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FINAL REPORT

BLUE/MACRAE (BLUE RIVER): WATERSHED ASSESSMENT

Prepared for:

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Project #753.1

May 1999

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May 10, 1999

Reference: **753.2**

Mr. Kevin Bonnett, R.P.F.
Weyerhaeuser Canada Ltd.
Vavenby Division
P.O. Box 130, KP Road
Vavenby, B.C.
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Dear Mr. Bonnett:

Re: Blue River Watershed Assessment

Summit Environmental Consultants Ltd. is pleased to provide this report of the Blue River Watershed Assessment. The report follows the format outlined in the most recent interim guidelines provided by the Ministry of Forests.

The report recommends ECA upper limits of 30% for the Macrae sub-basin and between 20% and 25% for the Blue sub-basin. Forest harvest proposed in the current five-year development plan for Macrae would maintain an ECA of less than 30%, and thus may proceed with negligible risk to the channel from changes in peak flow. No harvest is proposed for the Blue sub-basin in the current plan. For the Blue sub-basin, the ECA of the whole Blue River watershed (estimated to be 15% as of 1996) is a better indicator of hydrologic risk than the sub-basin ECA. Since the development proposed for the Macrae area would maintain an overall watershed ECA of <20%, that development also poses negligible risk to the channel through the Blue sub-basin.

Please call if you have any questions.

Yours truly,

Summit Environmental Consultants Ltd.

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist

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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

Blue River is a tributary of the North Thompson River, with a drainage basin area of about 281 km^2. The confluence of the Blue River and the North Thompson River is located near the town of Blue River, at latitude 52°07'00" north, longitude 119°18'0' west. For forest planning purposes, the Blue River watershed is divided into three sub-basins: i) Blue (48 km^2), ii) Macrae (68 km^2), and iii) North Blue (165 km^2). The Blue and Macrae sub-basins are within the operating area of Weyerhaeuser Canada Ltd., Vavenby Division ("Weyerhaeuser"), while North Blue[1] is largely within the operating area of Gilbert Smith Ltd. Under the *Forest Practices Code of B.C. Act*, Watershed Assessments (WAPs) are required for all Community Watersheds as well as streams with significant downstream fisheries values or licenced domestic water users. Blue River is deemed to have significant fisheries values[2], and a WAP is required before review of Forest Development Plans. This report presents the results of the WAP completed in 1999 for the Blue and Macrae sub-basins.

The report follows the recommended format provided in the Interim Watershed Assessment Procedures guidelines (MOF, 1998). It is based primarily on information collected in the fall of 1998 during the preparation of an Integrated Watershed Restoration Plan (IWRP; Summit Environmental Consultants Ltd., 1999). The IWRP included a Channel Condition and Prescription Assessment (CCPA), an Erosion and Mass Wasting Risk Assessment (EMWRA), and development of an Access Management Strategy (AMS). The AMS included consultations with watershed stakeholders and several open house meetings.

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[1] The North Blue was further divided into four sub-basins for an IWAP completed by B.C. Environment (Forsite, 1997). That report gives an overall area for North Blue of 139.3 km^2.

[2] Coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*) bull trout (*Salvelinus confluentus*), rainbow trout (*Oncorhynchus mykiss*), mountain whitefish, slimy sculpin (*Cottus cognatus*), and prickly sculpin (*Cottus* sp.) are found in Blue River (FISS, 1997).

1.2 Project Objectives

The general objectives of this report are to characterize the Blue and Macrae sub-basins, and provide recommendations on constraints to and opportunities for forest development. Specific objectives are to:

1. Describe the hydrology, geomorphology, and sediment transport characteristics of the channels in the Blue and Macrae sub-basins;
2. Document any anthropogenic disturbance in the watershed, and identify the probable cause;
3. Identify risks to water quality and fish habitat from the current (1998-2003) five-year forest development plan;
4. Provide recommendations concerning maximum equivalent clearcut area (ECA) levels; and
5. Provide recommendations regarding watershed management and follow-up studies, if required.

2.0 METHODS

As described above, this report is based largely on information collected during the 1998-99 IWRP. The Blue/Macrae CCPA was based on procedures outlined in the most recent WRP and Forest Practices Code guidebooks (Hogan et al., 1996; MOF/MELP, 1996a; 1996b), and included a helicopter survey and field inspections of stream reaches downstream of logging activity. The EMWRA followed procedures described by Moore (1994) and included inspection of more than 90% of the road network by truck, ATV, or on foot. Landslides in the watershed were inspected and characterized (length, width, slope angle, surface materials, drainage, risk of on-going instability). For both the CCPA and EMWRA, the level of effort of the field work exceeded the requirements of the current WAP interim procedures (MOF, 1998).

To guide recommendations for future forest development (Section 4.0), the results of the channel assessment have been utilized to develop a qualitative channel sensitivity rating (Low, Moderate, High) for each reach. "Sensitivity" is the potential for the reach to be impacted by changes in the timing and/or magnitude of peak flows. In bedrock-controlled reaches sensitivity is dependent on bed stability and the amount of erodible sediment on the channel bed. In alluvial reaches, sensitivity is dependent on the interaction between the type of channel and bank deposits, bank stability (e.g. presence/absence of tree with large roots and in-bank LWD), and the supply of sediment and woody debris. For example, a reach with high sensitivity would have all or some of the following characteristics: reduced channel capacity due to aggradation, little in-stream LWD or boulders to dissipate flow energy, and few large trees along the banks. A low sensitivity reach would have banks comprised of bedrock or boulders, adequate channel capacity to carry peak flows, and mature riparian vegetation.

Maximum recommended ECAs for each sub-basin were determined by considering both hydrologic hazard (a function of sensitivity) and consequence. **Hazard** is the probability that channel changes resulting from future forest harvest will lead to changes in water quality or fish habitat in the sub-basin. Hazard considers the length of sensitive reaches within the sub-basin and their proximity to areas of interest (i.e., spawning beds). **Consequence** is the severity of impacts if they occur. Table 2.1 lists the maximum recommended ECA for each **risk** (hazard × consequence) category. Given the presence of salmonid spawning habitat (especially coho salmon, chinook salmon and bull trout) in the Blue sub-basin, consequence was rated high. Thus the maximum possible recommended ECA for the Blue sub-basin is 30% (e.g., if the hazard was "low"). For Macrae, the consequence is rated as moderate, and the maximum possible recommended ECA is 35%.

Table 2.1. Hydrologic risk and recommended maximum ECA (%) as a function of hazard and consequence.

		CONSEQUENCE		
		H	**M**	**L**
HAZARD	**H**	High Risk *20%*	Moderate-High Risk *25%*	Moderate Risk *30%*
	M	High-Moderate Risk *25%*	Moderate Risk *30%*	Low-Moderate Risk *35%*
	L	Moderate Risk *30%*	Moderate-Low Risk *35%*	Low Risk *40%*

Recommended maximum ECA (un-weighted) shown for each hazard-consequence combination in bold.

3.0 WATERSHED DESCRIPTION & PREVIOUS STUDIES

3.1 WATERSHED HYDROLOGY

The Blue River watershed is within the "Northern Wet" climate region of the Kamloops Forest Region (Lloyd et al., 1990). The area is relatively wet, receiving normal annual precipitation of 1210 mm (Blue River North climate station, 1961-90; Atmospheric Environment Service, 1993). A stream discharge record is available for Blue River (Water Survey of Canada gauging station No. 08LB038) for the years 1984 to 1995. The station is located at the Highway #5 bridge, about 2.5 km above the mouth, in the Town of Blue River. Figure 3.1 illustrates the annual flow regime for this station. Flow levels are high during May, June and July, in response to snowmelt. However, the flow levels drop steadily over the summer months, a pattern typical of drainage basins in the B.C. Interior. Flow levels typically remain low throughout the winter months, and winter flood events are very rare.

A summary of the five highest flow events on record is presented in Table 3.1. Additional high discharge events occurred in 1996 and 1997. However, official data for these years is not yet available from the Water Survey of Canada. Table 3.2 presents a summary of the five lowest daily flows for the period of record. These flows have all occurred during the winter months, during which most precipitation is stored as snow.

There are two small lakes, Blue Lake (3 ha) and an unnamed lake (6 ha), at the headwaters of the Blue River mainstem (Map 1). The only other lakes of similar or larger size are Mystery Lake in the Blue study area and Eleanor Lake within the Town of Blue River. In addition, there are a number of smaller alpine lakes at the headwaters of tributaries.

3.2 WATERSHED MORPHOLOGY, SURFICIAL GEOLOGY & SOILS

The bedrock of the Blue River watershed is comprised primarily of undifferentiated metamorphic rocks from the Kootenay Terrane, and weakly foliated muscovite granite from the Blue River Pluton (GSC, 1990). Surficial materials observed within the study area include extensive sandy-gravelly glaciofluvial terraces along the main Blue River valley, and

Figure 3.1. Annual flow regime for Blue River near Blue River (08LB038).

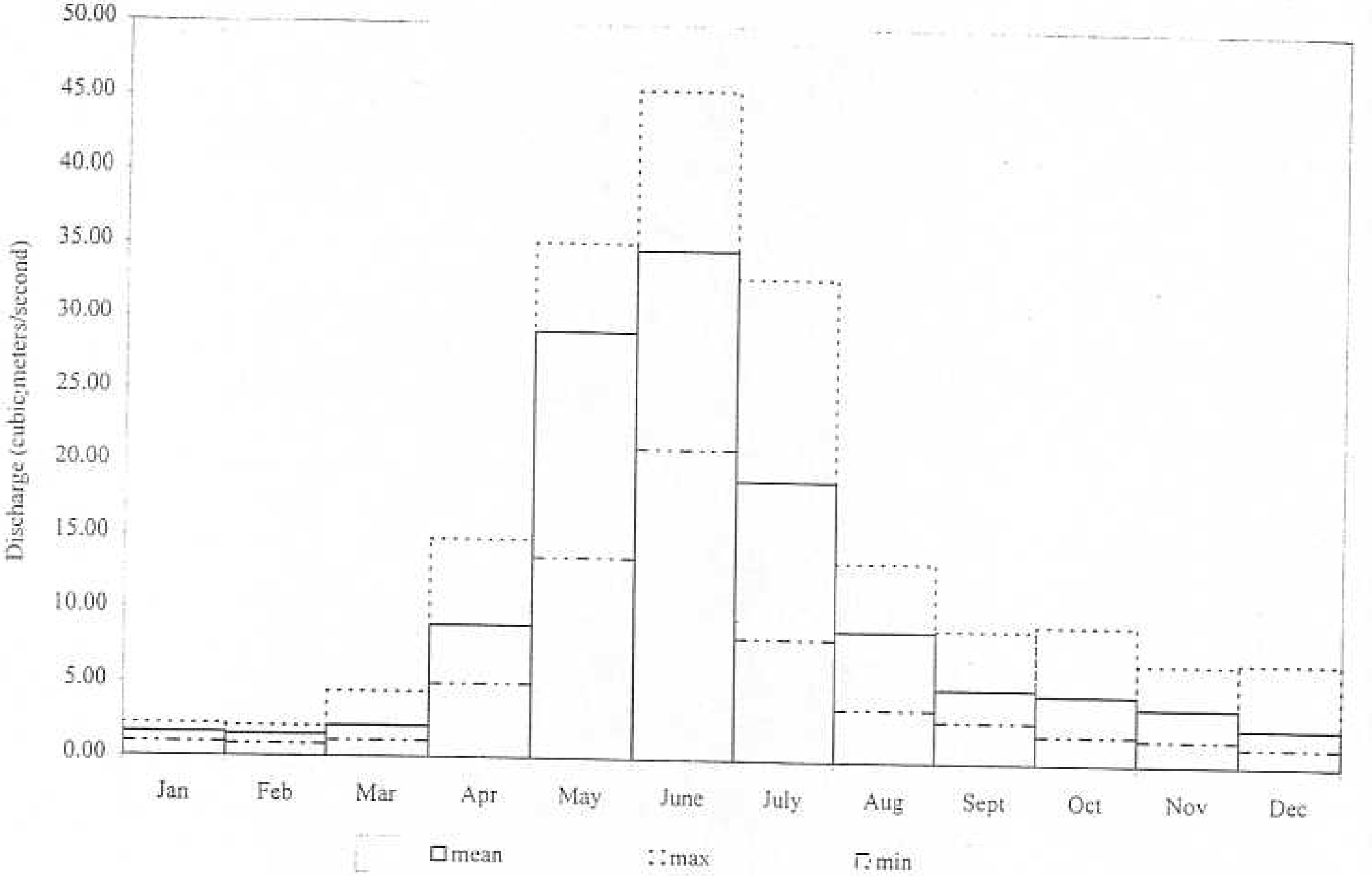

Table 3.1. High flow summary for Blue River (1984 – 1995).

Historical flood record (1984 – 1995)			
Rank	Maximum Daily Discharge (m^3/s)	Date	Exceedance Return Period*
1	84.8	May 29, 1986	35
2	75.4	June 29, 1984	7.5
3	72.4	May 25, 1985	5
4	67.6	May 26, 1992	3
5	63.5	May 15, 1993	2

*Based on Pearson type III distribution.

Table 3.2. Low flow summary for Blue River (1984 – 1995).

Historical low flow record (1984 – 1995)			
Rank	Minimum Daily Discharge (m^3/s)	Date	Non-Exceedance Return Period*
1	0.840	February 10, 1985	20
2	0.947	February 26, 1994	9
3	1.000	January 16, 1986	5
4	1.020	February 27, 1993	4.5
5	1.110	February 22, 1987	2.5

*Based on Pearson type III distribution.

glacial till at higher elevations. In addition, Blue River as built an extensive gravel fan out onto North Thompson River's floodplain. Surficial materials within the study area are generally sandy and well drained, regardless of their origin. Soils in this part of the province are dominantly Humo-Ferric Podzols (Valentine et al., 1981).

3.3 WATERSHED ASSESSMENT RESULTS: 1996-97

3.3.1 Level 1 IWAP

"Level 1" Interior Watershed Assessment Procedures (IWAP)[3] were completed for the Blue and Macrae sub-basins by Forsite Consultants Ltd. in 1997, on behalf of the Ministry of Environment, Lands and Parks (MELP). No fieldwork was completed for the Level 1 IWAPs. Table 3.3 summarizes the equivalent clear-cut area (ECA) and data hazard indices from the Level 1 IWAP. The results suggested potential for cumulative impacts from previous forest harvest, and follow-up field investigations were recommended to confirm the presence or absence of impacts.

Table 3.3. Estimated ECA values and Level 1 IWAP hazard scores (Forsite, 1997).

	Blue Sub-basin	Macrae Sub-basin
Un-weighted ECA	25%	22%
Peak flow hazard	*0.61*	0.46
Surface erosion hazard	*0.72*	*0.59*
Riparian buffer hazard	*0.56*	*0.69*
Landslide hazard	0.08	0.12

Note: Hazard scores >0.5 (in italics) indicate potential for cumulative impacts.

3.3.2 Channel Assessment

A stream channel assessment was completed in 1998 as part of the IWRP. The assessment documented channel conditions, identified disturbed areas, and established priorities for restoration. The following is a description of the channel conditions and reach sensitivity

[3] The IWAP has been superceded by the current WAP (MOF, 1998).

ratings. Section 3.4 presents the sensitivity ratings for each reach of each stream in the two sub-basins, a generalized sensitivity rating for each stream, and an overall sub-basin sensitivity rating. The channels are discussed below in order from the headwaters of Blue River (in the Macrae sub-basin) downstream to the mouth of Blue River (in the Blue sub-basin).

Macrae Sub-Basin

The headwaters are comprised of small but moderately active first and second order streams that transport moderate amounts of sediment to the Blue River mainstem (Map 1); these tributary streams considered to be stable and have low sensitivity (Table 3.4). The mainstem and its floodplain are moderately confined by the steep valley sides. The upper reaches of the Blue River mainstem (reaches 10 to 15) are comprised of lakes, wetlands, wetland – type channels, and some low energy riffle-pool sections. These reaches are not considered to be alluvial, and have not been given channel stability or sensitivity ratings.

Downstream of reach 10, several larger tributaries enter the mainstem (Macrae Creek, M – S – 3, and M – S – 2). These channels are larger and somewhat more active than the smaller tributaries upstream; they are generally stable, and have moderate to low sensitivity. The mainstem becomes progressively more energetic in the downstream direction as the channel becomes increasingly confined by the valley sides; reaches 8 and 9 are active riffle – pool systems, and reach 7 becomes cascade – pool; sensitivity ratings for these reaches range from moderate to high. The North Blue River enters the Blue River at the downstream end of reach 7, marking the downstream limit of the Macrae study area.

Blue Sub-Basin

Blue River below the confluence undergoes transition from a confined cascade – pool system (reach 6) to a more gentle riffle – pool system (reaches 1 to 5). The lower part of the Blue River valley is comprised of extensive glaciofluvial deposits. Remnants of glaciofluvial fill can be found as much as 280 m above the current floodplain level. Blue River has cut down through these deposits, and is continuing to incise, though at a slower rate than in the past. As a result, the channel in reaches 1 to 5 is strongly influenced by the input of sediment from

Table 3.4 Channel sensitivity for Macrae sub-basin.

Stream	Reach No.[1]	Length (m)	Slope (%)	Confined?	Channel morphology[2]	Disturbance level[3,4]	Stability rating[5]	Channel sensitivity[4]	Stream sensitivity	Sub-basin senitivity
Blue River	7	920	7.61	Y	CPc - w, CPb	1 - 2	3	3	Moderate	Moderate
	8	2960	3.38	Y	RPg - w	1	3	3 - 4		
	9	3540	1.07	N	RPg	1 - 2	3	3 - 4		
	10	1620	2.47	Y	RPg, wetland	1	3	3		
	11	1420	1.69	Y	RPg, wetland	1	3	3		
	12	2100	n/a	Y	wetland	n/a	n/a	n/a		
	13	300	n/a	Y	lake	n/a	n/a	n/a		
	14	240	n/a	Y	wetland	n/a	n/a	n/a		
	15	520	n/a	Y	lake	n/a	n/a	n/a		
Macrae	1	240	33	N	CPc	--	3	3	Moderate	
	2	900	49	Y	SPr	--	1 - 2	2		
	3	2240	14	Y	CPc - w	--	2 - 3	3		
M - N - 10	1	320	31	N	CPc	--	3	3	Moderate	
	2	780	41	Y	SPr	--	1 - 2	2		
	3	2400	10	Y	CPc - w	--	2 - 3	3		
M - S - 11	1	1120	27	Y	SPr	1	1	1	Low	
	2	1000	10	Y	SPb	--	1 - 2	2		
M - S - 10	1	780	24	Y	SPr	1	2 - 3	2	Low	
	2	1380	10	Y	SPb	--	1 - 2	2		
M - S - 9	1	940	35	Y	SPb, BR	2	2	2	Low	
	2	1180	12	N	SPb	--	2 - 1	2		
M - S - 8	1	1240	45	Y	SPc, SPc - w	3	3 - 2	3	Moderate	
	2	320	7	N	SPr, BR	--	1 - 2	2		
M - S - 7	1	1040	40	Y	SPb, SPc - w	1	2 - 3	2 - 3	Low	
	2	1420	21	Y	SPr	--	2 - 1	2		
M - S - 6	1	1400	38	Y	SPr	2	2	2	Low	
	2	1200	17	Y	SPb	--	2 - 1	2 - 1		
M - S - 3	1	780	21	Y	SPb, SPb - w	1	3	3	Low	
	2	660	30	Y	SPr	--	2	2		
	3	1700	13	Y	SPb	--	2	2		
M - S - 2	1	320	31	Y	SPb	1	3	2	Moderate - Low	
	2	400	10	Y	SPb	--	2	2		
	3	920	17	Y	SPb, SPr	--	2 - 1	2		
	4	2080	12	Y	CPc - w	1 - 3	3 - 4	3		

1: See Map 1 for reach locations.
2: The morphology types codes are RPg (riffle-pool, gravel bed), RPc (riffle-pool, cobble bed), CPc (cascade-pool, cobble), CPb (cascade-pool, boulder), SPb (step-pool, boulder), and SPr (step-pool, boulder-block); -w indicates presence of functioning LWD in the stream channel.
3: Presented only where reach has been visited in the field, or where evident from air photos or during helicopter flight.
4: Numbers refer to a five class system; very low (1), low (2), moderate (3), high (4), and very high (5). Where two values are presented, dominant class is presented first, followed by the sub-dominant class, a dash indicates a range of disturbance levels between the two classes.
5: Numbers refer to a five class system; very stable (1), stable (2), equilibrium (3), unstable (4), and very unstable (5). Where two values are presented, dominant class is presented first, followed by the sub-dominant class, a dash indicates a range of disturbance levels between the two classes.
6: Channel depth cannot be measured from air photos, reach was not visited on the ground.

high glaciofluvial terraces. Blue River is quite capable of transporting the sediment stored in bars and in the floodplain throughout the mainstem reaches in the Blue sub-basin. Reach 6 has a sensitivity rating of moderate to high all other mainstem reaches have high sensitivity ratings (Table 3.5). Logging-related channel impacts were observed in reach 5, just upstream of the reported limit of salmon spawning. Restoration prescriptions are presented and discussed in Summit (1999).

There are three large and active tributaries on the south side of the valley (B–S–4, B–S–5 and B–S–7; Map 1). These channels have deposited steep alluvial fans on top of a terrace on the right bank[4] of Blue River. The terrace acts as a natural sediment trap by inducing deposition well away from the Blue River mainstem. These tributaries are generally moderately sensitive (Table 3.5).

On the north side of the valley, three more tributaries have been documented (B–N–1, B–N–4, and B–N–7), all of which are considered to be moderately sensitive. Other tributaries appear on the TRIM maps, but were either small non-alluvial trickles, or nonexistent altogether. Of the three documented, only B–N–1 is of substantial size. This tributary is very active, with a morphology that ranges from riffle–pool to cascade–pool. It discharges into a wetland area adjacent to Blue River. This tributary has been impacted by logging on both banks. Restoration prescriptions are presented in Summit (1999).

3.3.3 EMWRA and AMS Summary

Three **landslides** were identified in the Blue River sub-basin, and four were identified in the Macrae sub-basin (locations shown on Map 1). All of the identified landslides are the result of road building. Only three of these slides have reached the stream network, one in the Blue River study area (LB2) and two in the Macrae study area (LM1 and LM4), though five of them are considered to be potential threats to the stream network (these slides have been identified as potential restoration sites by Summit, 1999).

[4] The terms "left bank" and "right bank" assume that the observer is looking downstream.

Table 3.5 Channel sensitivity for Blue sub-basin.

Stream	Reach No.[1]	Length (m)	Slope (%)	Confined?	Channel morphology[2]	Disturbance level[3,4]	Stability rating[5]	Reach sensitivity[4]	Stream sensitivity	Sub-basin senitivity
Blue River	1	3760	0.53	N	RPg	2	3	4	High	High - Moderate
	2	3560	0.28	Partially, by Fg Terraces	RPg	1 - 2	3	4		
	3	980	0.51	Y	RPc	1	3	4		
	4	1620	0.31	N	RPg - w	1	3	4		
	5	3920	0.51	Partially, by Fg Terraces	RPc	3 - 4	3 - 4	4		
	6	2140	3.5	Y	CPc, CPb	1	3	3 - 4		
B - N - 1	1	860	10	N	RPc-w, CPc	3 - 5	3 - 4	4	Moderate	
	2	560	21	Y	CPc	–	3	3		
	3	2100	33	Y	SPb	–	3 - 2	3		
B - N - 4	1	880	16	N	SPb	3	2	3	Moderate	
	2	1120	36	Y	SPb	–	2 - 1	2		
B - N - 7	1	1220	12	N	SPg - w	2 - 3	2 - 1	3	Moderate	
	2	720	19	Y	SPc	–	2 - 1	3		
B - S - 7	1	1160	21	Y	SPb, SPc - w	1 - 2	2 - 3	2 - 3	Low - Moderate	
	2	800	20	Y	SPb, SPc - w	–	2 - 3	2 - 3		
	3	840	21	Y	SPb, SPc - w	–	2 - 3	2 - 3		
	4	1580	14	Y	SPc - w	–	2 - 3	2 - 3		
	5	920	2	N	CPc	–	2	2		
B - S - 4	1	880	18	N	CPc, SPb	4	3 - 4	4	Moderate	
	2	520	55	Y	SPb	1	2 - 3	2 - 3		
	3	1040	23	Y	CPc	–	3	3		
B - S - 3	1	540	27	N	CPc, SPb	4	3	4	Moderate	
	2	920	43	Y	SPb	–	2 - 1	2		
	3	3080	10	Y	CPb, CPc - w	–	2	2 - 3		

1: See Map 1 for reach locations.
2: The morphology types codes are RPg (riffle-pool, gravel bed), RPc (riffle-pool, cobble bed), CPc (cascade-pool, cobble), CPb (cascade-pool, boulder), SPb (step-pool, boulder), and SPr (step-pool, boulder-block); -w indicates presence of functioning LWD in the stream channel.
3: Presented only where reach has been visited in the field, or where evident from air photos or during helicopter flight.
4: Numbers refer to a five class system; very low (1), low (2), moderate (3), high (4), and very high (5). Where two values are presented, dominant class is presented first, followed by the sub-dominant class, a dash indicates a range of disturbance levels between the two classes.
5: Numbers refer to a five class system; very stable (1), stable (2), equilibrium (3), unstable (4), and very unstable (5). Where two values are presented, dominant class is presented first, followed by the sub-dominant class, a dash indicates a range of disturbance levels between the two classes.

Of the identified slides, three are moderate priority for restoration, and the remaining four landslides are low priority. Restoration priorities are based on consideration of the current threat to the environment (a function of the current level of instability and of distance from the stream network), and the relative value of such restoration activities.

Inspections of the **road network** found four high risk road sections in the Blue sub-basin and five in Macrae. Most of the high risk sections are the result of "blown out" culverts, or wooden culverts on old roads, or eroding cutslopes and/or fillslopes (including fillslope slides) on roads cutting across steep terrain. All the high risk problem roads are directly impacting or have a potential to impact Blue River and/or Murtle Road.

There are four moderate risk road sections in Blue study area and seven in the Macrae study area. The moderate risk sections mainly involve oversteepened fillslopes, eroding cutslopes, road drainage problems, and plugged ditches and culverts. These sediment sources do not directly effect Blue River and/or Murtle Road, but generate sediment capable of being re-mobilized and ultimately delivered to the stream. Most of the remaining low risk roads do not require any work if left in their present status. Road deactivation prescriptions were prepared for 30 roads or road segments: three are high priority for deactivation, five are moderate priority; and 22 are low priority.

For the Blue/Macrae areas, a proposed deactivation scheme by the forest licensees was in place before the EMWRA was carried out, based on the licensees current Forest Development Plans. The scheme was later revised based on the information gathered during the road inspections and changes to Weyerhaeuser's Forest Development Plan. This information was then used to develop a preliminary Access Management Strategy Map. The preliminary **Access Management Strategy** (AMS) Map was then shown to area stakeholders and the public. All comments and concerns were documented. There have been no objections to Weyerhaeuser's proposed road deactivation plan from stakeholders consulted to date. Major concerns expressed include the stability of the Murtle Lake Road and the presence of roads in alpine areas. Readers are referred to the IWRP report (Summit, 1999) for more details on the AMS.

3.4 WATERSHED AND CHANNEL SENSITIVITY

Summaries of channel sensitivity to hydrologic change for each reach, stream and sub-basin are presented in Tables 3.4, and 3.5, for Macrae and Blue sub-basins, respectively. Assessment of **sensitivity**[5] on a reach-by-reach basis involves assessing both the level of **disturbance**[6] and the channel **stability**[7], and inferring the magnitude and direction of changes in stability as related to incremental changes in the level of disturbance. In practice, we consider the sensitivity of a given reach to specific potential impacts (i.e. increased peak flows). Individual reach sensitivity ratings are combined to produce stream sensitivity ratings by considering the length and spatial location relative to the point-of-interest of each reach and then assigning a representative sensitivity rating. Similarly, stream sensitivity ratings are combined to give a sub-basin sensitivity rating; this rating is referred to as the hydrologic hazard for the sub-basin.

The hydrologic hazard is defined as the probability that effects on channels in the sub-basin, and thus on water-related resources of the sub-basin (e.g. fish or fish habitat, water quality, or water quantity) will occur if forestry-related hydrologic changes occur in the future. The hydrologic hazard rating for the Macrae sub-basins is **Moderate**, while the hazard rating for the Blue sub-basin is **High-Moderate**. From Table 2.1, suggested guidelines for maximum sub-basin ECAs are 30% for Macrae (moderate hazard, moderate consequence) and 20% to 25% for Blue (high-moderate hazard, high consequence). These guidelines are discussed in Section 4.2 below.

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[5] Channel sensitivity refers to the potential for channel disturbance to result in decreased channel stability.

[6] Assessment of the channel disturbance involves identifying impacts (such as landslides, increased fine sediment supply, or altered riparian zones) on the channel.

[7] Stability is the tendency for channel morphology to remain the same over time (*in*stability is proportional to the rate-of-change of channel morphology, i.e. the rate of channel widening, bed aggradation or meander migration). Stability is related to disturbance in that disturbance often results in reduced channel stability. Stability is different from disturbance in that some channels are naturally unstable (i.e. very geomorphically active).

4.0 IMPLICATIONS FOR WATERSHED MANAGEMENT

4.1 PROPOSED FOREST DEVELOPMENT

Weyerhaeuser's current five-year (1998-2003) forest development plan for the **Macrae** sub-basin proposes seven cutblocks totaling about 780 ha. The proposed cutting system includes a combination of patch cuts, partial cuts, and reserve areas. Weyerhaeuser staff estimated the ECA for the proposed harvest, using MOF guidelines, to be 300 ha. The estimated sub-basin ECA was 22% based on 1996 data. Since then, Gilbert Smith Ltd. and the Small Business Forest Enterprise Program (SBFEP) have done some harvesting. Counting that harvest and assuming no tree growth since 1996, implementation of all proposed blocks would raise the Macrae ECA to about 29%, a value approaching the upper guideline of 30% (Section 3.4). Tree growth (and hydrologic recovery) has, of course, occurred in that interval. In addition, Weyerhaeuser's experience in the North Thompson Valley is that current tree growth models (which were used to generate the ECA estimates) tend to underestimate actual tree heights. Thus it is likely that the projected 2003 ECA would be less than 29%, and would probably be closer to 25%.

No development is currently planned for the **Blue** sub-basin. Given tree growth since 1996, the ECA is currently likely within the range of about 19-22%.

4.2 RISK ASSESSMENT

Macrae Sub-Basin

As outlined above, the overall hydrologic hazard rating for Macrae is "moderate", which combined with a "moderate" consequence results in a guideline maximum ECA of 30%. If the projected 2003 ECA (including the effects of both the new blocks and projected tree growth) can be confirmed to be less than 30%, the proposed development in Macrae can proceed with only negligible risk of peak flow effects. If the projected ECA is greater than 30%, the harvesting plans should be reviewed to assess the level of risk associated with the specific proposals. Possible strategies to reduce risks include changing the proposed sequence or schedule of block harvest, depending on block location, aspect, and elevation.

Blue Sub-Basin

For the Blue sub-basin, the hydrologic hazard is "high-moderate" (Table 3.5). Accordingly, the maximum ECA should be between 20-25%. The ECA reported by Forsite (1997) for the Blue sub-basin was 25%. However, the relevant measure of hydrologic risk through the Blue sub-basin is the ECA for the entire Blue River watershed, not just the sub-basin. Given the size of the North Blue sub-basin (about 59% of the watershed), stream processes in the Blue sub-basin are heavily influenced by hydrologic processes in North Blue. The ECA for North Blue was estimated at 8.5% using 1996 data[8], and the overall Blue River watershed ECA was thus approximately 15%.

We understand that only Gilbert Smith Ltd. proposes very limited development for the North Blue sub-basin, and Weyerhaeuser proposes no development for the Blue sub-basin. Given the whole watershed ECA of 15%, the current development proposed for the Macrae sub-basin poses negligible risk to the stream channel within the Blue sub-basin.

4.3 MITIGATION STRATEGIES

The risk assessment in Section 4.1 emphasizes peak flow impacts. Given the proximity of historic channel impacts and riparian logging to spawning and fish-bearing reaches of Blue River, it is important that the planned development proceed with due care to avoid direct impacts via sedimentation and reductions in riparian cover. This can be achieved through a combination of best management practices for road development and maintenance, and continuing to implement the restoration and road deactivation plans that were recommended by the IWRP process. In particular, the high priority in-stream works should be completed to help increase channel resilience (see section 4.3 of Summit, 1999). In addition, the high priority road deactivation and repair should also be undertaken as soon as possible.

[8] The weighted average for the four sub-basins: North Blue residual (13.1%), Upper Blue (0.5%), Mid-Blue (5.9%), and West Blue (7.8%).

5.0 CONCLUSIONS AND RECOMMENDATIONS

This WAP report summarizes the results of a series of watershed assessments, including detailed channel and sediment source assessments, completed in 1998 in the Macrae and Blue sub-basins of the Blue River watershed. From the WAP analyses the following conclusions are drawn:

1. The streams in the Blue sub-basin have "low-moderate" to "high" sensitivity peak flow impacts. The hydrologic hazard for this sub-basin is high-moderate.
2. The streams in the Macrae sub-basin have "moderate" to "low" sensitivity to peak flow impacts, based on the observed channel stability and disturbance level. The hydrologic hazard for this sub-basin is moderate.
3. The consequence of impacts to the channel from peak flow changes in the Blue sub-basin is considered high, based on the presence of salmonid spawning habitat in the lower reaches and rearing habitat throughout.
4. The consequence of impacts to the channel in the Macrae sub-basin are considered moderate.
5. As of 1998, the watershed did contain a number of forestry-related sediment sources that contributed sediment directly to the stream. Prescriptions have been developed for these sites/roads.

Derived from these conclusions are the following recommendations:

1. Given the combinations of hazard and consequence, the maximum recommended ECA in the Macrae sub-basin is 30%.
2. The maximum recommended ECA in Blue sub-basin is 20 to 25%, depending on the location and timing of specific road and cutblock proposals, and the overall watershed ECA. Proposals that would increase the either the sub-basin or whole watershed ECA to >20% (but <25%) should be evaluated by a professional hydrologist to assess potential hydrologic risks and develop mitigation strategies, as appropriate.
3. Estimates of current ECA levels may overestimate actual conditions. Given that the proposed development in Macrae may generate an ECA near the upper guideline of 30%,

the estimates should be updated and verified in the field through surveys of tree heights in representative blocks.

4. The high priority in-stream works and road deactivation/repair work recommended by the IWRP should be completed as soon as possible (ideally no later than 2000) to help enhance channel resilience and reduce sediment inputs.

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