



**S32 - HIGHWAY 56 – BOW RIVER,
UPSTREAM OF CROWFOOT FERRY
5 MAY 2016 CALL-OUT REPORT**

Submitted to:
Alberta Transportation
Calgary, Alberta

Submitted by:
Amec Foster Wheeler Environment & Infrastructure
Calgary, Alberta

May 2016

CG25399.400

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
2.0	SITE LOCATION AND BACKGROUND	1
3.0	5 MAY 2016 INSPECTION OBSERVATIONS	2
4.0	DISCUSSION AND ASSESSMENT	3
5.0	RISK LEVEL	4
6.0	RECOMMENDATIONS.....	4
6.1	Short Term Mitigation.....	4
6.2	Long Term/ Mitigation	5
7.0	CLOSURE.....	6

LIST OF APPENDICES

Appendix A	Figures
Appendix B	Site Photographs

1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler), attended a call-out request to the Bow River upstream of the Crowfoot Ferry on Highway 56, 4.4 km southbound of the intersection between Highway 56 and Highway 1. The call-out request was made by Mr. Ross Dickson of Alberta Transportation (AT). The site inspection was performed by Stephanie Weckman, G.I.T., of Amec Foster Wheeler on 5 May 2016.

The purpose of the site inspection was to:

- ▶ Assess potential damage and risk to the highway; and
- ▶ Provide recommendations for potential monitoring work, mitigative measures and potential geotechnical or hydrotechnical investigations.

On 25 April 2016, the maintenance contract inspector (MCI) reported concern with a location along the west shoulder of the highway. Reports from the MCI indicated that staff believed a landslide block had dropped approximately 0.3 m in 24 hours. AT requested Amec Foster Wheeler to inspect the site, assess the risk and provide recommendations based on the condition of the highway at the site. The call-out site inspection was authorized under the extended AT Consulting Services Agreement CON0013506.

2.0 SITE LOCATION AND BACKGROUND

The area of interest is located on Highway 56, 4.4 km southbound from the intersection of Highway 56 and Highway 1, and approximately 18 km west of the community of Bassano, Alberta. This segment of Highway 56 is a two lane gravel road leading to the Crowfoot vehicle ferry approximately 200 m southbound.

The site was first inspected by Amec Foster Wheeler's predecessor (AMEC) and AT personnel during the 2008 annual inspection tour¹. Significant bank erosion and a landslide along an approximately 200 m long segment of the left (east) river bank was observed. AMEC recommended air photos, river flow data and inspection information be reviewed by a hydrotechnical engineer to assess the current pattern and intensity of erosion and to devise repairs if necessary. Minimal changes were observed during annual inspections in 2009 and 2010.

During the annual inspection in June 2012 some fresh retrogression was noted a short distance upslope of the crossing and approximately 3 m of retrogression was measured just south of the ferry sign. A site survey of the ferry ramp and landslide crests was recommended at this time.

¹ Amec Environment & Infrastructure, 2008, *Southern Region Geohazard Assessment Program, Site S32 – Bow River Upstream of Crowfoot Ferry, Highway 56, 2008 Annual Inspection Report*, Project Number CG25277.B, submitted to AT September 2008.

The May 2014 annual inspection² observed approximately 20 m of bank retrogression (since the previous inspection) at the east ferry terminal which was suspected to be a result of the high precipitation and flood event of June 2013. The ferry was no longer in service. Slump blocks continued to develop and slide down the slope at the main slide location north of the ferry crossing. The minimum offset between the scarp and the fence line was 1.6 m.

New retrogression was observed at an area 30 m south of the minimum encroachment and cracks were observed there approximately 2.9 m from the fence line. A hydrotechnical review was recommended however annual site inspections were no longer required as long as the ferry crossing was out of service.

The area of interest lies within a region mapped as having bedrock of the Upper Cretaceous Horseshoe Canyon Formation³. This formation consists of mainly non-marine clayey sandstones, bentonitic mudstones and carbonaceous shales with some concretionary ironstone beds and scattered bentonite and coal beds. The area is mapped as being overlain by Pleistocene and Holocene fluvial coarse gravel and sand with minor silt belts⁴.

3.0 5 MAY 2016 INSPECTION OBSERVATIONS

The following observations were made during the 5 May 2016 site inspection; refer to Figures 1 and 2 for the site overview.

- ▶ The ferry was not in operation at the time of the inspection.
- ▶ The road surface was in good condition. Pylons and a barricade fence had been placed at the site but had blown over.
- ▶ The land to the east appeared to be used as grazing land. A driveway to a private residence was located approximately 60 m south of the area of minimum offset.
- ▶ The area of interest was along the left (east) bank of the river as it moves around a large meander bend. Left bank erosion was visible to the northwest for approximately 600 m from the area of concern and continued south to the ferry crossing. Refer to Photos 1 and 2.
- ▶ The right bank was a low-lying vegetated flood plain.
- ▶ No seepage was observed along the bank.
- ▶ Numerous old slump blocks were observed along the left bank along north of the ferry crossing.

² Amec Environment & Infrastructure, 2014, *Southern Region Geohazard Assessment Program, Site S32 – Bow River Upstream of Crowfoot Ferry, Highway 56, 2014 Annual Inspection Report*, Project Number CG25399, submitted to AT January 15, 2015.

³ Hamilton, W.N., Price, M.C., and Langenberg, C.W. (compilers), 1999: Geological Map of Alberta, Alberta Geological Survey, Alberta Energy and Utilities Board, Map No. 236, scale 1:1,000,000.

⁴ Shetsen, I. 1987. Quaternary Geology, Southern, Alberta. Alberta Research Council, Natural Resources Division, Terrain Sciences Department. Scale 1:500,000.

- ▶ The scarp of the landslide had undermined the fence for approximately 20 m. The affected fence posts had been marked with yellow flagging tape, possibly by the MCI. Refer to Photo 3.
- ▶ The slide block at the area of minimum offset had dropped 1.4 m from the road surface elevation. Cracks towards the north extent of the block had an aperture of 50 cm, and depth of 1.3 m. The minimum offset between the scarp of the landslide and the shoulder of the highway was 4.3 m. Refer to Photo 3.
- ▶ Exposed sediment in the scarp face was subrounded gravel and cobbles within a silty sand matrix with occasional to numerous boulders. Refer to Photo 4.
- ▶ Sandstone bedrock exposures were observed along the bank south of the area of minimum offset and was fine grained, well sorted, brown, laminated sands with occasional carbonaceous fragments and pockets. Refer to Photos 5 and 6.
- ▶ New cracks were observed continuing northward from the area of minimum offset and extended for approximately 90 m. Minimum offset from the highway was 12 m (measured approximately 50 m north of main headscarp location). Cracks were 30 cm deep with an aperture of up to 20 cm. Refer to Photos 7 and 8.
- ▶ Approximately 80 m south of the area of minimum offset, additional cracking was observed and extended 60 m. The crack was measured to be up to 30 cm in depth with an aperture of up to 20 cm. Refer to Photo 9.
- ▶ Erosion netting had been placed along the bank for approximately 100 m north of the ferry crossing. Refer to Photo 10.
- ▶ The left bank of the river directly north of the ferry crossing was armored with large boulders and geotextile fabric. The fabric was damaged in numerous locations. Refer to Photos 11 and 12.
- ▶ Water level was observed to be 0.5 m below the high water mark. Location of the thalweg was not observed due to wind disturbance on the water surface.

4.0 DISCUSSION AND ASSESSMENT

Retrogression of the scarp at the main slide area has continued since the previous inspection in May 2014. In 2014, the headscarp was measured to be 1.6 m offset from the fence line and has since undermined the fence and continued into the highway right-of-way. This indicates over 2.5 m of eastward retrogression since May 2014.

New cracks were observed north of the area of minimum offset. These cracks were not observed during previous inspections. Formation of the cracks indicate bank instability extends several hundred metres northward. Although these cracks are approximately 12 m west of the road edge, retrogression is expected to continue. Cracks to the south of the area of minimum offset appear unchanged since the previous inspection.

Retrogression of the scarp at the main slide area, as well as erosion of the banks between the slide area and the ferry crossing, is expected to continue and impact the highway. Erosion at the toe of the slope as the river meanders is suspected to be the source of slope movement.

The over-steepened upper area of the landslide will retrogress eastwards. An approximately 60 to 70 m long segment of the highway may become directly undermined by the landsliding. The risk of this occurring over the short term is judged to be moderate to high.

The landslide risk to the highway could be mitigated with one of the strategies discussed in the 2008 annual inspection report. A highway shift towards the east or erosion protection along the left (east) bank of the highway are likely the most applicable options. Further study would be required.

Significant erosion protection measures would likely be required for a river channel of this magnitude and the design of such measures would need to take into account the Crowfoot Ferry a short distance downstream. Furthermore, the regulatory and environmental permitting process for significant bank protection work along the Bow River could be relatively onerous. For the expected low volume of traffic along this segment of the highway (and presumably local traffic only during the winter months when the ferry does not operate), the most cost-effective approach may be to shift the road to the east. As the site is located within the Siksika Indian Reserve, the right-of-way acquisition aspects of which will need to be considered if contemplating shifting the highway alignment.

Reconstruction of the ferry infrastructure may result in increased traffic on this highway.

5.0 RISK LEVEL

The current recommended Risk Level for this site, based on AT's general geohazard risk matrix, is as follows:

- ▶ Probability Factor of 13 to reflect the ongoing movement and slope retrogression into the highway right of way and the rapidity of movement reported by the maintenance contractor.
- ▶ Consequence Factor of 4 reflecting the current impact on the road surface and potential loss of service to a portion of the roadway during repair.

Therefore, the recommended Risk Level is 52 (i.e. 13×4). This is an increase from the previous inspection rating of 24 to reflect the increased retrogression that has occurred into the highway right-of-way.

6.0 RECOMMENDATIONS

Amec Foster Wheeler provides the following recommendations based on observations from the 5 May 2016 call-out inspection.

6.1 Short Term Mitigation

- ▶ The MCI should continue to monitor this site frequently and alert Alberta Transportation if any changes are observed.
- ▶ More permeant barriers such as Jersey barriers should be placed along the shoulder of the affected roadway to protect motorists.

6.2 Long Term Mitigation

The hydrotechnical review of this site recommended in the previous annual inspection reports should be performed if the crossing is to be re-built. The scope of a hydrotechnical review would include:

- ▶ A review of site airphotos, available river flow data and information from previous inspections should be performed by a hydrotechnical engineer.
- ▶ Assess if the current pattern and intensity of erosion along the east bank will continue or change in the near future, and from that interpret whether or not the active landsliding will continue and if so how to mitigate it.

Such a review should also provide a basis to confirm the length of the highway segment that should be shifted eastward if necessary and could also provide long-term issues at the ferry crossing downstream of the landslide area due to bank erosion/channel shifting. If a hydrotechnical review confirms that the landsliding will continue, then AT should review the concept of an eastwards relocation of the highway by 10 to 15 m. The cost and issues associated with right-of-way relocation vs. bank protection and slope stabilization measures to preserve the existing highway could then be considered.

7.0 CLOSURE

This report has been prepared for the exclusive use of Alberta Transportation for the specific project described herein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler Americas Limited, cannot accept responsibility for such damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report has been prepared in accordance with accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

We trust that this meets your needs at this time. Please contact the undersigned if you have any questions or require any further information.

Respectfully Submitted,

Amec Foster Wheeler Environment & Infrastructure
a Division of Amec Foster Wheeler Americas Limited

SWeckman

Stephanie Weckman, B.Sc., G.I.T.,
Geologist-in-Training



May 26, 2016

Ryan Mateff, B.ASc., P.Eng.,
Geotechnical Engineer

Reviewed by:

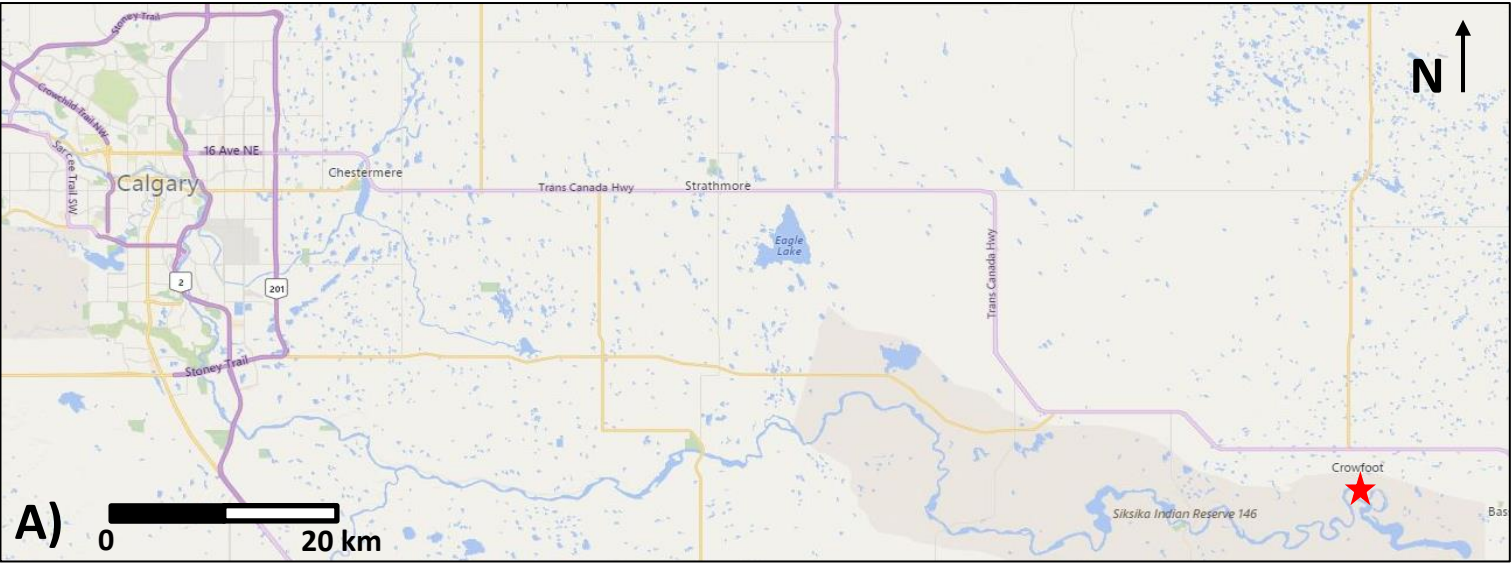
Mickey Davachi, PhD., P.Eng.,
Principle Geotechnical Engineer

Attach

APEGA Permit No. 04546



Appendix A Figures



Notes:

- 1. Image A obtained from Bing Maps.
- 2. Image B obtained from Bing Aerial imagery, photo from October 2012.
- 3. Photographs in Image C taken May 5, 2016 from right bank of Bow River facing east.


Legend:

Site Location ★



C)



<div> Transportation</div>		PROJECT: S32 - Crowfoot Ferry Call-Out Inspection				
		TITLE: Site Overview				
CLIENT: Alberta Transportation		DATE:	JOB No.:	FILE:	FIGURE No.:	REV.
		May 2016	CG25399	Figure 1.xlsx	1	A



0 m 50 100 m

Notes:

1. Lines are approximated based on observations and GPS coordinates taken during field inspection.
2. Image obtained from Bing Imagery, October 2012.

Legend:

- Current Headscarp extent ---
- New cracks observed in 2016 ---
- Erosion netting ---
- Barbed wire fence ---

amec foster wheeler



CLIENT:

Alberta
Transportation

PROJECT:

S32 - Crowfoot Ferry Call-out Inspection

TITLE:

Site Overview

DATE:

May 2016

JOB No.:

CG25399

FILE:

Figure 2.xlsx

FIGURE No.:

2

REV.

A



Appendix B

Site Photographs



Photo 1 - (May 2016) –
Standing north of the area of
minimum offset, facing south
towards the ferry crossing.



Photo 2 - (May 2016) –
Standing south of the area of
minimum offset, facing north.



Photo 3 - (May 2016) –
Standing at north end of slump
block facing south towards ferry
crossing.



Photo 4 - (May 2016) –
Close up of exposed soils.



Photo 5 - (March 2016) –
Bedrock exposure along left
(east) bank approximately 100 m
south of main headscarp
location.



Photo 6 - (March 2016) –
Bedrock exposure along left
(east) bank approximately 100 m
upstream of ferry terminal.



Photo 7 - (May 2016) –
New cracks observed north of
area of minimum offset. Facing
north.



Photo 8 - (March 2016) –
New cracks observed north of
area of minimum offset. Facing
south.



Photo 9 - (May 2016) –
Cracks observed south of the
main landslide location. Facing
south towards ferry terminal.



Photo 10 - (May 2016) –
Bank erosion on left (east) bank
upstream of ferry terminal.
Erosion netting placed over
scarp.



Photo 11 - (May 2016) –
Left bank armoring immediately
upstream of the ferry terminal.
Facing south.



Photo 12 - (May 2016) –
On right bank, facing east.
Armoring of left bank
immediately upstream of ferry
terminal.