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October 7, 2004 File: 15-16-191

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

Attention: Mr. Ed Szmata

PEACE RIVER (SWAN HILLS) REGION GEOHAZARD ASSESSMENT
Hwy 744:02 SLIDES (SH10, 11, 12 AND 13)
2004 ANNUAL INSPECTION REPORT

Dear Sir;

This letter documents the 2004 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 for GeoHazard Assessment, Instrumentation Monitoring and Related Work contract (CE047/04) with Alberta Transportation (AT).

The inspections were undertaken on June 9, 2004 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. Gerard Gravel of AT. Mr. Dave Kohut and Ms. Amanda Russell of AT were also present during the inspections of SH10 - Site 1 and SH 13 - Site 12.

1. BACKGROUND

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

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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:

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)

A summary of the background for Hwy 744:02 Little Smoky River Valley crossing up to our Spring site visit in 2003 was provided earlier this year in Part A of the binder.

Since then, based on discussions with Mr. Henderson some asphalt patching (120 tonnes of asphalt concrete) was carried out at Site #1 in July 2003 for a total cost of about $12,000. He was 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.

At Site # 12, an emergency call out was carried out on September 17, 2003 after the slide extended into the edge of the northbound driving lane. The cracking and movements were observed to have become worse since the call out and extended into the southbound driving lane during this inspection.

2. SITE OBSERVATIONS

Site observations for the spring 2004 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.

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- 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 #1 indicated 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 1.0 to 6.1 m below ground surface. The 2004 observations indicate that the three inclinometers at Site #1 have already sheared off due to excessive movements, and the inclinometer installed downslope of the highway at Site #1b which was near the periphery of previous cracking has been indicating movement in the last 2 monitor periods (fall 2003 and spring 2004). These movements in conjunction with the cracking observed in the highway at Sites #1a and #1b, suggest that the slide movements are accelerating and the slide may be expanding to the north.
- Site #2 appears to be in a stable condition since remedial measures were carried out in the Fall of 2001. However, some ditch erosion has developed that needs to be attended to.
- 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. The extent of cracking in the 2001 ACP overlay at Sites #4, #5 and #6 has become worse in 2004. Two apparent dips in the highway surface were observed at Site #4, which appear to be linked with settlement related slide block movement. Site #7 appears to be at the location where the main backscarp of the large slide block crosses the highway. At Site #7 in 2004, continued movement was indicated as the cracks were reflecting through the AC patch, and the scarp and toe roll that were observed outside the pavement in the backslope last year had enlarged slightly.
- 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. More extensive cracking in the 2001 ACP overlay was observed in 2004 than in 2003 at Sites #8, #9 and #11.

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- Sites #12, #12A and #12B are thought to be more localized slumps related to overly steep side hill embankment fills. Sites #12A and #12B were relatively unchanged this year, and the risk assessment rating for Site #12A was reduced to 16 from 52 subsequent to the 2002 repairs to reflect the increased stability At Site 12, a callout was required in July 2004, subsequent to additional slide movements which undermined a portion of the guardrail.
- Sites #13 and #14 are advanced erosion sites resulting from surface flows discharging from a culvert, and a highway ditch, respectively and running along steep gradients over unprotected clayey soils. The erosion during the 2004 inspection was observed to have slightly worsened since last year, but not as much as the year before (which was caused by severe spring thaw flows in 2002).

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.

South Hill Section
Site #1, #1a, #1b

The condition of Site #1, #1a and #1b appears to be worsening. The slide area will be remediated this fall by carrying out a highway realignment and associated slope unloading. The detailed design for the realignment was carried out by Stewart Weir Co. Ltd. with Thurber as their geotechnical subconsultant. Neudorf Trenching Ltd. has been retained to carry out the work in conjunction with an asphalt overlay project.

Site #2

Based on our Spring 2004 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. There was continued erosion observed downslope of the highway along the previously repaired gully, and recommendations are provided in Table 1 to address this.

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North Hill Section

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 continue to get worse. Hence, a higher than usual amount of maintenance (asphalt patching, crack sealing, ditch cleaning etc.) will 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.

Additional sags and cracks in the highway were evident at SH11 Site #4, and it is possible that Sites #3 and #4 may be connected by one very large block of movement. The more severe conditions at Site #4 prompted a re-evaluation of the risk level this year to 45 from 15, to reflect the fact that the observed movements, if they continue, could result in a road closure at this location.

The risk assessment rating at Site #12 was increased to 55 this year (from 40 in June, 2003 and 44 in the September, 2003 emergency call out) to reflect the increased movements and the slide boundary extension into the southbound driving lane. It was agreed on-site between AT and Thurber that a survey, design and tender package would be prepared to remediate this slide prior to freeze-up this year, in conjunction with approach improvements and erosion corrections. The approximate cost to repair this slide was estimated to be in the order of $300,000.

The repair work was added as an addendum to the paving contract and will be carried out by Neudorf Trenching Ltd. this fall. The proposed remedial measures consist of subexcavating the slide, installing a subdrain and reconstructing the embankment slope and roadway with pit run gravel. Select clay from the excavation will be used to construct a toe berm at the base of the slide.

The ditch erosion that occurred at several locations in the spring of 2003 and which have generally degraded slightly more this year 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 to form suitable ditch sections that should be covered with topsoil, seed and soil covering.

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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 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, 2004

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2004	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 additional short cracks have re-appeared in the 2001 asphalt overlay since last year - steep back slope -A 900 mm diameter culvert is present close to the ramp at the north side, and is rusted/perforated. The inlet of the culvert is being further undermined by erosion, and the 0.6 m deep x 1 m wide scour area extends on each side of the culvert along the ditch for a total distance of about 20 m (enlarged from last year) -The erosion gully observed last year upstream of the culvert outlet along the south ditch has not changed. -At the culvert outlet and further to the south the extensive erosion observed last year has enlarged (see Figure SH12 Site #10 sketch plan for dimensions). Sidewall slumping was observed in the larger gully immediately downstream of the outlet. This erosion gulley is joined by an exposed outlet of a 200 mm flexible plastic Big O subdrain pipe further downstream that carries drainage water from Slide #11 area. This erosion gulley extends a distance of at least 60 m south of the culvert outlet and maybe further into the bush.	9	3	27	Short Term: - Asphalt patching and crack sealing maintenance - The 900 mm dia. CSP culvert should be lined with a smooth pipe grouted in-place inside the existing pipe. The rusted inlet/outlet sections should be removed, a good seal cut-off plug should be placed around the inlet/outlet and the ground surface should be recontoured to provide a rounded bowl at each end and armoured with riprap (~20m^3) over non-woven geotextile. - The erosion gullies in the ditches should be repaired with compacted clay fill and covering with erosion matting. Extra care should be undertaken by properly compacting new fill and riprap below/around the new culvert inlet to reduce the threat of undermining. - Visually monitor Long Term: - major highway re-alignment	
NORTH HILL SECTION (SH13)											
# 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 crosses 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 90 m, 110 m, 220 m and 280 m marks. -Fill settlement cracks are still visible over the drainage blanket area. - The guardrail is deflected about 100 mm laterally at the scarp crack, relative to a point just north of the crack - The erosion observed last year along the west ditch was similar to the 2003 observations. -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 gullies observed at various intervals along the west ditch should be filled with well compacted clay and 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 (99-1) outside the slide block which previously showed no movement, but showed about 1.5 mm/year at a depth of 23 m in Spring, 2004, although this may be attributed to reading error. The SI inside the slide block has sheared off. One pneumatic and 4 standpipe piezometers indicate that the piezometric surface is located at 2.0 to 4.0 m below ground surface

TABLE 1
Hwy 744:02 LITTLE SMOKY RIVER VALLEY

SUMMARY OF LANDSLIDES-JUNE, 2004

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2004	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 - an emergency call out was necessitated on Sept. 17, 2003, after a slide occurred with the scarp extending into the edge of the northbound driving lane (see Thurber letter dated Sept. 24, 2003) - the cracks and scarp heights observed during the call out have become worse, and the toe roll observed along the south half of the slump was noticeable larger - additional cracks were observed extending about 1 m into the southbound driving lane towards the north end of the slump, and on the downside slope parallel to the road alignment, and an intermittent crack with some settlement was observed south of the patch about 15 m long straddling the guardrail - similar to Sept., 2003, the culvert was only about 1/3 open - small erosion gullies were observed in the ditch on both sides of the west approach road - the slump previously observed in the west backslope was grassed and appeared relatively unchanged	11	5	55	Short to Medium Term: -Since the site visit surveying, design and a tender package have been prepared. This site will be remediated in conjunction with the Site #1 re-alignment and Hwy 744 pavement overlay work being carried out this fall by Neudorf Trenching Ltd. under the supervision of Stewart Weir Co. Ltd. With Thurber as the subconsultant. -Remedial measures will consist of sub-excavating the slide, installing a subdrain, and reconstructing the slope with pit run gravel. Some of the excavated clay will be used to construct a toe berm at the base of the slope. - the approach road sideslopes will also be flattened to 5H:1V, and the culvert will be replaced with a longer CSP c/w appropriate riprap placed at the inlet/outlet. - the erosion gullies in the ditch will be filled with gravel and covering with high flow erosion matting 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	- No significant changes observed, the 2002 repairs appear to be performing well - new cracks were observed along the sawcut edges of the patch installed during the 2002 repairs - no seepage was observed from the subdrain	4	4	16	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. Since repair the culvert has been lined with a smooth steel culvert, 762 mm diameter. A construction summary report of the slide repairs was prepared dated October 14, 2003. Short Term - visually monitor Long Term: - major highway re-alignment	

TABLE 1
Hwy 744:02 LITTLE SMOKY RIVER VALLEY

SUMMARY OF LANDSLIDES-JUNE, 2004

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2004	AT RISK ASSESSMENT			POTENTIAL REMEDIAL MEASURES	GEOTECHNICAL INSTRUMENTS
				Backslope Cut	Embank. D/S Fill		PF	CF	RA		
#12B	km 21.0	20 m	- 5 km	—	—	(NO SITE SKETCH PROVIDED) (Located half way between Site #12 and #12A) - No significant changes observed since 2003 inspection, which included a 20 m long crack along middle of northbound lane, a bit of toe bulge in the northbound sideslope, and 2 possible 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 Long Term - major highway re-alignment	
# 13 (SH13)	km 21.45 (4.35 km northeast of the bridge)	50 m	- 8 m	20	19	- Highway 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 - New observations in 2004 showed two slumps have developed – one about 10 m long and 15 m in width in the east sideslope the south side of the culvert, and the other about 7 m long centred over top the culvert directly below the gabion wall. An erosion rill about 25 m long, 0.2 m deep and 0.3 m wide has developed along the east ditch that exits at the center of the gabion wall. The slope has a fairly thick vegetation cover this year. - Also since the last inspection the repaired end of the 900 mm diameter PVC surface pipe which connected to the outlet of the culvert has dropped slightly into the riprap over the erosion channel, and the last joint has again separated with flow going beneath the bottom. Material below the riprap has also eroded some more. - A deep erosion gully is present beyond the outlet of the surface culvert, which also has worsened since the last inspection with a new scarp slump, and the riprap there has slid about 1.5 m vertically downslope.			n/a	Short Term: - The new slump in the embankment sideslope could be repaired in a similar manner to the one repaired in 2002 by subexcavating the slide zone and rebuilding the slope with clay fill placed in thin horizontal well compected lifts benched into the intact fill slope. This work should be carried out under warm weather conditions using dry clay fill. - Thurber are currently conducting a preliminary engineering assessment to develop remedial measures for this erosion area. One feasible measure consists of conveying the flow from the culvert down the slope in a welded smooth wall steel pipe. -In the meantime, visually monitor the new slumps to see if they enlarge.	

TABLE 1
Hwy 744:02 LITTLE SMOKY RIVER VALLEY

SUMMARY OF LANDSLIDES-JUNE, 2004

SITE	LOCATION	LENGTH OF AFFECTED ROAD	ESTIMATED EMBANKMENT FILL HEIGHT AT D/S SHOULDER (m)	SLOPE ANGLES (degrees)		UPDATED SITE CONDITIONS FOR JUNE 2004	AT RISK ASSESSMENT			POTENTIAL REMEDIAL MEASURES	GEOTECHNICAL INSTRUMENTS
				Backslope Cut	Embank. D/S Fill		PF	CF	RA		
# 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, and at distances of 60 to 80 m from, the road - Currently not effecting the road stability, but possible future impact on the stability -Erosion of material along the ravine may have increased slightly since the last inspection. At one location in the short east-west gully (see Photo 2), the lower 1/6 of the channel caved in and created a bit of a dam, pooling water about 0.5 m deep. - There may be slightly additional retrogression of the erosion area upslope into the highway ditch. The headscarp of erosion scour was 1.9 m deep and 5.3 m wide in 2004. A small tree located on the east side of the erosion will be used as a reference to better track the retrogression. - In 2003, 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.			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. <u>Short Term:</u> - Monitor the erosion	

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

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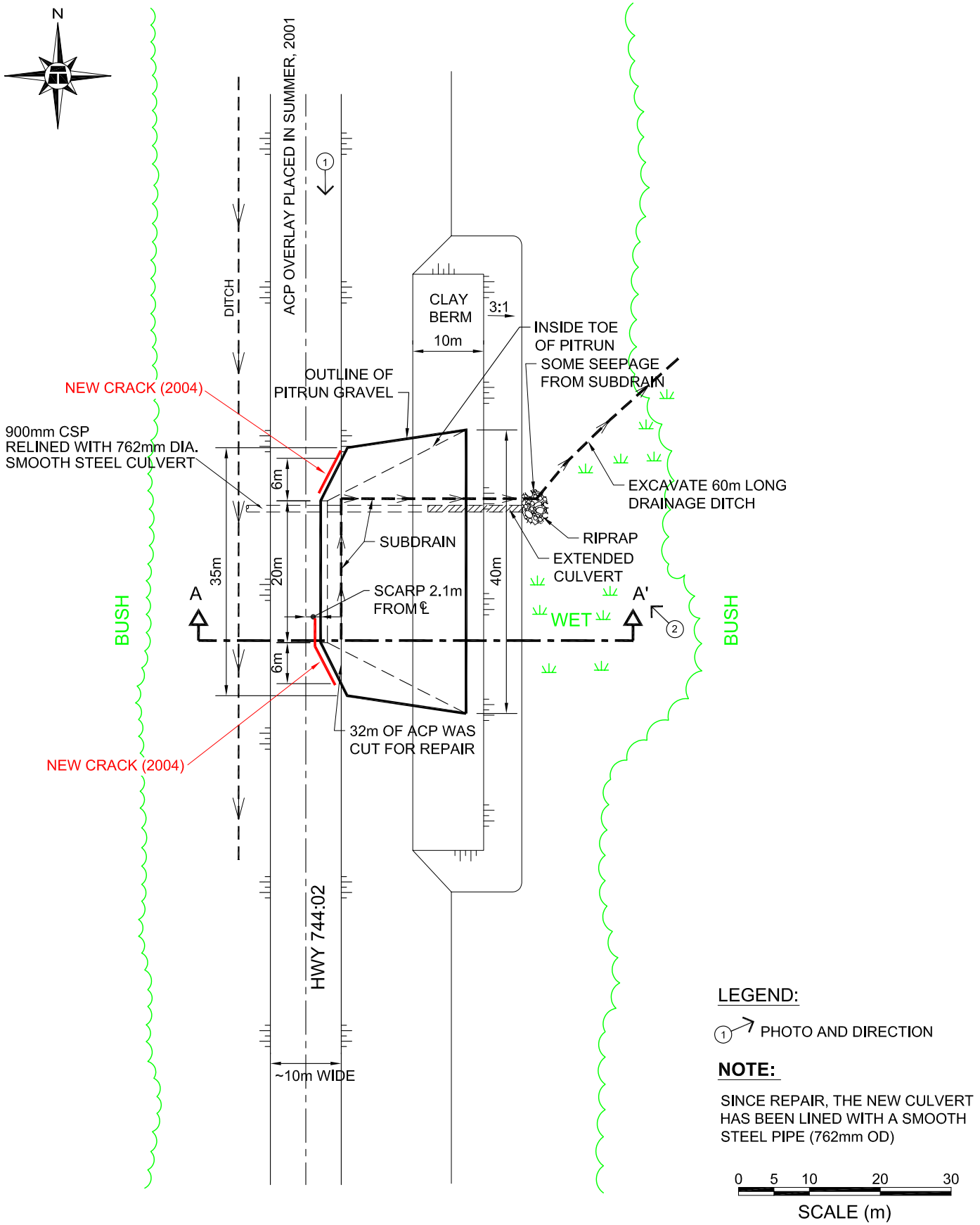

LEGEND:

① PHOTO AND DIRECTION

NOTE:

SINCE REPAIR, THE NEW CULVERT HAS BEEN LINED WITH A SMOOTH STEEL PIPE (762mm OD)

0 5 10 20 30

SCALE (m)

NOTES :

1. FEATURE LOCATIONS ARE APPROXIMATE.
2. PREVIOUS OBSERVATIONS SHOWN IN BLACK
3. JUNE 9, 2004 OBSERVATIONS SHOWN IN RED

FIGURE SH13-SITE #12A

HWY 744:02 LITTLE SMOKY RIVER VALLEY
SKETCH PLAN (JUNE 9, 2004)

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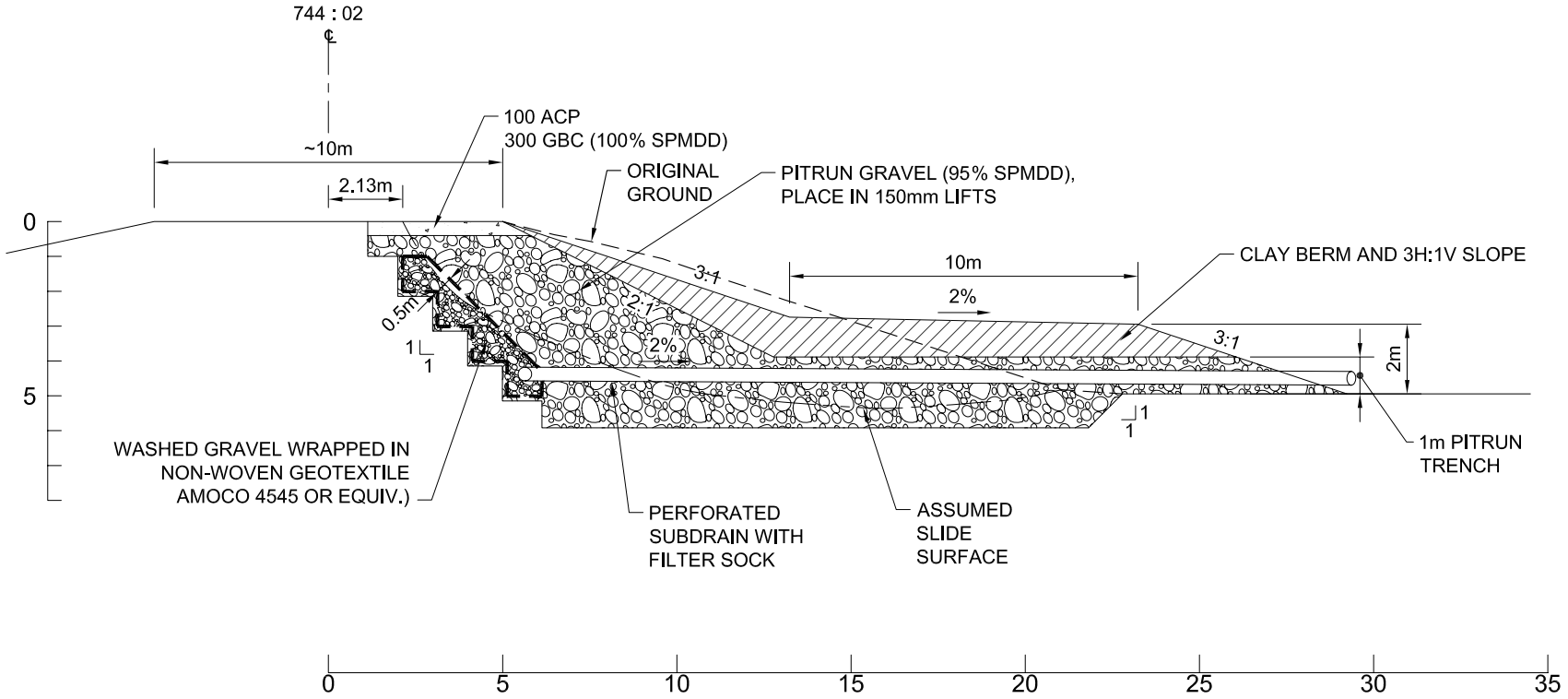

NOTE: REMEDIAL MEASURES CARRIED OUT ON JULY, 2002

FIGURE SH13-SITE #12A

HWY 744:02 LITTLE SMOKY RIVER VALLEY
CROSS-SECTON A - A' (JUNE 3, 2003)

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PHOTO #1 : LOOKING SOUTH TO SOUTHEAST AT SITE

SH13-SITE #12A

SH744:02 LITTLE SMOKY RIVER VALLEY
SELECTED SITE PHOTOGRAPH (JUNE 9, 2004)

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PHOTO #2 : LOOKING NORTHWEST AT CULVERT OUTLET.
NOTE : GOOD VEGETATION GROWTH SINCE LAST YEAR OVER REPAIRED AREA.

SH13-SITE #12A
SH744:02 LITTLE SMOKY RIVER VALLEY
SELECTED SITE PHOTOGRAPH (JUNE 9, 2004)
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