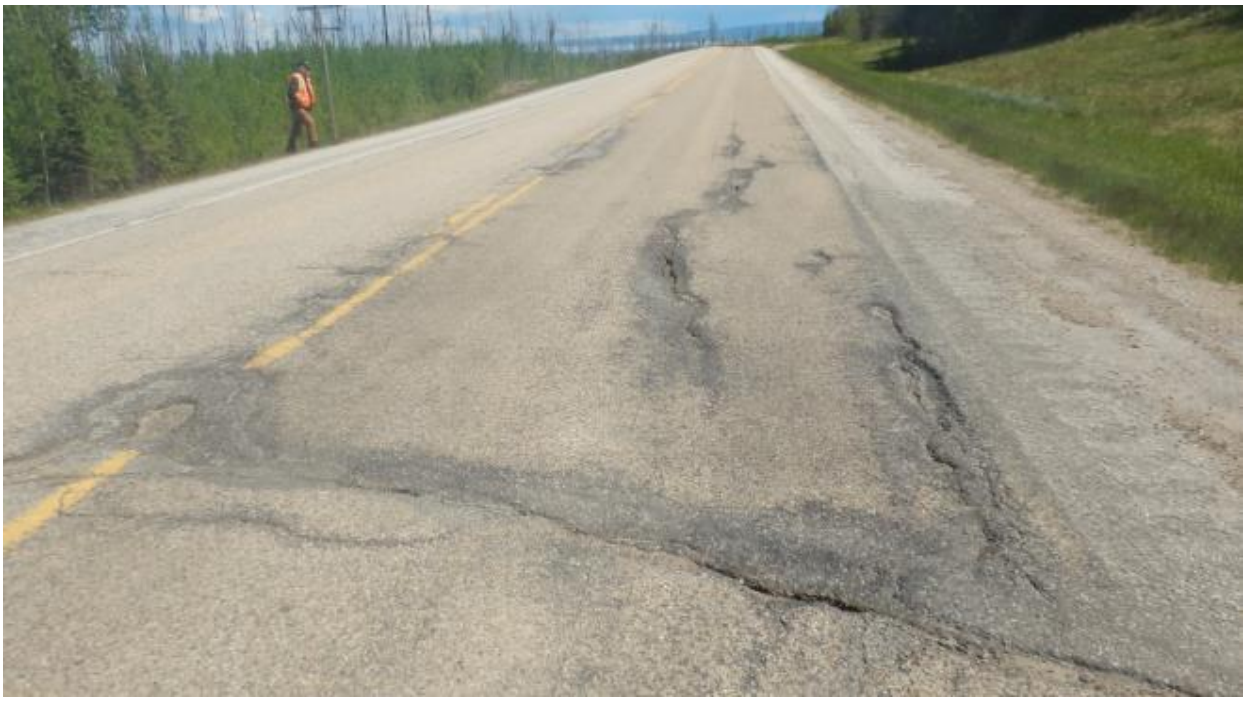

Photo No.2 – Looking east at transverse and longitudinal cracks on the highway surface at the landslide location; wide open cracks are more pronounced within the highway EBL

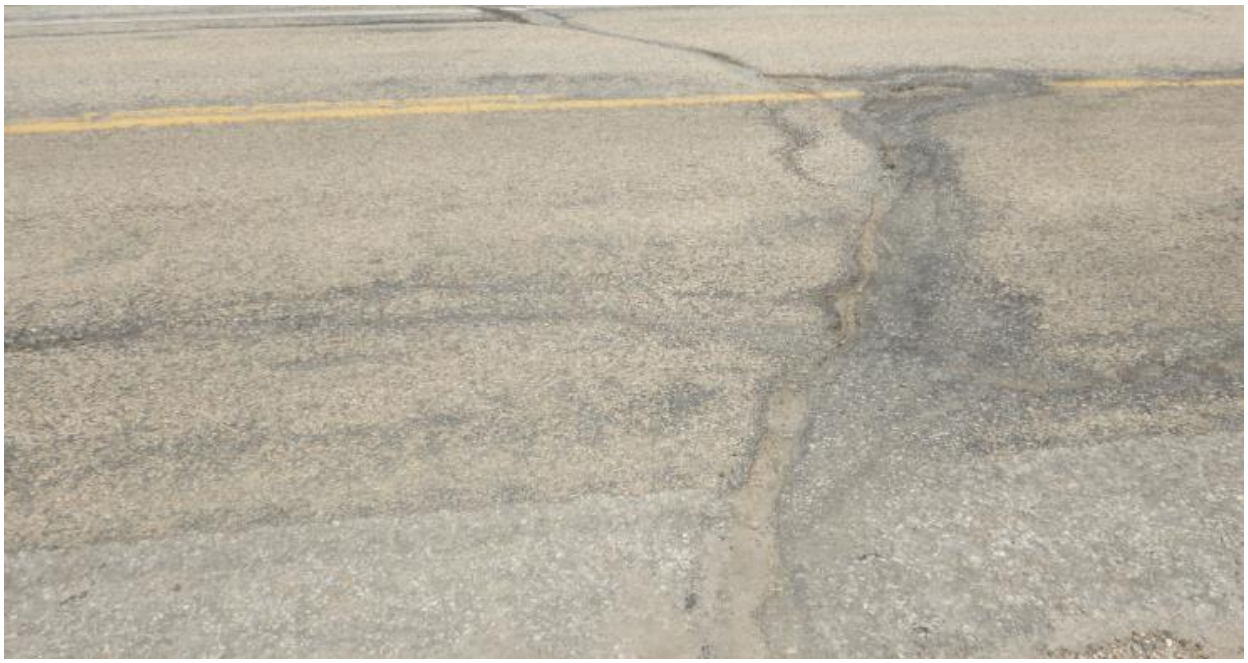

Photo No.3 – Looking north at a 50 to 130 mm wide transverse crack on the highway surface to the east of the landslide location

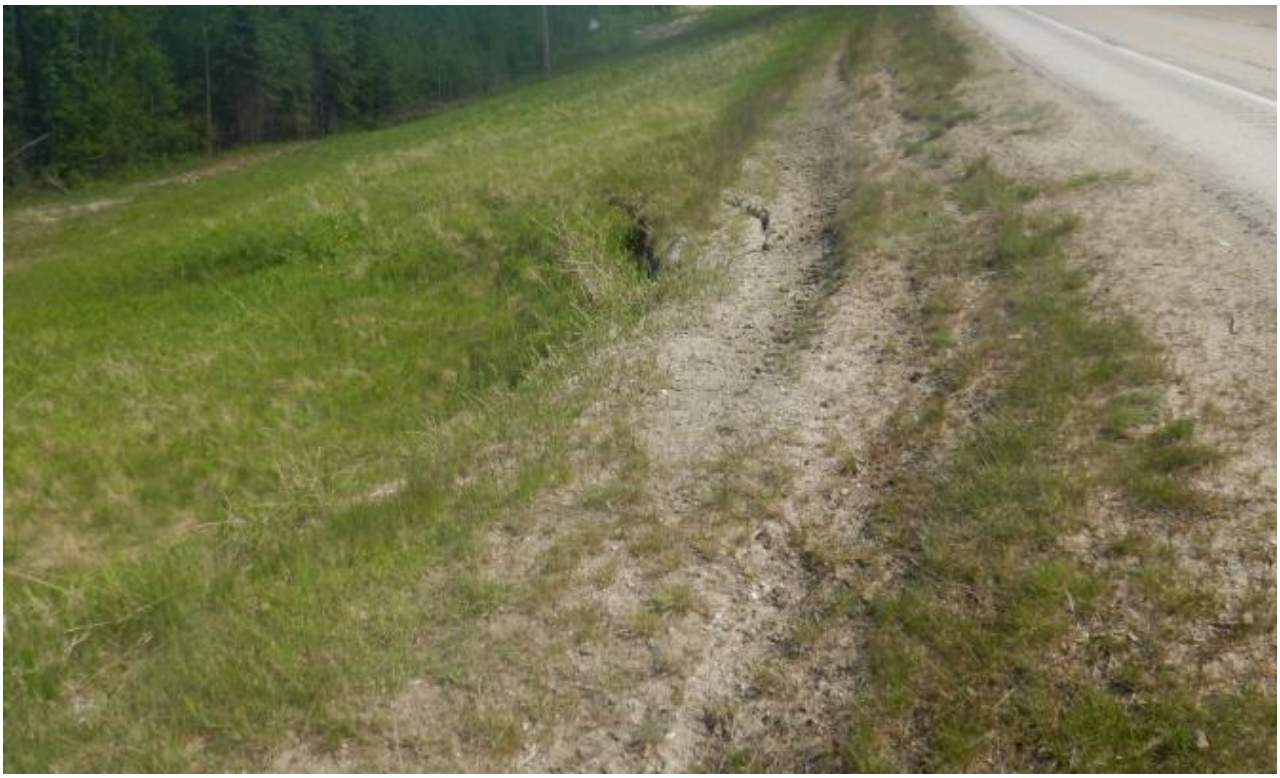

Photo No.4 – Looking east at the landslide developed on the highway side slope; note the retrogression of the landslide head scarp crack towards the highway

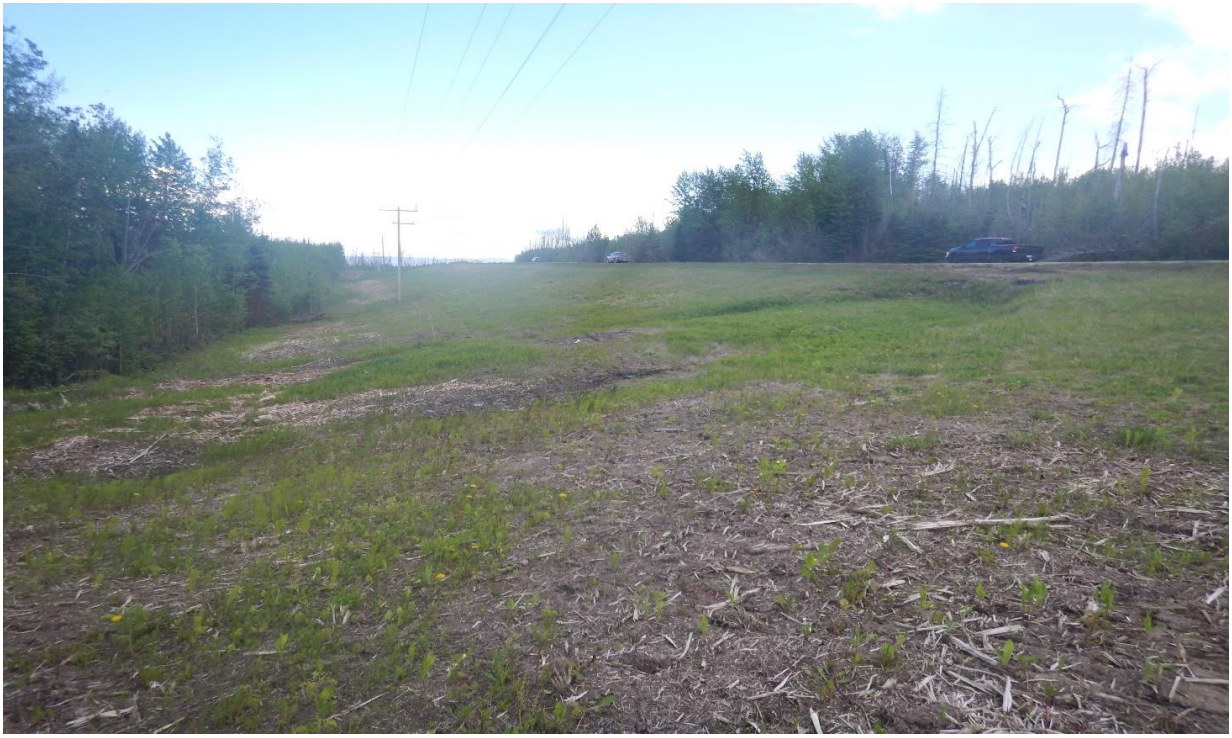

Photo No.5 – Looking east at the landslide mass and a distinct toe roll at the bottom of the slope

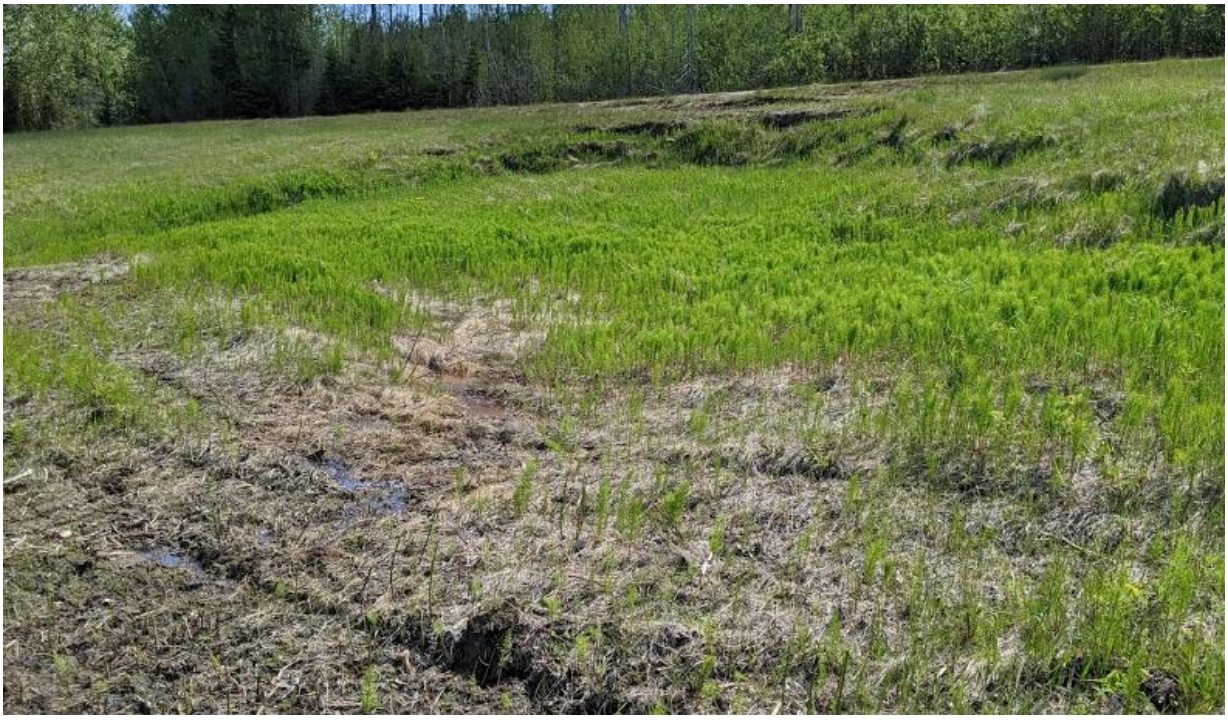

Photo No.6 – Looking southeast at the landslide head scarp crack and east flank

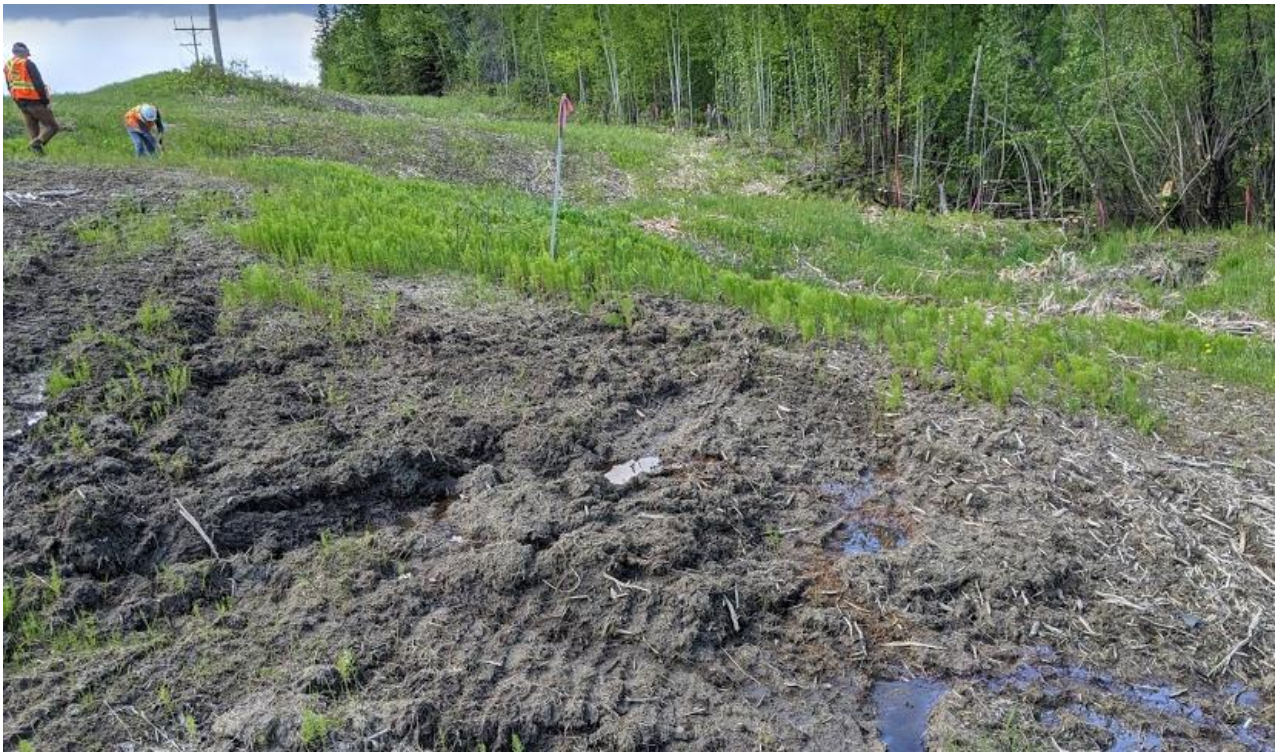

Photo No.7 – Looking north at the landslide toe roll; note the presence of seepage and Telus pedestal near the bottom of the slope