ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA
2018 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC90-1	17 Km NW of Athabasca	**Baptiste Creek Bridge NW Approach Fill Landslide**	02:42	17.94
Legal Description		**UTM Co-ordinates (NAD 83)**		
SW-6-67-23-W4M		12 6071799 E 338303		

	Date	PF	CF	Total
Previous Inspection:	November 8, 2017	12	6	72
Current Inspection	May 7, 2018	13	6	78
Road AADT:	1,650		**Year:**	2017
Inspected By:	Ron Hilligas, Arthur Kavulok, and Rocky Wang (AT) Tarek Abdelaziz and José Pineda (TEL)			
Report Attachments:	☑ Photographs	☐ Plans	☑ Maintenance Items	

Primary Site Issue	Landslide within the NW approach fill of Bridge File (BF) 7055, impacting highway, NW wing wall, abutment supports, and the capacity of the creek channel
Dimensions:	The slide is approximately 30 m long and 40 m wide
Site History / Available Information:	The existing bridge structure was constructed in 2008 under AT Contract No. 7681/08 to replace a six span bridge structure that was constructed in the 1970s. The new structure consists of a 47 m single span steel girder bridge with integral abutments. The construction of the new bridge required the construction of a temporary detour on the west side of the old bridge as well as a temporary bridge structure. The old bridge was supported on seven rows of piles. The tips of the old bridge piles were founded at an approximate elevation of 577 m. The piles of the old bridge were cut off and left in place as per the as-built drawings. In addition, the creek was realigned/shaped as part of the 2008 contract. The approach fill head slope is inclined at 2H:1V and 3H:1V on the north and south side of the Baptiste Creek, respectively. The side slopes of the approach fill are approximately 3H:1V on both sides of the creek. Approximately 6 m of fill was placed on the west side of the bridge to the north of the creek alignment to accommodate the construction of the new bridge. A geotechnical investigation was conducted in the 1970s for the design of the old bridge. The available records show that the soil at the landslide area (Test hole # 5) consist of low to high plastic sandy clay (possible fill to elevation 592 m) underlain by grey high plastic clay to elevation 572 m overlying coarse sand. Records indicate that an instability occurred within the south head slope during the construction of the old bridge in the 70s. The repair consisted of flattening the head slope from 2H:1V to 3H:1V, resulting in an increase of the bridge span by about 10 m. In 1979, an instability occurred to the east of the north abutment outside the bridge location. The repair consisted of slope flattening along with the construction of a toe buttress and finger drains.

	In September 2017, AT noticed a lateral movement of the NW side slopes. A void formed adjacent to the taper of the existing trough drain and below the NW corner of the abutment seat. Between October 16 and 20, 2017, eleven cubic meters of Class C concrete was used to fill voids formed behind the trough drain taper and below abutment seat. A concrete block was also constructed by the face of the abutment seat to fill the gap formed below the abutment seat. However, major slope movement occurred abruptly on October 23, 2017. The sudden movement resulted in the formation of a gap below the wing wall and the abutment seat, and the failure of the trough drain. A callout inspection was completed at this site in November 2017 and geotechnical instruments, consisting of three slope inclinometers complete with nested vibrating wire piezometers, were installed in late January 2018.	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	10 to 20 mm dip on the highway surface, mainly at the transition between the paved surface and the sleeper beam; landslide eastern flank is about 1.5 m from the back side of the wing wall (i.e. the flank extends under the highway shoulder).	☑
☑ Slope Movement	Up to 2 m differential height across the head scarp crack along trough drain location; overhanging taper of the trough drain, eastern flank of the landslide extended below and behind the wing wall and exposed two of the abutment pile casings at the existing bridge abutment location; distinct toe roll approximately 40 m long along the creek channel; landslide exposed two of the old bridge pier piles below the existing bridge; one of the old bridge pier piles rotated, possibility due to the landslide movement; western flank of the landslide took out part of existing fence; concrete block formed to fill the gap below abutment seat moved laterally towards creek by about 0.7 m; a 400 mm gap existed between the underside of the abutment and the top of the 600 mm deep concrete block formed to fill the gap below the abutment; toe roll pushed about 2 m into the creek.	☑
☑ Erosion	The creek continued to erode the toe of the landslide	☑
☑ Seepage	Seepage along exposed scarp crack surfaces	☐
☑ Bridge/Culvert Distress	200 to 500 mm gap developed below the wing wall; cast-in-place concrete abutment seat tilted by about 2 degrees; two of the abutment pile casings are exposed; the back of casing pushed against the piles	☐
☑ Other	The landslide took out the trough drain	☐

Active Instrumentation (3SIs, 5VWs, 1SP):

The Spring 2018 readings indicate that slope inclinometers SI18-1, SI18-2, and SI18-3 have sheared off at depths of 5.2 m, 5.3 m, and 4.8 m, respectively, below ground surface. The current groundwater levels were measured at a depth ranging from 4 m to 8 m below ground surface.

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

Based on existing information and LIDAR data, it appears that there is a history of slope instability near the bridge location. The placement of relatively steeply inclined fill (i.e. transitioning from 2H:1V at the head slope to 3H:1V at the trough drain original location) as well as the presence of weak high plastic clay are likely the main triggering factors for the landslide movement.

The landslide is actively moving, and the high rate of movement is due to the continued erosion action by the creek channel of the toe of the landslide and possibly uncontrolled surface water discharge from the highway into the 2 m deep head scarp crack due to the failure of the trough drain.

The dip in the highway surface above the wing wall location does not appear to be related to the ongoing movement. The dip occurred in the paved surface near the sleeper beam location. The dip may have occurred due to the differential settlement between the soils within and outside the footprint of the approach slab.

It appears that the landslide has pushed against the casings of the exposed piles. Hence, the piles are overstressed and are not as flexible as designed to accommodate seasonal thermal movements of the superstructure. The restricted movement of the exposed piles may result in intolerable stresses in the concrete abutment during seasonal movements.

It is anticipated that the landslide will continue to move until it flattens itself to reach an equilibrium. Future erosion action at the toe of the landslide and/or surface water infiltration into the landslide mass may result in further movements. A deep void may form below the wing wall in response to the subsidence in ground surface along the wall face. The gap will result in additional soil loss from below the highway surface and possibly the retrogression of the eastern flank towards the highway lanes. The movement could impose additional stresses on the exposed piles/abutment and/or expose additional pile supports.

The landslide poses a significant risk to the highway and the bridge. If the roadway/bridge fail at this location in response to accelerated landslide movement, a major detour will be required.

Recommendations:

In the short term, the local MCI should monitor the highway periodically for signs of distress and watch closely for the development of any additional voids near the overhanging taper of the trough drain or behind the wing wall. Consideration should be given to diverting the surface water from the bridge away from the overhanging taper of the trough drain. Sand bags or a temporary asphalt curb may be used to divert the flow away from the landslide area. Gravel or fillcrete may be used, as needed, to fill the voids below the wingwall and the abutment. Consideration should also be given for slightly grading the steep main head scarp to get it flattened. Excavated wedge from the head scarp area should be used to fill existing open cracks to reduce the amount of surface water infiltrating the landslide mass.

Based on the visual observations, instrumentation monitoring results, and discussions with AT, it is envisioned that the long-term repair methodology will be achieved through the construction of a retaining structure along with offloading the slope to maintain the stability of the bridge and stabilize the landslide mass. Since the landslide is pushing against the creek, the creek bed and banks will likely need to be armored to reduce the erosion forces and maintain the passive resistance downslope of the wall location. To avoid digging the roadway, fillcrete or cellular concrete may be utilized to fill in the gap formed behind the wing wall and the abutment seat. The casings surrounding the exterior piles will also need to be jacked to restore the flexibility of the piles.

It is anticipated that the cost of the repairs will be in the range of 2.5 to 3 million dollars.

Due to the implications of a major failure due to ongoing landslide movement, it is recommended to repair this site as soon as possible.

FENCE DAMAGED BY LANDSLIDE
SAME IN 2018

200mm WIDE, 400mm DROP

NW DRAIN TROUGH END TERMINAL

TOE ROLL PUSHED ABOUT 2m INTO CREEK CHANNEL

BRIDGE PLAQUE F 14

0.9m DROP (2017)
SAME IN 2018

SEEPAGE OBSERVED ALONG EXPOSED SCARP CRACK ON NOVEMBER 8, 2017 (SAME IN 2018)

DRAIN TROUGH DISPLACED DUE TO LANDSLIDE MOVEMENT

2.0m DROP (2017)
SAME IN 2018

DECK DRAIN
SEE DWG 26475-P

0.6m DROP
(SAME IN 2018)

VW18-1A/B
SI18-1

VW18-3A/B
SI18-3

VW18-2A/B
SI18-2

SP18-4

LANDSLIDE EXPOSED OLD BRIDGE PIER PILES
- 1.4m DROP AT THE MOST EASTERN PILE NEAR LANDSLIDE EAST FLANK (TILTED MORE)

DRAIN TROUGH TAPER WAS RECONSTRUCTED BY AT IN 2017
TO DIRECT WATER TOWARDS DISPLACED TROUGH DRAIN

150-450mm GAP BETWEEN WINGWALL AND NW APPROACH FILL
- GAP BELOW WING WALL 200mm NEAR BOTTOM AND 500mm NEAR TOP OF SLOPE
-ORIGINAL GROUND SURFACE DROPPED BY AT LEAST 2.3m DROP BY WING WALL LOCATION

CRACK, 8m LONG, 30-40mm WIDE, NO DROP

TO ATHABASCA

1.5-1.8m DROP

TH #2 (SBL)

TH #3

HWY 2 : 42

TO SLAVE LAKE

(NBL)

1.1m DROP
1.3m DROP, DRY

ROADWAY

BAPTISTE CREEK

5-10mm DIP (2017)
10-20mm DIP (2018)

APPROACH SLAB

APPROACH RAIL TRANSITION AS PER DWG S-1643-00 (TYP) SEE DWG 26463-P FOR SITE SPECIFIC DETAILS

APPROXIMATE LOCATION OF SLEEPER BEAM

BRIDGE PLAQUE F 14

STA. 5+000 ℄ STREAMBED
STA. 1+000 ℄ OF HWY 2

POTENTIAL LOCATION OF 1979 INSTABILITY

CREEK TOP OF BANK (APPROXIMATE)

LIDAR OBTAINED FROM AIRBORNE IMAGING (2008)
BASE PLAN PROVIDED BY ALBERTA TRANSPORTATION DRAWING 26462-P

LEGEND

- ACTIVE HEADSCARP CRACK
- DISTINCT TOE ROLL
- APPROXIMATE LOCATION OF EXISTING TEST HOLE
- GUARD RAIL
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION
- TH TEST HOLE
- APPROXIMATE INSTRUMENT LOCATION
- SI18-1 NOT OPERATIONAL INSTRUMENT
- SI SLOPE INCLINOMETER
- VW VIBRATING WIRE PIEZOMETER

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

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NORTH CENTRAL REGION (ATHABASCA AREA) 2018 GEOHAZARD ASSESSMENT

NC90 - BAPTISTE CREEK BRIDGE NW APPROACH FILL LANDSLIDE (BF7055) HWY 2:42, 17km NW OF ATHABASCA MAY 7, 2018 GEOHAZARD INSPECTION PLAN

DWG NO. 13357-NC90-1-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:500
DATE	AUGUST 2018
FILE No.	13357

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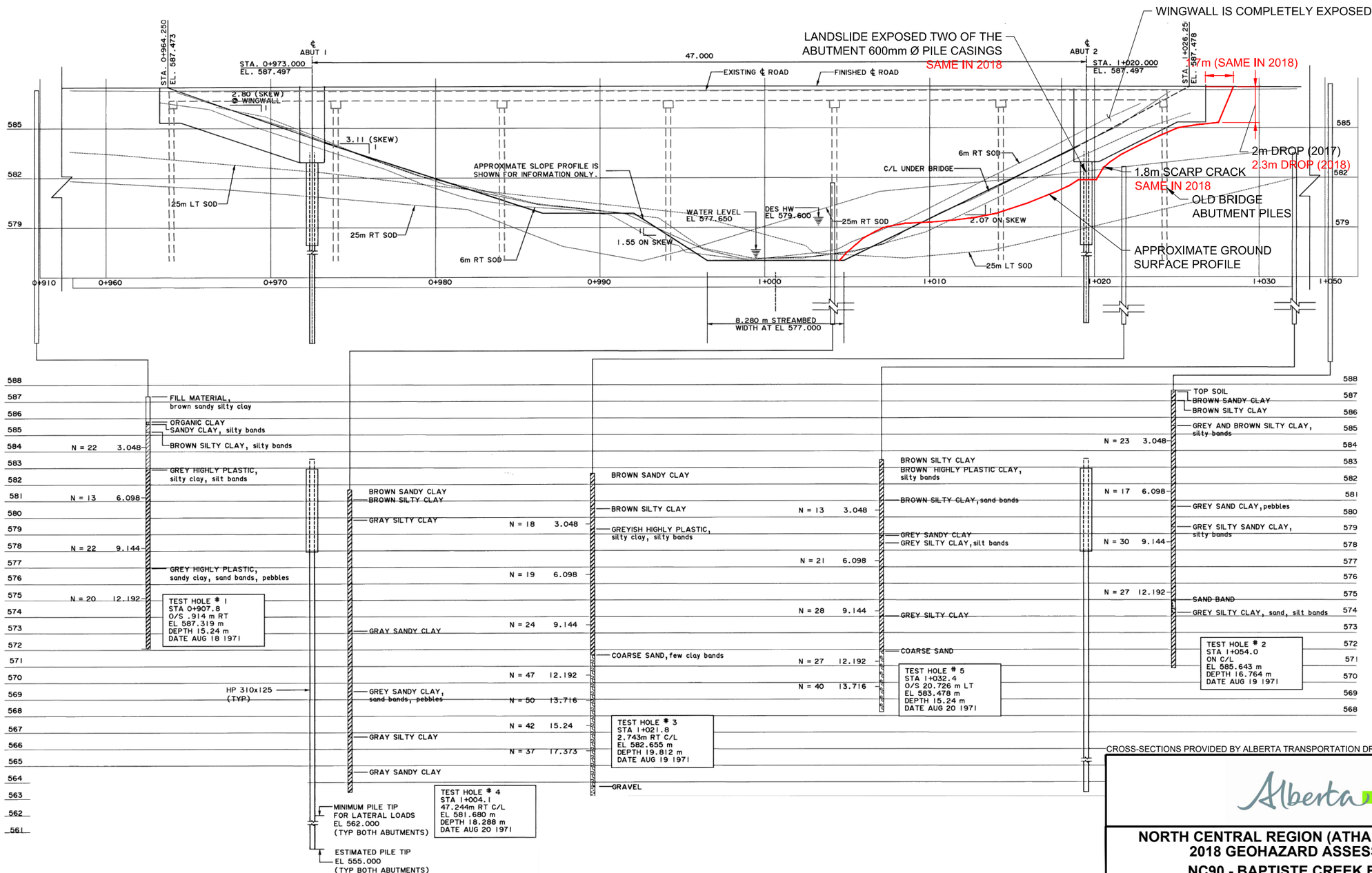
H:\13000\13357 Geohazard Assessment - Athabasca (CON0017605)\Drafting\2018\JGP\13357 NC090-1-1-4.dwg - 2 - Aug. 20, 2018



CROSS-SECTIONS PROVIDED BY ALBERTA TRANSPORTATION DRAWING NO. 26462-P & 26464-P

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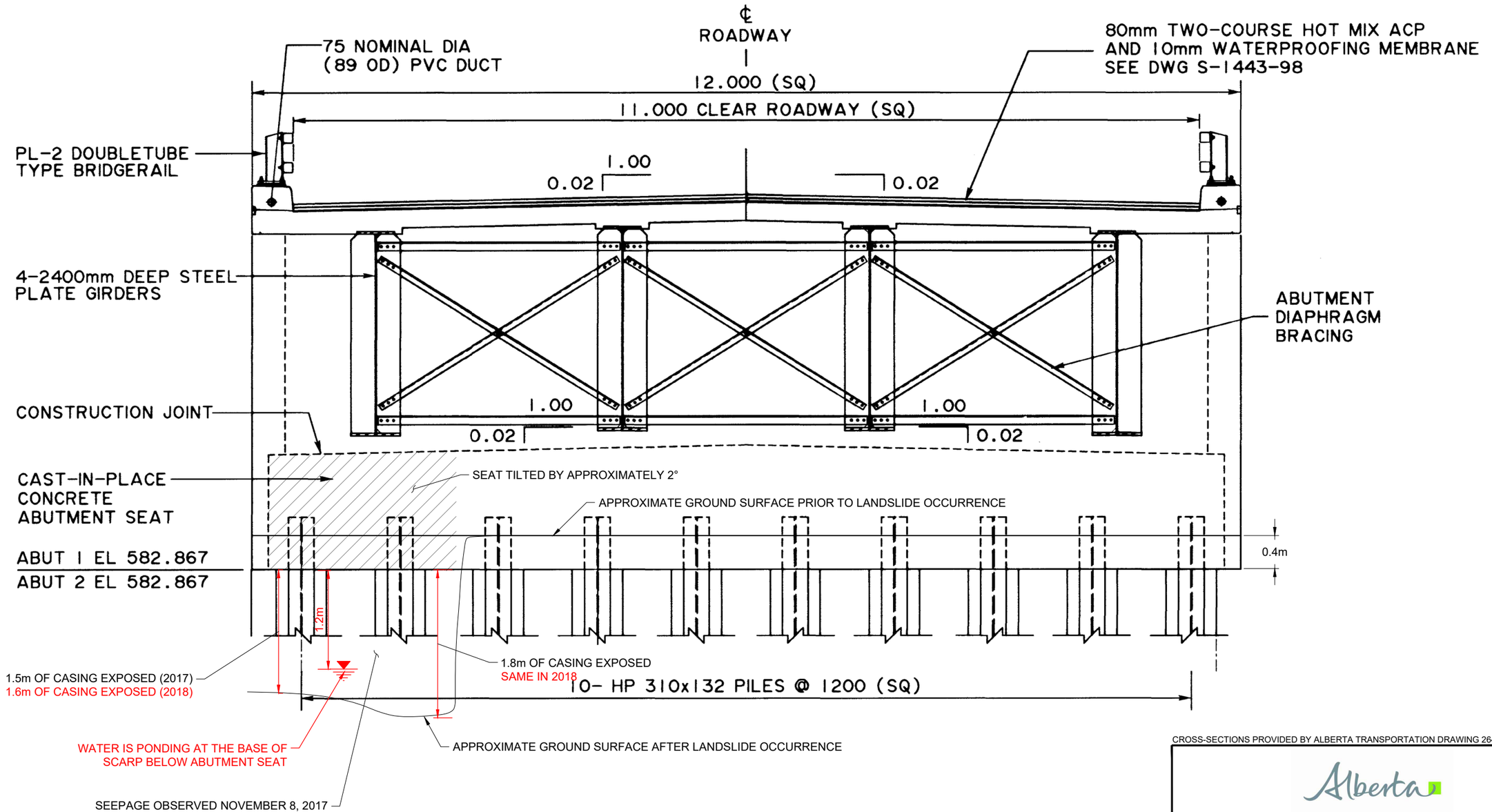
NORTH CENTRAL REGION (ATHABASCA AREA)
2018 GEOHAZARD ASSESSMENT

NC90 - BAPTISTE CREEK BRIDGE
NW APPROACH FILL LANDSLIDE (BF7055)
HWY 2:42, 17km NW OF ATHABASCA
CROSS - SECTION A - A'

DWG NO. 13357-NC90-1-2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:250
DATE	AUGUST 2018
FILE No.	13357

THURBER ENGINEERING LTD.



0 0.5 1 1.5 2 2.5 3m

SCALE 1:50

CROSS-SECTIONS PROVIDED BY ALBERTA TRANSPORTATION DRAWING 26462-P

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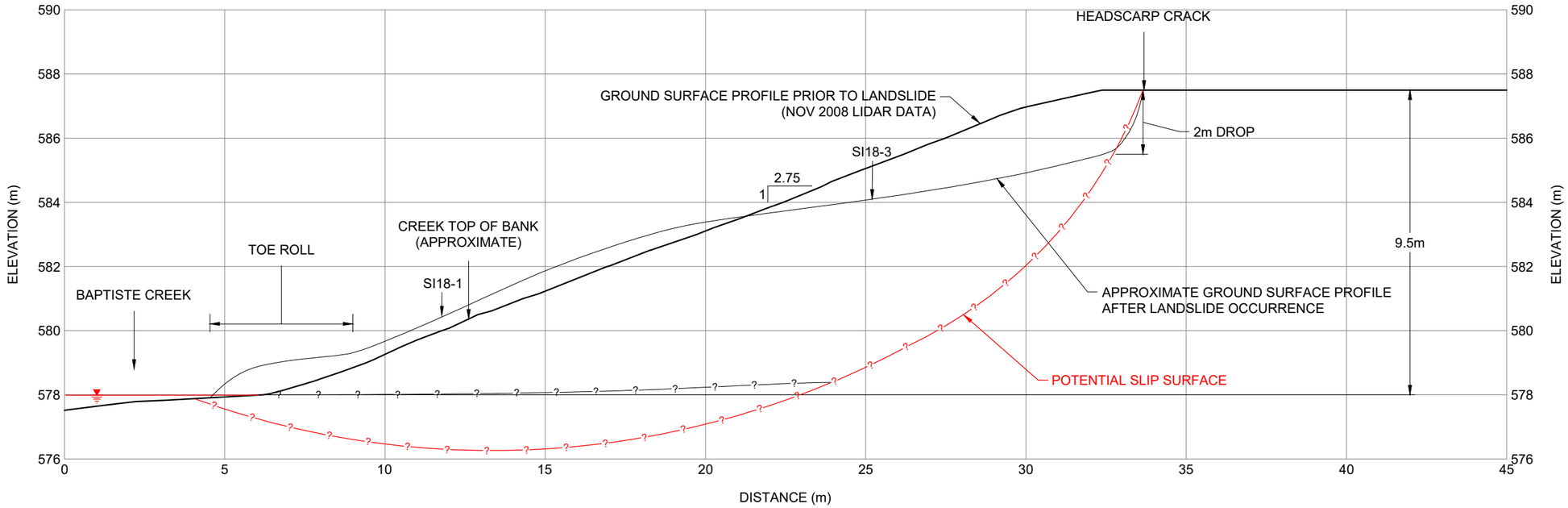
NORTH CENTRAL REGION (ATHABASCA AREA)
2018 GEOHAZARD ASSESSMENT

NC90 - BAPTISTE CREEK BRIDGE
NW APPROACH FILL LANDSLIDE (BF7055)
HWY 2:42, 17km NW OF ATHABASCA
CROSS - SECTION B - B'

DWG NO. 13357-NC90-1-3

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:50
DATE	AUGUST 2018
FILE No.	13357

THURBER ENGINEERING LTD.



NOTE: GROUND SURFACE PROFILE AFTER LANDSLIDE OCCURRENCE WAS OBTAINED THROUGH SIMPLE FIELD MEASUREMENTS. HENCE, THE ACTUAL GROUND SURFACE PROFILE MAY VARY FROM WHAT IS PRESENTED IN SECTION C-C'.

CROSS-SECTION IS BASED ON LIDAR DATA OBTAINED FROM AIRBORNE IMAGING (2008)

Alberta

NORTH CENTRAL REGION (ATHABASCA AREA)
2018 GEOHAZARD ASSESSMENT

NC90 - BAPTISTE CREEK BRIDGE
NW APPROACH FILL LANDSLIDE (BF7055)
HWY 2:42, 17km NW OF ATHABASCA
CROSS - SECTION C - C'

DWG NO. 13357-NC90-1-4

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:600
DATE	AUGUST 2018
FILE No.	13357

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Photo No. 1. - Overall Landslide Area (Looking North)

Photo No. 2. - Signs of seepage from the landslide head scarp crack (Looking East)

Photo No. 3. - A closer look at the observed seepage from the head scarp crack (Looking North)

Photo No. 4. - Eastern flank of landslide created a void below the wingwall (Looking South)

Photo No. 5. - Eastern flank of landslide created a void below the abutment seat (Looking North)

Photo No. 6. Looking north at the exposed abutment pile supports and the eastern flank of the landslide; note the gap developed between the top of the pile casing and the underside of the abutment seat. The gap is more distinguished in the casing adjacent to the eastern flank of the landslide

Photo No. 7. - Looking at the exposed casing of the most western abutment pile; the ground surface dropped by at least 1.6 m at this location and water ponded between the casing and the poured concrete slab by the abutment seat.

Photo No. 8. - Looking at one of the old bridge pier piles located on the head slope of existing bridge north abutment

Photo No. 9. - Landslide Area (Looking North)

Photo No. 10. - Looking east at the tension cracks of a slump developed within the landslide mass near the bottom of the slope

Photo No. 11. Backscarp, Lower Slump and Toe Roll in the Creek (Looking Northwest); the toe roll is reducing the capacity of the creek channel at the landslide location

Photo No. 12. Dip in highway surface near the end of the bridge approach slab (Looking South)