ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2024 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
SH003-1	North of Little Smoky River	Little Smoky River (North of Bridge)	49:12	0.4-0.8
Legal Description		**UTM Co-ordinates**		
NW34-74-21-W5M		11 E 490,730	N 6,145,966	

	Date	PF	CF	Total
Previous Inspection:	6-Jun-2023	13	6	78
Current Inspection:	3-Jun-2024	13	6	78
Road AADT:	1530		**Year:**	2024
Inspected By:	Rishi Adhikari, TEC Robert Senior, TEC		Ken Froese, Thurber Roger Skirrow, Thurber	
Report Attachments:	☒ Photographs	☒ Plans	☐ Maintenance	

Primary Site Issue:	The highway traverses the 120 m deep Little Smoky River valley over a WNW-oriented 55 m deep-seated, retrogressive landslide. There are persistent widespread creep movement over most of the valley slope. The movements are partly related to erosion of the bottom of valley by the Little Smoky River. This site is related to Geohazard sites SH004 and SH016.	
Dimensions:	At least 400 m length of highway affected by several intersecting scarps resulting in uneven riding surface. There is also a localized embankment failure on the north slope and erosion issues at specific locations. Approx. 1.5 km of the highway crosses this unstable east valley slope.	
Date of Remediation:	1972: Minor road realignment to accommodate new climbing lane. 1990's: Draining and regrading of a sag pond adjacent to the highway. 2003: Slope flattening of the local instability failure.	
Maintenance:	There is a repeated cycle of patching and milling and guardrail adjustments that extends to the original construction of the highway at this location. 2016: Grader-laid patch (350 t) 2018: $90,000 of milling on SH003 and SH004 Fall 2019: Milling both sides of valley for about $172,000 Fall 2020: Pavement overlay and guardrail replacement Spring 2022: Milling Spring 2023: Milling 2024: Patching	
Observations:	**Description**	**Worsened?**
☒ Pavement Distress	Cracking and uneven roadway surface requires ongoing patching and milling.	☒
☒ Slope Movement	Overall slope movement continues and the localize failure at Sta. 0+640 to 0+680 continues to ravel.	☐
☒ Erosion	Gully at 0+460 culvert inlet continues to down cut and now encroaching toward highway. Surface erosion gully between Sta. 0+480 to 0+610 was unchanged from 2022.	☐
☒ Seepage	Seepage observed at a few locations adjacent to the localized failure.	☐

☒ Bridge/Culvert	Erosion bowl forming at outlet of culvert at 0+810 Slumping obstructing culvert inlet at Sta. 0+460	☐
☐ Other		☐

Instrumentation (Spring 2024):	
SI96-4, SI96-5, SI96-6	These instruments show no discernable movement pattern as they are likely installed too shallow to record deep-seated movement patterns
SI31a	Sheared at 22.5 m; readings have continued above this depth after resetting in Spring 2017. A zone of movement between 15.7 m to 16.9 m has 3 mm of cumulative movement at an overall rate less than 1 mm/yr.
PZ01-1, PZ01-3, VW07-1, VW07-1A	Water levels at PZ01-1 and PZ01-3 generally stable over last decade with levels at 540 m and 515 m elevation, respectively. VW07-1 had been essentially stable since Fall 2016 at 14.3 m below ground but trending upwards since Fall 2021; VW07-1A has been relatively stable around 18.2 m below ground.
Sheared/ Damaged/ Destroyed	SI01-3 (discontinued, main movement was at 48.7 m), VW07-1B

Assessment:

The west and east valley slopes are prime examples of large scale, deep-seated retrogressive translational landslides. The overall east valley slope is moving as several separate slide blocks with numerous intermediate scarps, sag ponds, and differential movement zones. The highway intersects these features which results in multiple crack zones and several patches of uneven highway surface. The driving mechanism appears to be toe erosion by the Little Smoky River; a high ground water table may also be contributing. Based on GPS survey of the InSAR points conducted by Alberta Geological Survey (AGS Open Report 2013-14), the central portion of the highway distress is situated on a faster-moving block (40 mm to 90 mm per year) compared to the rest of the east valley slope which is moving at 5 mm to 40 mm per year. Drawing 32121-SH003-1-1 shows some of the slide scarps and sag pond features that have been interpreted from the 2008 LiDAR imagery.

The ongoing movement of the valley slope results in continued deformation of the highway surface that requires frequent widespread patching of the asphalt. Patching was necessary in Spring 2024 at Sta. 0+600 which is one of the transitions at the edge of the faster-moving blocks and the crack pattern was re-established by the time of the inspection in June 2024.

The localized embankment failure (Sta. 0+640 to 0+680) slope flattening repair appears to be stable based on the 2024 inspection.

An erosion gully in the south ditch leading to the culvert inlet at Sta. 0+460 was first observed about four years ago. There was not noticeably deteriorated of this problem area between 2023 and 2024.

Recommendations:

Short-term:

- Road maintenance consisting of milling and patching should continue as necessary (once or twice annually) to maintain the roadway surface in a safe condition. Crack sealing of the ACP should be done to limit infiltration of rain fall and snow melt into the extensive crack network.
- The gully in the north ditch from about Sta. 0+500 to 0+550 could be repaired with minor excavation and placement of pitrun gravel. Consideration could be given to placing topsoil and seed that is secured with an erosion control blanket.
- The erosion gully at the Sta. 0+460 culvert inlet is deteriorating and may affect the highway within a few years. Consideration should be given to regrading this section of the ditch and lining with erosion control measures (Class 1M riprap or comparable protection).
- The erosion bowl that has recently formed at the culvert outlet at about Sta. 0+810 could be repaired before it increases significantly in size. This could consist of backfilling the bowl with pitrun gravel and adding riprap as per TEC culvert outlet protection specifications.

Medium-Term:

The localized embankment failure could be repaired using clay or pitrun backfill and regraded to match the surrounding slope. Alternatively, consideration could be given to using a geogrid-reinforced backfill to reduce the amount of fill. This approach has the advantage of reducing the driving force on the slide block.

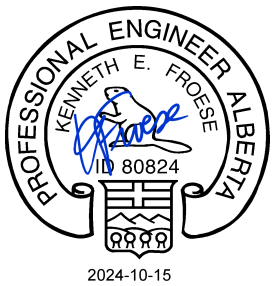
Long-Term:
The two alternatives for this location are to: realign the highway using the existing bridge, or; construct a new alignment and bridge on more stable ground. If the existing bridge location option is preferred, additional extensive riverbank protection could be installed to control river erosion at the toe of the slope. This would augment the effectiveness and life of the existing bridge alignment option.. It is understood that AMEC (now WSP) prepared a report under the 2013 High Water Related Mitigation Works program providing recommendations for erosion control at the toe and drainage measures on the slope to reduce the number and size of the sag ponds.

Ongoing Investigation:
- It is recommended that the annual Geohazard inspection and twice-annual instrumentation readings should continue as scheduled.
- At this time, additional test holes or slope inclinometers are not recommended at this site given the short life span of SIs. Consideration could be given to movement measurement methods that can tolerate higher displacements such as fibre optics or SAA.
- Consideration should be given to re-surveying the InSAR (interferometric synthetic aperture radar) targets, perhaps annually, to supplement the work done by the AGS as this will provide an overall view of ground movements. Restoration of the InSAR study could be undertaken as most of the InSAR targets are still in-place.
- A GPS real-time ground movement system (SparkFun or Geocube based), that is less expensive than the current systems, may be an option worth considering at this site particularly for identifying lower-movement rate zones for potential realignment. Alternatively, a series of targets or pins would be surveyed twice a year to map out the slower-moving zones. It is understood that a conventional terrestrial survey program is being considered for the west abutment of the bridge and this site could be included.

Closure

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Roger Skirrow, M.Sc., P.Eng.
Senior Geotechnical Engineer



PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE:
RM APEGA ID #: 51674
DATE: October 15, 2024
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Ken Froese, P.Eng.
Senior Geotechnical Engineer

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

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This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

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The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

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LEGEND

- OPERATIONAL SLOPE INCLINOMETER
- SHEARED SLOPE INCLINOMETER WITH DIRECTION OF MOVEMENT (BY THURBER)
- OPERATIONAL PNEUMATIC PIEZOMETER
- ABANDONED / INOPERABLE PNEUMATIC PIEZOMETER
- DRAINAGE DITCH
- OBSERVED SLIDE CRACK
- POSSIBLE SCARPS INTERPRETED FROM LIDAR
- DIRECTION AND NUMBER OF PHOTO
- BUMP SIGN
- GUARDRAIL

N W E S

SAG POND
SAG POND
REVISED SLIDE SCARP LIMIT
RILLING ON SIDESLOPE
2019: SOFT AND DAMP
GULLY - 1.4m WIDE AT GUARDRAIL (2022)
SI 96.1
RILLING ON SIDESLOPE
RIP RAP
DIP
RIGHT OF WAY
SURFACE EROSION GULLY
2014: 0.5m - 0.6m DEEP
2016: 0.3 - 0.7m DEEP
2017-2018: 0.8m DEEP
2019-2021: 0.9m DEEP
DROP OF 1.0m DUE TO EROSION
0.8m DEEP (2022)
NO GRASS GROWTH
GULLY
WINDROW FROM RECENT MILLING
2024: GULLY TYPICALLY 0.7m WIDE AND 0.6m DEEP
0.8m WIDE, 0.7m DEEP (SAME 2023)
0.9m WIDE, 0.3m DEEP (SAME 2023)
SURFACE EROSION GULLY
(2014): UP TO 0.8m DEEP
2016: UP TO 1.2m DEEP
2022: 20-30mm WIDE, 50mm DIFF
2023: 30-80mm WIDE, 10mm DIFF
6.7m TO FOG LINE (2019);
6.3m TO FOG LINE (2020)
1m TO SIGN
SIGN
10-30mm WIDE
EROSION AND SLUMPING IN DITCH
0.45m DEEP AT NICKPOINT (2016)
0.9m DEEP (2019); 1.0m DEEP (2020)
1.0m DEEP, 2-3m WIDE (2022)
EROSION CHANNEL; BECOMING VEGETATED (2023)
2.6m
WET
INLET CHANNEL PARTIALLY OBSTRUCTED
BUMP WARNING SIGN
750mm Ø SWSP CULVERT
POSSIBLE HEADSCARP (AMEC) GROUND CRACKS UP TO 10cm WIDE
SI 32
SI TO 45m
UPPER TOE PUSH
RILLS FORMING IN EXCESS GRAVEL: 0.8-1.0m WIDE, 0.15-0.3m HIGH
SI 35
35mm/yr @44.5m
24mm/yr @43.2m
SI TO 45m
SI 96.2
SI 31
SI 31A
SLOW RATE OF MOVEMENT AT 16 TO 19m
SI SHEARED BELOW 22.5m
DRAIN MARKER
SI 01-3
PZ 01-3
LOCALIZED EMBANKMENT FAILURE
WET
ORANGE COLOR SEEPAGE
SI 01-2
SI TO 69m
SI 34
SI TO 45m
3m LONG, 10mm WIDE
20mm WIDE
10-30mm WIDE, 30mm DIFF
10-20mm WIDE, 30mm DIFF
PATCH 2024
60mm WIDE, 70mm DIFF
5mm DIFF
WET AND SOFT AREA
COCONUT STRAW MATTING
SEEPAGE FROM SIDESLOPE ABOVE (2017-2018); NO SEEPAGE 2023
NO DISCERNABLE MOVEMENT SI TO 26m
SI 96.4
TELUS BOX
TELUS PEDESTAL
WET (2020, 2021)
MILLED 2023
RUNOFF
DIP
SI 30 (SHEARED OFF)
NO DISCERNABLE MOVEMENT
SI TO 49.2m
PZ 01-1 SI 01-1
NO DISCERNABLE MOVEMENT (2006)
SURFACE EROSION
TWO - TRACK WITH RUTTING
GULLY
MAY BE GONE
SI 33
SHEARED OFF
NO DISCERNABLE MOVEMENT
SI TO 45m
SI 96.6 (30m DEEP)
NO DISCERNABLE MOVEMENT
PONDED WATER
TOE BULGE;
2022: POSSIBLE;
2023: FORMING
HWY 49:12
DIP
TOPSOIL PILES
20-30mm WIDE
30mm DIFF IN LANE,
50mm DIFF AT SHOULDER
UP TO 150mm WIDE,
40mm DIFF
30-60mm WIDE, 40mm DIFF,
GRABEN FORMING
CULVERT OUTLET HANGING 0.4m
CONCRETE APRON CRACKED
SCOUR BOWL 1.5m WIDE, 0.9m DEEP
(SAME 2023, 2024)
60mm DIFF
10-20mm WIDE, 0 DIFF
TO BRIDGE
750mmØ SMOOTH STEEL CULVERT
PP

0 10 20 30 40 50 60 70 m
SCALE 1:1250

NOTES
1. FEATURE LOCATIONS ARE APPROXIMATE.
2. SOME HISTORICAL OBSERVATIONS FROM AMEC FIGURE 1, PROJECT EG10030, PROVIDED BY ALBERTA TRANSPORTATION.
3. ASPHALT OVERLAY PLACED THROUGH SITE IN SUMMER 2020
4. JUNE 2024 OBSERVATIONS SHOWN IN RED.
5. CRACK PATTERN RESET BASED ON UAV IMAGERY FLOWN MAY 2022 AND UPDATED FROM NEW IMAGERY ACQUIRED MAY 2024

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PEACE REGION (PEACE RIVER DISTRICT)

SH003-1: HWY 49:12
2024 SITE INSPECTION PLAN

DWG No. 32121-SH003-1-1

DRAWN BY	KLP
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:1250
DATE	OCTOBER 2024
FILE No.	32121

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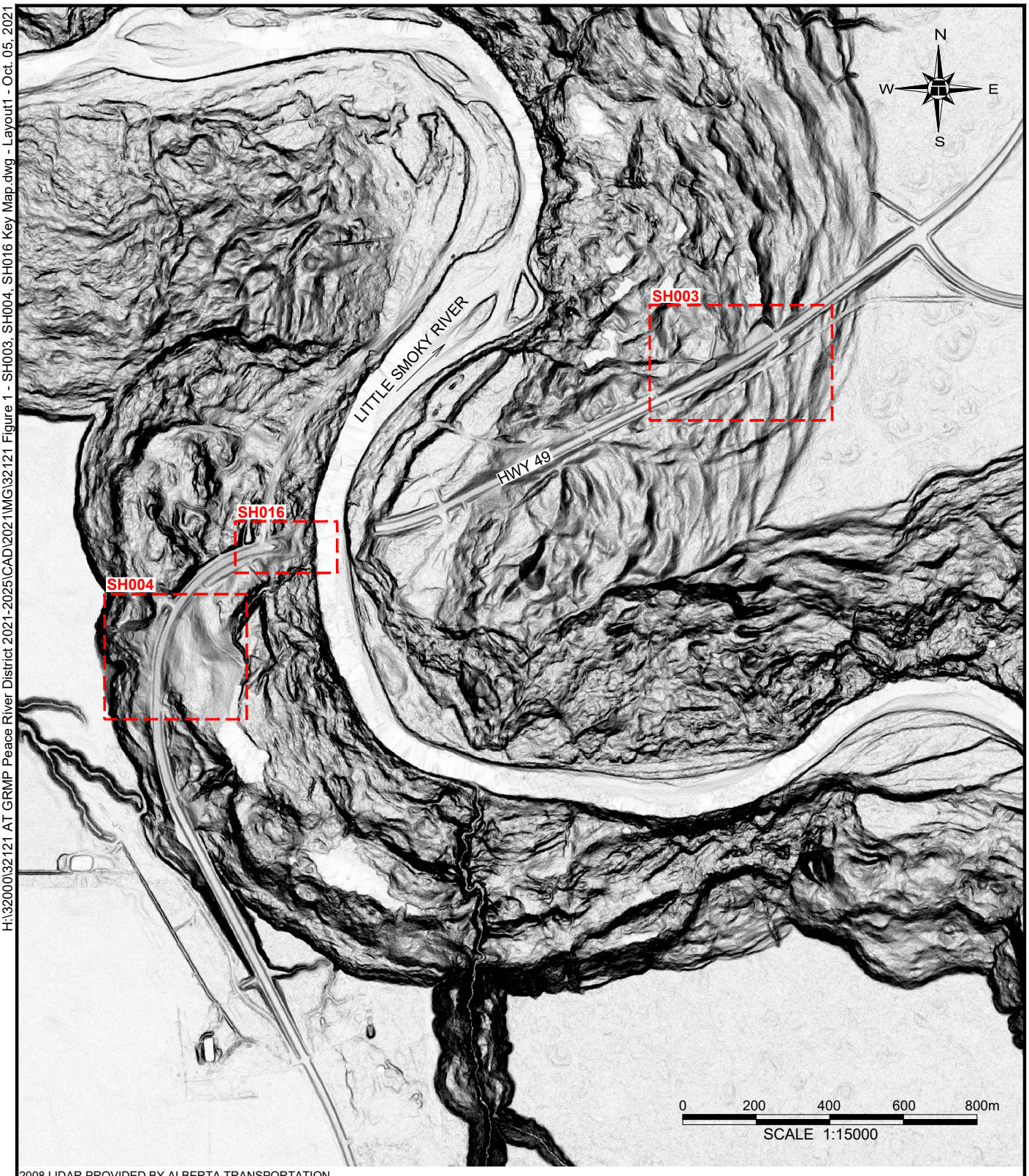
H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2021\MG\32121 Figure 1 - SH003, SH004, SH016 Key Map.dwg - Layout1 - Oct. 05, 2021



2008 LIDAR PROVIDED BY ALBERTA TRANSPORTATION.

PEACE REGION (PEACE RIVER DISTRICT)

SH003-1, SH004-1, SH016-1 KEY MAP

FIGURE 1

DRAWN BY	KLW
DESIGNED BY	MG
APPROVED BY	DWP
SCALE	1:15000
DATE	OCTOBER 2021
FILE No.	32121

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Photo 1 – Erosion gully at outlet of culvert at about Sta. 0+450.

Photo 2 – Looking southwest along erosion gully near Sta. 0+550.

Photo 3 – Looking east where the main scarps cross the highway at three locations.

Photo 4 – Looking southwest over the main sag (graben) area extending from Sta. 0+600 to Sta. 0+800.

Photo 5 – Looking north at area of frequent patching in the main graben block movement at Sta. 0+600.

Photo 6 – Looking west at main scarp cracks at Sta. 0+680.

Photo 7 – Looking southeast at the cracks on the west side of main scarp block at Sta. 0+770.

Photo 8 – Looking northeast at the cracks of the east side of main scarp block at Sta. 0+770.

Photo 9 – Developing erosion bowl at outlet of the 750 mm-dia. culvert at about Sta. 0+810.

Photo 10 – Erosion at the culvert inlet (left side) and scour bowl (right side) at Sta. 0+430 is starting to encroach towards the highway.

Photo 11 – Scour bowl forming close to the edge of the highway at Sta 0+430.

Photo 12 – Erosion rills by the guardrail and ravelling of the north side slope backscarp between Sta. 0+650 and 0+700.