Watershed Assessment Report

for the

VASEUX CREEK WATERSHED

Final Report

Prepared for
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1.0 INTRODUCTION

This report has been prepared for Weyerhaeuser Canada Ltd. to assess the current hydrologic conditions of the Vaseux Creek watershed and to identify any hydrologic concerns with the proposed forest development.

To complete the assessment the following tasks were identified:

- update Equivalent Clearcut Area (ECA) calculations
- update the watershed report card
- complete a reconnaissance level channel assessment procedure (Re-CAP)
- provide a risk assessment of the potential hydrologic impacts associated with the proposed forest development for the period of 1998 to 2003. Proposed blocks for the period of 2004+ were also included within this assessment.

Two points of interest (POI's) have been identified for this watershed assessment. POI1 is located at the Vaseux Creek and Okanagan River confluence. POI2 is located at the Vaseux Creek and Solco Creek confluence. The upstream area above POI 2 consists of the Solco Creek drainage area [the Venner sub-basin (V3-1) and the Solco Creek residual area (V3)] and the upper Vaseux Creek drainage area [the McIntyre sub-basin (V4), the Underdown sub-basin (V5) and the upper Vaseux Creek residual area (V6)]. The lower Vaseux Creek drainage area between the two POI's consists of the Dutton sub-basin (V2) and the lower Vaseux Creek residual area (V1).

2.0 BACKGROUND

Overview assessments have been completed for the Vaseux Creek watershed and are summarized in the ***Integrated Watershed Restoration Plan (IWRP)*** **for the Shuttleworth Creek and Vaseux Creek Watersheds** (completed by Dobson Engineering Ltd., dated February 1998). The IWRP report integrated the results of the

Sediment Source Survey (SSS), Access Management Strategies (AMS), Fisheries Habitat Assessment Procedure (FHAP) and ***Interior Watershed Assessment Procedure (IWAP).*** Forest Renewal BC approved a ***Watershed Restoration Program (WRP)*** project in the watershed in the fall of 1996.

Stream channel information was provided in the following reports:

- ***Hydrologic Review of CP 228, Blocks 2, 3 and 4 in the Vaseux Creek Watershed*** by Dobson Engineering Ltd. (dated March 1998)
- ***Hydrologic Assessment of TFL 15, CP 272 in the Vaseux Creek Watershed*** by Dobson Engineering Ltd. (dated January 1998)
- ***Hydrologic Review of CP 292 in the Vaseux Creek Watershed*** by Dobson Engineering Ltd. (dated December 1996)
- ***Hydrologic Assessment of CP 38*** by Dobson Engineering Ltd. (dated November 1996)
- ***Hydrologic Assessment of CP 214*** by Dobson Engineering Ltd. (dated November 1996)
- ***Hydrologic Assessment of CP 293*** by Dobson Engineering Ltd. (dated November 1996).

The report ***APD Bulletin 27, Coldstream and Vaseux Creek Watersheds: Analysis of Channel Stability & Sediment Sources*** by R.S. Hawthorn and E.J. Karanka (dated 1982) provided additional information. Some of the highlights of the report were:

- Most (85%) of the suspended sediment is being picked up by Vaseux Creek itself is in the middle reaches (from 2 km upstream of McIntyre Creek downstream to the top of the bedrock canyon) because of the valley wall instabilities
- A major change in channel morphology occurred between 1938 and 1951 (probably as result of the 1942 flood), the average channel width tripled from the canyon upstream to McIntyre Creek
- The 1942 flood event was estimated to be 60 m^3/sec at the lower Vaseux Creek gauging station, corresponding to a return period of at least 50 years.
- The channel has been relatively stable since 1951, many of the gravel bars created between 1938 and 1951 are being slowly revegetated.
- This type of channel (with very coarse-textured banks and bed material) is relatively insensitive to climate and land use changes because the channel and floodplain forming events are caused by extreme meteorological events which are probably not substantially affected by land use practices.

3.0 METHODS

A reconnaissance level channel assessment was carried out to determine the present stream channel conditions. Procedure details are summarized in Appendix A; longitudinal profiles and reach summaries are provided in Appendix B; and field forms and photos are in Appendices C and D.

Current (1998) and projected (2003) ECA values were provided by Weyerhaeuser Canada Ltd. Projected ECAs for blocks proposed beyond 2003 (Information Blocks for 2004+) were also included for information purposes. The IDF/MS biogeoclimatic boundary was deemed to better represent the snow-melt dominated area during spring runoff for the Vaseux Creek watershed. The average elevation of the IDF/MS line is 1480 m, 40 m below the H60 line (1520 m) for the watershed.

4.0 WATERSHED CHARACTERISTICS

The Vaseux Creek watershed, located in the Okanagan highlands region east of Vaseux Lake, covers an area of 292 km^2. The watershed ranges in elevation from approximately 325 m to 2,335 m at the peak of Baldy Mountain.

Bedrock consists of metamorphic (Gneiss and Schist) and intrusive igneous rock of the Cenozoic and late Mesozoic age and is overlaid by glacial till and colluvial veneers.

Biogeoclimatic zones for the watershed ranges from Interior Douglas Fir (IDF xh1) in the lower elevations, to Montane Spruce (MS dm1) and Engelmann Spruce and Sub-Alpine Fir (ESSF dc1) in the mid to upper elevations. Some of the higher peaks are capped with Alpine Tundra.

Climate data for the area shows annual mean precipitation of 330 mm in the valley, 550 mm in the mid elevations and 880 mm at higher elevations. Flow data for Vaseux Creek (1970-1990) indicates a mean daily discharge of approximately 1.41 m^3/sec and an average peak discharge in May of 7.25 m^3/sec.

5.0 CURRENT WATERSHED CONDITIONS

The current watershed report card for the Vaseux Creek watershed is presented below in Table 1.

TABLE 1
Watershed Report Card for Vaseux Creek (1998)

Watershed Inventory Category	Dutton (V2)	Venner (V3-1)	McIntyre (V4)	Underdown (V5)	POI2	POI1
Area of unit (ha)	2970	3103	3326	2599	20785	29192
Total area harvested (%)	43.3	48.4	35.9	30.2	32.8	28.5
ECA (%)	30.5	45.8	25.3	27.7	27.9	23.6
ECA above IDF zone (ha) (unweighted)	25	1408	840	678	5550	5692
ECA above IDF zone (%) (unweighted)	0.8	45.4	25.3	26.1	26.7	19.5
Total road density (km/km^2)	1.33	1.83	1.85	2.05	1.56	1.30
Length of road as a high sediment source (km)*	6.8	11.9	1.3	7.3	38.7	50.0
Total number of landslides	0	1	3	0	13	46
Length of road on potential unstable slopes (km)	0	0.1	0	0	0.4	0.6
Number of stream crossings	10	17	29	28	134	155
Portion of stream logged to the streambank (km/km)	0.36	0.26	0.27	0.20	0.17	0.15
Length of stream with unstable stream channel (km/km)	0.0	0.2**	0.0	0.0	0.2	1.2***

Note: ECA data current to December 1998, other data from IWAP (February 1998)

* Based on the 1995 IWAP process for calculation of the surface erosion hazard rating (eg. roads within 100m of a stream, roads on erodable soils & number of stream crossings).

** Unstable channel length based upon channel disturbance noted at the R200 road crossing and from cattle.

*** Unstable channel (1.0km) noted within Reach VA as a result of channel disturbance on the lower fan.

5.1 Stream Flows

The current (1998) ECA is estimated to be 23.6% for the Vaseux Creek watershed (POI1) *[Table 1]*. The current (1998) ECA for POI2 is 27.9% *[Table 1]* in which the ECA for the Solco Creek drainage area is 35.5% and the ECA for the upper Vaseux Creek drainage area is 22.9% *[Table 2]*. The current (1998) ECA for the Dutton, McIntyre, Underdown and Venner sub-basins are 30.5%, 25.3%, 27.7% and 45.8%, respectively *[Table 1]*. The ECA's in the watershed are at a level where increases in peak flow may occur.

There is a concern with the road densities greater than 1.5 km/km^2 *[Table 1]* in the Venner, McIntyre and Underdown sub-basins, but this concern can be reduced through road maintenance or deactivation in order that natural drainage patterns are maintained. To date, 68 km of road have been semi-permanently deactivated in these sub-basins and another 8.7 km has been permanently deactivated.

No moderate or high levels of channel instability associated with past forest development were identified on the mainstem channels, see section 5.4 for details.

TABLE 2
Current ECA's for the Vaseux Creek Drainage Areas

Drainage Area	Total Area (ha)	ECA above IDF/MS Line (%)	Total ECA (%)
Solco (V3-1 and V3)	8194	35.3	35.5
Upper Vaseux (V4, V5 and V6)	12591	21.1	22.9
POI2 (V3-1, V3, V4, V5, V6)	20785	26.7	27.9
POI1(total watershed)	29192	19.5	23.6

→ 30% ←

5.2 Surface Erosion

Of the 449 km of road assessed during the 1997 Sediment Source Survey only two high priority sites (0.25 km of total length) were identified in the watershed. The SSS also identified approximately 77 stream crossings on non-status roads that may be contributing to increased sediment transport to streams.

Field observations concurred with the SSS. In general there is concern with the delivery of sediment into streams from roads situated within the Vaseux Creek valley, such as the ditchline erosion on sections of the Underdown Road and altered drainage patterns on adjacent branch roads. Continued road maintenance or deactivation would help to minimize sediment delivery concerns.

Some of the stream crossings have been stabilized as 168.5 km of roads in the watershed have been deactivated (28.0 km of permanently deactivated and 140.5 km of semi-permanently deactivated), of which 44% are in the Solco Creek drainage area.

Two road-related failures that were not identified in the Sediment Source Survey were observed during the channel assessment. The first failure is situated to the east of CP 271 block 4, above the lower reach of Venner Creek. The second failure is initiated from a road within CP 33 block A1. This failure is considered small and is not connected to Vaseux Creek since the material was dispersed onto a terrace above the creek.

The main source of surface erosion in the watershed is considered to be natural and is from secondary erosion off of several exposed landslide scars located within the mainstem Vaseux Creek valley.

5.3 Landslides

The majority of landslides in the watershed are natural and are within the deeply incised valley of Vaseux Creek along the lower reaches of the major tributaries and along the mainstem of Vaseux Creek (between McIntyre Creek and Dutton Creek). Of the 42 failures identified along the mainstem of Vaseux Creek only one of the failures was related to forest development.

Most of the landslides probably existed before the 1942 flood event, however, there was significant widening of the channel which would have resulted in a combination of cutbank failures, undercutting of toe-of-slopes and increased erosion from existing landslides. At present sediment is delivered to the stream channels from retrogressive failures of the headwall areas and secondary erosion of the landslide tracks.

Three natural landslides that are directly connected to reach MA were identified in the McIntyre sub-basin. Two of the landslides are down slope of CP 37 block 15 and were present on air photos before the upslope harvesting occurred. The remaining landslide is located above the McIntyre Road.

5.4 Stream Channel Stability

This section summarizes the reconnaissance level channel assessment of the mainstem channels in the watershed. For description purposes, the watershed has been divided into three main drainage areas. They are:

- the upper Vaseux drainage area (V4, V5 and V6) above POI2;
- the Solco drainage area (V3 and V3-1);
- the lower Vaseux drainage area (V1 and V2) between POI1 and POI2.

5.4.1 Upper Vaseux Drainage Area

Reach VG

Reach VG is the upstream 4.4 km of third-order channel on Vaseux Creek. The reach has a stable riffle-pool channel morphology with LWD playing an important role. Forestry-related disturbances were limited to some elevated levels of fine-textured sediment downstream of the R200 bridge crossing. Minimal amounts of coarse bedload appear to be transported from the headwaters area.

Reach VF

Reach VF extends 3.4 km downstream to the McIntyre Creek confluence. This is a transition reach between the flatter upland plateau and the deeply entrenched downstream valley. This section of Vaseux Creek has a stable cascade-pool channel morphology as evident by the stable banks, mature riparian forest, and intact stone lines. Disturbances observed were limited to minor bank erosion from cattle.

Reach VE

Reach VE, the 3.2 km between McIntyre Creek and Underdown Creek, has a partially aggraded cascade pool morphology as a result of past landslides. Eight natural landslides are connected or partially connected to the stream channel in this reach. The failure upstream of the Underdown Road appeared stable except for some secondary erosion.

Reach VD

Reach VD extends 2.3 km down to the Solco Creek confluence, POI2. This section of channel appears to have similar channel characteristics as reach VE with slightly less aggradation.

McIntyre Creek

McIntyre Creek is a third-order stream that extends 8.5 km from the southeast corner of the watershed to Vaseux Creek. There is a well-established riparian forest along most of the mainstem channel.

A tributary, downstream from the M-24 Road, has a partially aggraded step-pool morphology for approximately 75 m. It appears that this channel aggradation is related to harvesting along the channel and the delivery of sediment off of the M-24 road. Further downstream the stream channel was stable with minor undercutting of the banks, deep pools and functioning LWD in the channel.

At the Baldy Road bridge crossing over McIntyre Creek (reach MC), the creek has a stable cascade-pool morphology, as evident by the stable banks, functioning LWD in the channel and an even distribution of bed material.

At the downstream end of CP 291 block 4 (further down reach MC) the creek appeared to have a partially disturbed riffle-pool morphology evidenced by a partially degraded channel. (no functioning woody debris and mobile bed material) with a sediment wedge behind a debris jam. The stream banks appeared stable with some minor, natural undercutting.

Reach MA has a partially aggraded cascade pool morphology as a result of sediment input from the connected natural landslides (see Section 5.3 above).

Underdown Creek

Underdown Creek has two main sections of stream channel:

- the upper 4.3 km of low gradient mainstem channel (reaches UB to UC) on the upper plateau, and
- the lower 2.8 km of steeper channel within the incised Vaseux Creek valley.

Minimal amounts of sediment are transported through the upper portion of the sub-basin which has a gentle relief with a wetland complex. At the downstream end of reach UB there was a stable riffle-pool morphology with evenly and randomly distributed woody debris in the stream channel, a mature riparian forest and minimal amounts of mobile sediment (gravel bars and overbank deposits).

For the most part reach UA has a stable step-pool morphology, as evident by the moss-covered boulders, established stonelines and stable banks. Some localized disturbances have occurred where the Underdown Road parallels the creek, however, the disturbances are limited to one short section of channel.

5.4.2 Solco Creek Drainage Area

The Solco Creek drainage area (22% of the watershed) consists of Venner Creek, a major tributary and Solco Creek. The upper two-thirds of the channels flow over the plateau before descending into the deeply entrenched Vaseux Creek valley.

Venner Creek

Upstream of the R200 Road Venner Creek flows through a large wetland area, no sediment appears to be transported from the upper parts of the sub-basin. Most of the channel below the R200 Road has a stable riffle-pool morphology as most of the creek is currently fenced off from cattle. There is localized bank destabilization and channel widening from cattle upstream of the fence.

Below the meadows Venner Creek has a stable cascade-pool morphology with moss-covered boulders and stable banks. Venner Creek then passes through an incised bedrock canyon before meeting Solco Creek. Forest development related disturbances observed were associated with a road-related failure (see Section 5.2) and the delivery of sediment to the stream at road crossings.

Tributary

The main tributary to the east of Venner Creek also flows through Venner Meadows. This creek has a riffle-pool morphology with channel disturbances associated with a stream crossing and cattle. There was some aggradation upstream of the R200 Road, it appeared that minimal amounts of bedload were being carried through the culverts. Below the R200 Road cattle have destabilized the stream banks, resulting in channel widening and aggradation. The extent of the channel disturbance by cattle is not known.

Solco Creek

The mainstem of Solco Creek extends 12.7 km from Solco Lake down to Vaseux Creek (POI2). On the plateau Solco Creek has a stable riffle-pool morphology with woody debris incorporated into the channel. Most of the riparian forest has been retained along the mainstem channel of Solco Creek. In the vicinity of the R200 Road the creek has a partially aggraded riffle-pool morphology, some of the material present in the channel appears to be related to surface erosion at stream crossings. Further downstream, the creek has a stable cascade-pool morphology and is controlled by boulders.

5.4.3 Lower Vaseux Creek Drainage Area

Reach VC

Reach VC extends 10.4 km from the Solco Creek confluence to the top of a bedrock canyon (reach VB). This is a very dynamic section of channel where several historic landslides have delivered large volumes of material to the steeply incised channel of Vaseux Creek. Overall, the reach has a partially aggraded cascade-pool morphology with some sections with multiple channels.

The helicopter overview flight and examination of recent air photos concur with the findings of APD Bulletin 27. Most of the failures occurred quite some time ago, as evident by the deep rilling and re-established vegetation along the lower runout deposits and on the mid-channel bars. The bed material is very coarse-textured with minimal accumulations of fine-textured material. There was no evidence of recent runout deposits or fresh landslide tracks.

Recent sediment delivery into Vaseux Creek in reach VC is from secondary erosion off of the historic landslides. Sediment is also delivered to the channel from the undercutting of cutbanks and continued failure of the headwall areas on the landslides.

Reach VB

Reach VB of Vaseux Creek is a stable, narrow bedrock canyon. Sediment and LWD are readily transported through this reach.

Vaseux Creek Fan (Reach VA)

The downstream 2.5 km of Vaseux Creek, between the bedrock canyon and the Okanagan River, flows through a large alluvial fan. Airphotos show several historic vegetated channels spread out over the fan.

The apex of the fan appears to be in an inactive state, as evident by the entrenched (3 m) upper part of the fan as it exits the bedrock canyon. The upper 200 m of Vaseux Creek on the fan is adjacent to the bedrock controlled south valley wall. The northern bank is composed of coarse-textured fan deposits.

Vaseux Creek is partially connected to a large outwash terrace on the upper part of the fan. The headscarp is unstable and is a continual source of sediment to the lower slopes. However, with the break in slope at the base of the slope minimal amounts of sediment are entering the creek. Alders have grown along the bottom of the slope, adjacent to the creek, indicating some stability.

From the outwash terrace to the transmission line crossing Vaseux Creek is a braided channel with minimal lateral stability. The creek has minimal stream bank integrity with its easily erodible coarse-textured banks, as evident by the undercutting of mature trees. For most of the upper half of the fan dyking is set back from the banks and has no impact on the channel. The creek is adjacent to the dyke through the transmission line corridor.

The stream bank instabilities observed on the braided section of Vaseux Creek appeared to be natural features that are typically found on fans. The wide channel allows peak flows to be dispersed over a wide area. The braided section of channel also appears to be a major source of sediment for the Okanagan River. It appears that sediment is quite readily transported through the lower half of the fan.

The main channel is a narrow, straight channel from the irrigation canal down to the Okanagan River. Recent instream work has been completed with a vertical drop at the irrigation canal crossing being removed, boulder steps being installed in the channel and some riprapping of banks taking place. In this area the dykes are setback from the stream channel banks.

There was one section of bank erosion on the lower half of the fan where additional riprap is required to minimize bank erosion (see Photo VA-6). There were no disturbance indicators that could be attributed to increases in peak flow.

No field observations were carried out on Dutton Creek. But during the overview flight the downstream reach of Dutton Creek was observed to have a stable bedrock controlled channel with minimal amounts of material being transported into the mainstem of Vaseux Creek.

6.0 RISK ASSESSMENT OF PROPOSED FOREST DEVELOPMENT

6.1 Stream Flows and Stream Channel Stability

Weyerhaeuser Canada Ltd. is proposing to harvest approximately 4.7% (1370 ha) of the watershed over the next five years. With the concurrent hydrologic recovery the ECA for the watershed (POI1) is anticipated to increase from 23.6% (1998) to 25.1% (2003) *[Table 3]*. An additional 1% increase in ECA to 26.1% is projected with the proposed blocks beyond 2003 (Information blocks for 2004+).

30% shift comes from downstream issues.

TABLE 3
Current and Proposed ECA's in the Vaseux Creek Watershed

Sub-basin	Total Area (ha)	ECA above IDF/MS Line (%)			Total ECA (%)		
		1998	2003	2004+ (Info. Blocks)	1998	2003	2004+ (Info. Blocks)
Dutton (V-2)	2970	0.8	0.6	0.6	30.5	28.3	28.3
Venner (V3-1)	5091	45.3	40.0	40.0	45.8	40.4	40.4
McIntyre (V4)	3326	25.3	26.6	26.6	25.3	26.6	26.6
Underdown (V5)	2599	26.1	29.5	30.3	27.7	31.6	32.4
Solco (V3-1 and V3)	8194	35.3	32.3	32.7	35.5	33.0	33.4
Upper Vaseux (V4, V5 and V6)	12591	21.1	25.6	26.2	22.9	27.2	27.8
POI2	20785	26.7	28.2	28.8	27.9	29.4	30.0
POI1	29192	19.5	20.5	21.2	23.6	25.1	26.1

ECA's are projected to decrease by 2.1% *[Table 3]* in the Solco Creek drainage area with projected hydrologic recovery greater than the proposed forest development (approximately 167 ha in the residual area and 15 ha in the Venner sub-basin). No increases in stream channel instability are anticipated as approximately 60 km of road have been deactivated and the stream channels have accommodated any past increases in peak flow.

Proposed ECA for the Underdown Creek sub-basin is projected to increase by 4.7% from 27.7% to 32.4%. The mainstem channel of Underdown Creek should accommodate the proposed forest development as 80% of the riparian zones are undisturbed, approximately 25% (13.1 km) of the roads have been semi-permanently deactivated and no loss of stream bank integrity has been identified (in both hydrologic investigations and in the FHAP).

The ECA is projected to increase by 1.3% to 26.6% in the McIntyre sub-basin. There are no anticipated concerns with this increase in peak flow as the stream channels have accommodated any past increases, approximately 39% (24.2 km) of the roads have been deactivated and most of the riparian zone along fish-bearing streams has been retained.

The ECA for the upper Vaseux Creek drainage area is projected to increase by 4.3% to 27.8%. The mainstem channel of Vaseux Creek should accommodate any potential increases in peak flow with the continued deactivation of roads and observed stable mainstem channels.

Current ECA levels have had minimal impact on the delivery of sediment from reach VC to the fan. Inputs of sediment and woody debris into the stream channels from past forest development is considered to be small. The proposed increase of the ECA of 2.5% for the watershed is not expected to have any significant impact on the rates of sediment delivery from reach VC.

To date the Vaseux Creek fan has accommodated an ECA of 24%. With the wide channel allowing peak flows to be dispersed over a broad area an additional increase to 26.1% is not expected to have any significant impact on the current shifting of the thalweg and associated stream bank erosion. In addition, most of the dyking is set back from the stream banks and should not be affected.

Vaseux Creek on the lower half of the fan appears to transport sediment quite readily down to the Okanagan River. The only concern identified was the unstable bank on private land above Highway 97. This instability will be exacerbated, with or without the proposed forest development.

6.2 Surface Erosion

As already identified, the main forest development related surface erosion concerns are related to the widely dispersed source of erosion from roads that are constructed in highly erodible, sandy surficial materials and the delivery of sediment at road crossings. Some of these concerns should have been reduced by the deactivation of approximately 168 km of road.

Proposed roads should have a minimal impact on surface erosion provided that appropriate measures are carried to minimize the production of sediment. Measures to minimize the production of sediment should include the use of silt fence, maintenance of natural drainage patterns, grass seeding, an active road deactivation program and avoidance of areas that have highly erodible soils with a high delivery potential.

6.3 Landslides

Potential cumulative impacts from future forestry-related landslides are of concern in the areas upslope from the steeper slopes coupled to the mainstem channels in the watershed. In these areas terrain stability field assessments should be carried out in conjunction with hydrologic assessments to determine the potential impacts of proposed upslope forest development on the hydrologic regime.

7.0 CONCLUSIONS

7.1 Peak Flows and Stream Channel Stability

- Overall stream channels appeared stable with limited evidence of impacts from potential increases in peak flows that may be associated with past forest development. The current ECA for the total watershed (POI1) is 23.6%.
- The fan area is located on private land. The upper half of Vaseux Creek on the fan is naturally laterally unstable where the channel is for the most part well back from the setback dykes. The lower half of Vaseux Creek on the fan is constricted with dykes along the banks of the channel. Sediment is transported quite readily across the lower fan to the Okanagan River.
- The stream channel stability hazard rating is considered low as the only site of concern identified was the potential for further erosion of the stream bank adjacent to the dyke on private land between the irrigation canal and Highway 97.
- The current ECA for the McIntyre sub-basin is 25.3%. Overall, the mainstem channel is considered to be stable.
- The current ECA for the Underdown sub-basin is 27.7% and the mainstem channel is stable.
- In the Solco drainage area the ECA is 35.5% and overall, the mainstem channels are stable.

7.2 Surface Erosion

- The surface erosion hazard for the watershed is considered to be low. The main sources of sediment into Vaseux Creek are natural from secondary erosion of the landslide tracks, retrogressive failure of the headwalls, and the erosion of cutbanks in reach VC (between the Solco Creek confluence and the bedrock canyon).

- Minimal amounts of sediment are delivered from the headwaters areas into the lower reaches. This is due to the rolling terrain, the decoupled hillslopes to channels and the low gradient reaches and wetlands which are deposition zones on the upper plateau.

- Some sediment delivery to the streams is due to cattle where they have destabilized sections of stream banks, resulting in channel widening and subsequent aggradation.

- Some sediment delivery to streams is associated with roads, however, the overall potential for surface erosion should have been reduced with the semi-permanent deactivation of 140.5 km of road and permanent deactivation of 28.0 km of road in the watershed.

7.3 Landslides

- There were 46 landslides identified in the watershed, of which 44 were natural and two related to past forest development. The majority of the slides (41) were along the mainstem of Vaseux Creek.

- A road-related failure was identified below CP 271 block 4 above the lower reach of Venner Creek which occurred after the sediment source survey was completed in 1997.

7.4 Proposed Forest Development

- There are no anticipated stream channel instabilities associated with proposed forest development on the tributary channels as evident by the lack of disturbance indicators, the low gradient, decoupled upper and middle reaches and the stable boulder-controlled lower reaches.

- The proposed ECA for the Underdown Creek sub-basin is projected to increase by 4.7% to 32.4%. The mainstem channel of Underdown Creek should accommodate the proposed forest development as 80% of the riparian zones are undisturbed, approximately 25% (13.1 km) of the roads have been semi-permanently deactivated and no loss of stream bank integrity has been identified (in both hydrologic investigations and in the FHAP).

- For the McIntyre sub-basin the ECA's are projected to increase by 1.3% to 26.6% and 39% of the roads have been deactivated.

- In the Solco Creek drainage area (including Venner Creek), there will be a reduction in the ECA by 2.5% to 33.4% and nearly 50% of the roads have been deactivated. Even though the ECA remains above 30%, it is being reduced from a high of 35.5%.

- The proposed development in Dutton Creek would result in an ECA of 28.3% which is a reduction of 2.2%.

- There are no anticipated stream channel instabilities on the mainstem channels associated with the proposed forest development in the Solco Creek drainage area. There will be an overall reduction in the ECA by 2.5% and to date nearly 50% of the roads have been deactivated.

- The proposed development should have no detectable effect on peak flows and therefore should have no impact on the natural rates of sediment delivery into or from reach VC of Vaseux Creek.

- The proposed forest development should not change the dynamics of the channel through the fan.

8.0 RECOMMENDATIONS

8.1 Nonforestry-related Issues

- The bank erosion on the private land above the Highway 97 bridge should be addressed by completing the riprap to the top of the bank along the eroding section.

- BC Environment should initiate a long-term fan management program to monitor and assess bedload movement through the channelized section of channel. The affected parties that have issues that need to be addressed on the fan include: BC Environment (fisheries branch), DFO, MOTH, residents and West Kootenay Power (transmission corridor).

- Changes to the cattle grazing management plan in the upper portions of the watershed should be considered by the Penticton Forest District and the grazing licensees that would reduce bank destabilization and surface erosion caused by cattle.

8.2 Past forest development

FRBC funding should be considered to address the following:

- Deactivation of the road below CP 271 block 4 and stabilization of the road-related landslide.

- Assess and develop riparian and stream channel stabilization prescriptions associated with cattle disturbances in past forest development areas.

8.3 Proposed forest development

Proposed forest development plans should consider the following:

- Minimize sediment transport from roads during construction, maintenance and deactivation programs through careful design and the use of appropriate construction techniques.

- Conduct post-harvesting inspections of the blocks to ensure natural drainage patterns have been maintained. Any disturbances identified should be mitigated as required.

To minimize potential cumulative impacts from future forestry-related landslides in areas upslope from the high hazard terrain that is coupled to the mainstem channels:

- Carry out combined terrain stability field assessments and hydrological assessments for proposed development that is either on or drains directly onto potentially unstable or unstable terrain (refer to Reconnaissance Terrain Stability Mapping, March 1999) to avoid an increased potential for failures along the mainstem of Vaseux Creek. This is a particular concern for any proposed development that drains directly onto potentially unstable or unstable terrain along Reach VC.

LD/rs/dd