Chapter Three

Fish Habitat Assessments

1.0 Introduction

Subsequent to application of Overview FHAPs to study area streams, Level 1 field surveys were conducted to gather reach-specific habitat data, confirm Overview Fish Habitat Assessments and determine suitability of preliminary restoration prescriptions. Level 1 FHAP surveys were conducted along selected streams between October 17 and 26, 1998. Specific reaches of six streams (Homathko River, Cochin Creek, Chavez Creek, Mosley Creek, Valleau Creek, Cherry Creek and Butler Creek) were assessed, and supplementary data gathered for three additional streams (Horn Lake Creek, Skinner Creek and Quakie Creek). Locations of Level 1 assessments were determined based on results of the Overview FHAP and by the MELP-approved Operational Work Plan developed for the Homathko-Mosley Study Area. FHAP field forms "Level 1 Fish Distribution Data Form", "Level 1 Habitat Survey Data Form" and "Level 1 Habitat Diagnosis Summary Form" appear as Appendices 1, 2, and 3, respectively, Maps 1 and 2 are provided in Appendix 6.

1.1 Survey Planning

A start-up meeting was convened between representatives of MELP, TWA and G3 to discuss project scope, timing and deliverables. Subsequent to this meeting G3 developed an Operational Work Plan to guide field assessments. The Operational Work Plan was developed to ensure Level 1 field surveys focussed on specific stream reaches identified by the Overview FHAP (G3 Consulting Ltd, 1998), to have been subject to up-slope, in-stream or related disturbances of fish habitat. Table 3-1 (below) describes stream reaches and types of assessments proposed as part of the Overview report for Level 1 survey. Contingency plans enabled modification of the Level 1 survey to account for such factors as changing field conditions (e.g., recent disturbance not represented on 1994 air photos) and restricted access (e.g., deactivated roads, private property).

During implementation of the Level 1 survey, changes in the selection of stream reaches were implemented to best represent current habitat conditions and disturbances of fish habitat in the study area. At some sites, access or other restricting conditions (e.g., stream depth or reach length) required reaches to be further divided into sub-reaches to facilitate data collection for specific stream sections. Table 3-1 presents specific Level 1 reaches or sub-reaches of streams surveyed.

Table 3-1: Level 1 Survey Sites for Homathko-Mosley Study Area

Subbasin	Reach	Bucket	Survey Type Conducted
Homathko River	1, 4, 5, 6, 10, 11, 12, 13	327 & 327a	Stratified random subsampling and point assessment of fish habitat.
Cochin Creek	3, 5	327a	Assessment of fish habitat condition and fish presence.
Chavez Creek	1	327a	Assessment of fish habitat condition and potential fish access.
Quakie Creek	1, 3	327a	Assessment of fish habitat condition and channel stability.
Skinner Creek	5, 6, 7	338	Point assessment of fish habitat and riparian vegetation condition.
Mosley Creek	10, 11, 12	332	Stratified random subsampling.
Cherry Creek	1-1	332	Stratified random subsampling.
Butler Creek	1	332	Stratified random subsampling.
Horn Lake Creek	1	332	Point assessment of off-channel habitat condition and fish presence.
Valleau Creek	1	336	Stratified random subsampling, assessment of debris flows and bank stability.

1.2 Remaining Streams

Streams within the study area not selected for Level 1 FHAP surveys (given the low priority assigned them during Overview assessment; G3 Consulting Ltd., 1998), are listed below. Preliminary information on fish habitat for these locations may be found in the Overview, streams include:

- Stikelan Creek;
- Cheshi Creek;
- Jamison Creek;
- Lincoln Creek;
- Charlie Creek;
- Sapeye Creek;
- Quartz Creek;
- Hell Raving Creek; and,
- Sand Creek.

2.0 Bucket 327

- Homathko River WSC: 900-4069-000-000-000-000

The Homathko River, in Bucket 327, was selected for Level 1 assessment. Bucket 327 encompasses approximately 43,400 ha surrounding the east, west and north shores of Tatlayoko Lake, extending northward (upstream) from the outflow of Tatlayoko Lake to the confluence of Homathko River and Skinner Creek (Map 2, Appendix 6.0). The Homathko River is the principal drainage of this bucket and Tatlayoko Lake is considered one of its reaches. Level 1 FHAP surveys and point assessments of fish habitat condition (i.e., inspection of fish habitat characteristics without completion of WRP Forms 4 to 6) were conducted along Reaches 1, 4, 5 and 6 of the Homathko River mainstem. Tributaries of the Homathko River or Tatlayoko Lake did not receive a Level 1 assessment as Overview information suggested few impacts on fish habitat.

2.1 Homathko River (Reaches 1 to 8)

The Homathko River at Reaches 1 through 8 flows south toward Tatlayoko Lake (Map 2). This section of the Homathko River was observed to have an average bankfull channel width of approximately 10.5 m and flowed through private agricultural and residential clearings. Channel pattern was dominated by a meandering glide with sections of low gradient (<1.5%) riffle-pool; deciduous shrubs were characteristic of most riparian areas. Off-channel habitat was abundant and comprised many wetlands and side-channels.

2.1.1 Fish Distribution

Known fish species composition within the Homathko River (Reaches 1 to 8) comprised several WRP target species rainbow trout, cutthroat trout, bull trout and Dolly Varden char and non-target suckers (DFO and MELP, 1996). Adult salmonids (i.e., trout or char) were noted throughout the Homathko River during Level 1 FHAP surveys. These fish could not be collected for further identification as conditions were unsuited for electrofishing (i.e., low water temperature) and spawning fish were potentially present (e.g., bull trout). No apparent barriers to fish migration were observed in Reaches 1 to 8 (Map 2).

2.1.2 Habitat Assessment

Reaches 1, 4, 5 and 6 were assessed using FHAP techniques described in *WRP Technical Circular No. 8, Fish Habitat Assessment Procedures* (Johnston and Slaney, 1996), with supplementary techniques from other Technical Circulars: *No. 6, Riparian Assessment and Prescription Procedures* (MELP and MOF, 1998); *No. 7, Channel Condition and Prescriptions Assessment* (Hogan *et al.*, 1996, Draft 1); and *No. 9, Fish Habitat Rehabilitation Procedures* (Slaney and Zaldokas, 1997). Level 1 habitat characteristics were described using WRP field forms for those reaches that received Level 1 surveys and are provided in Appendices 1, 2 and 3. Where point assessments were made, general fish habitat

characteristics were noted and used for habitat assessment. Habitat features for remaining reaches not subject to Level 1 field surveys are described in the Overview report (G3 Consulting Ltd., 1998).

Reach 1

Reach 1 of the Homathko River was accessible through private property to a point near the shore of Tatlayoko Lake (Map 2). Approximately 400 m of Reach 1 (farthest downstream) was assessed, and point assessments of habitat condition were conducted at points upstream. The nature of the Reach 1 channel (dominated by ponds and long glides) did not permit complete assessment.

The discharge of the Homathko River to Tatlayoko Lake at Reach 1 was approximately 1.0 m^3/s during assessment (October 20, 1998). This section of stream drained an area of extensive wetland and off-channel habitat. The mainstem channel was of low gradient (i.e., <0.5%) and slow moving meanders. Channel width varied from approximately 10 m near the outflow to Tatlayoko Lake to greater than 20 m in sections of main channel ponds and pools. Substrate was generally composed of fines, with gravel present in sections of localized scour (e.g., embedded riffles). Variable amounts of fish habitat cover were provided by riparian and in-stream vegetation. The quantity of LWD was limited and largely composed of medium diameter (i.e., ~0.20 m) deciduous logs.

Canopy Cover

Riparian vegetation along Reach 1 was dominated by tall shrubs (i.e., >2.0 m height), with coniferous and deciduous trees present in some areas. The stream channel was moderately shaded by riparian shrubs that tended to overhang the stream channel, increasing canopy closure.

Holding & Rearing Habitat

Adult holding and juvenile rearing habitat was abundant in Reach 1. Mainstem pools and glides comprised a majority of the stream reach and provided deep pool cover for adult and juvenile fish.

Spawning Habitat

Reach 1 habitat suited for fish spawning was limited by substrate dominated by fines and sands. Localized gravel deposits may be present below fines in some areas; however, they were not evident during assessment. Spawning habitat may be better distributed by increasing local scour at locations of natural gravel substrates.

Off-channel Habitat

Off-channel fish habitat was abundant throughout Reach 1 and comprised ponds, wetlands and sloughs. In addition to off-channel habitat adjacent to the mainstem, fish passage to and from Tatlayoko Lake was also unimpeded, enabling fish to reach habitat in the lake.

LWD Abundance & Structure

LWD amounts were moderate in Reach 1 and composed primarily of medium to small size (i.e., ~0.20 m diameter) deciduous trees and groupings of clumped tree and shrub stems. LWD tallies were not completed due to limited assessment of the stream channel, given its pond and slough-like character. Functional LWD was not observed in Reach 1.

Reaches 2 & 3

Reaches 2 & 3 (Map 2) of the Homathko River were meandering glides of relatively low gradient (~0.5%). These reaches were not given Level 1 FHAP surveys, as Overview study results did not suggest fish habitat disturbance (G3 Consulting Ltd., 1998).

Reach 4

Reach 4 of the Homathko River (Map 2) was accessible through private property to the left bank. General channel morphology was similar to Reaches 2 and 3, dominated by meandering glides with several deep pools and limited areas of localized scour (Photo 3-1). Bank erosion at several points appeared to be depositing fines in the stream channel. Road crossings and development, (observed during Overview assessment) did not appear to affect fish habitat in this reach.

During Level 1 assessments Reach 4 was divided into Subreaches 4-1 and 4-2, permitting detailed assessments to be made of shorter stream sections. Approximately 1,200 m of the channel was assessed, and Level 1 surveys (and associated data forms) to be completed along 500 m.

Twenty-five habitat units were observed in Subreach 4-1 (Map 2) and data for each are provided in Table 3-2. Level 1 Habitat Survey Data Forms for Subreach 4-1 are presented in Appendix 2.

Table 3-2: Habitat Unit Characteristics
Homathko River Subreach 4-1

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	13	NA	12	NA
Total length (m)	121	NA	415	NA
Average length (m)	10.1	NA	34.5	NA
Average Bankfull Width (m)	9.2	NA	8.4	NA
Average Wetted Width (m)	8.4	NA	7.9	NA
Average gradient (%)	<0.5	NA	<0.5	NA
Average bankfull depth (m)	1.94	NA	0.87	NA
Average water depth (m)	1.37	NA	0.56	NA
Average bankfull surface area (m^2)	1207	NA	3477	NA
Average wetted surface area (m^2)	1102	NA	3270	NA
Total LWD	11	NA	21	NA
Functioning LWD	11	NA	9	NA
Dominant/Sub-Dominant Substrate[1]	S/G	NA	G/S	NA
Average D90 (mm)	10	NA	20	NA

[1] S=Sand: G=Gravel: C=Cobble: B=Boulder

Canopy Closure

Tall shrubs (i.e., >2.0 m) dominated riparian vegetation, and immature and mature coniferous trees were present in limited quantity. This vegetation provided poor canopy closure (Johnston and Slaney, 1996; Appendix 3), and low potential for LWD recruitment (Photo 3-2).

Holding & Rearing Habitat

Holding and rearing habitat was abundant throughout Reach 4. In sections of Subreach 4-1 where Level 1 FHAP surveys were conducted, deep pools and glides provided holding and rearing habitat. Overstream vegetation, in-stream vegetation and limited LWD provided cover in these habitat units where present, with deep pools providing additional cover.

Spawning Habitat

Habitat in Reach 4, suited to spawning of resident fish, was limited by channel morphology dominated by glides and pools. Fine sediments and sand formed the dominant substrate in a majority of Subreach 4-1, with gravel dominating substrates in isolated areas (Appendix 2). Spawning gravel was of good quality and locally present in most areas and extensively in a few glides. The substrate was evaluated as "Fair" overall (Johnston and Slaney, 1996; Appendix 3), with sand often filling interstices between gravel-pebble sized clasts. Limited riffle abundance appeared to have reduced scour, enabling sediment to be deposited throughout Reach 4.

Off-channel Habitat

Off-channel habitat was limited in Reach 4; however, the mainstem provided abundant rearing habitat and cover typical of off-channel habitat.

LWD Abundance & Structure

Reach 4 of the Homathko River contained limited amounts of functioning LWD. LWD tallies suggested a presence of less than one piece of LWD per channel width in Subreach 4-1 (Appendices 2 & 3). LWD was deciduous and generally small to medium in diameter (i.e., 20 cm to 40 cm). Although LWD was limited in distribution, overhead vegetation, pool depth and in-stream vegetation provided habitat cover in most areas.

Reach 5

Reach 5 of the Homathko River flowed through areas of dense riparian shrub vegetation and agricultural fields were present along sections of the left stream bank. A buffer, approximately 10 m wide and composed of tall shrubs, tended to separate agricultural clearings from the stream.

Reach 5 was divided into two subreaches to facilitate Level 1 surveys (Map 2). Approximately 1,000 m of Subreach 5-2 were assessed, with detailed Level 1 surveys conducted on a 500 m stream section (Map 2). Subreach 5-2 had an average wetted width of approximately 8.6 m and bankfull width of 9.2 m. Stream gradient was approximately 0.5% throughout the reach.

Table 3-3 presents stream characteristics for Reach 5.

Table 3-3: Habitat Unit Characteristics
Homathko River Subreach 5-2

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	12	NA	11	NA
Total length (m)	127	NA	358	NA
Average length (m)	10.6	NA	32.5	NA
Average Bankfull Width (m)	9.0	NA	9.3	NA
Average Wetted Width(m)	8.4	NA	8.8	NA
Average gradient (%)	0.5	NA	0.5	NA
Average bankfull depth (m)	1.46	NA	0.85	NA
Average water depth (m)	1.11	NA	0.44	NA
Average bankfull surface area (m^2)	1145	NA	3324	NA
Average wetted surface area (m^2)	1068	NA	3146	NA
Total LWD	79	NA	63	NA
Functioning LWD	52	NA	19	NA
LWD pieces per channel width	NA	NA	NA	NA
Dominant/Sub-Dominant Substrate[1]	S/G, G/S	NA	G/S	NA
Average D90 (mm)	49	NA	35	NA

[1] S=Sand: G=Gravel: C=Cobble: B=Boulder

Canopy Closure

Riparian canopy closure was dominated by a deciduous shrub layer greater than 2.0 m tall. Few coniferous trees were noted in the riparian area along this reach. Overhanging vegetation provided some cover, but canopy closure was generally lacking, with less than 20% of the stream covered through most of the surveyed reach. Lands adjacent to the stream had been cleared to the banks at some locations, although banks were heavily vegetated with grasses and appeared stable (Photo 3-3). Overall overhead cover was low along the reach (Appendix 3), reflecting the nature of riparian vegetation. This value was likely reduced by the lack of leaves on shrub vegetation at the time of the survey (October 17 to 26, 1998).

Holding & Rearing Habitat

Channel structure of Reach 5 comprised glide-pool morphology with a sand-gravel bed material and high levels of sinuosity. This structure produced abundant holding and rearing habitat suitable for adult and juvenile fish. The stream channel appeared stable, although total pool area (~26 %), was lower than anticipated. Reach 5 was assigned a “Poor” rating for Percent Pool by Area but “Good” for

both Pool Frequency and Holding Pools/km (Appendix 3). This may have been the result of slight aggradation of the streambed due to depositional infilling of pools with fine sediments. Sediment deposition (i.e., sediment wedges or bars) was noted in some areas.

Spawning Habitat

Spawning gravel was of good quality, but present only in several relatively small, localized areas, though some extensive deposits were noted. Spawning habitat appeared to be localized in most habitat units, as quality of spawning gravels was lowered by the presence of sand. Glides typically had less sand and the highest quantity of exposed spawning gravels. Substrate of Reach 5 was considered "Fair" overall, with sand often filling interstices between gravel-pebble sized clasts. Limited embedded riffles were present in some sections of Reach 5, providing additional localized spawning habitat.

Off-channel Habitat

Off-channel habitat was abundant in Reach 5, consisting of small side-channels and slough-like wetlands. A majority of off-channel habitat was separated from the mainstem by meander cut-offs and associated oxbows, with moderate to good fish access.

LWD Abundance & Structure

LWD was abundant in Reach 5 and observed to be functioning in a majority of habitat units, especially pools, where it provided approximately 20% cover (Appendices 2 & 3). A lack of large LWD (i.e., >50 cm diameter) was noted in Reach 5, associated with limited numbers of large diameter trees in the riparian area. Application of WRP habitat diagnosis (Johnston and Slaney, 1996; Appendix 3) indicated that Percent Wood Cover in Pools was “Acceptable”.

Reach 6

Selected points of Reach 6 were assessed to determine where banks were unstable and how fish habitat may be affected. Level 2 WRP data collection forms were not applicable for this reach, as in-stream fish habitat appeared similar to that of sections of Reach 5. The channel in Reach 6 appeared stable, with riffle-pool morphology and channel parameters similar to those observed and assessed on Reach 5. Limited sections of Reach 6 exhibited localized bank instability (Photo 3-4).

Canopy Closure

Reach 6 flowed through a section of mature, deciduous riparian forest, then an area dominated by tall shrubs, then finally an area of grassland. Generally, sections of deciduous forest and tall shrubs appeared to provide adequate stream cover and shading; however, stream banks with agricultural clearings did not tend to provide adequate cover (Photo 3-4).

Holding & Rearing Habitat

Holding and rearing habitat was adequate in Reach 6, with characteristics similar to Reach 5 (Photo 3-4).

Spawning Habitat

Reach 6 exhibited good spawning habitat, with localized sections of riffles to scour sediment from gravels (Photo 3-5). Quantitative assessment of spawning habitat was not completed during point assessments of Reach 6; however, those areas viewed (~300 m) contained high quantities of spawning habitat suited to resident target fish and, based on channel morphology, appeared to be typical of Reach 6.

Off-channel Habitat

Off-channel habitat was not observed in Reach 6 during Level 2 FHAP point assessments. In middle sections of the reach, where the stream channel exhibited sinuous meanders (Map 2), side-channels (observed from air photos) likely resembled off-channel habitat of Reach 5.

LWD Abundance & Structure

Reach 6 contained moderate amounts of functioning LWD noted to be dominated by deciduous trees of medium diameter (i.e., 0.20 m to 0.35 m), with little or no coniferous LWD observed. This observation was consistent with an absence of coniferous riparian vegetation adjacent to this reach.

Reaches 7 & 8

Reaches 7 and 8 were not given Level 1 FHAP assessment as little or no impact on fish habitat was identified during previous Overview assessments (G3 Consulting Ltd., 1998). Point assessments (September 17 to 26, 1998) confirmed that Reach 8 did not to require Level 1 FHAP surveys. Reach 8 exhibited moderately complex riffle-pool stream morphology, with good overstream cover and fish holding habitat; spawning and rearing habitat was suited to resident fish. The channel of Reaches 7 and 8 was noted to contain medium sized coniferous and deciduous LWD that reflected tree species composition of the riparian zone.

2.1.3 Restoration Options

Restoration of fish habitat in Bucket 327 is recommended, to focus on reducing sediment input to the Homathko River by stabilizing localized sections of bank and restoring LWD abundance and function to the stream channel. Stream bank stabilization designs should consider Level 1 Riparian Assessment (RA) results (Refer to Chapter 4 and Chapter 5 for specific Level 1 RA findings). Where bank stabilization was recommended to improve fish habitat, RA recommendations for the stream reach should be incorporated where feasible (e.g., concurrent implementation of Level 2 FHA and RA surveys along a given stream reach).

Further, it is recommended that site- and restoration-specific assessments be conducted before implementing restoration measures described in this section.

Restoration and rehabilitation techniques to be considered (from Slaney and Zaldakos, 1997) include:

- stabilization of stream banks;
- placement of LWD to increase formation of localized scour and primary pools; and,
- planting of riparian vegetation along sections of cleared stream banks to enhance stream shading and overstream cover, and to prevent (limit) livestock eroding the stream banks.

Stream Bank Stabilization

Localized erosion was observed along banks of the Homathko River. Bank instability was observed in reaches where riparian vegetation had been removed or was present in low amounts (e.g., agricultural clearings). Sediment input from unstable banks appeared to have contributed to infilling of pools and sediment accumulation in glides and depositional areas of riffles, reducing fish habitat quality in these areas. In particular, there appeared to be limited deposits of exposed gravel available for fish spawning in some reaches (e.g., Reaches 4 and 5). Fine sediments had potentially covered suitable spawning gravel over prolonged periods of deposition, reducing abundance of spawning habitat.

A majority of bank failures along the Homathko River were localized cut banks and bank slumps associated with stream meanders (possibly accelerated due to reduced bank stability along cleared areas). These sites were generally suited to bioengineering measures, and restoration options could include:

- planting live stakes;
- installing live fascines; and,
- placing LWD and boulder revetments.

LWD Placement

LWD amounts were limited in a majority of Homathko River sections assessed (Reaches 1 to 8 within Bucket 327). Coniferous trees are preferable to deciduous trees as LWD, due to long in-stream life before decomposition. Stream sections with coniferous riparian forests appeared to have more abundant in-channel LWD. Reduced amounts of functioning LWD in some reaches of the Homathko River may have lessened localized scour that contributed to sediment transport and flushing, enabling sediments to settle out and potentially cover suitable spawning gravels.

Restoring functioning LWD to the Homathko River may increase localized scour, creating suitable spawning riffles, while providing rearing and holding cover for juvenile and adult fish. Although natural pools appeared to be abundant in a majority of stream sections assessed (e.g., Reaches 4, 5 and 6; Appendix 2), many pools lacked in-stream fish habitat cover such as LWD.

Restoration options for LWD placement within the Homathko River (Reaches 1 to 8) could include:

- creating primary riffle-pool habitat;
- increasing cover in existing pools and glides;
- creating log jam habitat in primary pools;
- creating LWD/boulder reefs in primary glides; and,
- promoting (controlled) sediment deposition.

2.1.4 Potential Restoration

Select reaches of the Homathko River located in Bucket 327 (Reaches 1 to 8) are recommended for Level 2 FHAP surveys and related assessment (e.g., Channel Assessment Procedures) to determine the feasibility of implementing specific fish habitat restoration measures.

Reaches 1 to 3

Reaches 1 to 3 of the Homathko River did not appear to require point-specific fish habitat restoration. Road crossings observed along Reaches 2 and 3 during the previous Overview assessments did not tend to affect fish habitat and few or no other impacts were noted (G3 Consulting Ltd., 1998). As point sources of sediment input to these reaches may be present, it is recommended that a bank stability overview of these reaches be conducted (where feasible) as part of Level 2 FHAP surveys.

Reach 4

Sections of Reach 4 exhibited bank instability attributed to lateral stream meander and riparian vegetation removal and alteration. A bank stability overview of Reach 4 is recommended as part of Level 2 FHAP surveys, to facilitate development of site specific prescriptions. Stream bank restoration may be suited to application of bioengineering measures to specific sites. Bank stabilization should be completed along these reaches before restoring in-stream primary habitat (e.g., LWD or boulder placement to create primary pools).

Level 2 FHAP surveys of Reach 4 are recommended to assess feasibility of fish habitat restoration (Map 2). Specifically, surveys should determine the feasibility of:

- stabilizing stream banks and channels at sources of sediment input (e.g., cattle ford crossings, bank erosion);
- adding LWD to existing pools to enhance scour and pool size;
- determining if in-stream vegetation abundance in some habitat units has compromised fish habitat; and,
- developing off-channel habitat in meander-loop cut-offs.

Reaches 5 & 6

Reaches 5 and 6 of the Homathko River exhibited locations of bank instability that were sources of sediment input to the stream channel. A majority of unstable banks were situated along areas of agricultural development, facilitating access to locations where restoration is required. Level 2 FHAP surveys are recommended throughout Reaches 5 and 6 to assess methods of controlling stream sedimentation and stabilizing stream banks by applying bioengineering measures.

Where landowners express interest, fences may be installed to limit livestock access to the stream and reduce stream bank erosion. Select stream sections would remain accessible to livestock. Stream bank and channel armouring at these select sites would further control bank erosion and associated sediment input to the stream.

Stream bank erosion and sediment input to the Homathko River should be controlled before restoring in-stream fish habitat. Where stream banks appear stable and upstream sedimentation is limited, localized placement of LWD, boulders, or both may benefit fish habitat by increasing scour and exposing gravel suited to resident fish spawning. Site-specific feasibility of this type of restoration should be assessed and appropriate measures prescribed where results would immediately benefit fish of target species.

Reaches 7 & 8

The previous Overview assessment of Reaches 7 and 8 of the Homathko River did not identify impacts on fish habitat (G3 Consulting Ltd., 1998); however, it is recommended that an overview of stream bank stability be completed along sections of Reaches 7 and 8 adjacent to agricultural areas, as bank instability may occur in such areas (Map 2).

2.1.5 Site-Specific Restoration Opportunities

Data collected during Level 1 field surveys enabled preliminary prescriptions for fish habitat restoration to be developed. Site-specific data collection and verification is required prior to implementation.

Table 3-4 presents potential restoration options and sites where fish habitat may benefit from restoration and rehabilitation activities. Sites are indicated with UTM coordinates and approximate stream length potentially suited to restoration given. Prioritized restoration locations are indicated on Map 2.

Table 3-4: Potential Assessment & Restoration Activities Homathko River (Reaches 1 to 8)

Reach	UTM			Restoration Potential	Length	Priority
	Zn.	East	North			
4	10	401894	5727148	Plant riparian vegetation on eroding bank, increase bank stability with bioengineering techniques, control stream sedimentation.	Point source	High
	10	401849	5727175	Plant riparian vegetation on eroding bank, increase bank stability with bioengineering techniques, control stream sedimentation.	Point source	High
	10	401845	5727327	Plant riparian vegetation on eroding bank; increase bank stability with bioengineering techniques, control stream sedimentation.	Point source	High
	10	401951	7527023	Place LWD to enhance scouring and growth of pools; increase total pool area for reach.	600 m	Moderate
	NA	NA	NA	Develop off-channel habitat in meander loop cut-offs.	Select points	Low
5	10	401231	5728549	Plant riparian vegetation; increase bank stability at eroding banks.	Point source	Moderate
6	10	400645	5730135	Plant riparian vegetation; increase bank stability with bioengineering techniques, control stream sedimentation at livestock crossing.	Point source	High
	NA	NA	NA	Install fences to control livestock crossing of stream channel; armour select channel areas	~1,500 m	Moderate
	10 10	400760 400876	5729987 5729635	Plant riparian vegetation; increase bank stability with bioengineering techniques.	Point source	High

3.0 Bucket 327a

The following streams within Bucket 327a were selected for Level 1 FHAP surveys:

- Homathko River WSC: 900-4069-000-000-000-000;
- Cochin Creek WSC: 900-4069-901-000-000-000;
- Chavez Creek WSC: 900-4069-901-149-000-000; and,
- Quakie Creek WSC: 900-4069-911-000-000-000.

Bucket 327a comprises approximately 25,400 ha of the upper Homathko River watershed. The principal drainage is the Homathko River (Reaches 9 to 16) into which the other streams drain (Map 2, Appendix 6). Quakie Creek flows eastward into the Homathko River, entering at Reach 12. Chavez Creek and Cochin Creek flow westward, entering the Homathko River as a common channel (Cochin Creek) at Reach Break 11/12 (Map

2). Much of Bucket 327a has been subject to agricultural clearing, and public and private roads are developed throughout.

3.1 Homathko River (Reaches 9 to 16)

Waters in Reaches 9 to 16 of the Homathko River flow southward approximately 20 km from the headwaters to the boundary of Buckets 327 and 327a (Map 2). The Homathko River had a bankfull channel width between 4 m and 10 m throughout this section. Stream morphology was dominated by riffle-pool sequences, with long meandering glides along the valley floor (Reaches 9 to 11) contrasting with cascade-pool and step-pool in higher gradient upper headwater reaches (Reaches 12 to 16; Map 2).

The previous Overview Assessment (G3 Consulting Ltd., 1998) of Reaches 9 to 11 indicated a stable, riffle-pool-dominated stream channel of high to very high fish habitat values. Level 1 FHAP surveys indicated stream morphology was more dominantly pool type habitat (e.g., pools and glides) with limited riffle sections observed. This was likely a result of low stream gradient of Reaches 9 to 11. Fish habitat was noted to be of moderate to high value based on the abundance of pools and glides.

Stream gradient increased slightly upstream of Reach 11, and aggrading substrate observed during field assessment of Reach 12, and through air photo interpretation of Reach 13, limited fish habitat value (Appendix 2). Overview assessment of the Homathko River, upstream of Reach 13, suggested little valuable fish habitat and, therefore, Level 1 assessment was not warranted (G3 Consulting Ltd., 1998).

3.1.1 Fish Distribution

The Homathko River is known to contain populations of rainbow trout, cutthroat trout and Dolly Varden char (all target species), upstream from Tatlayoko Lake to Reach 14 (DFO and MELP, 1996). Adult and juvenile resident target salmonids were noted throughout Reach 11 during Level 1 assessments. Resident fish are suspected to inhabit sections of the Homathko River upstream of Reach 14 to the headwaters, as gradient barriers were not identified during Overview air photo interpretation (G3 Consulting Ltd., 1998; Map 2). Bull trout are known to be present from Reach 11 downstream to Tatlayoko Lake (DFO and MELP, 1996) and are also suspected upstream (Reaches 12 to 16), as gradient did not appear to be a barrier (i.e., stream gradient does not exceed 20%). Bull trout populations are known to inhabit relatively high-gradient streams (MELP and MOF, 1995).

3.1.2 Fish Habitat Assessment (Reaches 9 to 13)

Sections of Reaches 10, 11, and 12 were assessed during Level 1 FHAP surveys (October 17 to 26, 1998). Sections of Reaches 9 and 13 were given concurrent point assessments of fish habitat (to confirm findings of Overview air photo

interpretation (G3 Consulting Ltd., 1998). Methods applied were similar to those used for FHAP surveys of Reaches 1 to 8 (Section 2.0).

Reach 9

Overview FHA assessments of Reach 9 (G3 Consulting Ltd., 1998) identified potential impacts to fish habitat associated with a public road crossing of the stream channel and limited agricultural activity adjacent to the stream channel in upper sections of the reach. Point inspections of fish habitat were conducted along Reach 9 to determine potential impacts associated with the road crossing and agricultural clearings. These assessments (conducted October 17 to 26, 1998) found little or no impact on fish habitat of Reach 9 (i.e., stream section appeared in natural condition). A bridge crossing the Homathko River (along a public road) did not appear to affect fish habitat of Reach 9. Coniferous riparian forests appeared to provide adequate stream cover and supply moderate amounts of LWD to the stream channel.

Reach 10

Approximately 1,000 m of Reach 10, predominantly wetland habitat, was surveyed. Level 1 FHAP assessments were conducted; however, it was determined that stream channel characteristics were not applicable to data collection on standard WRP Stream Habitat Survey Forms (as presented in Appendix 2), given the consistent glide/slough nature of the stream channel and a lack of distinct habitat units (Photo 3-6).

Reach 10 had an average bankfull channel width of 6.50 m and wetted width of 6.30 m. Average stream gradient was less than 0.5%, with an average water depth of 0.45 m, and bankfull depth of 0.65 m. Channel morphology throughout appeared to be a continuous glide, with a dominant silt/sand bed material and moderately meandering channel. Channel banks were undefined in some areas where the surrounding riparian zone consisted of flooded wetland.

Canopy Closure

Riparian vegetation consisted predominantly of herbs and grasses that provided little or no canopy closure. Shrubs were present in some riparian areas, but contributed little stream shading or fish habitat cover. Refer to Level 1 Riparian Assessment findings (Chapter 4) for riparian assessments of Homathko River Opening 1 (Reach 10).

Holding & Rearing Habitat

The dominant glide nature of Reach 10 provided good holding and rearing habitat, although the grassland character of riparian areas limited stream cover. In-stream vegetation provided approximately 15% fish habitat cover throughout Reach 10, while overstream vegetation provided less than 5% cover.

Spawning Habitat

Little or no spawning habitat suitable for resident fish was observed in Reach 10, due to the dominant sand and fines of bed material. Given relatively low gradient (<0.5%), Reach 10 was noted to lack riffles and sections of localized scour characteristic of spawning habitat.

Off-channel Habitat

Little off-channel habitat was observed along Reach 10; however, the predominant glide nature of the stream channel provided fish habitat with characteristics generally associated with off-channel habitat condition (e.g., holding and rearing habitat).

LWD Abundance & Structure

LWD was not observed in Reach 10, reflecting the absence of a treed riparian area along this section of stream (Photo 3-6).

Reach 11

Reach 11 was a relatively long stream section (~1,800 m) that was subsequently divided into two subreaches for the purpose of Level 1 surveys.

Fish habitat characteristics of Subreach 11-2 (Map 2) were assessed for a distance of approximately 1,000 m. Level 1 random stratified subsampling was conducted on 25 distinct habitat units over a stream section of approximately 350 m (Appendix 2).

Subreach 11-1 received spot assessments near the confluence of Cochin Creek (Map 2). The channel of Subreach 11-1 was dominated by riffle-pool morphology and a gradient between 0.5% and 1.0%. Riparian vegetation consisted of mixed forest, with areas of natural wetlands and cleared stream bank. LWD was abundant and influenced stream morphology, where riparian areas contained trees to contribute to LWD recruitment.

Channel morphology of Subreach 11-2 was dominated by a glide-pool pattern with a moderate amount of sinuosity (Photo 3-7). The stream channel meandered through floodplain soils and was moderately entrenched in most areas (0.5 m to 1.0 m naturally eroding cutbanks were present). Livestock crossings in some areas had associated bank erosion and likely contributed to moderate levels of localized streambed sedimentation (Photo 3-8). Point sources of natural stream bank erosion associated with relatively high stream sinuosity were also identified (Appendix 2). The total area of Reach 11 occupied by pools was <40%. The streambed may have been slightly aggraded by fines supplied by cutbanks and livestock crossings, resulting in infilled pools where flow velocity was reduced.

Table 3-5 presents stream parameters and habitat characteristics for Subreach 11-2.

Table 3-5: Habitat Unit Characteristics
Homathko River Subreach 11-2

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	12	NA	13	NA
Total length (m)	65	NA	244	NA
Average length (m)	5.4	NA	18.8	NA
Average Bankfull Width (m)	4.8	NA	3.9	NA
Average Wetted Width(m)	4.3	NA	3.6	NA
Average gradient (%)	0.5	NA	0.5	NA
Average bankfull depth (m)	0.90	NA	0.77	NA
Average water depth (m)	0.59	NA	0.44	NA
Average bankfull surface area (m^2)	311	NA	953	NA
Average wetted surface area (m^2)	279	NA	880	NA
Total LWD	11	NA	15	NA
Functioning LWD	7	NA	6	NA
Dominant/Sub-Dominant Substrate[1]	Sand/Gravel	NA	Gravel/Sand	NA
Average D90 (mm)	49	NA	NA	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Canopy Closure

Lower sections of Reach 11 (Subreach 11-1; Map 2) exhibited mixed forest riparian vegetation more diverse than that of Subreach 11-2, which was dominated by tall shrubs and grasses (Appendix 2). Transitional areas between these subreaches had higher levels of canopy closure (~40% to 70%) than areas in upper sections of Subreach 11-2 (0% to 20%).

Holding & Rearing Habitat

Glides and pools generally dominated the Reach 11 channel, with limited riffle sections noted. Pool size was relatively small (i.e., ~6 m^2), reflecting the narrow to medium stream width observed in Reach 11 (i.e., ~2.0 m to 6.0 m bankfull width; Appendix 2). By applying WRP fish habitat diagnosis (Johnston and Slaney, 1996; Appendix 3), Reach 11-2 was evaluated as "Poor" for Percent Pools by Area, but had an acceptable Pool Frequency. As observed in downstream reaches (i.e., Reaches 5 & 6), infilling of pools by fine sediments may have reduced the number and size of pools.

Spawning Habitat

As anticipated, Reach 11 spawning habitat was highly influenced by stream substrates. Where the dominant substrate was sand, localized patches of

spawning gravels were present. By contrast, spawning habitat was more extensive where gravel dominated the substrate (Appendices 2 & 3). Throughout Reach 11, the presence of fines likely reduced quality of available spawning gravels by filling interstices. Where localized scour or riffles were observed, fines did not settle on the substrate and spawning habitat was improved in quality and quantity.

Off-channel Habitat

Subreach 11-2 had limited off-channel habitat near the confluence of Cochin Creek (Map 2) and areas of observed beaver activity. Side-channel habitat (~50 m) was present near the confluence of Cochin Creek and, slightly upstream, a 20 m side-channel provided access to a beaver pond during high flows.

LWD Abundance & Structure

LWD was present and functioning in riparian forest section of Subreach 11-1, but not in the section of the stream flowing through agricultural lands (Subreach 11-2) where riparian vegetation was dominated by grass and shrubs. LWD cover was low in Subreachs 11-1 and 11-2 (Appendices 2 & 3); however, high channel banks and overhanging grasses and shrubs provided adequate cover in most areas.

Reach 12

Fish habitat of Reach 12 was assessed for approximately 1,400 m with Level 1 characteristics documented for approximately 550 m (Map 2: Appendix 2). The Reach 12 channel was observed to deviate from the course delineated on base maps produced as part of the previous Overview Assessments (TRIM and Forest Cover maps), indicating channel instability in the area. Other indications of channel instability, observed during Overview air photo interpretation (G3 Consulting Ltd., 1998), were confirmed during the Level 1 Assessment (October 17 to 26, 1998). Specifically, these included sections of channel aggradation, signs of debris flow, evidence of retaining bank construction (anthropogenic; Photo 3-9) and alluvial deposits and fans.

Sections of Reach 12 appeared to have been recently channelized (i.e., within 10 years) to prevent the stream from flooding onto agricultural land adjacent to the left bank. Sections of irrigation ditch created by local land owners may periodically contain water and contribute to seasonal fish habitat of Reach 12; however, residual pools were not observed in these ditches during Level 1 surveys.

Throughout Reach 12, the stream channel appeared unstable and aggraded, likely the result of debris flow. Evidence of debris flow observed included:

- clasts deposited in the stream larger than those potentially carried by peak flows;
- boulders and debris in the forest adjacent to the stream;
- marks made by boulders on tree trunks in the forest;

- channel abandonment (~350 m; Photo 3-9);
- large in-stream sediment/debris wedges (Photo 3-10); and,
- decreased channel depth and increased channel widening.

The source of debris flow appeared to be a large scarp located upstream (Reach 14; Map 2) where the creek was confined within a narrow canyon. Lower sections of Reach 12 exhibited less obvious evidence of disturbance, but the lack of an entrenched, well-established, channel suggested that lateral channel migration had occurred recently.

Table 3-6 presents stream parameters and fish habitat characteristics of Reach 12.

Table 3-6: Habitat Unit Characteristics
Homathko River Reach 12

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	5	9	NA	NA
Total length (m)	20	522	NA	NA
Average length (m)	4.0	58	NA	NA
Average Bankfull Width (m)	4.2	4.5	NA	NA
Average Wetted Width(m)	2.7	3.2	NA	NA
Average gradient (%)	0.5	2.1	NA	NA
Average bankfull depth (m)	0.64	0.48	NA	NA
Average water depth (m)	0.37	0.18	NA	NA
Average bankfull surface area (m^2)	84	2349	NA	NA
Average wetted surface area (m^2)	54	1670	NA	NA
Total LWD	8	34	NA	NA
Functioning LWD	7	16	NA	NA
Dominant/Sub-Dominant Substrate[1]	G/S	G/C	NA	NA
Average D90 (mm)	70	106	NA	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Canopy Closure

Levels of canopy closure observed along Reach 12 of the Homathko River were varied. Lower stream sections had relatively dense deciduous shrub and tree cover, while upper sections (near Reach Break 12/13) were less densely covered by deciduous and coniferous trees (Appendix 2).

Holding & Rearing Habitat

Fish holding habitat was limited by the low number and small size of pools (Appendix 2). Where pools were present, overstream vegetation provided moderate cover, while deep pool habitat and LWD cover was limited.

Spawning Habitat

Reach 12 had moderate deposits of gravel suitable for spawning resident fish (i.e., between ~10 mm and ~75 mm diameter; Johnston and Slaney, 1996; Appendix 2); however, stream instability associated with channel aggradation and lateral migration reduced the potential quality of spawning habitat.

Off-channel Habitat

No off-channel habitat was observed along Reach 12.

LWD Abundance & Structure

LWD was limited in distribution (Appendix 2) and appeared in small cluster groups associated with mass wasting. LWD was observed to function in stream morphology at some locations; however, limited distribution reduced potential influence on primary habitat formation and localized stream cover (Appendix 3).

Reaches 13 to 16

Point assessments of fish habitat and channel stability were conducted along Reach 13 near Reach Break 12/13. Natural channel aggradation noted was likely the result of upstream input of clasts and sediment associated with a large scarp in Reach 14. Substrate of Reach 13 (and sections of Reach 12) was observed to be fragmented, indicating relatively recent deposition in the stream channel. Colour of stream substrate in Reach 13 was similar to that of bedrock material of bank sections of Reach 14, further implicating the scarp (in Reach 14) as the source of debris flow input to Reaches 12 and 13. Forest Cover (FC) maps of the region describe stream banks (upstream of Reach 13) as consisting of extremely fragile or unstable soils (MOF, 1993).

Sections of the Homathko River upstream of Reach 13 were not assessed during Level 1 FHAP surveys as only localized impacts on fish habitat were identified during Overview assessment (e.g., localized input of debris to Reach 14; G3 Consulting Ltd., 1998). Air photo and field observations (October 17 to 26, 1998) indicated these reaches will likely continue to contribute sediment and debris to the stream channel and influence downstream morphology due to relatively unstable soils comprising the stream banks (MOF, 1993).

3.1.3 Restoration Options

Sections of the Homathko River located in Bucket 327a (Reaches 9 to 16) exhibited various impacts on fish habitat associated with clearing of stream banks, a lack of LWD, and natural aggradation of the streambed. Activities to stabilize the stream bank should consider Level 1 RA results (Chapter 4). Where bank stabilization is recommended for improving fish habitat, RA recommendations for the stream reach should be incorporated where feasible (e.g., simultaneously conducting Level 2 FHA and RA surveys along a given stream reach).

Quality of fish habitat in specific reaches may benefit from restoration measures. It is recommended that site- and restoration-specific assessments be conducted before implementation of restoration measures described in this section. Restoration and rehabilitation techniques (Slaney and Zaldakos, 1997) to be considered should include:

- stabilization of stream banks;
- placement of LWD to increase localized scour and primary pool formation;
- planting of riparian vegetation in sections of cleared stream banks to enhance stream shading and overstream cover and prevent livestock erosion of the stream banks; and,
- conducting a channel assessment procedure in upper reaches (i.e., Reaches 13 and 14) to determine if streambed stabilization is feasible.

Bank Stabilization

In Bucket 327a reaches of the Homathko River (Reaches 9 to 16), application of bioengineering methods may stabilize banks. Eroding banks were observed to contribute sand and fine sediment to the stream and appeared to be the source of some streambed aggradation and infilling in downstream reaches (e.g., Reaches 4 to 8). Specifically, stream banks along sections of Reaches 11 and 12 should be assessed to determine if bioengineering is feasible.

A majority of bank failures along the Homathko River appeared to be localized cut banks and bank slumps. Livestock crossings may act to accelerate localized stream bank erosion (e.g., Reach 11-2). Bank erosion sites were generally suited to bioengineering and stabilization measures, including:

- planting live willow stakes;
- increasing riparian vegetation to discourage livestock from crossing the stream channel;
- installing live fascines; and,
- placing LWD and boulder revetments.

LWD Placement

Restoring functioning LWD within the Homathko River may increase localized scour and create suitable spawning riffles, while providing rearing and holding cover for juvenile and adult fish. Natural deep pool and glide habitat was abundant in several reaches of the Homathko River (e.g., Reaches 9 to 11); however, some of these regions exhibited reduced abundance of LWD to provide in-stream cover (e.g., Reaches 10 and 11; Appendix 3). Specific restoration measures for LWD placement within the Homathko River (Reaches 9 to 16) could include:

- creating primary riffle-pool habitat;
- increasing cover in existing pools and glides;

- creating log jam habitat in primary pools;
- creating LWD/boulder reefs in primary glides; and,
- promoting (controlled) sediment deposition.

3.1.4 Potential Reach Restoration

Reach 9

Reach 9 of the Homathko River did not exhibit impacts on fish habitat associated with upslope activity or limited agricultural clearing of the banks (Map 2). Restoration of fish habitat is not recommended for Reach 9.

Reach 10

Reach 10 of the Homathko River corresponds to Riparian Opening 1. Reach 10 had a typical homogenous glide channel, and little or no riparian vegetation or LWD was present (Photo 3-6). This reach appeared to be a naturally occurring low gradient wetland fish habitat. Sections of the Reach 10 channel lacked defined banks and riparian vegetation consisted of grasses and rushes. Little or no disturbance of fish habitat was observed to be associated with agricultural activities.

It is recommended that riparian prescriptions be implemented (where feasible) to enhance stream shading, bank stabilization and development of a riparian buffer. In-stream restoration of Reach 10 does not appear necessary, given relatively low gradient (<0.5%) and abundance of natural deep pool and glide habitat (Appendices 2 & 3).

Reach 11

Subreach 11-1

Subreach 11-1 is recommended for an LWD tally and Level 2 FHAP surveys to determine feasibility of LWD placement; concurrent Level 2 RA surveys are also recommended. Localized scour may be increased through LWD placement, providing localized fish spawning habitat. LWD may increase s Refer to Chapter 4.0 and Chapter 5.0 for more details of riparian objectives for Reach 11.

Subreach 11-2

Subreach 11-2 may benefit from measures taken to stabilize banks and LWD placement at select points. Bank instability associated with livestock crossing the stream likely contributes sediment to the stream at various points along Subreach 11-2 (Photo 3-8). Level 2 FHAP surveys are recommended to determine appropriate prescriptions for stabilizing stream banks through bioengineering measures. Where land owners express interest, fencing may be prescribed to control livestock crossing of the stream channel. Fence placement would be prescribed in conjunction with land owners and would consider select livestock access points to the stream. Stream channel armouring at these points would

reduce bank and channel erosion. Fencing of the riparian zone would promote growth and restore function of riparian vegetation.

Sand and gravel were the dominant and sub-dominant substrates of Subreach 11-2 (Appendix 4) and there was less fine sediment in Reach 11 than in downstream reaches (e.g., Reaches 5 and 6). Level 2 FHAP surveys are recommended to determine appropriate prescriptions for restoring spawning habitat by increasing localized scour through LWD placement.

Reaches 12 to 14

Reaches 12 to 14 of the Homathko River exhibited natural historic mass wasting and debris deposition. The channel in Reaches 12 and 13 was laterally unstable and appeared to be downcutting and degrading in Reach 14. A Channel Assessment Procedure (CAP) survey is recommended before prescriptions are developed to restore or rehabilitate fish habitat. Further, it is recommended land owners be contacted for further information regarding recent channel activities along Reaches 12 and 13 (e.g., frequency of recent known debris flows).

Reaches 15 & 16

Air photo interpretation of Reaches 15 & 16 of the Homathko River indicated CAP overview assessment may identify channel stabilization opportunities for these reaches. No fish habitat restoration is currently recommended for these reaches.

3.1.5 Specific Restoration Opportunities

Data collected during Level 1 surveys enabled the development of recommended fish habitat restoration prescriptions for specific reaches. These prescriptions are preliminary and require that data be collected specific to restoration before implementation.

Table 3-7 presents potential restoration options and sites at which fish habitat may benefit from restoration or rehabilitation activities. Sites are identified with UTM coordinates and approximate stream length suited to restoration is given. Prioritized restoration locations are indicated on Map 2.

Table 3-7: Potential Assessment & Restoration Activities Homathko River (Reaches 11 to 14)

Reach	UTM			Restoration Potential	Length	Priority
	Zn.	East	North			
11-2	10	397920	5737470	Plant riparian vegetation along banks in open cleared areas to improve stream cover and reduce bank erosion.	~300 m	High
	10	397821	5737641	Control stream sedimentation at cattle and road crossings.	Select points	High

	NA	NA	NA	Provide fencing to control livestock crossing of stream channel; armour select channel areas	~5,000 m	Moderate
	10	397902	5737550	Increase scour and hydraulic complexity in glides with LWD and rootwads.	~500 m	Moderate
	10	397957	57377499	Develop off-channel areas as fish habitat .	~150 m	Low
12, 13, 14	NA	NA	NA	Require CAP prior to any habitat restoration work.	NA	Moderate

3.2 Cochin Creek

Cochin Creek flows westward approximately 15.7 km, draining two small unnamed lakes, and forms the inlet source and outlet drainage of Cochin Lake (Reach 4; Map 2). Chavez Creek flows into Reach 3 of Cochin Creek from the northeast (Map 2). Bankfull channel width of Cochin Creek was approximately 2.5 m, with riffle-pool morphology being the dominant channel type, and some reaches having step-pool morphology. The stream channel appeared stable in reaches with riffle-pool morphology (Reaches 1, 3 and 5), with this characteristic providing potentially high fish habitat value.

Two distinct sections of Cochin Creek were assessed during Level 1 FHAP surveys and point assessments: Reach 3, the outlet of Cochin Lake, and Reach 5, the inlet to Cochin Lake. As part of the Overview FHAP (G3 Consulting Ltd., 1998), Cochin Lake was designated Reach 4; however, was not assessed during Level 1 surveys as lakes are not within the scope of Level 1 FHAPs. Level 1 FHAP surveys determined that Level 1 Fish Habitat Survey Data Forms (Appendix 2) were not suitable for assessment of Reach 3 of Cochin Creek due to the highly homogenous stream characteristics associated with apparent past channelization (i.e., ~700 m of homogenous irrigation ditch).

3.2.1 Fish Distribution

The previous Overview assessment of Cochin Creek (G3 Consulting Ltd, 1998) determined that rainbow trout and bull trout were present in Cochin Lake and Cochin Creek downstream of Reach 6. A culvert below the Tatlayoko-Chilko Lake public road appeared to be a barrier to fish passage (Reach Break 2/3). Cochin Lake was noted to contain resident rainbow trout and bull trout (DFO and MELP, 1996) and local property owners confirmed that fish (rainbow trout) spawn in sections of Reach 5. The fisheries branch of MELP indicated presence of bull trout has not been reported in creel census data from Cochin Lake and this fish species likely inhabits sections of Cochin Creek where certain habitat characteristics may be more suitable (e.g., water temperature; Dolihan, 1999). Sections upstream of Reach 5 were not assessed during Level 1; however, fish presence in these reaches (Reaches 6 to 10) is likely, as gradient barriers were not observed during Overview aerial reconnaissance (G3 Consulting Ltd., 1998).

3.2.2 Fish Habitat Assessment

Point assessments of Cochin Creek during Level 1 FHAP surveys of the region confirmed potential disturbances to fish habitat, initially identified during the Overview assessment (G3 Consulting Ltd., 1998), in Reaches 3 and 5. A culvert identified as forming Reach Breach 2/3 was observed during Level 1 surveys to present a barrier to fish passage upstream (Photo 3-11; Map 2, Appendix 6).

Reaches 1 & 2

Cochin Creek Reaches 1 and 2 did not to require a Level 1 FHAP survey, as the Overview assessment indicated little or no disturbance of fish habitat (G3 Consulting Ltd. 1998). Point assessments of Reach 1 during Level 1 surveys (October 17 to 26, 1998) confirmed that fish habitat exhibited little or no impact. Reach 2 was not assessed.

A double pipe culvert that formed Reach-Break 2/3 presented a barrier to fish passage upstream (Photo 3-11). Two parallel 60 cm diameter corrugated steel pipes had a 0.55 m outflow drop with a 0.35 m outlet pool depth. The outlet drop (0.55 m) in combination with the outlet pool depth (0.35 m) exceeded maximum jumping height of target fish species of the region (MELP, 1997a).

Reach 3

Reach 3 was divided into two subreaches, based on fish habitat characteristics. The stream section immediately upstream of Reach-Break 2/3 was designated Subreach 3-1 (upstream ~500 m to a culvert under a private road). Subreach 3-2 was assigned to the remaining section of Reach 3, extending upstream to Cochin Lake (Map 2).

Subreach 3-1

Immediately upstream of the culverts forming Reach Break 2/3, the Cochin Creek channel had suitable fish habitat. The channel had a gradient of approximately 1.0%, an average wetted width of approximately 1.34 m and an average bankfull width of approximately 1.5 m. Average water depth was 0.11 m, with average bankfull water depth 0.27 m. Bed material was gravel and sand. Subreach 3-1 had riffle-pool morphology with stable streambed and banks and a moderately entrenched channel.

Fish habitat was observed to be composed of approximately 60% glide, 25% pool and 15% riffle. Pool frequency was a distance equal to approximately four times the bankfull width (5 m to 6 m). Abundant LWD and SOD were observed but not considered barriers to fish passage. Riparian vegetation consisted of mature, mixed forest with canopy closure of between 70% and 90%, providing good overhead stream cover. Spawning gravel of a type suited to resident populations of target fish species was present (i.e., between ~10 mm and 75 mm diameter; Johnston and Slaney, 1996). No off-channel habitat was observed. A culvert under a private road, forming the reach break between Subreach 3-1/3-2, was determined suitable for fish passage.

Subreach 3-2

The Cochin Creek streambed along Subreach 3-2 appeared to have been channelized for a distance of approximately 750 m directly downstream of Cochin Lake outlet (Map 2).

Reach 3-2 of Cochin Creek was traversed from a point upstream of the culvert forming Reach Break 3-1/3-2 to the edge of Cochin Lake. Reach 3-2 was a straight section of stream channel (~700 m long) separated from adjacent agricultural land by an open, grassy riparian area with few shrubs (refer to Cochin Creek, Riparian Opening 1, Chapter Four). The channel appeared stable with well-vegetated banks and bed material composed largely of fines. Flow was reduced at the time of Level 1 FHAP surveys (October 17 to 26, 1998), and sections of the channel exhibited wetland fish habitat characteristics.

The stream channel of Reach 3-2 had an average estimated wetted width of 1.5 m and average estimated bankfull width of 1.75 m. The average estimated water depth was 0.20 m and average bankfull depth 0.80 m. The gradient of Subreach 3-2 was approximately 0.5 % and the two culverts examined appeared passable by fish. Reach 3-2 was of low fish spawning potential, given that little or no gravel substrate was observed; it may, however, provide holding and rearing habitat and fish access between Cochin Lake and Subreach 3-1.

An apparent irrigation ditch parallel to Subreach 3-2 (approximately 300 m east; Map 2) was also assessed; however, water in it appeared to flow toward Cochin Lake and was not part of the Cochin Creek subbasin. During higher water flow it is suspected water enters this ditch from Cochin Lake and potentially flows into Cochin Creek through a series of channelized irrigation ditches. A wetland (associated with Chavez Creek) was observed approximately 100 m upland from the culvert forming the reach break between Subreaches 3-1/3-2 and may contribute limited ground flow water to this ditch.

The ditch parallel to Subreach 3-2 was approximately 660 m long and may have provided off-channel rearing and holding habitat for juvenile and adult fish. The ditch, which had a low gradient (0.5%), had stable banks and channel. Stream banks were well vegetated and the channel had a fine sediment substrate. The bankfull channel width was approximately 6.0 m at Cochin Lake, narrowing to approximately 2.5 m at its opposite end (Photo 3-12).

Reach 4

Cochin Lake comprised Reach 4 and was not assessed, as lakes are not within the scope of Level 1 FHAPs.

Reach 5

Reach 5 of Cochin Creek was situated immediately upstream of Cochin Lake (Map 2). Point assessments of fish habitat were conducted along ~980 m of relatively homogenous riffle-pool stream that flowed through agricultural lands. The lowermost section of channel (~400 m) had sparse riparian vegetation composed of scattered deciduous trees and tall shrubs. LWD was limited to three pieces in this section. Approximately 400 m upstream from Cochin Lake, both banks were buffered by a mature, deciduous riparian forest approximately 10 m wide. This buffer provided increased stream cover and improved LWD supply (Photo 3-13).

The Reach 5 channel was relatively homogenous in morphology and characteristics. Average bankfull width was approximately 2.4 m and average wetted width of approximately 2.0 m. Gradient was 2.5%, with riffle-pool channel morphology and cobble-gravel bed material. The channel was straight with few meanders. Average water depth was approximately 0.10 m, with an average bankfull depth 0.20 m.

Spawning habitat appeared to be of moderate-to-high quality in localized areas; however, the number of holding and rearing pools was limited in Reach 5. Local residents reported moderate to high rainbow trout use of Reach 5 for access to upstream spawning habitat, indicating fish generally bypassed potential spawning habitat of Reach 5. Predation of fish by mammals and birds was reported by residents to be relatively intense in Reach 5 during the spawning season, which suggested little overstream or in-stream cover was available for fish. Field observations indicated reduced riparian vegetation on the left stream bank in sections of agricultural clearings (e.g., lower most ~300 m section of stream).

Reaches 6 to 10

Upstream of Reach 5 (i.e., Reaches 6 to 10), little or no disturbance of fish habitat was indicated during Overview Assessments (G3 Consulting Ltd., 1998). Point assessment of Reaches 6 and 7 during Level 1 FHAP surveys confirmed that little or no disturbance of the channel had occurred. A small diversion, for collecting water in an open earth reservoir for agricultural purposes, was observed in Reach 6. This reservoir appeared to function as off-channel habitat, and fish access was moderate to good. A flow control device, situated at the stream's headwater lakes (for local agricultural use), was used by local residents and land owners to maintain a relatively constant water flow in Cochin Creek throughout the year (estimated at <0.25 m^3/s during FHA Level 1 surveys).

3.2.3 Restoration Options

Restoration of Cochin Creek fish habitat is recommended to focus on potential rearing habitat of Reach 3 and potential spawning areas of Reach 5. Two parallel culverts that formed Reach Break 2/3 appeared impassable for upstream fish migration; however, it appeared downstream movement of juvenile and adult fish was possible at the time of Level 1 FHA culvert assessment. The culverts did not appear suited to backflooding to restore fish passage as the vertical drop exceeded 0.5 m (Photo 3-11). Costs associated with the replacement of these culverts would likely be prohibitive. Prior to prescribing methods of the restoration of upstream fish movement at this barrier, it is recommended that downstream (i.e., Reaches 1 and 2) presence be assessed to determine which fish that may migrate upstream past this barrier.

A land owner, with property adjacent to Sub-Reach 3-2, indicated flow augmentation at the outlet of Cochin Lake, into Sub-Reach 3-2, may provide deeper residual water depth in Sub-Reach 3-2 during periods of low flow (Schuk,

1998). A beaver dam was observed at the lake outlet to Sub-Reach 3-2 during FHA Level 1 site assessments.

Reaches upstream of Reach 5 (e.g., Reaches 6 to 10) did not exhibit impacts to fish habitat, and, therefore, fish habitat restoration is not currently recommended for this stream section. A MELP regional fisheries specialist indicated a culvert located in Reach 6 was not an apparent barrier to fish passage (Dolihan, 1999).

Options for restoration or rehabilitation of fish habitat of select reaches of Cochin Creek (i.e., downstream of Reach 6) could include:

- assessing the efficacy of augmenting flows at the outlet of Cochin Lake to Subreach 3-2;
- increasing quality and quantity of riparian vegetation along sections of Subreach 3-2 to increase fish habitat cover; and,
- placing LWD in Reach 5 to create scour pools and stream cover.

3.2.4 Potential Reach Restoration

Reaches 1 & 2

Reaches 1 and 2 of Cochin Creek are not currently recommended for fish habitat restoration as overview assessments did not indicate apparent negative impacts to fish habitat. Two culverts forming Reach Break 2/3 appeared to be barriers to upstream fish passage (from Reaches 1 and 2 to Cochin Lake); however, due to high culvert replacement costs, it is recommended that downstream fish species likely to utilize upstream habitat or benefit from increased access be assessed.

Cochin Lake appeared to support a resident population of rainbow trout, of relatively high recreational value and independent of Reach 1 and 2 habitat downstream. Bull trout and suckers were also noted in Cochin Lake and suspected in Cochin Creek (DFO and MELP, 1996; Dolihan, 1999). It was undetermined from the Overview assessment (G3 Consulting Ltd., 1998) if bull trout were present in Cochin Creek (downstream of the barrier; DFO and MELP, 1996). Where bull trout presence is determined in Reaches 1 and 2, their upstream migration to Cochin Lake could promote or restore natural stock competition of rainbow trout in Cochin Lake and genetic mixing and stock viability of bull trout within Cochin Lake and Cochin Creek. Upstream migration of rainbow trout, where present downstream of the barrier (i.e., culverts), to Cochin Lake may provide population mixing of this species, potentially promoting a more viable fish stock through genetic diversification.

Under present conditions, it appeared periodic downstream transport of fish from Cochin Lake would maintain fish stocks of Reaches 1 and 2, where suitable habitat existed.

Reach 3

Reach 3 is recommended for a Level 2 FHAP survey, with prescriptions developed (in cooperation with landowners) to enhance sections of Subreach 3-2 into suitable rearing habitat. Methods of augmenting the outflow of Cochin Lake (to Subreach 3-2) could be considered that would increase residual water levels and provide over-wintering and rearing habitat. Increased riparian vegetation may contribute to stream shading, SOD and LWD input, and overstream cover along this reach.

Prior to channelization, the outflow stream of Cochin Lake (i.e., Subreach 3-2) was reported to provide limited spawning habitat for rainbow trout migrating downstream from Cochin Lake to spawn (Dolihan, 1999). Spawning habitat of this stream section was likely disrupted during past stream channelization. Where land owners express interest, Level 2 surveys may determine the feasibility of restoring spawning habitat through gravel placement and flow augmentation of Reach 3-2).

Reach 4

Cochin Lake comprises Reach 4 and was not addressed within the scope of this Level 1 FHAP survey.

Reach 5

Reach 5 fish habitat may benefit from LWD placement, to re-establish the thalweg along sections exhibiting low abundance of functioning LWD. Rainbow trout are reported (by local landowners) to spawn in upper sections of Cochin Creek (Reaches 6 to 10). Increasing holding areas of Reach 5 may increase suitable spawning habitat in localized areas, while providing cover to fish migrating upstream.

Reaches 6 to 10

Restoring fish habitat of Cochin Creek Reaches 6 to 10 is not recommended as necessary, as little or no impact on fish habitat was noted.

3.2.5 Specific Restoration Opportunities

Data collected during Level 1 surveys facilitated fish habitat restoration prescriptions recommended for specific reaches. These prescriptions are preliminary and require that data specific for this purpose be collected before implementation. Table 3-8 presents potential restoration options and sites where fish habitat may benefit from restoration or rehabilitation measures. Sites are indicated with UTM coordinates and approximate stream length potentially suited to restoration given. Prioritized restoration locations are indicated on Map 2.

Table 3-8: Potential Assessment & Restoration Activities Cochin Creek

Reach	UTM			Restoration Potential	Length	Priority
	Zn.	East	North			
1 & 2	NA	NA	NA	Assess fish populations to determine requirements of upstream migration for fish stock diversification. Develop culvert passage/replacement prescriptions where required.	~2,000 m	Low
3-2	10	400046	5738702	Riparian planting along cleared sections of agricultural ditch to increase stream cover; assess potential of flow augmentation, assess potential to restore spawning habitat.	~700 m	Low
5	10	400586	5738403	LWD complexing to increase cover and pool area and develop meander pattern.	~400 m	High
	10	400586	5738403	Bank stabilization as required.	~400 m	High
	10	400586	5738403	Riparian planting in sections to increase stream cover and reduce fish predation.	~400 m	Moderate

3.3 Chavez Creek

Chavez Creek (locally known as McGee Creek) flowed approximately 3 km westward into Reach 3 of Cochin Creek (Map 2). At the time of Level 1 assessment (October 17 to 26, 1998), its channel was between 1.0 m and 3.0 m wide with riffle-pool morphology (Appendix 3). Several sections of the lower 600 m (Reach 1) of Chavez Creek were channelized, altering the stream from its natural course. The section of stream assessed flowed entirely through private property. Local residents confirmed the stream channel had been altered for agricultural purposes.

The channel of Chavez Creek emerged from a wetland at a point approximately 600 m upstream of its confluence with Cochin Creek (Map 2). The source of Chavez creek was not determined during Level 1 assessment, as water levels were low and wetland areas did not exhibit a defined stream channel. A point assessment upstream of Reach 1 noted little or no water in the stream channel above (upslope of) the wetland. For the purpose of Level 1 FHAP surveys, Chavez Creek was assessed as a single reach.

3.3.1 Fish Distribution

Fish distribution was unknown for Chavez Creek (DFO and MELP, 1996); however, a juvenile salmonid was observed in Reach 1 during Level 1 assessments. Rainbow trout and bull trout presence is suspected, as populations of these species were present at the confluence with Cochin Creek (Map 2).

Gradient was not a barrier to fish distribution; however, distribution upstream of Reach 1 remains undetermined (Map 2).

3.3.2 Fish Habitat Assessment

The Level 1 FHAP survey assessed Chavez Creek as a single reach. Reach 1 extended from the confluence with Cochin Creek to a distinct wetland area approximately 600 m upstream (Map 2). Fish habitat of Reach 1 appeared to have been influenced by agricultural land use as sections of the stream had been channelized and directed (Photo 3-14).

Reach 1 exhibited fish habitat of poor quality during Level 1 assessments. The channel was predominantly low gradient pond-slough habitat, sections of which had little in-stream or overstream cover (Photo 3-14). Substrate generally consisted of fine sediment and sand, and little or no suitable spawning gravel was observed. Upper sections of Reach 1 (slightly downstream of the wetland area) exhibited higher fish habitat values, given the mature deciduous riparian vegetation and abundant in-stream vegetation cover.

3.3.3 Restoration Options

Chavez Creek may be suited to various types of fish habitat restoration; however, upstream fish habitat value (i.e., upstream of the observed wetland) and relatively poor connectivity of Reach 1 to Cochin Lake (via Cochin Creek Subreach 3-2) limits potential benefits of restoration to the fisheries resource. Restoration of Chavez Creek fish habitat would best benefit the fisheries resource if implemented in conjunction with the restoration of Cochin Creek (Subreach 3-2) to restore connectivity of Chavez Creek to the established fish population of Cochin Lake.

Local property owners with land adjacent to Reach 1 of Chavez Creek (and Subreach 3-2 of Cochin Creek) should be consulted to determine the feasibility of restoring fish habitat. Options could include:

- redirecting the stream to its original channel (where feasible);
- complexing the existing stream channel with LWD to increase cover;
- creating areas of scour where spawning gravel may be present (where gradient >0.5%);
- placing spawning gravel to create suitable habitat (should it be determined spawning habitat was degraded in the past and remediation is warranted); and,
- planting riparian vegetation to increase stream cover.

3.3.4 Potential Reach Restoration

Reach 1 of Chavez Creek is recommended for a Level 2 FHAP survey (moderate priority; in conjunction with assessment of Cochin Creek) to determine

the feasibility of restoration measures described above in Section 3.3.3. Further, property owners should be consulted during these assessments.

3.3.5 Specific Restoration Options

Specific restoration options for Chavez Creek Reach 1 have not been developed, as Level 2 FHAP surveys are recommended prior to habitat restoration.

3.4 Quakie Creek

Quakie Creek flows eastward approximately 10.7 km into Reach 13 of the Homathko River (Map 2 Appendix 6). Bankfull channel width varied between approximately 3 m and 11 m. Reaches 1 and 2 flowed along the valley floor and exhibited low-gradient riffle-pool channel morphology. Reaches 3 to 6 were dominated by cascade and step-pool morphology, as gradient increased upper reaches (i.e., 6% to 14%; Map 2). Overview assessment determined fish habitat value of Quakie Creek to be moderate, with riffle-pool reaches having the highest value (G3 Consulting Ltd., 1998). Level 1 point assessments of Reaches 1 and 2 during (October 17 to 26, 1998) confirmed these findings.

Upstream of Reach Break 2/3, approximately 300 m of the Quakie Creek channel appeared to be moderately entrenched. During Level 1 FHAP surveys, this stream section exhibited an emerged, aggraded streambed with subsurface flow. Stream banks were highly eroded, likely contributing sediment and debris to the channel during peak flows.

3.4.1 Fish Distribution

Rainbow trout are known to inhabit Reaches 1 and 2 of Quakie Creek (DFO and MELP, 1996), while other target species are also suspected to be present in Reaches 1 and 2 (G3 Consulting Ltd., 1998). Gradient upstream of Reach 3 did not exceed 20% (through air photo and map interpretation) and was considered to provide potential fish habitat (Map 2). Fish presence in Reach 3 was not assessed during Level 1, as no wetted stream channel was present.

3.4.2 Fish Habitat Assessment

Reaches 1 & 2

Point assessments of Reaches 1 and 2 confirmed habitat characteristics described during the previous Overview Assessment (G3 Consulting Ltd., 1998). The stream along these reaches flowed through a mature mixed forest and sections of agricultural land. The channel was dominated by riffle-pool morphology with sections of beaver ponds and sloughs. Stream gradient was estimated to be approximately 1.0% for the combined Reach 1 and 2. Bankfull channel width varied from approximately 1.5 m (in riffle-pool sections) to approximately 10 m in areas of beaver ponds and associated wetlands. Road crossings (bridges and culverts) at various locations with Reaches 1 and 2 did not appear to be barriers

to fish passage. The channel appeared well complexed, with abundant LWD, SOD and holding and rearing habitat. Gravel was present in sections of Reach 1 and likely provided spawning habitat suitable for resident populations of target fish species.

Reach 3

An assessment of fish habitat in Reach 3 was not practical, as the stream exhibited emerged substrate with no wetted channel.

Reaches 4 & 5

Upstream of Reach 3, there was little or no disturbance of fish habitat noted as part of the Overview Assessment (G3 Consulting Ltd., 1998). Surface flow of water was identified during the Level 1 point assessment conducted at Reach-Break 3/4 (upstream of the aggrading channel of Reach 3). The Reach 4 channel, which appeared moderately to highly complexed with LWD, flowed through a mature, mixed forest. Stream morphology consisted of step-pools, with a gradient estimated at 3.5% near the reach break, and increasing upstream (i.e., to ~15%). Fish habitat of Quakie Creek did not appear to be impacted upstream of Reach 3.

3.4.3 Restoration Options

Quakie Creek fish habitat is not suggested to require restoration. Aggrading sections of Reach 3 contained a porous substrate that permitted water to percolate and flow subsurface. Banks of this reach were not suited to bioengineering and will likely continue to contribute to localized debris input until reaching a natural angle of repose. Downstream pond and slough habitat likely provide adequate sediment filtration to prevent sediment transport to more valuable downstream fish habitat (e.g., riffle-pool areas and the Homathko River mainstem).

4.0 Bucket 332a

Four streams of Bucket 332 were selected for Level 1 FHAP surveys:

- Mosley Creek WSC: 900-4069-392-000-000-000;
- Cherry Creek WSC: 900-4069-392-801-000-000;
- Butler Creek WSC: 900-4069-392-818-000-000; and,
- Horn Lake Creek WSC: 900-4069-392-834-000-000.

Bucket 332 comprises the upper Mosley Creek watershed extending north from Reach Break 9/10, at the boundary of Buckets 332a and 332, to the system headwaters in Reach 22 (Maps 1 & 2, Appendix 6). Mosley Creek forms the primary drainage of Bucket 332, with approximately 25 km of mainstem located within the bucket. Bluff Lake, Sapeye Lake, Waterlily Lake and Little Sapeye Lake form three reaches of Mosley Creek, and Horn Lake is situated along a tributary (Horn Lake Creek; Map 1).

4.1 Mosley Creek (Reaches 10 to 12)

Mosley Creek Reaches 10 to 12 (downstream of Bluff Lake; Map 1, Appendix 6) were selected for Level 1 FHAP surveys. Reaches 1 to 9, situated downstream in Bucket 332a, were not surveyed at this level. Fish habitat of these reaches is described in the *Homathko River & Mosley Creek Overview Fish Habitat Assessment* report (G3 Consulting Ltd., 1998).

Reaches 10 to 12 of Mosley Creek were divided into subreaches for survey purposes (Map 1). Subreaches 10-1, 11-1 and 12-1 were surveyed by random stratified sampling. Approximate average bankfull stream width of Reaches 10 to 12 was 13.3 m, with a wetted width of 9.5 m. Stream gradient was approximately 1.0 % over the length of Reaches 10 to 12 (~8.5 km), and stream morphology was predominantly riffle-pool). This channel type is thought to contain potentially high fish habitat value (Johnson and Slaney, 1996).

Sections of Reaches 10 to 12 exhibited some impacts on fish habitat, including alterations of in-stream characteristics (e.g., LWD abundance) and stream bank instability and erosion. Level 1 Fish Habitat Assessment Survey Forms are included in Appendix 2 and Level 1 Habitat Diagnosis Summary Forms in Appendix 3.

4.1.1 Fish Distribution

Reaches 10 to 20 of Mosley Creek are known to contain populations of the target species rainbow trout, bull trout, Dolly Varden char, and non-target suckers and minnows (DFO and MELP, 1996). Level 1 fish surveys were limited to a visual observation of target species, as their presence had been well documented (e.g., FISS maps, local knowledge, and fisheries reports). Juvenile salmonids of unidentified species were observed throughout Reaches 10 to 12.

4.1.2 Fish Habitat Assessment (Reaches 10 to 12)

Subreaches of Reaches 10, 11 and 12 were assessed between October 17 and 26, 1998. Point assessments of Reach 9 (Bucket 332a) were conducted during a concurrent Riparian Assessment (RA) of Mosley Creek Opening 2. Observations of Reach 9 fish habitat are discussed at the end of this section, and RA results in Chapter Four.

Reach 10

Road stream crossings and road development identified during the Overview Assessment were potentially detrimental to fish habitat (G3 Consulting Ltd., 1998) did not appear to affect the stream channel in Reach 10. Reach 10 was further divided into Subreach 10-1 and Subreach 10-2.

Subreach 10-1 was not surveyed, as a Level 1 point assessment determined fish habitat characteristics were similar to those of Subreach 10-2.

Reach 10-2 channel morphology was riffle-pool, with a bed material predominantly of gravel, and high sinuosity (Photo 3-15). Slight channel aggradation was evident, indicated by (Hogan *et al.* 1996; Johnston and Slaney, 1996):

- pools that comprised approximately 25% of the reach length and riffles of approximately 50%, indicating extensive riffle presence;
- side- and mid-channel bars being present, but limited;
- LWD often oriented parallel to the banks, clumped in jams in several locations; and,
- channel widening in some locations, and numerous eroding banks and ones exhibiting a lack of undercutting (Photo 3-16).

Minor channel aggradation observed in Reach 10 likely resulted from influxes of sediment from tributary creeks and upstream bank erosion. Valleau Creek, Cherry Creek and Clay Creek may periodically contribute sediment to Mosley Creek during flood flows. Valleau Creek is likely the largest contributor of sediment due to its larger stream size.

Table 3-9 presents stream parameters and habitat characteristics for Reach 10-2.

Table 3-9: Stream Parameters & Habitat Unit Characteristics Mosley Creek Subreach 10-2

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	15	13	4	NA
Total length (m)	229	574	203	NA
Average length (m)	15.3	44.1	50.8	NA
Average Bankfull Width (m)	12.3	14.5	14.0	NA
Average Wetted Width (m)	9.2	9.5	11.5	NA
Average gradient (%)	<0.5	1.0	0.5	NA
Average bankfull depth (m)	1.25	0.50	0.51	NA
Average water depth (m)	0.97	0.30	0.31	NA
Average bankfull surface area (m^2)	2,823	8,313	2,844	NA
Average wetted surface area (m^2)	2,111	5,446	2,336	NA
Total LWD	109	116	56	NA
Functioning LWD	26	16	9	NA
Dominant/Sub-Dominant Substrate[1]	G/S	G/C	G/C	NA
Average D90 (mm)	68.5	73.5	85	NA

[1] S=Sand: G=Gravel: C=Cobble: B=Boulder

Canopy Closure

Riparian vegetation of Subreach 10-2 varied from herbaceous and shrubby cover to young deciduous forest (Appendix 2). Vegetation was noted to be moderately

dense along most of the subreach, with the exception of areas where stream banks had been cleared for agriculture; however, canopy closure, ranging from none to 20%, was relatively low. Stream bank erosion was noted in areas of reduced riparian vegetation associated with agricultural clearings (Photo 3-16).

Holding & Rearing Habitat

Holding and rearing habitat of Subreach 10-2 was sufficient, based on the number of pools (Appendix 3; Johnston and Slaney, 1996). When WRP habitat diagnosis were applied (Johnston and Slaney, 1996), Subreach 10-2 received a "Poor" rating for Percent Pools, consistent with the aggrading riffle-pool channel discussed above; however, the Percent Pools by Area (Appendix 3; 20% for Subreach 10-2) score did not reflect the surface area occupied by embedded and secondary pools that were also present. The "Fair" rating for pool frequency (Appendix 3) indicated an adequate number of pools was present for fish holding and rearing. Pools were not as large as generally required, perhaps due to depositional infilling as a result of the minor channel aggradation observed. Pool substrate was noted to be predominantly sand (Appendix 2).

Spawning Habitat

Gravel suitable for resident fish of target species (i.e., 75 mm to 110 mm diameter) was abundant in Subreach 10-2 (Appendix 2). Gravel of "Good" quantity for spawning was the dominant substrate throughout the reach (Appendix 3); however, moderate to high amounts of sand observed in pools of Subreach 10-2 (likely a result of aggradation) possibly reduced the quality of spawning gravel by filling interstices of gravels downstream of pools.

Off-channel Habitat

Limited pond habitat was noted on the left stream bank in lower reach sections, while wetlands were present in upstream sections of the reach. A small side-channel (<2.0 m wide) estimated to be 70 m long was observed near the upstream end (Appendix 2). Off-channel habitat of Subreach 10-2 was assigned a "Fair/Good" rating (Appendix 3).

LWD Abundance & Structure

The quantity of LWD in the Subreach 10-2 channel was rated "Good", at 3.8 pieces per channel width; however, a notable proportion of LWD was oriented parallel to the stream banks and had little function in channel morphology (Appendices 2 and 3). A majority of LWD pieces were of small to medium size (i.e., 10 cm to 40 cm diameter), with few large pieces observed (>50 cm diameter). Potential recruitment of LWD >50 cm diameter is not likely limited by the riparian vegetation, dominated by shrubs and small trees.

Reach 11

Reach 11 of Mosley Creek had fish habitat characteristics similar to those of Reach 10. Stream morphology was riffle-pool, and riparian vegetation had been

removed from sections of both banks (Appendix 2). Field assessments (October 17 to 26, 1998) confirmed Overview results indicating that an aggrading stream channel of a tributary stream (Clay Creek) that entered Mosley Creek from the west at Reach Break 11/12 contributed sediment and clastic debris to the portion of Mosley Creek near its confluence (Map 1). An alluvial fan, attributed to aggradation of this tributary channel, extended directly to Mosley Creek and may contribute sediment and debris during high precipitation and snowmelt.

Reach 11 was further divided into Subreaches 11-1 and 11-2 for Level 1 FHAP surveys.

Subreach 11-1 was surveyed for 1,270 m upstream from Reach-Break 10/11 using random stratified sampling (Map 1). Morphology of Subreach 11-1 was a repeated riffle-pool pattern, with a substrate dominated by cobbles, and relatively straight channel for the initial 400 m, beyond which the channel meandered (Photo 3-17).

The increase in bed material size from predominantly gravel in Subreach 10-2 to predominantly cobble immediately upstream in Subreach 11-1 is likely associated with the increased gradient, straighter channel at the beginning of the reach, and proximity to the alluvial fans of steep-sloped tributaries. The creek valley was restricted at this location, then broadened downstream at Reach 10.

Indicators of partial channel degradation, such as a lack of pools, reduced channel complexity, LWD oriented parallel to channel banks, and coarsening of the channel bed were observed in the channel.

The presence of channel bars, composed of cobbles and lacking gravel and sand, suggested the influx of sediment from a tributary (e.g., Valleau Creek or Clay Creek) in the past. The stream appeared to have sorted the bed material, depositing large clasts and transporting finer sand and gravel downstream to Reach 10 where it was deposited in this lower gradient, anastomosed section of the creek.

Table 3-10 presents stream parameters and habitat characteristics for Reach 11-1.

Table 3-10: Stream Parameters & Habitat Unit Characteristics Mosley Creek Subreach 11-1

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	9	11	2	3 (jams)
Total length (m)	124	908	99	147
Average length (m)	13.8	82.5	49.5	NA
Average Bankfull Width (m)	13.0	14.6	12.5	NA
Average Wetted Width (m)	8.5	10.7	10.8	NA
Average gradient (%)	<0.5	1.25	0.75	NA

Average bankfull depth (m)	1.35	0.70	0.93	NA
Average water depth (m)	0.95	0.38	0.40	NA
Average bankfull surface area (m^2)	1711	13256	1237	NA
Average wetted surface area (m^2)	1612	9715	1069	NA
Total LWD	67	107	10	>100
Functioning LWD	45	26	6	NA
Dominant/Sub-Dominant Substrate[1]	G/C	C/G	C/G	C/G
Average D90 (mm)	49	112	NA	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Dominant bed material of Subreach 11-1 was cobble, representing an increase in average bed material size from the gravel observed immediately downstream in Subreach 10-2 (Appendix 2). This phenomenon was attributed to the relatively straight channel pattern and increased gradient (to ~1.5%) at the beginning of Subreach 11-1, and proximity of alluvial fans of high gradient tributaries (i.e., ~20%; Map 1).

Channel bars, composed almost exclusively of cobbles (i.e., lacking gravel and sand), suggested that Reach 11 had received a considerable influx of debris from tributaries (e.g., Valleau Creek, Clay Creek and other unnamed tributaries) in the past. It appeared that the stream had sorted and transported fine material (e.g., sediment, sand and gravel) downstream to Reach 10 where it was deposited in lower gradient, anastomosed stream sections (Appendix 2).

Indicators of partial channel degradation were also noted in Subreach 11-1, suggesting downstream transport of materials. Observations included the lack of pools, reduced channel complexity, LWD oriented parallel to channel banks, and coarsening of the channel bed (Hogan *et al.*, 1996).

Canopy Closure

Canopy closure (stream surface covered by projecting riparian vegetation) was low (i.e., <20%; Appendix 2) throughout Subreach 11-1. Riparian vegetation along Subreach 11-1 was similar to that of Subreach 10-2 and typically varied from herbaceous-shrub cover to young deciduous forest. The riparian area was densely vegetated along most of the reach; however, it appeared sparse in areas where stream banks had been cleared for agriculture.

Holding & Rearing Habitat

Holding and rearing habitat of Subreach 11-1 appeared in relatively low abundance, based on the number of pools present (Appendices 2 & 3), particularly in the approximately 400 m long downstream portion. Primary pools and limited glides provided a majority of fish holding and rearing habitat, and some secondary and tertiary pool habitat was present (Appendix 2). The percentage of pools and pool frequency of Subreach 11-1 were considered "Poor" when applying WRP habitat diagnosis (Appendix 3).

Few boulders or boulder clusters were observed in Subreach 11-1, indicating a reduction in the amount of rearing habitat associated with these structures (Appendix 2).

Spawning Habitat

The dominant stream substrate was cobble, with primarily gravel being subdominant (Appendix 2). This substrate combination resulted in an overall "Fair" rating being assigned to spawning habitat in Mosley Creek Subreach 11-1, as substrate interstices were rarely noted to be filled with sand or small particles of gravel (Appendix 3; Johnston and Slaney, 1996). Deposits of gravel of good quality for spawning (i.e., lacking sand) were observed at some locations.

Off-channel Habitat

Three areas with side-channel habitat available to fish were noted along Subreach 11-1 of Mosley Creek (Appendix 2). Two of these side-channels were considered accessible during a majority of flow conditions, while one was determined to provide access to fish only at elevated and peak flows. A less accessible side-channel was observed to be a remnant portion channel cut off from the mainstem by a recent breakthrough of the stream bank by Mosley Creek (Photo 3-18). Deposits of LWD were observed at the point of stream breakthrough (located on a river bend), suggesting a logjam may have blocked the original channel (now the side-channel), diverting the stream flow to the recently formed mainstem. Signs of debris wasting (e.g., rootwads and SOD deposits) were noted in the new mainstem. This mainstem extended approximately 50 m downstream from the breakthrough point, where the side-channel rejoined the mainstem in the original stream channel.

LWD Abundance & Structure

Functioning LWD was relatively abundant in Subreach 11-1 (Appendices 2 & 3). More large pieces (>50 cm) were observed in Subreach 11-1 than over approximately the same distance in Subreach 10-2 (Appendix 2); however, much of the LWD in the channel was oriented parallel to the stream banks, reflecting channel conditions discussed above (e.g., localized degradation).

Reach 12

Reach 12 of Mosley Creek drains Bluff Lake and includes the confluence of Valleau Creek (Map 1, Appendix 6). The reach was subdivided for the Level 1 FHAP surveys: Subreach 12-1, extending from Reach Break 11/12 to the mouth of Valleau Creek, and Subreach 12-2, from this point to Bluff Lake.

Approximately 1,500 m of Subreach 12-1 was surveyed using random stratified subsampling. Residential and agricultural clearing of both stream banks had occurred along sections of Subreach 12-1. The largest clearing observed was a road right-of-way where vegetation had been removed directly to the stream bank for a distance of approximately 200 m. Banks were observed to be eroding at

various points and appeared to contribute to sediment and debris to the stream (Photo 3-19).

At the confluence of Valleau Creek, which enters Mosley Creek from the east and forms the boundary of Buckets 332 and 336 (Map 1), the channel was aggrading and braided, and a potential source of clastic debris and sediment accumulation. Directly opposite the mouth of Valleau Creek, a branch of Cherry Creek entered Mosley Creek from the west (Map 1). A culvert, located at the inflow of Cherry Creek, appeared to be a potential barrier to fish passage, limiting fish access to the tributary and associated off-channel habitat of Cherry Creek (Map1).

Channel morphology of Subreach 12-1 was observed to be a repeated riffle-pool structure with predominantly cobble substrate and a meandering pattern (Photo 3-20). The average gradient was steeper (~1.25%) in the approximately 1,000 m downstream portion of Subreach 12-1 than in the upper portion, approximately 500 m long (~0.85%; Appendix 2). In the downstream portion, bed material generally increased in size from small cobble (i.e., ~70 mm diameter) to large cobble (i.e., ~150 mm diameter). In the upstream portion, bed material was slightly finer (i.e., small cobble and gravel; Appendix 2).

Channel disturbance was noted in sections of Subreach 12-1. LWD aligned parallel to the bank and a low percentage of pool area indicated that Subreach 12-1 may be slightly degraded (Appendices 2 & 3; Hogan *et al.*, 1996).

Subreach 12-1 appeared to have received a large input of sediment from a tributary stream (e.g., Valleau Creek) in the past, and natural sorting of bed material was noted. The stream had transported a majority of fine material associated with a depositional event (e.g. sand and gravel) downstream from higher gradient sections to areas of lower gradient. Sediment transport resulted in coarser bed material (e.g., cobble and boulders) remaining in higher gradient sections (>1.5 %). Deposits of fines were also present near the confluence of Valleau Creek where the gradient was lower (Appendix 2).

Table 3-11 presents stream parameters and habitat characteristics for Reach 12-1.

Table 3-11: Stream Parameters & Habitat Unit Characteristics Mosley Creek Subreach 12-1

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	8	14	4	NA
Total length (m)	83	1272	141	NA
Average length (m)	10.4	88.5	35.3	NA
Average Bankfull Width (m)	11.7	12.6	12.1	NA
Average Wetted Width (m)	7.5	9.2	10.6	NA

Average gradient (%)	0.5	1.47	1.0	NA
Average bankfull depth (m)	1.14	0.88	0.75	NA
Average water depth (m)	0.82	0.32	0.40	NA
Average bankfull surface area (m^2)	971	16027	1706	NA
Average wetted surface area (m^2)	622	11702	1494	NA
Total LWD	67	46	5	NA
Functioning LWD	25	16	3	NA
Dominant/Sub-Dominant Substrate[1]	C/G	C/B	C/G	NA
Average D90 (mm)	123	205	153	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Canopy Closure

Riparian vegetation of Subreach 12-1 was similar to that observed along Reaches 10 and 11 and typically varied from herbaceous-shrub cover to young deciduous forest. Canopy closure from the riparian zone was low throughout the reach, ranging up to 20% of the stream surface. A relatively long section of stream bank, adjacent to the confluence of Valleau Creek with little or no riparian vegetation, had very low stream cover and shading.

Holding & Rearing Habitat

The quantity of holding and rearing habitat for adult and juvenile fish was low, based on the small number of pools in the reach (Appendix 3); however, pools were deep and well covered. Subreach 12-1 was assigned a "Poor" rating for Percent Pools, Pool Frequency, and Holding Pools per Kilometre (Appendix 3). Eight primary pools were identified along the approximately 1,500 m Subreach 12-1, with the greatest distance between pools being approximately 350 m (Appendix 2).

Spawning Habitat

Gravel deposits, suitable for resident populations of target fish species (i.e., ~10 mm to ~75 mm diameter), were present at some locations; however, certain habitat units had little or no spawning gravel and very few units had extensive amounts (Appendix 2). Gravel was observed to accumulate in stream sections of lower gradient (<1.5 %), whereas cobble was the dominant substrate of higher gradient sections (>1.5%) and boulders were subdominant. Application of WRP habitat diagnosis resulted in a "Fair" rating for spawning gravel quality and quantity of Subreach 12-1 (Appendix 3).

Off-channel Habitat

Subreach 12-1 exhibited off-channel habitat in three separate areas (Appendix 2). Three side-channels existed along Subreach 12-1, each providing fish access during most stream flow levels. One side-channel contained approximately 250 m

of potential fish habitat and exhibited relatively good habitat characteristics (i.e., cover, LWD, etc.; Appendix 2). Off-channel habitat was assigned a "Good" rating when WRP habitat diagnosis criteria were applied (Appendix 3).

LWD Abundance & Structure

LWD abundance in Subreach 12-1 of Mosley Creek was low compared to that of downstream reaches (Reaches 10 and 11); however an acceptable amount of LWD was observed in Subreach 12-1 (as indicated by a "Fair/Poor" rating; Appendix 3), where approximately one third was functioning. The majority of functioning LWD was located in pools and, as a result, percent wood cover was "High" in pools (Appendix 3). LWD were notably absent from certain sections of the channel, particularly those with higher stream gradient (Photo 3-20).

Point Assessment (Reach 9)

Fish habitat of Reach 9 was assessed along a section of stream approximately 300 m long. Reach 9 was located downstream of the Razor Creek confluence (Map 1). Flow in Mosley Creek appeared to be higher downstream of this point and the water was a notable green/grey colour (typical of glacial sediment). Fish habitat characteristics were similar at the point assessment site to those observed in sections of Reaches 10 to 12. As anticipated, the Reach 9 channel appeared to be slightly aggraded, with areas of cobble and gravel deposition (Photo 3-21). LWD in Reach 9 was clustered and in single pieces. Bank erosion was noted to be a source of localized sediment input and a potential disturbance of fish habitat (Photo 3-21).

4.1.3 Restoration Options

Restoration of Mosley Creek fish habitat (Reaches 10, 11 and 12) is recommended to focus initially on bioengineering of stream banks to control sediment and debris input to the stream channel, followed by in-stream restoration. Where bank stabilization is recommended for improving fish habitat (e.g., Reach 9), RA recommendations for the stream reach should be incorporated where feasible (e.g., concurrent Level 2 FHA and RA surveys for a given stream reach). Further, site-specific assessments should be considered, to identify appropriate techniques before implementation of restoration measures described in this section. Restoration and rehabilitation techniques (Slaney and Zaldakos, 1997) to be considered include:

- stabilizing stream banks;
- planting riparian vegetation along sections of cleared stream banks to enhance stream shading and overstream cover and prevent livestock erosion;
- placing boulders and LWD to increase localized scour and primary pool formation;
- placement of boulder/LWD reefs to increase rearing habitat; and,

- restoring off-channel habitat.

Stream Bank Stabilization

Mosley Creek reaches surveyed or assessed (Reaches 9, 10, 11 and 12) exhibited areas of bank instability that may be suited to bioengineering. Banks along these reaches should be considered for Level 2 assessment of the feasibility of such techniques.

Boulder/LWD Structures

Subsequent to assessment and stabilization of stream banks (where feasible), it is recommended that in-stream fish habitat prescriptions be developed. Areas of reduced pool distribution and frequency along Reaches 10, 11 and 12 would likely benefit from the creation of primary pools by placement of boulders and LWD. Higher gradient reaches (>1.5 %) may be better suited to boulder placement as LWD is less effective in high gradient streams. Combinations of boulder and LWD placement may increase localized scour to create pools and provide cover for rearing and holding fish throughout these reaches.

Off-Channel Habitat Restoration

Sections of Reaches 10 and 11 had side-channels potentially suited to restoration measures that would increase rearing habitat for juvenile fish.

4.1.4 Potential Reach Restoration (Reaches 10 to 12)

Reaches 10 to 12 of Mosley Creek offered potential sites for Level 2 FHAP surveys to determine fish habitat restoration options. Portions of Mosley Creek, upstream of Reach 12 and downstream of Reach 10 (with the exception of a point assessment at Reach 9), did not undergo Level 1 assessment as little or no impact on fish habitat had been identified during the Overview Assessment (G3 Consulting Ltd., 1998). Fish habitat of Mosley Creek Reach 9 is summarized in Section 4.1.2; it is recommended riparian areas along this reach also be assessed to address local bank instability.

Reach 10

Mosley Creek Reach 10 is recommended for a Level 2 FHAP survey to determine the feasibility of stabilizing banks to control sediment input. Where combined with restoration of upstream fish habitat (e.g., stream bank stabilization along Reaches 11 and 12), this action would likely contribute to improving fish habitat.

Limited in-stream restoration may benefit fish habitat in this reach. The feasibility of increasing localized scour at select pool sites should be investigated during Level 2 surveys. Opportunities may also exist to improve fish access to off-channel habitat.

Reach 11

A Level 2 FHAP survey to investigate the feasibility of stream bank stabilization should be considered along sections of Mosley Creek Reach 11, as sediment and debris input to this relatively high energy reach likely contributes to disturbance of downstream habitat.

Restoration of primary pools in areas of limited pool distribution and size may provide more holding and rearing habitat for fish in this reach. Recommended Level 2 FHAP surveys would assist in evaluating the feasibility of boulder and LWD placement to increase localized scour and increase stream cover.

Off-channel habitat observed in sections of Reach 11 may be suited to restoration of fish access and rearing habitat. Level 2 FHAP surveys should be conducted to evaluate the feasibility of increasing off-channel development where side-channels and other off-channel habitat were observed during Level 1 assessments (Appendix 2).

Reach 12

It is recommended that Level 2 surveys assess the feasibility of stabilizing banks along selected portions of Mosley Creek Reach 12. Application of bioengineering techniques would likely reduce sediment and debris input to the stream channel.

LWD abundance in Reach 12 was low compared to downstream reaches assessed (Appendices 2 & 3). Level 2 FHAP surveys recommended would assist in determining the feasibility of LWD and boulder placement to restore pools in areas of extensive riffles and to increase cover in existing pools. Feasibility of placing boulder clusters should be assessed in high gradient stream sections of Reach 12.

Fish habitat in off-channel sections of Mosley Creek Reach 12 was noted to be suitable for restoration. One side-channel (in upper sections of Subreach 12-1) offered potential for restoration of rearing habitat by forming secondary pools and increasing cover (Appendix 2).

4.1.5 Specific Restoration Opportunities

Data collected during Level 1 surveys identified specific reaches that would be good candidates for fish habitat restoration. Prescriptions developed for these sites are preliminary and require further site-specific data before implementation.

Table 3-12 presents potential restoration options and sites where fish habitat may benefit from remediation. Sites are indicated with UTM coordinates and approximate stream length potentially suited to restoration is given. Prioritized restoration locations are indicated on Map 1.

Table 3-12: Potential Assessment & Restoration Activities Mosley Creek (Reaches 10 to 12)

Reach	UTM			Restoration Potential	Length	Priority
	Zn.	East	North			
10-2	10	376281	5730292	Side-channel; option for off-channel habitat development at 10 m.	~200m	Low
	10	NA	NA	Right bank cleared by agriculture at 234 m; riparian planting and bioengineering to stabilize banks.	Point source	High
	10	376432	5730582	Right bank cleared by agriculture at 300 m; riparian planting and bioengineering to stabilize banks.	Point source	High
	10	376567	5730588	Off-channel habitat development option in wetland area at 520 m.	~100 m	Low
	NA	NA	NA	Side-channels (accessible high flow only) at 830 m and 900 m; option for off-channel habitat development.	~100 m	Low
	NA	NA	NA	LWD placement in pools to encourage scouring and pool growth for fish holding and rearing.	Select points ~1000 m	Moderate
11-1	10	377212	5730698	Right bank cleared by agriculture at 319 m; riparian planting and bioengineering to stabilize banks.	Point source	High
	10	377180	5730780	LWD and boulder placement in straight section of channel from 0 m - 400 m to promote pool development.	~400 m	Moderate
	10	377592	5730762	Side-channel at log jam at 740 m; good off-channel habitat potential	~120 m	Moderate
	NA	NA	NA	Potential LWD placement in tertiary pools at 203, 557, 981 m ; increase total pool area	Select points ~800 m	Moderate
12-1	10	378891	5731850	Bank erosion on LB at 0 m; riparian planting and bioengineering to stabilize banks.	Point source	High
	10	379262	5732109	Bank erosion at 392 m; riparian planting and bioengineering required to stabilize banks over 200m.	~200 m	High
	10	379425	5732574	Eroding LB at 1000 m (King's cabin); riparian planting to improve bank stabilization.	~200 m	High
	10	379562	5732875	Eroding RB in clearing; riparian planting required to stabilize banks.	Point source	High
	10 10	379200 379393	5732010 5732695	LWD and boulder placement in extensive riffle/glide sections to encourage scouring and formation of pools or refuge for juvenile fish rearing at 550 m, 615 m, 845 m, 1030 m, 1125 m and 1227 m	Select points ~800	Moderate

4.2 Cherry Creek

The moderately entrenched Cherry Creek flows eastward approximately 8.5 km into Mosley Creek (Map 1). Cherry Creek appeared to have undergone a change in channel pattern in recent years. NTS maps created from 1978 and 1979 air photos indicated the creek mouth to be located at Bluff Lake, while more recent MOF FC maps (1993), and observations made during Level 1 surveys (October 17 to 26, 1998), indicated the stream to enter Mosley Creek along Reach 12 (Map 1). Local landowners reported the former stream channel (Subreach 1-2) as ephemeral.

4.2.1 Fish Distribution

The Overview Assessment study of fish distribution in Cherry Creek indicated Dolly Varden char and rainbow trout to be present (DFO and MELP, 1996), and bull trout to be suspected in the mainstem (G3 Consulting Ltd., 1998). During this Level 1 survey, juvenile bull trout were collected from Reach 1-1 (Map 1). Bull trout within the MELP Cariboo Region are on the BC Conservation Data Centre Blue-list (BCCDC, 1996; Appendix 5), signifying they are vulnerable to events impacting on their populations or habitat. As gradient did not appear to form a barrier to fish migration, the entire length of Cherry Creek is potentially fish-bearing (Map 1); however, debris accumulation and small chutes associated with step-pool morphology, may inhibit fish passage through some sections.

4.2.2 Fish Habitat Assessment

Subreach 1-1 underwent random stratified subsampling for approximately 850 m upstream from the confluence of Cherry Creek with Mosley Creek (Map 1). Subreach 1-1 was located on private property. Approximately 20 m upstream from its mouth, Cherry Creek flowed through a culvert that presented a potential barrier to fish passage (Appendix 2). The vertical drop from the culvert to the outlet pool was determined to be approximately 0.16 m, with an outlet pool depth of 0.45 m, enabling juvenile members of target fish species to enter the pipe (Photo 3-22; MELP, 1997); however, culvert gradient was noted to be approximately 6.0% and water velocity within the culvert approximately 1.5 m/s, levels exceeding accepted fish passage standards (MELP, 1997a). Upstream of the culvert, the channel of Subreach 1-1 was aggraded, and little or no defined channel was present in braided sections immediately upstream (~10 m; Photo 3-23). Approximate average bankfull width of Subreach 1-1 was 3.26 m and average wetted width 2.75 m. During field assessment (October 17 to 26, 1998), Cherry Creek discharge was determined to be approximately 0.09 m^3/s at a point approximately 15 m upstream of the culvert inlet.

The initial 120 m (approximately) of Subreach 1-1 was an unstable riffle-pool channel. Aggrading gravel bars were observed and evidence of past channel instability noted (i.e., eroding banks, channel braiding; Appendix 2). Local landowners appeared to control flooding, for example, by placing riprap at the

culvert inflow. The stream channel alternated between glides and riffles with few pools over this section (Appendix 2). Signs of increased channel stability were observed over the next 100 m (approximately) that had riffle-pool morphology (e.g., less extensive gravel bars and a single defined channel); however, higher gradient (~3.0%) and slight entrenchment of this straight stream section (Photo 3-24) likely contributed to downstream aggradation.

From a point approximately 220 m upstream of the mouth, the channel was dominated by cascade-pool and step-pool morphology for the remainder of the reach surveyed (~630 m). This stream section was a homogenous unit of cascade and step-pool complexed by LWD and SOD. Some evidence of stream downcutting was observed in upper areas of the surveyed section and stream banks were noted to be unstable at various locations (Appendix 2). Stream gradient in upper sections of Subreach 1-1 reached approximately 6.0% (Appendix 2).

Table 3-13 presents stream parameters and habitat characteristics for Reach 1-1.

Table 3-13: Stream Parameters & Habitat Unit Characteristics Cherry Creek Subreach 1-1

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	5	13	6	NA
Total length (m)	20	743	89	NA
Average length (m)	4	57	15	NA
Average Bankfull Width (m)	4.2	3.1	3.0	NA
Average Wetted Width(m)	4.1	2.3	2.7	NA
Average gradient (%)	<0.5	3.7	1.1	NA
Average bankfull depth (m)	0.61	0.45	0.44	NA
Average water depth (m)	0.38	0.13	0.19	NA
Average bankfull surface area (m^2)	84	2303	267	NA
Average wetted surface area (m^2)	82	1709	240	NA
Total LWD	12	35	3	NA
Functioning LWD	9	15	2	NA
Dominant/Sub-Dominant Substrate[1]	NA	NA	NA	NA
Average D90 (mm)	NA	NA	NA	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Canopy Closure

The section of Subreach 1-1 farthest downstream, extending approximately 100 m, had moderate canopy closure (i.e., <40%; Appendix 2). Vegetation was observed to consist predominantly of immature deciduous trees and shrubs that provided little or no LWD recruitment (Photo 3-23). Further upstream (~200 m

from stream mouth), where the riparian area was predominantly forested with mature deciduous and young conifer trees, canopy closure was 20% to 70% (Appendix 2). Mature conifers were locally present and increased in abundance farther along the reach (~600 m from the mouth).

Holding & Rearing Habitat

Lower sections of Subreach 1-1 (up to ~200 m from the mouth) contained limited adult holding habitat (i.e., glides) and little or no juvenile rearing habitat (i.e., pools). Holding and rearing habitat in the lower portion (~200 m) of Subreach 1-1 was of relatively poor quality due to lack of LWD and related stream cover (Appendix 2).

At distances greater than 200 m, Subreach 1-1 pool frequency increased and holding and rearing habitat was more abundant. Several step pools were observed to be complexed with LWD and SOD, providing fish with habitat cover.

Spawning Habitat

Localized spawning habitat was present in limited quantities in Subreach 1-1. Substrate was predominantly cobble and gravel, and deposits of spawning gravel were determined to be of "Fair" quality (Appendix 3). Spawning access was classified as "Poor" (Appendix 3) due to presence of a culvert, potentially impassable by fish, near the mouth and localized debris jams in step-pool channel sections (Appendix 2).

Off-channel Habitat

A small hydroelectric power generating station was withdrawing water from an upstream reach of Cherry Creek and a small diversion channel was re-directing this water into Subreach 1-1. This drainage provided little or no off-channel habitat as it was a narrow, shallow channel with little stream complexing and limited water volume.

LWD Abundance & Structure

LWD was present in the stream channel beyond 200 m. Downstream of this point little or no LWD was observed (Appendix 2). In some sections beyond 200 m, LWD complexing of step-pools may present seasonal barriers to fish passage in higher gradient (~3.5%) stream sections (Appendix 2).

4.2.3 Potential Reach Restoration

Subreach 1-1 provided opportunities to restore or rehabilitate several fish habitat components, including:

- fish access;
- holding and rearing habitat condition; and,
- level of stream bank erosion.

It is recommended that fish access through a culvert near the mouth of Subreach 1-1 be assessed at various flow conditions. As bull trout were identified upstream of this culvert, fish passage should be improved, where required, to ensure passage of this regionally significant species.

Complexing of the stream channel in lower sections of Subreach 1-1 may rehabilitate holding and rearing habitat in aggraded areas. Stream channel stabilization and erosion control at points of stream bed or bank disturbance may decrease the rate of aggradation in some sections.

4.2.4 Reach-Specific Restoration

Fish habitat restoration should be considered for Subreach 1-1 of Cherry Creek, as this stream section appeared to offer specific opportunities.

Subreach 1-1

Subreach 1-1 of Cherry Creek is recommended for a Level 2 survey to determine methods of restoring (or improving) fish passage through a culvert. Back flooding of the culvert may reduce stream velocity in the pipe. Placing baffles in the culvert may also decrease stream velocity, and enhance fish passage during low flows.

Lower sections of Subreach 1-1 (up to ~100 m upstream of the culvert) may be suited to stream thalweg restoration by placing LWD and boulder structures; however, bank stability and channel degradation should be surveyed (at Level 2) in upstream sections (e.g., beyond ~120 m) to prescribe feasible stabilization methods (e.g., bioengineering or LWD placement).

Select areas of step-pool channel in upper sections of the reach (higher than 400 m) may be suited to stream complexing and bank stabilization to dissipate stream energy in higher gradient sections. A Level 2 survey could assess stream downcutting and bank erosion in these areas.

4.2.5 Specific Restoration Opportunities

Table 3-14 presents potential restoration options at fish habitat sites that may benefit from restoration or rehabilitation activities. Sites are indicated with UTM coordinates and approximate stream length potentially suited to restoration given. Prioritized restoration locations are indicated on Map 1.

Table 3-14: Potential Assessment & Restoration Activities Cherry Creek (Subreach 1-1)

Reach	UTM			Restoration Potential	Length	Priority
	Zn.	East	North			
1-1	10	379543	5732899	Culvert backflooding to provide fish access at varied water flows.	Point source	High

	10	379543	5732899	Stream complexing immediately upstream of culvert to control large flows at 20 m	~20 m	High
	10	379524	5732981	LWD and boulder complexing stream section to enhance pool development and create stable RP morphology at 50 m.	~200 m	High
	10	379537	5733096	Livestock crossing; riparian planting, sedimentation control at 216 m	Point source	Moderate
	NA	NA	NA	Ford crossing (EB) at approx. 350 m; riparian planting to improve cover and reduce sedimentation	Point source	Moderate
	10	379408	5733308	Assess if LWD jam at 535 m is a barrier to fish passage during various flows	Point source	Low
	NA	NA	NA	Control sediment/debris input and transport throughout reach, complex stream channel and address bank stability/debris input	~600 m	High

4.3 Butler Creek

Butler Creek flows approximately 12 km southwestward into the north end of Bluff Lake (Map 1). Channel morphology was predominantly stable cascades and step-pools, with some aggradation in lower sections (e.g., Reach 1; Appendix 2). When applied to WRP Overview fish habitat indicators, these channel characteristics indicated that the fish habitat value of Butler Creek was "Moderate" to "Low" (G3 Consulting Ltd., 1998).

A point assessment was conducted in Reach 2 of Butler Creek during fish collection activities (Appendix 3).

4.3.1 Fish Distribution

Rainbow trout and Dolly Varden char are known to inhabit Reach 1 of Butler Creek (DFO and MELP, 1996), and suspected in to be present in Reach 2; however, Level 1 FHAP fish collection efforts at Reach Break 1/2 (October 17 to 26, 1998; minnow trapping and electrofishing) in primary and tertiary pools were unsuccessful in establishing presence (Appendix 1). Upstream fish distribution was unknown; however, gradient did not appear to be a barrier, suggesting that fish may be present throughout the mainstem channel of Butler Creek (Map 1).

4.3.2 Fish Habitat Assessment

Reach 1 of Butler Creek was assessed from the mouth (at Bluff Lake) to the bridge on the Bluff Lake Road, approximately 550 m upstream (Map 1). Lower sections of this reach were aggrading and had no defined stream channel. Discharge at the mouth of Butler Creek during Level 1 surveys (October 17 to 26, 1998; Appendix 1) was approximately 0.44 m^3/s. Approximate Average bankfull width was 8.54 m and wetted width 2.97 m; the large disparity between

bankfull and wetted width suggests the channel may periodically carry much larger flows.

WRP personnel have indicate that irrigation ditches upstream of Reach 1 have diverted substantial flows (described as 100% of stream water volume) in the past (Parker, 1999). However, stream flow diversion was not evident during Level 1 FHA surveys (October 17 to 26, 1998). Potential restoration of sections of Butler Creek downstream of these irrigation ditches (i.e., Reach 1) should consider land owner involvement in maintaining a minimum flow required for fish habitat.

The mouth of Butler Creek appeared highly aggraded. The lower section (~100 m, with gradient <1.0%) had deposits of fines and gravel causing channel braiding through the forest. Channel diversion associated with braiding had created a side-channel that was potential fish rearing habitat (Photo 3-25). Approximately 100 m upstream from the mouth, gradient increased slightly and abundant coarse cobble and boulder-sized material was present in the remainder of the reach (Photo 3-26). Stream bank erosion was observed throughout the upper section of Reach 1.

Table 3-15 presents stream parameters and habitat characteristics for Reach 1.

Table 3-15: Stream Parameters & Habitat Unit Characteristics Butler Creek Reach 1

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	5	6	3	NA
Total length (m)	20	432	80	NA
Average length (m)	3.9	71	26.7	NA
Average Bankfull Width (m)	8.5	8.6	NA	NA
Average Wetted Width(m)	3.4	3.1	2.1	NA
Average gradient (%)	<0.5	1.8	0.8	NA
Average bankfull depth (m)	0.65	0.75	NA	NA
Average water depth (m)	0.42	0.18	0.11	NA
Average bankfull surface area (m^2)	363	3664	688	NA
Average wetted surface area (m^2)	66	1320	168	NA
Total LWD	16	50	65	NA
Functioning LWD	14	46	60	NA
Dominant/Sub-Dominant Substrate[1]	G/S	C/G	S/G	NA
Average D90 (mm)	NA	NA	NA	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Canopy Closure

Reach 1 of Butler Creek had good canopy closure ranging from 40% to 70% (Appendices 2 & 3). Riparian vegetation was primarily mature deciduous forest along much of the reach, with approximately the lower 100 m dominated by deciduous trees of pole-sapling age and younger.

Holding & Rearing Habitat

Availability of adult holding and juvenile rearing habitat was limited in Butler Creek Reach 1 (Appendices 2 & 3), as the limited number of pools noted were typically shallow and small. Through application of WRP fish habitat diagnosis, Reach 1 was assigned "Poor" ratings for Percent Pools, Pool Frequency and Holding Pools per km, reflecting observed channel disturbance (e.g., aggrading stream channel).

Spawning Habitat

Spawning habitat was of limited quantity in Reach 1 due to a poor distribution of spawning gravel observed in the reach. Gravel deposits were present primarily in lower reach sections where sand-dominated substrate likely filled gravel interstices, reducing spawning gravel quality (Appendix 2).

Off-channel Habitat

A section of side-channel habitat was present near the stream mouth and extended approximately 80 m upstream, parallel to the right stream bank. Fish access appeared fair under most flow conditions (Appendix 2).

LWD Abundance & Structure

LWD abundance was poor in Reach 1, with fewer than 1 LWD piece per bankfull channel width. Wood cover in pools was fair, however, suggesting the LWD was functioning (Appendices 2 & 3).

4.3.3 Restoration Options

There appeared to be limited opportunity to restore fish habitat in Butler Creek under stream channel conditions observed during Level 1 FHAP surveys (October 17 to 26, 1998). An opportunity may exist to restructure the upper stream channel of Reach 1 to dissipate stream energy and control sediment and debris input; however, more detailed site assessment would be required. It is recommended that Level 2 FHAP surveys incorporate channel assessment procedures (CAPs) to determine the feasibility of stabilizing the Reach 1 channel before restoration of in-stream fish habitat is prescribed.

Stabilization of eroding stream banks (Photo 3-25) through bioengineering should also be considered for evaluation as part of Level 2 work.

Off-channel habitat in lower stream sections may provide the opportunity to increase rearing habitat, as a relatively long (~80 m) side-channel with a moderate gradient (1.0%) and apparent stable channel pattern was identified (Appendix 2).

4.3.4 Reach Specific Restoration

Level 2 FHAP and CAP surveys are recommended to determine the feasibility of:

- stream bed stabilization;
- stream bank stabilization; and,
- off-channel habitat rehabilitation.

Subsequent to assessment of the above features, in-stream prescriptions may or may not be applicable for development.

4.3.5 Specific Restoration Opportunities

Table 3-16 presents fish habitat sites which may benefit from the potential restoration measures prescribed. Sites are indicated with UTM coordinates and approximate stream length potentially suited to restoration is given. Prioritized restoration locations are indicated on Map 1.

Table 3-16: Potential Assessment & Restoration Activities Butler Creek (Reach 1)

Reach	UTM			Restoration Potential	Length	Priority
	Zn.	East	North			
1	10	381458	5735632	Assess potential to stabilize stream channel.	~500 m	Moderate
	10	381591	5736174	Side-channel development.	~100	Moderate

4.4 Horn Lake Creek

Horn Lake Creek, the drainage from Horn Lake, flows approximately 4 km southward into Little Sapeye Lake (Map 1). The previous Overview assessment (G3 Consulting Ltd., 1998) determined the stream channel to consist predominantly of riffle-pool morphology, with stable channel conditions of potentially high fish habitat value. Reach 1 was selected for a Level 1 FHA; however, Level 1 FHAP surveys (October 17 to 26, 1998) were not possible, as water was absent from Reach 1 and no wetted stream channel was observed.

A beaver dam was noted during a point assessment upstream of Reach 1, at the outlet of an unnamed lake (Little Horn Lake; Map 1). Water seepage through the beaver dam was observed and a defined stream channel downstream contained water. However, little water volume was noted as wetted width of the channel was estimated as <0.5 m and discharge estimated as <0.1 m/s. Water flow from the source extended less than 600 m, as assessments at a road crossing (~600 m downstream) encountered a dry channel. It was determined stream water observed at the source (i.e., seepage at the beaver dam) percolated through the stream substrate, as evidence of channel diversion was not noted.

4.4.1 Fish Distribution

Horn Lake Creek Reach 1 has been identified as a major area of rainbow trout spawning (DFO and MELP, 1996). In addition, bull trout and non-target suckers have been identified to inhabit the full length of Horn Lake Creek (i.e., Reaches 1 to 4; DFO and MELP, 1996).

4.4.2 Restoration Options

As sections of Reach 1 of Horn Lake Creek have been identified as major areas of rainbow trout spawning, it is recommended that seasonal flow patterns be assessed. Where stream flow was determined to have been altered (e.g., water diversion or beaver damming) flow augmentation measures could be considered. Further fish habitat restoration is not recommended.

5.0 Bucket 336

One stream in Bucket 336 was selected for Level 1 FHAP surveys:

- Valleau Creek WSC: 900-4069-786-000-000.

Bucket 336 encompassed approximately 13,400 ha, draining the Valleau Creek watershed into upper Mosley Creek at its border with Bucket 332 (Figure 2; Maps 1 & 2, Appendix 6). Valleau Creek was the primary drainage and only gazetted stream in the bucket (i.e., named and identified with a unique watershed code). Overview FHA and RA studies (Map 1; G3 Consulting Ltd., 1998) identified recent clearcut logging up-slope of the mainstem channel along lower sections of the stream, adjacent to Reach 3; however, logging did not appear to have directly affected fish habitat of Valleau Creek.

5.1 Valleau Creek

Valleau Creek flows approximately 20 km northwestward, entering Mosley Creek in Reach 13 (Map 1). The channel morphology was varied, changing from riffle-pool near the mouth to step-pool in upper reaches as gradient increased (Appendix 2). Morphology of upper sections of Valleau Creek (i.e., upstream of Reach 2; Map 1) were moderately entrenched and aggrading. Downstream of Reach 2, the stream channel was unconfined and a highly aggraded depositional zone. Characteristics of stream morphology resulted in an overall “Low” potential fish habitat classification during the Overview FHAP (G3 Consulting Ltd., 1998).

5.1.1 Fish Distribution

Rainbow trout and Dolly Varden char are known to inhabit Reach 1 of Valleau Creek (DFO and MELP, 1996). Dolly Varden and bull trout are suspected throughout Valleau Creek, as gradient did not exceed 20%. In addition, during the Overview Assessment, a local resident described distribution of fish of unconfirmed species (believed to be Dolly Varden or potentially bull trout) throughout the mainstem (G3 Consulting Ltd., 1998; Maps 1 & 2). The Overview Assessment identified chutes throughout several entrenched reaches (e.g., Reaches 3, 4 and 5); however, they were not found to present barriers to fish passage (G3 Consulting Ltd., 1998).

5.1.2 Fish Habitat Assessment

Reach 1 of Valleau Creek was selected for a Level 1 assessment of fish habitat condition. Reach 1 was surveyed for approximately 1,400 m using random stratified subsampling. A notable change occurred in gradient and substrate type beyond approximately 1,100 m, indicating that surveys may have extended into Reach 2 (reach boundaries were originally assigned during Overview assessment and difficult to verify in the field). The 1,400 m section was considered to be Reach 1 (Map 1) during the Level 1 FHAP. The lowermost portion of Reach 1 (~100 m) was not suited to standard Level 1 assessment (i.e., use of Fish Habitat Assessment Survey Form), due to the highly aggraded nature of the stream and lack of a single, defined channel (Photo 3-27).

Reach 1 of Valleau Creek had an average bankfull width of approximately 12.75 m and average wetted width of approximately 7.50 m (Appendix 2). Level 1 assessment found stream discharge to be approximately 1.38 m^3/s at a distance 100 m upstream of the mouth of Valleau Creek.

Reach 1 channel morphology was riffle-pool, with predominantly cobble bed material for approximately the lower 650 m (Photo 3-28) and cascade-pool, with predominantly cobble- to boulder-sized bed material for the remaining 750 m (Photo 3-29). The full length of Reach 1 was in a moderate to highly aggraded state, indicated by presence of extensive riffles and runs, in-filled pools, lack of moss and vegetation on stream banks (bars), and elevated bars and banks composed of cobbles and gravel (Hogan *et al.*, 1996).

Debris flows appeared to have contributed to aggradation of Valleau Creek. Indicators of debris flows present in Reach 1 included:

- boulders deposited in forested areas;
- stream banks and beds composed of boulders and clasts larger than those moved in normal peak flows;
- ridges of debris material with characteristic unsorted texture deposited parallel to the stream channel; and,
- severe bank scouring.

Past use of machines to create berms and retaining walls was evident in upper sections of the Reach 1, indicating recent stream instability.

Disturbances noted in Reach 1 of Valleau Creek may periodically contribute sediment to Mosley Creek, particularly to minor channel aggradation in Reaches 10, 11, and 12 (Section 4.1).

Table 3-17 presents stream parameters and habitat characteristics of Valleau Creek, Reach 1.

Table 3-17: Stream Parameters & Habitat Unit Characteristics Valleau Creek Reach 1

Characteristic	Pools	Riffles	Glides	Other
Total number of habitat units	3	6	NA	NA
Total length (m)	27	1373	NA	NA
Average length (m)	9	229	NA	NA
Average Bankfull Width (m)	10.6	13.86	NA	NA
Average Wetted Width (m)	5.7	8.43	NA	NA
Average gradient (%)	0.5	2.9	NA	NA
Average bankfull depth (m)	1.07	0.89	NA	NA
Average water depth (m)	0.77	0.37	NA	NA
Average bankfull surface area (m^2)	256	26456	NA	NA
Average wetted surface area (m^2)	158	13120	NA	NA
Total LWD	4	192	NA	NA
Functioning LWD	4	134	NA	NA
Dominant/Sub-Dominant Substrate[1]	C/G	C/G,C/B	NA	NA
Average D90 (mm)	203	225+	NA	NA

[1] S=Sand; G=Gravel: C=Cobble; B=Boulder

Canopy Closure

Canopy closure of Valleau Creek varied along Reach 1. Lower sections, where the stream channel was highly braided and flowed through the riparian forest, had high canopy closure (Photo 3-27); however, upstream areas, where extensive unvegetated bars were present, had little canopy closure (Photo 3-29; Appendix 2).

Holding & Rearing Habitat

Reach 1 was assigned "Poor" ratings for Percent Pools, Pool Frequency and Holding Pools per Kilometre (Appendix 3). These ratings were indicative of the channel disturbances described above. Localized secondary and tertiary pools were present in the lower 650 m of channel (Photo 3-27); however, only three primary pools were observed in Reach 1 (Appendix 4).

Spawning Habitat

Gravel suited for resident fish spawning (i.e., from 10 mm to 75 mm diameter) was present through most of the lower 650 m of Reach 1 and of generally good quality in most areas. In the boulder dominated cascade-pool section (~650 m upstream from the mouth of Valleau Creek), little or no spawning gravel was observed.

Off-channel Habitat

Braided sections of Reach 1 (lower ~650 m) had abundant side-channels associated with channel braiding; however, these areas were noted to be poor fish habitat due to extensive riffle zones and aggrading channel.

Upstream sections of Reach 1 (~1,000 m extent) contained some side-channel habitat potentially accessible to fish. Approximately 150 m of the side-channel was assessed and formed a distinct channel that flowed separately of Valleau Creek for an undetermined length. The channel flowed down what appeared to be an abandoned roadway and was not seen to flow back into Valleau Creek, but rather, flowed independently into another tributary channel or directly into Bluff Lake. The side-channel, estimated to have a 1.0 m bankfull width, was considered relatively young (evident from exposed stream bank soils and downcutting stream channel) and had little fish habitat (i.e., primary pools, etc.).

LWD Abundance & Structure

LWD pieces per channel width were rated "Poor" in Reach 1 (Appendix 3). A large proportion of Reach 1 LWD (~75 pieces) comprised a single log jam located approximately 150 m upstream of the mouth. Remaining LWD was distributed throughout the reach, with a majority of functioning pieces located in the lower 650 m (Appendix 2). LWD served little function in stream morphology or stream cover upstream of approximately 650 m.

5.1.3 Restoration Options

Prior to considering restoration of fish habitat in Valleau Creek, a CAP survey is recommended to determine feasibility of restoring stream channel stability in Reaches 1 and 2. A site-specific assessment should also be considered prior to detailing restoration techniques described in this section. Where stream channel stabilization is feasible, remediation techniques (Slaney and Zaldakos, 1997) to be considered could include:

- stabilizing the stream bank to control sediment and debris input;
- complexing the stream channel with boulders and LWD to increase localized scour;
- constructing off-channel habitat for spawning and rearing; and,
- increasing riparian canopy density at fish habitat restoration sites.

5.1.4 Potential Reach Restoration

Reach 1 may be suitable to the types of in-stream restoration described in Section 5.1.3 (above) where recommended. CAP surveys (moderate priority) would determine where stream channel stabilization is feasible.

Restoration of in-steam fish habitat (e.g., LWD or rootwad placement) is not currently recommended for Valleau Creek, pending the outcome of stream channel stabilization assessments. In the event that stream channel stabilization is not deemed feasible within the scope of WRP initiatives, development of off-

channel habitat remains a viable option for Reach 1 (Moderate priority; Map 1). Level 2 surveys (e.g., CAP) should include an assessment of potential off-channel development at the side-channel, approximately 1,000 m upstream from the Valleau Creek mouth (Appendix 2).

5.1.5 Specific Restoration Opportunities

No specific restoration options are currently recommended for this reach. Level 2 FHAP and CAP surveys are suggested to determine the feasibility of restoring the fish habitat of Valleau Creek.

6.0 Bucket 338

Bucket 338 contained one stream selected for Level 1 assessment:

- Skinner Creek WSC: 900-4069-865-000-000.

Bucket 338 was situated in the northeast corner of the study area, draining the subbasin of Skinner Creek into the Homathko River at Reach Break 9/10 (Figure 2; Map 2). The Overview Assessment (G3 Consulting Ltd., 1998) identified Skinner Creek as the only gazetted stream in this bucket. Bucket 338 contained a moderate level of cleared land and road development for agricultural, residential and logging purposes.

6.1 Skinner Creek

Skinner Creek flows approximately 22.7 km southwestward into the Homathko River (Map 2). Level 1 Point Assessments of Reaches 3, 6, 7 and 10 (Map 2) confirmed Overview Assessments (G3 Consulting Ltd., 1998) that the channel was relatively small (e.g., <4 m bankfull width) and channel type varied from riffle-pool to cascade-pool with a stable pattern.

6.1.1 Fish Distribution

Rainbow trout, cutthroat trout, bull trout and Dolly Varden are target species with populations known to inhabit sections of Reach 1 near the confluence of Skinner Creek and Homathko River (DFO and MELP, 1996). Rainbow trout were found in sections of Reach 10 during Level 1 surveys, and a landowner reported the seasonal presence of rainbow trout in Reach 6, suggesting a distribution from Reach 1 to Reach 10 (Map 2). A waterfall in Reach 2 was described by a local landowner (Schuk, 1998a) as being a barrier to fish passage. Field assessment of sections of Reach 2 (October 16 to 27, 1998) did not identify the waterfall; however, the stream channel was dry during the assessment, confirming a seasonal barrier to fish passage in Reach 2. As gradient did not appear to be a barrier upstream of Reach 10, rainbow trout presence would be anticipated beyond this point (Map 2).

6.1.2 Fish Habitat Assessment

The Skinner Creek subbasin had undergone moderate land development associated with agriculture, logging and road building. The channel was relatively narrow
(<3 m wide) and stable throughout (e.g., Reaches 3, 6, 7 and 10 were stable). Assessments were made at certain points to assess relative quality of fish habitat and to confirm fish presence in upstream reaches (e.g., Reach 10). Reaches of Skinner Creek (Reaches 3, 6, 7 and 10) were not suited to collection of habitat data as presented on WRP Fish Habitat Assessment Forms, due to small stream size and relatively homogenous channel pattern. General habitat characteristics of these areas are presented below.

Reach 3

Reach 3 of Skinner Creek was dry at the time of Level 1 survey. The stream channel was approximately 3.5 m wide and contained boulder and cobble substrate. Fish habitat characteristics were undetermined in Reach 3 as stream flow was subsurface.

Reaches 6 & 7

Reaches 6 and 7 flowed through an area of meadow-grassland and localized wetland habitat (Map 2; Photo 3-30). The stream channel was moderately entrenched through the relatively low gradient grasslands (~0.5 %) and riparian shrub vegetation provided dense overstream cover along most sections. The channel was approximately 1.0 m wide (wetted and bankfull) in most sections, with localized widening and beaver pond complexing in specific areas. Rainbow trout were reported seasonally present in Reach 6 by a landowner (Schuk, 1998a). Field assessment of three culverts determined they did not present barriers to fish passage through these low gradient stream reaches.

Reach 10

Upstream of the wetland habitat of Reaches 6 and 7 (Map 2), Skinner Creek flowed through relatively dense, mixed forest (Reaches 8 to 10). Rainbow trout were observed at the site of a culvert in Reach 10 (Map 2). The culvert did not appear to be a barrier to fish passage and distribution of fish upstream is suspected. The Reach 10 channel appeared to be well complexed with LWD and riparian forest provided good overstream cover.

6.1.3 Restoration Options

Reach 3 of Skinner Creek contained no water during the period of Level 1 assessment, which may be attributable to subsurface flows of water within the streambed. Reach 3 was an observed barrier to fish migration in Skinner Creek; however, restoration is not recommended as this event appeared to be seasonal.

Reaches 3, 6, 7 and 10 of Skinner Creek exhibited little or no impact on fish habitat, and further assessment of restoration of these areas is not currently recommended.