August 7, 2007 File: 15-85-68

Alberta Infrastructure and Transportation
2nd Floor, Provincial Building
111 – 54 Street
Edson, Alberta
T7E 1T2

Attention: Mr. Cliff Corner

NORTH CENTRAL REGION GEOHAZARD ASSESSMENT
HWY 734:22 EROSION OF PEMBINA RIVER BANKS (NC28)
SITE 1
2007 ANNUAL INSPECTION REPORT

Dear Sir:

This letter documents the 2007 annual site inspection of one of three sites located along Hwy 734:22 between 36.5 km and 40.5 km southeast of Robb, Alberta. Thurber Engineering Ltd. (Thurber) undertook this inspection in partial fulfillment of our Geotechnical Services for Geohazard Assessment, Instrumentation Monitoring and Related Work contract (CE046/2004) with Alberta Infrastructure and Transportation (AIT).

Site 1 is located 40.5 km southeast of Robb on Hwy 734:22 (km 35) at legal land description NW33-45-18-W5M. The site plan was previously included in Section F (Figure NC28-4A) and is considered accurate with no changes.

Mr. Don Law, P.Eng. and Mr. Ken Froese, P.Eng., of Thurber undertook the inspection on June 12, 2007, in the presence of Mr. Roger Skirrow, P.Eng., Mr. Fred Cheng, P.Eng., Dr. Rocky Wang, and Mr. Ron Coley of AIT.

1. BACKGROUND

Thurber last visited the site as part of the Geohazards Assessment program in June 2006 and the site conditions at that time are described in our Part B assessment letter in the site binder. Additional background information is provided in the geotechnical File Review in Section A of the site binder.

During September and October 2005, a repair was undertaken to address the ongoing erosion and poor riparian habitat conditions at the site. The work was completed under Contract 7148/05 and is summarized in the Project Summary Report dated March 20, 2006, which should be referred to for details of the construction methodology employed. A bioengineering and biotechnical seminar/workshop was also held in conjunction with the repair work. Since that time, a site-specific monitoring program was established for 2006 and 2007 to observe the vegetative growth, rock riprap stability, and overall integrity of the various slope treatments. Daily monitoring of stream levels and weather conditions is undertaken via a monitoring station installed at a nearby bridge. The results of the monitoring program are reported under separate cover.

2. SITE OBSERVATIONS

The repairs appear to be stable with no cracking observed on the roadway or bank slopes. No erosion gullies or rills were observed and vegetative growth including willow plants and grasses is well established. It was observed that the rock vanes have pushed the thalweg away from the bank and several areas of deposition have been established against the toe of the slope in backwater areas between the vanes.

The area of concern noted in 2005 between Spurs 3 and 4 was repaired using vegetated riprap and showed no evidence of distress or continued regression in 2006 or 2007.

No erosion was noted at the culvert inlet and outlet. Flow appeared to be contained within the culvert for its whole length.

The water level was relatively high during the site visit; significantly higher than the low water level seen during the 2006 visit. Based on water level measurements at the nearby bridge (where the monitoring station is located), the river elevation was 1295.27 m shortly after the June 6, 2006, site visit and at elevation 1295.62 m on June 12, 2007.

3. ASSESSMENT

The repairs undertaken in 2005 appear to have stabilized this site.

4. RISK LEVEL

The risk level for this site has been assessed as follows:

PF(1) * CF(2) = 2

A Probability Factor of 1 is considered appropriate since the erosion by the river has been effectively removed. Although the methods of repair at this site are experimental in nature, there was almost no damage following a 1-in-2 year flood event in the first growing season (June 2006) and the vegetation is becoming more established with time effectively lowering the risk with each year. A Consequence Factor of 2 is applicable since the embankment is relatively low, no major structures are at risk, and only partial closure of the highway would result. This risk level is substantially reduced from a value of 18 applied in 2005 and lower than the value of 6 applied in 2006.

5. RECOMMENDATIONS

5.1 Short Term

No short term measures need to be undertaken at this time.

5.2 Long Term

Long term remediation measures have been undertaken and appear to be functioning as expected. Furthermore, a separate monitoring program is in place where frequent inspections of the site are made. Therefore, it is recommended to discontinue detailed inspection and reporting on Site 1 on an annual basis under the GeoHazards program. Consideration should be given to reintroducing Site 1 to the annual program if there is any reason for concern about the long-term stability of the site following completion of the monitoring program.

5.3 Investigation

No additional investigation is required at this time.

5.4 Maintenance

No maintenance measures are required at this time.

6. CLOSURE

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

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

Ken Froese, P.Eng.
Project Engineer
/dw

Attachments

cc: Mr. Roger Skirrow, P.Eng., Director of Geotechnical Services, AIT

August 7, 2007 File: 15-85-68

Alberta Infrastructure and Transportation
2nd Floor, Provincial Building
111 – 54 Street
Edson, Alberta
T7E 1T2

Attention: Mr. Cliff Corner

NORTH CENTRAL REGION GEOHAZARD ASSESSMENT
HWY 734:22 EROSION OF PEMBINA RIVER BANKS (NC28)
SITE 8
2007 ANNUAL INSPECTION REPORT

Dear Sir:

This letter documents the 2007 annual site inspection of one of three sites located along Hwy 734:22 between 36.5 km and 40.5 km southeast of Robb, Alberta. Thurber Engineering Ltd. (Thurber) undertook this inspection in partial fulfillment of our Geotechnical Services for Geohazard Assessment, Instrumentation Monitoring and Related Work contract (CE046/2004) with Alberta Infrastructure and Transportation (AIT).

Site 8 is located 37 km southeast of Robb on Hwy 734:22 (km 40.4, corrected from past reports) at legal land description S18-46-18-W5M (also corrected from past reports). Site features are shown in Figures NC28-2A and -2B (attached for inclusion in Section F). Cross-section A-A' on Figure NC28-2A shows the reconstructed slope in the guardrail area.

Mr. Don Law, P.Eng. and Mr. Ken Froese, P.Eng., of Thurber undertook the inspection on June 12, 2007, in the presence of Mr. Roger Skirrow, P.Eng., Mr. Fred Cheng, P.Eng., Dr. Rocky Wang, and Mr. Ron Coley of AIT.

1. BACKGROUND

Thurber last visited the site as part of the Geohazard Assessments program in June 2006 and the site conditions at that time are described in our Part B

assessment letter in the site binder. Additional background information is provided in the geotechnical File Review in Section A of the site binder.

During September and October 2006, a repair was undertaken to address the ongoing erosion and poor riparian habitat conditions at the site. The work was completed under Contract 7334/06 and is summarized in the Project Summary Report dated November 29, 2006, which should be referred to for details of the construction methodology employed. A bioengineering and biotechnical seminar/workshop was also held in conjunction with the repair work. Since that time, a site-specific monitoring program was established to observe the vegetative growth, rock riprap stability, and overall integrity of the various slope treatments. Daily monitoring of stream levels and weather conditions is undertaken via a monitoring station installed at a nearby bridge. The results of the monitoring program will be reported under separate cover.

This 2007 inspection documented herein is the first Geohazards Assessment visit to the site since the completion of construction in Fall 2006.

2. SITE OBSERVATIONS

Conditions have significantly improved since 2006 as the site was rebuilt later that same fall. The repairs appear to be stable with no cracking observed on the roadway. Some minor settlement cracking was noted on the slope below the guardrail and over the rootwad installations. Some minor rills were observed in the blown compost cover along the guardrail section. It was observed that the rock vanes were successful in maintaining the thalweg away from the bank.

As part of the repairs, the top of bank was extended at least 2 m from the guardrail. Several compost berms were installed further north along the west ditch to direct surface runoff away from the high slopes that had experienced slumping in the past. This runoff is directed to the river partially via a live pole drain at the end of the compost berm and through a rock apron further downhill (immediately upstream of the guardrail). Minor erosion was noted at the rock apron. It also appeared that runoff was accumulating in the ditch beside the guardrail. This ponding was corrected on-site by the LaPrairie grader operator as directed by Mr. Ron Coley, AIT.

The water level was relatively high during the site visit; significantly higher than the low water level seen during the 2006 visit. Based on water level measurements at the nearby bridge (where the monitoring station is located), the river elevation was 1295.27 m shortly after the June 6, 2006, site visit and at elevation 1295.62 m on June 12, 2007.

3. ASSESSMENT

The repairs undertaken in 2006 appear to have stabilized this site. Aside from any unusually high river events, no deterioration of this site is expected. Although minor erosion of the compost blanket was noted in a few areas, it is anticipated that future vegetation development will be sufficient to resist runoff. Maintaining the ditch swale to prevent ponding of water is recommended to prevent concentrated flow on the slopes.

4. RISK LEVEL

The risk level for this site has been assessed as follows:

PF(3) * CF(2) = 6

A Probability Factor of 3 is considered appropriate since the erosion by the river has been effectively removed. However, as the methods of repair at this site are experimental in nature, there remains the possibility that erosion could continue in limited areas. With time, as vegetative cover is fully established, the probability of damage to the bank as a result of river erosion is expected to decrease. A Consequence Factor of 2 is applicable since the embankment is relatively low, no major structures are at risk, and only partial closure of the highway would result. This risk level is substantially reduced from a risk level of 18 applied in 2006.

5. RECOMMENDATIONS

5.1 Short Term

No short term remedial measures are required at this time. There remains the possibility that a high flow event could result in erosion that would threaten the highway. Any significant changes noted by the maintenance contractor or MCI during routine road inspections should be assessed.

5.2 Long Term

Long term remediation measures have been undertaken and appear to be functioning as expected. Furthermore, a separate monitoring program has been initiated to undertake frequent inspections of the site. However, it is recommended to conduct a GeoHazard Assessment site visit in 2008 to review the site after the first full growing season.

5.3 Investigation

No additional investigation is required at this time.

5.4 Maintenance

No maintenance is required at this time.

6. CLOSURE

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

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

Ken Froese, P.Eng.
Project Engineer

Attachments

cc: Mr. Roger Skirrow, P.Eng., Director of Geotechnical Services, AIT

August 7, 2007 File: 15-85-68

Alberta Infrastructure and Transportation
2nd Floor, Provincial Building
111 – 54 Street
Edson, Alberta
T7E 1T2

Attention: Mr. Cliff Corner

NORTH CENTRAL REGION GEOHAZARD ASSESSMENT
HWY 734:22 EROSION OF PEMBINA RIVER BANKS (NC28)
SITE 9
2007 ANNUAL INSPECTION REPORT

Dear Sir:

This letter documents the 2007 annual site inspection of one of three sites located along Hwy 734:22 between 36.5 km and 40.5 km southeast of Robb, Alberta. Thurber Engineering Ltd. (Thurber) undertook this inspection in partial fulfillment of our Geotechnical Services for Geohazard Assessment, Instrumentation Monitoring and Related Work contract (CE046/2004) with Alberta Infrastructure and Transportation (AIT).

Site 9 is located 36.5 km southeast of Robb on Hwy 734:22 (km 42.3) at legal land description NW18-46-18-W5M (Figure NC28-1A, attached for inclusion in Section F). Cross-section A-A' on the figure shows the reconstructed slope profile.

Mr. Don Law, P.Eng. and Mr. Ken Froese, P.Eng., of Thurber undertook the inspection on June 12, 2007, in the presence of Mr. Roger Skirrow, P.Eng., Mr. Fred Cheng, P.Eng., Dr. Rocky Wang, and Mr. Ron Coley of AIT.

1. BACKGROUND

Thurber last visited the site as part of the Geohazards Assessment program in June 2006 and the site conditions at that time are described in our Part B assessment letter in the site binder. Additional background information is provided in the geotechnical File Review in Section A of the site binder.

During September and October 2005, a repair was undertaken to address the ongoing erosion and poor riparian habitat conditions at the site. The work was completed under Contract 7148/05 and is summarized in the Project Summary Report dated March 20, 2006, which should be referred to for details of the construction methodology employed. A bioengineering and biotechnical seminar/workshop was also held in conjunction with the repair work. Since that time, a site-specific monitoring program was established for 2006 and 2007 to observe the vegetative growth, rock riprap stability, and overall integrity of the various slope treatments. Daily monitoring of stream levels and weather conditions is undertaken via a monitoring station installed at a nearby bridge. The results of the monitoring program are reported under separate cover.

2. SITE OBSERVATIONS

Conditions have significantly improved since 2005 as the site was rebuilt in Fall 2005. The repairs appear to be stable with no cracking observed on the roadway or bank slopes. No erosion gullies or rills were observed. It was observed that the rock vanes were successful in maintaining the thalweg away from the bank.

As part of the repairs, the top of bank was extended at least 0.8 m from the guardrail and the previously damaged culvert was replaced and extended. The inlet ditch (north side) was modified to improve flow to the culvert. No erosion was noted at either end of the culvert and flow appeared to be contained within the culvert for its whole length.

There is on-going erosion of the bank immediately downstream of the end of the riprap as evidenced by bank under-cutting and leaning trees. The erosion noted downstream of the riprap protection had begun before the repairs were undertaken and is similar to areas of the bank slightly further downstream. As this is away from the roadway, the impact to the highway is expected to be negligible.

The water level was relatively high during the site visit; significantly higher than the low water level seen during the 2006 visit. Based on water level measurements at the nearby bridge (where the monitoring station is located), the river elevation was 1295.27 m shortly after the June 6, 2006, site visit and at elevation 1295.62 m on June 12, 2007.

3. ASSESSMENT

The repairs undertaken in 2005 appear to have stabilized this site. Aside from any unusually high river events, no deterioration of this site is expected.

Ongoing vegetative growth will continue to improve the surficial soil stability at the site. It is believed that the eroding area immediately downstream of the riprap treatment will stabilize with time.

4. RISK LEVEL

The risk level for this site has been assessed as follows:

PF(1) * CF(2) = 2

A Probability Factor of 1 is considered appropriate since the erosion by the river has been effectively removed. Although the methods of repair at this site are experimental in nature, there was almost no damage following a 1-in-2 year flood event in the first growing season (June 2006) and the vegetation is becoming more established with time effectively lowering the risk with each year. A Consequence Factor of 2 is applicable since the embankment is relatively low, no major structures are at risk, and only partial closure of the highway would result. This risk level is substantially reduced from a risk level of 22 applied in 2005 and is lower than the value applied in 2006.

5. RECOMMENDATIONS

5.1 Short Term

No short term measures need to be undertaken at this time although on-going monitoring of the downstream area should continue.

5.2 Long Term

Long term remediation measures have been undertaken and appear to be functioning as expected. Furthermore, a separate monitoring program is in place to undertake frequent inspections of the site. However, given the on-going bank regression downstream of the treatment zone and discussions with Fisheries and Oceans Canada, it is recommended that detailed inspection and reporting for Site 9 continue for at least one more year.

5.3 Investigation

No additional investigation is required at this time.

5.4 Maintenance

No maintenance measures are required at this time.

6. CLOSURE

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

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

Ken Froese, P.Eng.
Project Engineer
/dw

Attachments

cc: Mr. Roger Skirrow, P.Eng., Director of Geotechnical Services, AIT

Z:\15\15-85-68\FIGURE NC28-2A.dwg - NC28-2A - Jul. 25, 2007 10:43 AM

N E S W

1313

℄ HIGHWAY 734

DELINEATOR POST

AREA COVERED BY COMPOST BLANKET (TYP)

ROCK APRON

MINOR SETTLEMENT CRACK

MINOR RILL

GUARDRAIL

MINOR PONDED WATER (CORRECTED ON SITE WITH MC GRADER)

DELINEATOR POSTS

REBUILT TOP OF BANK (TYP)

MM11

MINOR SETTLEMENT CRACK

ROCK APRON

TOE OF LPSTP

VANE 3 ASBUILT HIGH POINT EL. 1311.576

EL. 1309.887

VANE 2 ASBUILT HIGH POINT EL. 1311.319

EL. 1309.493

℄ LPSTP

LPSTP END TREATMENT

EL. 1310.313

VANE 1 ASBUILT HIGH POINT EL. 1311.481

MINOR EROSION

WATTLES & LIVE STAKING

7.5m

12m

3m

BRUSH LAYERING (2 LAYERS)

ROOTWADS (7), POLE PLANTING & LIVE STAKING & BRUSH LAYERING (1 LAYER)

ROOTWADS (2)

LPSTP END TREATMENT

XS1

XS2

XS3

XS4

XS5

65m

LPSTP & LIVE SILTATION

EL. 1310.191

LOG JAM

GRAVEL BAR

REBUILT TOP OF BANK (TYP)

ISLAND

LOG JAM

EL. 1309.756

LEGEND

- VANE HIGH POINT
- VANE FOOTPRINT
- BOULDER CLUSTER
- DEEPEST POINT ALONG CROSS-SECTION (SEPT 2006)
- XS4 — CROSS-SECTION LOCATION (APPROXIMATE)

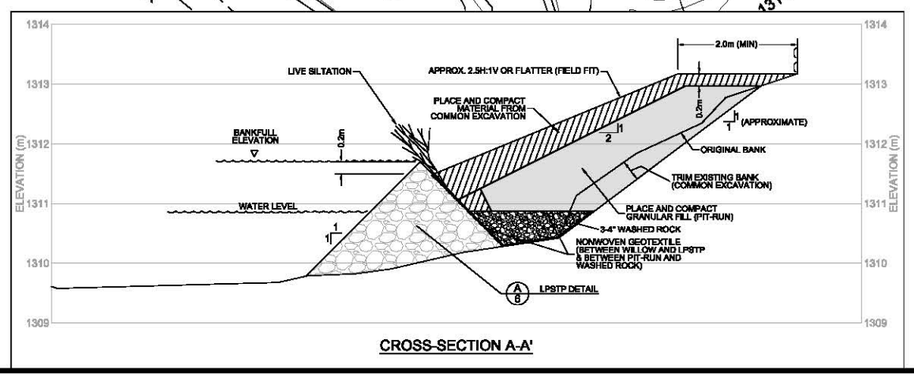
NOTE: 2007 OBSERVATIONS IN RED

NOTES

1. ALL TREATMENT DIMENSIONS MEASURED AT TOE OF BANK.
2. CONTOUR INTERVAL: 0.5m

0 5 10 15 20 25m

SCALE 1:400



CROSS-SECTION A-A'

AS-BUILT SURVEY OCTOBER 21, 2006.
BASE PLAN PROVIDED BY EXH ENGINEERING SERVICES LTD.

THURBER PROJECT #15-85-68

ALBERTA INFRASTRUCTURE & TRANSPORTATION

SITE PLAN - SITE 8 (DOWNSTREAM SECTION)

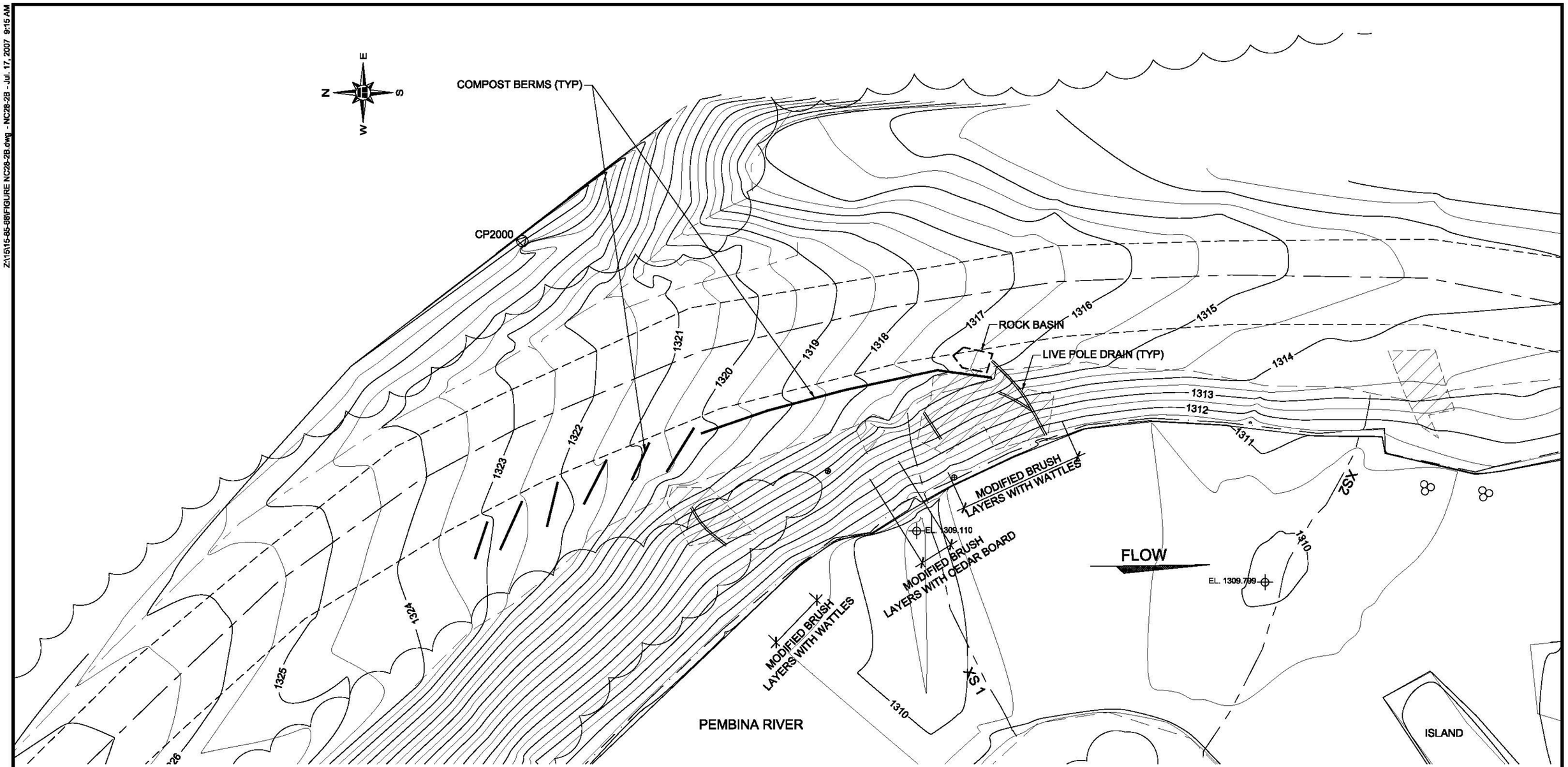
NORTH CENTRAL 2007
GEOHAZARDS ASSESSMENT

HWY 734 : 22 km 40.4 - (NC28)
S 18-46-18 W5M
SOUTH OF ROBB, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER:	DRAWN:	APPROVED:
KEF	PS	DJL
DATE: JULY 2007	SCALE: 1:400	DRAWING No. FIGURE NC28-2A

Z:\15\15-85-86\FIGURE NC28-2B.dwg - NC28-2B - Jul. 17, 2007 9:15 AM



LEGEND

⊠ DEEPEST POINT ALONG CROSS-SECTION (SEPT 2006)

—— XS1 —— CROSS-SECTION LOCATION (APPROXIMATE)

NOTE: 2007 OBSERVATIONS IN RED

NOTE

CONTOUR INTERVAL: 0.5m

0 5 10 15 20 25m

SCALE 1:400

AS-BUILT SURVEY OCTOBER 21, 2006.
BASE PLAN PROVIDED BY EXH ENGINEERING SERVICES LTD.

THURBER PROJECT #15-85-68

ALBERTA INFRASTRUCTURE & TRANSPORTATION

SITE PLAN - SITE 8
(UPSTREAM SECTION)

NORTH CENTRAL 2007
GEOHAZARDS ASSESSMENT

HWY 734 : 22 km 40.4 - (NC28)
S 18-46-18 W5M
SOUTH OF ROBB, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER:	DRAWN:	APPROVED:
KEF	HH	DJL
DATE:	SCALE:	DRAWING No.
JULY 2007	1:400	FIGURE NC28-2B

LPSTP & RIPRAP & GRANULAR FILL

29m

33m

NEW 600mm x 18.0m CSP
N INV EL 99.275
S INV EL 98.855

℄ HIGHWAY 734

℄ LPSTP

COMPOST

ECB

TOP OF BANK (TYP)

TIP EL. 97.221

97.032

VANE 1 ASBUILT HIGH POINT EL. 98.702

TIP EL. 96.903

VANE 2 ASBUILT HIGH POINT EL. 98.567

96.908

TIP EL. 96.780

VANE 3 ASBUILT HIGH POINT EL. 98.485

96.800

TIP EL. 96.352

96.482

96.147

VANE 4 ASBUILT HIGH POINT EL. 98.273

ROCK (TYP)

ON-GOING BANK EROSION (2007) (SEE PHOTO 3)

3m END TREATMENT

95.550

96.525

FLOW

PEMBINA RIVER

XS 1

XS 2

XS 3

XS 4

XS 5

XS 6

XS 7

XS 8

6 SX

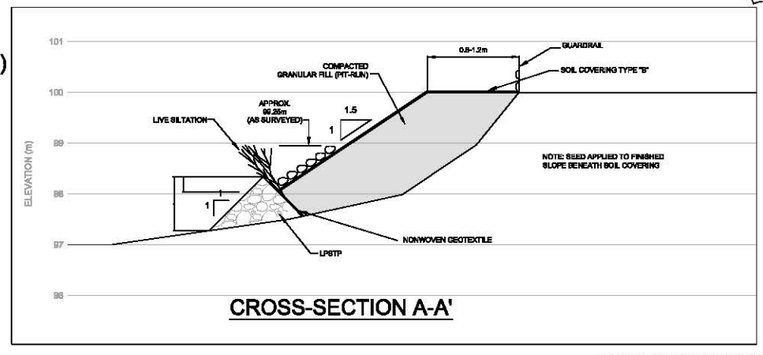
XS 10

NW 18-46-18-5

33.5m LIVE SILTATION

MIXED NATIVE TREES

BOTTOM OF BANK (TYP)



CROSS-SECTION A-A'

LEGEND

LPSTP	LONGITUDINAL PEAKED STONE TOE PROTECTION
	VANE FOOTPRINT
	LPSTP
ECB	EROSION CONTROL BLANKET (APPROX.)
COMPOST	COMPOST (APPROX.)
XS8	CROSS-SECTION OCT. 2005
	CROSS-SECTION NOV. 2004
⊕	DEEPEST POINT ALONG CROSS-SECTION (OCT. 2005)

NOTE: 2007 OBSERVATIONS IN RED

GEODETIC ELEVATIONS ADD 1214.328m

BASE PLAN PROVIDED BY EXH ENGINEERING SERVICES LTD. & SURVEYED ON APRIL 15, 2005

THURBER PROJECT #15-85-68

ALBERTA INFRASTRUCTURE & TRANSPORTATION

SITE PLAN - SITE 9

NORTH CENTRAL 2007 GEOHAZARDS ASSESSMENT

HWY 734 : 22 km 42.3 - (NC28)
NW 18-46-18 W5M
SOUTH OF ROBB, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER:	DRAWN:	APPROVED:
KEF	HH	DJL
DATE: JULY 2007	SCALE: 1:500	DRAWING No. FIGURE NC28-1A

Photo 1 – Looking northwest at Vane 2 and upstream – note higher water levels and vegetation growth compared to 2006 visit, June 12, 2007.

Photo 2 – Looking east at Vane 2 and downstream, June 12, 2007.

Photo 3 – Looking east (downstream) at culvert and Vanes 4 to 6, June 12, 2007.

Photo 4 – Looking east (downstream) toward Vane 6 – this had been the slumping section between Spurs 3 and 4, June 12, 2007.

Photo 1 – Looking northeast at repaired slump area below guardrail, June 12, 2007.

Photo 2 – Looking southeast at repaired main slump area, June 12, 2007.

Photo 3 – Looking north at north slope area, June 12, 2007.

Photo 4 – Looking southwest at repaired slump area at south end of site, June 12, 2007.

Photo 1 – Looking east (downstream) at culvert and Vane 4, June 12, 2007.

Photo 2 – Looking west (upstream) at Vanes 3, 2, and 1, June 12, 2007.

Photo 3 – Looking at eroding outside bank downstream of Site 9, June 12, 2007.

Photo 4 – Closer view of bank in Photo 3, June 12, 2007.