HABITAT ASSESSMENT AND RESTORATION OPPORTUNITIES IN THE ASH RIVER, BC

Prepared for:

Hupacasath First Nations
Port Alberni, BC

Prepared with financial assistance from:

BC Hydro Bridge Coastal Fish and Wildlife Restoration Program
6911 Southpoint Drive (E14),
Burnaby, BC V3N 4X8

BCRP Report No. 06.ASH.02

June 2007

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EXECUTIVE SUMMARY

Fish habitat surveys were completed by BCCF, LGL Limited, and HFN fisheries staff in the Ash River watershed downstream of Elsie Dam in the summer of 2006. The objectives of this project were to implement a salmon habitat assessment and to identify and develop high priority and cost-effective restoration treatments and designs for Ash River and Wolf and Lanterman creeks. Detailed fish habitat assessments were completed on 12 high priority reaches downstream of Elsie Dam to assist in the identification of fish habitat impacts. Surveys to develop restoration or enhancement designs where habitat impacts or limiting factors were identified in the detailed habitat assessments were then conducted in three reaches between Dickson Lake and Elsie Lake.

In total, 10,076 m of Ash River mainstem and 5,720 m of tributary streams as well as several hundred meters of off-channel habitat were assessed. Channel morphology and habitat characteristics were found in relatively good condition in the reaches of Ash River and Wolf and Lanterman creeks surveyed. Disturbance indicators were more prevalent in the tributaries with disturbances only recorded in three reaches of the mainstem. Disturbance was indicated by relatively low levels of bank erosion and mid-channel gravel bars, and evidence of large woody debris (LWD) lying parallel with the channel. Habitat limitations appeared primarily in the percent wood cover in pools, percent of the riffle area comprised of boulders, and percent overhead cover for all reaches surveyed. However, it was found that within the mainstem, deep pools provided more than adequate cover for salmon and trout.

Our detailed habitat and restoration assessments indicated a lack of viable restoration opportunities within Reaches 4 and 6. Restoration opportunities are limited as the mainstem channel is stable with very limited evidence of severe bank erosion or channel aggradation. This further suggests that sediment loading to the mainstem is currently not excessive. Pools are plentiful with significant cover being provided by deep holding pools. In addition, ample amounts of high quality spawning gravel and several off-channels are present within each reach.

For the other reaches surveyed, the detailed habitat assessment results suggest that some restoration works may be warranted in the lower reaches of the Ash River mainstem and in Wolf Creek. Conclusions from our habitat assessment were:

- Ash Reach 1: Overall poor-fair ratings for the three pool habitat diagnostics in Reaches 1 A and 1 B, and for all instream cover elements in Reach 1 suggest that restoration opportunities to restore fish habitats exist.
- Ash Reach 3: Overall, fair to poor ratings for instream cover elements suggests that some additional LWD cover may be appropriate for the native fish species inhabiting this reach.
- Wolf Creek: Restoration opportunities are not clear but an assessment of channel stability and potential stabilization options for the avulsion is warranted.
- Lanterman Creek: Restoration opportunities in Reach 2 of Lanterman Creek are limited by equipment accessibility and a predominance of deep bedrock pools. Also, Reach 1 had an abundance of LWD in various states of functionality. Several large logjams were noted, although none appear to be preventing fish migration. No clear restoration opportunities exist at this time.

The following recommendations stem from our observations of the Ash River and tributary habitats and our interpretation of 2006 assessment results:

1. Based on the condition of the existing channel and habitat within Reaches 4 and 6 of the Ash River mainstem, no restoration works are recommended.
2. The 2006 assessment identified habitat limitations and opportunities for restoration in mainstem Reaches 1 and 3, and Wolf and Lanterman creeks. It is recommended that restoration opportunities be assessed and prescriptions developed for these reaches in 2007.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
LIST OF TABLES v
LIST OF FIGURES v
LIST OF MAPS v
LIST OF APPENDICES v
LIST OF PHOTOS vi
1 INTRODUCTION 1
2 STUDY AREA 3
2.1 Physical Setting 3
2.2 Fish Resources 4
3 METHODS 5
3.1 Overview Assessment Methodology 6
3.2 Detailed Habitat Assessment Methodology 7
3.2.1 Stream Habitat Condition 7
3.2.2 Photography 7
3.2.3 Data Analysis and Interpretation 7
3.2.3.1 Diagnostic Value for Percent Pools and Pool Frequency 8
3.2.3.2 Diagnostic Value for Deep Pools (Holding Pools) 8
3.2.3.3 Diagnostic Value for Spawning Gravel Quantity 8
3.2.3.4 Diagnostic Value for Spawning Gravel Quality 9
3.2.3.5 Diagnostic Value for Off-channel Habitat 9
3.3 Restoration Design Methodology 9
4 RESULTS 10
4.1 Overview Assessment 10
4.1.1 Watershed Characteristics 10
4.1.2 Hydrology 10
4.1.3 Reach Breaks 15
4.1.4 Reach and Sub-basin Priorities 17
4.2 Detailed Habitat Assessment 18
4.2.1 Fish Sampling and Observations 18
4.2.2 Fish Habitat Condition 18
4.2.3 Ash River Reach 1 20
4.2.3.1 Ash River Reach 1 A 20
4.2.3.2 Ash River Reach 1 B 20
4.2.3.3 Ash River Reach 1 C 20
4.2.4 Ash River Reach 3 21
4.2.5 Ash River Reach 4 A 21
4.2.6 Ash River (Reach 6 A, 6 C) 22
4.2.6.1 Ash River Reach 6 A 22
4.2.6.2 Ash River Reach 6 C 22
4.2.7 Lanterman Creek Reaches 1 and 2 23
4.2.8 Wolf Creek Reaches 1, 1 AV, 2 23
4.2.4 Habitat Limitations 24
4.3 Fish Habitat Restoration 27

5 DISCUSSION 28
6 RECOMMENDATIONS 29
7 ACKNOWLEDGMENTS 29
8 REFERENCES 31

MAPS
APPENDICES
PHOTO PLATES

LIST OF TABLES

Table 1. Known fish species of the Ash River watershed. 4
Table 2. Drainage areas for Ash River and two major tributaries. 10
Table 3. Reach breaks modified from Burt and Horchik (1999) and Griffith (1993) for reporting and prescription purposes. Habitat was assessed in all the reaches identified below. Only reaches highlighted in green were assessed for restoration prescriptions in 2006. 15
Table 4. Summary of annual peak and mean monthly discharges for the Ash River and other East Vancouver Island streams. 16
Table 5. Preliminary reach priorities identified for detailed habitat assessment in Ash River watershed. 17
Table 6. Diagnostic summary of salmonid habitat condition within the Ash River watershed. Restoration opportunities identified in reaches highlighted in green were assessed in detail in 2006. 19
Table 7. Comparison of required and available quantities of spawning gravel in selected reaches of the Ash River watershed. 26

LIST OF FIGURES

Figure 1. Index map of Ash River watershed. 2
Figure 2. Ash River summer run steelhead counts in the standard index section from Lanterman Falls Trestle to Stamp River confluence (5.8 km), 1983 to 2006 (MoE and BCCF unpubl. data). 5
Figure 3. Map of the lower Ash River showing reaches, obstructions and distribution of salmonids. Modified from Burt and Horchik (1999). Abbreviations: F=Falls (height in meters), LWD=large woody debris jam (height in meters), CH=Chinook, CM=Chum, CO=Coho, SK=Sockeye, ST=Steelhead, CT=Cutthroat, ACT = Anadromous Cutthroat, Trout, RB=Rainbow Trout. Species in brackets=minor use by this species. 12
Figure 4. Long profiles and reach boundaries for Ash River (excluding upper Ash River above Elsie Lake) and several tributaries. Modified after Burt and Horchik (1999). 13
Figure 5. Long profiles for Ash River tributaries; West and East Wolf, and Lanterman creeks. Modified after Burt and Horchik (1999). 14
Figure 6. Average annual hydrograph for the Ash River at WSC station 08HB023 below Moran Creek for the period 1961-2005. 15

LIST OF MAPS

Map 1. Orthophoto mosaic of the lower Ash River downstream of Elsie Lake.
Map 2. Air photos for selected sections of the Ash River, 12 May 2007.

LIST OF APPENDICES

Appendix A. Flood frequency plots for Ash River WSC station below Moran Creek. 34
Appendix B. Fish habitat assessment data for Ash River and two of its major tributaries. 35

LIST OF PHOTOS

Photo 1. Looking downstream at boulder-riffle habitat at 1+033 m in Reach Ash 1 A, Sept 15, 2006....... 48
Photo 2. Flood channel habitat at 1+388 m in Reach Ash 1 A, Sept 15, 2006....... 48
Photo 3. Looking downstream at 1+684 m in Reach Ash 1 A, Sept 15, 2006. 49
Photo 4. Looking upstream at Moran Creek confluence pool at 0+000 m in Reach Ash 1 B, 14 September 2006. 49
Photo 5. Looking upstream at Moran Creek from the Ash confluence pool at 0+000 m in Reach Ash 1 B, 14 September 2006. 50
Photo 6. Looking downstream at 1+014 m in Reach Ash 1 B, 14 September 2006....... 50
Photo 7. Left bank spawning habitat at 1+046 m in Reach Ash 1 B, 14 September 2006....... 51
Photo 8. Typical riffle habitat at 1+370 m in Reach Ash 1 B, 14 September 2006....... 51
Photo 9. Lanterman Creek (left) entering the mainstem Ash at 0+650 m in Reach Ash 1 C, 13 September 2006. 52
Photo 10. Typical canyon pool habitat at 1+525 m in Reach Ash 1 C, 13 September 2006....... 52
Photo 11. Lanterman Falls at 1+855 m in Reach Ash 1 C, 13 September 2006. 53
Photo 12. Looking upstream at Dickson Falls at 0+000 m in Reach Ash 3, 15 August 2006....... 54
Photo 13. Looking downstream from 1+138 m in Reach Ash 3, 19 September 2006. 54
Photo 14. Looking upstream at dry tributary creek (right bank) draining wetland area at 0+745 m in Reach Ash 4, 12 September 2006....... 55
Photo 15. Looking upstream at side channel confluence at 1+250 m in Reach Ash 4, 12 September 2006. 55
Photo 16. Looking downstream at start of side channel (left) at 1+428 m in Reach Ash 4, 12 September 2006. 56
Photo 17. Looking downstream at boulder habitat at 1+525 m in Reach Ash 4, 12 September 2006....... 56
Photo 18. Looking upstream at Ash Mainline bridge at 1+655 m in Reach Ash 4, 12 September 2006....... 57
Photo 19. Looking downstream at right bank flood channel (bedrock) at 0+206 m in Reach Ash 6 C. Note high quality spawning habitat in tailout, 18 September 2006. 57
Photo 20. Substrate composition and typical pool/glide habitat at 0+053 m in Reach Ash 6 A, 18 September 2006. 58
Photo 21. Off-channel alcove habitat at 0+270 m in Reach Ash 6 A, 18 September 2006....... 58
Photo 22. Left bank at 0+292 m in Reach Ash 6 A showing compacted sand/gravel composition, 18 September 2006. 59
Photo 23. Looking downstream at 0+304 m in Reach Ash 6 A, 18 September 2006. 59
Photo 24. Looking upstream at 0+304 m in Reach Ash 6 A, 18 September, 2006. Bedrock dominates the channel upstream of this point....... 60
Photo 25. Looking upstream at 0+427 m in Reach Ash 6 A, 18 September 2006. 60
Photo 26. Looking south west off the dam at Elsie Lake, 18 September 2006. The intake to the HCV is on the left side of the frame. 61
Photo 27. Looking from left bank at the Ash Lake-Dickson Lake connector creek, 18 September 2006. Total length estimated to be 20 m....... 61
Photo 28. Looking downstream at 0+121 m in Wolf Creek, 25 September 2006....... 62

Photo 29. Looking downstream at undercut banks at 0+580 m in Wolf Creek, 25 September 2006.......... 62
Photo 30. Looking upstream at the avulsion channel confluence at 0+813 m in Wolf Creek, 25 September 2006. 63
Photo 31. Looking upstream at the avulsion channel from 0+870 m in Wolf Creek, 25 September 2006. 63
Photo 32. Looking downstream from 0+900 m at a relic channel in Wolf Creek, 25 September 2006.......... 64
Photo 33. Looking upstream at the avulsion channel at 0+990 m in Wolf Creek, 25 September 2006.......... 64
Photo 34. Downstream view of the log jam at 1+086 m that created the avulsion channel (right) in Wolf Creek, 25 September 2006.......... 65
Photo 35. Looking at right bank scour at 1+592 m in Wolf Creek, 26 September 2006.......... 66
Photo 36. Looking upstream at LWD in the right channel of a braid at 1+795 m, just above the Comox ML logging road bridge over Wolf Creek, 26 September 2006. 66
Photo 37. Looking upstream at LWD spanning the full channel at 2+080 m in Wolf Creek, 26 September 2006. 67
Photo 38. Looking upstream at a left bank tributary at 2+323 m in Wolf Creek, 26 September 2006.......... 67
Photo 39. Looking upstream at the confluence of the east and west forks at 2+460 m of Wolf Creek, 26 September 2006.......... 68
Photo 40. Looking downstream at typical LWD habitat at 0+618 m in Lanterman Creek, 21 September 2006. 68
Photo 41. Looking downstream at typical riffle/glide habitat at 0+845 m in Lanterman Creek, 21 September 2006. 69
Photo 42. Old growth stump providing wood cover in a pool at 0+928 m in Lanterman Creek, 21 September 2006. 69
Photo 43. Looking upstream at undercut banks at 1+138 m in Lanterman Creek, 21 September 2006.......... 70
Photo 44. Looking upstream at the confluence of a right bank tributary at 1+544 m in Lanterman Creek, 21 September 2006.......... 70
Photo 45. Looking downstream at LWD habitat at 1+641 m in Lanterman Creek, 21 September 2006.......... 71
Photo 46. Looking downstream at full spanning LWD jam at 2+178 m in Lanterman Creek, 25 September 2006. 71
Photo 47. Looking upstream at start of bedrock section at 2+378 m in Lanterman Creek, 25 September 2006. 72
Photo 48. Looking downstream at a deep bedrock holding pool at 2+847 m in Lanterman Creek, 25 September 2006. 72
Photo 49. Looking upstream at the anadromous barrier at 3+048 m in Lanterman Creek, 25 September 2006. 73

1 INTRODUCTION

The objectives of this project were to implement a salmon habitat assessment and to identify and develop high priority and cost-effective restoration treatments and designs for Ash River and Wolf and Lanterman creeks. The rationale for undertaking this work was to mitigate for footprint impacts associated with dam/reservoir construction listed in BC Hydro's Strategic Plan (Conlin et al. 2000). By identifying current habitat limiting factors in the Ash River downstream of Elsie Dam and implementing restoration works to address those factors, some of the aquatic habitat impacts associated with construction of Elsie Dam would be mitigated.

The planning and prioritizing of assessments and treatment strategies in this project were based on assessment and restoration protocols developed under British Columbia's Watershed Restoration Program (Anonymous 2004a). Achievement of the project's objectives entailed first determining the condition and functional status of salmon habitat and watershed processes in each specific watershed, then identifying and prioritizing specific locations and methods for restoring salmon habitat.

The project in 2006 involved three key tasks: 1) assemble sufficient habitat data within the Ash River watershed to identify factors that may be limiting fish production or health; 2) develop restoration strategies to mitigate these limiting factors; and 3) prescribe appropriate restoration projects including cost estimates in that portion of the study area that extends from Elsie Lake to Dickson Lake, including sub-basins. The identification of restoration opportunities targeted spawning, rearing and migration habitats of salmonids. This project did not examine the portion of the watershed upstream of Elsie Lake dam, as assessment and prescriptive work had been completed previously by Burt and Robert (2003).

In 2006, detailed habitat assessments were undertaken on 12 reaches of the Ash River mainstem, and Wolf and Lanterman creeks. The assessment and development of restoration prescriptions was restricted in 2006 to three reaches of the Ash River mainstem between Elsie and Dickson lakes. Detailed surveys of potential restoration sites in the mainstem and sub-basins between Dickson Lake (including the lake's influent tributaries) and the Stamp River are proposed to be prepared in 2007. A second report detailing potential restoration projects in the lower watershed will be completed in 2008.

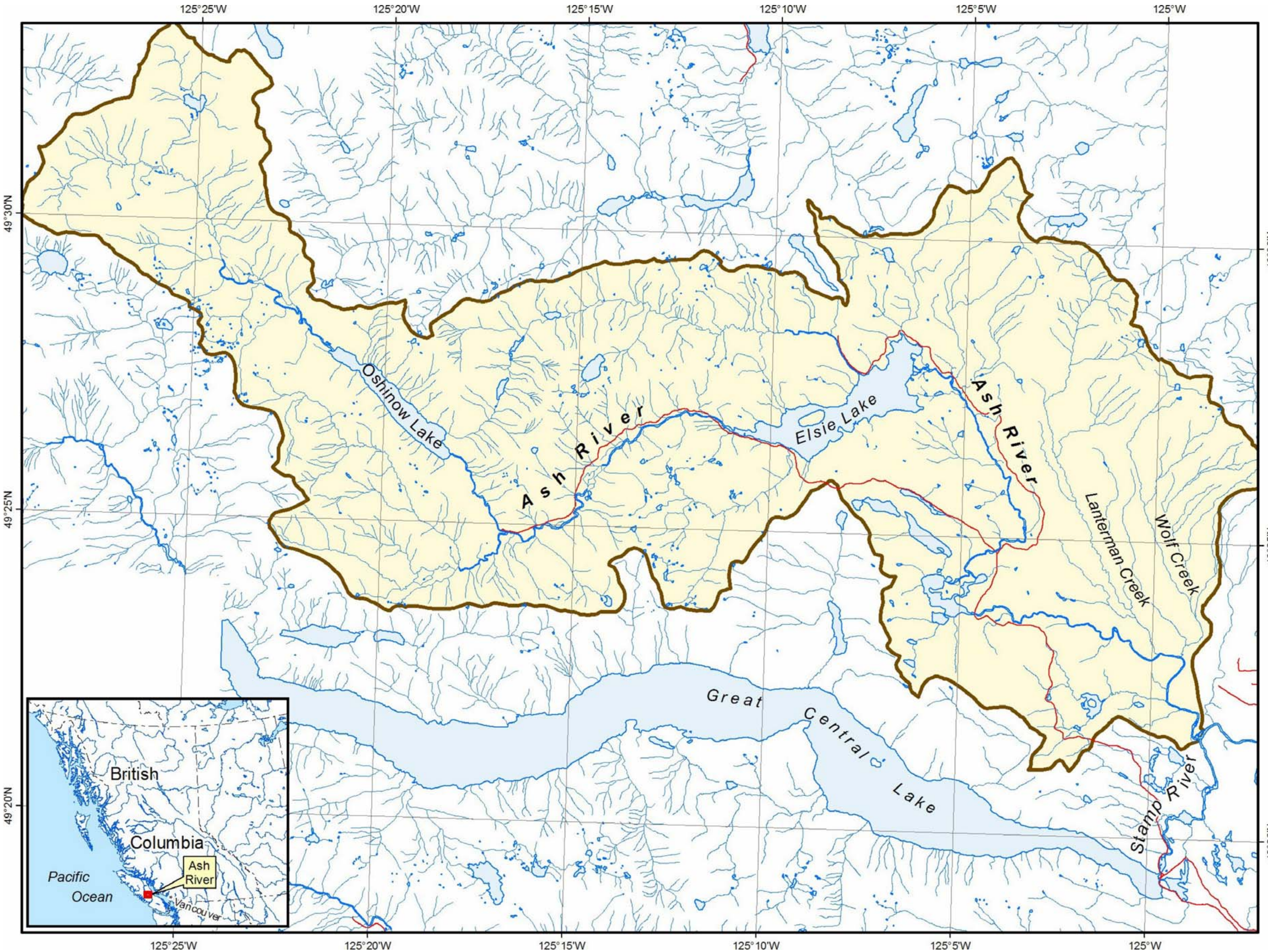

Figure 1. Index map of Ash River watershed.

2 STUDY AREA

2.1 Physical Setting

The Ash River is one of two main tributaries to the Stamp River. The Ash River watershed originates on the west side of the Beaufort Mountain Range, flows southeast for approximately 25 km, and meets the Stamp River 18 km upstream of tidewater. The Stamp meets the Sproat River 14 km downstream of the Ash River confluence. At this point it becomes the Somass River which flows for 3.7 km before it terminates in the Alberni Canal at the town of Port Alberni.

The Elsie Lake hydro-electric impoundment consists of one main rock and earth filled dam 185 m long and 30 m high as well as four separate saddle dams ranging in length from 50 m to 450 m and 3 m to 18 m in height. The purpose of the impoundment structure is to divert water down to a powerhouse located 6.5 km away on the north side of Great Central Lake. The facility, constructed in 1958, has an operating capacity of 25.2 MW. The water licence allows for a maximum of 76.5 million m^3 of storage and 339 million m^3 to be diverted into Great Central Lake per annum (Hirst 1991).

Stream flow releases from Elsie Dam are now regulated according to the Ash River Project Water Use Plan (Anonymous 2004b). To accommodate fish rearing and other aquatic requirements, a minimum of 3.5 m^3/s is released from 1 May to 31 October. From 1 November to 30 April, a minimum of 5 m^3/s is released for spawning and incubation requirements. Pulse flows are currently under development as part of a new water use plan. The events occur in August and September to facilitate the upstream migration of adult steelhead and salmon past selective barriers. The duration of the 10 m^3/s and 20 m^3/s flows was set in the Ash River Water Use Plan, Monitoring Program Terms of Reference at 42 hours and 11 hours, respectively, with controlled ramping to reduce effects on the aquatic environment (Anonymous 2005).

In addition to the BC Hydro controlled reservoir at Elsie Lake, the basin contains several large lakes and bedrock controlled areas that help to buffer stream flows and maintain relatively stable fish habitat conditions. Dickson Lake, located on the Ash River mainstem 12.5 km upstream of the Stamp River confluence and downstream of Elsie Lake, is situated in the middle of six reaches defined by Griffith (1993). Several tributaries enter the mainstem along these six reaches, with Lanterman, Wolf, and Moran creeks being the most significant. The remaining sub-basins are not gazetted (though some have small lakes that are named) and little pertinent fish habitat or production data exists.

The Ash River mainstem is easily accessed by vehicle and most tributaries cross under the main road. The river flows adjacent to the well-used Ash Main and Comox Main logging roads for most of its length, although several washouts along secondary roads between Elsie and Dickson lakes prevent access to part of that reach. Several logging operations are situated along its length, including recent activity near Moran and Wolf creeks as well as the upper reaches of the Lanterman sub-basin.

2.2 Fish Resources

The Ash River supports a variety of anadromous salmonids including coho, Chinook, summer and winter run steelhead trout, as well as sea run cutthroat trout (Table 1). A few sockeye and chum salmon have been noted on occasion in the lower river (MoE unpubl. data, Nanaimo). Resident stocks include Dolly Varden char as well as rainbow and cutthroat trout (Griffith 1993). Distribution is strongly influenced by Lanterman and Dickson falls, selective barriers situated in the mainstem below Dickson Lake. Summer run steelhead ascend both barriers and are generally the only anadromous species found in the upper river as far as Elsie Lake dam. Chinook salmon distribution is limited to the lower river with Lanterman Falls as the upstream barrier. Burt and Horchick (1999) describe Lanterman Falls as the upstream limit for coho distribution. Coho are noted at the base of Dickson Falls regularly but only anecdotal reports of adults above the falls exist. Two coho fry were captured in the mainstem approximately 1.5 km downstream of Elsie Lake in 2005 during fish sampling as part of a BCRP stream enrichment project (M. McCulloch, Fisheries Technician, MoE, Nanaimo, pers. comm.). This may be the first documented evidence of coho being present above Dickson Falls.

Table 1. Known fish species of the Ash River watershed.

Common Name	Scientific Name
Chinook Salmon	*Oncorhynchus tshawytscha*
Chum Salmon	*Oncorhynchus keta*
Coho Salmon	*Oncorhynchus kisutch*
Sockeye Salmon	*Oncorhynchus nerka*
Dolly Varden	*Salvelinus malma*
Steelhead (summer and winter run)	*Oncorhynchus mykiss*
Cutthroat Trout	*Oncorhynchus clarki*
Rainbow Trout	*Oncorhynchus mykiss*
Threespine Stickleback	*Gasterosteus aculeatus*

Monitoring by BC Conservation Foundation (BCCF) staff has identified a significant presence of summer run steelhead in the reach between Elsie and Dickson lakes. On 1 February 2001, 54 adult steelhead were observed in a 1.2 km reach downstream of Elsie Lake. On 24 January 2002, 18 were observed in the same reach. Numerous fresh redds were noted as well (MoE unpubl. data, Nanaimo). During 2006 WUP-related migration surveys, significant numbers of adult summer run steelhead were observed in mainstem reaches between Elsie and Dickson lakes. Sixty-four (64) summer run steelhead as well as 195 Chinook and 167 coho salmon were documented on an October snorkel survey from Lanterman Falls to the Stamp confluence (C. Roberts, CBR & Associates, Nanaimo, pers. comm.). Figure 2 illustrates the summer run steelhead snorkel count data from 1983 to 2006 for the lower 5.8 km of the Ash River.

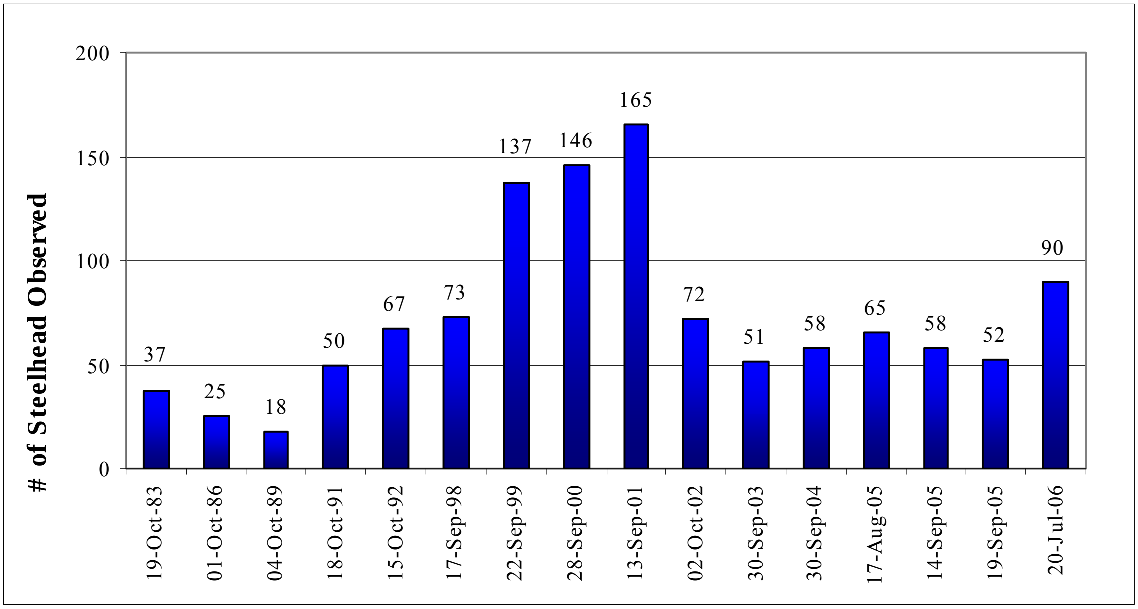

Figure 2. Ash River summer run steelhead counts in the standard index section from Lanterman Falls Trestle to Stamp River confluence (5.8 km), 1983 to 2006 (MoE and BCCF unpubl. data).

3 METHODS

To achieve this project's objectives, scheduled activities included:

April - mid-May 2006: In collaboration with Hupacasath FN technicians and consultants familiar with the watershed (Project Group), we reviewed existing literature concerning fish presence and abundance and fish habitat in the Ash River watershed downstream of Elsie Reservoir. Hupacasath FN technicians and consultants also assisted in the prioritization of reaches for detailed habitat assessments. Priorities were based on channel gradient (i.e., preferred gradients for rearing and spawning for salmon and steelhead), and restoration potential (i.e., current and potential salmon and trout utilization and habitat carrying capacity; likelihood of restoration success that considers probable habitat limiting factors and potential impacts to restoration works from upslope, riparian, etc., land use developments/changes; and ease of access for heavy equipment used in restoration construction). A focus was placed on identifying habitat limiting factors relative to species present. Data requiring confirmation or updating was identified as well as data gaps.

August - October: Habitat assessments were undertaken to update freshwater habitat data and fill gaps required to identify/confirm limiting factors for species present. Level 1 habitat assessments followed the Fish Habitat Assessment Procedure (FHAP) methodology by Johnston and Slaney (1996). Technicians sampled mainstem and tributary habitats to acquire biophysical data and document features such as Large Woody Debris (LWD) frequency/quality, pool (holding & rearing) area and frequency, spawning gravel abundance/quality, flow and access issues, and off-channel habitat.

September - December: The FHAP data were analyzed to identify those habitat limiting factors to fish production/health using standard diagnostics or regional standards applicable to this watershed. Restoration opportunities that addressed habitat limiting factors identified in the analysis were prioritized.

October: The assessment of restoration potential and development of prescriptions was restricted in 2006 to that portion of the study area that extends from Elsie Lake to Dickson Lake, including sub-basins[1].

November to June 2007: A project report was prepared of the 2006 assessment that included fish habitat data, factors limiting production, an assessment of potential restoration projects in the upper study area.

3.1 Overview Assessment Methodology

An overview watershed assessment was undertaken to identify priority sub-basins and reaches in relation to their importance to target fish species, probable critical limiting factors and potential for restoration success. The overview assessment involved the following three steps:

1. Identifying the basins of the Ash River.
Boundaries of the Ash River watershed and its major sub-basins were delineated and their drainage areas calculated using ArcView GIS. Long profiles for the mainstem and major sub-basins were drawn based on a 1:20,000 scale topographic map.

2. Estimating stream discharges for the Ash River and its tributaries.
Mean annual, mean monthly and 2, 10, 25 and 50 year return period maximum discharges were estimated for the mainstem and sub-basins based on archived data from the Ash River hydrometric station 08HB023. Estimated flood frequency values for the Ash River tributaries were based on average unit values for the regional stations at Ash River (08HB023 and 08HB016), Nile Creek (08HB022), Rosewall Creek (08HB037), Tsable River (08HB024) and Cruickshank River (08HB074). The estimates of maximum daily peak discharges for the various flood frequencies were determined using HydroTech analysis system, developed by Science Technology Associates (Anonymous 1997). Estimates of instantaneous peak discharges were interpolated from flood frequency plots.

3. Prioritizing sub-basins for detailed habitat assessments.
This step involved determining the importance of the sub-basin to the target species and the potential for success in restoring watershed processes and/or fish habitat in each sub-basin. The potential for success was guided by the following principles:

- The main goal was to restore channel function so that the watershed will naturally recover critical habitat at an accelerated rate. Restoration work that follows has the

[1] Based on Level 1 findings and strategies developed in Year 1, complete detailed surveys (Level 2) of potential restoration sites in the mainstem and sub-basins between Dickson Lake (including the lake's influent tributaries) and the Stamp River are proposed to be prepared in Year 2. The Year 2 report would provide detailed restoration designs for potential projects in the lower watershed.

greatest potential for success if it addresses the root causes most strongly affecting channel processes in an impacted reach.
- The most cost-effective works are those that address the critical limiting factors for the targeted fish species.

3.2 Detailed Habitat Assessment Methodology

Fish and fish habitat field assessments were conducted during August-October 2006. These surveys were conducted on foot and involved a crew of two people. Detailed fish-habitat surveys involved complete sampling of all habitat types within each reach. Information was collected, recorded and analyzed for the following biophysical parameters:

3.2.1 Stream Habitat Condition

Detailed fish habitat assessments in the Ash River watershed followed the methodologies and procedures described in British Columbia's Watershed Restoration Technical Circular No. 8 (Johnston and Slaney 1996). The characteristics and condition of the existing fish habitat were described by the following attributes:

- classification of habitat types – riffle, pool, glide and other,
- potential fish migration barriers,
- percent pools, residual pool depth, quality and quantity of adult holding pools,
- type and effectiveness of cover for juvenile summer rearing and adult escape cover during spawning,
- extent of and access to off-channel habitat, and
- quality and quantity of anadromous spawning habitat.

3.2.2 Photography

Digital photographs of selected habitat units and significant features were taken with a Pentax® Optio W10 digital camera. Each picture was labelled with:

- chainage of the habitat unit or feature,
- direction of view,
- date, and
- description of the habitat unit or feature.

3.2.3 Data Analysis and Interpretation

Detailed habitat assessment data for the Ash River watershed were analyzed to determine salmonid habitat condition and to identify potential physical habitat limitations to salmonid production. Habitat characteristics were compared to observed natural stream morphologies (Newbury and Gaboury 1993) and biostandards for undisturbed salmonid streams (Johnston and Slaney 1996) to detect habitats that are degraded or at risk, and which may be improved through restoration. A summary of diagnostic values for salmonid habitat condition in the Ash River watershed was prepared based on bio-standards for the following parameters:

3.2.3.1 Diagnostic Value for Percent Pools and Pool Frequency

Ratings for percent pool habitat and pool frequency (spacing) were conducted for each reach. A poor rating was given if percent pool was less than 30%, a fair rating was given if less than or equal to 40%, and good rating was given if greater than 40%. Similarly, for pool frequency, a poor rating was given if the number of bankfull widths per pool was greater than 6, a fair rating was given if less than or equal to 10, and good rating was given if less than 10.

3.2.3.2 Diagnostic Value for Deep Pools (Holding Pools)

Johnston and Slaney (1996) use the simple criteria of pool depth greater than 1 m to define a “good” holding pool for adult fish. However, this ignores the importance of cover within the pool for creating good fish holding habitat. To account for the inter-relationship between pool depth and cover, the number of deep pools (adult holding pool) was identified using the following criterion:

holding pool, if (deep pool cover > 0 and maximum depth x % total instream cover >= 30)

where, instream cover includes LWD, boulder, cutbank, deep pool and instream vegetation. Maximum depth was measured during summer low flows. This diagnostic was developed to better reflect the interaction of cover and pool depth in providing suitable habitat to adult salmonids. It is based on observations by the authors, within Vancouver Island streams, of numerous pools that had greater than 1.0 m depth, but no cover and no utilization by adult salmonids (or juvenile fish for that matter). Conversely, there are also numerous examples of pools with less than 1.0 m depth, abundant cover (e.g., cutbanks) and adults present.

The diagnostic value used to assess adequacy of adult holding pools within a reach was then the total number of deep pools per 1000 m of stream within each reach. A rating of poor was given if the number of deep pools as defined above was less than 1 per 1000 m of stream, a rating of fair was given if greater than or equal to 1, but less than or equal to 2, and a rating of good was given if greater than 2.

3.2.3.3 Diagnostic Value for Spawning Gravel Quantity

Spawning gravel quantity was calculated as 100% of the stream wetted area with available gravels (2-64 mm), plus 20% of the stream wetted area with available cobbles (64-256 mm) times the wetted area of the reach. Gravel quantity was rated as poor if the spawning area was less than 10% of the wetted total area, fair if greater than or equal to 10%, but less than or equal to 25%, and good if greater than 25%.

A more in-depth analysis of spawning gravel quantity was accomplished using data from Burt and Horchick (1999). Minimum spawner densities to fully seed the habitat were used to calculate the amount of gravel required for each species in the study reaches. This was then compared to both the spawning area visually estimated during Level 1 field surveys and the amount of area calculated using the formula above.

3.2.3.4 Diagnostic Value for Spawning Gravel Quality

Spawning gravel quality was coded as high, medium or low based on the degree of compaction and embeddedness (percent fines). Loose and clean substrates (fines ≤15%) providing excellent spawning opportunity received a rating of high (H), while compact and embedded substrates (fines > 25%) received a ranking of low (L). A medium ranking (M) refers to moderately embedded and uncompacted gravel (15% < fines < 25%).

3.2.3.5 Diagnostic Value for Off-channel Habitat

Off-channel habitat was rated as good if there was more than one off-channel area (of any type), fair if there was only one off-channel area, and poor if no off-channel areas were present. Note that this diagnostic as currently defined in Watershed Restoration Program Technical Circular No. 8 (Johnston and Slaney 1996) does not account for the amount of off-channel habitat (i.e., length or area). However, for an off-channel area to be included, it had to be considered, in the opinion of the field biologist, as important habitat. Minimum length or area was not considered.

3.3 Restoration Design Methodology

Habitat restoration methods and procedures are described in several sources in the literature. The most frequently used references in this study are those of Newbury and Gaboury (1993) and British Columbia's Watershed Restoration Program (Johnston and Slaney 1996; Slaney and Zaldokas 1997).

The restoration design methodology involved the following steps:

1. *Conducting field surveys at restoration sites in high priority restoration reaches.*

From the detailed habitat assessment information, priority sites or reaches were identified where habitat restoration designs could be prepared. A matrix was used to prioritize reaches that have the greatest potential to affect successful restoration of watershed processes and the critical limiting habitat of the target fish species. Designs were prepared for specific sites within high priority reaches where there is a high likelihood of restoration success. Potential treatment effectiveness was based on a general assessment of cost-effectiveness, risk, primary or persistent sediment sources, and whether benefits were expected in a long or short time period.

Field surveys for the assessment and design of restoration treatments were conducted in October 2006. Where potential restoration sites were identified, reference reach surveys were conducted on channel sections which appeared relatively undisturbed to provide field-measured data on channel morphology and habitat that was used as a baseline for designing channel restoration measures. Field information collected at potential sites included:

- Locating each proposed restoration site by thalweg chainage,
- Measuring bankfull width, bankfull height, and restoration site length,
- Estimating right and left bank heights above present water level,
- Estimating the type and size distribution of bed paving substrates,

- Topographic (engineer's level) surveys of the stream channel and floodplain near the restoration sites to provide plan, profile and cross section elevation drawings for the section of channel to be restored, and
- Photographs of each project site, labeled with D/M/Y, thalweg chainage or Geographic Position System (GPS) location in Lat/Long or UTM coordinates, and point of view.

2. *Prepare site-specific restoration designs.*

For all proposed restoration treatments, restoration design drawings included:

1. Plan and profile views of the restoration reach,
2. Representative cross section plots of typical project site locations with restoration project details overlain on the cross sectional plot (Note: left and right banks as viewed looking downstream),
3. Methods for design, including design criteria, assumptions and calculations, and
4. Methods, specifications and scheduling for construction.

4 RESULTS

4.1 Overview Assessment

4.1.1 Watershed Characteristics

The Ash River is a 4th order watershed (at 1:20,000 scale) with a mainstem length of approximately 54.4 km. The drainage areas of the Ash River and two of its major tributaries range from 26 to 380 km^2 (Table 2). Figure 3 and Map 1 show the extent of the study area within the lower Ash River watershed. Recent aerial photos of the study reaches taken 12 May 2007 are shown in Map 2.

Table 2. Drainage areas for Ash River and two major tributaries.

Watercourse	Drainage Area (km^2)
Ash River	380
Wolf Creek	26
Lanterman Creek	32

Longitudinal profiles in Ash River, and Wolf and Lanterman creeks are irregular, with numerous resets in the channel profile primarily caused by bedrock falls (Figure 4 and Figure 5).

4.1.2 Hydrology

Discharges in the Ash River have been monitored since 1959 on a continual basis at Water Survey of Canada (WSC) gauging station 08HB023 located below Moran Creek. Mean monthly flows in this coastal watershed begin to rise in late April in response to snow melt, peak in mid

May, and steadily decline to baseflow conditions in July. Fall rains beginning typically in September or October begin to recharge the reservoir and increase flows through the winter (Figure 6).

Changes to the mean annual discharge for lower Ash River have occurred as a result of the diversion of a portion of the flows at Elsie Lake. At WSC station 08HB023, mean annual discharge (MAD) has been measured at 16.7 m^3/s for the period 1959-2005 (WSC 2006) (Table 4). Naturalized MAD for the period 1961-1995 was estimated at 27.4 m^3/s (Burt and Horchik 1999). This naturalized value included the amount diverted from the Ash River to Great Central Lake. The estimated daily diversion rate was calculated at 10.75 m^3/s and was based on the existing water license for the diversion of 339 million m^3 per year.

Based on HydroTech software analyses and interpolation of flood frequency plots from gauging station 08HB023 (Appendix A), two-year and 50-year maximum daily flows for the Ash River watershed were estimated at 188 and 548 cms, respectively. The unit flood discharge (daily max) with a return period of 50 yr was calculated at 1448 $l/s/km^2$ for the regulated Ash River but ranged between 2000-4000 $l/s/km^2$ for the unregulated and smaller Cruickshank, Tsable and Rosewall drainages.

Mean annual discharges for Wolf and Lanterman creeks were calculated at 1.7 and 2.1 m^3/s. Mean monthly discharges for August and September were estimated at 0.5 m^3/s in Wolf Creek and 0.6 m^3/s in Lanterman Creek.

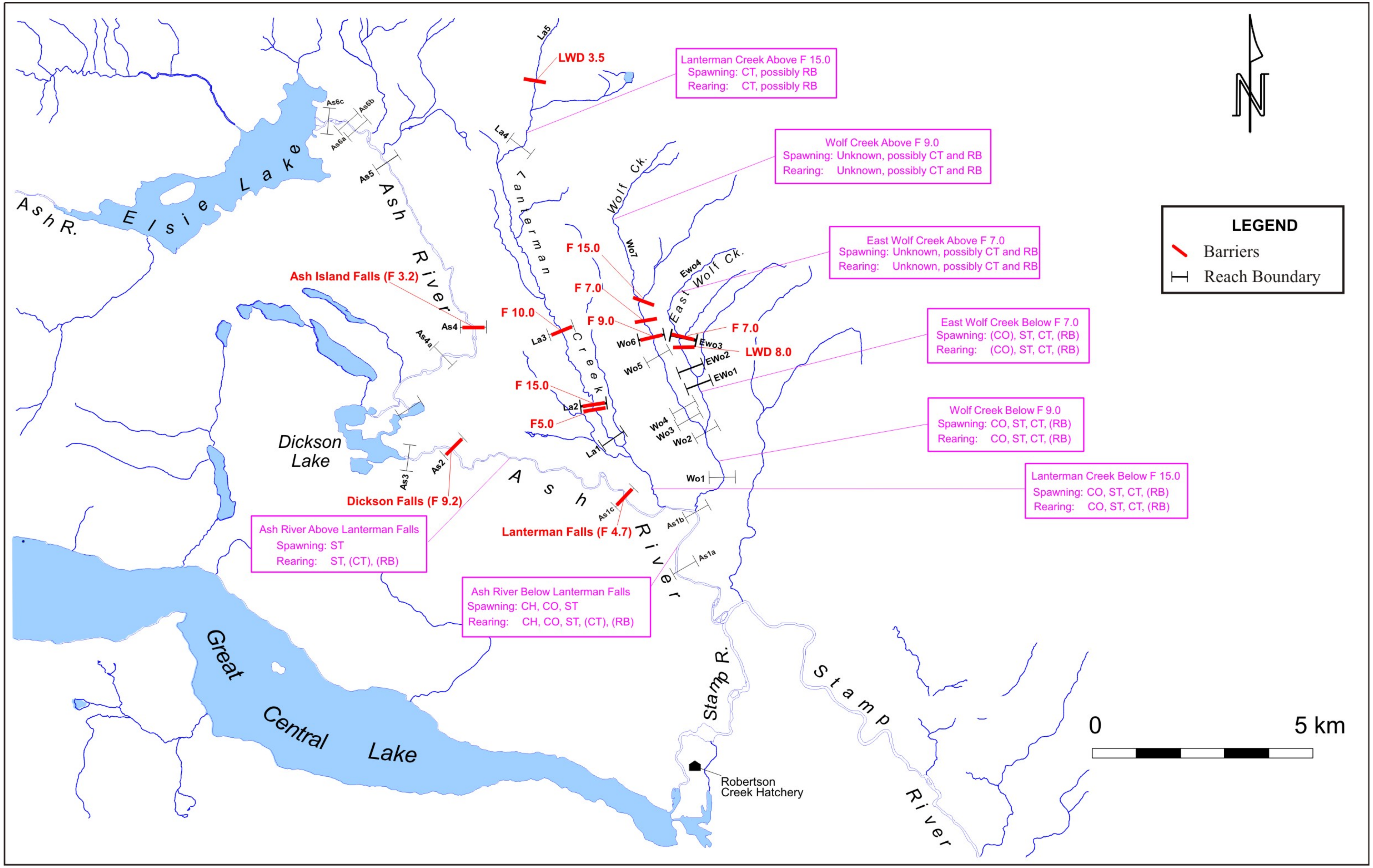

Figure 3. Map of the lower Ash River showing reaches, obstructions and distribution of salmonids. Modified from Burt and Horchik (1999). Abbreviations: F=Falls (height in meters), LWD=large woody debris jam (height in meters), CH=Chinook, CM=Chum, CO=Coho, SK=Sockeye, ST=Steelhead, CT=Cutthroat, ACT = Anadromous Cutthroat, Trout, RB=Rainbow Trout. Species in brackets=minor use by this species.

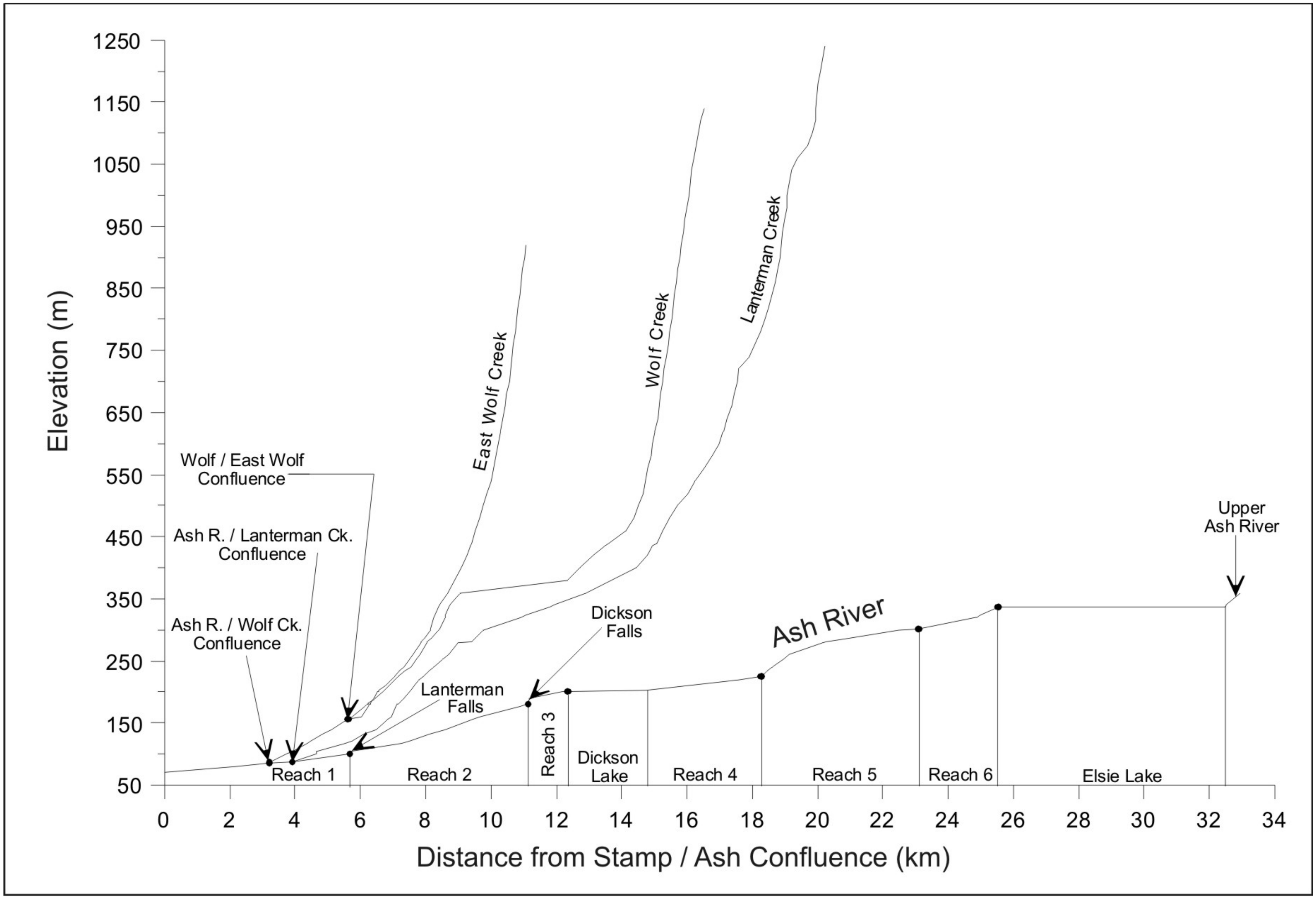

Figure 4. Long profiles and reach boundaries for Ash River (excluding upper Ash River above Elsie Lake) and several tributaries. Modified after Burt and Horchik (1999).

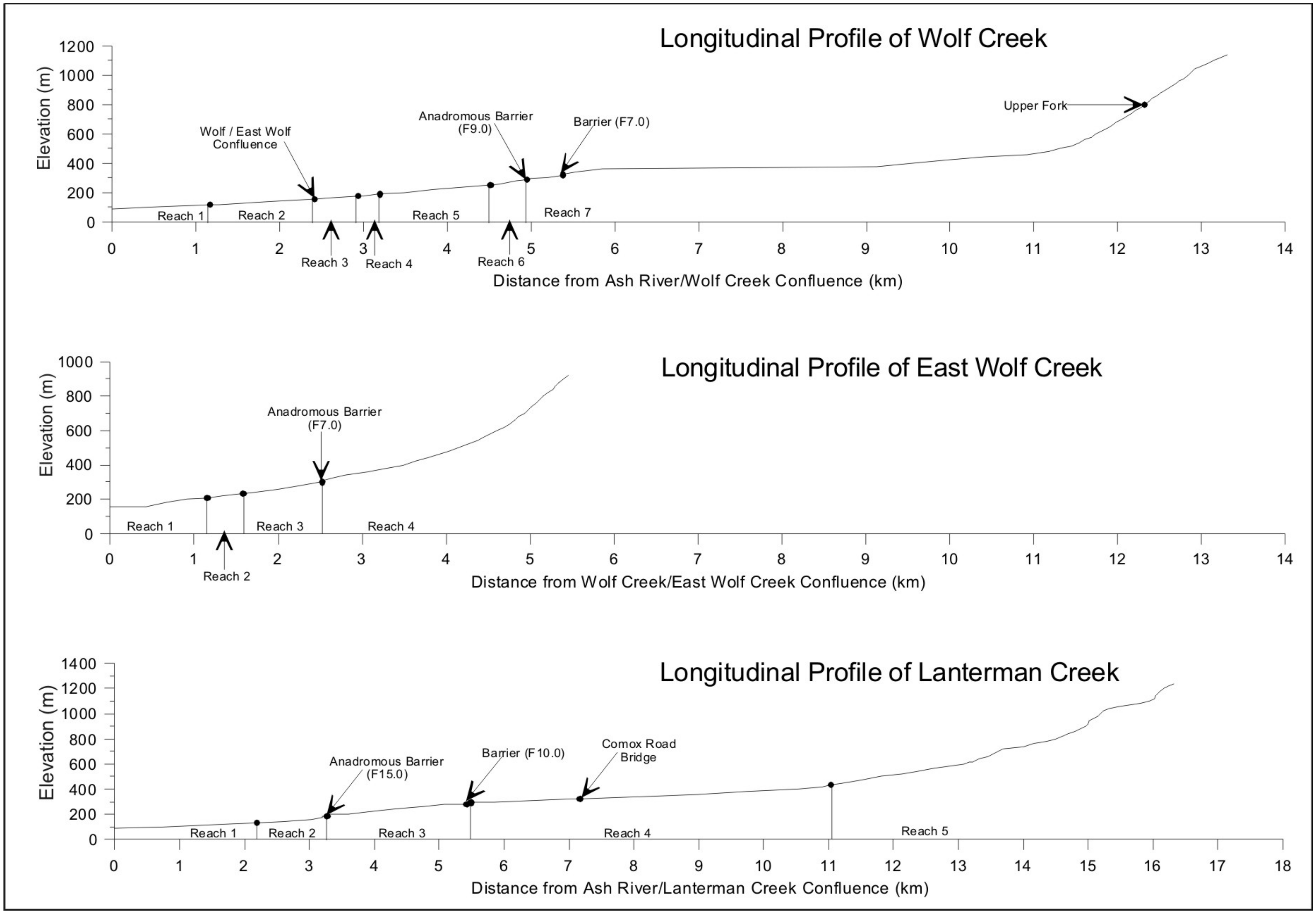

Figure 5. Long profiles for Ash River tributaries; West and East Wolf, and Lanterman creeks. Modified after Burt and Horchik (1999).

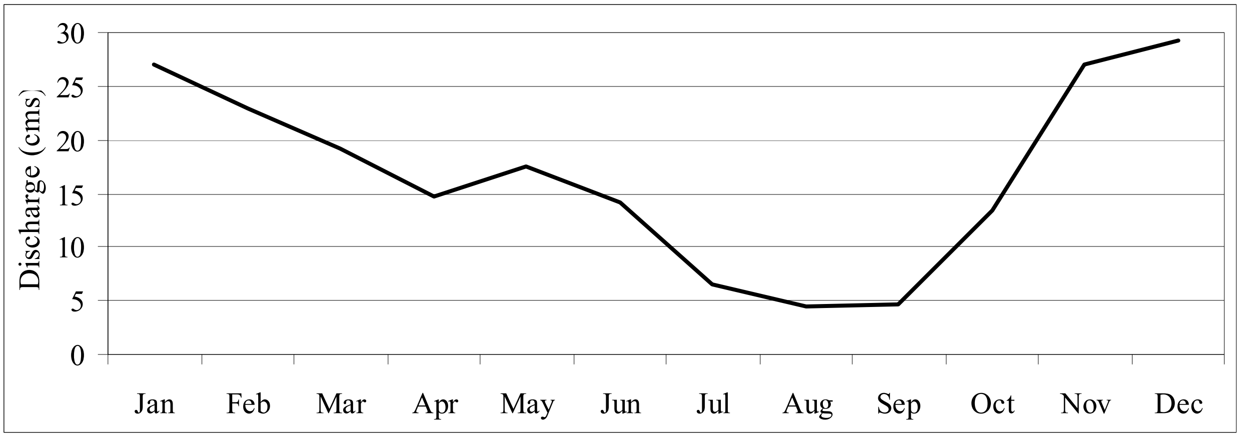

Figure 6. Average annual hydrograph for the Ash River at WSC station 08HB023 below Moran Creek for the period 1961-2005.

4.1.3 Reach Breaks

Reach breaks identified in Griffith (1993) were used as a starting point for prioritizing survey reaches. Based on field assessments, reaches were further separated by the confluence of tributaries and sudden changes to the predominant substrate. Reach 1 in Ash River was subdivided into Reaches 1 A, 1 B, and 1 C based on the location of Lanterman, Wolf, and Moran creek confluences (Figure 3, Table 3). Lower Lanterman Creek was separated into two reaches, the reach break denoted by a shift to bedrock dominated substrate. An avulsion channel in lower Wolf Creek was later identified as Reach Wolf 1 AV with the upstream end denoting the start of Reach 2.

Table 3. Reach breaks modified from Burt and Horchik (1999) and Griffith (1993) for reporting and prescription purposes. Habitat was assessed in all the reaches identified below. Only reaches highlighted in green were assessed for restoration prescriptions in 2006.

Reach	Length (m)	Start of Habitat Assessment	End of Habitat Assessment
Ash 1 A	2364	Stamp River	Moran Creek
Ash 1 B	1695	Moran Creek	Wolf Creek
Ash 1 C	2268	Wolf Creek	Lanterman Trestle
Ash 3	1274	Dickson Lake	Dickson Falls
Ash 4 A	1655	Dickson Lake	Ash ML Bridge
Ash 6 A	361	Second LB trib	Rapid section
Ash 6 C	459	Rapid section	181 m d/s Elsie Dam spillway confluence
Lant 1	2202	Ash River confluence	2+217 m start of bedrock
Lant 2	831	2+217 m start of bedrock	3+048 m anadromous barrier
Wolf 1	1091	Ash River confluence	1+091 m
Wolf 1 AV	281	0+810 m	1+008 m
Wolf 2	1369	1+091	2+460 m East and West fork confluence
Total	**15850**		

Table 4. Summary of annual peak and mean monthly discharges for the Ash River and other East Vancouver Island streams.

Gauge	**Station Name**	**Years**	**No. of Years**	**Area (km^2)**	**Peak Flow**	**Unit Discharge ($l/s/km^2$)**						**Average Monthly Discharge ($l/s/km^2$)**											
						Mean Annual	**2 yr**	**10 yr**	**25 yr**	**50 yr**	**Max**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
08HB023	Ash River below Moran Creek	1960-2004	45	378	Instantaneous		595	1243	1579	1653	1640												
08HB023*	Ash River below Moran Creek	1959-2005	47	378	Daily Max	44	497	1009	1264	1448	1407	72	61	51	39	47	38	17	12	12	35	71	77
08HB016*	Ash River near Great Central	1956-1966	11	293	Daily Max	57	631	1618	2379	3085	2126	86	80	46	55	72	48	22	13	17	41	70	131
08HB009	Stamp River near Great Central	1958-1999	41	456	Instantaneous		570	772	840	908	895												
08HB009	Stamp River near Great Central	1913-22, 1958-99	50	456	Daily Max	129	550	726	770	838	838	161	149	114	118	138	133	90	63	71	136	194	185
08HB010	Stamp River near Alberni	1965-1999	35	899	Daily Max	85	406	753	851	864	867	105	95	71	83	103	92	53	31	34	90	127	135
08HB022*	Nile Creek near Bowser	1959-2000	42	15	Daily Max	68	1038	2300	3183	3964	3353	127	113	93	67	47	27	13	13	20	60	107	127
08HB037*	Rosewall Creek at the Mouth	1968-1978	10	43	Daily Max	66	961	1658	1912	2067	1693	74	77	86	72	91	67	28	9	23	67	93	100
08HB024*	Tsable River near Fanny Bay	1960-2000	41	113	Daily Max	70	1169	2026	2401	2657	2381	103	92	73	66	82	65	28	13	16	70	114	118
08HB074*	Cruickshank River near the Mouth	1982-2000	19	214	Daily Max	85	755	1542	1987	2335	1785	93	90	82	80	123	128	77	46	26	76	114	83
	Mean of Instantaneous Discharges					79	583	1008	1210	1281	1267												
	Mean of Daily Flows For * Stations Above					65	842	1692	2188	2593	2124	92	85	72	63	77	62	31	18	19	58	95	106

Gauge	Station Name	Years	No. of Years	Area (km^2)	Peak Flow	**Discharge (m^3/s)**						**Average Monthly Discharge (m^3/s)**											
						Mean Annual	2 yr	10 yr	25 yr	50 yr	Max	January	February	March	April	May	June	July	August	September	October	November	December
08HB023	Ash River below Moran Creek	1960-2004	45	378	Instantaneous		225	470	597	625	620												
08HB023*	Ash River below Moran Creek	1959-2005	47	378	Daily Max	16.7	188	381	478	548	532	27.1	23.0	19.1	14.8	17.6	14.2	6.6	4.4	4.6	13.4	27.0	29.2
08HB016*	Ash River near Great Central	1956-1966	11	293	Daily Max	16.6	185	474	697	904	623	25.2	23.3	13.6	16.0	21.1	14.1	6.4	3.7	5.1	11.9	20.6	38.4
08HB009	Stamp River near Great Central	1958-1999	41	456	Instantaneous		260	352	383	414	408												
08HB009	Stamp River near Great Central	1913-22, 1958-99	50	456	Daily Max	59.0	251	331	351	382	382	73.2	68.1	51.8	54.0	62.9	60.6	41.0	28.9	32.3	62.0	88.5	84.2
08HB010	Stamp River near Alberni	1965-1999	35	899	Daily Max	76.2	365	677	765	777	779	94.1	85.1	63.8	74.3	92.2	82.6	47.5	27.5	30.9	80.9	114.0	121.0
08HB022*	Nile Creek near Bowser	1959-2000	42	15	Daily Max	1.0	16	35	48	59	50	1.9	1.7	1.4	1.0	0.7	0.4	0.2	0.2	0.3	0.9	1.6	1.9
08HB037*	Rosewall Creek at the Mouth	1968-1978	10	43	Daily Max	2.8	41	71	82	89	73	3.2	3.3	3.7	3.1	3.9	2.9	1.2	0.4	1.0	2.9	4.0	4.3
08HB024*	Tsable River near Fanny Bay	1960-2000	41	113	Daily Max	7.9	132	229	271	300	269	11.6	10.4	8.2	7.5	9.3	7.3	3.2	1.5	1.8	7.9	12.9	13.3
08HB074*	Cruickshank River near the Mouth	1982-2000	19	214	Daily Max	18.1	162	330	425	500	382	19.8	19.2	17.6	17.1	26.3	27.4	16.4	9.8	5.6	16.2	24.4	17.7
	Estimate for Wolf Creek (based on unit discharges for * gauges)			26		1.7	21.9	44.0	56.9	67.4	55.2	2.4	2.2	1.9	1.6	2.0	1.6	0.8	0.5	0.5	1.5	2.5	2.8
	Estimate for Lanterman Creek (based on unit discharges for * gauges)			32		2.1	26.9	54.1	70.0	83.0	68.0	3.0	2.7	2.3	2.0	2.5	2.0	1.0	0.6	0.6	1.9	3.0	3.4

Note: Ash, Stamp and Nile stations are 'Regulated'; Cruickshank, Tsable and Rosewall are 'Natural' flows

4.1.4 Reach and Sub-basin Priorities

A complete assessment of habitat in all high and moderate priority reaches was undertaken in 2006, with the exception of McLaughlin – Ash Lake Creek (Table 5). Priority reaches of the Ash River mainstem included those sections where salmon and steelhead spawn, rear and overwinter. Reaches Ash 1 A through 1 C (to Lanterman Falls) encompass the preferred habitats for steelhead, coho and Chinook salmon (Figure 3). Reach Ash 3 is utilized by steelhead and some coho, while Ash Reach 4 and Reach 6 (above Dickson Falls) is used exclusively by summer run steelhead (Burt and Horchik 1999; Griffith 1993). Occasionally chum and sockeye enter the Ash River system but are rarely observed on snorkel surveys (MoE and BCCF unpubl. data).

Table 5. Preliminary reach priorities identified for detailed habitat assessment in Ash River watershed.

Stream Name	Reach #	Area	Reach Length (km)	Gradient	Access	Survey Type	Restoration Potential	Overall Priority
Ash River	1	Stamp to Lanterman Falls	5.5	Low	Fair	Complete	High	High
	2	Lanterman Falls - Dickson Falls	5.0	Mod.	Poor	Sub-sample	Low	Low
	3	Dickson Falls - Dickson Lake	1.5	Low	Poor	Sub-sample	Low	Mod.
	4 A	Dickson Lake - Ash River ML Bridge	~ 1.8	Low	Fair-Good	Complete	Moderate	Mod.
	4 B	Ash River ML Bridge - Ash Island Falls	~1.2	Mod.	Poor-Fair	Sub-sample	Low	Low
	5	Ash Island Falls - 2nd LB tributary below Elsie Lake	5	High	Poor	Sub-sample	Low	Low
	6 A	2nd LB tributary below Elsie Lake - downstream end of rapid section	~1	Low	Good	Complete	High	High
	6 B	Rapid section	~ 0.5	High	---	Sub-sample	Low	Low
	6 C	Rapid section - 181 m d/s of Elsie Dam spillway	~ 0.5	Low	Good	Complete	High	High
Moran Creek	1	Moran Creek Drainage	~ 1.0	Low	Good	Sub-sample	Low (creek possibly dry)	Low
Wolf Creek	1	Lower Wolf Creek	2.5	Mod. (1.8%)	Good	Complete	Moderate-High	Mod.
	2 E	Wolf Creek East	2.5	High (4.3%)	Poor	Sub-sample	Low	Low
	2 W	Wolf Creek West	2.0	High (3.8%)	Poor	Sub-sample	Low	Low
Lanterman Creek	1	Lower Lanterman Creek	3.5	Low-Mod. (1.6%)	Fair-Good	Complete	High	High
McLaughlin-Ash Lake Creek	1	Ash Lake - Dickson Lake connector creek	~ 0.5	Low	Good	Complete	High	High
Turnbull Lake Creek	1	Turnbull Lake - Dickson Lake	~ 2.0	---	Good	Sub-sample	Low (creek possibly dry)	Low
Tributary #1	1	Lower section of Trib. 1	0.19	Low	Poor-Fair	Sub-sample	Low (short anadromous length)	Low
Tributary #2	1	Lower section of Trib. 2	0.12	High (4.4%)	---	Sub-sample	Low (short anadromous length)	Low

Wolf and Lanterman creeks were identified as priority sub-basins for restoration. Reaches 1 and 2 of Lanterman Creek support both coho and summer run steelhead to the anadromous barrier, located 3048 m upstream of the Ash River. Wolf Creek also contains summer steelhead and coho throughout the anadromous length. Anadromous barriers exist in Reaches 2 E and 2 W at 2530 m and 4960 m upstream from the Ash River, respectively. In addition, one log jam in the West fork and four in the East fork of Wolf Creek have been identified as partial barriers to coho and steelhead (Hay and Lough 2002).

4.2 Detailed Habitat Assessment

Following the overview assessment, detailed habitat assessments were made on the Ash River and its sub-basins. Detailed habitat assessments were concentrated on high priority sub-basins identified in the overview assessment. Reaches in moderate and low priority sub-basins were not assessed.

4.2.1 Fish Sampling and Observations

No fish sampling activities were scheduled as part of this study although observations of adults and juveniles were made throughout the survey. Detailed juvenile sampling was conducted by Griffith (1993) as well as Burt and Horchik (1999). Small numbers of adult steelhead were consistently observed under the Ash Mainline Bridge at the outlet of Dickson Lake. Four adults were also noted just downstream of the hollow cone valve at Elsie Dam as well as 18 above the second left bank tributary in a deep canyon holding pool on 18 September 2006. Juvenile trout and coho were noted in woody debris and bedrock pools throughout all reaches surveyed in Wolf and Lanterman creeks. One adult coho was visually identified in a pool 800 m upstream of the washed out bridge over Lanterman Creek on 22 September 2006. In addition, one adult sockeye was observed 150 m upstream of the mainline crossing over Wolf Creek on 26 September 2006.

4.2.2 Fish Habitat Condition

Detailed habitat condition results are presented in five tables located in Appendix B as follows: Appendix B1 is a spreadsheet listing detailed habitat attributes in each reach surveyed; Appendix B2 is a summary of area surveyed and percentage of each primary habitat type present in each reach; Appendix B3 is a summary of cover attributes in each reach surveyed; Appendix B4 is a summary of bed material and spawning attributes for surveyed reaches; and Appendix B5 is a summary of LWD attributes for surveyed reaches. A diagnostic summary of salmonid habitat condition is presented in Table 6. Representative photos for the habitats observed at the project streams are presented in the accompanying photo plates (Photo 1 to 49).

A detailed fish habitat assessment was completed on 10,076 m of Ash River mainstem and 5720 m of tributary streams as well as several hundred meters of off-channel habitat. The assessment was completed over the entire area of each priority reach. No reaches were sub-sampled. Riffle-pool habitats were the predominant channel type assessed.

Table 6. Diagnostic summary of salmonid habitat condition within the Ash River watershed. Restoration opportunities identified in reaches highlighted in green were assessed in detail in 2006.

Reach Number[1]	% Pools[2]		Pool Frequency[3]		Holding Pools[4]		% Wood in Pools[5]		% Boulder in Riffles[6]		% Overhead Cover[7]		Gravel Quantity[8]		Gravel Quality[9]		Off-channel Habitat[10]	
	Value	Rating	Value	Rating	Value	Rating	Value	Ratin	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Ash 1 A	25.3	Poor	12.0	Fair	0.0	Poor	1.9	Poor	20.4	Fair	11.8	Fair	27.8	Good	2	Good	4	Good
Ash 1 B	18.9	Poor	23.0	Poor	0.0	Poor	0.7	Poor	6.6	Poor	7.2	Poor	15.0	Fair	0	Good	0	Poor
Ash 1 C	28.5	Poor	7.4	Good	0.0	Poor	0.0	Poor	6.7	Poor	6.8	Poor	9.4	Poor	0	Good	0	Poor
Ash 3	35.0	Fair	7.7	Good	0.0	Poor	0.2	Poor	11.8	Fair	8.4	Poor	5.5	Poor	1	Good	1	Fair
Ash 4 A	39.6	Fair	9.6	Good	0.0	Poor	0.6	Poor	4.8	Poor	2.6	Poor	48.0	Good	12	Good	4	Good
Ash 6 A	66.0	Good	7.8	Good	0.0	Poor	0.0	Poor	3.9	Poor	4.0	Poor	21.7	Fair	3	Good	1	Fair
Ash 6 C	88.6	Good	4.5	Good	0.0	Poor	0.2	Poor	0.0	Poor	3.5	Poor	70.2	Good	9	Good	1	Fair
Lant 1	21.9	Poor	5.0	Good	0.0	Poor	8.1	Fair	8.3	Poor	14.3	Fair	17.7	Fair	0	Good	7	Good
Lant 2	35.5	Fair	5.4	Good	0.0	Poor	0.7	Poor	5.2	Poor	5.8	Poor	3.0	Poor	0	Good	0	Poor
Wolf 1	25.6	Poor	5.3	Good	0.0	Poor	7.6	Fair	2.7	Poor	8.0	Poor	47.2	Good	1	Good	5	Good
Wolf 1 AV	7.4	Poor	17.8	Poor	0.0	Poor	11.6	Fair	0.0	Poor	11.0	Fair	11.1	Fair	3	Good	0	Poor
Wolf 2	25.0	Poor	5.6	Good	0.0	Poor	7.4	Fair	10.9	Fair	13.2	Fair	25.0	Good	1	Good	0	Poor

[1] Modified from Burt and Horchick (1999) and Griffith (1993).

[2] Value is percent pools (%P = total pool area / total wetted area). Poor < 30%, Fair <= 40%, Good > 40% (for gradients 2-5%).

[3] Value is number of bankfull widths per pool (PF = mean bankfull width / total number of pools). Good < 10, Fair <= 15, Poor > 15.

[4] Value is the number of pools per 1000 m for which the deep pool cover > 0 and maximum depth x % total instream cover >= 30. Poor < 1, Fair <= 2, Good > 2.

[5] Value is the mean percent wood cover in pools. Poor < 6%, Fair <= 20%, Good > 20%.

[6] Value is the percent boulder cover in riffles. Poor < 10%, Fair <= 30%, Good > 30%.

[7] Value is the percent overhead cover in pools. Poor < 10%, Fair < 20%, Good > 20%.

[8] Value reflects the percentage of spawining gravel in all habitat areas of each reach. Poor < 10%, Fair <= 25%, Good >25%

[9] Value is the percent of substrate in <2 mm category (fines). Poor > 25%, Fair >15% and uncompacted, Good < =15% and uncompacted.

[10] Value is the number of off-channel habitats. Poor < 1, Fair <= 2, Good > 2.

4.2.3 Ash River Reach 1

4.2.3.1 Ash River Reach 1 A

Reach 1 A extends from the Stamp River confluence upstream to Moran Creek, a distance of 2364 m (Figure 3). Mean bankfull width is 28.2 m with predominantly large gravel/cobble substrate. The instream habitat type breakdown is 47% glide, followed by 28% riffle and 25% pool. In all habitat types, the major components of instream cover are boulder (7.3%), deep pool (6.8%) and instream vegetation (3.1%). Substrate composition is cobble (53.4%), gravel (34.8%), boulder (7.8%), and fines (1.9%). Channel disturbance indicators include bank erosion, mid-channel bars, multiple channels, parallel LWD, and scour.

4.2.3.2 Ash River Reach 1 B

Reach 1 B is located between Moran Creek confluence and Wolf Creek confluence. The mean bankfull width for the 1695 m reach is 36.8 m with predominantly large gravel/cobble substrate. The instream habitat type breakdown is 34.6% glide, followed by 46.5% riffle and 18.9% pool. In all habitat types, the major components of instream cover are boulder (3.9%), LWD/SWD (0.6%), and instream vegetation (0.5%). Deep pool cover was found in 74% of the habitat area of pools. Substrate composition is cobble (61.5%), gravel (28.4%), and boulder (6.4%). No channel disturbance indicators were identified in this survey.

4.2.3.3 Ash River Reach 1 C

Reach 1 C extends from the Wolf Creek confluence upstream to the Lanterman Falls trestle, a distance of 2268 m. Mean bankfull width is 34.2 m with predominantly boulder/cobble substrate. The instream habitat type breakdown is 58% riffle, followed by 29% pool and 13% glide. In all habitat types, the major components of instream cover are boulder (5.2%) and instream vegetation (0.6%). In pools, deep pool cover was identified in 31.5% of the total habitat area. Substrate composition is cobble (47.1%), boulder (24.8%), gravel (14.5%), and fines (0.1%). No channel disturbance indicators were identified in this survey.

The diagnostic summary in Table 6 of salmonid habitat condition gives a good rating for number of off-channel habitats within Reach 1 A with good access; however, no off-channel habitats were identified in Reaches 1 B and 1 C. The quality of spawning substrates is given a good rating based on amount of fine material (<2 mm) present. In addition, the summary indicates fair-good ratings for the number of holding pools per km over the three reaches. Pool frequency rated fair for Reach 1 A, poor for 1 B and good for 1 C. Percent boulder in riffles and overhead cover both rated fair for 1 A but poor for 1 B and 1 C. Percent wood debris in pools was identified as poor in all reaches. Overall poor-fair ratings for the three pool habitat diagnostics in Reaches 1 A and 1 B, and for all instream cover elements in Reach 1 suggest that restoration opportunities to restore fish habitats exist.

4.2.4 Ash River Reach 3

Reach 3 extends 1274 m upstream from Dickson Falls to Dickson Lake (Figure 3, Appendix B). Channel pattern is confined by bedrock upstream of the falls to mid-way through the reach. This reach is also bounded by the Ash Mainline on right bank and Branch 73 on left bank allowing for moderately easy access. Mean bankfull width is 33.2 m and channel type is glide-pool morphology with a predominance of cobble substrate. Instream habitat type is predominantly glide (51.5%), followed by pool (35.0%) and riffle (13.5%). In all habitat types, total instream cover is high at 32.8%; primary components are deep pools (pools only) (68.8%), boulder cover (3.8%) and instream vegetation (2.6%). Substrate composition is cobble (46.5%), gravel (22.1%), boulder (18.5%) and bedrock (12.2%). Fines comprised about 1% of the substrate. No channel disturbance indicators were found.

The diagnostic summary in Table 6 of salmonid habitat condition gives a fair rating for both the number of off-channel habitats with good access and for the quantity of suitable sized spawning substrate. Spawning habitat quality was ranked high based on a fines content of about 1%. A good rating was given to pool frequency and the number of holding pools per km, poor to percent wood debris and overhead cover in pools, and fair to percent boulder cover in riffles for juvenile rearing. Overall, fair to poor ratings for instream cover elements suggests that some additional LWD cover may be appropriate for the native fish species inhabiting this reach.

4.2.5 Ash River Reach 4 A

Reach 4 A extends from Dickson Lake to the Ash Mainline bridge pool located 1655 m upstream (Figure 3, Appendix B). Channel pattern is regular but becomes somewhat irregular as it nears Dickson Lake. Channel type is riffle-pool morphology with a predominance of gravel/cobble substrate. Mean bankfull width is 34.6 m. Instream habitat is comprised of 39.6% pool, 34.8% riffle, and 25.5% glide. Overall, deep pool cover (pools only) (30.4%), and boulder cover (2.2%) are the dominant instream cover components. Substrate composition is gravel (40.0%), cobble (39.7%), fines (12.4%), and boulder (6.5%). Channel disturbance indicators include bank erosion, mid-channel bars, sediment wedge, and denuded bars.

The diagnostic summary of salmonid habitat condition gives a good rating for the abundance of suitable sized substrate for spawning purposes and for the number of off-channel habitats with good access (Table 6). Gravel quality, pool frequency and the number of holding pools also received good ratings. However, percent overhead cover and woody cover in pools as well as boulder cover in riffles received a poor rating. Percent pools criterion was rated fair. Restoration opportunities would be limited as significant cover is provided by deep holding pools. In addition, ample amounts of high quality spawning gravel are present throughout the reach.

4.2.6 Ash River (Reach 6 A, 6 C)

4.2.6.1 Ash River Reach 6 A

Reach 6 A begins at a left bank tributary and continues 361 m upstream to the downstream end of the boulder/canyon section (Figure 3, Appendix B). Channel type in Reach 6 A is riffle-pool morphology with a predominance of bedrock substrate. Mean bankfull width is 23.0 m. Instream habitat type is predominantly pool (66.0%) followed by riffle (34.0%). Key instream cover components in all habitat types are boulder (1.9%) and instream vegetation (1.9%). Deep pool cover was available in 76.7 % of the total pool habitat due mostly to the presence of an excellent canyon holding pool at the end of the reach. Substrate composition is bedrock (58.8%), gravel (24.5%), boulder (5.7%), cobble (8.1%) and fines (2.9%). No channel disturbances were noted in this reach.

The diagnostic summary in Table 6 of salmonid habitat condition gives a fair rating for quantity and a good rating for quality of spawning substrate. The number of off-channel habitats in Reach 6 A is rated fair due to the presence of a 75 m bedrock side channel. All pool diagnostics rated well with percent pool area, pool frequency and the number of holding pools per km rating good. An overall good rating for the three pool habitat diagnostics suggests that restoration opportunities to restore fish habitats may be limited. However, percent overhead cover, wood cover in pools, boulder cover in riffles all received poor ratings.

4.2.6.2 Ash River Reach 6 C

Reach 6 C extends upstream from the upstream end of the boulder/canyon section for 459 m to the Elsie Lake spillway confluence, located 181 m below the hollow cone valve at Elsie Lake Dam. Channel type is pool-riffle morphology with a predominance of gravel substrate. Mean bankfull width is 20.2 m. Instream habitat type is predominantly pool (88.6%), followed by riffle (7.0%), and glide (4.4%). Key instream cover components in all habitat types are undercut banks (1.8%) and instream vegetation (1.4%). Deep pool cover was available in 31.5% of the total pool habitat. Substrate composition is gravel (72.0%), cobble (12.2%), fines (8.8%), and boulder (2.3%). Channel disturbance indicators include scour, bank erosion, mid-channel bars, multiple channels, parallel LWD, and a sediment wedge. The majority of this disturbance is located within a 300 m stretch just upstream of the boulder reach and downstream of the spillway channel (bedrock).

The diagnostic summary in Table 6 of salmonid habitat condition rates the quantity and quality of spawning substrate as good. The quantity of off-channel habitat rated fair due to a large alcove which led back to a side-channel. Percent pool area, pool frequency, and the number of holding pools per km all rated good. However, percent overhead cover, wood cover in pools, boulder cover in riffles all received poor ratings. An overall good rating for the three pool habitat diagnostics suggests that restoration opportunities to restore fish habitats may be limited. Although instream cover elements rated low (with the exception of deep pools), excellent boulder cover is provided in the 250 m boulder section in Reach 6 B (Griffith 1993). Furthermore, additional deep pool cover is provided at the base of the rapids in a large canyon holding pool in Reach 6 A and above the end of Reach 6 C in bedrock pools below the dam.

4.2.7 Lanterman Creek Reaches 1 and 2

Reach 1 extends 2202 m upstream from the Ash River confluence to a point at which there is a marked shift to bedrock substrate (Figure 3, Appendix B). Reach 2 then carries on upstream for 846 m to a series of falls that make up the anadromous barrier. Channel pattern is irregular meandering and occasionally confined. Channel type is riffle-pool morphology with a predominance of cobble/gravel substrate in Reach 1 and bedrock in Reach 2. Mean bankfull widths are 16.3 m and 12.7 m, respectively. Instream habitat type in Reach 1 is 71.3% riffle, 21.9% pool, and 6.8% glide. Reach 2 is similar with 58.6% riffle, 35.5% pool, and 5.9% glide habitats. Of the pool habitats located in Reach 1 and Reach 2, deep pool cover represented 24.0% and 38.1% of the total instream cover, respectively. For all habitats, boulder cover (6.5% and 3.8%) is the dominant instream cover component. Substrate composition in Reach 1 is cobble (47.2%), gravel (32.8%), boulder (11.2%), and fines (0.4%). In Reach 2, the dominant substrate is bedrock at 64.8% followed by cobble (15.9%), gravel (11.2%), and boulder (8.1%). Channel disturbance indicators include scour, bank erosion, mid-channel bars, parallel LWD, and LWD jams.

The diagnostic summary of salmonid habitat condition provides a good rating for pool frequency, fair-good for the abundance and quality of suitable sized substrate for spawning purposes as well as for the number of accessible off-channel habitats (Table 6). Pool diagnostics were mixed with pool frequency and number of holding pools rating good in both reaches but the percentage of pool habitat in both reaches as well as the amount of wood in pools rated fair to poor. Instream cover components, other than deep pool cover, received fair-poor ratings. Restoration opportunities in Reach 2 of Lanterman Creek are limited by equipment accessibility and a predominance of deep bedrock pools. Also, Reach 1 had an abundance of LWD in various states of functionality. Several large log jams were noted, although none appear to be preventing fish migration. No clear restoration opportunities exist at this time.

4.2.8 Wolf Creek Reaches 1, 1 AV, 2

Reach 1 extends 1091 m to the upstream end of the avulsion channel (Figure 3, Appendix B). Channel type is riffle-pool morphology with a predominance of gravel/cobble substrate. Mean bankfull width is 14.3 m. Instream habitat type is predominantly riffle (62.4%), followed by pool (25.6%) and glide (12.0%). Most important instream cover components in all habitat types are LWD/SWD (2.7%) and undercut banks (2.4%). In pools, deep pool cover represented 8.1% of total habitat area. Substrate composition over the entire reach was dominated by gravel (53.2%), then cobble (41.4%) and boulder (4.6%).

Reach 1 AV is a 280 m long avulsion channel at chainage 0+810 m that was created by a LWD jam at 1+008 m. It is a relatively new channel that cuts a path through the forest to an average bank height of 0.65 m. The avulsion channel is 7.9 m wide and has 87% riffle habitat with 81% gravel substrate. Channel disturbance indicators throughout the reach include scour, bank erosion, mid-channel bars, multiple channels, avulsion, and parallel LWD.

Reach 2 starts at the top of the avulsion channel and ends at the West/East Wolf Creek confluence, located 1369 m upstream. Channel type is riffle-pool morphology with a predominance of gravel/cobble substrate. Mean bankfull width is 11.4 m. Instream habitat type is predominantly riffle (67.7%), followed by pool (25.0%) and glide (7.3%). The most important instream cover components in all habitat types are boulder (9.1%) and LWD/SWD (3.0%). In pools, deep pool cover represented 30.0% of all the habitat area. Substrate composition is dominated by cobble (42.6%), gravel (37.5%), and boulder (18.1%). Bedrock accounted for only 1.1% of the substrates in this reach and silt was less than 1%.

The diagnostic summary of salmonid habitat condition gives a good rating for the abundance and quality of spawning substrate in both reaches. Five off-channel habitats with good access were identified in Reach 1 (Table 6). Pool frequency and the presence of quality holding pools also received a good rating in Reach 1. Poor ratings were determined in both reaches for percent pools and percent boulder cover in riffles. The amount of instream LWD cover in pools as well as the quantity of overhead cover in all habitats was found to be fair in both reaches. Restoration opportunities are not clear but an assessment of channel stability and potential stabilization options for the avulsion is warranted.

4.2.4 Habitat Limitations

The field assessment employed in this study collected quantitative information on the following features to characterize habitat conditions for the target species. The habitat features of particular importance to salmonids are:

- adult holding pools;
- spawning gravel quantity and quality;
- (rearing) pool area and frequency;
- cover in pools and riffles;
- SWD/LWD frequency and distribution;
- substrate characteristics of the streambed; and
- off-channel habitat.

To evaluate habitat condition, the assessment compared the values of the above habitat features within each reach to expected values. Since regional criteria for habitat condition currently do not exist, the diagnostic criteria in Table 6 were used to evaluate conditions in each reach. To identify potentially degraded or limiting habitats, the following questions were asked corresponding to salmonid life stages in freshwater habitats.

Adult Upstream Migration

1. Are there obstructions to upstream migration?

There are documented natural and man-made barriers to upstream migration of anadromous species within the Ash River mainstem. Lanterman and Dickson falls both are semi-selective natural barriers to the migration of certain species. Summer steelhead are the only anadromous species that commonly occurs in the reaches upstream of these falls. However, two coho fry were found by BCCF staff while sampling Reach 6 in 2005. Blasting was conducted at Dickson Falls in the late 1970’s by BC fisheries staff to improve summer steelhead access to upper reaches of the Ash River. At the same time, a massive log jam was removed at the inlet of

Dickson Lake to improve summer run steelhead access into the upper river (Gary Horncastle, BC MOE pers. comm.). Elsie Lake dam is a man-made barrier to all fish species.

Summer base flows of 3.5 m^3/s (mandated by the WUP) provide sufficient water for anadromous species to migrate at any time. In addition, pulse flows provide opportunities for steelhead and other species to ascend semi-selective barriers. Water temperatures do exceed 20 °C in areas below Dickson Lake later in the summer which may impede migration. The dam at Elsie Lake is a low level outlet which releases water from depth at a cooler temperature. It is likely that this water sinks below the thermocline in Dickson Lake and does not have any affect on the lower river.

In tributary streams and off-channel areas, culverts and beaver dams are assessed as potential barriers to fish migration using the criteria:

- potential impassable obstruction if vertical drop during the upstream migration period is greater than 2 m for salmon and 0.8 m for resident trout; and
- velocities greater than 2.5 m/s for salmon and 1.2 m/s for resident trout during the migration period.

Neither feature was encountered during the Level 1 assessment so they were not considered to be a limiting factor.

<u>Adult Holding Pools</u>
Is quantity and/or quality of adult holding habitat adequate?

Yes, adequate adult holding pools with instream cover exist in tributary and mainstem reaches. All reaches rated as good with the exception of Ash 1 A and Ash 1 B which rated fair. Although not surveyed, Ash 2 is characterized by canyon holding pools and bedrock dominated substrate which likely provides additional holding habitat.

<u>Spawning and Incubation Conditions</u>
Is the quality and quantity of spawning and incubation habitat adequate for native salmonids?

None of the species present in the system were actively spawning at the time of the surveys. As part of another BCRP project (Ash River WUP Monitoring), Reach 1 was snorkeled on 27 October 2006. At this time, Chinook and coho salmon were observed actively using spawning habitat earlier documented in the Level 1 survey. Although the other reaches were also snorkeled, only summer run steelhead were present which were not spawning at the time of the survey. Notes on spawning distribution observed during the snorkel survey and from this study include:

- Majority of Chinook spawning activity was located below Wolf Creek with many redds located in the tailout of the confluence pool.
- At chainage 1+684 m in Reach Ash 1 A and 1+046 m in Reach Ash 1 B there were many Chinook redds and plenty of adults located on high quality gravel identified in Level 1 surveys (Photo 3 and Photo 7).

- In Reach Ash 6 A, approximately 500 m^2 of high quality spawning gravel was documented in the tailout of a large canyon pool (Photo 20).
- In general, the amount of spawning habitat estimated in Level 1 surveys was far less than what was observed during the snorkel survey.

Suitable spawning sites for salmonids are pool tail-out and riffle crest areas where the dominant substrate sizes are approximately 1 to 10 cm diameter, <15%fines (particle size less than 2 mm), minimum water depths exceed 15 to 30 cm, and water velocities are between about 10 and 100 cm/s. Individual patches of gravel generally must be 1-2 m^2 to be considered suitable spawning areas. A biostandard has been developed to account for territorial behavior and size, estimated at 20 m^2 for a pair of Chinook, 10 m^2 for coho, and 15 m^2 for steelhead (Burt 2004). These conditions are abundant in the Ash River watershed and exceed the spawning area required for the target escapement (Table 7). However, an artificial spawning platform was constructed using 200 m^3 of gravel at the outlet of Dickson Lake in 1990. The spawning platform was subsequently scoured by flood discharges and shifted downstream. In September 2003, a second pad was created slightly upstream using 400 m^3 of gravel and resulted in approximately 665 m^2 of high quality spawning habitat (Smith 2004). Both of these placements were able to be utilized by summer steelhead only. It has also been suggested that species with stream rearing periods of more than one year (such as steelhead and coho) are rarely limited by the availability of spawning habitat except in extreme cases (Whyte et al. 1997).

Table 7. Comparison of required and available quantities of spawning gravel in selected reaches of the Ash River watershed.

Reach	Spawners Required [1]			Gravel Required (m^2) [2]				Gravel Present (m^2) [4]	
	CO	ST	CH	CO	ST	CH	Minimum[3]	Minimum	Maximum
Ash 1	115	97	40	575	737	400	1137	1345	29783
Ash 2-6		312			2371		2371	6280 [5]	35620 [5]
Lant	50	88		250	669		669	279	3723
Wolf	26	80		130	608		608	530	6477

Notes: 1. Number of spawners (male + female) based on total available fry habitat and maximum fry densities (Burt and Horchik 1999).
2. Based on gravel requirements per pair of CH - 20 m^2, CO - 10 m^2, and ST - 15 m^2 (Burt 2004).
3. Assume overlap in spawning habitat between coho and steelhead but no overlap with Chinook
4. From Level 1 surveys (2006). See Table C4 for definitions and individual reach estimates.
5. Does not include Reaches 2 and 5.

Summer Rearing

Is the quality and quantity of summer rearing habitat adequate for native salmonids?

Summer rearing in streams may be limiting for species such as steelhead and coho if baseflows are below optimal. Summer baseflows in the mainstem Ash River are augmented by the dam at Elsie Lake. As part of the water use plan, a discharge of 3.5 m^3/s is required throughout the summer to ensure there is adequate summer rearing habitat. This flow represents 20% of the current mean annual discharge (13% of naturalized MAD) which is ideal for juvenile salmonids (Lill 2002). Other fisheries programs in the watershed such as stream enrichment help to boost summer productivity and further improve summer rearing conditions below Elsie Lake Dam (Pellett and Wright 2006).

Quality of summer rearing habitat varies by species. Steelhead parr require boulder riffles while coho tend to favour pools with cover and off-channel areas. The Ash River has been described as a steelhead stream meaning the river is dominated by high gradient boulder riffles. The quantity of coho habitat is therefore much less, as indicated by Burt and Horchick (1999) and Griffith (1993). Large Woody Debris (LWD) provides cover and rearing areas for both steelhead and coho juveniles. The amount of LWD contained within pools of the Ash River mainstem has been identified as limiting even though the quantity and depth of pools is not. Wolf and Lanterman creeks both contain fair amounts of LWD for summer rearing.

<u>Winter Rearing</u>
Is the quality and quantity of overwintering habitat adequate for native salmonids?

Critical overwintering habitats in rivers usually include deep pools with sufficient cover (especially LWD) as well as off-channel areas. Rivers with limited overwintering habitat are defined as having less than one pool per km with depths greater than 1 m (Johnston and Slaney 1996). Similar to summer rearing habitat, the amount of wood in pools was rated poor in all reaches of the Ash River. Although there may be sufficient quantity and depth of pools, the amount of LWD cover in the pools appears to be limiting. In general, sufficient LWD cover is limiting in all reaches of the Ash River that were surveyed. Wolf and Lanterman creeks appear to have sufficient wood to provide overwintering cover, as indicated by a fair rating in Table 6.

4.3 Fish Habitat Restoration

Detailed habitat assessment results for Ash River mainstem Reaches 4 A, 6 A and 6 C indicated that existing habitat was not degraded from its natural state and in little need of improvement through instream or off-channel restoration. These results and conclusions were confirmed through a field inspection of the three reaches by the authors. Based on the detailed assessments, the proportions of riffle, pool and glide habitats in Reaches 4 A and 6 A are appropriate for the summer run steelhead that use these reaches exclusively. Riffle habitat comprises about a third of the total channel area in these two reaches. Only 7% of the area in Reach 6 C was riffle habitat but the habitat is replete with high quality holding pools. The assessment found that percent pools, pool frequency and number of holding pools rated fair to good for the three reaches, with pool habitat comprising between 40 and 89% of the total channel area. Relatively deep pools provide the necessary cover for holding and rearing. Mean wetted depths in pools ranged from 0.73-2.00 m and holding pools had mean residual depths of 1.4-3.1 m. Consequently, the quality and quantity of pool habitat suggests that the need to construct structures that promote pool scour and provide cover is not warranted in these three reaches.

Improvements to spawning habitat and off-channel rearing are also not required in these reaches. Spawning habitat is abundant and of high quality in all three reaches. Also, a sufficient number of off-channel habitats exist in each reach.

5 DISCUSSION

Fish habitat in the Ash River between Elsie and Dickson lakes and in the Ash River downstream of Dickson Lake to the Stamp River confluence was assessed. This project updated previous work by Griffith (1993) and Burt and Horchik (1999). For the upper reach, this assessment also included specific investigations for mitigation and restoration measures. These investigations were consistent with recommendations for the lower Ash River (i.e., below Elsie Lake) in the BCRP Strategic Plan (Conlin et al. 2000) which included the following:

(a) Identify sites for future habitat enhancement or creation;

(b) Identify opportunities for purchasing or placing (restrictive) covenants on streamside properties suitable for future habitat (restoration) projects; and

(c) Identify an artificial recruitment scheme to restore delivery of spawning gravel and wood to the mainstem river.

Channel morphology and habitat characteristics were found in relatively good condition in the reaches of Ash River and Wolf and Lanterman creeks surveyed in this assessment. Disturbance indicators were more prevalent in the tributaries with disturbances only recorded in three reaches of the mainstem. Disturbance was indicated by relatively low levels of bank erosion and mid-channel gravel bars, and evidence of LWD lying parallel with the channel. Habitat limitations appeared primarily in the percent wood cover in pools, percent of the riffle area comprised of boulders, and percent overhead cover for all reaches surveyed. However, it was found that within the mainstem, deep pools provided more than adequate cover for salmon and trout. Burt and Horchik (1999) also found cover was mainly provided by boulders and deep pools in the Ash River mainstem.

Our detailed habitat and restoration assessments indicated a lack of viable restoration opportunities within Reaches 4 and 6. Restoration opportunities are limited as the mainstem channel is stable with very limited evidence of severe bank erosion or channel aggradation. This further suggests that sediment loading to the mainstem is currently not excessive. Pools are plentiful with significant cover being provided by deep holding pools. In addition, ample amounts of high quality spawning gravel and several off-channels are present within each reach. Consequently, no restoration designs have been proposed for these two reaches. These assessment results and recommendations reaffirm those of Griffith (1993) who conducted a biophysical assessment of the river in 1992/93 and identified no mitigation / compensation needs or opportunities. He stated that the "relative lack of coho habitat in the Ash River mainstem is due to the general character of the stream itself (swift, cobbly/bouldery)", being principally suited to rainbow trout / steelhead. He found that existing habitat was of high quality and not being fully exploited by wild fish, and concluded that habitat improvement activities would be inappropriate.

For the other reaches surveyed, the detailed habitat assessment results suggest that some restoration works may be warranted in the lower reaches of the Ash River mainstem and in Wolf Creek. Conclusions from our habitat assessment are:

- Ash Reach 1: Overall poor-fair ratings for the three pool habitat diagnostics in Reaches 1 A and 1 B, and for all instream cover elements in Reach 1 suggest that restoration opportunities to restore fish habitats exist.
- Ash Reach 3: Overall, fair to poor ratings for instream cover elements suggests that some additional LWD cover may be appropriate for the native fish species inhabiting this reach.
- Wolf Creek: Restoration opportunities are not clear but an assessment of channel stability and potential stabilization options for the avulsion is warranted.
- Lanterman Creek: Restoration opportunities in Reach 2 of Lanterman Creek are limited by equipment accessibility and a predominance of deep bedrock pools. Also, Reach 1 had an abundance of LWD in various states of functionality. Several large logjams were noted, although none appear to be preventing fish migration. No clear restoration opportunities exist at this time.

Burt and Horchik (1999) found evidence of habitat degradation in Wolf, East Wolf and Lanterman creeks. Disturbances included log jams damming large sediment wedges upstream, channel aggradation and widening, bank erosion, pool infilling and siltation. Hay and Lough (2002) have assessed the log jams and provided restoration prescriptions to allow for fish passage. We will investigate the causes of the channel stability problems in 2007 to determine a restoration strategy for these tributaries. In addition, we will undertake further restoration assessments on the Ash River mainstem - Reaches 1 and 3 and prepare prescriptions, if warranted. Potential restoration prescriptions could include new side-channels for summer steelhead, salmon and resident trout/char, LWD placements, and bank stabilization and riparian treatments.

6 RECOMMENDATIONS

The following recommendations stem from our observations of the Ash River and tributary habitats and our interpretation of 2006 assessment results:

1. Based on the condition of the existing channel and habitat within Reaches 4 and 6 of the Ash River mainstem, no restoration works are recommended.
2. The 2006 assessment identified habitat limitations and opportunities for restoration in mainstem Reaches 1 and 3, and Wolf and Lanterman creeks. It is recommended that restoration opportunities be assessed and prescriptions developed for these reaches in 2007.

7 ACKNOWLEDGMENTS

Many people participated in one way or another in the completion of this study. We thank Tara Denton (HFN) and Pat Stephenson (BCCF) who provided administrative support and contract management. We thank Craig Wightman (MoE), Gary Horncastle (COS) C. Robert (CBR & Associates) and Mike McCulloch (MoE) for their assistance in providing historic and current information on the watershed. Dave Burt provided valuable information and insights on past and proposed surveys and studies. He kindly provided several map figures which were reproduced in this report. Robertson Creek Hatchery staff provided field support throughout the study. Steve Tatoosh (HFN) assisted with data collection and also provided local knowledge. Robin Tamasi (LGL Limited) prepared the maps for the report. Dorothy Baker proofread and coordinated the production of this report. The support of all these individuals is greatly appreciated. Financial support for this project was provided by BC Hydro Bridge Coastal Fish and Wildlife Restoration Program.

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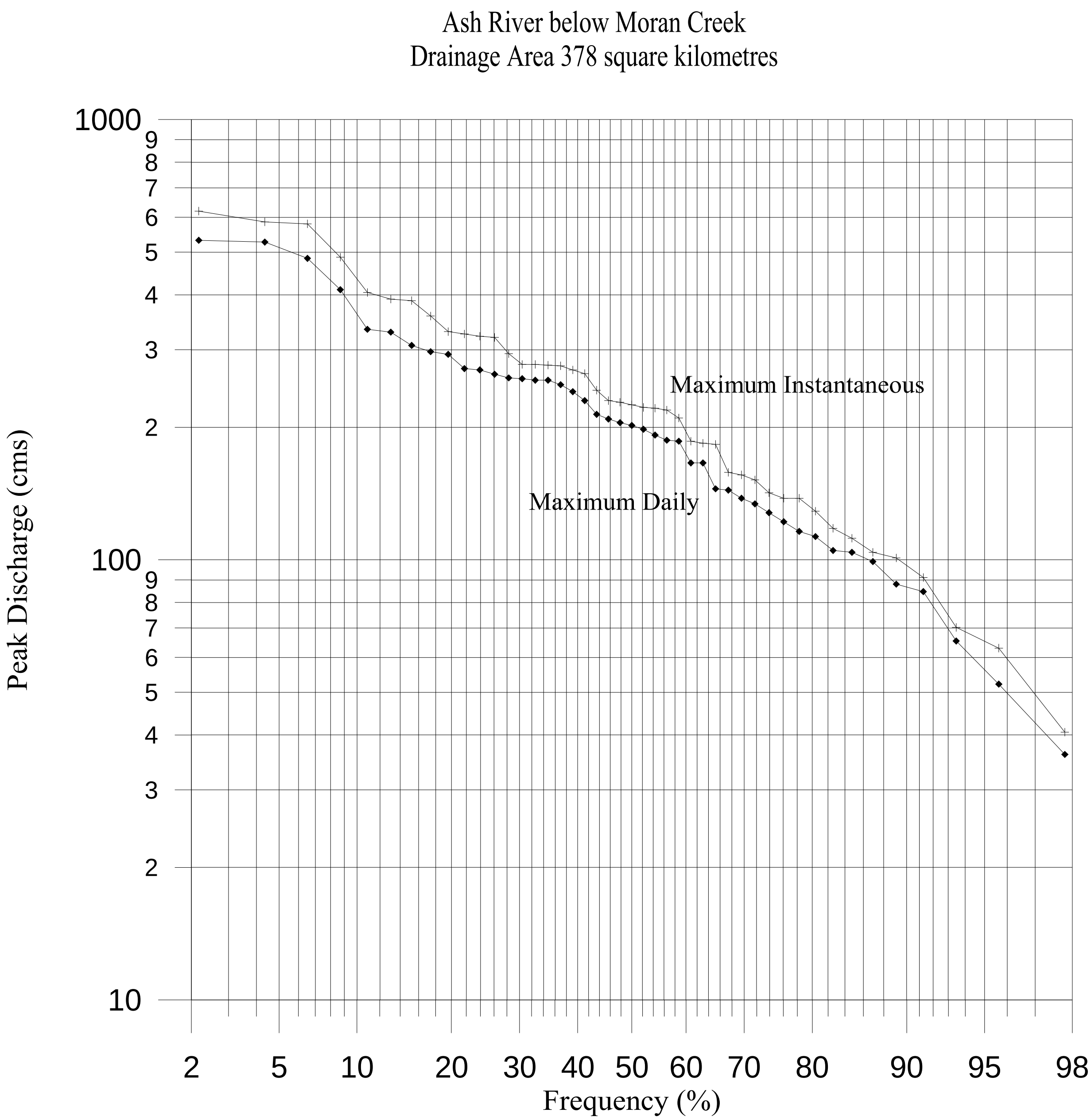
APPENDICES

Appendix A. Flood frequency plots for Ash River WSC station below Moran Creek.



Appendix B. Fish habitat assessment data for Ash River and two of its major tributaries.

Appendix B1. Detailed habitat descriptions for selected reaches in Ash River watershed.

												Percent Bed Material (range in mm)						Spawning Gravel				Pools Only					Functional LWD Tally				Cover							Off-channel Habitat				
Sub Basin	Reach	Reach location (m)[1] Sampling Fraction[2]	Habitat type[3]	Habitat category[4]	Habitat length (m)	Gradient (%)	Mean depth (m)	Bank height (m)	Bankfull width (m)	Wetted width (m)	Rearing Habitat Area (m^2)[5]	<2 mm	2-64 mm	64-256 mm	>256 mm	Bed rock	100%	Type[6]	Quality[7]	Amount (m^2)	Estimated m^2 (on site)	Maximum depth (m)	Crest depth (m)	Residual depth (m)	Control element[8]	Good holding pool?[9]	Total LWD tally	10 to 20 cm	20 to 50 cm	>50 cm	Woody debris	Boulder	Cutbank	Deep pool	Instream veg.	Total instream cover	Overhanging veg.	Type[10]	Access[11]	Length (m)	Channel Disturbances[12]	Barriers[13]
Ash River	Ash 4 A	-130	P	1	130	0.0	4.00	5	42.0	41.0	5330	60	10	15	10	5	100	AR	L	693		6.00	0.60	5.40	R	Y	0	0	0	0	0.0	5	0	50	0.0	55	0					N
Ash River	Ash 4 A	0	R	1	97		0.45	6.00	24.0	16.0	1552	0	10	45	45	0	100	AR	L	295	100						0	0	0	0	0.0	30	0	0	0	30	0	SC	G			N
Ash River	Ash 4 A	97	P	1	33	0.0	1.00	0.60	42.0	37.0	1221	5	30	60	5	0	100	AR	H	513	50	3.00				Y	0	0	0	0	0.0	0	0	40	0	40	0	SC	G	112		N
Ash River	Ash 4 A	130	G	1	95		0.60	0.50	39.0	21.0	1995	0	40	60	0	0	100	AR	H	1037							0	0	0	0	0.0	0	0	0	1	1	0					N
Ash River	Ash 4 A	225	R	1	61	0.48	0.25	1.00	33.0	17.0	1037	5	40	50	5	0	100	AR	L	519		0.35					0	0	0	0	0	8	0	0	0	8	0					N
Ash River	Ash 4 A	286	P	1	122		3.00	1.50	27.0	24.0	2928	35	25	30	10	0	100	A	M	908	150	3.00	0.20		R	Y	0	0	0	0	0	0	0	60	0	60	0					N
Ash River	Ash 4 A	408	R	1	165		0.25	1.80	41.0	39.0	6435	0	10	70	20	0	100			1544							0	0	0	0	0	5	0	0	0	5	0					N
Ash River	Ash 4 A	573	G	1	227		0.55	1.80	35.0	29.0	6583	0	15	80	5	0	100	AR	L	2041							1	1	0	0	0.0	0	0	0	0	0	0					N
Ash River	Ash 4 A	800	P	1	220		0.60	1.50	42.0	40.0	8800	10	70	20	0	0	100	AR	H	6512	4600	1.50	0.20		R		4	7	0	0	1.0	0	0	5	0	6	0	WL	P	75		N
Ash River	Ash 4 A	1020	R	1	92	0.48	0.35	1.50	35.0	29.0	2668	8	60	22	5	5	100	AR	H	1718	40	0.80					1	1	0	0	0.0	0	0	0	0	0	0					N
Ash River	Ash 4 A	1112	P	1	86		0.45	0.18	30.0	26.0	2236	15	35	35	0	15	100	AR	H	939	280	3.00	0.25		R	Y	10	6	4	0	2.0	0	3	40	0	45	0				SC,DW,WG.MB	N
Ash River	Ash 4 A	1198	R	1	141		0.35	1.00	53.0	45.0	6345	10	75	15	0	0	100	AR	M	4949		0.60					0	0	0	0	0.0	0	0	0	1	1	0	SL	G	100 +	SC,DW,WG.MB	N
Ash River	Ash 4 A	1339	G	1	186		0.40	2.00	42.0	25.0	4650	0	60	40	0	0	100	AR	M	3162							0	0	0	0						0						
Ash River	Ash 4 A	1525	G	1							0						0										0	0	0	0						0						
Ash River	Ash 1 C	0	P	1	30		0.70	0.5	25.0	21	630	0	10	60	15	15	100	N/A				1.50	0.75		R		0	0	0	0	0.5	3	0	8	0	12	1					N
Ash River	Ash 1 C	0	R	2	30		0.40	0.5	16.0	10	300	0	5	20	5	70	100	N/A									0	0	0	0	0.5	0	0	0	0	1	0					N
Ash River	Ash 1 C	30	R	1	106	2.7	0.35	1.40	43.0	41.0	4346	0	5	55	40	0	100	N/A									1	1	0	0	0.5	15	0	0	0	16	0					N
Ash River	Ash 1 C	136	P	1	35		0.80	1.20	34.0	26.0	910	5	5	5	5	80	100	N/A				2.50	0.80		R	Y	0	0	0	0	0.0	3	0	15	0	18	0					N
Ash River	Ash 1 C	171	G	1	74		0.70	1.20	39.0	24.0	1776	0	5	15	10	70	100	N/A									4	1	3	0	0.5	0	0	0	1	1	1					N
Ash River	Ash 1 C	245	P	1	72	4.9	0.75	3.00	39.0	29.0	2088	0	10	20	40	30	100	N/A				1.50	0.50		BD	Y	2	1	0	1	0.0	20	0	60	0	80	0					Y
Ash River	Ash 1 C	317	R	1	43	1.1	0.60	2.00	28.0	23.0	989	0	5	15	10	70	100	N/A									1	1	0	0	0.0	5	0	0	0	5	0					N
Ash River	Ash 1 C	360	P	1	76	0.0	1.00	1.00	28.0	23.0	1748	0	15	27	8	50	100	AR	L	357	10	1.80	N/A		R	Y	0	0	0	0	0.0	10	0	80	0	90	0					N
Ash River	Ash 1 C	436	R	1	67	2.5	0.40	2.00	31.0	17.0	1139	0	3	25	7	65	100	N/A									1	1	0	0	0.0	30	0	0	0	30	0					N
Ash River	Ash 1 C	503	P	1	72	0	0.80	3.50	26.0	20.0	1440	0	0	25	30	45	100	N/A				2.00	0.75		R	Y	0	0	0	0	0.0	10	0	40	0	50	0					N
Ash River	Ash 1 C	575	P	1	83	0	1.50	1.50	28.0	23.0	1909	0	5	10	5	80	100	A	L	134	5	3.00	0.70		BD	Y	0	0	0	0	0.0	0	0	30	0	30	0					N
Ash River	Ash 1 C	658	P	1	169	0	1.20	1.50	45.0	25.0	4225	0	5	55	15	25	100	N/A				3.00	0.55		R	Y	3	1	2	0	0.0	0	0	30	0	30	1					N
Ash River	Ash 1 C	827	R	1	314	1.1	0.18	1.00	41.0	35.0	10990	0	10	70	20	0	100	N/A									8	2	3	3	0.5	5	0	0	3	9	3					N
Ash River	Ash 1 C	1141	R	1	202	1.0	0.40	2.00	29.0	22.0	4444	0	10	50	40	0	100	N/A									3	0	0	3	0.5	10	0	0	0	11	3					N
Ash River	Ash 1 C	1343	R	1	131		0.35	1.00	41.0	37.0	4847	0	10	40	50	0	100	N/A									9	1	7	1	0.5	10	0	0	0	11	3					N
Ash River	Ash 1 C	1474	P	1	83	0.0	0.45	1.30	28.0	19.0	1577	3	12	50	20	15	100	N/A				1.40	0.35		BD		1	0	0	1	0.0	1	0	15	0	16	3					N
Ash River	Ash 1 C	1557	G	1	313		0.25	1.10	32.0	21.0	6573	0	40	40	20	0	100	AR	M	3155	10						5	2	1	2	0.0	0	0	0	0	0	0					N
Ash River	Ash 1 C	1870	R	1	230	1.2	0.18	0.50	51.0	47.0	10810	0	10	60	30	0	100	N/A									6	1	3	2	0.0	0	0	0	0	0	0					N
Ash River	Ash 1 C	2100	P	1	138	0.0	0.50	0.50	45.0	28.0	3864	0	55	35	10	0	100	AR	H	2396	200	1.80	0.45		R		1	0	1	0	0.0	2	0	8	1	11	5					N
Ash River	Ash 1 B	2238	R	1	0		0.25	0.50	38.0	33.0	0	0	25	50	25	0	100	N/A									5	3	2	0	5.0	5	1	0	3	14	5					N
Ash River	Ash 1 B	2238	R	2	106		0.10	0.50	18.0	14.0	1484	1	14	65	20	0	100	N/A									2	1	1	0	1.0	3	0	10	0	14	5					N
Ash River	Ash 1 B	2308	G	1	36		0.30	0.60	25.0	20.0	720	0	20	65	15	0	100	N/A									11	3	7	1	5.0	3	0	0	0	8	5					N
Ash River	Ash 1 B	2344	R	1	130		0.20	0.40	49.0	25.0	3250	0	25	65	10	0	100	N/A									2	0	2	0	1.0	35	0	0	0	36	5					N
Ash River	Ash 1 B	2474	G	1	92		0.30	0.50	43.0	23.0	2116	0	15	70	15	0	100	N/A									0	0	0	0	1.0	3	0	0.0	1	5	1					N
Ash River	Ash 1 B	2566	R	1	75		0.20	1.30	41.0	35.0	2625	0	35	55	5	5	100	AR	H	1208	30						6	2	3	1	2.0	3	0	0	4	9	5					N
Ash River	Ash 1 B	2641	P	1	61		0.40	0.80	43.0	39.0	2379	0	15	65	20	0	100	AR	M	666	15	1.50	0.35		R	Y	3	1	0	2	3.0	8	0	20	1	32	3					N
Ash River	Ash 1 B	2641	R	2	66		0.15	0.50	10.0	6.5	429	0	15	65	20	0	100	N/A									1	0	0	1	0.0	1	0	0	0	1	0					N
Ash River	Ash 1 B	2702	G	1	72		0.20	1.00	47.0	44.0	3168	0	50	35	15	0	100	A	L	1806	50						0	0	0	0	0.0	3	0	0	0	3	0					N
Ash River	Ash 1 B	2774	R	1	180	1.3	0.20	0.40	44.0	41.0	7380	0	25	70	5	0	100	N/A									0	0	0	0	0.0	2	0	0	0	2	3					N
Ash River	Ash 1 B	2954	G	1	224	1.2	0.27	1.10	36.0	32.0	7168	0	30	65	5	0	100	N/A									7	3	4	0	0.0	0	0	0	0	0	3					N
Ash River	Ash 1 B	3178	R	1	77		0.25	0.80	37.0	34.0	2618	0	20	70	10	0	100	N/A									3	3	0	0	1.0	5	0	0	0	6	5					N
Ash River	Ash 1 B	3255	G	1	111		0.30	0.60	39.0	37.0	4107	0	28	70	2	0	100	N/A									5	0	0	0	1.0	1	0	0	0	2	3					N
Ash River	Ash 1 B	3366	R	1	121		0.21	1.00	46.0	43.0	5203	0	15	70	2	13	100	N/A									3	1	1	1	1.0	0	0	0	1	2	3					N
Ash River	Ash 1 B	3487	G	1	56		0.35	1.50	32.0	29.0	1624	0	18	80	2	0	100	N/A									2	2	0	0	0.0	2	0	0	0	2	2					N
Ash River	Ash 1 B	3543	R	1	73	1.2	0.30	2.00	37.0	33.0	2409	0	17	80	2	1	100	N/A									1	1	0	0	0.0	5	0	0	0	5	1					N
Ash River	Ash 1 B	3616	P	1	215		1.50	1.50	41.0	37.0	7955	0	50	35	0	15	100	A	L	4534	100	4.00	0.45		R	Y	5	1	2	2	0.0	0	0	90	1	91	1					N
Ash River	Ash 1 A	3831	R	1	61	2.2	0.30	2.00	26.0	17.0	1037	0	20	70	10	0	100	N/A									2	0	1	1	0.0	20	0	0	1	21	1	SC	P	200	EB, MC	N

												Percent Bed Material (range in mm)						Spawning Gravel				Pools Only					Functional LWD Tally				Cover							Off-channel Habitat				
Sub Basin	Reach	Reach location (m) [1] Sampling Fraction [2]	Habitat type [3]	Habitat category [4]	Habitat length (m)	Gradient (%)	Mean depth (m)	Bank height (m)	Bankfull width (m)	Wetted width (m)	Rearing Habitat Area (m^2) [5]	<2 mm	2-64 mm	64-256 mm	>256 mm	Bed rock	100%	Type [6]	Quality [7]	Amount (m^2)	Estimated m^2 (on site)	Maximum depth (m)	Crest depth (m)	Residual depth (m)	Control element [8]	Good holding pool? [9]	Total LWD tally	10 to 20 cm	20 to 50 cm	>50 cm	Woody debris	Boulder	Cutbank	Deep pool	Instream veg.	Total instream cover	Overhanging veg.	Type [10]	Access [11]	Length (m)	Channel Disturbances [12]	Barriers [13]
Ash River	Ash 4 A	-130	P	1	130	0.0	4.00	5	42.0	41.0	5330	60	10	15	10	5	100	AR	L	693		6.00	0.60	5.40	R	Y	0	0	0	0	0.0	5	0	50	0.0	55	0					N
Ash River	Ash 4 A	0	R	1	97		0.45	6.00	24.0	16.0	1552	0	10	45	45	0	100	AR	L	295	100						0	0	0	0	0.0	30	0	0	0	30	0	SC	G			N
Ash River	Ash 4 A	97	P	1	33	0.0	1.00	0.60	42.0	37.0	1221	5	30	60	5	0	100	AR	H	513	50	3.00				Y	0	0	0	0	0.0	0	0	40	0	40	0	SC	G	112		N
Ash River	Ash 4 A	130	G	1	95		0.60	0.50	39.0	21.0	1995	0	40	60	0	0	100	AR	H	1037							0	0	0	0	0.0	0	0	0	1	1	0					N
Ash River	Ash 4 A	225	R	1	61	0.48	0.25	1.00	33.0	17.0	1037	5	40	50	5	0	100	AR	L	519		0.35					0	0	0	0	0	8	0	0	0	8	0					N
Ash River	Ash 4 A	286	P	1	122		3.00	1.50	27.0	24.0	2928	35	25	30	10	0	100	A	M	908	150	3.00	0.20		R	Y	0	0	0	0	0	0	0	60	0	60	0					N
Ash River	Ash 4 A	408	R	1	165		0.25	1.80	41.0	39.0	6435	0	10	70	20	0	100			1544							0	0	0	0	0	5	0	0	0	5	0					N
Ash River	Ash 4 A	573	G	1	227		0.55	1.80	35.0	29.0	6583	0	15	80	5	0	100	AR	L	2041							1	1	0	0	0.0	0	0	0	0	0	0					N
Ash River	Ash 4 A	800	P	1	220		0.60	1.50	42.0	40.0	8800	10	70	20	0	0	100	AR	H	6512	4600	1.50	0.20		R		4	7	0	0	1.0	0	0	5	0	6	0	WL	P	75		N
Ash River	Ash 4 A	1020	R	1	92	0.48	0.35	1.50	35.0	29.0	2668	8	60	22	5	5	100	AR	H	1718	40	0.80					1	1	0	0	0.0	0	0	0	0	0	0					N
Ash River	Ash 4 A	1112	P	1	86		0.45	0.18	30.0	26.0	2236	15	35	35	0	15	100	AR	H	939	280	3.00	0.25		R	Y	10	6	4	0	2.0	0	3	40	0	45	0				SC,DW,WG.MB	N
Ash River	Ash 4 A	1198	R	1	141		0.35	1.00	53.0	45.0	6345	10	75	15	0	0	100	AR	M	4949		0.60					0	0	0	0	0.0	0	0	0	1	1	0	SL	G	100 +	SC,DW,WG.MB	N
Ash River	Ash 4 A	1339	G	1	186		0.40	2.00	42.0	25.0	4650	0	60	40	0	0	100	AR	M	3162							0	0	0	0						0						
Ash River	Ash 4 A	1525	G	1							0						0										0	0	0	0						0						
Ash River	Ash 1 C	0	P	1	30		0.70	0.5	25.0	21	630	0	10	60	15	15	100	N/A				1.50	0.75		R		0	0	0	0	0.5	3	0	8	0	12	1					N
Ash River	Ash 1 C	0	R	2	30		0.40	0.5	16.0	10	300	0	5	20	5	70	100	N/A									0	0	0	0	0.5	0	0	0	0	1	0					N
Ash River	Ash 1 C	30	R	1	106	2.7	0.35	1.40	43.0	41.0	4346	0	5	55	40	0	100	N/A									1	1	0	0	0.5	15	0	0	0	16	0					N
Ash River	Ash 1 C	136	P	1	35		0.80	1.20	34.0	26.0	910	5	5	5	5	80	100	N/A				2.50	0.80		R	Y	0	0	0	0	0.0	3	0	15	0	18	0					N
Ash River	Ash 1 C	171	G	1	74		0.70	1.20	39.0	24.0	1776	0	5	15	10	70	100	N/A									4	1	3	0	0.5	0	0	0	1	1	1					N
Ash River	Ash 1 C	245	P	1	72	4.9	0.75	3.00	39.0	29.0	2088	0	10	20	40	30	100	N/A				1.50	0.50		BD	Y	2	1	0	1	0.0	20	0	60	0	80	0					Y
Ash River	Ash 1 C	317	R	1	43	1.1	0.60	2.00	28.0	23.0	989	0	5	15	10	70	100	N/A									1	1	0	0	0.0	5	0	0	0	5	0					N
Ash River	Ash 1 C	360	P	1	76	0.0	1.00	1.00	28.0	23.0	1748	0	15	27	8	50	100	AR	L	357	10	1.80	N/A		R	Y	0	0	0	0	0.0	10	0	80	0	90	0					N
Ash River	Ash 1 C	436	R	1	67	2.5	0.40	2.00	31.0	17.0	1139	0	3	25	7	65	100	N/A									1	1	0	0	0.0	30	0	0	0	30	0					N
Ash River	Ash 1 C	503	P	1	72	0	0.80	3.50	26.0	20.0	1440	0	0	25	30	45	100	N/A				2.00	0.75		R	Y	0	0	0	0	0.0	10	0	40	0	50	0					N
Ash River	Ash 1 C	575	P	1	83	0	1.50	1.50	28.0	23.0	1909	0	5	10	5	80	100	A	L	134	5	3.00	0.70		BD	Y	0	0	0	0	0.0	0	0	30	0	30	0					N
Ash River	Ash 1 C	658	P	1	169	0	1.20	1.50	45.0	25.0	4225	0	5	55	15	25	100	N/A				3.00	0.55		R	Y	3	1	2	0	0.0	0	0	30	0	30	1					N
Ash River	Ash 1 C	827	R	1	314	1.1	0.18	1.00	41.0	35.0	10990	0	10	70	20	0	100	N/A									8	2	3	3	0.5	5	0	0	3	9	3					N
Ash River	Ash 1 C	1141	R	1	202	1.0	0.40	2.00	29.0	22.0	4444	0	10	50	40	0	100	N/A									3	0	0	3	0.5	10	0	0	0	11	3					N
Ash River	Ash 1 C	1343	R	1	131		0.35	1.00	41.0	37.0	4847	0	10	40	50	0	100	N/A									9	1	7	1	0.5	10	0	0	0	11	3					N
Ash River	Ash 1 C	1474	P	1	83	0.0	0.45	1.30	28.0	19.0	1577	3	12	50	20	15	100	N/A				1.40	0.35		BD		1	0	0	1	0.0	1	0	15	0	16	3					N
Ash River	Ash 1 C	1557	G	1	313		0.25	1.10	32.0	21.0	6573	0	40	40	20	0	100	AR	M	3155	10						5	2	1	2	0.0	0	0	0	0	0	0					N
Ash River	Ash 1 C	1870	R	1	230	1.2	0.18	0.50	51.0	47.0	10810	0	10	60	30	0	100	N/A									6	1	3	2	0.0	0	0	0	0	0	0					N
Ash River	Ash 1 C	2100	P	1	138	0.0	0.50	0.50	45.0	28.0	3864	0	55	35	10	0	100	AR	H	2396	200	1.80	0.45		R		1	0	1	0	0.0	2	0	8	1	11	5					N
Ash River	Ash 1 B	2238	R	1	0		0.25	0.50	38.0	33.0	0	0	25	50	25	0	100	N/A									5	3	2	0	5.0	5	1	0	3	14	5					N
Ash River	Ash 1 B	2238	R	2	106		0.10	0.50	18.0	14.0	1484	1	14	65	20	0	100	N/A									2	1	1	0	1.0	3	0	10	0	14	5					N
Ash River	Ash 1 B	2308	G	1	36		0.30	0.60	25.0	20.0	720	0	20	65	15	0	100	N/A									11	3	7	1	5.0	3	0	0	0	8	5					N
Ash River	Ash 1 B	2344	R	1	130		0.20	0.40	49.0	25.0	3250	0	25	65	10	0	100	N/A									2	0	2	0	1.0	35	0	0	0	36	5					N
Ash River	Ash 1 B	2474	G	1	92		0.30	0.50	43.0	23.0	2116	0	15	70	15	0	100	N/A									0	0	0	0	1.0	3	0	0.0	1	5	1					N
Ash River	Ash 1 B	2566	R	1	75		0.20	1.30	41.0	35.0	2625	0	35	55	5	5	100	AR	H	1208	30						6	2	3	1	2.0	3	0	0	4	9	5					N
Ash River	Ash 1 B	2641	P	1	61		0.40	0.80	43.0	39.0	2379	0	15	65	20	0	100	AR	M	666	15	1.50	0.35		R	Y	3	1	0	2	3.0	8	0	20	1	32	3					N
Ash River	Ash 1 B	2641	R	2	66		0.15	0.50	10.0	6.5	429	0	15	65	20	0	100	N/A									1	0	0	1	0.0	1	0	0	0	1	0					N
Ash River	Ash 1 B	2702	G	1	72		0.20	1.00	47.0	44.0	3168	0	50	35	15	0	100	A	L	1806	50						0	0	0	0	0.0	3	0	0	0	3	0					N
Ash River	Ash 1 B	2774	R	1	180	1.3	0.20	0.40	44.0	41.0	7380	0	25	70	5	0	100	N/A									0	0	0	0	0.0	2	0	0	0	2	3					N
Ash River	Ash 1 B	2954	G	1	224	1.2	0.27	1.10	36.0	32.0	7168	0	30	65	5	0	100	N/A									7	3	4	0	0.0	0	0	0	0	0	3					N
Ash River	Ash 1 B	3178	R	1	77		0.25	0.80	37.0	34.0	2618	0	20	70	10	0	100	N/A									3	3	0	0	1.0	5	0	0	0	6	5					N
Ash River	Ash 1 B	3255	G	1	111		0.30	0.60	39.0	37.0	4107	0	28	70	2	0	100	N/A									5	0	0	0	1.0	1	0	0	0	2	3					N
Ash River	Ash 1 B	3366	R	1	121		0.21	1.00	46.0	43.0	5203	0	15	70	2	13	100	N/A									3	1	1	1	1.0	0	0	0	1	2	3					N
Ash River	Ash 1 B	3487	G	1	56		0.35	1.50	32.0	29.0	1624	0	18	80	2	0	100	N/A									2	2	0	0	0.0	2	0	0	0	2	2					N
Ash River	Ash 1 B	3543	R	1	73	1.2	0.30	2.00	37.0	33.0	2409	0	17	80	2	1	100	N/A									1	1	0	0	0.0	5	0	0	0	5	1					N
Ash River	Ash 1 B	3616	P	1	215		1.50	1.50	41.0	37.0	7955	0	50	35	0	15	100	A	L	4534	100	4.00	0.45		R	Y	5	1	2	2	0.0	0	0	90	1	91	1					N
Ash River	Ash 1 A	3831	R	1	61	2.2	0.30	2.00	26.0	17.0	1037	0	20	70	10	0	100	N/A									2	0	1	1	0.0	20	0	0	1	21	1	SC	P	200	EB, MC	N

												Percent Bed Material (range in mm)						Spawning Gravel				Pools Only					Functional LWD Tally				Cover							Off-channel Habitat				
Sub Basin	Reach	Reach location (m) [1] Sampling Fraction [2]	Habitat type [3]	Habitat category [4]	Habitat length (m)	Gradient (%)	Mean depth (m)	Bank height (m)	Bankfull width (m)	Wetted width (m)	Rearing Habitat Area (m^2) [5]	<2 mm	2-64 mm	64-256 mm	>256 mm	Bed rock	100%	Type [6]	Quality [7]	Amount (m^2)	Estimated m^2 (on site)	Maximum depth (m)	Crest depth (m)	Residual depth (m)	Control element [8]	Good holding pool? [9]	Total LWD tally	10 to 20 cm	20 to 50 cm	>50 cm	Woody debris	Boulder	Cutbank	Deep pool	Instream veg.	Total instream cover	Overhanging veg.	Type [10]	Access [11]	Length (m)	Channel Disturbances [12]	Barriers [13]
Ash River	Ash 3	511	R	1	78		0.45	1.2	24.0	22.0	1716	1	5	60	34	0	100	N/A									0	0	0	0	0.0	15	0	0	1	16	2					N
Ash River	Ash 3	523	P	2	66		0.65	0.5	14.0	12.0	792	10	10	30	15	35	100	N/A				1.30	N/A		R	Y	0	0	0	0	0.0	1	2	75	0	78	3					N
Ash River	Ash 3	589	R	1	97		0.60	1.3	35.0	31.0	3007	0	5	55	25	15	100	N/A									1	1	0	0	0.0	10	0	0	1	11	1					N
Ash River	Ash 3	686	P	1	98		1.50	0.5	56.0	51.0	4998	0	30	40	20	10	100	N/A				3.00	0.70		R	Y	5	2	0	3	0.0	0	0	85	1	86	1					N
Ash River	Ash 3	784	G	1	79		0.65	0.5	28.0	25.0	1975	5	20	60	15	10	110	N/A									2	0	0	0	0.0	0	0	8	3	11	2					N
Ash River	Ash 3	863	G	1	314		0.60	1.4	39.0	35.0	10990	0	30	60	10	0	100	N/A									7	1	4	2	1.0	0	0	0	3	4	5	SC	P	160		N
Ash River	Ash 3	1177															0																									
Lanterman	Lant 1	1863															0																									
Lanterman	Lant 1	1821	R	1	42		0.40	0.6	15.0	7.0	294	0	20	35	5	40	100	N/A				0.55					3	1	1	1	6.0	0	0	0	0	6	0					
Lanterman	Lant 1	1798	P	1	23		0.58	0.8	17.0	8.5	196	0	65	28	2	5	100	AR	L	138	15	0.85	0.35		R	Y	2	0	1	1	4.0	5	3	40	0	52	1					
Lanterman	Lant 1	1769	R	1	29		0.25	0.6	16.0	12.0	348	0	35	62	2	1	100	AR	M	165	10	0.50					0	0	0	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 1	1752	P	1	17		0.45	1	15.0	9.8	167	0	38	60	2	0	100	AR	M	83	5	0.90	0.30		R		1	0	0	1	3.0	0	0	8	0	11	0					
Lanterman	Lant 1	1686	R	1	66		0.30	0.75	16.0	9.0	594	0	15	80	5	0	100	AR	M	184	15	0.50					5	0	3	2	0.0	1	3	0	0	4	5					
Lanterman	Lant 1	1651	P	1	35		0.50	0.5	13.0	10.0	350	0	55	43	0	2	100	AR	M	223	15	1.00	0.38		R		0	0	0	0	0.0	0	0	10	0	10	0					
Lanterman	Lant 1	1581	R	1	70		0.25	1.5	16.0	12.0	840	0	50	42	8	0	100	AR	H	491	18	0.40					7	0	6	1	1.0	5	0	0	4	10	4					
Lanterman	Lant 1	1563	G	2	18		0.40	0.75	14.0	9.0	162	0	30	25	5	40	100	AR	M	57	8	0.60					0	0	0	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 1	1438	R	1	125	2.1	0.28	0.7	13.0	9.5	1188	0	30	35	5	30	100					0.45					3	0	0	3	0.0	5	0	0	0	5	15					
Lanterman	Lant 1	1413	P	2	25		1.10	2	15.0	7.0	175	1	35	44	0	20	100	AR	M	77	5	2.40	N/A		R	Y	1	0	1	0	2.0	6	0	50	0	58	0				SC, EB	
Lanterman	Lant 1	1374	R	1	39		0.40	1.3	26.0	6.3	246	0	50	42	8	0	100	N/A				0.68					1	0	0	1	0.0	10	0	0	5	15	2				EB	
Lanterman	Lant 1	1339	G	1	35	0.9	0.53	0.75	18.0	6.0	210	0	47	50	3	0	100	AR	M	120	5	0.97					0	0	0	0	0.0	0	3	20	0	23	15				MB	
Lanterman	Lant 1	1305	R	1	34	1.7	0.33	0.8	22.0	5.0	170	0	48	40	12	0	100	AR	H	95	5	0.60					4	0	2	2	5.0	0	0	0	0	5	2				MB	
Lanterman	Lant 1	1272	G	1	33		0.45	1.5	16.0	6.0	198	0	45	52	3	0	100	N/A				0.80					7	3	2	2	15.0	1	0	0	0	16	3				EB,PD	
Lanterman	Lant 1	1260	R	1	12	2.4	0.38	1.8	17.0	5.0	60	0	25	60	15	0	100	N/A				0.50					0	0	0	0	0.0	18	0	0	0	18	0					
Lanterman	Lant 1	1233	P	1	27		0.50	0.9	27.0	5.5	149	0	25	73	2	0	100	AR	H	59	25	0.90	0.28		R	Y	37	20	10	7	25.0	0	2	30	0	57	2	SC	G	100	MB, EB	
Lanterman	Lant 1	1210	R	1	23		0.30	1.1	32.0	5.5	127	0	28	70	2	0	100	N/A				0.55					3	2	0	1	20.0	0	0	0	0	20	0				EB, PD	
Lanterman	Lant 1	1191	G	1	19		0.48	1.4	14.0	11.0	209	0	28	70	2	0	100	AR	M	88	15	0.74					3	0	1	2	0.0	0	0	0	0	0	1					
Lanterman	Lant 1	1176	R	2	15		0.30	1	14.0	12.0	180	0	30	65	2	3	100	AR	L	77	8	0.60					3	1	2	0	1.0	0	3	0	0	4	1				EB	
Lanterman	Lant 1	1138	P		38		0.80	1.1	17.0	12.0	456	0	50	45	5	0	100	AR	H	269	10	0.50	0.20		R		6	1	3	2	5.0	2	1	8	0	16	0	SC	P	130	WG, MG, EB	
Lanterman	Lant 1	1117	R		21		0.23	1.2	15.0	6.5	137	0	25	72	3	0	100	N/A				0.41					18	5	5	8	0.0	0	0	0	1	1	1				MB, JM, EB	
Lanterman	Lant 1	1100	P		17		0.46	0.75	16.0	5.5	94	0	62	29	1	8	100	N/A				0.70	0.35		R	Y	12	5	5	2	5.0	0	0	40	0	45	0					
Lanterman	Lant 1	1066	R		34	2.8	0.27	1	15.0	12.0	408	0	40	55	5	0	100	N/A				0.38					0	0	0	0	0.0	0	1	0	0	1	2				EB	
Lanterman	Lant 1	1029	G		37		0.30	0.7	14.0	9.0	333	0	65	33	2	0	100	N/A				0.55					1	1	0	0	0.0	0	1	0	1	2	2					
Lanterman	Lant 1	944	R		85		0.40	1.1	16.0	12.0	1020	0	60	30	10	0	100	N/A				0.65					3	1	2	0	1.0	5	1	0	0	7	3					
Lanterman	Lant 1	935	P		9		0.50	0.75	20.0	7.0	63	0	85	10	5	0	100	AR	M	55	3	0.80	0.35		R	Y	3	0	1	2	15.0	0	0	70	0	85	0					
Lanterman	Lant 1	900	R		35	2.6	0.20	1.5	16.0	10.0	350	0	40	50	10	0	100	N/A				0.35					4	1	2	1	1.0	5	0	0	0	6	0					
Lanterman	Lant 1	889	P	2	11		0.60	1	14.0	5.0	55	0	25	65	10	0	100	AR	M	21	2	1.10	0.35		R	Y	1	0	1	0	0.0	10	8	70	0	88	0				EB	
Lanterman	Lant 1	858	R	1	31		0.20	1.5	15.0	6.0	186	0	25	65	10	0	100	N/A				0.40					4	0	2	2	8.0	5	0	0	0	13	50				MC, EB, PD	
Lanterman	Lant 1	840	P	1	18		0.65	1.5	18.0	8.0	144	0	35	59	4	2	100	AR	M	67	10	1.80	0.25		R	Y	16	5	8	3	4.0	5	0	70	3	82	3					
Lanterman	Lant 1	803	R	1	37		0.30	1.4	27.0	5.5	204	0	20	70	10	0	100	N/A				0.40					1	0	0	1	1.0	8	1	0	0	10	12	SC	P	30		
Lanterman	Lant 1	756	R	2	47		0.15	0.5	10.0	6.0	282	0	15	75	10	0	100	AR	M	85	30	0.40					2	0	0	2	2.0	2	0	8	1	13	0					
Lanterman	Lant 1	756	G	1	0	0.0	0.20	1	15.0	11.0	0	0	80	15	2	3	100	AR	M	0	2	0.70					3	2	1	0	2.0	3	1	0	0	6	1					
Lanterman	Lant 1	739	P	1	17	0.0	0.48	1.3	16.0	6.0	102	0	35	52	8	5	100	N/A				0.73	N/A		R		1	0	1	0	0.0	0	5	35	0	40	7				EB	
Lanterman	Lant 1	719	R	1	20	2.5	0.20	2.5	16.0	6.5	130	0	55	37	0	8	100	N/A				0.40					0	0	0	0	0.0	5	0	0	0	5	1				EB	
Lanterman	Lant 1	702	G	1	17		0.28	2	15.0	5.0	85	0	25	50	5	20	100	N/A				0.60					1	1	0	0	0.0	0	0	0	0	0	0				EB	
Lanterman	Lant 1	682	P	2	20		0.40	0.5	13.0	6.0	120	0	25	65	10	0	100	N/A				0.70	N/A		R		1	1	0	0	2.0	0	2	15	0	19	1				EB	
Lanterman	Lant 1	660	G	2	22		0.40	1.1	19.0	7.0	154	5	65	28	2	0	100	AR	M	109	7	0.60					1	0	1	0	5.0	0	2	0	1	8	3				DW, PD	
Lanterman	Lant 1	623	R	1	37		0.35	1.5	16.0	6.0	222	0	50	35	15	0	100	N/A				0.55					16	6	5	5	2.0	20	0	0	0	22	1	SC	P	130	JM	
Lanterman	Lant 1	479	R	1	144	1.8	0.37	1	12.0	10.0	1440	0	25	60	15	0	100	AR	H	533	10	0.70					5	1	2	2	0.0	15	0	0	0	15	5					
Lanterman	Lant 1	446	P	1	33		0.50	2	15.0	8.0	264	5	60	30	5	0	100	N/A				1.75	0.35		R		3	1	1	1	1.0	0	0	10	0	11	3					
Lanterman	Lant 1	329	R	1	117		0.35	0.5	16.0	10.0	1170	0	30	62	8	0	100	N/A				0.45					11	5	5	1	0.0	0	3	0	0	3	3	SC	P	56		
Lanterman	Lant 1	312	P	2	17		0.50	0.75	16.0	9.0	153	0	50	35	15	0	100	AR	M	87	5	0.90	0.25		R	Y					80.0	3	0	5	0	88	0					

												Percent Bed Material (range in mm)						Spawning Gravel				Pools Only					Functional LWD Tally				Cover							Off-channel Habitat				
Sub Basin	Reach	Reach location (m)[1] Sampling Fraction[2]	Habitat type[3]	Habitat category[4]	Habitat length (m)	Gradient (%)	Mean depth (m)	Bank height (m)	Bankfull width (m)	Wetted width (m)	Rearing Habitat Area (m^2)[5]	<2 mm	2-64 mm	64-256 mm	>256 mm	Bed rock	100%	Type[6]	Quality[7]	Amount (m^2)	Estimated m^2 (on site)	Maximum depth (m)	Crest depth (m)	Residual depth (m)	Control element[8]	Good holding pool?[9]	Total LWD tally	10 to 20 cm	20 to 50 cm	>50 cm	Woody debris	Boulder	Cutbank	Deep pool	Instream veg.	Total instream cover	Overhanging veg.	Type[10]	Access[11]	Length (m)	Channel Disturbances[12]	Barriers[13]
Lanterman	Lant 1	274	R	1	#REF!		0.32	1.3	14.0	8.0	#####	0	40	40	20	0	100	AR	M	#REF!	3						6	2	3	1	2.0	0	3	0	0	5	0					
Lanterman	Lant 1	260	P	1	14		0.38	0.8	12.0	9.0	126	0	10	22	5	63	100	N/A				0.60	0.32		R		8	3	4	2	8.0	1	0	0	0	9	0					
Lanterman	Lant 1	229	R	1	31		0.30	0.9	17.0	15.0	465	0	30	40	10	20	100	AR	H	177	10	1.50	0.30		R		0	0	0	0	0.0	3	0	0	1	4	0					
Lanterman	Lant 1	210	P	2	19		0.80	2	12.0	8.0	152	0	30	40	10	20	100	N/A									0	0	0	0	0.0	0	0	80	0	80	0					
Lanterman	Lant 1	162	R	1	48	2.5	0.35	0.8	18.0	10.0	480	3	20	52	20	5	100	N/A									5	0	2	3	0.0	15	0	0	0	15	3					
Lanterman	Lant 1	144	P	2	18		0.30	0.75	15.0	11.0	198	5	25	55	15	0	100	N/A				0.45	0.20		R		0	0	0	0	0.0	0	8	30	5	43	10	SC	P	15		
Lanterman	Lant 1	128	R	1	16		0.20	0.8	16.0	14.0	224	5	25	55	15	0	100	N/A									0	0	0	0	0.0	0	0	0	3	3	3					
Lanterman	Lant 1	117	P	2	11		0.30	0.8	16.0	12.0	132	5	25	55	15	0	100	AR	L	48	3	0.55	0.20		R	Y	3	2	1	0	15.0	15	10	20	5	65	5					
Lanterman	Lant 1	46	R	1	71	2.9	0.25	1	18.0	16.0	1136	1	14	50	35	0	100	N/A									5	1	2	2	1.0	30	5	0	3	39	5					
Lanterman	Lant 1	24	P	1	22		0.35	1	19.0	15.0	330	0	10	20	10	60	100	AR	M	46	2	0.60	0.20		R		3	0	1	2	0.0	10	0	15	0	25	0					
Lanterman	Lant 1	15	P	2	9		0.40	1.5	17.0	12.0	108	3	40	40	15	2	100	N/A				0.75	0.25		BD	Y	11	6	3	2	15.0	5	0	60	5	85	5					
Lanterman	Lant 1	0	R	1	15		0.18	1.5	29.0	17.0	255	3	40	40	15	2	100	N/A									3	1	1	1	1.0	15	0	0	0	16	5					
Lanterman	Lant 1	15	R	1	66	1.4	0.30	0.75	12.0	7.5	495	0	25	55	20	0	100					0.50					10	2	3	5	0.0	0	0	0	1	1	3					
Lanterman	Lant 1	81	P	2	25	0.0	0.65	2.5	9.0	5.0	125	0	25	25	5	45	100					0.90	0.25		R		5	1	3	1	0.0	0	0	25	0	25	0				JM, EB	
Lanterman	Lant 1	106	P	2	12	0.0	0.65	1.5	8.0	6.0	72	0	65	35	0	0	100					0.89	0.20		R	Y	1	0	0	1	30.0	0	0	40	0	70	0				JM	
Lanterman	Lant 1	118	R	1	16		0.30	1	17.0	5.5	88											0.40					0	0	0	0	0.0	0	0	0	0	0	0				WG	
Lanterman	Lant 1	134	P	1	23	0.0	0.40	0.7	13.0	5.0	115	0	15	25	0	60	100	AR	L	23	6	0.65	0.25		R		0	0	0	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 1	157	R	1	21		0.35	0.5	18.0	6.0	126	0	30	62	8	0	100					0.40					8	0	3	5	3.0	0	0	0	0	3	8	SC	G	83		
Lanterman	Lant 1	178	P	1	13	0.0	0.50	0.3	20.0	5.0	65	0	12	18	15	55	100					0.70	0.35		R		0	0	0	0	0.0	4	0	8	0	12	15					
Lanterman	Lant 1	191	R	1	31		0.25	1	17.0	10.0	310	0	20	40	35	5	100					0.41					1	0	1	0	3.0	20	0	0	0	23	5					
Lanterman	Lant 1	222	P	1	18		0.46	0.75	18.0	8.0	144						0					0.80	0.36		R	Y	30	15	10	5	20.0	0	0	35	0	55	0					
Lanterman	Lant 1	240	R	1	31	3.76	0.38	1.2	17.0	7.5	233	0	15	45	35	5	100					0.70					3	0	0	3	20.0	10	0	0	0	30	0					
Lanterman	Lant 1	271	P	1	14		0.40	1.8	12.0	8.0	112	0	30	35	15	20	100					0.75	0.25		R		8	2	2	4	2.0	3	0	5	0	10	5					
Lanterman	Lant 1	285	R	1	36	4.35	0.38	0.8	20.0	10.0	360	0	10	45	30	15	100					0.65	0.25		R		13	6	5	2	0.0	30	0	0	0	30	0					
Lanterman	Lant 1	321	P	1	18	0	0.60	0.7	21.0	11.0	198	0	10	30	15	45	100					0.90					9	2	4	2	15.0	0	0	0	0	15	0					
Lanterman	Lant 1	339	R	1	15		0.35	0.6	16.0	8.0	120	0	35	40	20	5	100					0.45	0.35		BD		9	4	4	1	5.0	3	0	0	0	8	0					
Lanterman	Lant 2	354	P	1	36	0	0.50	1	16.0	9.0	324	0	10	18	2	70	100					1.20					35	15	15	5	2.0	0	0	10	0	12	0					
Lanterman	Lant 2	390	R	1	51		0.50	2	18.0	5.0	255	0	2	3	0	95	100					1.10					0	0	0	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 2	441	P	1	30	0	0.60	1.5	13.0	4.5	135	0	10	20	0	70	100					1.30	0.30		R	Y	0	0	0	0	0.0	0	0	45	0	45	0					
Lanterman	Lant 2	471	G	1	33		0.45	1.5	17.0	12.0	396	0	10	15	5	70	100					1.00					3	0	2	1	0.0	5	0	0	0	5	0					
Lanterman	Lant 2	504	P	1	11	0	0.70	2	14.0	7.5	83	0	2	3	0	95	100					1.20	0.30		BD	Y	0	0	0	0	0.0	0	0	40	0	40	0					
Lanterman	Lant 2	515	R	1	103	1.76	0.18	0.75	11.0	7.5	773	0	2	3	2	93	100					0.72					2	0	2	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 2	618	R	1	83	2.04	0.28	0.65	12.0	8.6	714	0	10	15	10	65	100					0.65	0.25		R		4	1	2	1	0.0	8	0	3	0	11	0					
Lanterman	Lant 2	701	P	1	29	0	0.50	1.8	12.0	9.2	267	0	10	8	4	78	100					0.75					4	1	2	1	0.0	0	0	0	0	0	0					
Lanterman	Lant 2	730	R	1	37		0.30	0.6	10.0	8.5	315	0	25	55	12	8	100					0.58					0	0	0	0	6.0	2	0	0	0	8	0					
Lanterman	Lant 2	767	R	1	29		0.30	0.5	12.0	6.0	174	0	20	30	45	5	100					0.47	0.38		BD		4	0	2	2	0.0	8	0	0	0	8	0					
Lanterman	Lant 2	796	P	1	14	0	0.52	0.5	13.0	10.0	140	0	15	15	10	60	100					0.75					1	1	0	0	0.0	3	0	8	0	11	0					
Lanterman	Lant 2	810	R	2	9		0.20	0.5	13.0	6.0	54	0	0	0	0	100	100					0.45	0.20		BD		0	0	0	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 2	819	P	1	21	0	0.65	0.5	10.0	8.0	168	0	1	3	1	95	100					1.35				Y	3	2	1	0	0.0	0	0	90	0	90	0					
Lanterman	Lant 2	840	R	1	22		0.35	0.5	11.0	6.0	132	0	5	5	2	88	100					0.60					1	0	0	1	0.0	0	5	0	0	5	0					
Lanterman	Lant 2	862	P	1	21	0	0.60	0.8	10.0	6.0	126	0	15	13	2	70	100					1.10	0.20		BD	Y	0	0	0	0	0.0	0	0	30	0	30	0					
Lanterman	Lant 2	883	R	1	16		0.40	0.75	14.0	10.0	160	0	25	35	20	20	100					0.60					0	0	0	0	0.0	15	0	0	0	15	0					
Lanterman	Lant 2	899	P	1	21	0	0.52	0.8	15.0	11.0	231	0	7	3	5	85	100					0.85	0.26		W		1	0	0	1	4.0	0	0	0	0	4	0					
Lanterman	Lant 2	920	R	1	12		0.18	1	15.0	5.0	60	0	8	14	0	78	100	AR	M	6	3	0.35					2	0	1	1	8.0	0	0	0	0	8	0					
Lanterman	Lant 2	932	P	1	21	0	0.50	1	11.6	9.5	200	0	10	20	10	60	100	AR	M	28	2	0.85	0.22		R		0	0	0	0	0.0	10	0	0	0	10	0					
Lanterman	Lant 2	953	R	1	31	3.88	0.25	0.65	12.0	8.0	248	0	5	20	5	70	100					0.42					5	1	2	2	2.0	2	0	0	0	4	0					
Lanterman	Lant 2	984	P	1	31	0	1.50	0.45	10.0	7.0	217	0	35	10	0	55	100	AR	M	80	12	2.50	0.25		BD	Y	0	0	0	0	0.0	0	0	95	0	95	0					
Lanterman	Lant 2	1015	R	1	39	4.74	0.30	0.45	12.0	7.0	273	0	1	4	0	95	100					0.45					3	2	1	0	0.0	0	0	0	0	0	0					
Lanterman	Lant 2	1054	R	1	39	2.93	0.35	0.45	14.0	9.5	371	0	15	30	30	25	100					0.48					3	0	0	3	5.0	18	0	0	3	26	5					
Lanterman	Lant 2	1093	P	1	12	0	0.48	0.5	15.0	8.5	102	0	15	8	2	75	100	AR	M	17	5	0.90	0.35		BD		3	0	2	1	0.0	0	0	15	0	15	0					
Lanterman	Lant 2	1105	R	1	51		0.35	0.45	15.0	8.5	434	0	20	30	15	35	100					0.50					12	3	4	5	5.0	8	0	0	2	15	5					

												Percent Bed Material (range in mm)						Spawning Gravel				Pools Only					Functional LWD Tally				Cover							Off-channel Habitat				
Sub Basin	Reach	Reach location (m) [1] Sampling Fraction [2]	Habitat type [3]	Habitat category [4]	Habitat length (m)	Gradient (%)	Mean depth (m)	Bank height (m)	Bankfull width (m)	Wetted width (m)	Rearing Habitat Area (m^2) [5]	<2 mm	2-64 mm	64-256 mm	>256 mm	Bed rock	100%	Type [6]	Quality [7]	Amount (m^2)	Estimated m^2 (on site)	Maximum depth (m)	Crest depth (m)	Residual depth (m)	Control element [8]	Good holding pool? [9]	Total LWD tally	10 to 20 cm	20 to 50 cm	>50 cm	Woody debris	Boulder	Cutbank	Deep pool	Instream veg.	Total instream cover	Overhanging veg.	Type [10]	Access [11]	Length (m)	Channel Disturbances [12]	Barriers [13]
Lanterman	Lant 2	1156	P	1	29	0	1.00	0.6	18.0	14.0	406	0	15	12	8	65	100	AR	L	71	5	1.70	0.35		R	Y	0	0	0	0	0.0	2	0	90	0	92	0					
Lanterman	Lant 2	1185															0																									
Wolf	Wolf 1	0	R	1	26		0.15	0.45	26.0	6.5	169	0	65	34	1	0	100	AR	M	121	5	0.36					2	1	1	0	0.0	5	0	2	35	42	0					
Wolf	Wolf 1	26	P	1	29	0	0.38	0.5	14.0	10.5	305	3	60	37	0	0	100	AR	M	205	15	0.85	0.15		R		10	3	2	5	7.0	0	0	5	0	12	0					
Wolf	Wolf 1	55	R	1	30		0.25	1.5	14.0	9.0	270	2	55	40	3	0	100	AR	H	170	5	0.58					4	1	0	3	0.0	0	0	0	0	0	5					
Wolf	Wolf 1	85	R	1	44	1.97	0.32	1	11.0	7.0	308	0	45	40	15	0	100	AR	M	163	8	0.50					1	0	1	0	0.0	15	2	0	0	17	0					
Wolf	Wolf 1	129	P	1	10	0	0.55	1	15.0	8.0	80	0	30	55	15	0	100					1.21	0.20		R	Y	2	2	0	0	0.0	40	0	10	0	50	0					
Wolf	Wolf 1	139	R	1	29		0.25	0.75	13.5	6.0	174	0	60	38	2	0	100	AR	M	118	5	0.45					0	0	0	0	0.0	0	0	0	0	0	0					
Wolf	Wolf 1	168	R	1	29		0.40	1.5	16.0	6.0	174	0	45	30	25	0	100	AR	H	89	10	0.80					5	2	1	2	0.0	30	0	0	0	30	0					
Wolf	Wolf 1	197	R	1	62		0.28	0.75	18.0	5.0	310	0	55	43	2	0	100	AR	M	197	8	0.52					10	3	3	4	0.0	0	1	0	0	1	10	SC	G	25	EB, PD	
Wolf	Wolf 1	259	G	1	41		0.18	0.8	15.0	8.0	328	0	65	32	3	0	100	AR	H	234	20	0.45					2	0	1	1	1.0	0	0	0	0	1	0					
Wolf	Wolf 1	300	R	1	51	3.23	0.30	0.65	13.5	6.0	306	0	40	52	8	0	100	AR	H	154	15	0.50					6	0	4	2	1.0	5	0	0	0	6	0				EB, PD	
Wolf	Wolf 1	351	G	1	46		0.30	1	14.0	7.0	322	0	52	43	5	0	100	AR	H	195	30	0.62					17	5	8	4	2.0	0	5	0	0	7	0				JM, MC, EB	
Wolf	Wolf 1	397	P	1	21	0	0.45	1	12.0	6.2	130	0	80	8	2	10	100	AR	M	106	8	0.75	0.30		R		0	0	0	0	0.0	0	0	20	0	20	0				EB	
Wolf	Wolf 1	418	P	1	17	0	0.38	0.75	13.0	7.0	119	0	60	25	15	0	100	AR	M	77	2	0.75	0.25		R	Y	1	0	0	1	0.0	2	0	40	10	52	0				EB	
Wolf	Wolf 1	435	R	1	28	0	0.48	1	13.0	8.5	238	0	60	25	15	0	100	AR	L	155	5	0.35					7	2	2	3	0.0	0	0	0	0	0	0				EB	
Wolf	Wolf 1	463	P	1	14		0.45	1	15.0	6.0	84	0	70	30	0	0	100					0.85	0.17		R	Y	1	0	1	0	25.0	0	8	15	0	48	0				EB, PD	
Wolf	Wolf 1	477	R	1	93		0.15	0.5	15.0	8.5	791	0	53	45	2	0	100	AR	L	490	8	0.65					1	0	0	0	0.0	0	3	0	0	3	0	SC	P	50		
Wolf	Wolf 1	570	P	1	16	0	0.50	1.2	14.7	5.8	93	0	70	27	3	0	100	AR	L	70	2	0.90	0.32		R		0	0	0	0	0.0	0	0	15	0	15	0				EB	
Wolf	Wolf 1	586	G	1	28		0.27	0.75	11.5	5.0	140	0	60	40	0	0	100					0.60					7	3	1	3	2.0	0	3	0	0	5	0				MC	
Wolf	Wolf 1	614	R	1	9		0.35	0.75	12.0	6.0	54	0	60	40	0	0	100					0.20					4	1	2	1	25.0	0	0	0	0	25	0					
Wolf	Wolf 1	623	P	2	20	0	0.56	0.55	11.0	7.5	150	0	70	30	0	0	100					1.00	0.27		R	Y	1	0	0	1	5.0	0	30	0	0	35	0				MC	
Wolf	Wolf 1	643	R	1	51		0.15	0.5	16.0	8.5	434	0	35	60	5	0	100	AR	M	204	5	0.61					11	4	6	1	2.0	0	6	3	0	11	2				MB, EB	
Wolf	Wolf 1	694	P	1	39	0	0.40	1.1	9.5	7.5	293	0	65	33	2	0	100	AR	M	209	15	0.78	0.20		R		2	0	0	2	2.0	0	0	0	0	2	0					
Wolf	Wolf 1	733	R	1	24	3.4	0.15	0.7	15.0	5.0	120	0	65	35	0	0	100					0.30					1	0	1	0	0.0	0	0	0	0	0	0	SC	P	50		
Wolf	Wolf 1	757	P	1	14	0	0.40	0.75	14.0	5.5	77	0	75	25	0	0	100	AR	M	62	3	0.70	0.15		R	Y	4	0	0	4	40.0	0	0	15	0	55	0					
Wolf	Wolf 1	771	G	1	19		0.35	0.5	15.0	4.5	86	0	65	35	0	0	100	AR	H	62	5	0.52					0	0	0	0	0.0	0	25	0	0	25	0	WL	P	UK		
Wolf	Wolf 1	790	P	1	20		0.30	0.6	14.0	5.5	110	0	85	15	0	0	100	AR	M	97	10	0.61	N/A		R		0	0	0	0	0.0	0	0	0	0	0	0					
Wolf	Wolf 1 AV	810	R	1	15		0.15	0.45	10.5	6.5	98	0	60	40	0	0	100					0.25					0	0	0	0	0.0	0	0	0	0	0	0					
Wolf	Wolf 1 AV	825	P	1	6		0.50	0.4	8.5	3.5	21	0	70	30	0	0	100	AR	H	16	3	0.75	0.15		R		0	0	0	0	0.0	0	15	15	0	30	0					
Wolf	Wolf 1 AV	831	G	1	17		0.35	1	4.8	4.2	71	0	75	25	0	0	100	AR	M	57	6	0.50					0	0	0	0	0.0	0	0	0	0	0	8				SC,EB	
Wolf	Wolf 1 AV	848	P	1	12	0	0.70	1.5	8.5	6.0	72	0	95	5	0	0	100	AR	M	69	10	1.08				Y	1	0	0	1	15.0	0	10	55	0	80	0				SC,EB	
Wolf	Wolf 1 AV	860	R	1	26		0.20	0.5	5.5	3.0	78	0	75	25	0	0	100					0.38					0	0	0	0	0.0	0	0	0	0	0	40				SC,EB, AV	
Wolf	Wolf 1 AV	886	R	1	26		0.15	0.5	12.0	7.0	182	5	90	5	0	0	100	AR	L	166	15	0.55					10	4	5	1	5.0	0	0	0	0	5	0				MB, JM, EB, PD	
Wolf	Wolf 1 AV	912	R	1	96		0.25	0.3	2.5	2.5	240	2	75	23	0	0	100	AR	H	191	40	0.35					1	0	1	0	0.0	0	20	0	0	20	10				SC,MB,JM, AV, EB	
Wolf	Wolf 1 AV	1008	R	1	83		0.15	0.5	11.0	6.0	498	5	85	10	0	0	100	AR	L	433	25	0.25					3	0	0	3	0.0	0	0	0	0	0	0				SC, MB, JM, AV	
Wolf	Wolf 1	810	P	2	30		0.35	0.8	10.5	22.0	660	0	65	35	0	0	100					0.80	0.10		R		1	1	0	0	0.0	0	3	15	0	18	0				EB	
Wolf	Wolf 1	840	R	2	47	2.7	0.12	1	9.5	6.8	320	3	57	40	0	0	100	AR	H	208	10	0.28					16	5	5	6	0.0	0	2	0	0	2	0					
Wolf	Wolf 1	887	P	2	14	0	0.40	1.5	13.5	7.5	105	5	85	10	0	0	100					0.98	0.12		R		4	1	2	1	30.0	0	0	0	0	30	0				EB	
Wolf	Wolf 1	901	P	2	18	0	0.45	1.3	15.0	6.0	108	6	50	44	0	0	100	AR	M	64	6	0.70	0.08		R	Y	5	2	3	0	15.0	0	15	15	0	45	0				EB	
Wolf	Wolf 1	919	P	2	17		0.35	0.75	16.0	5.0	85	5	65	30	0	0	100					0.58	0.10		R		4	0	2	2	10.0	0	2	0	0	12	0				EB	
Wolf	Wolf 1	936	R	2	20		0.10	0.75	17.0	8.5	170	0	45	55	0	0	100					0.25					1	0	1	0	0.0	0	0	0	0	0	2	SC	P	50		
Wolf	Wolf 1	956	P	2	30	0	0.35	1.5	14.0	4.5	135	8	32	60	0	0	100					0.81	0.10		R		3	0	2	1	0.0	0	0	0	0	0	0				EB	
Wolf	Wolf 1	986	R	2	46		0.20	1.5	16.0	5.5	253	0	30	65	5	0	100					0.65					14	2	5	7	6.0	0	0	2	0	8	0				EB	
Wolf	Wolf 1	1032	R	2	59	3.79	0.12	0.7	13.5	8.0	472	0	30	60	10	0	100					0.25					2	2	0	0	0.0	0	0	0	0	0	0				EB	
Wolf	Wolf 2	1091	G	1	35		0.28	0.5	14.2	7.0	245	5	65	30	0	0	100	AR	H	174	60	0.42					2	0	1	1	2.0	0	0	0	0	2	0					
Wolf	Wolf 2	1126	R	1	124		0.20	N/A	13.5	8.0	992	0	30	50	20	0	100	AR	H	397	35	0.80					9	0	2	7	2.0	0	0	0	3	5	2				WG	
Wolf	Wolf 2	1250	P	1	31	0	0.40	1.1	11.0	6.5	202	0	45	35	20	0	100					0.54	0.25		R		3	1	1	1	0.0	7	0	0	0	7	0					
Wolf	Wolf 2	1281	P	1	13	0	0.42	0.5	10.0	5.5	72	0	30	25	45	0	100					0.65	0.25		R	Y	5	1	3	1	0.0	50	0	20	0	70	0					
Wolf	Wolf 2	1294	R	1	20		0.35	0.5	14.3	7.0	140	0	15	45	40	0	100					0.50					3	0	3	0	0.0	15	0	0	0	15	0					
Wolf	Wolf 2	1314	P	1	19	0	0.35	0.65	10.5	8.0	152	2	28	50	20	0	100	AR	M	58	5	0.65	0.25		R		3	0	2	1	10.0	0	0	30	0	40	0					

												Percent Bed Material (range in mm)						Spawning Gravel				Pools Only					Functional LWD Tally				Cover							Off-channel Habitat				
Sub Basin	Reach	Reach location (m) [1] Sampling Fraction [2]	Habitat type [3]	Habitat category [4]	Habitat length (m)	Gradient (%)	Mean depth (m)	Bank height (m)	Bankfull width (m)	Wetted width (m)	Rearing Habitat Area (m^2) [5]	<2 mm	2-64 mm	64-256 mm	>256 mm	Bed rock	100%	Type [6]	Quality [7]	Amount (m^2)	Estimated m^2 (on site)	Maximum depth (m)	Crest depth (m)	Residual depth (m)	Control element [8]	Good holding pool? [9]	Total LWD tally	10 to 20 cm	20 to 50 cm	>50 cm	Woody debris	Boulder	Cutbank	Deep pool	Instream veg.	Total instream cover	Overhanging veg.	Type [10]	Access [11]	Length (m)	Channel Disturbances [12]	Barriers [13]
Wolf	Wolf 2	1333	R	1	24	3.8	0.23	0.4	12.0	9.5	228	0	25	65	10	0	100					0.40					0	0	0	0	0.0	2	3	0	0	5	0					
Wolf	Wolf 2	1357	P	1	12		0.70	N/A	11.2	9.1	109	20	10	30	40	0	100	AR	M	17	2	1.70	0.20		R	Y	0	0	0	0	0.0	20	0	80	0	100	0					
Wolf	Wolf 2	1369	R	1	151	3.5	0.18	N/A	12.2	5.0	755	0	20	40	40	0	100	AR	L	211	10	0.60					11	1	4	6	1.0	40	0	0	0	41	1					
Wolf	Wolf 2	1520	P	1	9	0	0.30	1.5	9.5	6.8	61	2	18	20	60	0	100	AR	M	13	5	0.95	0.35		R	Y	0	0	0	0	0.0	20	0	35	0	55	0					
Wolf	Wolf 2	1529	R	1	63		0.17	0.5	13.2	7.0	441	1	29	64	5	1	100					0.35					8	2	1	5	2.0	1	0	0	0	3	0					
Wolf	Wolf 2	1592	P	1	18	0	0.40	0.6	23.0	5.0	126	2	90	8	0	0	100	AR	M	82	8	0.68	0.25		R	Y	13	8	1	5	60.0	0	2	20	0	82	5				SC, MB, JM, EB, PD	
Wolf	Wolf 2	1610	R	1	9		0.32	0.4	13.0	4.5	45	2	31	65	2	0	100					0.55					7	0	0	7	5.0	0	0	0	0	5	0				EB	
Wolf	Wolf 2	1619	P	1	6		0.60	0.4	12.0	5.0	27	0	60	32	0	8	100					0.90	0.20		R	Y	5	0	1	4	5.0	0	0	70	0	75	2					
Wolf	Wolf 2	1625	R	1	31	3	0.15	0.5	13.5	13.5	155	0	50	46	4	0	100					0.35					1	0	1	0	0.0	2	0	0	0	2	0				MC	
Wolf	Wolf 2	1656	P	1	19	0	0.50	0.4	8.0	4	257	2	75	13	10	0	100	AR	H	59	10	0.85	0.21		R	Y	1	0	1	0	0.0	3	0	70	0	73	0					
Wolf	Wolf 2	1675	P	1	29	0	0.60	0.3	14.0	6.5	116	1	60	35	4	0	100					1.00	0.25		R		1	0	0	1	0.0	5	0	8	0	13	0					
Wolf	Wolf 2	1656	P	2	12	0	0.45	0.4	6.0	3.5	78	2	75	13	10	0	100					0.76	0.15		R	Y	0	0	0	0	0.0	2	0	40	0	42	5					
Wolf	Wolf 2	1668	R	2	7		0.10	0.4	7.0	2.0	25	0	60	35	5	0	100					0.22					0	0	0	0	0.0	0	0	0	0	0	0					
Wolf	Wolf 2	1704	R	1	26	2.12	0.23	0.7	15.0	6.5	52	0	53	40	7	0	100	AR	H	103	8	0.55					1	0	0	1	0.0	5	0	2	0	7	0					
Wolf	Wolf 2	1773	R	1	26		0.36	1	6.5	5.5	169	0	70	27	3	0	100					0.65					0	0	0	0	0.0	6	0	0	0	6	0					
Wolf	Wolf 2	1799	P	1	9	0	0.45	1	7.0	5.0	50	1	79	18	2	0	100					0.92	0.19		R	Y	25	5	6	14	40.0	0	5	30	0	75	0				SC, JM, PD	
Wolf	Wolf 2	1808	P	2	11	0	0.50	0.75	7.0	5.5	55	0	70	25	5	0	100					0.85	0.35		R	Y	1	0	0	1	0.0	5	0	70	0	75	0				JM	
Wolf	Wolf 2	1819	R	1	20		0.15	0.7	15.0	8.5	110	0	35	60	5	0	100					0.30					6	0	3	3	25.0	0	0	0	0	25	0				SC, JM, EB	
Wolf	Wolf 2	1839	P	1	15	0	0.40	0.75	14.0	8.5	128	0	40	45	15	0	100		M	62	2	0.63	0.20		R		1	0	0	1	2.0	2	0	15	0	19	0					
Wolf	Wolf 2	1854	R	1	14		0.30	1	14.0	4.5	119	0	25	65	10	0	100					0.40					3	0	2	1	20.0	0	0	0	0	20	0					
Wolf	Wolf 2	1868	P	1	12	0	0.50	1	14.5	5.5	54	1	79	15	5	0	100					0.70	0.23		R		0	0	0	0	0.0	3	0	30	0	33	0					
Wolf	Wolf 2	1880	G	1	15	1.7	0.35	0.75	10.0	7.0	83	0	77	20	3	0	100		M	85	5	0.45					1	0	0	1	0.0	0	0	0	0	0	0					
Wolf	Wolf 2	1895	R	1	96	4.24	0.28	1	12.0	4.5	672	0	30	49	20	1	100					0.45					3	0	2	1	0.0	15	0	0	0	15	0					
Wolf	Wolf 2	1991	P	1	14	0	0.46	0.8	9.5	5.0	63	0	20	40	5	35	100		H	20	10	0.90	0.12		R		0	0	0	0	0.0	0	0	15	0	15	0					
Wolf	Wolf 2	2005	R	1	53		0.30	1.2	10.0	5.5	265	0	30	30	20	20	100					0.60					0	0	0	0	0.0	5	0	0	0	5	0				EB	
Wolf	Wolf 2	2058	P	2	12	0	0.35	1	8.0	5.2	66	0	66	30	4	0	100		M	45	7	0.52	0.20		R		4	0	3	1	1.0	0	0	0	0	1	0				EB	
Wolf	Wolf 2	2070	R	1	10		0.25	0.75	11.0	6.0	52	0	50	45	5	0	100					0.35					0	0	0	0	0.0	0	0	0	0	0	0				EB	
Wolf	Wolf 2	2080	P	1	11	0	1.20	1	12.0	8.0	66	0	60	30	10	0	100		M	58	5	1.80	0.20		R	Y	31	15	10	6	5.0	0	0	90	0	95	0					
Wolf	Wolf 2	2091	P	1	19	0	0.65	0.7	11.0	6.0	152	1	79	15	5	0	100		H	93	15	1.10	0.18		R	Y	2	0	0	2	20.0	0	25	0	0	45	0					
Wolf	Wolf 2	2110	R	1	52	2.05	0.24	0.6	12.0	4.5	312	0	25	65	10	0	100		H	89	10	0.42					34	20	10	4	1.0	0	2	0	0	3	0					
Wolf	Wolf 2	2162	G	1	22		0.33	1	13.0	6.0	99	1	35	54	10	0	100		H	60	3	0.50					1	1	0	0	0.0	2	0	0	0	2	0					
Wolf	Wolf 2	2184	R	1	28	3.36	0.28	0.5	9.5	5.5	168	0	48	45	7	0	100					0.53					2	2	0	0	1.0	5	0	0	0	6	0					
Wolf	Wolf 2	2212	P	1	11	0.0	0.38	1	5.5	4.7	61	0	15	65	20	0	100					0.80	0.25		R	Y	3	0	1	2	10.0	5	0	60	0	75	0					
Wolf	Wolf 2	2223	R	1	76		0.26	0.55	13.0	7.7	357	0	20	35	45	0	100	AR	M	158	10	0.55					0	0	0	0	0.0	30	0	0	0	30	0					
Wolf	Wolf 2	2299	G	1	24		0.30	0.45	14.0	6.5	185	0	35	45	20	0	100	AR	L	69	5	0.50					1	0	0	1	0.0	15	0	0	0	15	0					
Wolf	Wolf 2	2323	R	1	79		0.25	1	11.0	5.5	514	0	25	55	20	0	100	AR	M	156	8	0.45					4	0	2	2	0.0	5	0	0	0	5	0					
Wolf	Wolf 2	2402	P	2	13	0.0	0.30	1.2	12.0	4.0	72	0	40	40	20	0	100					0.55	0.18		R		2	0	1	1	0.0	5	0	0	0	5	0					
Wolf	Wolf 2	2415	R	1	27	3.5	0.25	0.7	10.5	7.1	108	0	25	40	35	0	100					0.48					0	0	0	0	0.0	15	0	0	0	15	0					
Wolf	Wolf 2	2442	P	1	18	0.0	0.50	0.75	8.0	5.7	128	3	80	10	5	2	100	AR	H	84	8	1.00	0.22		R		0	0	0	0	0.0	0	0	0	0	0	0					
		2460																																								

[1] Reach location denotes the distance upstream from the lower reach break.
[2] Sampling fraction is used to expand habitat measurements to the entire reach (e.g. $SF_p = 0.2$ if only 1 in every 5th pool was sampled). (N/A for this project).
[3] Habitat types are: pool (P), riffle (R), glide (G), cascade (C), other (O).
[4] Habitat categories are: primary habitat type (1), side channel (2), tertiary scour pool (3).
[5] Habitat area is calculated for rearing salmonids as length multiplied by wetted width.
[6] Spawning gravel type codes are: suitable for anadromous salmon (A), suitable for resident trout and char (R), suitable for both salmon and trout (AR), not suitable (N).
[7] Spawning gravel quality codes are: low (L), moderate (M), high (H), none (N).
[8] Control element codes are: boulder (B), bedrock (R), wood (W), beaver dam (D), culvert (CV), other (O).
[9] A pool is classified as a good adult holding pool (Y) if the product of the maximum depth times the total overhead cover is >= 30. Overhead cover is the sum of LWD, boulder, cutbank and overhanging vegetation.
[10] Off-channel habitat codes are: alcove (ALC), side channel (SC), slough (SL), pond (PD), wetland (WL), spring (SP), other (O).
[11] Off-channel access codes are: no access (N), high flow only (P), most flows (G).
[12] Disturbance indicator codes are: scour (SC), unvegetated bar (DW), sediment wedge (WG), middle-channel bars (MB), extensive riffle zone (LR), road crossing thru creek at riffle crest or pool tailout (RC), multiple channels (MC), eroding banks (EB), back-channels (BC), LWD parallel to bank (PD), LWD jams (JM), avulsion (AV), >50% silt content (E), other (O).
[13] Potential barrier codes are: none (N), log jam (X), falls > 2 m (F), culvert (CV), bridge (BR), beaver dam (BD), land slide or bank failure (LS), cascade or chute (C), other (O).

Appendix B2. Area surveyed and percentage of each primary habitat type in Ash River watershed.

Reach Number	Mean Bankfull Width (m)	Surveyed Length (m)	Surveyed Area (m^2)	Percent Habitat Type		
				Pool	Riffle	Glide
Ash 1 A	28.2	2364	55880	25.3	27.8	46.9
Ash 1 B	36.8	1695	54635	18.9	46.5	34.6
Ash 1 C	34.2	2268	64605	28.5	58.6	12.9
Ash 3	33.2	1274	42129	35.0	13.5	51.5
Ash 4 A	34.6	1655	51780	39.6	34.8	25.5
Ash 6 A	23.0	361	10339	66.0	34.0	0.0
Ash 6 C	20.2	459	8888	88.6	7.0	4.4
Lant 1	16.3	2202	19903	21.9	71.3	6.8
Lant 2	12.7	831	6755	35.5	58.6	5.9
Wolf 1	14.3	1061	7310	25.6	62.4	12.0
Wolf 1 AV	7.9	281	1260	7.4	87.0	5.7
Wolf 2	11.4	1345	8381	25.0	67.7	7.3

Appendix B3. Summary of cover attributes for Ash River watershed.

Reach Number	Habitat Unit	Percent Instream Cover Types						
		LWD / SWD	Boulder	Undercut Banks	Deep Pool	Instream Vegetation	Total Percent Instream Cover	Overhanging Vegetation
Ash 1 A	P	0.0	1.9	0.9	0.6	19.3	1.7	0.4
Ash 1 A	R	0.0	1.1	20.4	0.2	2.4	0.7	1.0
Ash 1 A	G	0.0	0.6	3.0	0.5	2.6	0.7	0.0
Ash 1 A	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 1 A	All	0.0	1.0	7.3	0.4	6.8	0.9	0.4
Ash 1 B	P	0.0	0.7	1.8	0.0	73.9	1.0	0.0
Ash 1 B	R	0.0	0.7	6.6	0.0	0.6	0.6	0.1
Ash 1 B	G	0.0	0.5	1.3	0.0	0.0	0.1	0.0
Ash 1 B	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 1 B	All	0.0	0.6	3.9	0.0	14.2	0.5	0.0
Ash 1 C	P	0.0	0.0	4.7	0.0	31.5	0.1	0.0
Ash 1 C	R	0.0	0.3	6.7	0.0	0.0	0.9	0.0
Ash 1 C	G	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Ash 1 C	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 1 C	All	0.0	0.2	5.2	0.0	9.0	0.6	0.0
Ash 3	P	0.0	0.2	3.2	0.1	68.8	2.4	0.0
Ash 3	R	0.0	0.0	11.8	0.0	0.0	1.0	0.0
Ash 3	G	0.0	0.6	2.1	0.0	3.5	3.2	0.0
Ash 3	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 3	All	0.0	0.4	3.8	0.0	25.9	2.6	0.0
Ash 4 A	P	0.0	0.6	1.3	0.3	30.4	0.0	0.0
Ash 4 A	R	0.0	0.0	4.8	0.0	0.0	0.4	0.0
Ash 4 A	G	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Ash 4 A	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 4 A	All	0.0	0.3	2.2	0.1	12.1	0.2	0.0
Ash 6 A	P	0.0	0.0	0.9	0.0	76.7	0.1	0.0
Ash 6 A	R	0.0	0.6	3.9	0.0	0.0	1.4	0.0
Ash 6 A	G	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 6 A	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 6 A	All	0.0	0.2	1.9	0.0	50.7	0.5	0.0
Ash 6 C	P	0.0	0.2	0.0	1.9	31.5	1.5	0.0
Ash 6 C	R	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ash 6 C	G	0.0	3.0	0.0	2.0	0.0	2.0	0.0
Ash 6 C	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ash 6 C	All	0.0	0.3	0.0	1.8	27.9	1.4	0.0

Reach Number	Habitat Unit	Percent Instream Cover Types						
		LWD / SWD	Boulder	Undercut Banks	Deep Pool	Instream Vegetation	Total Percent Instream Cover	Overhanging Vegetation
Lant 1	P	0.0	8.1	2.6	1.2	24.0	0.6	0.1
Lant 1	R	0.0	1.3	8.3	1.0	0.2	0.7	0.0
Lant 1	G	0.0	2.8	0.1	0.9	3.1	0.4	0.0
Lant 1	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lant 1	All	0.0	2.9	6.5	1.0	5.6	0.7	0.0
Lant 2	P	0.0	0.7	1.3	0.0	38.1	0.0	0.0
Lant 2	R	0.0	1.7	5.2	0.2	0.5	0.5	0.5
Lant 2	G	0.0	0.0	5.0	0.0	0.0	0.0	0.0
Lant 2	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lant 2	All	0.0	1.3	3.8	0.1	13.8	0.3	0.3
Wolf 1	P	0.0	7.6	1.8	3.7	8.1	0.6	0.0
Wolf 1	R	0.0	0.9	2.7	1.4	0.5	1.3	0.0
Wolf 1	G	0.0	1.4	0.0	4.8	0.0	0.0	0.0
Wolf 1	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wolf 1	All	0.0	2.7	2.1	2.4	2.4	1.0	0.0
Wolf 1 AV	P	0.0	11.6	0.0	11.1	46.0	0.0	0.0
Wolf 1 AV	R	0.0	0.8	0.0	4.4	0.0	0.0	0.0
Wolf 1 AV	G	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wolf 1 AV	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wolf 1 AV	All	0.0	1.6	0.0	4.6	3.4	0.0	0.0
Wolf 2	P	0.0	7.4	5.4	2.1	30.0	0.0	0.0
Wolf 2	R	0.0	1.7	10.9	0.2	0.0	0.5	0.0
Wolf 2	G	0.0	0.8	4.9	0.0	0.0	0.0	0.0
Wolf 2	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wolf 2	All	0.0	3.0	9.1	0.7	7.5	0.4	0.0

Appendix B4. Summary of bed material and spawning attributes for study area reaches.

Reach Number	Bed Material Composition (%)					Spawning Quantity (m^2)		Spawning Quality[3]
	<2 mm	2-64 mm	64-256 mm	>256 mm	Bedrock	Minimum[1]	Maximum[2]	
Ash 1 A	1.9	34.8	53.4	7.8	2.0	925	15528	Good
Ash 1 B	0.0	28.4	61.5	6.4	3.7	195	8214	Good
Ash 1 C	0.1	14.5	47.1	24.8	13.4	225	6041	Good
Ash 3	1.2	22.1	46.5	18.5	12.2	200	2305	Good
Ash 4 A	12.4	40.0	39.7	6.5	1.4	5220	24830	Good
Ash 6 A	2.9	24.5	8.1	5.7	58.8	575	2249	Good
Ash 6 C	8.8	72.0	12.2	2.3	4.7	285	6237	Good
Lant 1	0.4	32.8	47.2	11.2	7.2	252	3521	Good
Lant 2	0.0	11.2	15.9	8.1	64.8	27	202	Good
Wolf 1	0.7	53.2	41.4	4.6	0.2	200	3450	Good
Wolf 1 AV	3.1	81.0	15.9	0.0	0.0	99	932	Good
Wolf 2	0.7	37.5	42.6	18.1	1.1	231	2096	Good

[1] Value estimated from actual measurements of spawning area at high quality spawning gravel sites or where redds were observed.

[2] Value = (%gravels (2-64 mm) + 20 % cobbles (64-256 mm))*length*wetted width (surveyed area only).

[3] Poor is fines (<2 mm) >25%, Fair if fines >15% and uncompacted, Good if fines < =15% and uncompacted.

Appendix B5. Summary of large woody debris (LWD) attributes for study area reaches.

Reach Number	Habitat Unit	Surveyed Length (m)	Mean Bankfull Width (m)	Number of Functional LWD [1]				Total All LWD	Recommended Number of LWD Pieces [2]		
				<20 cm	20-50 cm	>50 cm	Total		10m x 0.35m pieces	10m x 0.5m pieces	10m x 0.75m pieces
Ash 1 A	All	2364	28.2	43	36	38	117	117	985	482	214
Ash 1 B	All	1695	36.8	21	22	8	51	56	706	346	153
Ash 1 C	All	2268	34.2	12	20	13	45	45	945	463	205
Ash 3	All	1274	33.2	7	7	9	23	25	531	260	115
Ash 4 A	All	1655	34.6	15	4	0	19	16	690	338	150
Ash 6 A	All	361	23.0	1	2	0	3	3	150	74	33
Ash 6 C	All	459	20.2	2	2	0	4	4	191	94	42
Lant 1	All	2202	16.3	110	126	98	334	334	918	449	199
Lant 2	All	831	12.7	26	36	24	86	86	346	170	75
Wolf 1	All	1061	14.3	39	54	54	147	148	442	217	96
Wolf 1 AV	All	281	7.9	4	6	5	15	15	234	115	51
Wolf 2	All	1345	11.4	56	61	81	198	197	560	274	122

[1] To be termed functional, a piece of LWD must be providing cover, a control element for a pool or modifying channel morphology.

[2] Modified from Cederholm et al. (1997) such that recommended volume of LWD per 100 m of stream is 80 m^3 for streams with less than or equal to 10 m bankfull width and 40 m^3 for streams with greater than 10 m bankfull width.