GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA
2020 INSPECTION REPORT

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC089	On the backslope of Hwy 63 to the south of King Street Interchange in Fort McMurray	**Beacon Hill Backslope Slide**	63:11	8.7
Legal Description		**UTM Co-ordinates (NAD 83)**		
SW-10-89-09-W4M		12 N 6284132.65 E 478495.60		

	Date	PF	CF	Total
Previous Inspection:	June 11, 2019	14	3	42
Current Inspection:	June 25, 2020	11	3	33
Road AADT:	31,740		**Year:**	2019
Inspected By:	Tarek Abdelaziz, José Pineda (Thurber) Roger Skirrow, Arthur Kavoluk (TRANS)			
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items			

Primary Site Issue	An active landslide toeing out immediately above the highway west ditch but not currently impacting the highway (2016 lower landslide block)	
Dimensions:	About 75 m wide along the highway alignment and 55 m long perpendicular to the highway alignment (southern half of a 140 m wide ancient lower landside block)	
Site History:	Beacon hill has experienced extensive landslide activities in ancient times. Multiple dormant landslide blocks are visible in the slopes above the highway alignment. Landslide movements occurred within the hill above Hwy 63 at other locations in the past. The backslope repairs consisted mainly of slope regrading and drainage improvement. The northern half of the active landslide is the vicinity of the southern flank of a repaired landslide. This landslide was first noted in the fall of 2016 after the August 2016 callout inspection of the ditch erosion. The landslide grew bigger in size between 2016 and 2017. Geotechnical instruments were installed during the winter of 2018.	
Observations:	**Description**	**Worse?**
☑ Slope Movement	2016 landslide block: 1.75 m deep and 2.0 m wide exposed head scarp crack; tilting trees; distinct toe roll (0.6 m high) located 9.5 m away from the edge of the highway	☐
☑ Seepage	Standing water and seepage areas within landslide mass increased in size	☑
☑ Other	Vegetation grew within the landslide mass; sink hole (1.3 m long x 0.8 m wide x 0.6 m deep) developed approximately 20 m north of the landslide toe; severe erosion developed at the inlet of the C6 pipe	☐

Instrumentation: (5SIs, 12PNs)

Since the fall of 2019, the rate of movement in SI17-2, SI17-3, and SI17-4 (located within the 2016 landslide block) ranged from 0.1 mm/year to 10.9 mm/year. SI17-5 located within the northern half of the lower ancient landslide block (i.e. located to the north of the 2016 active block) showed no discernable movement. SI17-7, located in the upper landslide block, also showed no discernable movement.

The rate of movement increased in SI17-2 and SI17-3 by 1.3 mm/year and 8.8 mm/year, respectively. The rate of movement decreased in SI17-4 by 0.3 mm/yr.

Most of the piezometers showed no change or an increase in groundwater levels of up to 1.35 m. PN17-3B and PN17-6B, however, showed decreases in groundwater levels of 0.18 m and 0.1 m, respectively, compared to the fall of 2019 readings.

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

The 2016 lower landslide block (i.e. southern half of the ancient landslide block), toeing above the highway ditch, is about 7 m deep, 75 m wide, 55 long and extends midway up the hill side. The landslide is visible on recent and previous LiDAR images and constitutes the southern portion an ancient landslide block, which is about 140 m wide (parallel to the highway).

It appears that the ancient landslide block was re-activated in response to elevated groundwater levels. It is likely that the lack of vegetation, due to the 2016 forest fire, resulted in an increase in surface water runoff and elevated groundwater infiltration rates into the slope surface. The situation appears to have been aggravated at this location due to the presence of an existing gully that directs surface water into the landslide block.

The site observations and instrumentation readings indicate that the 2016 landslide block is still moving but at relatively slow rates. Although signs of slope movement have not yet been detected within the northern half of the ancient block, abrupt movement may take place as previously occurred within the southern half of the block.

Although the 2016 landslide does not currently appear to affect the highway ditch, landslide debris may quickly spill over the existing shallow ditch and possibly spread over the highway shoulder/lanes in response to an accelerated movement. Similar risk should be expected if the northern half of the ancient landslide block fails in the future.

The ditch erosion will need to be addressed to reduce the risk of local instability which could trigger accelerated movement of the landslide block.

It is possible that the sinkhole developed 20 m north of the landslide toe is the result of the C6 culvert rupture or separation.

The Probability Factor (PF) at this site has been decreased from 14 to 11 since the instrumentation monitoring results indicates that the landslide is relatively active with moderate but increasing rate of movement.

Recommendations:

In the short term, the landslide should be regularly monitored, and the ditch bottom should be touched to be cleared of the landslide debris as needed (without significantly changing grades) to improve surface water drainage. Excavated landslide debris (if any) from the highway ditch should be pushed back into the toe of the slope.

The severe erosion noted at the C6 culvert inlet location should be repaired as part of the ditch maintenance work to prevent further loss of support at the toe of the landslide. In addition, the sinkhole noted about 20 north of the landslide should be filled with gravel. If the sinkhole develops again, consideration should be given to undertaking a CCTV inspection of the C6 culvert to confirm whether it is separated/ruptured.

An intermediate remedial measure, consisting of the construction of a riprap-lined channel to drain the standing water within the landslide mass to the highway ditch, has been designed as part of the highway ditch drainage improvement work. This measure aims to reduce groundwater levels within the landslide mass and hence landslide movement rates.

The long-term remedial option to retain the southern half of the lower landslide block would include the installation of a 100 m long concrete cast-in place pile wall along the west side of the highway (between the existing tree line and the ditch) to retain the landslide. The location of the pile wall will need to consider existing highway widening plans (if any). The ballpark cost of this option would be in the range of $3.5 Million (excluding Engineering). If it is required to extend the wall to retain the entire lower landslide block, the cost would be in the range of $6.5 Million (excluding engineering).

The decision to when to implement the long-term remedial option should consider the impact of landslide movement on the proposed ditch improvement work. It is ideal, subject to financial constraints, to implement the landslide and the ditch improvement remedial projects concurrently to avoid throwaway costs. This would be the case if the ditch repairs fail in response to a sudden landslide movement.

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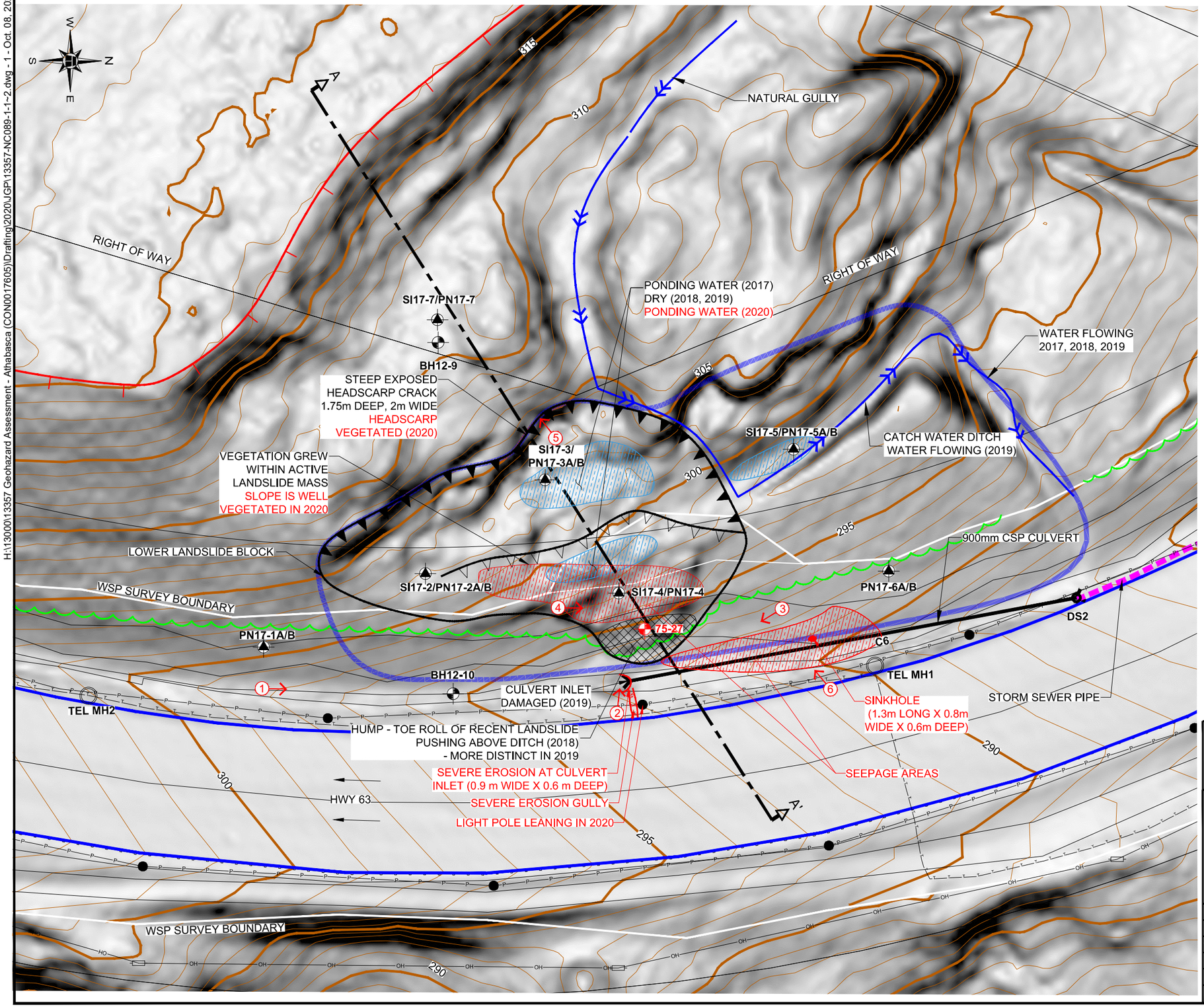

LEGEND

- APPROXIMATE LOCATION OF SLOPE INCLINOMETER (SI) / PNEUMATIC PIEZOMETER (PN)
- APPROXIMATE LOCATION OF PREVIOUS TEST HOLE
- HEADSCARP CRACK
- TENSION CRACK
- APPROXIMATE BOUNDARY OF LOWER ANCIENT LANDSLIDE BLOCK (LIDAR)
- APPROXIMATE BOUNDARY OF RECENT ACTIVE LANDSLIDE (SOUTHERN HALF OF ANCIENT BLOCK)
- APPROXIMATE VALLEY CREST
- TREE LINE
- GUARDRAIL
- OVERHEAD POWER LINE
- UNDERGROUND POWER LINE
- UNDERGROUND TELUS CABLE
- LIGHT STAND
- TELUS MANHOLE
- POWER POLE
- DROP STRUCTURE (DS#)
- STANDING WATER
- WATER FLOW
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTES:

1. LIMITED SURVEY IN THE VICINITY OF THE HIGHWAY WAS CONDUCTED ON AUGUST 30, 2017 BY WSP.
2. BACKSLOPE CONTOURS ARE BASED ON 20016 LIDAR DATA.
3. JUNE 25, 2020 OBSERVATIONS ARE SHOWN IN RED.
4. GRADING WORK TO INSTALL THE INSTRUMENT IN THE WINTER OF 2018 MASKED LANDSLIDE FEATURES.

0 10 20 30 40 50m

SCALE 1:800

Alberta

2020 GEOHAZARD ASSESSMENT
NORTH CENTRAL REGION (ATHABASCA AREA)

NC089-1: HWY 63:11 BEACON HILL BACKSLOPE SLIDE (km 8.7) SITE INSPECTION PLAN

DWG No. 13357-NC089-1-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:800
DATE	AUGUST 2020
FILE No.	13357

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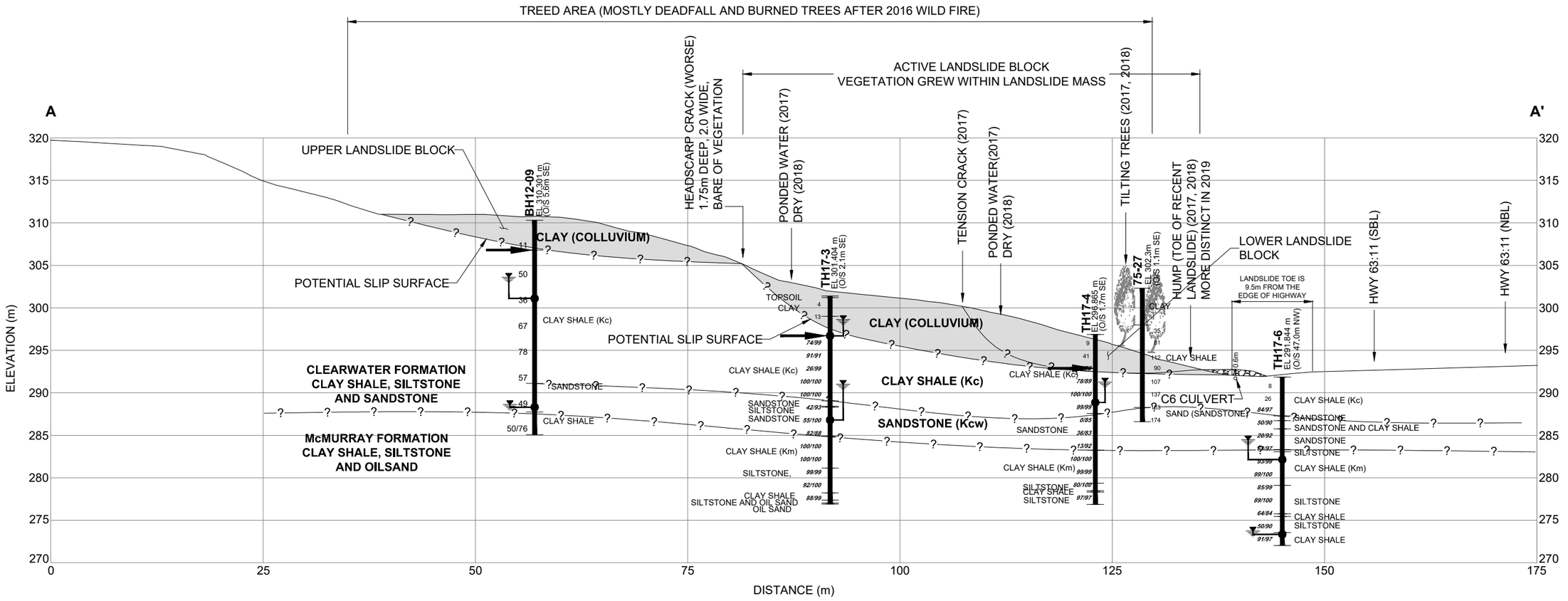

LEGEND

- 13/38 — RQD / RECOVERY %
- 15 — SPT N VALUE
- WATER LEVEL IN PIEZOMETER (OCTOBER 18, 2017 AND FEBRUARY 21, 2018)
- PNEUMATIC PIEZOMETER TIP
- POTENTIAL ZONE OF MOVEMENT IN SLOPE INCLINOMETER

NOTE:

1. CROSS-SECTION A-A' IS BASED ON THE 2016 LIDAR DATA.
2. JUNE 25, 2020 OBSERVATIONS ARE SHOWN IN RED.

Alberta

2020 GEOHAZARD ASSESSMENT
NORTH CENTRAL REGION (ATHABASCA AREA)

NC089-1: HWY 63:11 BEACON HILL BACKSLOPE SLIDE (km 8.7)
CROSS - SECTION A - A'

DWG No. 13357-NC089-1-2

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

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Photo No.1 – Looking north at the toe of the landslide; the landslide is toeing out above the ditch near culvert C6

Photo No.2 – Erosion gully downslope of the toe of the landslide at culvert inlet location (Looking West)

Photo No.2a – Severe erosion gully on the highway side slope to the east of the culvert inlet location (Looking east)

Photo No.3 –Looking south at the toe of the landslide; note tilting trees within the landslide mass

Photo No.4 –Looking north at SI17-4; landslide mass is well vegetated

Photo No.5 – Looking west at 1.75 m deep and 2 m wide vegetated backscarp crack

Photo No.6 –Sinkhole (1.3 m long x 0.8 m wide x 0.6 m deep) developed at the base of the backslope