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July 21, 2003

File: 15-16-166

Alberta Transportation
Room 301, Provincial Building
9621 - 96 Avenue
Peace River, Alberta
T8S 1T4

Attention: Mr. Ed Szmata

PEACE RIVER (SWAN HILLS) REGION LANDSLIDE ASSESSMENT
Hwy 744:02 SLIDES (SH10, 11, 12 AND 13)
2003 ANNUAL INSPECTION REPORT

Dear Sir;

This letter documents the 2003 annual site inspections of 15 areas of slope instability and/or erosion located along Hwy 744:02 within the Little Smoky River valley crossing. This inspection was undertaken by Thurber Engineering Ltd. (Thurber) in partial fulfillment of our Geotechnical Services, Monitoring and Assessment of Instrumentation and Landslides contract with Alberta Transportation (AT).

The inspections were undertaken on June 3, 2003 by Mr. Don Proudfoot, P. Eng. and Mr. Barry Meays of Thurber in the presence of Mr. Roger Skirrow, P. Eng., Mr. Ed Szmata, Mr. Bruce Henderson, and Mr. Rick Turcotte of AT.

1. BACKGROUND

The section of Hwy 744:02 which crosses the Little Smoky River valley has been affected by 12 slide areas (Site #1 through Site #12) and 2 severe erosion sites (Site #13 and Site #14). The locations of the sites are shown on the attached site contour plan.

For the purpose of the annual landslide inspection contract, the slides and erosion sites have been grouped under 4 separate assessment site identification numbers as follows:

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Assessment Site Identification Number	Landslide / Erosion Site #
SH10	Site #1 and #2 (South Hill Section)
SH11	Site #3, #4, #5 and #6 (North Hill Section)
SH12	Site#7, #8, #9 and #10 (North Hill Section)
SH13	Site #11, #12, #12a, #13 and #14 (North Hill Section)

Based on discussions with Mr. Henderson, AT spent approximately $115,000 in the fall of 2000 on maintenance measures consisting of asphalt patches on the highway, clearing of bush within the right-of-way limits, ditch cleaning and removal of slumped material from the backslope cut at Site #1b.

Remedial measures for Site #11, which were constructed in the fall of 2000 or spring of 2001, consisting of a subsurface drainage blanket installed below the toe of the embankment fill slope as shown on Figures SH13(11)-1 and SH13(11)-2. A slope inclinometer and standpipe piezometer installed and monitored over the period of April to May, 2000 to assess the effectiveness of the measures prior to a scheduled overlay of the south hill section of the highway indicated that the slide block was still creeping after construction of the remedial measures.

An asphalt overlay was applied to the entire north hill section of the highway in June 2001 as part of a previously scheduled maintenance program. The overlay occurred after the annual landslide assessment visit of June 5 and 6, 2001.

Remedial works were carried out for Site #2 in the fall of 2001 consisting of a subdrain below the upslope ditch, four French drains through the slide area, slope flattening by reconstructing the slope at an inclination of 5H:1V and reconstruction of the highway GBC and ACP for a total cost of about $345,000 (construction plus engineering costs). "As-constructed" drawings and photographs of the remedial measures are included in the Site#2 appendix of the binder.

In August, 2001 a new slide occurred in the recent asphalt overlay about 200 m north of Site #12 (Site #12A). Some patching of this area was carried out after the initial slide episode but the slide reappeared through the patches. A shallow slump also occurred in the downslope side of the roadway embankment of Site 13.

Both of the slumps were repaired in July 2002 on an hourly basis by the maintenance contractor LaPrairie Group. The repair of Slide 12A consisted of subexcavating the slide zone to 1m below the toe of the sideslope, extending an existing culvert, installing a subdrain, and reconstructing the slope with imported pit run gravel to an outside inclination of 2H:1V. The excavated clay was then placed as a 2 m high toe berm and the sideslope built out to 3H:1V. A sketch plan and section of the repair are included in Site 12A section of the binder.

Continued...

The sideslope slump at Site #13 was subexcavated, a subdrain was installed in a wet area, and the slope was reconstructed using imported drier clay placed in well compacted horizontal lifts benched into the slope. The cost of the remedial measures for Sites 12A and 13 were in the order of $110,000.

Based on discussions with Mr. Henderson some asphalt patching was carried out at Site #1 in early spring 2002 for a total cost of $1,200 and he is projecting another $10,000 of maintenance work consisting of asphalt patches, building up the shoulder area with pit run gravel at Site #1 and cleaning of slumped material from the backslope at Site #1 to be required in 2003 for the south hill portion of the Hwy744:02 valley crossing section.

Five (5) slope inclinometers and 4 standpipe piezometers were installed at Site #1. Details of the installations were provided in a report dated September 3, 2002, copies of which were already forwarded to AT for inclusion in the site binder. Ground movements and piezometric levels have been summarized in the fall 2002 and spring 2003 instrumentation reports.

A preliminary engineering assessment is also currently being carried out of potential remedial measures for the erosion problems at Sites 13 and 14.

2. SITE OBSERVATIONS

Site observations for the spring 2003 visit are shown in red on the updated site sketch plans and cross-sections and on the selected photographs provided under the corresponding binder appendices for each site. A summary of the updated conditions for each site is also provided in Table 1 of this report.

3. ASSESSMENT

Detailed assessments of the slides located along the valley section were provided in our original report. A brief update of our understanding of the failure mechanisms at work is as follows:

- At the valley crossing location, the Little Smoky River and it's tributary Peavine Creek are aggressively down-cutting their valleys resulting in large scale landsliding of the existing valley slopes.
- Where river terraces are present along the inside of river meander bends, the slopes above the terraces are typically more stable than those where no river terraces are present. For example, the south hill section of the highway, where terraces are present at three locations below the highway, is more stable than the north hill section, where there are no river terraces below the numerous problem areas affecting the highway.
- The problem areas on the south hill section appear to be related to side hill fills over weak, presheared slope colluvium.

- The instrumentation installed at Site #1indicate slide movements at 5 to 9 m depth below the affected highway section with creep rates of 25 to 100 mm/year. The piezometric surface in this area is located at 1.1 to 6.1 m below ground surface.
- Site #2 appears to be in a stable condition since remedial measures were carried out in the Fall of 2001.
- The slide areas along the north hill section appear to be related to the movement of deep seated slide blocks and weak subgrade conditions related to ponding of surface and subsurface water in the flat lying grabens (sag pond) of the slide blocks.
- Sites #4, #5, #6 and #7 appear to located along a large slide block moving south toward the Little Smoky River. Sites # 5 and #6 appear to be located in the sag pond area of the slide block where soft, wet subgrade conditions are resulting in rutting and alligator cracking of the pavement. Additional cracking, and extensions in length/width of previous cracks were observed at Sites #5 and #6 in 2003. Site #7 appears to be at the location where the main backscarp of the large slide block crosses the highway. At Site #7 in 2003, continued movement necessitated milling of the overlay at one location, and a scarp and a toe roll were observed outside the pavement.
- Site #3 is likely located at the edge of a separate slide block moving southwest toward the Little Smoky River.
- Sites #8, #9, #10 and #11 appear to be located along another large slide block moving southeast toward Peavine Creek. Site #8 and Site#11 appear to be located at the downslope and upslope edges, respectively, of the slide block. An intermediate scarp crack crosses the highway at Site #9. Site #10 appears to be located along the sag pond of the slide block. New and/or more prominent cracking was observed in 2003 at Sites #8, #9 and #11.
- Sites #12, #12A and #12B could be more localized slumps related to overly steep side hill embankment fills, and were observed to indicate movement in 2003 due to new and more extensive cracking.
- Sites #13 and #14 are advanced erosion sites related to surface flows discharging from a culvert, and a highway ditch, respectively and running along steep gradients over unprotected clayey soils. The erosion during the 2003 inspection was observed to have worsened significantly since the fall of 2002 (caused by spring thaw flows).
- Erosion of the highway ditches has occurred at a number of locations since 2002. The erosion is attributed to a very fast melt of significant snow accumulation in spring 2003.

4. RISK LEVEL

The assessed risk levels for each site are summarized in Table 1.

5. RECOMMENDATIONS

Recommendations for each site are provided in Table 1. Generalizing, our recommended long term approach for the valley crossing is to remediate the individual slide sites on the south hill section and to carry out a major re-alignment of the highway for the north hill section.

The condition of Site #1 appears to be worsening. This area has required annual asphalt patches and the cracks that appeared in the pavement in 2002 have become more severe since the last inspection. Instrumentation installed at this site indicate a high rate of slide movement in the order of up to 90 mm per year in 2002, although this has slowed to up to 40 mm per year in 2003 (but may be only due to climatic conditions). Based on the above we have left the Risk Level the same for this site at 65 and still recommend it for remedial measures next year.

A cost estimate dated May 9, 2003, was submitted to Alberta Transportation for preliminary design/detailed design/tender preparation for Site #1. The cost estimate was prepared based on selection of one of two separate rehabilitation options; either a re-alignment combined with slope unloading, or a pile wall. The cost to undertake this design work was estimated at about $48,000. The remedial measures are expected to cost in the order of $500,000.

Based on our Spring 2003 inspection, the remedial measures carried out in the fall of 2001 for Site #2 appear to have stabilized the slide area as there are currently no signs of further movement in this area.

The 2001 overlay placed on the north hill section improved the highway smoothness, safety and overall performance in the short term. However, on-going deep seated slide block movements continue to affect the highway and the cracks are reappearing in the road surface and are expected to gradually get worse. Hence, a higher than usual amount of maintenance (asphalt patching, crack sealing, ditch cleaning etc.) will likely be required for the current alignment of the north hill section compared to typical highway maintenance for other road sections and the road surface will eventually require another overlay to maintain a smooth surface.

In the short term, it is important for the Maintenance Contract Inspector to carry out regular inspections of the valley crossing section to promptly identify any change in slide movements and/or erosion and road conditions which could affect the use of the highway.

The ditch erosion that occurred at several locations this spring should be dealt with promptly to avoid worsening of the condition. The general method proposed consists of backfilling the eroded sections with imported well compacted clay and covering the suitable ditch sections wit topsoil, seed and soil covering.

Erosion protection measures should also be carried out at Sites #13 and #14 and will be required to address environmental concerns even if the highway re-alignment option is adopted. Preliminary remedial options will be presented in our preliminary engineering report to be issued in the near future.

The major re-alignment proposed for the north hill section is expected to drastically reduce the cost of ongoing maintenance but at a high initial construction cost. Details of the major realignment option and estimated costs for the north hill section were provided in our original report.

6. CLOSURE

We trust this assessment and recommendations meet with your needs at this time. Please contact the undersigned should questions or concerns arise.

Yours very truly,
Thurber Engineering Ltd.
Don Proudfoot, P.Eng.
Review Principal

Barry Meays, P.Eng.
Project Engineer

/slp

Attachments

TABLE 1
Hwy 744:02 LITTLE SMOKY RIVER VALLEY

SUMMARY OF LANDSLIDES-JUNE, 2003

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2003	AT RISK ASSESSMENT			POTENTIAL REMEDIAL MEASURES	GEOTECHNICAL INSTRUMENTS
				Backslope Cut	Embank. D/S Fill		PF	CF	RA		
#10 (SH12)	km 20.2 to 20.25 (3.1 to 3.15 km northeast of the bridge)	50 m	2 to 4 m	20	20	- a few short cracks have re-appeared in the 2001 asphalt overlay - steep back slope -a 900 mm diameter culvert present close to the ramp at north side -the inlet of the culvert is being undermined by erosion, and the 0.5 m deep x 1 m wide scour area extends on each side of the culvert along the ditch for a distance of about 16 m -extensive erosion was observed along the south ditch and beyond the culvert outlet. A 1 m wide x 0.6 m deep erosion gulley extends a distance of about 66 m northeast of the culvert, and at the culvert outlet joins a 15 m long erosion gulley that is about 2 m wide x 0.5 m deep southwest of the outlet. About 17 m further downslope from the above noted erosion, another 40 m long erosion gulley about 1.5 m deep and 1.5 m wide extends on either side of the outlet of a 200 mm flexible plastic subdrain pipe that carries drainage water from Slide #11 area.	9	3	27	Short Term: - asphalt patching and crack sealing maintenance - the erosion gulleys in the ditches should be repaired by grading/filling and covering with erosion matting. Extra care should be undertaken by properly compacting new fill below/around the culvert inlet to reduce the threat of undermining. - visually monitor Long Term: - major highway re-alignment	
NORTH HILL SECTION (SH13) - June 2003											
# 11 (SH13)	km 20.4 to 20.65 (3.3 to 3.55 km northeast of the bridge)	250 m	4 to 6 m	18	vary from 18 to 22 (embankment) 2 to 9 in the area below	- the scarp of a deep seated slide block appears to cross diagonally through the hwy and the scarp cracks have re-appeared through the 2001 asphalt overlay -the cracks observed in 2002 have become more prominent, and some new cracks were noted in the new overlay at the 60 m and 90 m marks. The S.B. lane was milled down at the cracks observed last year at the 295 m mark. -Fill settlement cracks are still visible over the drainage blanket area - erosion was observed along the west ditch (6% grade) at: between 320 m to 350 m marks (1 m wide x 0.4 m deep); 12 m length at 230 m mark; 15 m length at 190 m mark; between 150 m to 170 m marks (1 m wide x 0.4 m deep); between 25 m to 130 m marks (1.4 m wide x 0.6 m deep). In addition, the french drain enclosed by composite non-woven geotextile and membrane is all eroded out and exposed. -A cross-section of the overall slope between Site #11 and Peavine Creek is shown on Figure SH13(11)-3. This slope is characterized by at least two deep seated slide blocks and associated sag ponds (grabens), the upper of which passes through Site #11.	12	5	60	Short Term: - asphalt patching and crack sealing maintenance - the erosion gulleys observed at various intervals along the west ditch should be graded/filled and/or covered with high flow erosion matting - the french drain in the west ditch should be inspected and repaired - continue to monitor instrumentation Long Term: - major highway re-alignment	There is one operable SI outside the slide block which shows no movement. The SI inside the slide block has sheared off and perhaps should be replaced. One pneumatic and 4 standpipe piezometers indicate that the piezometric surface is located at 2.4 to 4.2 m below ground surface

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TABLE 1
Hwy 744:02 LITTLE SMOKY RIVER VALLEY

SUMMARY OF LANDSLIDES-JUNE, 2003

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2003	AT RISK ASSESSMENT			POTENTIAL REMEDIAL MEASURES	GEOTECHNICAL INSTRUMENTS
				Backslope Cut	Embank. D/S Fill		PF	CF	RA		
# 12 (SH13)	km 20.8 to 20.9 (3.7to 3.8 km northeast of the bridge)	100 m	4 to 6 m	20	22 to20	- location of high embankment fill that failed previously was rebuilt using pit run gravel in the upper portion and likely over clay fill in the lower portion - evidence of slight cracks and movements on downside slope parallel to the road alignment, with 2 toe rolls apparent this year (about midslope and just in front of the trees) - the cracks that reappeared in the 2001 overlay in 2002 have become worse and were about 10 mm wide by 15 mm high in 2003 where the original scarp crack used to be - the culvert was only about 1/3 open this year (as opposed to ½ open in 2002) - movement at this site appears to be accelerating	10	4	40	Short Term: - asphalt patching and crack sealing maintenance - if condition worsens, may need to build out toe of embankment slope to achieve an overall flatter angle with additional pit run gravel, or subexcavate the slump and reconstruct the slope with geogrid reinforced free draining gravel - culvert should be cleaned/maintained - visually monitor Long Term: - major highway re-alignment	
#12A (SH13)	km 21.2 (4 km northeast of the bridge)	10 m	5 m		12 upper slope 18 lower slope, 14.5 overall	- some seepage was observed from the new subdrain - The top of the d/s slope was wet and soft -Since repair the culvert has been lined with a smooth steel culvert, 762 mm in outside diameter	13	4	52	This slide area was remediated in July, 2002 by subexcavating the slide area, installing a subdrain inside the excavation, reconstructing the slope with imported pit run gravel, using the excavated clay to construct a toe berm and repairing and extending the culvert. The work was carried out by the maintenance contractor on an hourly basis supervised by one of Thurber's technologists. A summary of the slide repairs will be presented in a construction summary report in the near future Long Term: - major highway re-alignment	
#12B	km 21.0	20 m	- 5 km	---	---	(NO SITE SKETCH PROVIDED) (Located half way betwwen Site #12 and #12A) - A 20 m long crack along middle of northbound lane - bit of toe bulge in the northbound sideslope - possibly 2 shallow slumps on the southbound back slope	9	4	36	Short Term - asphalt patching and crack sealing maintenance - if conditions worsen, may need to flatten downstream slope by filling lower portion or subexcavate slump & reconstruct with gravel/geogrid, and/or cut upstream slope to flatter slope or repair existing slumps - visually monitor Long Term - major highway re-alignment	

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TABLE 1
Hwy 744:02 LITTLE SMOKY RIVER VALLEY

SUMMARY OF LANDSLIDES-JUNE, 2003

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2003	AT RISK ASSESSMENT			POTENTIAL REMEDIAL MEASURES	GEOTECHNICAL INSTRUMENTS
				Backslope Cut	Embank. D/S Fill		PF	CF	RA		
# 13 (SH13)	km 21.45 (4.35 km northeast of the bridge)	50 m	~ 8 m	20	19	- high hwy embankment at location where hwy crosses perpendicular over a drainage gully - 1300 mm diameter culvert located below highway fill, which transitions into 900 mm diameter outlet - d/s toe of embankment retained by a short gabion wall - since the last inspection the broken end of the 900 mm diameter PVC surface pipe which connected to the outlet of the culvert has been removed and riprap has been placed over the erosion channel. Material below the riprap has eroded severely since a site visit in the fall of 2002. - a deep erosion gully is present beyond the outlet of the surface culvert, which also has worsened since fall 2002			n/a	The slump observed in the 2002 inspection was remediated in the summer of 2002 on an hourly basis by the maintenance contractor. The remedial measures consisted of excavating the slumped material to below the slip surface of the slump and compacting drier clay fill in horizontal lifts to reconstruct the embankment slope. A subdrain pipe was installed in a wet area of the excavated slump. The work was supervised by Thurber and will be summarized in a construction summary report in the near future. <u>Short Term:</u> - Thurber are currently conducting a preliminary engineering assessment to develop potential remedial measures for this erosion area. One feasible remedial measure consists of conveying the flow from the culvert down the slope in a welded smooth wall steel pipe.	
# 14 (SH13)	km 21.45 to 21.65 (4.35 to 4.55 km northeast of the bridge)	400 m	n/a*	n/a*	n/a*	- huge erosion gulley extends parallel to the road at distances of 60 to 80 m - currently not effecting the road stability, but possible future impact on the stability -Erosion of material along the ravine has worsened since the last inspection and since a site visit in the fall of 2002. - there are signs of additional retrogression of the erosion area upslope into the highway ditch. Evidence of slight erosion in the east highway ditch was observed as far back as 350 m north of the point where the first deep erosion scour exists. - A reference stake was installed to better track the retrogression.			n/a	- Thurber are currently conducting a preliminary engineering assessment to develop potential remedial measures for this erosion area. -Remedial options vary from conveying the flow in a welded smooth wall steel pipe to the use of an armoured open channel.	

Notes: Bridge location = km 17.0 to 17.1 U/S = upslope D/S = downslope SI = slope indicator PZ = piezometer

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