

File: 17275-20/DCK Norrish; 17275-20/Singh

February 17, 2006

To: John Stevenson
Tenure Forester
Chilliwack Forest District

From: Tom Millard
Research Geomorphologist
Coast Forest Region

Re: Overview assessment of cutblocks in Teal Cedar Products Ltd. Amendment #49

At the request of John Stevenson, I have completed an overview assessment of the landslide and sedimentation hazards presented by cutblocks contained in Teal Cedar Products Ltd. Amendment #49. Dr. Robert Hudson (Research Hydrologist), Brian Roberts (Research Geoscientist), and I had reviewed the report "*Lower Norrish Sediment Source Surveys and Potential Impacts from Harvesting as Proposed in Amendment #49*" report by Raveen Singh, P.Eng. Since we could not support the conclusions contained in the report, John Stevenson requested this assessment.



Amendment #49

Amendment #49 initially included 11 blocks: NC1, NC3, NC5, NC7, NC9, NC20, NC22, NC24, NC26, NC28, and NC30. Currently, NC9 and NC30 have been removed from Amendment #49 and so are not considered in this review. Block NC22 has been incorporated into Block NC20. All of the Amendment #49 cutblocks are located downstream of the community watershed area. Users of this report should refer to TCP Amendment #49 map for block locations and additional information. Cutblocks NC1, NC3, NC20, NC24, NC26 and NC28 are laid out and block maps are available. Cutblock NC28 has a Terrain Stability Assessment (TSA) report available.

Watershed setting and elements at risk

Norrish Creek is located north of the Fraser River and about 12 km east of Mission. In addition to Norrish Creek being an S1 fish stream, the alluvial fan at the base of the watershed has extensive rural development and the CPR rail line also crosses the fan. The Fraser Valley Regional District/Central Fraser Valley Water Supply Services uses the upper portion of the watershed as a community water supply and has a filtration plant and pipeline in the lower portion of the watershed. The pipeline is immediately downslope of the west side mainline road for much of its distance. The Fraser Valley Regional district has expressed concern regarding the proposed development, citing local resident concerns and potential risk to the water supply.

Canadian Pacific Railways has expressed concern regarding development in Norrish Watershed. CPR identifies sediment deposition near the rail bridge crossing of Norrish Creek as a concern and has a gravel extraction program to maintain bridge capacity.

Methods

To familiarize ourselves with the watershed, Brian Roberts (Research Geoscientist, RCO) and Tom Millard conducted extensive aerial photograph reviews using five sets of photos dated from 1952 to 2002. On November 10, 2005 we accompanied John Stevenson on an overview helicopter flight examining all of the cutblocks within Amendment #49. We then drove to the alluvial fan and the watershed for a brief field visit. Aerial photographs from 1993 and 2002 were used to inventory landslides within the lower portion of the watershed. A number of documents were reviewed to familiarize ourselves with the issues (see references).

Lower Norrish Watershed description and condition

The lower portion of Norrish Creek is located in a broad U-shaped valley with broad open slopes that generally have steep upper portions and gentle or moderate gradient lower slopes. At the bottom of the broad open slopes, Norrish Creek occupies a steep-walled canyon. Tributaries to Norrish Creek are generally steep and gullied, with most of them capable of discharging debris flows directly into Norrish Creek. As a result of these channel characteristics, most sediment introduced into the channel system reaches the alluvial fan.

Landslides related to logging are a significant source of sediment. We inventoried 235 landslides visible in the 1993 and 2002 air photographs in the lower portion of the watershed, and of these, 84% were logging related with 47% originating in clearcuts and 37% originating from roads. Eighty-eight percent of slides deliver sediment into the channel system, indicating that most slopes are directly connected with the channel system. The large number of logging-related landslides, and the direct connection between hillslopes and stream channels has resulted in significantly increased sediment supply to Norrish Creek.

Only four slides occurred from 1993 to 2002, indicating that modern forestry practices have probably reduced the occurrence of landslides. This observation is somewhat preliminary since logging-related slides may occur for 10 or 20 years after harvest.

Alluvial fan description and condition

Norrish Creek exits the watershed and flows across its alluvial fan until it reaches Nicomen Slough. Above the CPR rail line the channel is confined between dykes. Below the CPR bridge the channel is unconfined and splits into two main channels before entering Nicomen Slough. Aerial photographs show a significantly increased channel width, almost certainly a result of increased sediment loads, in recent decades and particularly after the very large flood of 1984. The CPR reported in 2005 that it is increasing the amount and frequency at which they are removing gravel from Norrish Creek. Recent aerial photographs show vegetation is becoming established on gravel bars in the alluvial fan reach of Norrish Creek, possibly indicating the channel is becoming more stable. However, it is clear that sediment from Norrish Watershed continues to be an issue on the alluvial fan.

Overview assessment of Amendment #49 cutblocks

The cutblocks in Amendment #49 can be described as being on two types of slopes:

1. Open slopes that are part of the broad, U-shaped valley above the lower Norrish Creek. Upper portions of these slopes are steep, but slope gradients generally decrease towards the bottom of the valley. If landslides initiate on these upper slopes, they are likely to deposit before reaching Norrish Creek unless they become confined within a gully that is connected with Norrish Creek. Blocks NC1, NC20, NC28, and portions of NC7, NC24 and NC26 are on these slopes.
2. Slopes leading into gullies or directly on gully walls. These slopes are almost always directly connected with the channel system, so if a landslide initiates, most likely it will deliver sediment to the alluvial fan. However some of these slopes are not steep, and therefore unlikely to initiate a landslide. Blocks NC3 and NC5 are on these slopes, as are portions of NC7, NC24 and NC26.

Specific block descriptions, derived from aerial photographs, maps, and the helicopter overview flight information, are contained in Table 1.

Table 1. Amendment #49 cutblock-related observations.

Block	Description
NC1	Block NC1 ranges from 300 m to 1000 m horizontal distance to Norrish Creek. Average slope gradient from the top of the block to Norrish Creek is 25%, with much of the area at about 10% gradient. A small creek runs parallel to the edge of the block. The block is within second-growth timber with no indication of slope failures after the first harvesting.
NC3	NC3 is adjacent to a large gully which likely is capable of delivering debris flows directly into Norrish Creek. The gully channel gradient is about 25%. Average slope gradient from the upper cutblock boundary to the gully is 40%. Our brief field visit indicated that a portion of the block has a till ridge that would prevent slides from entering the gully channel, but in the rest of the cutblock slides could enter into the gully channel. A 1990-94 cutblock located partially on the opposite gully sidewall has not had any slides to date.
NC5	NC5 is located on both sides of a ridge between two gullies that join together below the block. 1968 photos clearly show the main gully to the north of the block has had a debris flow directly into Norrish Creek. The cutblock is a maximum of about 400 m from the gully with 50% average slope gradients from the upper cutblock boundary to the gully. Slope gradients >60% are common in the block, and smaller tributary gullies are present within the cutblock. The north main gully channel gradient averages about 30%, and the gully channel gradient to the south averages about 40%. A 1996-98 cutblock partially located on the opposite gully sidewall to the north has no slides to date, however, these slopes appear somewhat more gentle in this block than in NC5.
NC7	Much of NC7 is on similar gully slope terrain as NC5, but some of the block is located on open slopes above Norrish Creek. Slides from the northern portion of the block would go into same gully system as slides from NC5. Obviously

	unstable gullied slopes have been excluded on the north boundary of NC7, however some of these gullies extend into the cutblock area. Slope gradients within the portion of the block that slopes into the gully between NC7 and NC5 average about 70%. A 1960's cutblock located immediately upslope of NC7, on the same gully sideslope, shows a very small landslide in the 1979 photos. It appears that this slide did not reach the main gully.
NC20	NC22 is now incorporated into NC20. The area is in second-growth forests located on open slopes that are above Norrish Creek. Small gullies or channels are located in the cutblock or adjacent to the cutblock. Lower portions are on moderate gradient slopes (average about 35%), with the NC22 area on slopes up to about 60%. No slides were evident after the first logging.
NC24	NC24 is partially located on a sidewall of a major gully system that has had debris flows directly enter Norrish Creek, and partially on open slopes above Norrish Creek. Slopes average 60% from the top of block to the gully channel. Small portions of the block were harvested previously with no sign of slides, however the road crossing of the side gully that forms the eastern boundary of the cutblock has had slope failures that likely entered the main gully. Open slopes below the block remain fairly steep, approximately 60% for much of the distance to Norrish Creek.
NC26	NC26 is primarily on open slopes above Norrish Creek, with average slope gradients of about 50%. Below the open slope portion of the block minimum slope gradients are about 40% for 100 m. A portion of the block is located above a gully, and has slopes averaging about 65%. Lower portions of this gully were logged in the 1960s and appear to have had a landslide.
NC28	This is a partial harvesting block located 450 – 1400 m from Norrish Creek. Some slopes within the block are very steep. Below the block the minimum slope is 40% for 100 m.

Recommendations

The large number of logging-related landslides within the lower Norrish Watershed and the subsequent delivery of sediment to the alluvial fan indicates forest management should ensure landslides do not enter into the stream system. In addition, the water pipeline is vulnerable to debris flow damage where it crosses gullies on the west side of the valley. Given the extent of elements at risk in this watershed, I recommend that the Forest Practices Code Timber Harvesting Practices Regulation #4 (December 12, 2003 version) harvesting restrictions for community watersheds should be extended to the lower portion of the watershed. This regulation has greater restrictions on harvesting on slopes with a high likelihood of landslides and slopes with a moderate likelihood of landslides and a high likelihood of the landslide entering a stream. See Appendix 1 for definitions of landslide likelihood and the likelihood of landslides entering into the channel system.

Timber Harvesting Practices Regulation #4 allows partial harvesting of moderate hazard slopes with a high likelihood of landslide debris entering a stream. To my knowledge, there is no data available to indicate what level of partial harvesting will result in little change to slope stability, however the general principle is the greater the amount of harvesting, the greater the likelihood of landslides. For slopes with a moderate likelihood of landslides and a high likelihood of landslides entering a stream, I recommend dispersed single tree selection with a maximum of 20% basal area removal.

Cutblock edges adjacent to potentially unstable terrain should be evaluated for windthrow and prescriptions developed if needed.

This overview assessment cannot provide sufficient detail to accurately assess the extent of risk in all cases. For most of the blocks identified in Amendment #49, Terrain Stability Assessments (TSAs) will be required to determine the actual level of risk that the cutblock presents. If the recommendation for community watershed harvesting restrictions is accepted, then persons conducting the TSAs should be informed of this standard so they can conduct their assessments in accordance with the recommendation. Assessments of Blocks NC3, NC5, and NC7 should evaluate the potential for damage to the water pipeline.

The following block-specific recommendations and comments are developed on the basis of our field trip to Norrish Creek, air photograph and map interpretation, and reports prepared for Teal Cedar Products. TSAs are generally recommended for slopes steeper than 50%. Howes (1987) found significant clearcut landslide rates on some terrain types with slopes as low as 50%.

- Block NC1 is on generally moderate slopes that did not have landslides after logging. No landslides are anticipated.
- Block NC3 is generally on moderate slopes, but with some steeper portions. If landslides do occur, they may directly supply sediment to Norrish Creek since the block is adjacent to a large gully. In addition, the water pipeline may be at risk. I recommend a TSA of the slopes steeper than 50%. The cutblock edge adjacent to the gully channel should be evaluated for windthrow-induced instability.
- Block NC5 and the northern portion of NC7 present the greatest risk of landslides entering directly into Norrish Creek and damage to the water pipeline. Any forest operations in these areas would require careful planning, TSAs, and consideration of the effect of windthrow on slope stability. A complete prohibition on harvesting of moderate landslide hazard slopes may be warranted. The southern portion of NC7 is on open slopes and presents less risk, however a TSA should be done.
- Block NC20 is on open slopes, however there are some small gullies or streams located within or adjacent to the block. I recommend a TSA of any areas steeper than 50%, with the assessment to include whether any landslide might reach Norrish Creek if the landslide enters a confined channel.
- Approximately half of Block NC24 is located on slopes that are directly connected with the gully located between NC24 and NC26. This gully has the potential to deliver

landslides directly into Norrish Creek. The open slope portion of NC24 has relatively steep slopes below the cutblock. A TSA should be conducted to evaluate landslide likelihood and likelihood of a landslide entering a channel from both the open slope and the gully wall areas.

- A TSA will be required for Block N26. The area near the boundary from C10 to C29 is adjacent to the gully that likely had a slide in its lower portion after logging in the 1970's. The area near C55 to B14 is also adjacent to a gully. Both areas should be carefully evaluated, including potential windthrow effects.
- Block NC28 has a TSA report prepared. The assessment and its findings appear appropriate.

Conclusion

The cutblocks in Amendment #49 range in landslide and sedimentation hazard. It is clear that Blocks NC1 and most of NC20 present very little risk from landslides. Block NC28, and most portions of NC24 and NC26 likely present little risk. Blocks NC5 and NC7 appear to present very significant landslide and sedimentation risk, however detailed assessments will provide a clearer picture. A cautious approach is warranted given the history of the watershed. This evaluation is an overview; more accurate assessments of landslide and sedimentation risk will require detailed terrain stability assessments.

This report has not evaluated whether past logging and proposed logging will result in significant changes to peak flows or low flows. In my opinion the increase in sediment supply from logging is the primary issue within Norrish Creek, however an evaluation of changes to peak and low flows is warranted. Such an evaluation should consider the entire watershed since logging in the entire watershed, not just the lower portion of the watershed, affects the alluvial fan.

Should you have any questions or would like further information, do not hesitate to contact me.

 

Tom Millard, P.Geo

pc: Denis Collins, Raveen Singh

References

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Landslide initiation likelihood criteria in Table 1 were developed by Howes (1987). These criteria were derived from data that was collected primarily in the Norrish Watershed and are therefore particularly appropriate.

Table 1. Definition of Landslide Initiation Likelihood (from Howes, 1987)

Qualitative landslide initiation rating	Post-clearcut landslide density (landslides/ha)	Approximate percent of terrain polygons with one or more post-clearcut landslides
High	>0.10	>40
Moderate	>0.05 – 0.10	>20 – 40
Low	>0.01 – 0.05	>5 – 20
Very low	≤0.01	≤5

Table 2 shows criteria for the likelihood of a landslide, once initiated, depositing into the stream system. In almost all cases, once a landslide reaches a gully or any other part of the stream system in the lower Norrish Watershed, it can be expected to contribute a significant amount of sediment to the mainstem and alluvial fan reaches of Norrish Creek. Streams that may be exceptions to this rule are small (<3m wide), with gentle gradients (<10%) and that are unconfined (banks <3m high).

Table 2. Definition of Landslide Deposition into Stream Likelihood.

Qualitative deposition in stream rating	Likelihood of landslide, once initiated, reaching the stream	Typical open slope site descriptions (note that confined conditions significantly increase landslide travel distance)
High	>40%	Slopes steeper than 40%
Moderate	>20 – 40%	Slopes 50 - 100 m in length and with slope gradients <30%.
Low	>5 – 20%	Slopes gradients less than 30% for distances of 50 – 200 m.
Very low	≤5	Slope gradients less than 30% for distances >200 m.