

Two vertical bars, one green and one blue, are positioned on the left side of the page.

Peace Project Water Use Plan

Williston Reservoir Trial Tributaries

Implementation Year 5

Reference: GMSWORKS-19

Ole Creek 2016 Engineering Inspection Report

Study Period: 2016

KERR WOOD LEIDAL

May 14, 2018

Site Inspection Report

PROJECT:	WILLISTON TRIAL TRIBUTARIES POST-CONSTRUCTION MONITORING				
CLIENT:	BC Hydro				
TO:	Shelley Wennas, PMP				
SITE NAME:	Ole Creek				
REPORT DATE:	May 14, 2018				
FILE NO.:	BC Hydro Contract 00093683 & KWL File: 0478.189				
PREPARED BY:	Stefan Joyce, P.Eng	ON SITE	May 4: 11am May 5: 9am	OFF SITE	May 4: 5:30pm May 5: 5:45pm
DATE:	May 4 & 5, 2016	WEATHER	May 4: Cloudy with sunny breaks, some light rain May 5: Sunny and windy		
TAILGATE MEETING NOTES	Reviewed hazards, risks, game plan for day and check-in schedule. Confirmed safety gear and equipment. <i>{Used in this form in lieu of KWL "Appendix B04-Tailgate Meeting"}</i>				

KWL STAFF		EMERGENCY CONTACT	
Stefan Joyce	{Original hardcopy signed}	Nearest Hospital: Mackenzie District Hospital 45 Centennial Dr., Mackenzie BC	
Tom Claxton	{Original hardcopy signed}		
Peter Collins	{Original hardcopy signed}		
Planned Daily Activities		Emergency Services	911
Survey and inspection (May 4, 2016)		Hospital (non-emergency):	250 997-3263
Training of the environmental monitoring contractor for future annual inspections (May 4, 2016)		Police (non-emergency):	250 997-3288
Survey and inspection (May 5, 2016)		Wildfire Management	1800 663-5555
		Client Project Manager	Shelley Wenaas 604 528-7791
		On-site First aid Attendant	Peter Collins
Additional Identified Hazards		Additional Identified Hazard Mitigation	
No additional hazards that weren't identified in the project safety plan.		Not applicable.	

Site Hazard Assessment and Safety Plan reviewed?



YES



NO



N/A

1.0 SURVEY SUMMARY

- All the berms were above the reservoir level (not submerged) and the creek flow was high, but safe to wade in most locations, so a complete survey of the berm and channel in the vicinity of the work area was conducted.
- The 2016 survey extents are presented in the enclosed drawings.
- Berm profiles and sections are presented in the survey drawings showing the 2014 pre-construction, 2014 post-construction, and the 2016 follow up surveys.
- The 2016 survey drawings used the record drawings as base and have retained the 2014 drawing numbering of 1000-C1800061 for plan and profile of Ole Creek. A new 2016 cross section drawing was added as drawing number 1000-C1800066 to follow the numbering from the 2014 drawing set. Digital survey data was also provided for BC Hydro's records.

2.0 GENERAL SITE OBSERVATIONS:

- The reservoir level at the time of the work was surveyed at 664.6 m (May 5)
- The works are performing well and the creek is still maintaining a single thread channel as designed.
- There appears to be some settlement / erosion on the right bank (looking downstream) berm crest.
- The debris catchers have sustained some damage, but are largely performing well and have prevented log debris from blocking the creek mouth.
- Upstream of the works there is gravel deposition and a logjam that is threatening the long-term effectiveness of the constructed works downstream within the reservoir.



PHOTO 1 (Panoramic): Ole Creek works looking upstream from downstream left bank



PHOTO 2 (Panoramic): Ole Creek works looking upstream from downstream left bank



PHOTO 3 (Panoramic): Ole Creek works looking upstream at upper berms and debris catchers



PHOTO 4 (Panoramic): Ole Creek looking downstream along Berm 'A' just upstream of Berm 'C'



PHOTO 5 (Panoramic): Ole Creek looking downstream from below Berm 'A'

3.0 BERM GEOMETRY, EROSION AND AGGRADATION, CHANNEL OBSERVATIONS

List of berms (in order from reservoir to upland):

3.1 Berm 'D': Low gravel berm (right bank)

- The berm is generally in good condition; however, there has been some settlement/displacement and erosion of the finer fraction of material from the berm crest based on visual observations and the survey (see Profile on DWG 1000-C1800061-R2, and Sections 0+360 and 0+380 on 1000-C1800066-R0).
- The top of berm is slightly uneven in some locations with some large cobble proud of crest.
- The erosion, settlement and displacement of some material could be caused by large woody debris movement, wave action, ice movement, and creek flow over the berm as the reservoir level rises.
- The berm is still functioning well and serving the purpose of maintaining a single thread channel.
- Berm 'D' and the lower portion of Berm 'C' have been altered more than the other berms since construction, which is likely due to it being at a lower elevation than the other berms, and thus subject to more erosive action.



PHOTO 6 (Panoramic): Looking upstream at Berm 'D' from right bank



PHOTO 7 (Panoramic): Looking upstream along Berm 'D' from downstream end of berm



PHOTO 8: Berm 'D' looking from left bank



PHOTO 9: Berm 'D' looking downstream



PHOTO 10: Looking upstream at Berm 'D' from downstream end of berm. Note erosion of fine fraction of the berm crest.



PHOTO 11: Looking downstream at Berm 'D'

3.2 Berm 'B': Low gravel berm (left bank)

- Berm 'B' has retained its shape and shows no significant signs of erosion or settlement based on visual observations and the survey (see Profile on DWG 1000-C1800061-R2, and Sections 0+280 through 0+300 on 1000-C1800066-R0).
- There is some unevenness to the berm crest with some large cobble proud of crest. This has likely occurred due to floating log movement, wave action, and reservoir ice movement
- The LWD embedded in the berm is intact and does not appear to have shifted.



PHOTO 12 (Panoramic): Berm 'B' looking downstream on left side of photo and Berm 'D' at right side



PHOTO 13 (Panoramic): Berm 'B' looking upstream at lower end (in centre of photo)



PHOTO 14 (Panoramic): Looking at Berm 'B' from Berm 'D'



PHOTO 15: Looking downstream along Berm 'B'



PHOTO 16: Buried LWD in Berm 'B'



PHOTO 17: Looking downstream along Berm 'B'



PHOTO 18: Downstream end of Berm 'B'

3.3 Berm 'C': Low gravel berm with wood debris catcher and buried wood debris elements (right bank)

- Berm 'C' is generally in good condition; however, there has been some settlement/displacement and erosion of the finer fraction of material from the berm crest based on visual observations and the survey, particularly in the lower section of the berm (see Profile on DWG 1000-C1800061-R2, and Sections 0+200 through 0+320 on 1000-C1800066-R0).
- The berm is still functioning well and serving the purpose of maintaining a single thread channel.
- The top of berm is slightly uneven in some locations with some large cobble proud of crest.
- The erosion, settlement and displacement of some material could be caused by large woody debris movement, wave action, ice movement, and creek flow over the berm as the reservoir level rises.
- The lower portion of Berm 'C' and Berm 'D' have been altered more than the other berms since construction, which is likely due to it being at a lower elevation than the other berms, and thus subject to more erosive action.
- The buried / embedded large woody debris (LWD) is intact and does not appear to have shifted.
- The wood debris catcher has been effective in capturing log debris limiting deposition of log debris at the creek mouth (see Photos 28 & 29).
- The woody debris catcher has sustained some impact damage resulting in two broken upright logs.
- There is also frictional damage on the wood debris catchers (tan coloured where rubbed, see Photo 30).



PHOTO 19 (Panoramic): Looking downstream along the lower section of Berm 'C' at LWD location



PHOTO 20 (Panoramic): Looking downstream along Berm 'C' from just downstream of woody debris catcher



PHOTO 21 (Panoramic): Looking upstream at Berm 'C' and woody debris catcher



PHOTO 22 (Panoramic): Looking upstream along Berm 'C' and woody debris catcher (on left in photo)



PHOTO 23 (Panoramic): Looking downstream at Berm 'C' and woody debris catcher



PHOTO 24 (Panoramic): Looking upstream at Berm 'C' and woody debris catcher



PHOTO 25: Captured woody debris & broken logs



PHOTO 26: Damage to woody debris catcher



PHOTO 27: Looking upstream at lower Berm 'C' from downstream end of berm. Note uneven top of berm, some large cobble proud of crest.



PHOTO 28: Looking downstream at Berm 'C'. Armour layer of cobble in good condition.



PHOTO 29: Looking upstream at Berm 'C' from downstream end of berm.



PHOTO 30: LWD Looking downstream

3.4 Berm 'A': Low gravel berm with wood debris catcher (left bank)

- Berm 'A' has retained its shape and shows no significant signs of erosion or settlement based on visual observations and the survey (see Profile on DWG 1000-C1800061-R2, and Sections 0+160 through 0+220 on 1000-C1800066-R0).
- Some erosion is visible around the base of the upright logs of the woody debris catcher, where additional backfill had been placed. Erosion did not occur on the berm crest.
- The woody debris catcher has largely been effective and has captured much log debris and has prevented blockage of the creek mouth (see Photos 33, 34 & 39). Some of the upright logs in the woody debris catcher have sustained impact damage. Three upright logs have broken and a few have shifted by log impact, many show rubbing and impact damage near the base of the logs (see example Photos 40 & 41).
- There is some log debris that has managed to float between the left (berm 'A') and right bank (Berm 'C') woody debris catchers, but this is limited and could be manually removed if it becomes an issue (see Woody Debris Observations section below).
- There has been some vegetation growth on the berm crest, however the willow stakes did not take following installation (noted in previous monitoring).
- The ECM is mostly intact but is deteriorating (as expected).
- The buried / embedded LWD is intact and does not appear to have shifted.



PHOTO 31 (Panoramic): Berm 'A' and left bank woody debris catcher



PHOTO 32 (Panoramic): Berm 'A' and left bank woody debris catcher (note bend is exaggerated)



PHOTO 33 (Panoramic): Downstream end of Berm 'A' (note flotsam) and woody debris catcher



PHOTO 34 (Panoramic): Woody debris catcher with captured wood visible behind the upright logs. Some wood debris not captured is visible to the right (note bend is exaggerated in panoramic).



PHOTO 35 (Panoramic): Berm A and left bank woody debris catcher looking from left bank. Note some shifted and broken upright logs.



PHOTO 36: Downstream end of Berm 'A' looking downstream



PHOTO 37: Flotsam at downstream end of Berm 'A' looking downstream



PHOTO 38: Upstream end of Berm 'A'



PHOTO 39: logs caught by woody debris catcher



Photo 40: Broken upright log of the woody debris catcher



Photo 41: Damage to base of woody debris catcher upright logs



Photo 42: Downstream end of Berm 'A' and LWD embedded in berm (left side of photo)



Photo 43: Embedded LWD in Berm 'A'

4.0 WOOD DEBRIS OBSERVATIONS

- There is a small logjam that has formed just upstream of Berm 'C' and along Berm 'A'. It is in the vicinity of where some log debris was able to pass between the woody debris catchers, so it is likely a combination of log debris transported by the creek and logs floated from the reservoir.
- The environmental monitoring contractor noted that the logjam is not presently a barrier to fish passage, but could become one if it accumulates material. This logjam should be monitored and could be removed if it becomes a barrier to fish passage.
- The log debris that has managed to float between the debris catchers and has come to rest on the berm crest could be removed, but at present it is limited and not a problem. The environmental monitoring contractor commented that the wood often floats in and out during the season. The accumulation of wood should be monitored.
- If the opening at the creek between the left and right bank wood debris catcher were narrower, then there may have been less material floated upstream along the creek, however if it were narrower, it could have encouraged a logjam at the debris catcher opening around the creek.



PHOTO 44 (Panoramic): Looking upstream at logjam from right bank



PHOTO 45 (Panoramic): Looking upstream at logjam from right bank



PHOTO 46 (Panoramic): Looking at channel upstream of logjam from right bank, Berm 'A' at right



PHOTO 47: Looking at logjam from left bank



PHOTO 48: Looking upstream opening between left and right bank woody debris catchers

5.0 UPSTREAM CHANNEL OBSERVATIONS

- As noted in the construction completion report¹, there is a gravel bar and logjam upstream of the constructed works that could result in an avulsion along a historical dry channel (see Figure 1 enclosed).
- Gravel/cobble deposited during a large event perhaps about 5 years ago (The environmental monitoring contractor commented that 2011 flow was high in this area). This has changed the course of the creek and it is now undermining tree roots, which will cause trees to fall over and potentially create log jams. The channel has become less defined and more unstable since the 2014 observation. Selective removal of trees at risk of falling across channel could be considered and monitoring is recommended during the annual inspections.
- As noted in 2014 during construction, there is a log jam located just downstream of gravel/cobble deposition that could encourage an avulsion around the creek works constructed in 2014, rendering them ineffective. The log jam accumulated additional debris since 2014. The logjam is located at Long. 124°31'48.53"W & Lat. 56°27'15.54"N (GPS Waypoint). It is recommended that the logjam be monitored and potentially removed where it spans stream.



PHOTO 49 (Panoramic): Logjam creating backwater that could cause an avulsion around the Ole Creek works downstream

¹ KWL, February 2015, Construction Completion Report: GMSWORKS #19 Williston Reservoir Trial Tributaries – BC Hydro Report No. N3700.



PHOTO 50 (Panoramic): Logjam at centre and potential avulsion path (to the left) looking downstream



PHOTO 51 (Panoramic): Former creek channel blocked by gravel, looking upstream



PHOTO 52 (Panoramic): Upstream end of gravel bar on left and altered creek path to right looking downstream. Trees at right could fall and create additional logjams.



PHOTO 53 (Panoramic): Upstream end of gravel bar on left looking upstream



PHOTO 54: Looking downstream at logjam



PHOTO 55: Primary log in logjam recommended for monitoring and potential removal



6.0 RECOMMENDATIONS

- The settlement/displacement on Berm 'D', should be monitored during the annual monitoring work. It is possible that the settlement / erosion could have been greatest in the first season, and may lessen with time. If the berm height becomes less than 0.8 m above the creek, then repairs should be considered.
- The logjam in the creek channel between Berm 'A' & Berm 'C', should be monitored. If it accumulates more material and becomes a barrier to fish passage, then it should be removed.
- The log debris that floated between the woody debris catchers and has come to rest on the berm crest should be monitored during annual inspections. If it continues to accumulate, then it should be removed.
- The logjam located at Long. 124°31'48.53"W & Lat. 56°27'15.54"N (GPS Waypoint) should be monitored and potentially removed. It could be removed in the late summer or winter when creek flows are much less.
- The creek channel upstream of the logjam proposed for removal should be monitored for additional logjams created by trees falling due to the change creek alignment.
- Continue to monitor the works annually. This inspection form could be used as a template.
- Schedule the 2019 survey and inspection to be conducted prior to increased spring melt (high creek flow), and during the lowest annual reservoir levels (following icemelt) to enable survey of the creek bed and inspection of the lowest elevation berm works.
- As the annual monitoring does not include a survey component, the monitoring should include GPS waypoints of key observations or issues. Photographs should be referenced to key berm features (eg downstream end of Berm 'B' looking upstream) and could be geo-referenced with waypoints.

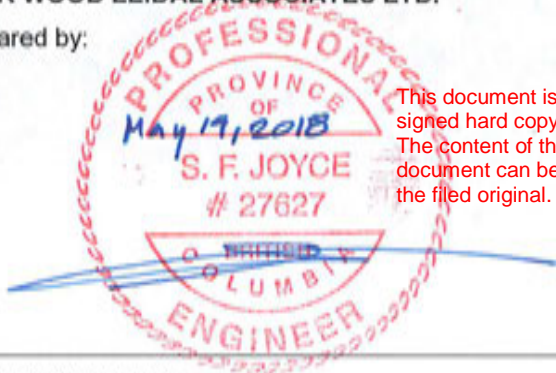
Closing

If you have any questions regarding this Inspection report, please contact the undersigned at 604-294-2088.

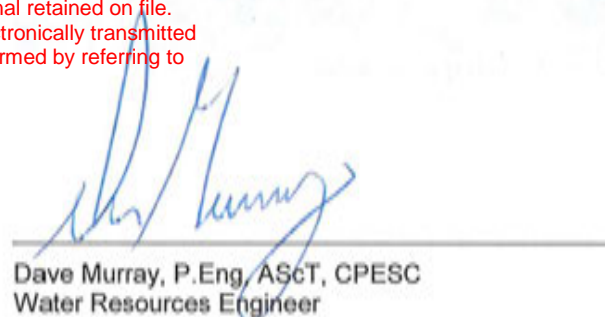
KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

Reviewed by:



This document is a copy of the sealed and signed hard copy original retained on file. The content of the electronically transmitted document can be confirmed by referring to the filed original.



Stefan Joyce, P.Eng
Hydrotechnical Engineer

Dave Murray, P.Eng, ASCT, CPESC
Water Resources Engineer

Encl.: Figure 1
Survey Drawings

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of the intended recipient. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

Copyright Notice

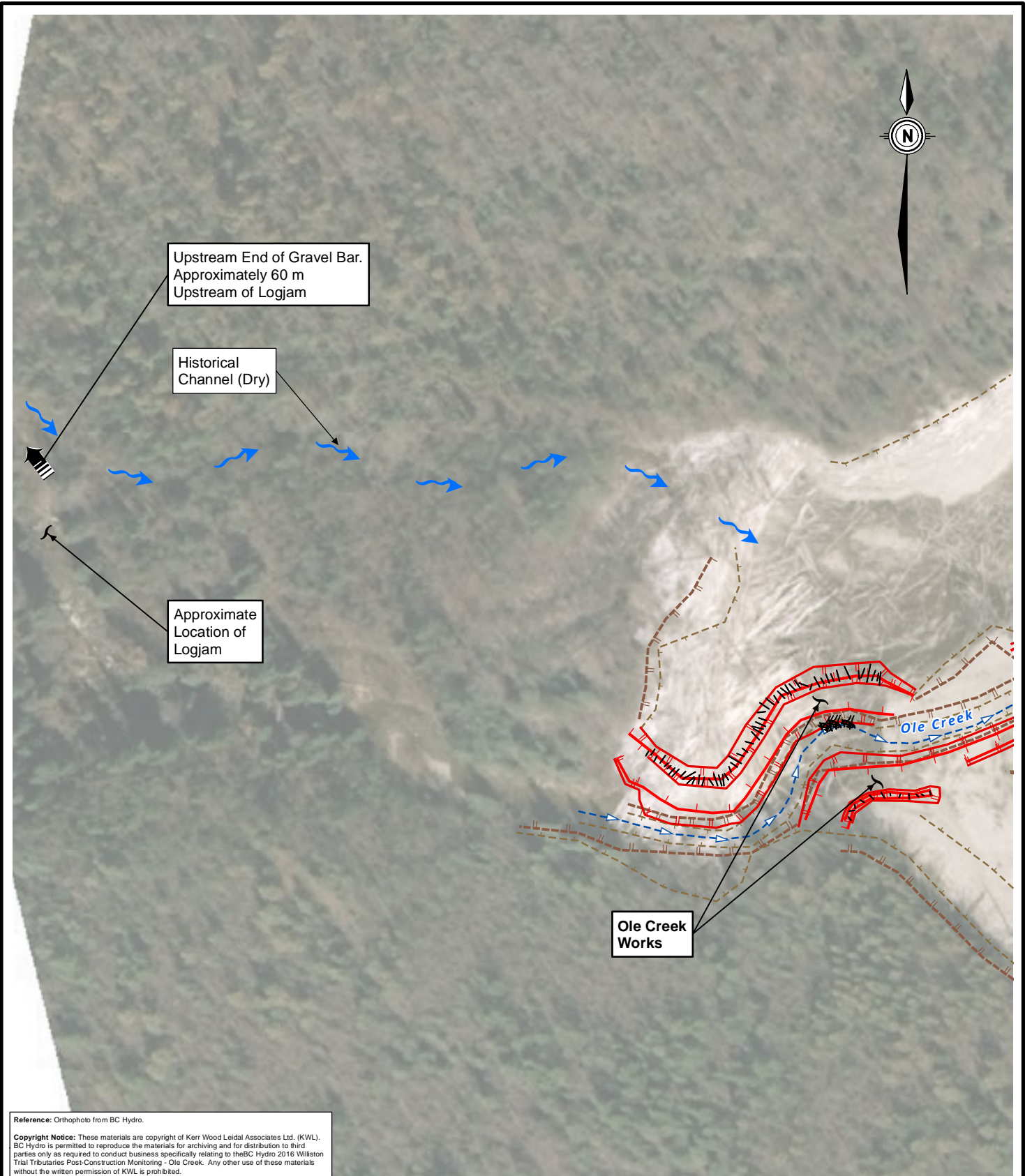
These materials (text, tables, figures and drawings included herein) are copyright of Kerr Wood Leidal Associates Ltd. (KWL). Kerr Wood Leidal Associates Ltd. and the Province of British Columbia is permitted to reproduce the materials for archiving and for distribution to third parties only as required to conduct business specifically relating to the 2016 Williston Trial Tributaries Post-Construction Monitoring – Ole Creek. Any other use of these materials without the written permission of KWL is prohibited.

Revision History

Revision #	Date	Status	Revision Description	Author
0	May 14, 2018	Final	Final	PAC/SFJ
A	September 2, 2016	Draft	Draft for Client Review	PAC/SFJ

Survey Drawings

Path: C:\0400-0499\478-189\430-GIS\MXD-Rp\478189_Fig1_Location_of_Logjam.mxd Date Saved: 5/11/2018 1:39:06 PM
Author: jlau



kwj KERR WOOD LEIDAL
consulting engineers
© 2018 Kerr Wood Leidal Associates Ltd.

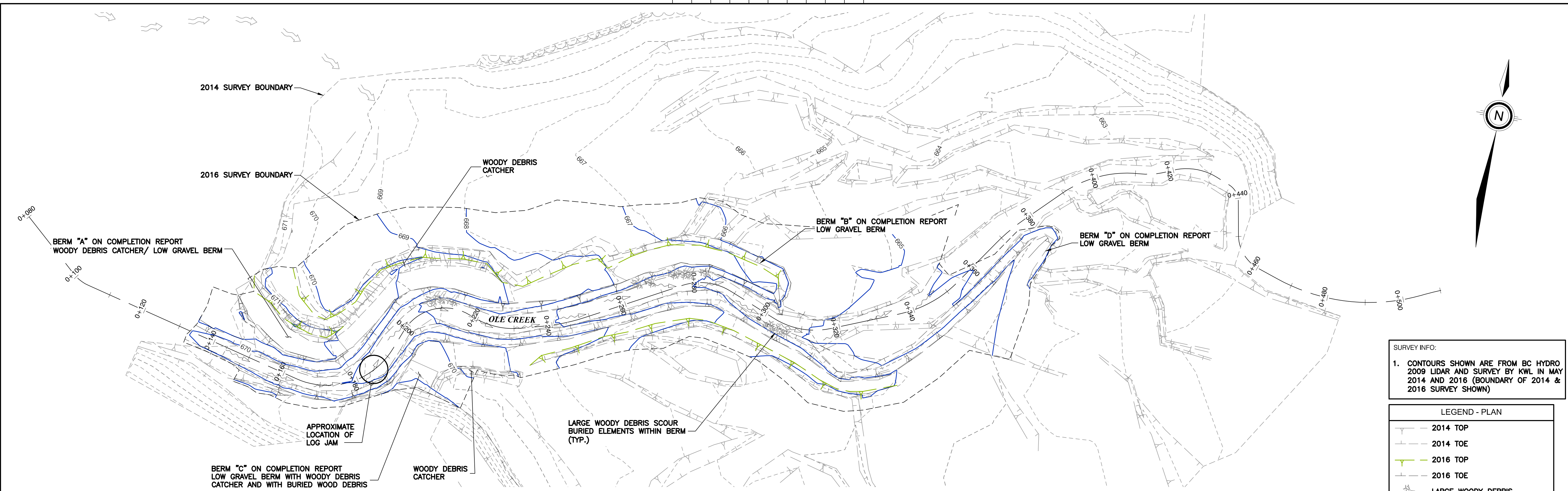
BC Hydro
2016 Williston Trial Tributaries Post-Construction Monitoring - Ole Creek

Project No.	Date
478-189	May 2018

20 0 20
1:1,250 (m)

**Location of the Logjam, Gravel Bar,
and Potential Avulsion Path**

Figure 1



PLAN

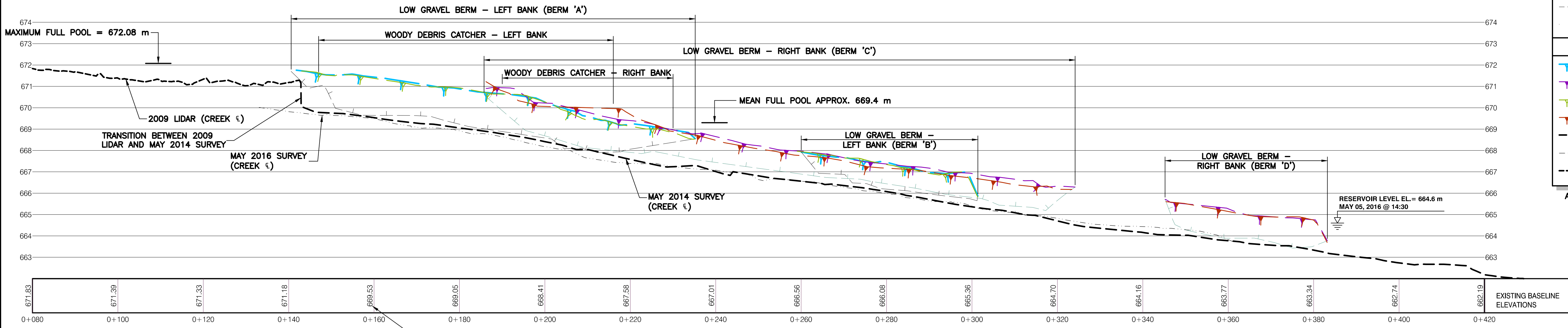
SCALE 1:500

SURVEY INFO:
 1. CONTOURS SHOWN ARE FROM BC HYDRO 2009 LIDAR AND SURVEY BY KWL IN MAY 2014 AND 2016 (BOUNDARY OF 2014 & 2016 SURVEY SHOWN)

LEGEND - PLAN	
	2014 TOP
	2014 TOE
	2016 TOP
	2016 TOE
	LARGE WOODY DEBRIS
	668 2016 CONTOUR LINE
	668 2014 CONTOUR LINE
	STREAM FLOW

LEGEND - PROFILE	
	2014 LEFT TOP OF BERM
	2014 RIGHT TOP OF BERM
	2016 LEFT TOP OF BERM
	2016 RIGHT TOP OF BERM
	2014 SURVEY DATA
	2016 SURVEY DATA
	2014 CONTOUR DATA

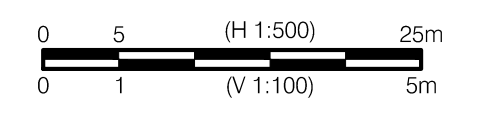
ALL 2014 LINES SHOWN FOR INFORMATION



CREEK PROFILE

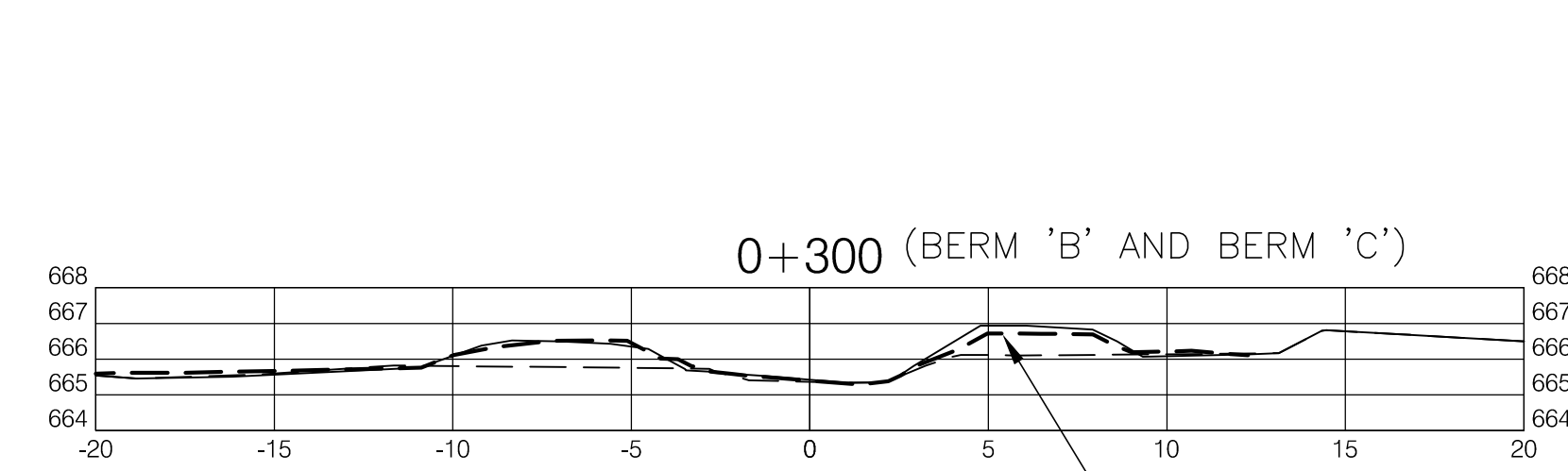
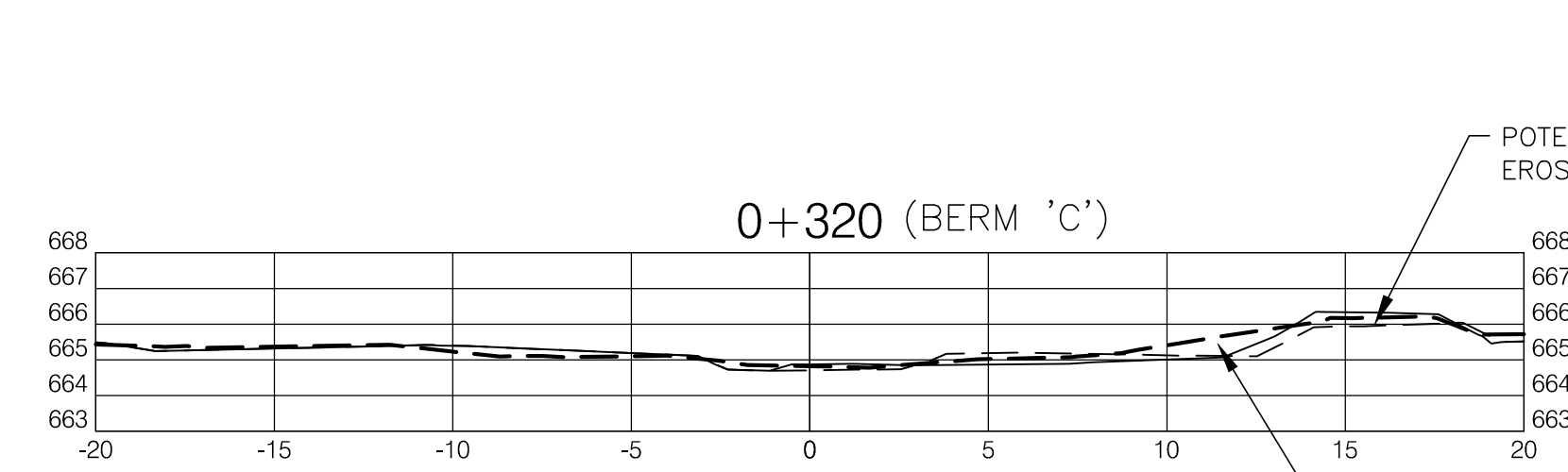
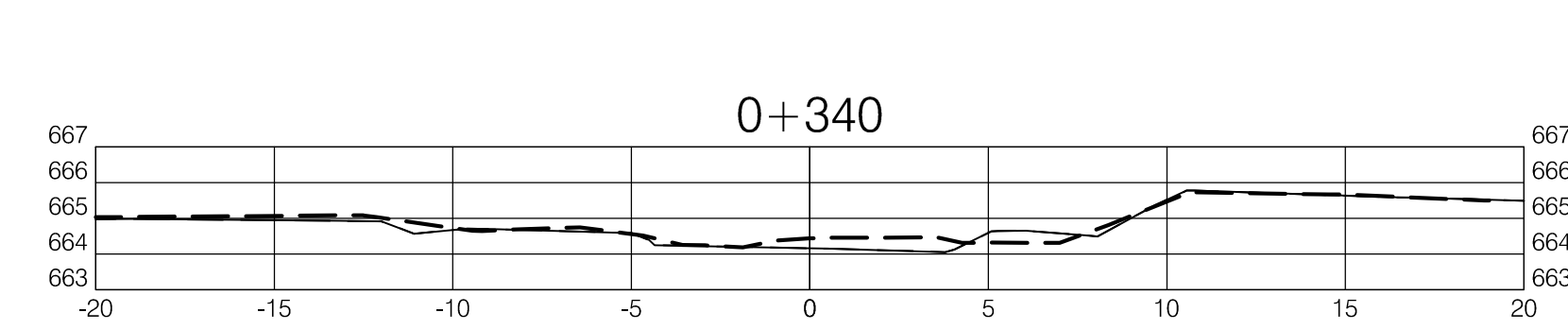
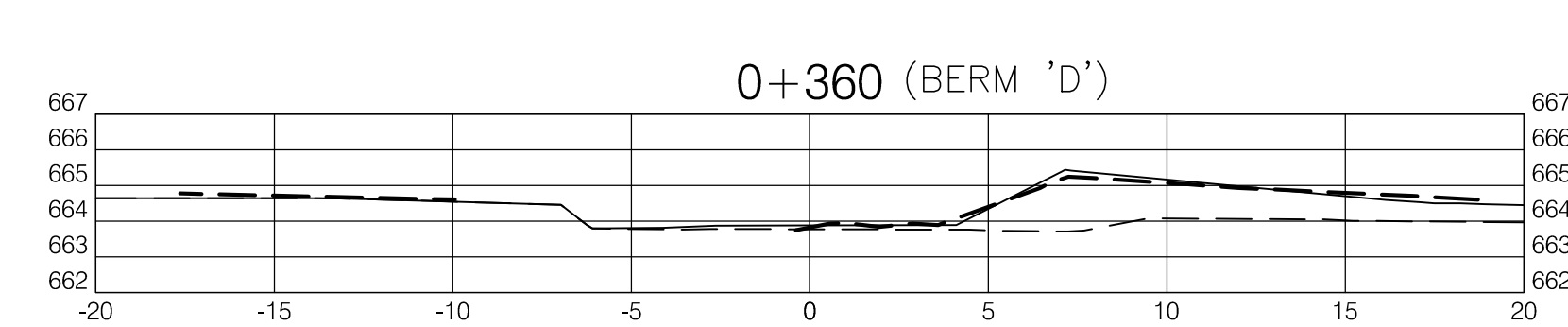
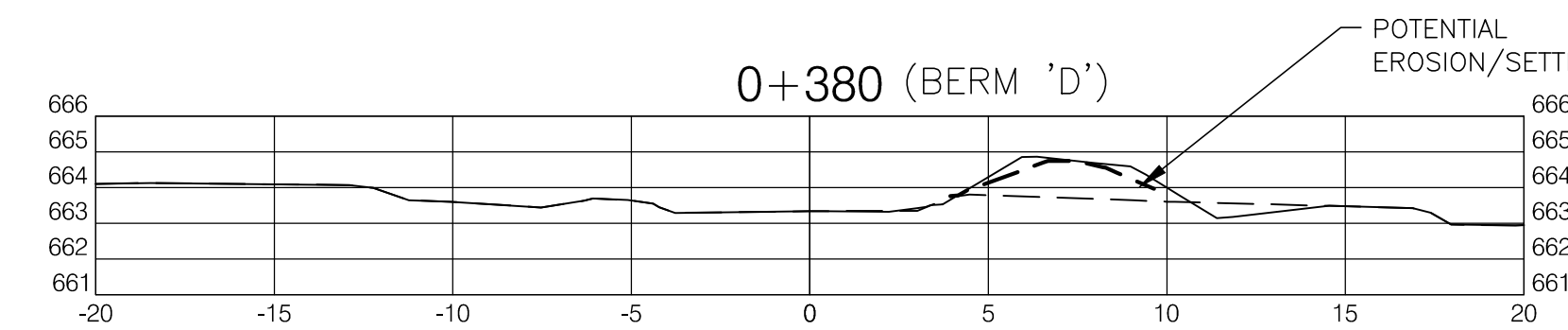
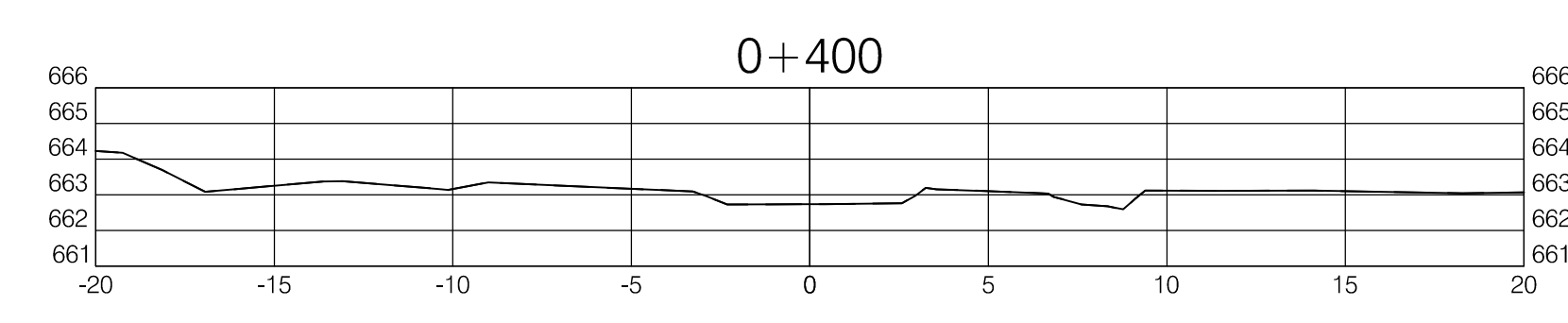
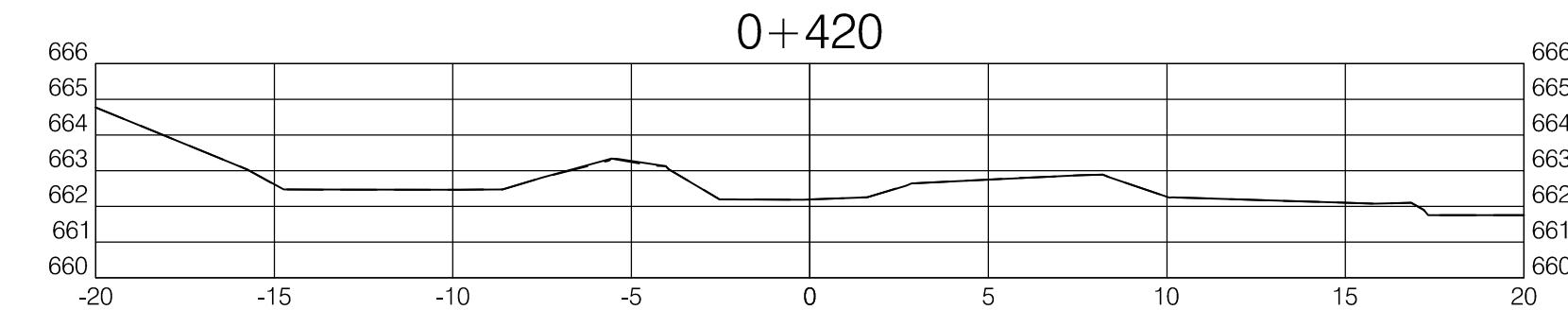
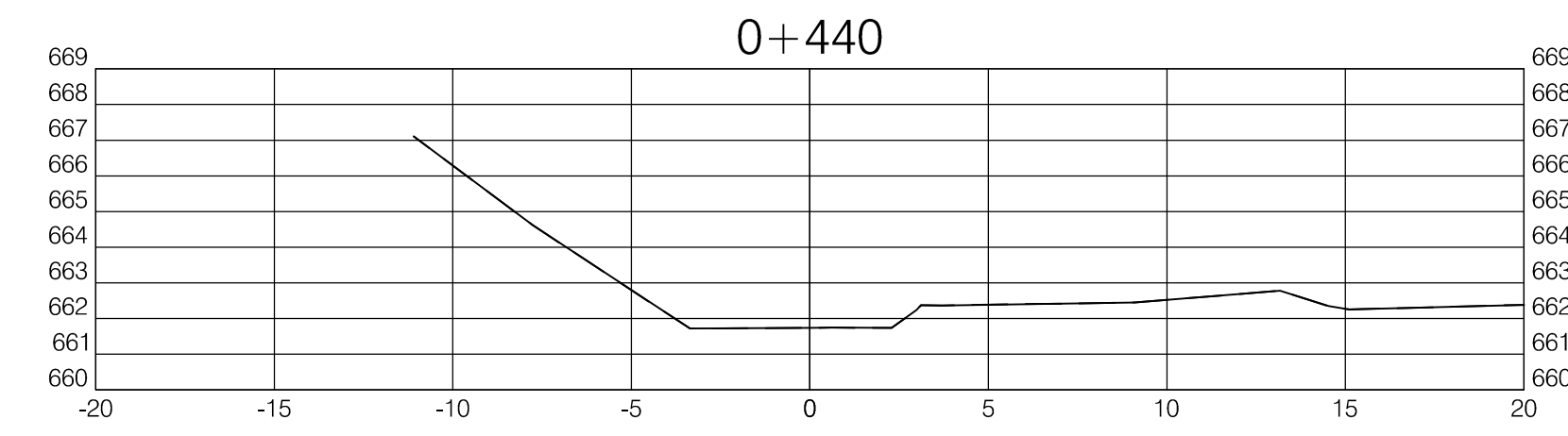
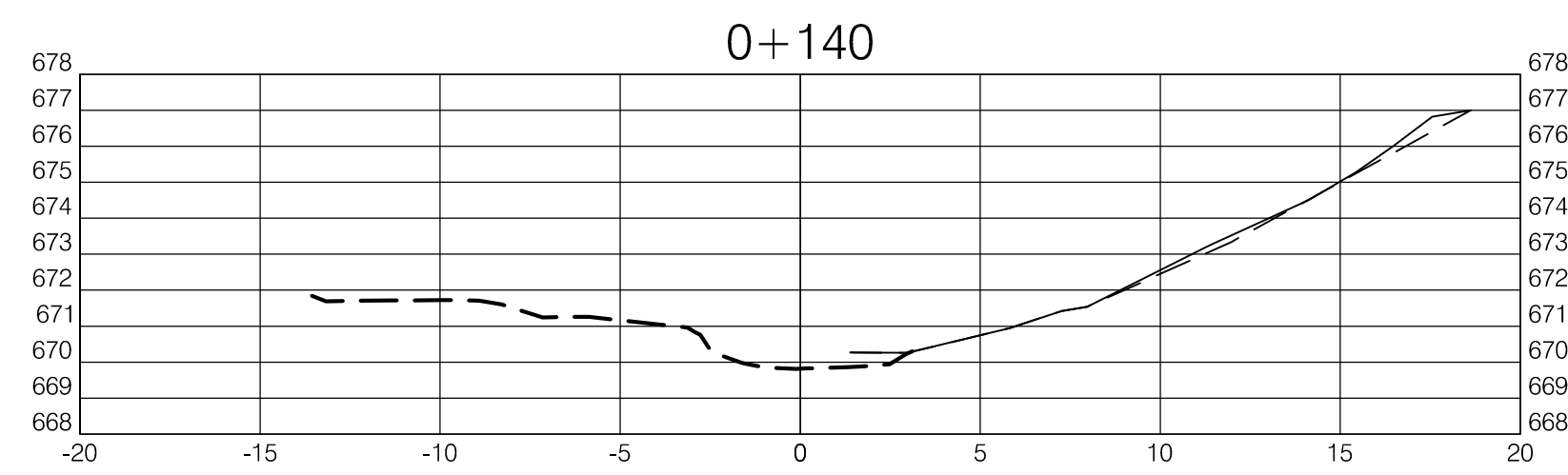
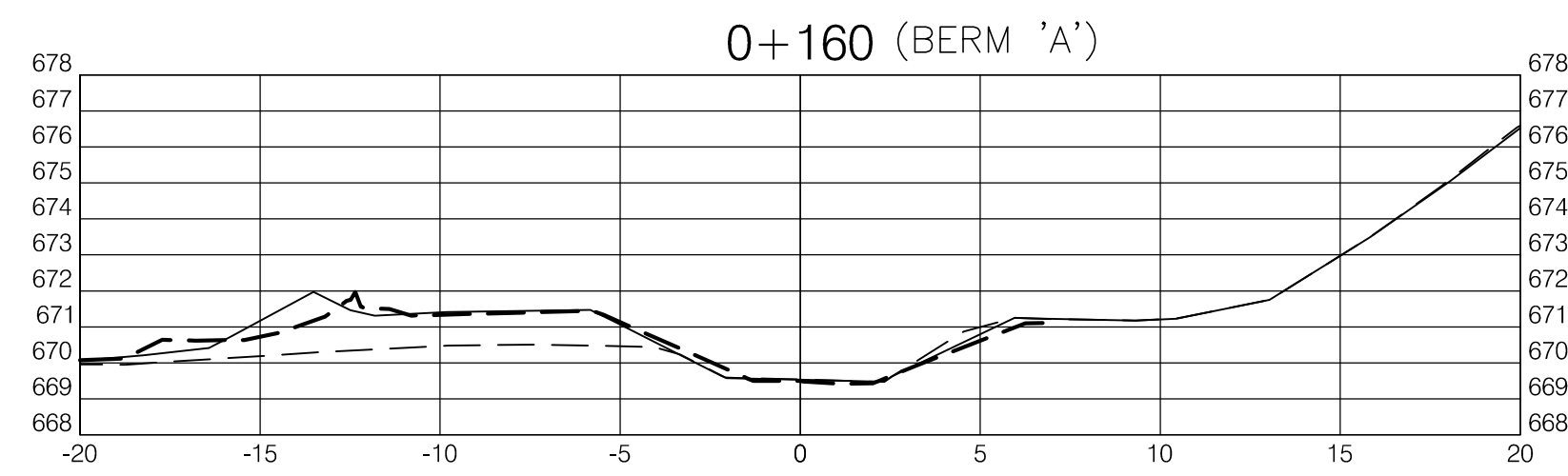
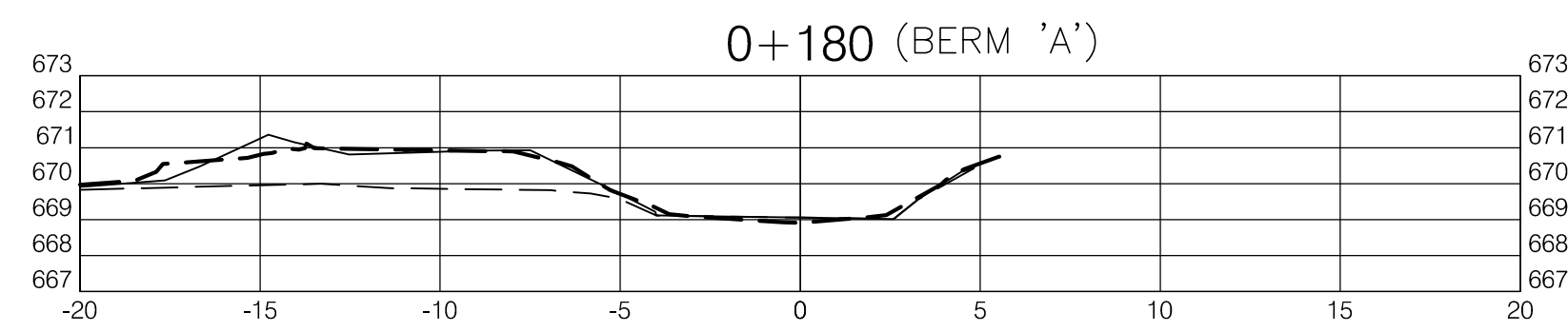
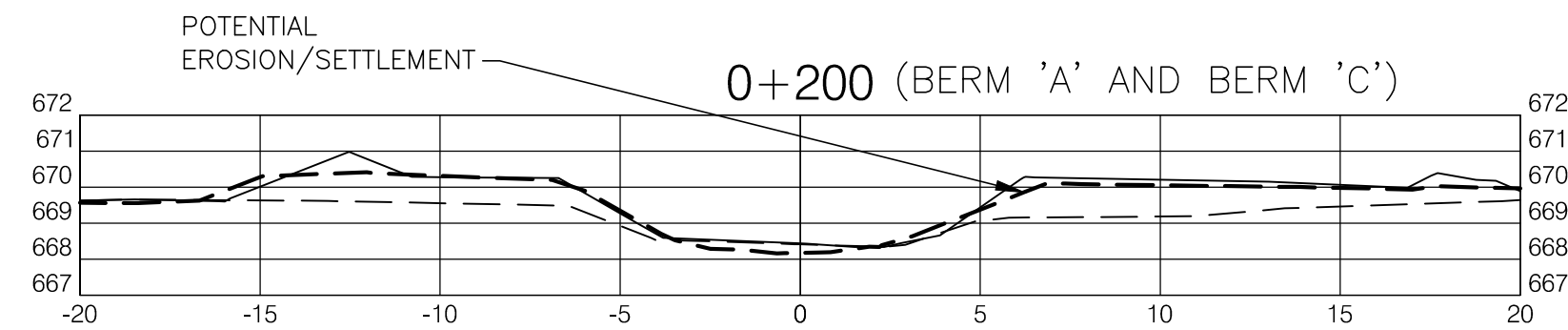
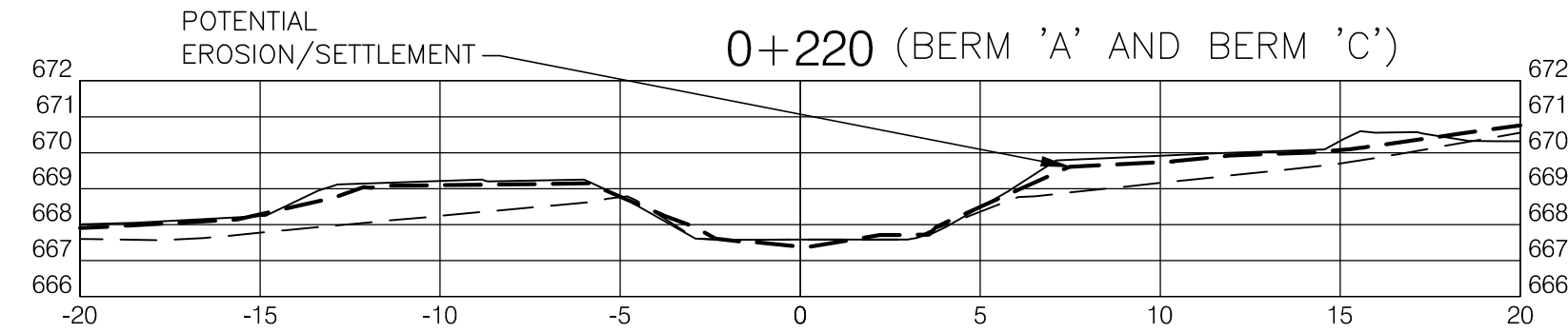
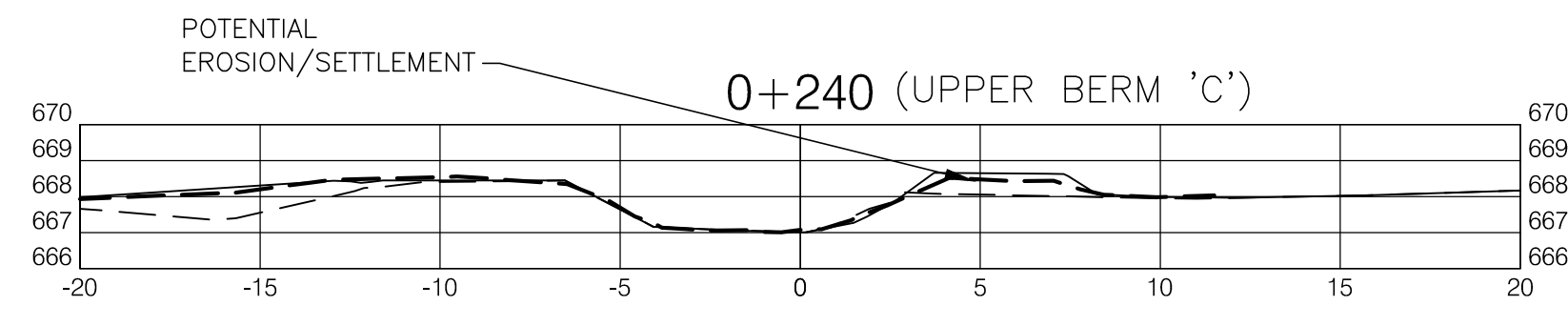
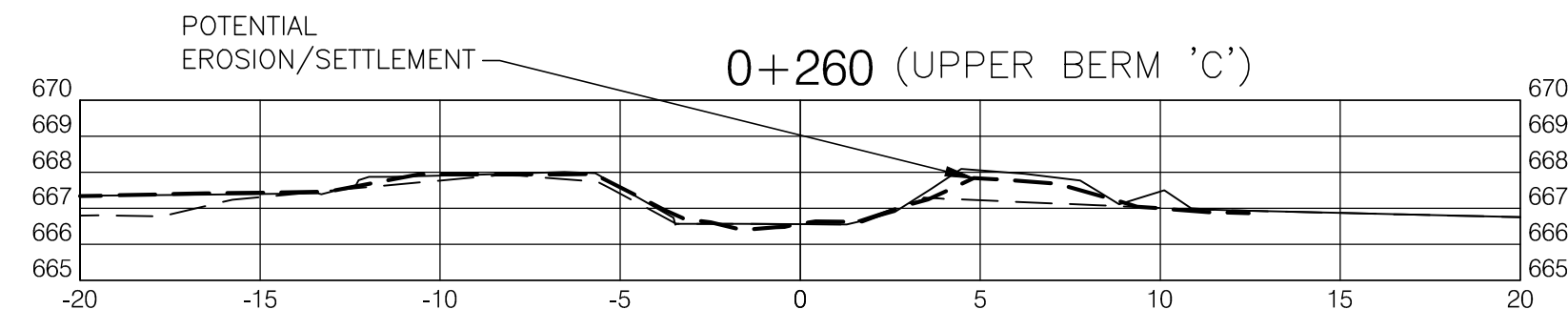
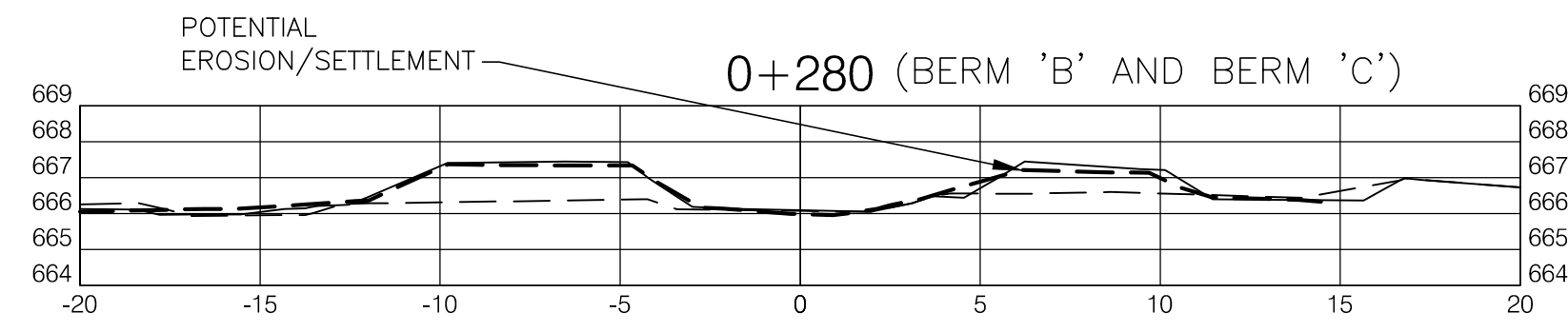
SCALE: HORIZ. 1:500 VERT. 1:100

NOTE:
 1. ALL BANK REFERENCES ARE DEFINED AS IF LOOKING DOWNSTREAM.



GMS WORKS #19
 WILLISTON RESERVOIR TRIAL TRIBUTARIES
 OLE CREEK
 PLAN AND PROFILE

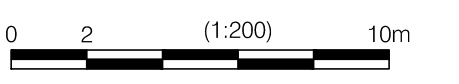
REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG CHK	INSP	REV	ACPT	DATE	DIST	DWG NO	SIZE	R
		REFERENCE DRAWINGS			REFERENCE DRAWINGS	0	2016 SURVEY	01 SEPT'16	SFJ						2016-07		1006-C18-00061	D	0



LEGEND	
---	2014 PRE-CONSTRUCTION SURFACE
—	2014 POST-CONSTRUCTION SURFACE
- · -	2016 SURFACE

NOTE:
1. ALL SECTIONS REFERENCES ARE DEFINED AS IF LOOKING DOWNSTREAM.

OLE CREEK SECTIONS
SCALE: 1:200



DSGN	SFJ
INDEP CHK	
DFTG	PAC
DFTG CHK	
INSP	
REV	
ACPT	

DATE	2016-07
DIST	-
DWG NO	1006-C18-00066

BChydro	
GMS WORKS #19	
WILLISTON RESERVOIR TRIAL TRIBUTARIES OLE CREEK CROSS SECTIONS	
SIZE	D
R	0

\\NAS\VICTORIA\KERRWOOD\LEIDAL\ORCA\VICTORIA\PROJECTS\0000-0999\0400-0499\728-189\501-DRAWINGS\AL-PRODUCTION\DWGS\728-189\OLE-SECT\MS.DWG

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE
		REFERENCE DRAWINGS			REFERENCE DRAWINGS

NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
0	2016 SURVEY	01 SEPT'16	SFJ		PAC		-		