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2001 Interior Watershed Assessment Update

for the

POWERS CREEK WATERSHED

(Penticton Forest District)

Prepared for
Riverside Forest Products Ltd.,
Small Business Forest Enterprise Program (Penticton) and
Gorman Bros. Lumber Ltd.

By

DOBSON
Engineering Ltd.

December 2001

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2001 Interior Watershed Assessment Update
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December 11, 2001

1.0 INTRODUCTION

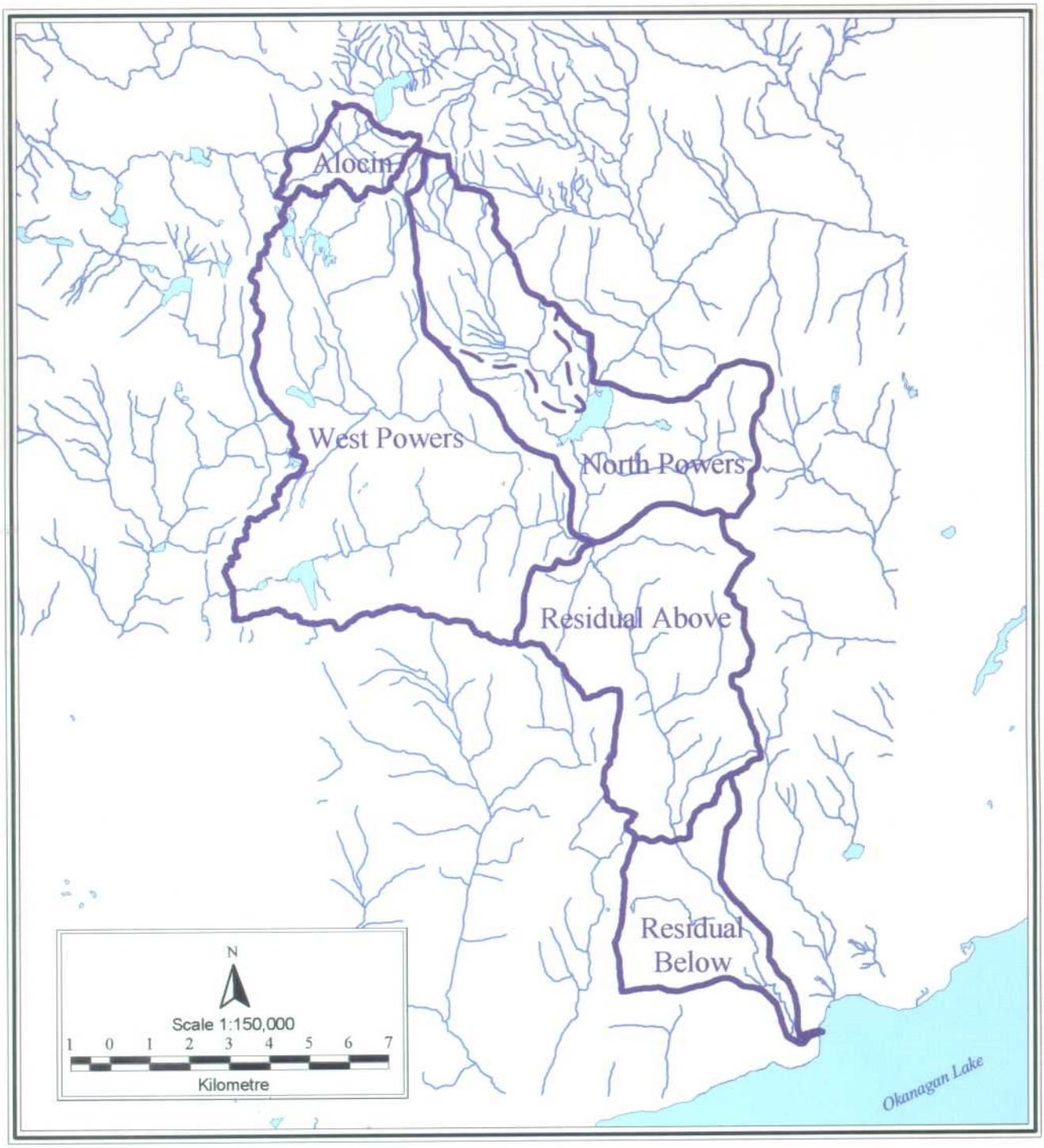
As requested by Riverside Forest Products Ltd., Kelowna Division (Riverside); Gorman Bros. Lumber Ltd. (Gormans); and the Small Business Forest Enterprise Program, Penticton (the licensees), the Interior Watershed Assessment Procedure (IWAP) for the Powers Creek watershed has been updated from the November 1998 report to 2001. The IWAP update includes a summary of the 1998 IWAP, an office review of any work completed since 1998, field assessments of selected sites in the watershed, and recommendations for the development proposed in the forest development plan (FDP) update for the period of 2002 to 2006. The current assessment was conducted in accordance with the requirements of the Okanagan-Shuswap Land and Resource Management Plan (LRMP) (refer to Appendix A for details).

The objectives of this report are as follows:

- Address the issues identified by the Watershed Assessment Committee (WAC) at the May 16, 2001 initial IWAP meeting.
- Present the current condition of the watershed based on the field assessments conducted in August 2001.
- Review the current five-year FDP in relation to the current watershed condition.
- Discuss the potential hydrologic effects of the proposed development and provide recommendations.
- Comply with the requirements of the Forest Practices Code Operational Planning Regulation that watershed assessments must be completed for community watersheds every three years and before submitting an FDP.

The Powers Creek community watershed drains southeast into Okanagan Lake approximately two kilometers south of Westbank, BC (Figure 1). The watershed encompasses an area of 139km^2 ranging in elevation from 342m at Okanagan Lake to 1,860m at the summit of Whiterocks Mountain. The Alocin Creek community watershed is 474ha ranging in elevation from 1,500m at the Nicola Diversion Ditch to 1,600m at Tadpole Lake. Forest development in the Powers Creek watershed has taken place since approximately the mid-1940s. The majority of clear-cut harvesting in the upper portion of the watershed occurred in the 1980s and 1990s. Approximately 30% of the watershed has been harvested.

Figure 1
Location and Sub-basins of the Powers Creek Watershed



2.0 METHODS

This IWAP report updates the results of the 1998 IWAP report and provides a summary of the pertinent background information. Some of the hazard ratings reported in this update report vary from those reported in the 1998 report because the methodology of the assessment has changed. The current IWAP procedure utilizes the April 1999 Interior Watershed Assessment Procedure Guidebook, which is based primarily on professional judgment and field investigations with office analyses as supporting information; whereas, the 1998 IWAP report was based primarily on results from office analyses with limited field investigations. The change in the assessment procedure results in the hazard ratings reflecting the actual field conditions rather than the results of an office-based numerical analysis.

Potential impacts from the development of the rural and sub-urban portions of the watershed were not assessed since these issues were considered to be beyond the scope of this assessment. It should also be noted that the potential impacts of the proposed forest development within the community watershed portion of Alocin Creek were only assessed within the drainage area above the Nicola Diversion. Potential impacts were only considered in context with impacts to the Powers Creek watershed since impacts within the entire Alocin Creek watershed were beyond the scope of this report.

To initiate the IWAP process, an initial round table meeting was held with the members of the WAC on May 16, 2001. At the initial WAC meeting, the 1998 IWAP report was reviewed and current water-related concerns for the Powers Creek watershed were discussed (refer to Appendix B for initial meeting minutes). To finalize the IWAP process, a final round table meeting was held with the members of the WAC on December 11, 2001. The findings of the 2001 Powers Creek IWAP draft report were presented and the report recommendations were discussed (refer to Appendix B for final meeting minutes).

3.0 KEY WATERSHED ASSESSMENT ISSUES

At the May 16, 2001 WAC meeting, the following issues/actions were identified:

- Conduct a modified reconnaissance channel assessment procedure (Re-CAP) on the watershed and sub-basin mainstem channels downstream from recent and proposed development.
  Status—Addressed in section 5.5 and Appendix E.

- Determine the impacts of the Westbank Irrigation District's (WID) proposed diversion and pipeline in Powers Creek. Include the potential watershed boundary change on the watershed map.
  Status—Addressed in section 6.0

- Update the condition of the remaining wooden culverts in the Alocin Creek community watershed.

Status—Addressed in section 5.2

- Review the recommendation from the 1998 IWAP that proposed harvesting in the North Powers Creek sub-basin proceed slowly at a rate such that the Equivalent Clear-cut Area (ECA) would not increase by more than 2% in any three year period.
  Status—Addressed in section 6.1

- Incorporate the proposed expansion to the Crystal Mountain Resort.
  Status—Addressed in section 6.0

4.0 BACKGROUND INFORMATION

4.1 Summary of the 1998 IWAP Conditions

The following is a summary of the 1998 IWAP conclusions:

- The peak flow hazard rating is moderate for West Powers Creek sub-basin and the entire Powers Creek watershed, and high for the North Powers Creek sub-basin, mainly due to the current ECAs. The peak flow hazard rating is low for the Alocin Creek community watershed.

- Little to no channel instability was observed in the North Powers Creek and West Powers Creek sub-basins, and the Alocin Creek community watershed. The Powers Creek mainstem was slightly to moderately disturbed due to cumulative impacts from activities on private land, the presence of a landslide in the lower portion of the watershed, the diversion of stream flows from Lambly Creek watershed, and a higher than normal spring freshet event in 1997.

- The surface erosion hazard rating is moderate for all sub-basins and the entire Powers Creek watershed based on the density of the roads. Delivery of sediment from active roads is minimal to moderate. Several wood culverts on inactive roads throughout the sub-basins are collapsing. The greatest surface erosion concern is related to landslides.

- The riparian hazard rating is low for the entire Powers Creek watershed and most of the sub-basins. The riparian hazard rating is moderate for the Alocin Creek community watershed due to the percentage of riparian area harvested.

- Five landslides were identified in the Powers Creek watershed. Four are not related to forest development. One appears to be road related and is located in the North Powers Creek watershed. All of the landslides are at least partially connected to channels. The landslide hazard ratings are low for all of the sub-basins and the entire watershed based on the limited number of landslides and the limited amount of existing road located on potentially unstable or unstable terrain.

- Several proposed cutting permits located within the North Powers Creek sub-basin could result in hydrologic impacts due to the high proposed ECA and the location of the blocks above the Lambly Creek reservoir.

- WID has expressed concern that the proposed forest development may result in peak flows occurring early in the spring, which would force the WID to rely on stored water earlier.

- The forest development should not result in earlier peak flows within the West Powers Creek and North Powers Creek sub-basins because the increased water yield associated with the development should offset any potential changes in the timing of runoff.

A summary of the overall hazard ratings is presented in Table 1. The 1998 watershed report card is presented in Appendix C.

TABLE 1
1998 Hazard Ratings for the Powers Creek Watershed

Drainage	HAZARD CATEGORY				
	Peak Flows*	**Surface Erosion**	**Landslides**	**Riparian**	**Channel Stability***
West Powers	Moderate	Moderate	Low	Low	Moderate
North Powers	High	Moderate	Low	Low	High
POI 2**	Moderate	Moderate	Low	Low	Moderate
POI 1**	Moderate	Moderate	Low	Low	Moderate
Alocin	Low	Moderate	Low	Moderate	Low

* The hazard category was "Peak Flows and Channel Stability" in the 1998 IWAP.
** POI 1 is at the confluence with Okanagan Lake. POI 2 is at the WID intake.

4.2 Status of the 1998 IWAP Recommendations

The following list presents the recommendations from the 1998 IWAP and the current status of each:

- *Recommendation 1*—It is recommended that development within the North Powers Creek sub-basin proceed slowly at a rate such that the ECA would not increase by more than 2% in any three-year period. In addition, channel monitoring sites that have already been established within the North Powers Creek sub-basin should be reviewed annually to provide details regarding possible channel changes and the relationship of any changes that might be associated with the proposed forest development. The harvest areas should also be developed so that potential water

quality impacts at the reservoir are minimized (e.g. silt fencing, culvert socks, rip rapping of culvert inlets and outlets and appropriate deactivation of inactive roads).
Status—The 2% ECA recommendation has been followed by the licensee, but is reviewed in the 2001 IWAP update. The channel monitoring sites have been reviewed annually.

- *Recommendation 2*—If not already carried out, a qualified professional should review the large landslide located below the Glenrosa sub-division to determine if there is a public safety concern. It should be noted that this landslide is not forest development related and is situated within the jurisdiction of the Regional District of the Central Okanagan.
  Status—Completed by Dobson Engineering Ltd. for the Regional District of Central Okanagan in 1999.

- *Recommendation 3*—Inactive roads throughout the watershed should be assessed and rehabilitated by taking appropriate measures to reduce the amount of old wood culverts and to restore natural drainage patterns. Old wood culverts crossing over the main channel in the Alocin Creek watershed are of particular concern and should be removed as soon as possible.
  Status—High priority sites have been completed. Three culverts replaced along Alocin Creek. Additional culverts remain in place.

- *Recommendation 4*—Maintain or deactivate roads (i.e. status roads) upon completion of harvesting to minimize surface erosion and mass wasting.
  Status—Forest Practices Code requirement.

- *Recommendation 5*—Following the completion of the proposed development, roads associated with the cutting permits should be deactivated or maintained to a level appropriate with their anticipated future use and natural drainage should be maintained or restored within all blocks and on access roads.
  Status—Forest Practices Code requirement.

- *Recommendation 6*—A combined long-term FDP should be developed for the watershed that incorporates the results of the Complan work developed by Riverside along with the portion of the watershed that is outside of the TFL, which includes the Small Business Forest Enterprise Program and Gorman Bros. Lumber Ltd. operating area.
  Status—Completed. Gormans portion is outstanding, but no development planned for the area within the near future.

- *Recommendation 7*—The long-term sustainable level of harvest and associated ECAs for the watershed should be based on information collected from the channel monitoring sites, streamflow information, and the long-term FDP (e.g. Complan) to ensure that stream channel stability and water quality are protected.

Status—A long-term sustainable timber harvest plan is being developed as part of the TFL 49 results-based code project currently underway.

4.3 Water Quality Assessment and Objectives

A report titled *Water Quality Assessment and Objectives for Powers Creek Community Watershed* was completed by Mould Engineering in December 2000 for the BC Environment and Riverside. This report summarized the data collected at a monitoring station located at the WID intake and at two sampling sites (grab samples collected for laboratory analysis) in the watershed between June 1996 and December 1999. One of the grab sample locations was immediately upstream from the WID intake and the other was in the upper watershed.

The report concluded that the most sensitive water use in the Powers Creek watershed was the potable water supply. Forest harvesting and cattle grazing were identified as the two major activities that have the greatest potential to impact the water quality in the watershed. Water quality objectives for turbidity, non-filterable residue, stream temperature, true colour, fecal coliform, and *E. coli* bacteria are summarized in Appendix D. The report recommended establishing a monitoring program for continuous sampling at one site in the watershed and collection of grab samples at various frequencies at three sites in the watershed. In the fall of 2000, Riverside assumed operation of the water quality station at the WID intake as part of the TFL 49 project.

4.4 Channel Monitoring

The stream channel monitoring program is summarized in the report titled *Stream Channel Monitoring Program for the Powers Creek Watershed* completed by Dobson Engineering Ltd. in March 2001. Two permanent channel monitoring sites were established in 2000. Site 1 is located on Harding Creek and was established to monitor channel conditions before and after the diversion of water from Paynter Lake and Upper Powers Creek via a pipeline to Harding Creek. Site 2 is located on North Powers Creek upstream from Lambly Lake in a basin identified as having a high ECA.

The report did not contain conclusions due to having only one year of data. It was recommended to continue the monitoring program in 2001 to help determine annual variability and potential trends that may exist at the monitoring sites.

4.5 FRBC Restoration Work Completed Since 1998

Since 1998, there have been several Forest Renewal BC (FRBC) projects completed in the Powers Creek watershed. Three failing wood culverts were replaced with metal culverts in the Alocin Creek watershed as a joint project between WID and Riverside. The culverts were located at approximately 39km on the Horseshoe Forest Service Road (FSR).

Restoration work was conducted on a landslide at 26.25km on Bear Creek FSR. The headscarp of the failure was located directly below a culvert and the failure material deposited in Powers Creek mainstem. Restoration work included installation of an additional culvert in the road, pullback of the failure headscarp, construction of a sediment catchment area at the base of the failure, and revegetation of the failure area. Further details are in the report completed on August 13, 1999, by Dobson Engineering titled *Powers Creek Watershed/Road Deactivation Prescriptions.*

Restoration work was conducted on the failure identified as Landslide No. 1 in the 1998 IWAP report. The restoration work included pullback of the headscarp, revegetation of the failure surface, and deactivation of the local roads. Further details are in the report completed on August 26, 1999, by Dobson Engineering titled *Powers Creek Watershed/Bear Creek Main—Road Deactivation Prescriptions.*

5.0 CURRENT WATERSHED CONDITION

The current watershed report card for the Powers Creek watershed and the Alocin Creek watershed is presented in Appendix C. The 2001 report card includes all forest development completed up to and including January 1, 2001. A modified channel assessment was completed at the sites assessed in the 1998 IWAP, as well as downstream from recent and proposed development. The detailed results of the assessment are presented in Appendix E and the maps are in Appendix F. In the current assessment (2001), some of the hazard ratings are lower than those reported in the 1998 IWAP report due to changes in the assessment procedure, as explained in the Methods section (section 2.0).

Following the presentation of the draft report at the final round table meeting on December 13, 2001, new data were provided on measured tree heights for existing blocks in the watershed. These data were used to calculate more accurate site index values for stands in the watershed. More accurate ECAs were subsequently calculated and presented in this final IWAP report (Table 2).

5.1 Peak Flows

The peak flow hazard rating is low for the West Powers sub-basin (previously rated as moderate) and is maintained at low for the Alocin Creek watershed. The peak flow hazard rating is moderate for the North Powers sub-basin (previously rated as high) and is maintained at moderate for the entire Powers Creek watershed.

The ECA for the West Powers sub-basin is low at 21.9% (Table 2) and disturbance related to potential increases in peak flows was not observed. The ECA for the Alocin Creek watershed is moderate at 37.1%, but peak flow related channel disturbance was not discernable. The mainstem channels in these basins are stable with low gradient swampy sections and boulder/cobble dominated sections. The channel conditions are similar to those observed during the 1998 assessment. Both channel types are relatively insensitive to peak flow increases. In addition, reservoirs in the West Powers sub-basin may act to reduce peak flows through water storage, which reduces the potential for

peak flow impacts. The stable channel conditions observed during the field investigations warrant low peak flow hazard ratings for the West Powers Creek sub-basin and the Alocin Creek watershed.

The peak flow hazard rating for the North Powers Creek sub-basin was rated as high in the 1998 IWAP primarily due to the high ECA above the H60 elevation. The rating is decreased to moderate in the current (2001) assessment reflecting the change in the IWAP procedure (section 2.0) and the general stability of the channel downstream from Lambly Lake. The decrease in the rating does not reflect a change in peak flows, as the current peak flow and channel conditions are similar to those in 1998.

Although the peak flow hazard rating is moderate for the North Powers Creek sub-basin, the 600m section of channel immediately upstream from Lambly Lake is moderately aggraded (site P) and the peak flow hazard rating for the drainage area of North Powers Creek upstream from Lambly Lake is rated as high. The disturbance is related to pre-1995 stream cleaning and, likely, increased peak flows. The ECA for the North Powers sub-basin is moderate at 28.9%, but the ECA for the North Powers Creek drainage upstream from Lambly Lake is 42.3%, which suggests that increased peak flows have exacerbated the channel disturbance.

The lower reach of Powers Creek is slightly aggraded with minimal pool area and negligible amounts of functioning large wood present in the channel (site T). The main factor that has contributed to the condition of the lower reach is related to development on adjacent private land. The ECA for the entire Powers Creek watershed is low at 22.6%, but the lower reach is sensitive to peak flow increases warranting a moderate peak flow hazard rating.

TABLE 2
Current and Proposed ECAs for the Powers Creek Watershed

Drainage	Equivalent Clear-cut Area (%)	
	Current (January 1/2001)	Proposed (2006)
West Powers	21.9	24.7
North Powers	28.9	30.2
POI 2	20.1	21.6
POI 1	22.6	24.2
Alocin	37.1	35.4

5.2 Surface Erosion

The surface erosion hazard ratings are low for the West Powers and North Powers sub-basins and for the entire Powers Creek watershed (previously rated as moderate). The surface erosion hazard rating is maintained at moderate for the Alocin Creek watershed.

Many of the roads in the watershed are rated as moderately to highly erodable due to the sub-grade material and moderate surface erosion was observed on several road sections (site F). However, the roads are generally well maintained and stable, and most of the eroded surfaces are disconnected from the channel system. In addition, recent watershed restoration work has been effective at curtailing the delivery of sediment to channels. All of the deactivated roads reviewed during field investigations are stable and effective at reducing surface erosion. The landslides inspected during field investigations are well vegetated and stable (sites A and O). All of these issues, in combination with the change in the assessment procedure (section 2.0) warrant reductions in the surface erosion hazard ratings for the West Powers and North Powers sub-basins as well as the entire watershed.

Three old wood culverts have been replaced with metal culverts in the Alocin Creek watershed; however, several others in the Alocin Creek watershed and one on a tributary channel to Dobbin Lake in the West Powers sub-basin are failing (sites D and H). In addition, soil is exposed and eroding along the outlet channel from Tadpole Lake (site G). Some sediment has been contributed to the channels warranting a moderate surface erosion hazard rating for the Alocin Creek watershed. The hydrologic impacts are mostly confined to Alocin Creek since the Alocin Creek flow is diverted into Dobbin Lake where the majority of transported sediment can settle.

Cattle activity around channel crossings has resulted in the delivery of sediment to channels. The impacts are generally localized and minor, but chronic.

5.3 Landslides

The landslide hazard ratings remain low for the West Powers Creek and North Powers Creek sub-basins, the entire Powers Creek watershed, and the Alocin Creek watershed. Six landslides have been identified with one initiating since the 1998 IWAP. A stability assessment has been conducted on the recent failure and the slide has been rehabilitated. This failure and the previously reviewed failures are not significantly impacting the hydrologic condition of the watershed.

5.4 Riparian

The riparian hazard rating remains low for the West Powers Creek and North Powers Creek sub-basins and for the entire Powers Creek watershed, and is reduced to low for the Alocin Creek watershed. As in 1998, the majority of the riparian vegetation in the watershed is intact and contributing to channel stability and complexity. A large portion of the riparian vegetation has been harvested in the Alocin Creek watershed, but

has not resulted in channel instabilities. The lower reach of Powers Creek mainstem immediately upstream from Okanagan Lake is the only mainstem reach in the watershed with detectable impacts from the removal of riparian vegetation, which is on private land. However, the associated instabilities are relatively minor and have resulted mainly from development on adjacent private land.

5.5 Channel Stability

The channel stability hazard rating is low for the West Powers sub-basin (previously rated as moderate) and maintained at low for the Alocin Creek watershed. The channel stability hazard rating is moderate for North Powers Creek sub-basin (previously rated as high) and maintained at moderate for the entire Powers Creek watershed.

Most of the major channels that are tributary to the Powers Creek mainstem as well as the middle and upper reaches of Powers Creek are generally stable with negligible channel disturbance. The mainstem channels in the West Powers sub-basin and the Alocin Creek watershed are generally stable warranting low channel stability hazard ratings. Sand and gravel have deposited in the section of Powers Creek immediately upstream from the Jackpine FSR crossing (site M). It is understood that the aggradation has existed for at least 15 years. It is likely that the source of the material is natural and has deposited because of reduced stream power with the local decrease in channel gradient. Local beaver activity was also observed, which may be responsible for the deposition of transported sediment.

North Powers Creek downstream from Lambly Lake is generally stable warranting a reduction in the hazard rating for the sub-basin to moderate; however, the section of North Powers Creek immediately upstream from Lambly Lake continues to be moderately aggraded (site P). The disturbance is related to pre-1995 stream cleaning and, likely, increased peak flows. The reported removal of large wood from the channel (pers. com. D. Gooding) reduced the sediment storage capacity of the channel and increased the flow velocity; thereby, bank scour and sediment transport rates were increased. In addition, increased peak flows have exacerbated the channel disturbance. The level of channel disturbance has not increased since the 1998 assessment, but the disturbance coupled with the high local ECA warrants concern for the drainage into Lambly Lake.

The lower section of Powers Creek mainstem on the alluvial fan adjacent to Okanagan Lake is slightly aggraded (site T). Land-use practices on adjacent private lands have led to reductions in channel complexity, bank scour, and excessive deposition of gravel. The landslide below the Glenrosa sub-division may also be contributing material to the gravel deposits in the lower reach. Channel restoration structures in the lower reach are enhancing the channel complexity in the lower reach. Although recent watershed restoration activities have decreased the amount of ongoing disturbance in the watershed, the channel in the lower reach has not sufficiently recovered to warrant decreasing the channel stability hazard rating for the entire watershed to low.

5.6 Grazing Impacts

Cattle are present in the watershed and contribute to channel disturbance in those areas where they congregate for water. Repeated movement in and out of the channels, along with grazing of the riparian vegetation, leads to destabilization of the banks and an influx of sediment to the channel system. The cattle activity often occurs in the same locations year after year.

5.7 Hazard Ratings

A summary of the overall hazard ratings is presented in Table 3 below:

TABLE 3
2001 Hazard Ratings for the Powers Creek Watershed

Drainage	HAZARD CATEGORY				
	Peak Flows	**Surface Erosion**	**Landslides**	**Riparian**	**Channel Stability**
West Powers	Low	Low	Low	Low	Low
North Powers	Moderate	Low	Low	Low	Moderate
POI 2	Moderate	Low	Low	Low	Low
POI 1	Moderate	Low	Low	Low	Moderate
Alocin	Low	Moderate	Low	Low	Low

6.0 RISKS OF PROPOSED FOREST DEVELOPMENT

A total of 686.4ha of timber are proposed for harvest in the Powers Creek and Alocin Creek watersheds during the period of 2001 to 2006 representing 4.7% of the total area. The blocks are dispersed between all of the sub-basins including the residual area and the Alocin Creek watershed with a greater concentration of harvest northwest of Lambly Lake in the North Powers sub-basin. The watershed report card incorporating the development proposed to 2006 is presented in Appendix C.

The development of additional ski runs is tentatively proposed for Crystal Mountain Resort, which falls within the West Powers sub-basin. Approximately 29ha of forest is proposed for clearing between 2001 and 2006, which is dependent on several factors (i.e. ski hill use, development of housing, etc.). Due to the limited extent of the Crystal Mountain Resort development and the stable condition of the West Powers sub-basin, it is expected that the associated harvesting will not impact the overall hydrologic condition of the watershed. The development was not included in the ECA calculations and maps due to not knowing the exact

timing of the proposed clearing, but accounts for approximately 0.6% of the West Powers sub-basin and 0.2% of the Powers Creek watershed.

WID plans to construct a pipeline to divert water from Paynter Lake into Harding Creek during periods of low flow. Harding Creek drains into Lambly Lake and the water intake will be relocated from POI 2 to the outlet of Lamby Lake. Currently, the proposed pipeline from Paynter Lake to Harding Creek is designed to accommodate flows of 0.33 m^3/s. These flows are approximately equal to the bank-full discharge of Harding Creek at the channel monitoring site, which suggests that the discharge from Harding Creek may be at least bank-full for longer periods of time than under natural conditions, following construction of the pipeline. It is a concern that these flows could result in degradation of Harding Creek if the channel is not designed to accommodate the increase in flows. Unless the Harding Creek channel is designed to accommodate sustained high flows, the delivery of sediment to Lambly Lake will increase until the channel adjusts to the new flows.

6.1 Peak Flows

The proposed development will increase the ECA for the Powers Creek watershed to 24.2% (Table 2) by the end of 2006. The 2006 ECA level is low and any increase in peak flows as a result of the proposed development would likely be undetectable at the mouth of Powers Creek. Not withstanding the issues in North Powers Creek upstream from Lambly Lake, based on the condition of the watershed, it is unlikely that the potential increase in peak flows would impact the overall hydrologic condition at the watershed level. The peak flow hazard rating (moderate) is expected to remain the same for the entire Powers Creek watershed.

In the West Powers Creek sub-basin, the ECA will increase to 24.7%. Again, any increase in peak flows would likely be undetectable and channel conditions should remain the same. The ECA will decrease in the Alocin Creek watershed to 35.4% and it is expected that the channel condition will remain stable. The peak flow hazard rating should remain unchanged at low.

The proposed development for the North Powers Creek sub-basin will increase the ECA to 30.2%, which is consistent with the recommendation in the 1998 IWAP report to avoid increasing the ECA in North Powers Creek sub-basin by more than 2% in any three year period. However, the 600m section of North Powers Creek immediately upstream from Lambly Lake is aggraded and the harvest level of the North Powers Creek drainage upstream from Lambly Lake is high. The original proposed development that would have increased the ECA from the current (2001) level of 43.2% to 48.9% was subsequently modified due to the high concern for potential peak flow impacts upstream from Lambly Lake. It is unlikely that the proposed development would impact the condition of North Powers Creek downstream from Lambly Lake since the downstream channel has a much greater flow capacity than the upstream channel; however, further disturbance to the channel upstream from Lambly Lake could impact water quality in the lake.

In response to the concerns regarding the channel condition in North Powers Creek upstream from Lambly Lake, Riverside has agreed to maintain the ECA at the current level of 42.3% (approximately 42.5%). It is likely that, as long as the ECA for the drainage upstream from Lambly Lake is not increased from its current level, the channel will slowly recover, as much of the disturbance is related to past stream cleaning. Through time, the reintroduction of large wood from adjacent riparian areas should improve channel complexity and facilitate recovery. The available harvest, as presented in Appendix C for the drainage of Powers Creek upstream from Lambly Lake, is based on maintaining an ECA of 42.5%. Based on these conditions, the peak flow hazard rating should not increase for the entire North Powers Creek sub-basin. In fact, the hazard rating may eventually be reduced for the entire sub-basin and the drainage of North Powers Creek upstream Lambly Lake permitted that channel recovery occurs in North Powers Creek upstream from Lambly Lake.

6.2 Surface Erosion

Surface erosion concerns are limited to the outlet channel from Tadpole Lake, the failed culverts in the Alocin Creek watershed, and the failed culvert on a tributary channel to Dobbin Lake. These are localized problems and should not be exacerbated as long as flows from Tadpole Lake are not significantly increased. The surface erosion hazard ratings for both sub-basins, the entire Powers Creek watershed, and the Alocin Creek watershed should not increase as long as cumulative impacts from roads are limited by road construction, deactivation, and maintenance procedures consistent with the Forest Practices Code.

6.3 Landslides

Two blocks proposed in each of North Powers Creek and West Powers Creek sub-basins are located on terrain mapped as potentially unstable. Terrain stability field assessments (TSFA) are required to ensure that potential impacts from landslides are not increased. Provided that the proposed development does not increase the likelihood of landslides, the landslide hazard ratings for both sub-basins, the entire Powers Creek watershed, and the Alocin Creek watershed are expected to remain low.

6.4 Channel Stability

The majority of channels in the Powers Creek watershed are stable and should not be impacted by the proposed forest development. The lower reach of Powers Creek mainstem is disturbed, but provided peak flows do not significantly increase at the mouth of the channel, the channel stability hazard rating for the entire Powers Creek watershed should remain moderate. The hazard ratings should remain low for the West Powers Creek sub-basin and the Alocin Creek watershed. The only concern regarding channel stability is related to additional impacts to the lower reach of North Powers Creek upstream from Lambly Lake. Increases in peak flows due to the proposed development would likely increase the severity of channel disturbance in the lower reach above Lambly Lake, but the impacts to North Powers Creek downstream from

Lambly Lake would likely be negligible. The channel stability hazard rating is expected to remain moderate at the sub-basin level.

7.0 CONCLUSIONS

The following conclusions were determined for the current condition of the Powers Creek watershed and for the proposed forest development:

- The Powers Creek watershed and the Alocin Creek community watershed are considered to be in good overall condition.

- The lower 600m section of North Powers Creek upstream from Lambly Lake is moderately aggraded, which is related to pre-1995 stream cleaning and, likely, increased peak flows. The lower reach of Powers Creek mainstem is slightly aggraded, but is mostly attributed to land-use on adjacent private land. All of the other channels are generally stable.

- Several wood culverts in the Alocin Creek watershed and one in the West Powers Creek sub-basin are failing and contribute sediment to the channel system. Otherwise, surface erosion is a low concern since the roads are generally well maintained and the recent watershed restoration activities have been effective at reducing surface erosion.

- Landslides and riparian areas are generally low hydrologic concerns.

- The forest development initially proposed in the drainage of North Powers Creek upstream from Lambly Lake would be a high concern for potential peak flow impacts to that section of channel; however, Riverside has modified the proposed development in order to maintain the current ECA, which should facilitate channel recovery. Otherwise, the proposed development is generally a low concern for peak flow, surface erosion, landslide, and channel stability impacts to the Powers Creek watershed, including the section of North Powers Creek downstream from Lambly Lake, and the Alocin Creek watershed.

- The harvest associated with the proposed Crystal Mountain Resort expansion is not expected to significantly impact the watershed.

- The potential for degradation of Harding Creek without alterations to the channel following the diversion of water is a high concern.

8.0 RECOMMENDATIONS

Forest Development Plan (FDP) Related Issues

- Maintain the ECA for the drainage of North Powers Creek upstream from Lambly Lake at or below 42.5% in order to limit the potential for peak flow impacts and to facilitate channel recovery. Annual monitoring of the channel section upstream from Lambly Lake should continue and the rate of future forest development should be based on the information obtained.

- Deactivate or maintain inactive permitted roads in accordance with the Forest Practices Code.

Non-FDP Issues

- Remove or upgrade any remaining failed wood culverts on non-status roads in order to reduce the delivery of sediment to channels (if funding is available).

- Westbank Irrigation District should consider increasing the channel capacity of Harding Creek downstream from the outlet of the proposed pipeline in order to reduce the potential for increased sedimentation into Lambly Lake caused by increases in stream flows.

R.S. Smith, FIT, Project Hydrologist

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA D. A. DOBSON

D.A. Dobson, P.Eng., Senior Reviewer

RS/dd/fw

APPENDICES

APPENDIX A

Okanagan-Shuswap LRMP

Okanagan Shuswap LRMP

General Resource Management; Water 3-26

Table 2 Attributes Addressed in the Powers Creek IWAP Update

The following text is a presentation of the issues addressed in the current IWAP as they relate to the requirements presented in Table 2 of the Water sub-section within the General Resource Management section of the Okanagan-Shuswap LRMP.

1) Sediment

Suspended solids or non-filterable residue (NFR) data are available for Powers Creek watershed for the period 1996-1999. There is no guideline for NFR for potable water; however, there are guidelines for aquatic life (25 mg/L) and for wildlife (20 mg/L). The median value for NFR at the WID intake is <5 mg/L and the maximum value is 107 mg/L.

Turbidity data are also available for Powers Creek. The acceptable turbidity level for raw drinking water that is to be chlorinated is ≤ 5 NTU. The guideline for aquatic life is 8 NTU. The Water Quality Branch has established "clear flow" and "turbid flow" periods for interior streams. For Powers Creek, the clear flow period is June 16-March 14 and the turbid flow period is March 15-June 15. For the period 1996-1999, the turbidity values for Powers Creek at the WID diversion are as follows:

- Clear Flow: mean (NTU) = 0.82; max (NTU) = 3.4 (101 samples)
- Turbid Flow: mean (NTU) = 5.14; max (NTU) = 20 (32 samples)

For an interior stream, these are unusually low values indicating good water quality. It is likely that the suspended sediment concentrations would be similarly low and would be consistent with the following criteria:

- Waters with <25 mg/SS/L should support excellent fisheries; however, the best trout streams are characterized by clear water with <5 mg SS/L for most of the hydrologic cycle.

2) Peak Flows

The peak flow hazard rating for the watershed with regards to forest development is moderate mainly due to the increased sensitivity of the lower reach of the mainstem channel. However, based on the channel conditions and the low ECA for the entire watershed, the current and proposed development should achieve the following criteria:

- Maintain the hydrograph peak flow and return periods within the range of the downstream evolved natural channel capacity.

- Maintain the timing of the rising and falling limbs and the base flow components of the hydrograph within the normal range.

Peak Flows

Drainage	HAZARD CATEGORY	ECA (%)	
	Peak Flows	Current (January 1/2001)	Proposed (2006)
West Powers	Low	21.9	24.7
North Powers	Moderate	28.9	30.2
POI 2	Moderate	20.1	21.6
POI 1	Moderate	22.6	24.2
Alocin	Low	37.1	35.4

3) Riparian

The riparian hazard ratings, considering forest development, are low for all sub-basins and the entire watershed. Although there has been riparian harvesting in the past, regeneration is occurring and the channels are generally stable.

4) Channel Assessments

The channel stability hazard ratings, considering forest development, are low for the West Powers sub-basin, POI 2, and the Alocin Creek watershed. The existing channel instabilities in the lower mainstem of Powers Creek are associated with localized non-forestry related development. The instabilities in North Powers Creek upstream from Lambly Lake are associated with forest development, but the recommendations regarding the development proposed for the sub-basin should facilitate channel recovery.

5) Other attributes concerning water quality for human consumption

- **Coliform**: For raw, untreated water, the Water Quality Guidelines recommend a 90th percentile of $\leq$ 10 CFU/100ml (based on a minimum of 10 samples collected over a 30-day period). For the period 1996-1999, 15% of the raw water samples exceeded this value.
- **temperature:** Data are only available from the WID intake. Water Quality Guidelines recommend temperatures <15°C. For the period 1996-1999, water temperatures exceeded the guideline on three occasions during the summer months reaching a maximum of temperature of 17.7 °C.
- **nitrate** (N): Trace
- **pesticides**: Not sampled
- **algae**: Not sampled

APPENDIX B

Round Table Meeting Minutes

Interior Watershed Assessment Procedure
for the
Lambly Creek, Powers Creek, Trout Creek and Ellis Creek Watersheds

Initial Roundtable Meeting Minutes

Date: **May 16, 2001**
Location: **Riverside Woodlands Office**
#11 – 368 Industrial, Kelowna (across from OK builders on Ellis)

Call to order: 9:25 a.m.

1. **Participants:**
Pat Poulin, Westbank Irrigation District (Powers)
Pete Rodd, District of Summerland (Trout)
Bill Muir, City of Penticton (Ellis)
Ted Jefferey, Lakeview Irrigation District (Lambly)
Greg Baytalan, Okanagan Similkameen Health Region
Dr. Bill Moorehead, Okanagan Similkameen Health Region
Nelson Grant, Penticton Forest District
Tony Zanotto, Penticton Forest District
Ken Langedyk, Dobson Engineering Ltd.
Mike Doiron, Riverside Forest Products Ltd.
Don McKee, BC Environment
Kerry Rouck, Gorman Bros. Lumber Ltd. (Trout)
Brian Harris, BC Environment
Jerome Jang, Penticton Forest District
Alan Rasmussen (Chair), Penticton Forest District
Mike Jobke, Penticton Forest District

2. **Introduction of Attendees**
   - invitation was also extended to Westbank First Nation, however there was no reply

3. **Review of meeting agenda**
   - Alan reviews the agenda
   - The following format will be used for each watershed:
     - Summarize work completed on recommendations in IWAP report – DEL
     - Summarize FDP – Licensees/SBFEP
     - Any work since last IWAP (1998) – Licensees/SBFEP/Irrigation District.
     - Water delivery system – Irrigation district or DEL
     - WAP direction and next steps – Alan/DEL
   - Add other business at the bottom of each watershed

4. Watershed Assessments according the Forest Practice Code

- Jerome provides background/summary
- As part of operational planning regulations, watershed assessments need to be carried out every three years
- Early Jan/Feb 2001 MELP and MOF met to review which watersheds would require assessments and determined that it be those impacted by heavy developments
- Licensees were asked to review those watersheds with heavy development
- Some were requested to be deferred
- Mike Doiron comments that forest development plans are on crown land, information is included that is not related to the crown land but is considered as additional info
- Regulation states the interior watershed assessment procedures are to be followed
- Mike Doiron comments that changes have been made since 1998 like the inclusion of Health and Range
- Jerome's response is at that time it didn't have the same profile as it does today

5. Terms of Reference for Technical Advisory Committee

- Ken Langedyk lists the following:
  a) Bring background information to the table
  b) Provide direction to the hydrologist
  c) Identifying any issues from the last IWAP
  d) Make recommendation to be included in the IWAP, bring these forward
  e) Provide summary

6. LAMBLY CREEK WATERSHED

Lambly Creek meeting minutes removed.

7. COFFEE BREAK 11:15

8. POWERS CREEK WATERSHED *(follow above format)*

Review previous WAP report – DEL

- Ken distributes handout "Interior Watershed Assessment Procedure for the Powers Creek Watershed, November 1998 report" (copy on file)
- identifies area on map
- reviews the conclusions and recommendations
- some discussion generated around landslides, one more to be added
- Mike Doiron – channel monitoring sites around Bear have been set up, mostly selective harvesting, some clearcuts
- Dobson and Ted Fuller have reviewed the large landslide by Glenrosa subdivision. CORD has been made aware of the landslides and the issues around it
- 3 culverts were replaced on road up to Tadpole Lake jointly by Riverside and Westbank Irrigation District, detailed info to be provided by Pat Poulin to Ken
- Mike comments as per FDP maintenance and deactivation schedule is outlined on the plan

Mike Doiron - FDP
- increasing harvesting at 2.1% over three years
- adjustments will be made to comply with the 2% in 3 years.
- some blocks have been deferred to comply with the 2%
- blocks added around horseshoe lake
- adding blocks on basis to limit amount of harvesting in watershed

Tony - SBFEP
- limited to east of Bear Lake
- no proposed blocks at this time
- planning is on hold until clarification is made in regards to First Nations involvement, if this changes Tony will contact Ken

Major Works – Pat Poulin
- water quality improvement project relocating intake source at Bear Lake, major pipeline project
- diversion required at Powers Creek to better utilize the storages
- forestry consultant working with MOF re CPs, etc…
- clear right-of-way - scheduled for between July/September
- run pipeline to Harding Cr scheduled for later part of year
- goal is to drain Bear Lake next year, but need to have upland work diversion done first (planned sometime in November)
- hope to complete project by 2003
- problems around terrain
- 2nd phase is to raise Bear Lake to 24 feet
- concerns about recreational and cattle use of Bear Lake, once the intake is complete
- Don McKee comments - will require amending community watershed boundaries
- Future Claims – expand storage capabilities of Painter lake and Dobbin Lake

SBFEP
- no updates other than semi-deactivation of some roads

Outstanding Issues
- Channel stability and disturbance and implications proposed logging will have – modified recap similar to Lambly - Ken
- Incorporate impacts of proposed pipeline – Pat Poulin to supply Ken with plan
- Potential Community Watershed Boundary Change – note on map - Ken
- Update on wood culverts on Alocin – Ken to discuss location with Pat and Fred Swetitch
- Re-visit 2% over 3 years - continue or drop – (Dave Gooding's Letter)
- Incorporate Crystal expansion if relevant - Ken

Next meeting date October (to be advised)
- Ken to provide draft beforehand

9. LUNCH 12:30 P.M. TO 1:00 P.M.

10. TROUT CREEK WATERSHED *(follow above format)*

Trout Creek meeting minutes removed.

11. ELLIS CREEK WATERSHED *(follow above format)*

Ellis Creek meeting minutes removed.

12. OTHER BUSINESS

- Mission Watershed WAC meeting suggested to be held in Fall (October)

Ken comments on LRMP discussion with Steve Carr. EWAC committee won't be formed until next year and should not hold up the IWAP.

- discuss further whether or not to bring in EWAC participants in as observers.
- Suggestion: information be provided to them in report format and visa versa for us.
- Suggestion: invitations should be extended to Regional District, and City of Kelowna
- adaptive mgmt plan - Should be incorporated in IWAP

Open Discussion/Comments:

- good to have Health Region participate and Irrigation Districts
- good mix of people to whom issue may impact
- encourage licensees to meet with ranchers and discuss issues regarding cattle

Meeting adjourned at 14:35 hrs.

Watershed Assessment Procedure for the POWERS CREEK WATERSHED

Final Watershed Assessment Committee (WAC) Meeting Summary Notes December 11, 2001

Location: Riverside Forest Products, Kelowna B.C.

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1. Introduction of Attendees

Des Anderson	MWLAP, Kamloops
Greg Baytalan	Okanagan Similkameen Health Region, Kelowna
Don Dobson	Dobson Engineering Ltd., Kelowna
Mike Doiron	Riverside Forest Products Ltd., Kelowna
Dave Gooding	MSRM, Victoria
Jerome Jang	MOF, Penticton
Bernie Kaplun	MOF, Penticton
Pat Poulin	Westbank Irrigation District (WID)
Barb Pryce	MOF, Penticton
Alan Rasmussen (Chair)	MOF, Penticton
Russell Smith	Dobson Engineering Ltd., Kelowna
Tony Zanotto	SBFEP, MOF, Penticton

2. Review of WAC Terms of Reference

- IWAPs are a Forest Practices Code requirement, to be completed every three years.
- purpose is to review the Hydrologist's report and work towards achieving consensus on the recommendations.
- this information feeds into the Forest Development Plan (FDP).
- if the hydrologist notes other issues in the watershed (e.g. range, recreation or private land impacts) these will be forwarded as appropriate for possible resolution.
- the WAC does not approve the report, but provides advice to the Prescribing Forester.

3. Presentation of Watershed Assessment Report

Don Dobson reviewed the 2001 Powers Creek Watershed Assessment Report.

Discussion

- new hazard ratings are based on the new April 1999 WAP guidebook; the old guidebook ratings were more office based, new guidebook ratings are based on field visits and are therefore more accurate.
- DG - concern about North Powers/Paddle Creek turbidity and channel problems throughout. Old large woody debris was pulled out in the 1980s so fines flowed down to fill in pools. Based on CAP training exercise, low to severe impacts were seen. Greater than 40% ECA on south facing slope, therefore consistent with what would be expected. Want it clarified that Lambly Lake does moderate flows.
- PP – get a quick fill in early part of runoff then overflow for about 6 weeks. Sediment settles out prior to going into Powers Cr. Each year, reservoir fills at different times in relation to when the peak flow occurs. WID has an issue with turbidity and is concerned with high ECA in upper North Powers (above Lambly Lake). Paddle Cr. is diverted into Lambly Lake in some years. WID does not track when peak flow occurs.
- DD - can't assume that peak does go straight through the lake into Powers Cr. Channel is stable therefore peak flows are attenuated somewhat by the lake.
- PP – if the lake is lower by 11', it takes about one month to fill. Don't relate peak flow to when water starts spilling over.
- really don't know whether peak flow goes over the spillway or not – needs to be reflected in the report.
- during freshet, WID takes samples from 6 to 8 locations and sees a pattern of turbidity which may be related to peak flow.

- DD presented table comparing channel reach data from 1998 to that of 2001. This will be added to the report, along with explanation. DA asked for clarification and rationale on why the channel hazard ratings are lower for the 2001 report, given that the ReCAP was used in the 1998 and 2001 field assessments. DEL agreed to provide this.

- discussion about the Crystal Mountain expansion.
- discussion about the WID pipeline project and how Harding Creek will respond to increased flows. WID proposes to let Harding Cr. stabilise naturally. DD, DG and DA all recommend that WID has their engineers review this site and consider additional measures to protect channel.
- WID's proposal to raise dam at Lambly Lake would occur sooner rather than later due to increase in demand.

- DG - north Powers stressed beyond current capacity.
- DD – current stream condition is as a result of historical activities or conditions.
- options to cut current FDP in half per DEL's recommendation or halt harvesting in upper North Powers sub-basin.
- JJ – comments re TFL 49 FDP may be extended under Section 19 of the FPC to accommodate the pilot project. Under Professional Reliance the prescribing forester has responsibility to prepare FDPs based on all information provided. The approval process also considers all information provided.
- DA – on the basis of information provided, he would not recommend harvesting in upper North

Powers to DEO for FDP approval; conflict with source area protection and approval of FDPs. Strong supporting rationale needed to justify the high level of harvest.
- concern about channel not being able to handle steady or increase in ECA.
- flushing flows over time could flush out fine sediment and clear out pools so this could improve condition over time.
- given riparian impacts, keep concerns in mind on riparian management plans.

Action: Don will look at turbidity and water quality data from WID and clarify. Will also add more information to the report about ECA.

- PP – once the pipeline is in, flow down Powers Cr. Will be regulated, so less chance of degradation. Major construction won't start until 2003. Want to increase Lambly Lake level by 26'.

LRMP Direction:

- LRMP Table 2 with WAP attributes was presented – will be included in report.
- WAP conforms with LRMP direction.

- grazing – occurs everywhere as dispersed use over the watershed. Does cause some sedimentation, deposition of manure in and about the creek as well as some bank disturbance.

Action: DEL will provide field information on cattle concerns to DPE Range staff for consideration in the Lambly Range Use Plan. New WAC recommendation.

- new WAC recommendation directed at FDP re: prevention of cattle congregation sites in riparian areas. (Note: this recommendation will be included in the FDP and non-FDP WAC recommendations).
- link to fisheries and fish habitat to be added to the report.
- DEL to provide clarification and rationale on why the channel hazard ratings are lower for the 2001 report, given that the ReCAP was used in the 1998 and 2001 field assessment.

4. Recommendations

See attached document for Final WAC Recommendations.

5. Next Steps.

Barb Pryce will draft meeting notes and recommendations from today's meeting. A draft will be forwarded to all WAC members for comment prior to forwarding to Prescribing Foresters.

DEL will make modifications to Hydrologist's report and will forward complete copies to WAC members. To be complete by the end of February, 2002.

6. Other Items.

Okanagan Shuswap LRMP website: http://srmwww.gov.bc.ca/sir/lrmp/okan/index.html

7. Adjourn. Powers Creek Watershed Assessment Process completed.

APPENDIX C
Watershed Report Cards

Watershed Report Card for Powers Creek 1998

Basin	Gross Area ha	Total Harvested Area ha %	ECA ha %	ECA below H60 %	ECA Above ha %	Total Road Density km/km^2	Total Road Length km	Landslides Entering Streams	High Sediment Source Roads Km	Road on Class IV or V Terrain km	Stream Crossings	Streams LTB **km/km**	Length of Disturbed Mainstem **km/km**
North Powers	3344.0	31.0	29.0		27.0	1.8		1	0.0	3.0	22	0.32	0.06
West Powers	6117.0	28.0	24.0		20.0	1.9		0	0.0	1.3	43	0.23	0.03
Above WID Intake (POI 2)	12515.0	28.0	22.0		19.0	1.7		3	0.0	8.0	71	0.25	0.05
Entire Watershed (POI 1)	13867.0	30.0	24.0		17.0	1.9		4	0.0	8.0	79	0.26	0.05
Alocin*	474.0	46.0	34.0		34.0	2.4		0	0.0	0.0	4	0.60	0.00

* Only includes the Community Watershed portion of the Alocin Creek watershed situated above the Nicola Diversion into Dobbin Lake

Watershed Report Card for Powers Creek January 1, 2001

Basin	Gross Area ha	Total Harvested Area ha %	ECA ha %	ECA Below H60 ha %	ECA Above H60 ha %	Total Road Density km/km^2	Total Road Length km	High Sediment Souce Roads km	Landslides Entering Streams	Road on Class IV or V Terrain km	Stream Crossings	Streams Logged to the Bank km	Length of Disturbed Mainstem km
North Powers	3356.2	1164.8 34.7	969.7 28.9	32.4 1.0	937.3 27.9	2.0	67.5	0.0	1	8.5	54	21.7	0.0
West Powers	6169.6	1598.8 25.9	1352.0 21.9	176.4 2.9	1175.6 19.1	2.0	124.8	0.0	1	2.7	62	17.6	0.0
Above WID Intake (POI 2)	12653.4	3056.6 24.2	2544.8 20.1	208.8 1.6	2336.0 18.5	1.8	228.1	0.0	4	16.8	125	43.8	0.0
Entire Watershed (POI 1)	14004.9	3654.4 26.1	3170.9 22.6	834.9 6.0	2336.0 16.7	1.7	239.4	0.0	6	16.8	125	48.0	5.7
Alocin	472.2	202.2 42.8	175.3 37.1	0.0	175.3 37.1	3.1	14.5	0.0	0	0.0	25	7.0	0.0

* Only includes the Community Watershed portion of the Alocin Creek watershed situated Above the Nicola Diversion into Dobbin Lake

Watershed Report Card for Powers Creek December 31, 2006

Basin	Gross Area ha	Total Harvested Area ha %	ECA ha %	ECA Below H60 ha %	ECA Above H60 ha %	Total Road Density km/km^2	Total Road Length km	High Sediment Souce Roads km	Landslides Entering Streams	Road on Class IV or V Terrain km	Stream Crossings	Streams Logged to the Bank km	Length of Disturbed Mainstem km
North Powers	3356.2	1385.2 41.3	1013.1 30.2	52.7 1.6	960.4 28.6	2.0	67.5	0.0	1	8.5	54	21.7	0.0
West Powers	6169.9	2011.5 32.6	1525.6 24.7	294.7 4.8	1231.0 20.0	2.0	124.8	0.0	1	2.7	62	17.6	0.0
Above WID Intake (POI 2)	12653.7	3699.2 29.2	2735.1 21.6	357.0 2.8	2378.2 18.8	1.8	228.0	0.0	4	16.9	125	43.8	0.0
Entire Watershed (POI 1)	14005.2	4318.1 30.8	3382.3 24.2	1004.2 7.5	2378.2 17.0	1.7	239.3	0.0	6	16.9	125	48.0	5.7
Alocin	472.2	238.9 50.6	167.3 35.4	0.0 0.0	167.3 35.4	3.1	14.5	0.0	0	0.0	25	7.0	0.0

* Only includes the Community Watershed portion of the Alocin Creek watershed situated above the Nicola Diversion into Dobbin Lake

ECA for the Drainage of North Powers Creek Upstream from Lambly Lake

Year	Gross Area ha	Total Harvested Area ha %	ECA ha %	ECA Below H60 ha %	ECA Above H60 ha %
2000	1320.4	666.3 50.5	558.8 42.3	11.9 0.9	546.9 41.4
2006	1320.4	856.7 64.9	645.2 48.9	23.9 1.8	621.3 47.1

Projected Hydrologic Recovery and Available Harvest for the Drainage of North Powers Creek Upstream from Lambly Lake

Year	2000	2001	2002	2003	2004	2005	2006
ECA without development (%)	42.3	40.3	39.5	36.3	36.3	34.5	34.4
Available harvest* (% of drainage)	N/A	2.2	0.8	3.2	0.0	1.8	0.1
Available harvest* (ha)	N/A	29.0	10.6	42.3	0.0	23.8	1.3
Total available harvest (ha)							107.0

* Available harvest based on maintaining a 42.5% ECA.

APPENDIX D

Water Quality Assessment Summaries

Water Quality Assessment and Objectives for Powers Creek Community Watershed

Mould Engineering. 2001. *Water Quality Assessment and Objectives for Powers Creek Community Watershed: Draft.* Water Quality Branch; Water Management Division; Ministry of Environment, Lands, and Parks; Southern Interior Region. pp. 42.

Turbidity Measured by Laboratory Analysis

Where attainment is to be checked by samples submitted for laboratory analysis, the recommended water quality objective for turbidity for Powers Creek, at the WID diversion during the clear flow period, shall not exceed a mean value of 0.82 NTU, and a maximum value of 3.4 NTU based on a minimum of five samples collected within a 30-day period. During the turbid flow period, turbidity shall not exceed a mean of 5.14 NTU and a maximum of 20 NTU based on a minimum of five samples collected in a 30-day period. At all other locations in the watershed upstream of the intake and at all times of the year, turbidity induced by anthropogenic activity shall not increase by more than 5 NTU or 10% (whichever is greater) above upstream concentrations.

Turbidity Measured by Continuous Monitoring Equipment

Where attainment of the water quality objective for turbidity is to be checked by continuous automated monitoring equipment, the recommended water quality objective for turbidity for Powers Creek at the WID diversion is not to exceed the percent occurrence of values for the ranges set out in the table below (values are not presented in the current draft report).

Distribution of Powers Creek Automated Turbidity Values Recorded during the Period April 27, 1998, to December 14, 1999.

	Clear Flow Period (Jun 16 – Mar 14)		Turbid Flow Period (Mar 15 – Jun 15)	
Sample Distribution	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0 – 5 NTU				
>5 – 10 NTU				
>10 – 50 NTU				
>50 NTU				
Total				

Non-Filterable Residue

The recommended water quality objective for non-filterable residue during the clear flow period shall not exceed 25 mg/L increase over background at any one time for a duration of 24 hours or 5 mg/L increase at any one time over background for a duration of 30 days.

The recommended water quality objective for non-filterable residue during the turbid flow period shall not exceed 10-mg/L increase over background when background ranges from 25 mg/L to 100 mg/L and shall not exceed 10% increase over background when background is greater than 100 mg/L.

Stream Temperature

The recommended objective for protection of aquatic life from anthropogenically-induced temperature change at all locations in the watershed upstream of the WID intake shall not exceed 1°C change in the Maximum Weekly Mean Temperature (MWMT). Change in the MWMT shall be determined by hourly measurements with electronic instruments deployed at locations upstream and downstream of anthropogenic activity.

Fecal Coliform and *E. Coli* Bacteria

The recommended objective for fecal coliform and *E. coli* for Powers Creek at the WID intake shall not exceed 10 CFU/100mL (90^{th} percentile) based on a minimum of 10 samples collected in a consecutive 30 day period between June 1^{st} and August 30^{th}.

True Colour

To protect from further increases in true colour from anthropogenic activity, the recommended water quality objective for true colour shall not exceed a twenty-percent increase over samples taken immediately upstream of anthropogenic activity.

APPENDIX E

Field Assessment Information

1998 and 2001 Field Assessment Information

Reach	1998 Channel Information	Slope (%)	Assessment Sites	2001 Site Information
A	RPg-A2	1	S,T	RPg-A2
B1	Bedrock Confined	-	N/A	
B2	CPc-D1	2	N/A, ANC	
B3	Bedrock Confined	-	N/A	
B4	CPc-D2	3	U	CPc-D2
C	CPc-A2	3	N/A, ANC	
D	CPc-A1	5	N/A, ANC	
E	N/A	-	N/A	
F	CPc-A1	4	N/A, ANC	
NA	SPb-D1	5	N/A, ANC	
NB	CPc-A1	5	P	CPc-A1
WA	CPc-S	4	N/A, ANC	
UPA	N/A	-	N/A	
UPB	RPg-D1	2	A,M	RPg-A1[1]
UPC	CPc-S	4	N/A, ANC	
JPA	N/A	-	N/A	
JPB	RPg-S	1	N	RPg-S
JPC	N/A	-	N/A	

N/A-Not Assessed, ANC-Assumed No Change

Legend

Channel Types
SP - Step Pool
CP - Cascade Pool
RP - Riffle Pool

Substrates/Large Wood
s - Sand
g - Gravel
c - Cobble
b - Boulder
r - Boulder Block
w - Large Wood Present

Channel Descriptor
A3 - Severely Aggraded
A2 - Moderately Aggraded
A1 - Slightly Aggraded
S - Stable
D1 - Slightly Degraded
D2 - Moderately Degraded
D3 - Severely Degraded

1. It is unclear why the channel was assessed as slightly degraded in 1998 because it is clearly aggraded and there is no evidence that the channel morphology has changed.

2001 IWAP FIELD ASSESSMENT

Site Number: A

Site Location: 26 ¼ km on Bear FSR at failure

Date: August 9, 2001

Sub basin: West Powers Creek

Reviewed in 1998 IWAP: No, failure occurred in 1999

Downstream from Proposed Harvesting: Yes

Comments: Failure has re-vegetated and is stable

Looking down failure from road

2001 IWAP FIELD ASSESSMENT

Site Number: B

Site Location: 33 ½ km on Bear FSR – Tributary to Powers Creek, 5m upstream from road crossing

Date: August 9, 2001

Sub basin: West Powers Creek

Channel type: **S**tep pool, boulder, stable (SPb:S)

Disturbance Indicators: None

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: No

Comments: Stable, moss covered boulders

Looking upstream from road

2001 IWAP FIELD ASSESSMENT

Site Number: C

Site Location: 31½ km on Bear at Powers Creek, 10m upstream from road crossing

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Step pool, boulder, slightly degraded (SPb:D1)

Disturbance Indicators: Minimal pool area, disturbed stone lines

Reviewed in 1998 IWAP: No

Trend: Stabilizing

Downstream from Proposed Harvesting: Yes

Comments: Stable, moss covered boulders

Looking upstream from road

2001 IWAP FIELD ASSESSMENT

Site Number: D

Site Location: 38 ½ km on Horseshoe Road at tributary to Dobbin Lake

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: n/a

Disturbance Indicators: n/a

Reviewed in 1998 IWAP: No

Trend: n/a

Downstream from Proposed Harvesting: Yes

Comments: Will be a safety issue in the future

Failed wood culvert on road

2001 IWAP FIELD ASSESSMENT

Site Number: E

Site Location: Alocin Creek, 30 m upstream from intake

Date: August 9, 2001

Sub basin: Alocin Community Watershed

Channel Type: Riffle pool, cobble, stable (RPc:S)

Disturbance Indicators: Homogenous bed texture

Reviewed in 1998 IWAP: Yes

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Stable, undercut banks, channel complexity

Looking upstream at Alocin Creek

Alocin intake structure

2001 IWAP FIELD ASSESSMENT

Site Number: F

Site Location: Road above Alocin diversion

Date: August 9, 2001

Sub basin: Alocin Community Watershed

Channel Type: n/a

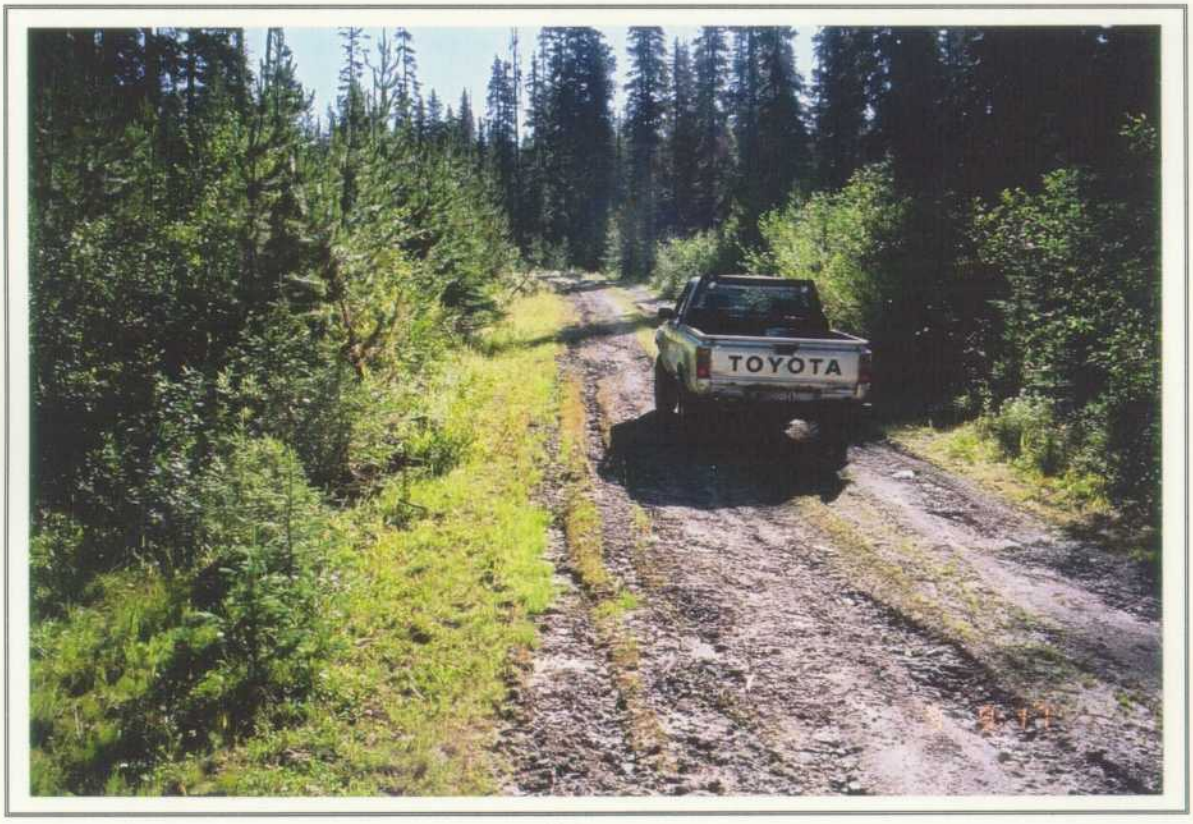
Disturbance Indicators: n/a

Reviewed in 1998 IWAP: n/a

Trend: n/a

Downstream from Proposed Harvesting: Yes

Comments: Surface erosion on gentle grade



2001 IWAP FIELD ASSESSMENT

Site Number: G

Site Location: Outlet of Tadpole Lake

Date: August 9, 2001

Sub basin: Alocin Community Watershed

Channel Type: Excavated channel

Disturbance Indicators: None

Reviewed in 1998 IWAP: Yes

Trend: Continued erosion

Downstream from Proposed Harvesting: No

Comments: Significant surface erosion during rainfall and during spring runoff

2001 IWAP FIELD ASSESSMENT

Site Number: H

Site Location: Failed wood culvert on Alocin Creek downstream from Tadpole outlet

Date: August 9, 2001

Sub basin: Alocin Community Watershed

Channel Type: n/a

Disturbance Indicators: n/a

Reviewed in 1998 IWAP: n/a

Trend: Continued failure

Downstream from Proposed Harvesting: No

Comments: Contributing sediment to channel, adjacent riparian zone is harvested, but creek is stable

2001 IWAP FIELD ASSESSMENT

Site Number: I

Site Location: Bit Creek at 33.4 km on Horseshoe Main, 10m upstream from road crossing

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Step pool, boulder, stable (SPb:S)

Disturbance Indicators: Minimal pool area, disturbed stone lines

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Creek flows infrequently probably due to upstream diversion

Bit Creek 10 m upstream from road crossing.

2001 IWAP FIELD ASSESSMENT

Site Number: J

Site Location: 30.7 km on Bear, upstream from road

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Riffle pool, gravel, LWD, stable (RPg-w:S)

Disturbance Indicators: Homogenous bed texture, extensive riffles or cascades

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Stable creek on <2% grade, cattle impacts upstream from culvert

Creek 10 m upstream from culvert

2001 IWAP FIELD ASSESSMENT

Site Number: K

Site Location: 30.5 km on old road, 20m upstream from culvert

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Riffle pool, gravel, LWD, stable (RPg-w:S)

Disturbance Indicators: N/A

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Stable creek on <1% grade, silt/sand bed

20 m upstream from culvert

2001 IWAP FIELD ASSESSMENT

Site Number: L

Site Location: 28.3 km on Bear FSR, 50m upstream from road crossing

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Cascade pool, cobble, slightly aggraded (CPc:A1)

Disturbance Indicators: Homogenous bed texture, extensive riffles or cascades, minimal pool area.

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Stable creek on approximately 5% grade, two creeks and two culverts on Bear FSR, the western creek was assessed

50m upstream from road

2001 IWAP FIELD ASSESSMENT

Site Number: M

Site Location: 12 km on Jackpine FSR at Powers Creek, immediately upstream from culvert

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Riffle pool, gravel, slightly aggraded (RPg:A1)

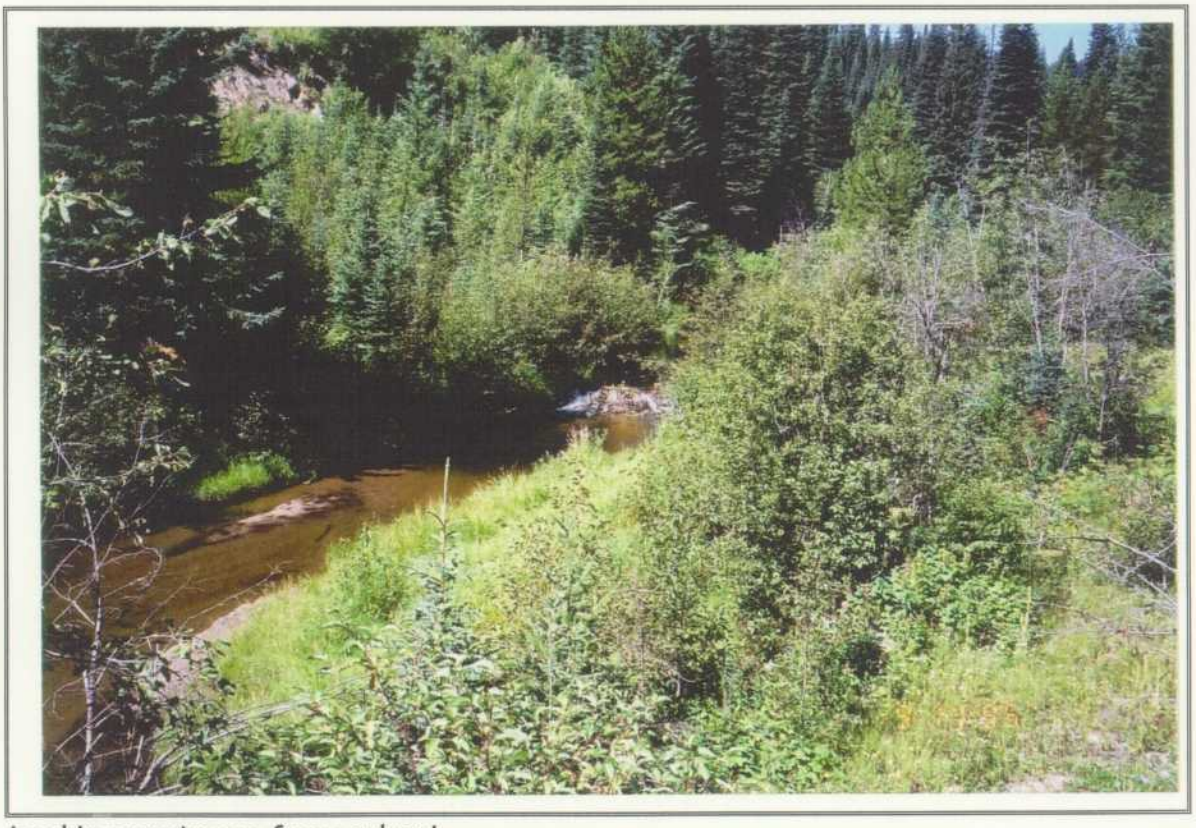
Disturbance Indicators: Homogenous bed texture, sediment wedges, elevated mid-channel bars

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Creek is on <2% grade, creek bed is sand/silt



Looking upstream from culvert

2001 IWAP FIELD ASSESSMENT

Site Number: N

Site Location: 10 km on Jackpine FSR, 20m upstream from culverts

Date: August 9, 2001

Sub basin: West Powers Creek

Channel Type: Cascade pool, cobble, stable (CPc-w:S)

Disturbance Indicators: Slightly disturbed stone lines

Reviewed in 1998 IWAP:

Downstream from Proposed Harvesting: Yes

Comments: Two 1.2m culverts at road, stable creek on <2% grade

20 m upstream from culvert

Harding Creek 50m upstream from, above road crossing

2001 IWAP FIELD ASSESSMENT

Site Number: O

Site Location: Fillslope failure into Harding Creek

Date: August 9, 2001

Sub basin: North Powers Creek

Reviewed in 1998 IWAP: n/a

Downstream from Proposed Harvesting: Yes

Comments: Remedial work completed on failure in 1999, stable creek on <2%, sand/silt bed, will be erosion when flows increased by WID diversion

Looking across pulled back failure

2001 IWAP FIELD ASSESSMENT

Site Number: P

Site Location: 23.9 km on Bear FSR, 10m upstream from culvert

Date: August 9, 2001

Sub basin: North Powers Creek

Channel Type: Step pool, cobble, LWD, slightly degraded (CPc-w:D1)

Disturbance Indicators: Disturbed stone lines, small woody debris

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Stable channel on <5% grade, gravel and cobble bed

10 m upstream from culvert

2001 IWAP FIELD ASSESSMENT

Site Number: Q

Site Location: North Powers Creek upstream from deactivated road (right on North Fork at 25.8 km.)

Date: August 9, 2001

Sub basin: North Powers Creek

Channel Type: Step pool, boulder, stable (SPb:S)

Disturbance Indicators: None

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: 6% slope, stable, wood culvert failing at road crossing

30m upstream from road

2001 IWAP FIELD ASSESSMENT

Site Number: R

Site Location: North Fork at 25.4 km

Date: August 9, 2001

Sub basin: North Powers Creek

Channel Type: N/A

Disturbance Indicators: N/A

Reviewed in 1998 IWAP: N/A

Trend: N/A

Downstream from Proposed Harvesting: Yes

Comments: No channel defined, no photo

2001 IWAP FIELD ASSESSMENT

Site Number: S

Site Location: At weir by Gellatly Road

Date: August 22, 2001

Sub basin: Residual Below

Channel Type: Cascade pool, cobble, slightly aggraded (CPc:A1)

Disturbance Indicators: Disturbed stone lines, minimal pool area

Reviewed in 1998 IWAP: No

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Channel aggraded upstream from weir

2001 IWAP FIELD ASSESSMENT

Site Number: T

Site Location: On fan by Gellatly Road

Date: August 22, 2001

Sub basin: Residual Below

Channel Type: Riffle pool, gravel, moderately aggraded (RPg:A2)

Disturbance Indicators: Extensive bars, elevated mid-channel bars, abandoned channels

Reviewed in 1998 IWAP: Yes

Trend: Recovering

Downstream from Proposed Harvesting: Yes

Comments: Borders private land, channel on 1% grade, evidence of historic beaver activity

Looking downstream

Looking upstream

2001 IWAP FIELD ASSESSMENT

Site Number: U

Site Location: 20m downstream from culvert on Highway 97

Sub basin: Residual Below

Channel Type: Cobble pool, cobble, moderately degraded (CPc:D2)

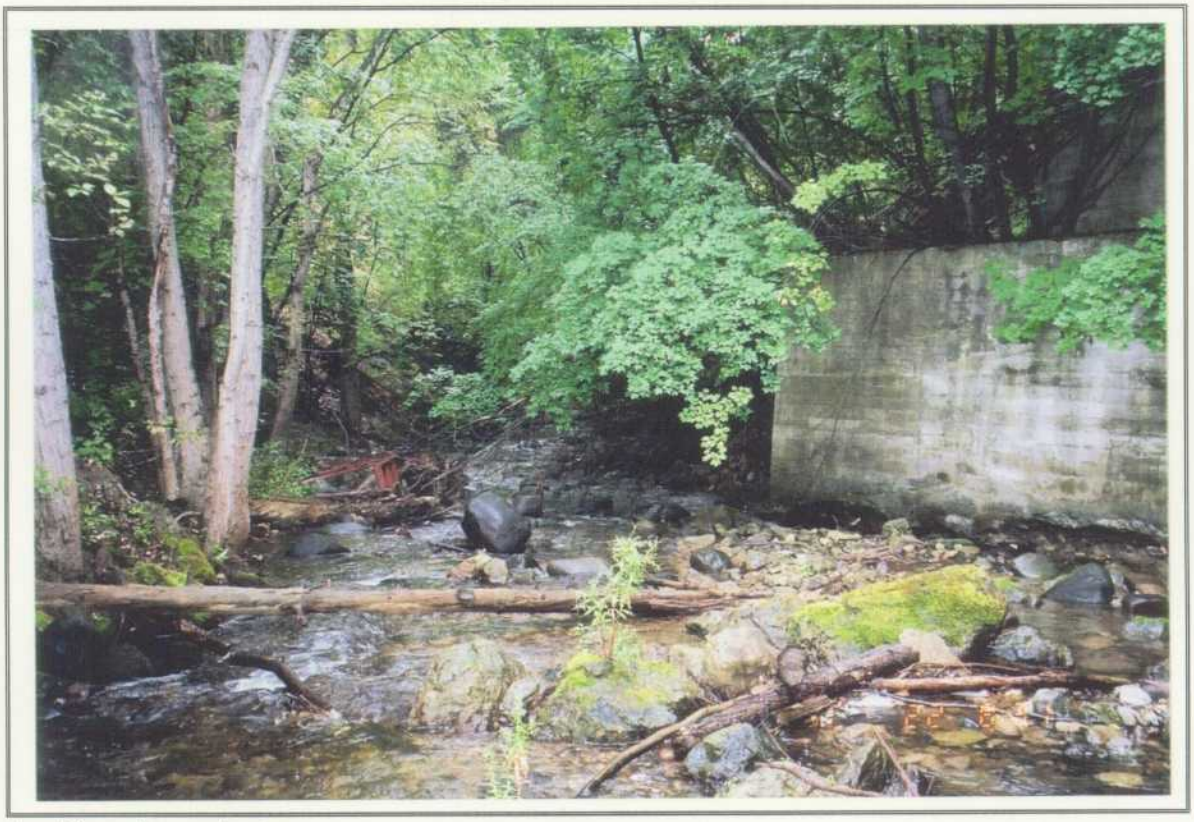
Disturbance Indicators: Extensive scoured zones, eroding banks, disturbed stone lines

Reviewed in 1998 IWAP: Yes

Trend: Stable

Downstream from Proposed Harvesting: Yes

Comments: Stable channel (except immediately downstream from culvert). Fish in creek, beaver activity



Looking downstream