



Erosion Assessment Block T141 – Beaufort Range

FOR

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BY

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TABLE OF CONTENTS

1	SUMMARY	1
2	INTRODUCTION	2
2.1	SCOPE	3
3	FIELD OBSERVATIONS	4
4	CONCLUSIONS	11
4.1	LEAVING CULVERTS IN PLACE	11
4.2	REVEGETATION	11
4.3	EROSION AT STREAM CROSSINGS	12
4.4	SEDIMENT GENERATION AT STREAM CROSSINGS	13
4.5	TOTAL SEDIMENT GENERATION	14



Erosion Assessment Block T141 – Beaufort Range

1 Summary

1. Deactivation of Todd Mainline in Block T141 since the November 2006 storm has been adequate, if not exemplary. Stream crossing structures have survived a large rain-on-snow event on December 3, 2007.
2. TimberWest has left pipe culverts in some stream crossings; this represents a “semi-permanent” level of deactivation that normally requires periodic checking and maintenance in the future. Pipe culverts in critical crossings have been removed. To comply with PMFLC Regulations TimberWest would either have to actively maintain the 1200 mm pipe culvert in the Stream 6 crossing at C20 or remove it; TimberWest has stated they will remove it.
3. Sediment production at the various deactivated stream crossings are relatively minor for Streams 4, 5, 6, and 9 respectively.
4. An area of recent sediment deposition was identified between Todd Mainline and the Log Train Trail. This was probably caused by the storm of November 15, 2006. Some of these deposits were remobilized in early December, 2007 and transported downstream, contributing to the sedimentation observed by Mr. Crowley.

5. An additional source of sediment was the destabilized channel downstream of the Log Train Trail; this channel has been widened and deepened. Earlier (and on-going) excavations in the fan downstream of the Log Train Trail may have contributed to this destabilization.
6. Compared to these two sources (as well as natural sediment load associated with high runoff events) the amount of sediment produced from road and trail crossings of streams in Block T141 is deemed insignificant.
7. I recommend that TimberWest apply additional seed to exposed soils in certain crossings (especially Stream 6). I also recommend measures to mitigate future erosion upstream of C20.

2 Introduction

Madrone Environmental Services Ltd. (Madrone) was retained by the Private Managed Forest Council (PMFLC) to conduct a review of road drainage structures and potential sediment sources in TimberWest's Block T141, located on the southern slopes of the Beaufort Range, 7.2 km north-northwest of Port Alberni.

A severe storm on November 15, 2006 resulted in flooding in several creeks that run through this block. Flood damage on the property located at the base of the slope triggered an investigation commissioned by the PMFLC and a report submitted on February 22, 2007. In that report, I concluded that the storm damage was a result of unusually heavy precipitation and snowmelt, accompanied by a small debris slide along Stream 6 above the harvest area, and not specifically to shortcomings in road design, construction, maintenance or deactivation.

Since then, additional flooding and sediment deposition along Stream 6 was reported by the Mr. Wayne Crowley, the owner of a property downslope.

I revisited the area on December 5, 2007, just over 12 months after the event occurred and after substantial rainfall in November and December 2007. I was accompanied by Mr. Domenico Iannidinaro, R.P.F., R.P.Bio., P.Eng., of TimberWest. We drove up the Todd Mainline to the crossing of Stream 4 (C18), and then walked the remainder of the road to the northern end of Block T141 at C1 (Stream 4). The weather was overcast with patchy cloud, but overall visibility was excellent. Map 1 shows the locations of stream crossings in Block T141.

At this time we did not have access to Mr. Crowley's property. However, on December 19, 2007, Mr. Terry Rollerson, P. Geo., of Golder Associates, (along with TimberWest staff and a friend) visited the property, walking up Stream 6 from the Crowley property to the Todd Mainline. Mr. Rollerson has shared his observations and photographs with me.

This investigation comes nearly one year after my first visit to the area. TimberWest had completed the road deactivation in early 2007. Earlier attempts to visit the area in late November 2007, had to be postponed due to snow cover. In early December, heavy rains fell in the area, removing any snow that would have been present. On December 3, 2007 the climate station in Port Alberni received 123.4 mm of rain, followed by 27.6 mm on December 4, 2007¹. Records show freezing temperatures in the period immediately preceding December 3, 2007. Runoff generated from this rainfall would have been augmented by snowmelt in the upper and mid basins of the creeks draining through Block T141. This amount exceeds the maximum daily rainfall recorded in Port Alberni between 1971 and 2000. It is similar to the amount that fell on November 15, 2006 which triggered my initial investigation.

2.1 Scope

The purpose of this inspection was to review the current condition of the road and drainage structures to determine if they were functioning properly. Since my inspection the previous winter, there had been additional storms, some of which apparently caused additional sediment transport and deposition on the fan within the property downslope of the Log Train Trail. I did not review that property and cannot comment on the reported sedimentation. This review focuses only on the condition of the road and the creeks draining through Block T141, in particular Streams 4, 5, 6, and 9.

The PMFLC asked me to review the state of the road deactivation in Block T141 against the standard contained in the Private Managed Forest Land Council Regulation, in particular sections 15, 17, 18, 19, 21, and 22. These pertain to the management of forest road and trail crossings of streams.

¹http://www.climate.weatheroffice.ec.gc.ca/climateData/dailydata_e.html?timeframe=1&Prov=XX&StationID=8045&Year=2007&Month=12&Day=4. (Accessed January 2, 2007).

3 Field Observations

In my field review I noted no significant wash-outs despite the extreme rain-on-snow event on December 3 and 4, 2007

C1 crossing (Stream 4). This is a ford crossing. No significant erosion has occurred, nor was water diverted outside of the natural channel. There was some minor rill erosion on the road surface on the uphill side, and some minor sheet erosion on the ford base. The base appears to be largely armoured now and I expect little additional sediment production. Grass/legume seeding has been done, with relatively little 'catch'. I suggest that no additional action is necessary here; the structure has an effective swale and has performed well.



FIGURE 1. SHEET EROSION ON FORD BASE AT CROSSING C1 (STREAM 4). THE SURFACE IS NOW 'ARMORED' AS MOST ERODIBLE SOIL HAS BEEN REMOVED.

C1 to C27

The section of road climbs across a sidehill of about 45 to 55%. During deactivation in 2006 much of the fill was pulled back with the spoil placed into the cut, and cross-drains were placed against the cut to prevent drainage build-up along the road. Disturbed ground was seeded with a grass/legume mix. Grass cover on the fill and on the ditch-lines is helping to reduce erosion but is not complete. I expect the grass cover will continue to increase next spring. The grass cover is adequate but should be augmented with additional seeding.



FIGURE 2. ROAD BETWEEN C1 AND C27. DEACTIVATION IS APPROPRIATE AND HAS SUCCESSFULLY WEATHERED ITS FIRST YEAR. SEEDING IS ADEQUATE.

C27 (Stream 6)

In the November 15, 2006 storm, this crossing was badly damaged. The original 1200 mm pipe was washed out, and a substantial amount of sediment was deposited on the road. Since then TimberWest has completely deactivated the crossing, removing the pipe and pulling back part of the fill at the crossing and along adjacent sections of road. This fulfills expectations of a “restore natural crossing” prescription and represents an appropriate response to the damage. The remaining road on the downgrade side of the crossing is suitable for ATV traffic only. There has been some minor slumping in the sidewalls of the cross-ditch in the original roadfill, but this would have been difficult to avoid completely. The cross-ditch is now sitting at a gradient that is sufficiently steep to avoid significant additional sedimentation.



FIGURE 3. C27 CROSSING LOOKING TOWARDS THE NORTHWEST. THE CROSSING HAS BEEN RESTORED TO NATURAL CONFIGURATION AND SPOIL WAS PULLED AND PLACED AGAINST THE CUT. THE CROSSING HAS BEEN ERODED BUT IS NOW PROPERLY GRADED AND SHOULD NOT PRODUCE SUBSTANTIALLY MORE SEDIMENT.

C23 (Stream 9)

The mainline road switchbacks tightly just beyond C23. During the November, 2006 storm water from Stream 9 at C24 was diverted into the ditch and followed the switchback, discharging back into the natural channel at C23. Both C23 and C24 have been properly deactivated since the storm and both are now functioning well. Water is no longer diverted into the ditch. The ditch itself has been graded and seeded, although the 'catch' is not yet complete. The restored crossing at C23 has been eroded and minor slumping has occurred. I expect that some additional erosion will occur, but it will be minor. The channel base is largely armoured.



FIGURE 4. C23. NOTE SLUMPING ALONG THE BANKS OF THE CROSS-DITCH. THIS DITCH SHOULD HAVE HAD A STEEPER GRADIENT, BUT IT SHOULD NOT PRODUCE SUBSTANTIALLY MORE SEDIMENT. NOTE THE SEEDING ON THE OUTSIDE OF THE ROAD. COVER WILL LIKELY INCREASE NEXT YEAR.

C20 (Stream 1)

This is a large crossing that experienced substantial scour and deposition during the November, 2006 storm. TimberWest has cleared most of the aggraded sand, gravel and woody debris from the stream channel above the crossing. It has also constructed a berm to re-train the creek back into its original channel and cross-ditched the road. However, it had not removed the 1200 mm pipe.

The structure has been performing well so far this fall and there was no evidence of channel diversion, blockage or erosion of the road prism. However, the stream channel upstream of the culvert was eroding back to a new bed level (the result is a small 'waterfall' about 1 m high). I expect the channel to continue this upstream retreat as it regrades (Figure 5).

I recommended to TimberWest that they remove the culvert, and I understand that this is planned. I also suggested they consider planting of suitable shrubs and/or trees (e.g., willow cottonwood, red alder, or maple) on the aggraded sediment upstream of the crossing for future sedimentation control. I suggest TimberWest also places coarse rock in the channel downstream of the 'waterfall', to slow the rate of upstream channel erosion.

At this time, the channel bed erosion at a 'knickpoint' above the road (Figure 5) is generating some suspended and bedload sediment.

The berm across the road will effectively ensure the creek does not divert along the road to the southeast.



FIGURE 5. LOOKING UPSTREAM FROM C20 CROSSING (STREAM 6). TIMBERWEST HAS CLEARED THIS AREA OF SANDS, GRAVELS AND WOODY MATERIAL DEPOSITED IN THE NOVEMBER 2006 FLOOD. THE CHANNEL IS RE-GRADING TO A NEW, LOWER BASE LEVEL (SMALL 'KNICKPOINT' AT LOWER LEFT). THIS WILL CONTRIBUTE TO GENERATE SOME ADDITIONAL SEDIMENT UNTIL IT STABILIZES.

C18 (Stream 4)

TimberWest left this 800 mm pipe in place, but installed a cross-ditch above it. During the November 2006 storm, the creek initially scoured all the roadfill around the pipe (and probably moved it a few metres downstream), then buried it with new alluvial material. I was not aware of this sequence of events during my earlier inspection because the pipe was completely buried. Erosion of the road prism was restricted in part because TimberWest had placed coarse angular rock on the fillslope around the outlet of the culvert. Recent storms had eroded the fill around in the intake (Figure 6). The pipe is still functioning, but the road fill around the intake is actively eroding and producing sediment. I suggested that TimberWest remove this culvert and restore the natural stream channel gradient. I understand that this has already been done.



FIGURE 6. EROSION AROUND PIPE INTAKE (THE INTAKE IS AT THE BOTTOM OF THE HOLE) AT CROSSING C18. THE PIPE SHOULD HAVE BEEN REMOVED IN DEACTIVATION AND THE ORIGINAL CHANNEL GRADIENT RESTORED, BUT THIS HAS SINCE BEEN DULY COMPLETED (D. IANNIDINARDO, PERS.COMM).

C11 and C13

C11 contained a 1000 mm pipe that accommodated the flow from Stream 4. It was buried by an alluvial deposition during the November 2006 storm. Since then TimberWest has excavated a channel, and installed a berm on the down-grade side. Recent stormflows have resulted in minor erosion on the fan surface resulting in rills up to 15 cm deep. This is a minor sediment source that will continue to erode until the channel bed becomes naturally armoured. The culvert remains in place and appears to be performing well.

C13 showed very minor rill erosion.



FIGURE 7. LOOKING DOWNSTREAM AT C11. TIMBERWEST HAS EXCAVATED A CROSS-DITCH AND INSTALLED A BERM ON THE DOWN-GRADE (LEFT) SIDE. SOME EROSION IN THE FORM OF RILLING HAS OCCURRED ON BASE OF THE DITCH; THIS IS A RELATIVELY MINOR SOURCE OF SEDIMENT. THE CULVERT REMAINS IN PLACE, SO IT SHOULD BE MONITORED FROM TIME TO TIME.

Todd Mainline

This road is being maintained by Mr. Todd Thompson for access to Woodlot 0011. The Stream 6 crossing originally contained a 1000 mm pipe culvert, which plugged and washed out after the November 15, 2006 storm. At Mr. Thompson's request, I inspected this crossing location with him on May 29, 2007. I recommended that he install a 2x4 wood box culvert to ensure passage of water, entrained sediment and debris. I returned on November 1, 2007 to inspect the culvert (and again on December 5, 2007 with Mr. Iannidinardo) and found it was working well. There was no accumulation of sediment or debris, nor significant scour around the cribbing. I noted that there appeared to have been some degradation (deepening) of the channel immediately upstream of the crossing, but I could not tell if this was due to the November 2006 storm. Downstream, the channel appeared to be neither degraded nor aggraded, however, I did not walk down Stream 6 between Todd Mainline and the Log Train Trail.

Mr. Rollerson, in his December 19, 2007, visit to Stream 6, identified an area of recent sediment deposition and channel aggradation between the Log Train Trail and Todd Mainline. This deposition occurred on either an extension of the alluvial fan that extends down to Mr. Crowley's property, or an 'intermediate' fan that is separate from the larger one downstream.

Mr. Rollerson's interpretation of this feature (based on comparison of his own photographs compared with those taken by Shawn Hamilton in an earlier assessment of fish habitat effects²) is that this sediment deposition and channel aggradation developed after the November 15, 2006 storm. He points to evidence of recent sediment deposition completely filling in the channel as well as an adjacent area up to 30 m wide.

More recently Stream 6 has started to erode through these deposits, mobilizing some of the sediment that had been stored there since November, 2006. This would certainly have contributed to the sediment that reached Mr. Crowley's property.

4 CONCLUSIONS

4.1 Leaving Culverts in Place

Despite the generally effective deactivation (both before and after the November 2006 storm), TimberWest has left some pipe culverts in place, but at all crossings they have excavated cross-ditches above the pipes. This to my mind represents not permanent but semi-permanent deactivation; as long as the pipes are in place, they should be monitored. I would recommend at least annual monitoring initially. Semi-permanent deactivation is generally considered to be good for about 3 years after which a review is required. I was concerned mainly about the remaining pipes at C20 and C18, but C18 has since been removed and C20 is planned for removal, according to Mr. Iannidinardo.

The PMFLC Regulation Section 22 (of the revised regulation of September 1, 2007) states that "an owner who no longer requires a road and who intends to cease maintaining it must...remove round-pipe stream culverts...", if doing so will reduce the likelihood of a material adverse effect in relation to fish habitat or water diverted by a licensed waterworks intake." Stream 6 clearly falls in this category, and therefore to be compliant with the regulation, TimberWest (assuming they no longer require the road) would be required to remove the culvert at C20. The other creeks, namely 4, 5, and 9, are not pertinent.

4.2 Revegetation

The PMFLC Regulation Section 19 requires owners to revegetate exposed soils that would likely contribute to the material adverse effect on fish habitat. In the case of Block T141 this means that exposed soils on all crossings of Stream 6 should be properly revegetated.

² Shawn Hamilton and Associates 2006. Block T141 - TimberWest. Unpublished Consultant Report for Private Managed Forest Land Council, Victoria.

TimberWest has seeded most exposed areas with a grass-legume mix; the result is substantially short of 100% cover. Not everything seeded can be expected to grow. Most of the ditches have been well seeded. However, I would recommend that TimberWest apply additional seed on areas that have inadequate cover now, with a focus on Stream 6.

A potential sediment source exists at the Stream 6 crossing C20. The channel is eroding its bed upstream of the crossing; the loss of riparian vegetation due to storm damage last year will result in this continuing unabated.

I suggest some planting whips of willow, cottonwood, red alder, bigleaf maple, or other suitable shrubs or trees upstream of one of the Stream 6 crossings; this will increase the likelihood of mitigating future stream erosion (Figure 8). Additionally, TimberWest might consider placement of coarse, angular rock in the channel downstream of the 'waterfall', may slow the rate of retreat, and thus sediment production.



Figure 8. C20 upstream (Stream 6). TimberWest cleared a large amount of debris from this reach, spoiling it to the right (southeast) in a berm to prevent stream capture by the road. This has created an area of potential sediment production in the future. Note the 'waterfall' in the foreground.

4.3 Erosion at Stream Crossings

At crossings where water flows over the road, there is minor erosion of the road surface; this has created rills up to 5-10 cm deep. The resulting erosion and sedimentation is minor from each individual road, but likely contributed some sediment transported downstream.

In several cases, the bases of installed cross-ditches had gradients that were gentler than the gradient of the natural channels. As a result, the ditch bottoms eroded, leading in some places, to undercutting of banks. This could also have been lessened by armouring the bottoms of the cross-ditches, or by restoring natural stream gradients.

Proper deactivation of road crossings of streams with substantial flow should restore the original dimensions and gradients of the stream. Failure to do so is a common industry practice; this is an area where improvement is needed. Armouring is seldom done unless in a community watershed (and even then rarely). TimberWest did place rock armour below the outfalls of most culverts within Block T141.

4.4 Sediment Generation at Stream Crossings

I have estimated the amount of sediment generated at each of the stream crossings in Block T141 between the completion of deactivation and December 5, 2007. Table 1 shows my estimates. Streams 4,5, and 9 do not connect with larger streams below. Stream 4 crosses the Log Train Trail, but disappears a short distance downstream of that crossing. Stream 6 does connect to fish habitat downstream, and therefore is the watercourse of main concern.

Table 1. Estimated Sediment Production from Stream Crossings in Block T141 (as of December 5, 2007).

Stream Crossing	Stream	Estimated Volume (m ³)	Impact
C1	4	0.25	Negligible; mainly sheet flow from adjacent running surface
C13	4	0.25	Negligible rilling on road surface
C11	4	3	Erosion in alluvial fan deposited upstream of culvert.
C18	4	5	Sediment is from eroded intake above culvert
Subtotal Stream 4		8.5	This stream does not connect to fish habitat
C2	5	0	Streamflow is contained in pipe, which was left in place
Subtotal Stream 5		5	This stream does not connect to fish habitat
C27	6	1	Sediment from regrading of ditch, undermining of banks and sheetwash from adjacent slopes.
C20	6	2	Sediment from channel re-grading upstream of road crossing
Subtotal Stream 6		3	This is Stream 6 that drains into fish habitat
C23/C24	9	2	Sediment from ditch erosion, undermining of banks and regrading of ford base.
Subtotal Stream 9		2	This stream does not connect to fish habitat
Total Streams 4, 5, 6, and 9 in Block T141		13.5	

Table 1 shows that sediment generation from the stream crossings in Block T141 at the time of my inspection on December 5, 2007 was modest, despite the occurrence of a significant rain-on-snow event two days previously. The most significant erosion associated with road crossings had occurred on Stream 6 immediately upstream of the crossing at C20. The total amount of sediment generated from the crossings at C20 and C27 (both on Stream 6) is about 3 m³. The sediment generation in streams 4, 5, and 9 was relatively minor. The effect of erosion on the road surface (over and above ditch and cross-drain sources) so far appears to have been marginal.

Overall, the sediment production from stream crossings on the Todd Mainline in Block T141 has amounts to an insignificant augmentation of the total suspended and bedload sediment transport in the affected streams. This implies that the large sediment deposited in Mr. Crowley's property must have had a different source.

4.5 Total Sediment Generation

It is important to emphasize that any storm of this magnitude would transport a substantial amount of sediment. There likely would have been sedimentation in the lower reaches of Stream 6 if Block T141 had not been logged. The fan over which the lower reach of Stream 6 flows was constructed over thousands of years by sediment brought down mainly during storms.

Total sediment production in Stream 6 is from several sources:

1. Sediment generated in stream channels above Block T141.
2. In-channel erosion (including bed and banks) as streams flow through Block T141.
3. Sediment contributed by deactivated roads, ditches, cross-drains and trails in Block T141.
4. Re-working of recent sediment deposits between Todd Mainline and Log Train Trail³.
5. Re-working of fan deposits by the destabilized Stream 6 channel downstream of the Log Train Trail.

The first source made a significant contribution to sediment transport during the November 15, 2006 storm in part due to a debris slide located upstream of Block T141. This would have occurred whether or not Block T141 was developed.

³ Some of these deposits may have extended a short distance upstream of the Todd Mainline, but most of the deposition was downstream.

The second source, namely channel erosion, undoubtedly contributed to the total amount of sediment transported. The magnitude of this contribution is difficult to determine. In my original field assessment on November 17, 2006, I did not observe substantial widening of channels within the logged areas, nor did I note widening on December 5, 2007. It appeared that bank erosion had been largely held in check by intact roots. It is highly likely that stormflows caused scour (mainly deepening) of channel beds, followed rapidly by in-filling by fresh bedload. This 'scour and fill' is a process that naturally occurs in stream channels during floods. In my January, 2007 report I concluded that channel erosion had not been significantly affected by logging, at least not at the time of my assessment.

Based on my observations in this most recent investigation, I conclude that source number 3, i.e., sediment from roads and trails, has been minor and likely makes a relatively insignificant contribution to the total sediment production.

My own observations of the Stream 6 reach downstream of the Log Train Trail (together with Mr. Rollerson's photos of Stream 6 between Todd Mainline and the Log Train Trail), lead me to conclude that the largest contribution of sediment originated from sources 4 and 5.

The reach of Stream 6 below the Log Train Trail has experienced substantial deepening and widening, as well as in-filling, in recent years. Comparing photos of this reach, taken by Mr. Hamilton (January, 2006), myself (November 2006, December 2007), Mr. Rollerson (December 2007) as well as photos from TimberWest, I believe that the channel is wider and deeper now than it was immediately after the November 15, 2006 storm. This is difficult to quantify, since the photos were not taken at exactly the same place, and channel enlargement is not consistent along the length of the reach. Certainly there is evidence of fresh bank erosion, suggesting on-going widening.

In any case, the reach of Stream 6 below the Log Train Trail, and above Mr. Crowley's property has been destabilized, such that the banks (formed of highly erodible alluvial deposits) are actively eroding. As I noted in my January 2007 report, excavation of alluvial materials by Mr. Crowley has probably affected the stability of the stream on this fan and therefore has likely contributed to the enlargement of the channel.

I conclude that recent sedimentation on Mr. Crowley's property was due to high runoff from a significant rain-on-snow event on December 3, 2007. The resulting stormflows re-mobilized previously deposited sediment mainly downstream of Todd Mainline. It is likely that additional sediment was generated from the active fan downstream of the Log Train Trail. I believe it is likely that Mr. Crowley's excavation of the fan may have contributed to this process.

TimberWest has not been negligent in deactivating the road network in Block T141 and sediment production from roads and stream crossings has not contributed significantly to recent storm deposition on the alluvial fan downstream of the Log Train Trail.

Madrone Environmental Services Ltd.

Prepared by:

**This is a digitally signed duplicate of the official manually signed and sealed document.*



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MAP 1. LAYOUT OF BLOCK T141,
SHOWING LOCATION OF CULVERTS.

MAP SUPPLIED BY TIMBERWEST

SCALE: ~1:5,000
DOSSIER: 06.0477



LEGEND

- Culvert
- Stream
- Proposed Road
- Old Grade Upgrade Road
- Block Boundary

