Homathko River & Mosley Creek Watersheds

Level 2 Fish Habitat & Riparian Assessment Procedure & Restoration Prescriptions

Final Report

G3 Consulting Ltd.
Innovation & Excellence in Environmental Science

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LEVEL 2 FISH HABITAT & RIPARIAN ASSESSMENT PROCEDURE & RESTORATION PRESCRIPTIONS

Final Report

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1.0 Introduction

This report presents fish habitat and riparian restoration prescriptions based on a Level 2 Fish Habitat Assessment (FHA) and Riparian (RAPP) Assessment and recommendations of Reaches 4, 5, 6, 10 and 11 of the Homathko River and sections of Reaches 10, 11 and 12 of Mosley Creek within the Chilcotin region of BC.

As part of a continuing Watershed Restoration Program (WRP) initiative undertaken by Tatlayoko Woodlot Association (TWA) and funded by Forest Renewal BC (FRBC), G3 Consulting Ltd. (G3) examined sections of streams within the Homathko River and Mosley Creek watersheds. Work was conducted in accordance with Level 2 FHAP guidance documents (Johnston and Slaney, 1996; Slaney and Zaldokas, 1997; Newbury and Gaboury, 1996), and with specific reference to the *Habitat Restoration Prescription Guidebook, Vancouver Island Region 1* (MELP, 1998). Riparian procedures were adapted from Technical Circular No. 6, *Riparian Assessment and Prescriptions Procedures* (Koning, 1999). Subsequent to Ministry of Environment, Lands and Parks (MELP) and land owner approval, several restoration prescriptions were implemented on-site with assistance from a provincially-funded Environmental Youth Team.

This report includes site descriptions of locations within the Homathko River and Mosley Creek watersheds for select watershed restoration projects. Appendices 1 & 2 present typical restoration methods and site specific application for fish habitat restoration, respectively. Appendix 3 presents riparian planting prescriptions, Appendix 4 an estimate of materials and equipment required for prescription implementation and, Appendix 5 presents a summary of prescribed projects which were approved and implemented during 1999 (August 16 to September 3, 1999).

1.1 Project Scope

An on-site project start-up meeting was convened July 12, 1999, between representatives of Tatlayoko Woodlot Association, G3 Consulting Ltd. and the Environmental Youth Team. Representatives of MELP were unable to attend this initial start-up meeting. At that time, study locations, project elements, assessment and implementation schedules and field and safety protocols were established as previously discussed with and approved by MELP.

Sections of five reaches of the Homathko River (4, 5, 6, 10 and 11) and three reaches of Mosley Creek (10, 11 and 12) were assessed to determine the feasibility of remediating fish and riparian habitat and to develop prescriptions for in-stream channel restoration, riparian restoration and channel stabilization projects. The term “restoration” is applied in this sense and commonly used in WRP discussions to refer to both restoration and rehabilitation of fish habitat.

Given the high level of agricultural and private land development adjacent to portions of the Homathko River and Mosley Creek, sites selected for Level 2 FHA and RAPP surveys were situated on private property. Landowner approval for field surveys was obtained prior to of on-site assessments.

This report outlines recommendations for restoring or rehabilitating fish and riparian habitat in specified stream sections. Prescriptions were based on ecological criteria, current and expected land-use objectives and practicality of implementing habitat restoration (i.e., resource availability, site access, etc.) and were not specifically considerate of future land use development or forest harvest activity in upstream areas (i.e., removed from the study area).

Target Species

Recent field assessment of the study region (G3 Consulting Ltd, 1998 and 1999) and resource databases (DFO and MELP, 1998) indicated rainbow trout and bull trout to be predominant target species in portions of the watersheds selected for in-stream habitat restoration (e.g., LWD placement). Prescriptions for in-stream work were predicated on this assumption while prescriptions for bank stabilization considered ecological impacts of sediment on streams as well as stabilization of riparian areas for prescribed restoration. Prescriptions and associated elements (e.g., expense estimates, implementation timing and materials, equipment and machinery requirements) may require site-specific modification.

1.2 Study Area Description

The study area (Figure 1) was situated approximately 250 km west of Williams Lake and is accessible from Highway 20 via the Tatlayoko and Bluff Lake roads. The Homathko River and Mosley Creek watersheds drain the southwest portion of the South Chilcotin Region of the BC interior southwestward to Bute Inlet, then to the Pacific Ocean via Johnstone Strait and Strait of Georgia. Lower portions of these watercourses flow through the Coast Mountains between Mount Waddington to the west and the Homathko Icefield to the east. The southern boundary of the Chilcotin Forest Region crosses the Homathko River at a point approximately 10 km downstream of the Mosley Creek confluence. The study area comprised watershed sections upstream of this confluence (Figures 2 & 3).

1.3 Land Use

Land use in study area valley bottoms consists primarily of agricultural cropland and rangeland. Recent industrial logging is limited, though several private land holdings have been cleared for land-use requirements (e.g., cleared for pastureland or crops). The rural population is centred at Tatla Lake, Tatlayoko Lake and the West Branch area with residential and industrial road service within the region.

The Cariboo-Chilcotin Land-Use Plan (CCLUP; BC Government, 1995) includes much of the study area in Special Resource Development Zones. The 224,144 ha Niut region, located west of the Homathko River, has a total forest area of approximately 54,040 ha, of which 15% is targeted for conventional harvesting, 76% for modified harvesting and 9 % for no harvesting (BC Government, 1995). The Potato Range region, located east of the Homathko River, is approximately 157,388 ha in size, with a total forest area of 72,489 ha; 50% of the forest area is targeted for conventional harvesting, 37% for modified harvesting, and 13% for no harvesting.

The CCLUP has also designated approximately 34,000 hectares of the watershed as the Homathko River-Tatlayoko Protected area, given its high fish and wildlife habitat values and its notable recreational, historic and cultural resources. The boundary of the protected area includes Tatlayoko Lake and downstream portions of the Homathko River valley at lower elevations, and lower elevations of the Mosley Creek valley downstream from Middle Lake.

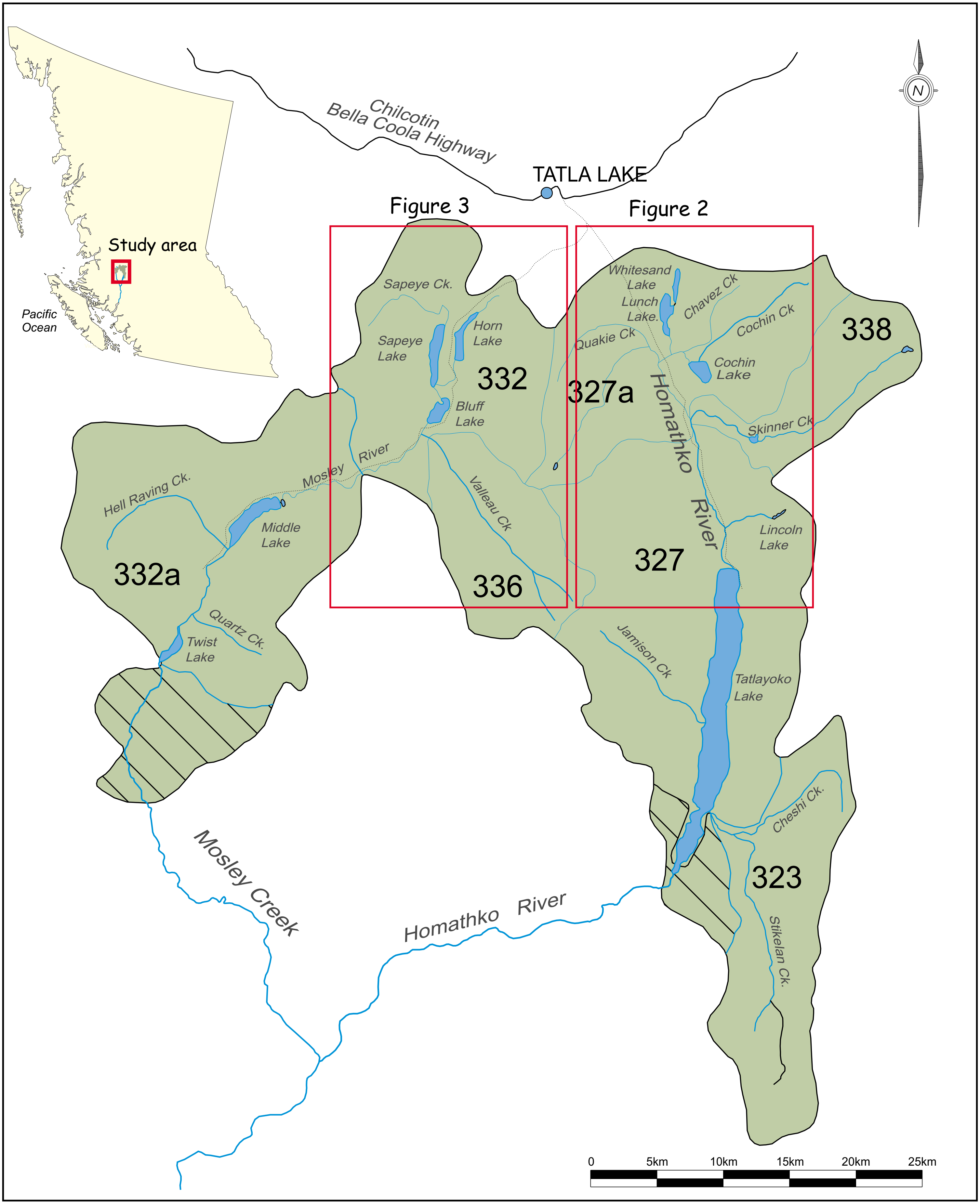

Figure 1: Relative Location of Study Region within BC & Details of Level 2 FHA & RA Survey Areas

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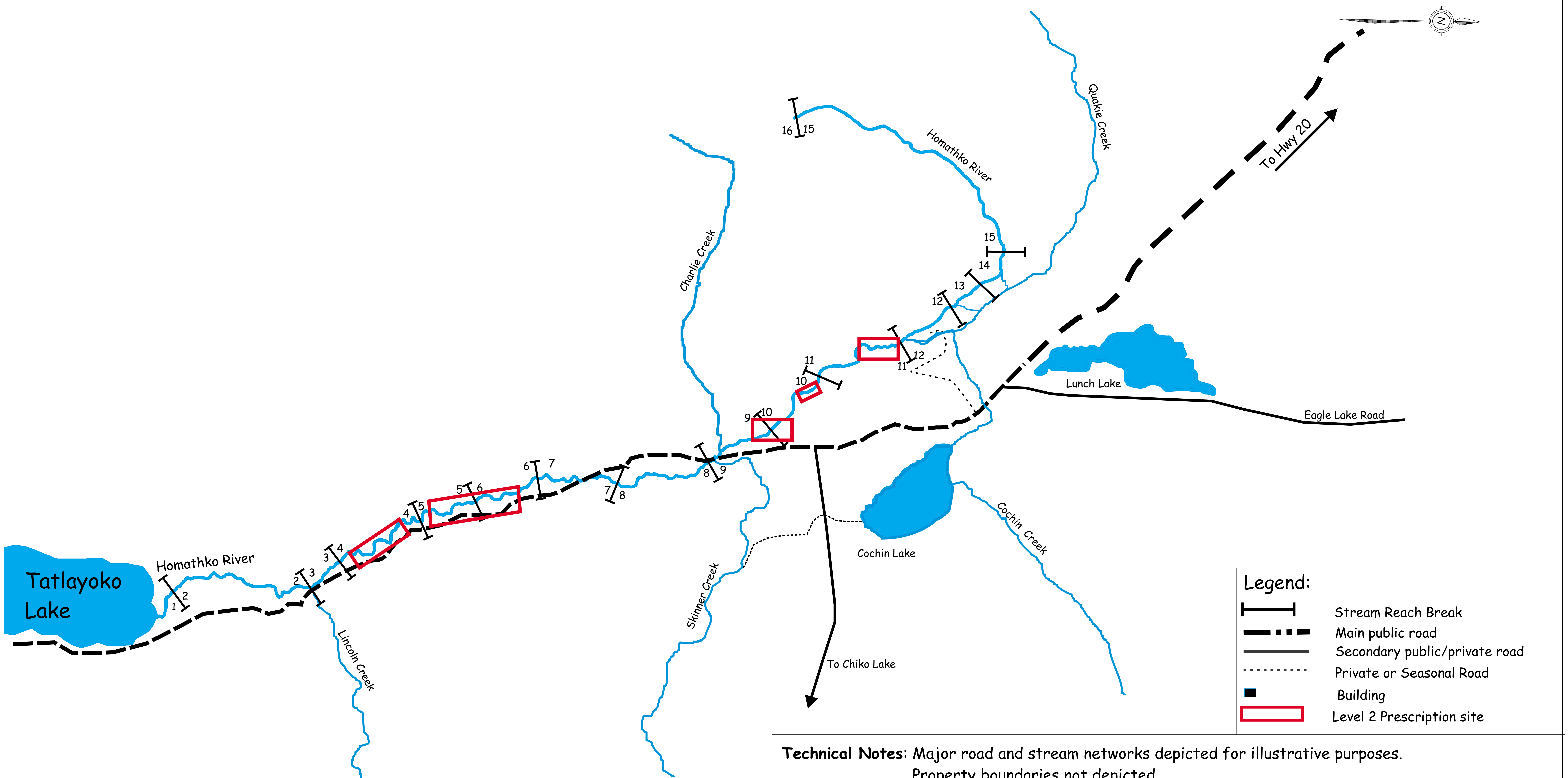
Figure 2: Homathko River Study Area Map

Date:	September 20, 1999	Stream Name:	Homathko River	Watershed:	Homathko	Reach:	1 to 15
Project:	9H	Survey Crew:	NA	Comments:	Created from air photo and TRIM data. Approximate scale 1:70,000		



Technical Notes: Major road and stream networks depicted for illustrative purposes. Property boundaries not depicted.

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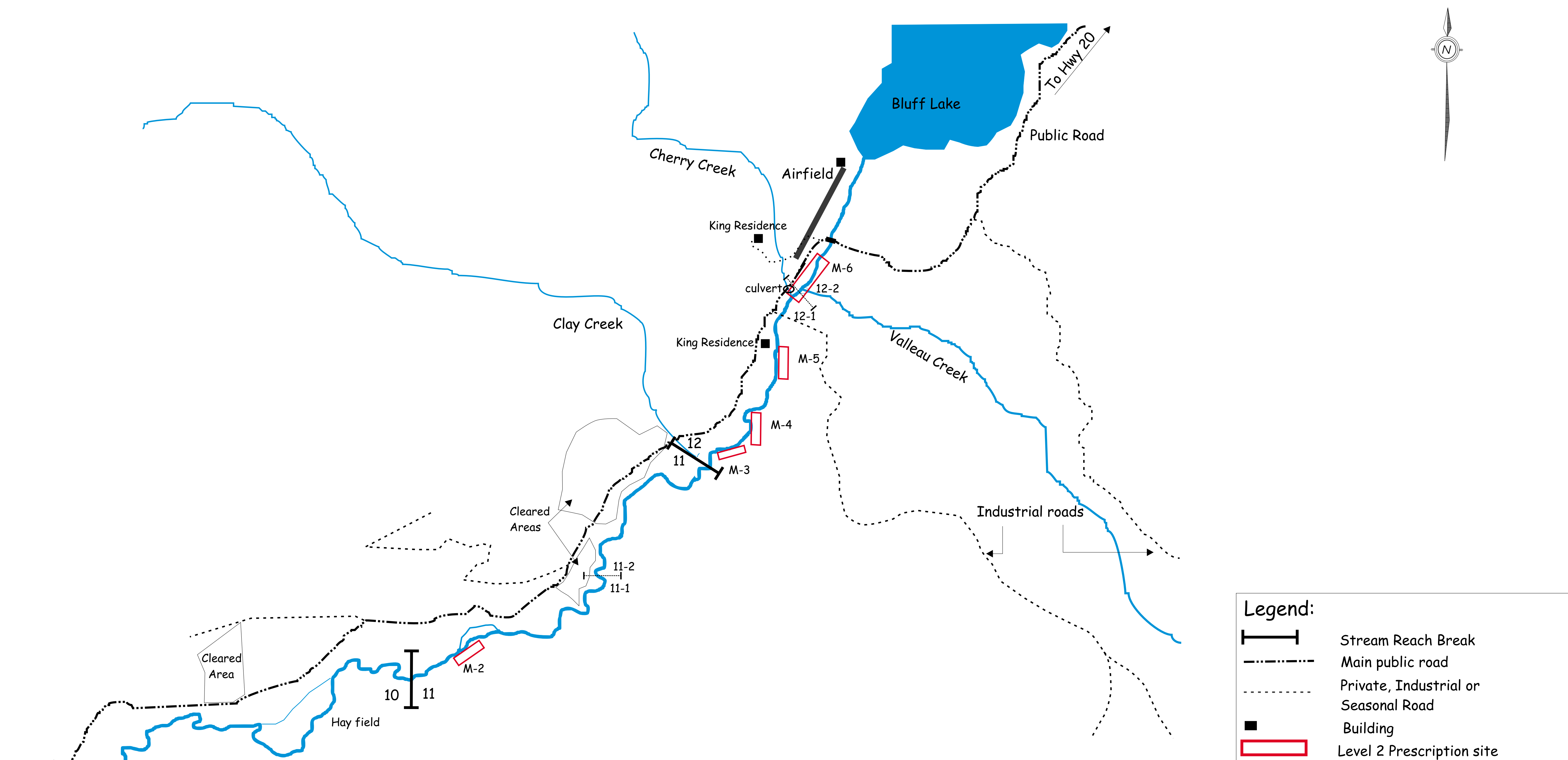
Figure 3: Mosley Creek Study Area Map

Date:	September 20, 1999	Stream Name:	Mosley Creek	Watershed:	Homathko River	Reach:	10 to 12
Project:	9H	Survey Crew:	NA	Comments:	Created from air photo and TRIM data. Approximate scale 1:20,000		



Technical Notes: Major road and stream networks depicted for illustrative purposes.
Property boundaries not depicted.

2.0 Methodology

Level 2 FHA methods described by Slaney and Zaldokas (1997) and Newbury and Gaboury (1993) and RAPP methods described in WRP Technical Circular No. 6 *Riparian Assessment and Prescriptions* Procedures (Koning, 1999) and FPC Guidebook *Establishment to Free Growth* (MOF and MELP, 1995) were applied throughout the Level 2 program. Stream sections and associated riparian habitat were assessed July 10 to 17 with subsequent site assessments conducted August, 1999. Although this time of year typically reflects near summer low-flow conditions, extensive snow pack and localized precipitation, occurring in the spring and summer months of 1999, resulted in unseasonably high water conditions within the study area.

2.1 Site Identification, Selection & Confirmation

Stream reaches and riparian areas to be assessed were determined by Tatlayoko Woodlot Association and MELP, based on Level 1 FHAP and RAPP results (G3 Consulting Ltd., 1999) and land owner consultation. Site locations were confirmed in the field using TRIM-based site maps and the Global Positioning System (GPS). Air photos (1:20,000 scale) were used in the field to georeference specific landmarks and landscape features (e.g., river bends, road locations and cleared areas).

2.2 Site Classification

Prior to fieldwork, study sites were classified according to type of Level 2 FHA or RAPP surveys to be conducted (based on anticipated impacts on subject stream reaches). Review of Level 1 FHA and RAPP surveys (G3 Consulting Ltd., 1999) facilitated planning of the survey approach. Table 1 identifies each study Reach and outlines assessments required as part of Level 2 surveys. Figures 2 and 3 depict locations of stream reaches on the Homathko River and Mosley Creek, respectively.

**Table 1: Scope of Requested Restoration Prescriptions
Homathko River and Mosley Creek Watersheds**

Stream	Reach	Length (m)	Work Required
Homathko River	4	Select points ~500 m	Bank stabilization, stream complexing (in existing pools and glides); riparian planting of conifers, bioengineering
Homathko River	5	Select points ~600 m	Bank stabilization, stream complexing (in existing pools and glides); riparian planting of conifers, bioengineering
Homathko River	6	~700 m	Bank stabilization, stream complexing (in existing pools and glides); riparian planting of conifers, bioengineering
Homathko River	10	~800 m	Riparian planting of conifers, bioengineering
Homathko River	11	~500 m	Stream complexing to provide cover and dissipate stream energy, livestock exclusion from stream channel, riparian planting of mixed vegetation
Mosley Creek	10, 11 & 12	~100 m to 150 m sections	Bank stabilization through bioengineering and riparian planting

2.3 Restoration & Rehabilitation Options

Level 2 FHAP and RAPP surveys are intended to provide prescriptions for watershed remediation to improving fish habitat and fisheries resources associated with in-stream fish habitat characteristics (e.g., LWD) and riparian area interaction with the stream network. Stabilization and sediment control of select upslope areas of the Homathko River and Mosley Creek watersheds have been addressed by Tatlayoko Woodlot Association (e.g., road deactivation, Sediment Source Surveys). This has enabled prescribed restoration of fish and riparian habitat to focus on areas directly adjacent to (i.e., within ~10 m) and within stream banks, by the following means:

1. stabilization of stream banks through revetment installation and bioengineering;
2. restoration and/or creation of secondary and tertiary habitat units (e.g., pools, LWD jams, rootwads);
3. restoration of primary physical fish habitat units (e.g., pools, riffles, LWD cover); and,
4. restoration of riparian areas through conifer planting and bioengineering.

Stream Bank Stabilization

Stabilization of degraded or eroded stream banks may reduce sediment input and lateral channel movement that may be detrimental to fish habitat. Prescriptions for bank stabilization and sediment control were based on appropriate site-specific characteristics. Bioengineering methods prescribed have been adapted from techniques described in WRP Technical Circular No. 9, *Fish Habitat Rehabilitation Procedures* (Slaney and Zaldokas, 1997), and may include a combination of:

- live staking;
- brush layering;
- live fascines; and,
- tree or rock/large wood debris revetments.

Appendix 1 provides further details of typical stream bank stabilization methods and bioengineering techniques proposed.

Restoration of Primary Fish Habitat

Primary fish habitat units are considered to be those pools, riffles, glides and other units that occupy more than 50% of wetted width of a stream (Johnston and Slaney, 1996). Restoration of primary fish habitat units in study area streams would often be best achieved by re-establishing their natural thalwegs. In small streams (such as those in the study area), this objective may be achieved by placement of LWD. LWD spanner logs placed at pre-determined distances would increase localized scour and deposition, simulating natural fluvial processes, and possibly benefiting fish habitat by:

- creating scour pools suitable for fish rearing and cover;
- creating riffles and glides of suitable spawning habitat;
- transporting sediment to defined depositional areas; and,
- providing stream cover in areas of LWD and Small Organic Debris (SOD) accumulation.

Appendix 1 provides further details of proposed measures and techniques for restoring primary fish habitat.

Restoration of Secondary & Tertiary Fish Habitat

Secondary fish habitat units occur in minor channels removed from the mainstem. Tertiary habitat units are embedded within a primary unit of the mainstem, but occupy less than 50% of the wetted width. In areas where the natural stream thalweg has not been altered or has been re-established (as described above), restoration of secondary and tertiary habitat units may directly benefit local fish habitat by:

- creating localized habitat such as scour pools and riffles;
- increasing fish rearing and holding habitat cover through LWD or rootwad placement; and,
- increasing local stream shading.

Appendix 1 provides details of proposed methods for restoring secondary and tertiary fish habitat.

Restoration of Riparian Habitat

Riparian zones represent transitional portions of the landscape where terrestrial and aquatic environments closely interact. Riparian or streamside vegetation forms an integral part of a stream environment and serves multiple interconnected functions. These functions include soil formation, stream bank retention and stabilization, prevention of erosion and siltation, microclimate modification, provision of wildlife habitat and contribution to in-stream nutrient levels and biogeochemical cycling. In addition, riparian areas serve as buffer zones to ameliorate potential chemical inputs from human activities (e.g., application of fertilizers, pesticides or herbicides, etc.) and for landslides and other sources of sediment or discharge to watercourses.

Restoration of previously cleared riparian areas by planting conifer tree species, augmented with native deciduous trees and shrubs, is intended to restore riparian function and increase in-stream fish habitat quality (e.g., increased stream shading, reduced sediment input, etc.).

2.4 Timing of Restoration

Fish habitat restoration requiring in-stream work (e.g., LWD/boulder placement) is subject to timing constraints based on fish life cycles and habitat requirements. Generally, in-stream operations should be conducted when fish eggs have completely developed and juveniles have emerged from gravel. Populations of anadromous salmon do not reach sections of the Homathko River or Mosley Creek within the study region (DFO and MELP, 1998); however, rainbow and bull trout tarhet species have been confirmed in stream sections recommended for restoration.

Work windows for streams containing rainbow and bull trout within the study region were suitable for in-stream restoration activities from July 15 to September 10, defined by MELP (Dolighan, 1999). Where restoration prescriptions do not require in-stream work (e.g., live staking banks), and target fish do not include regionally significant species or anadromous salmon, work windows would not require consideration. Consideration of in-stream fish habitat should be made during prescriptive implementation and, where it is determined this work would impact on local fish populations or habitat, deferred to a more appropriate period.

2.5 Prescription Approval

As resources and materials for implementation of several fish and riparian habitat restoration prescriptions were available immediately (i.e., August and September, 1999), Preliminary prescriptions were submitted directly to the TWA and MELP to expedite applications for Section 9 Water Act approval. Submissions included an application for "Proposed Works In and About a Stream" to MELP (Section 9 Regulation of the *Water Act*, BC Water Management Branch) and consultation with MELP fish habitat specialists. This application included summaries of restoration prescriptions, landowner authorization and identified target fish species where applicable. Similarly, preliminary riparian restoration prescriptions were submitted to MELP for approval.

2.6 Fisheries Work Windows

In-stream work windows for bull trout protection are from June 15 to September 10 and rainbow trout windows are from July 15 to April 10 (of the following year). In-stream work was proposed to coincide with work windows for both rainbow and bull trout populations in subject stream reaches (August 10 to September 10, 1999).

2.7 Environmental Monitoring

Where in-stream work was prescribed, a site supervisor was to be provided by G3 to ensure appropriate sediment control structures and methods were implemented (where applicable) to limit potential sedimentation during stream restoration activities. This would include (but not be limited to) formation of site specific sediment control plans and instruction of proper in-stream work methods.

3.0 Level 1 Assessment Summary

A summary of Level 1 FHA and RAPP results is provided below. Results of Level 2 FHAP and RAPP surveys are discussed and restoration prescriptions are described in Section 4.0. Typical restoration techniques and plans are provided in Appendix 1 and stream reach plans and associated figures and profiles in Appendix 2. Appendix 3 provides riparian restoration prescriptions and Appendix 4 estimates of materials and associated costs for 1999 restoration work.

3.1 Summary of Level 1 FHA & RAPP Results

Overview and Level 1 FHA and RAPP procedures were completed for select reaches of the Homathko River and Mosley Creek during 1997 and 1998 (G3 Consulting Ltd, 1998, 1998a & 1999).

3.1.1 Summary of Level 1 FHA Results

The Homathko River and Mosley Creek were observed from Overview and Level 1 FHAs to offer unique fish habitat and associated restoration opportunities. While subject reaches of the Homathko River (i.e., Reaches 4, 5, 6, 10 and 11) were identified as having extensive agricultural development of adjacent lands, those of Mosley Creek (i.e., Reaches 10, 11 and 12) have undergone considerably less development.

Fish habitat degradation of Reaches 4, 5 and 11 of the Homathko River were associated with reduced levels of LWD and associated infilling and covering of pools and riffles with sediment due to decreased localized hydrological scour (typically supplied by LWD). Mosley Creek had more abundant LWD; however, low to moderate levels of channel aggradation (of the mainstem and tributaries) had changed stream morphology resulting in decreased LWD function (where present).

Both watersheds were subject to extensive stream bank instability associated with land development and changed stream morphology. Generally, where riparian vegetation was comprised of mature deciduous or mixed forests, bank instability was decreased and LWD more abundant.

Homathko River (Reaches 4, 5, 6, 10 & 11)

Subsequent to Overview and Level 1 assessments of fish habitat, moderate to high priority Level 2 FHA surveys were recommended to prescribe bank stabilization and LWD placement in sections of Reaches 4, 5, 6 10 and 11. Each of these reaches had moderate to good access and were suited to a variety of bioengineering and/or in-stream LWD or boulder placement for bank stabilization. Bioengineering provides bank stability, reducing watershed erosion, while restoring fish habitat through stream shading, nutrient cycling and cover enhancement.

Mosley Creek (Reaches 10, 11 & 12)

A Level 2 FHA was recommended for Reaches 10, 11 and 12 of Mosley Creek to prescribe methods of bioengineering to promote bank stability and options of stream complexing through use of boulders or LWD. Integrated riparian zone rehabilitation was also recommended to promote stream cover and stream shading in sections. While off-channel rehabilitation opportunities were noted, the scope of work for the 1999 field season preclude their development. It was recommended that prescriptions focus on *in-situ* restoration of stream bank stability through bioengineering and LWD/boulder placement at opportunistic sites (i.e., areas where access and resources are best suited to in-stream work).

3.1.2 Summary of Level 1 RAPP Results

Level 1 Riparian Assessment and Prescription Procedures (RAPP) were conducted at several areas identified during Overview assessments (G3 Consulting Ltd., 1999). Particular focus was placed on sections directly adjacent to the Homathko River, as most sites of high or medium priority were located in this region.

Areas of valley bottom and associated valley walls adjacent to upper sections of the Homathko River (i.e., upstream of Tatlayoko Lake; Figure 2) have undergone notable anthropogenic alteration. Extensive areas were cleared for agricultural cropland or rangeland, and others more recently clearcut or selectively logged. Some large up-slope cutblocks were noted within this region, but were of no associated riparian concern, as buffer areas were sufficient. Several openings, located along Cochin Creek, Quakie Creek and the Homathko mainstem, were of riparian concern.

Mosley Creek is a tributary of the Homathko River. Agricultural and logging impacts were less extensive in this region than in the Homathko River valley. A moderate amount of land had been cleared for agricultural use in the Mosley Creek valley, with other areas clearcut or selectively logged. Limited areas along Mosley Creek were identified as having potential to benefit from rehabilitation of riparian area.

Two areas of high riparian rehabilitation priority were identified during Level 1 assessments: areas along Reaches 9, 10 and 11 of the Homathko River mainstem (Opening 1); and, Reach 9 along Mosley Creek (Opening 2).

Homathko River, Reaches 9, 10 & 11

Following Level 1 surveys, riparian function at several locations adjacent to agricultural lands along Reaches 9, 10 and 11 of the Homathko River was identified as impaired. These areas were assessed a low rating for providing stream shading and potential LWD and SOD, and moderate for sediment filtering, channel stability and bank stability. The area contained a mosaic of vegetation communities. Disturbance indicators observed included livestock grazing and beaver activity.

The portion of Homathko River comprising Reach 10 flowed through wetland where the riparian area contained no shrubs or trees. Consultation with the landowner confirmed that the original (pre-settlement) state of this portion of the valley was wetland, and portions had been drained to increase agricultural capability.

It was suggested that a mosaic of nurse-tree shelterwoods, clustered tree planting and shrub augmentation would improve function along portions of the riparian area of Reaches 9, 10 and 11; however, no action was recommended for the wetland area of Reach 10. Opportunities to prescribe livestock fencing in riparian areas (to limit impacts in the riparian zone through exclusion or controlled access) may also exist and were recommended to be investigated as part of Level 2 RAPP surveys.

Discussions with landowners in the area would assist in assessing the feasibility of riparian remediation and, if so, what constraints and opportunities exist relating to current and foreseen land use. This information would assist in determining specific sites for Level 2 riparian assessments and development of detailed prescriptions.

Mosley Creek, Reaches 9, 10, 11 & 12

In addition to select riparian planting in localized opening of Reaches 10, 11 and 12 of Mosley Creek, Opening 2, located on the right side of Mosley Creek along Reach 9, was recommended for a Level 2 RAPP survey. This section was cleared for agricultural use. A portion of the riparian area along Opening 2 (approximately 100 m long) appeared unvegetated during an aerial overview. This condition could increase the potential for surficial sediments to enter Mosley Creek. Disturbance indicators noted included livestock grazing and clearing of riparian vegetation for agricultural use, factors that may contribute to surface erosion. A lack of riparian trees and shrubs may have exacerbated bank erosion along the outside bend in the stream channel.

Preliminary prescriptions developed following Overview and Level 1 RAPPs (G3 Consulting Ltd., 1998a; 1999) consisted of planting shrubs commonly found in moist regions of the IDF zone (e.g., black gooseberry, black twinberry, common snowberry, Douglas maple and red-osier dogwood) along the approximately 100 m untreed portion of the riparian area to mitigate potential sediment input. It was proposed that several of these species could be regenerated from cuttings at minimal expense. To control the area of highest erosion along the outside channel bend, it may be more effective to live stake willows to quickly establish a root mass.

4.0 Level 2 FHA and RAPP Findings

Based on Level 1 fish and riparian habitat assessments, sections of the Homathko River and Mosley Creek watersheds were surveyed at Level 2 from July 7 to 17, 1999.

4.1 Homathko River

Sections of Reaches 4, 5, 6, 10 and 11 of the Homathko River were surveyed (Figure 2). These sites were assessed to determine means of restoring or rehabilitating watershed characteristics including:

- Reaches 4, 5, and 6 to assess bank erosion adjacent to agricultural clearings, riparian vegetation removal associated with active agricultural practices;
- Reach 10 to assess in-stream cover and complexing in existing pools and glides, riparian vegetation removal associated with active agricultural practices; and,
- Reach 11 to assess in-stream cover and complexing in existing pools, establishment of primary pools through scour structures, riparian vegetation removal in areas of active agriculture, bank stabilization through bioengineering.

4.1.1 Homathko River (Reach 4)

Reach 4 of the Homathko River flowed through areas of moderate to extensive agriculture use with sections of limited riparian vegetation (G3 Consulting Ltd., 1999). Bank erosion was noted at several river bends where crops were harvested directly adjacent to the stream channel (e.g., hay fields with little or no riparian buffer). A majority of riparian vegetation was willow or aspen shrubs and trees. Limited numbers of coniferous trees were observed throughout surveyed sections of this reach (G3 Consulting Ltd, 1999).

Level 1 FHA surveys indicated stream morphology was generally glide-pool with limited riffles in this low gradient stream section. Gradient was generally <1% and bankfull width approximately 10 m. Stream substrate was dominated by fines and sand with notable areas of exposed clay-silt on eroding stream banks. Little LWD was present in Reach 4 (Photo 1). Subsequent Level 2 FHA and RAPP surveys (July 7 to 17, 1999) confirmed several areas of bank erosion in areas of reduced riparian vegetation and little or no functioning LWD (Photo 2).

Restoration Objectives

Restoration prescriptions were developed to stabilize bank erosion, increase LWD/rootwad cover, increase riparian vegetation density and provide future localized LWD recruitment. Preliminary prescriptions were developed in consideration of potential project limitations, including limited abundance and relative size of materials (LWD, rootwads, boulders), limited heavy machinery availability and type (e.g., potential use of farm equipment) and extensive use of labour from available sources (e.g., Environmental Youth Team).

Eleven sites were selected to receive Level 2 FHA prescriptions with associated RAPP prescriptions developed for stream banks previously cleared for agricultural purposes. Table 2 provides site information and general prescription details for Reach 4. Appendix 2 further details specific in-stream restoration requirements and Appendix 3 riparian prescriptions for Reach 4. Figure 2 depicts locations of prescribed restoration sites.

Table 2: Fish & Riparian Habitat Restoration Prescriptions
Homathko River, Reach 4

Site	Length (m)	Restoration Opportunity	Prescription
4-A-1	10	Bank stabilization, increased pool and glide cover	LWD complexing, live staking
4-A-2	35	Bank stabilization, increased pool and glide cover	Live tree revetment, rootwad placement, bioengineering
4-A-3	70	Bank stabilization, increased pool and glide cover	Live tree revetment, rootwad placement, bioengineering
4-B-1	30	Bank stabilization	Live tree revetment, rootwad placement, bioengineering
4-B-2	20	Bank stabilization, increased pool and glide cover	Live-tree revetment, rootwad placement, live staking
4-C	45	Bank stabilization, increased pool cover	Live fascine, reef development, rootwad placement
4-D	40	Bank stabilization, increased pool and glide cover	Live-tree revetment, live staking
4-E	42	Bank stabilization, increased pool and glide cover	Live-tree revetment, rootwad placement, live staking
4-F	22	Increased pool and glide cover	Rootwad placement
4-G	15	Bank stabilization. Increased pool cover	Live-tree revetment, rootwad placement, live staking
4-H	10	Bank stabilization	Live-tree revetment, live fascine
4-I	40	Bank stabilization	Live-tree revetment, rootwad placement, live staking

Stream Bank Instability

The stream bank of outside bends of Reach 4 of the Homathko River were noted to be eroding and sloughing into the stream channel at several locations (i.e., prescribed restoration sites; Photo 2; Appendix 2). Past agricultural practices of harvesting crops (e.g., hay) likely contributed to bank destabilization, as shrubs and trees were removed from the area immediately adjacent to the stream to facilitate crop harvest. Stream banks appeared suited to tree revetments and stabilization through bioengineering. An LWD/boulder or tree revetment at the toe of the slope may contribute to bank stability and energy dissipation. Recommended bioengineering methods could include live staking and placement of fascines and brush layers (Appendices 1 & 2). Live staking of stream banks is also recommended to assist in providing stream cover.

To stabilize bank slumping through sections of Reach 4, the following options were identified:

- placement of tree or rock/LWD revetments to attenuate and redirect flows along the toe of the slope;
- placement of combined brush layer/live fascine at toe of slope; and,

- live staking of stream bank in affected area upon completion of major works (i.e., revetment placement).

Access was good at Reach 4 across hay fields and developed residential lands accessible from private property (with landowner permission). An excavator would be required for LWD and rootwad/revetment placement while little or no machinery would be required for bioengineering.

Appendix 1 provides schematics for revetments and bioengineering techniques recommended for sites located in Reach 4, and Appendix 2 provides restoration plans.

Reduced Stream Cover

It is estimated that each rootwad would create approximately 2.5 m^2 of stream cover and live-tree revetments approximately 1.0 m^2 for each linear metre of structure length. Rootwads and LWD revetments were generally prescribed together to increase bank stability and increase stream cover in localized areas. Planting of conifer tree species in the riparian area and bioengineering with local deciduous shrub and tree species was prescribed to supplement stream cover and contribute to bank stabilization.

4.1.2 Homathko River Reaches 5 & 6

Reaches 5 and 6 of the Homathko River had fish habitat similar to those of Reach 4 (G3 Consulting Ltd., 1999). Gradient was noted to be <1%, and bankfull width approximately 10 m. Stream cross section profiles indicated steep stream banks and a bankfull depth of approximately 1.5 m. (Photo 3). While LWD was noted to be more abundant in Reaches 5 and 6 than in Reach 4, there was little or no LWD >50 cm diameter observed (G3 Consulting Ltd., 1999).

Sources of bank instability similar to those noted in Reach 4 were observed in Reaches 5 and 6 (Photo 4; Appendix 2). Banks were particularly unstable in areas of reduced or cleared riparian vegetation associated with crop fields (Photo 3).

Restoration Objectives

Stream channel observations and presence of some functioning LWD indicated that stream morphology included abundant pools and glides suited to holding and rearing habitat for fish. Gravel suited to resident fish spawning was observed in several locations. Restoration of fish and riparian habitat of Reaches 5 and 6 should have the objective of stabilizing stream banks and increasing in-stream and over-stream cover through LWD/rootwad revetments and increased riparian vegetation stocking (Photos 3 &4).

Table 3 provides site information and general prescription details for Level 2 FHAP sites of Reaches 5 and 6. Figure 2 indicates the approximate position of prescribed sites. Appendix 1 describes revetment and rootwad placement techniques, Appendix 2 restoration details for sites of Reaches 5 and 6, and, Appendix 3 riparian planting prescriptions for relevant sites.

Table 3: Fish & Riparian Habitat Restoration Prescriptions
Homathko River, Reaches 5 & 6

Site	Length (m)	Restoration Opportunity	Prescription
5-A	30	Bank stabilization, increased pool and glide cover	Live-tree revetment, live staking, fascine placement, riparian planting
5-A-1	15	Bank stabilization	Live-tree revetment, bioengineering
5-A-2	45	Bank stabilization, increased pool and glide cover	Live-tree revetment, rootwad placement, bioengineering
5-B	35	Bank stabilization	Live-tree revetment, rootwad placement, bioengineering
5-C	25	Bank stabilization, increased pool and glide cover	Live-tree revetment, rootwad placement, live staking, riparian planting
5-D	23	Bank stabilization	rootwad placement
5-E	30	Bank stabilization,	Live-tree revetment, live staking, brush layer
6-A	55	Bank stabilization, increased pool and glide cover	Live-tree revetment, rootwad placement, live staking, fascine placement
6-B	35	Bank stabilization	Live staking, fascine placement, riparian planting
6-C	30	Bank stabilization, increased pool cover	Live-tree revetment, rootwad placement, live staking
6-D	35	Bank stabilization	Live-tree revetment, live fascine
6-E	25	Bank stabilization	Live-tree revetment, rootwad placement, live staking

4.1.3 Homathko River Reach 10

Level 1 FHAP and RAPP surveys of Reaches 9 and 10 of the Homathko River indicated riparian shrub vegetation was relatively abundant in lower sections of Reach 10 and contributed to localized bank stabilization (Photo 5). Upstream sections of Reach 10 were described by landowners as having been a lake or swamp that was subsequently drained to increase pasture area. Although upstream sections of Reach 10 exhibited little or no riparian vegetation, (Photo 6) LWD or stream complexing, natural wetlands remaining adjacent to the stream channel appeared to inhibit growth of stream side vegetation and limited access to the stream channel (i.e., upper 1,000 m of Reach 10).

Restoration Objectives

The lower ~800 m of Reach 10 were suited to increased stream complexity and in-stream cover (G3 Consulting Ltd., 1999; Photo 6). An access road and bridge located on private property would enable access for in-stream work in that stream section. It is recommended that rootwads and LWD clusters be placed in the stream to provide in-stream fish habitat cover and potentially create LWD accumulation points should natural recruitment of LWD occur. Stream profile of lower sections of Reach 10 exhibited high near vertical banks with a moderately entrenched stream channel. Banks appeared stable and vegetated with willow shrubs in most sections. Substrates were noted to be sand and fine material, as anticipated in an area of low gradient deposition (e.g., >0.5% gradient).

Use of boulders and epoxy anchoring methods is recommended as ballast for LWD and rootwads in conjunction with dead-stout anchors to prevent downstream transport. It is also recommended that structures consist of between three to five pieces of LWD (preferably with rootwads) placed in a tripod or other similar LWD catchment structure that would encourage natural LWD accumulation. These structures would provide immediate in-stream fish habitat cover as it is anticipated that limited natural LWD would accumulate in this stream section (as riparian vegetation is limited). Appendix 1 provides details on LWD structures recommended for Reach 10 and Appendix 2 provides locations and approximate positions of recommended LWD structures. Where heavy machinery availability is limited, it is anticipated that LWD structures could be constructed and ballast added on the stream bank adjacent to the restoration site and placed in the river channel with locally available farm equipment.

Although banks of Reach 10 appeared well vegetated with a forb and shrub layer, LWD revetments at outside stream bends would dissipate energy and increase stream cover. It is recommended these structures be anchored with dead-stout anchors and remain floating in the stream channel to be effective at various water levels.

Fish habitat restoration structures for Reach 10 are intended to increase stream complexity and fish habitat cover in this relatively homogenous, low gradient, pool-glide stream reach. Structures are not intended to create extensive scour or alter stream morphology (i.e., structures are not intended to create primary fish habitat units). For these reasons, site specific selection of placement locations should be determined during installation. Site selection should ultimately be based on material availability and land use objectives determined by the landowner (e.g., stream access). LWD structures should be placed in existing pools where feasible, while revetments should be placed in glides or on outside stream bends.

4.1.4 Homathko River Reach 11

Reach 11 was subdivided into Subreaches 11-1 and 11-2 during Level 1 FHA and RAPP surveys (G3 Consulting Ltd., 1999). Subreach 11-2 was subsequently chosen to receive Level 2 assessments, based on stream channel and riparian habitat conditions. Subreach 11-2 exhibited limited riparian vegetation cover dominated by localized clusters of deciduous shrubs and trees (e.g., willow, poplar and birch). The stream channel of Subreach 11-2 differed notably from downstream reaches. Gradient of Subreach 11-2 was between 0.5% and 1.0%, with abundant riffles and a defined riffle-pool morphology (G3 Consulting Ltd., 1999). Bankfull width was between approximately 3 m and 5 m with bankfull depth between 0.30 m and 1.10 m.

Course sand and gravel dominated stream substrate and localized aggradation and degradation indicated an active stream channel (Photo 8). Little or no cobble or boulder was observed in Subreach 11-2; however, upstream sections of the Homathko River (i.e., Reaches 12 and 13) had large deposits of cobble and boulder as gradient increased towards the headwater. Although eroding banks were noted throughout Subreach 11-2, much of the sand and gravel substrate was transported from upstream sections of the river, where a large bedrock escarpment was observed (G3 Consulting Ltd., 1999). Bank erosion was generally limited to stream sections adjacent to cleared crop lands and areas actively used by cattle. Natural undercutting of banks vegetated with shrubs and forbs were observed in select stream sections providing in-stream fish cover (Photo 7).

Although little or no LWD was observed during Level 1 FHAP surveys, a distinct stream thalweg was evident throughout most of Subreach 11-2 (G3 Consulting Ltd., 1999; Photo 8). An alternating pattern of left- and right-bank pools was noted in most sections of the predominantly riffle-pool reach. Most stream sections exhibited little of complexing, resulting in extensive areas of riffle with no primary pools (e.g., 50 m of riffle section) compared to the regularly alternating pool pattern described above.

Restoration Objectives

Several primary pools were observed throughout Subreach 11-2, provided by in-stream vegetation and shrub root-masses providing stream complexing in the channel (Photo 9). Where natural primary pools existed and the thalweg appeared to be in a natural position, restoration of secondary and tertiary habitat was recommended. LWD from local sources, supplemented with that transported to the site, would provide sufficient materials to implement fish habitat restoration (Appendices 1 & 2). It is further recommended that several small, localized land slumps on the right stream bank be stabilized by placing a brush layer, live stake and fascines at exposed areas of the slopes (Appendices 1 & 2).

Riparian vegetation should be supplemented with conifer stocking in areas not actively harvested for agriculture crops (Photo 10). Landowner cooperation would be necessary to ensure that land use objectives are met for the designated riparian planting areas and cattle grazing and agricultural activities did not jeopardize riparian planting prescriptions. Where required, use of cattle exclusion fencing may be necessary to achieve these objectives.

Fish Habitat Restoration

During the Level 1 FHAP survey, bankfull channel width and depth of Subreach 11-2 of the Homathko River were estimated to be 4.4 m, and 0.85 m respectively (G3 Consulting Ltd., 1999). Bankfull depth measurements included relatively deep primary glides and pools and were considerably less for riffle areas (e.g., 0.50 m). Based on bankfull channel width and a desired thalweg distance of approximately six times the bankfull width (Newbury and Gaboury, 1993), it was recommended that primary restoration structures be placed approximately every 26.4 m. A typical LWD placement prescription is illustrated in Appendix 1. LWD is recommended to have a diameter approximately one-third the bankfull depth (i.e., ~0.30 m).

Where available, cedar logs are recommended as they are most resistant to decomposition; however, as cedar is not common in the study area, regional species of coniferous trees should be used (e.g., Douglas-fir, hybrid spruce or lodgepole pine). Logs should have rootwads attached to increase structure complexity. Undercutting of full spanning logs is anticipated in Subreach 11-2 as stream substrate is predominantly sand and gravel. For this reason, LWD structures should consist of two pieces of LWD with roots attached, each keyed in to alternate stream bank at an approximately 30° angle to stream flow, with rootwads crossing in the center of the stream. As stream sections requiring primary habitat restoration (i.e., LWD placement) were comparably short in distance (e.g., ~50 m) it is not anticipated that an alternating pattern of left and right pool formation would be required (i.e., alternating thalweg structures).

It is anticipated that keying LWD into stream banks, and employing mid-span re-bar anchors, will be sufficient to maintain structural integrity of LWD spanning logs in high stream discharges. Where it is required that LWD structures have boulder ballast, conservative application of ballast is recommended (Slaney and Zaldokas, 1997). Ballast required would be 100 kg/m for LWD of approximately 0.30 m diameter, at discharge assumed to be 3 m/s high flow (e.g., a 5 m piece of LWD would require 500 kg of ballast).

Secondary and tertiary habitats may also benefit from increased LWD cover in stream sections not directly associated with primary habitat units. It is further recommended that rootwad and tertiary LWD structures be placed according to field assessment. Appendix 2 describes secondary and tertiary habitat restoration prescriptions and placement methods for this site.

Stream Bank Instability

The right stream bank appeared unstable at several locations approximately 75 m to 200 m upstream of a private bridge crossing of Subreach 11-2 (Photo 5: Appendix 2). It was estimated the extent of the unstable sites was between 12.5 m^2 and 40 m^2. It is recommended that stream banks be stabilized through a combination of brush layer and fascine placement, live staking, and cattle exclusion (Appendix 1). Materials for brush layer construction and live staking could be collected on site. Planting of mixed coniferous species are recommended for upslope (i.e., top of bank) sites adjacent to bank instability sites to further stabilize stream banks and increase localized stream shading and cover.

Appendices 3 and 4, respectively, describe material requirements and availability, and associated cost estimates for restoration prescribed for Site D.

4.2 Mosley Creek Reaches 10, 11 & 12

General Description

Overview and Level 1 FHAP surveys indicated that 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 (G3 Consulting Ltd., 1998 & 1999). Field assessment of Mosley Creek (July 7 to 17, 1999) further identified one site suited to riparian planting in Reach 9, which was included in the Level 2 assessment. Reaches 10 to 12 of Mosley Creek are known to contain populations of rainbow trout and bull trout (described as Dolly Varden char) target species and non-target suckers and minnows (DFO and MELP, 1996). Level 1 FHA and RAPP surveys identified fish and riparian habitat of Reaches 10, 11 and 12 of Mosley Creek as potentially benefiting from bank stabilization, increased riparian vegetation planting and increased LWD placement in specific stream sections.

Level 2 FHA and RAPP surveys were conducted from July 7 to 17 to confirm Overview findings. During this period Mosley Creek exhibited unseasonably high water flow (particularly downstream of Valleau Creek). Subsequent site visits in August indicated that water levels of Mosley Creek remained relatively high throughout the summer and the stream was subject to immediate increases in discharge associated with localized precipitation.

Reaches 10, 11 and 12 of Mosley Creek had bankfull widths between 10 m and 14 m downstream of Valleau Creek, and approximately 6 m upstream of the confluence. Bankfull depth was approximately 0.85 m with riffles averaging 0.55 m and pools averaging 1.10 m bankfull depth (G3 Consulting Ltd., 1999). Stream gradient varied from approximately 1.0% to 2.5% as stream morphology changed from riffle-pool to step-pool according to localized conditions.

Restoration Objectives

Level 2 FHA and RAPP surveys determined that objectives originally recommended of increasing LWD complexity in existing primary pools and glides (G3 Consulting Ltd,. 1999) were not applicable at this time. Conclusion were based on analysis of existing LWD abundance and distribution and logistical problems associated with increasing LWD abundance through structure placement (i.e., limited access, extensive use of machinery, etc.). Level 1 habitat diagnosis determined Reaches 11 and 12 had “Fair to Good” ratings for LWD abundance while Reach 10 had a “Fair” rating (with abundant LWD noted in pools). Application of this data in conjunction with limited access to specific sites suggested priority of assessment should concentrate on stabilizing stream banks in areas of riparian vegetation removal or alteration.

Level 2 surveys (July 7 to 17) determined bank stabilization was a main priority for sections of Reaches 10, 11 and 12. Several opportunities to increase bank stability through a combination of LWD/rootwad revetments, bioengineering and riparian planting were identified. Stabilizing banks at areas of noted erosion would contribute to controlling sedimentation and stabilizing the channel, potentially improving water quality and fish habitat (Appendix 1).

Fish Habitat Restoration

It is recommended fish habitat restoration of Mosley Creek focus on specific areas of bank instability associated with riparian vegetation removal or alteration. Specifically these sites should include a revetment recommended for upper sections of Reach 12 (Photo 11; upstream of the confluence with Valleau Creek) and bioengineering of sections of Reaches 10, 11 and 12 as identified on Figure 3 (Photo 12). Prescription of stream channel stabilization through revetment installation has been limited to sections upstream of Valleau Creek. Valleau Creek was an active contributor of sediment and clastic debris to Mosley Creek and downstream stabilization of Mosley Creek would likely be of limited value given sediment influxes from Valleau Creek; however, as bioengineering is a relatively cost effective measure of enhancing bank stability and increasing stream cover, it is recommended that bioengineering of unstable banks be completed throughout reaches 9, 11 and 12 (Reach 10 appeared to exhibit stable banks).

Stream Bank Instability

One area of bank instability (Site M-6) which would benefit from stabilization was identified in upstream sections of Reach 12 (upstream of the confluence with Valleau Creek; Figure 3; Photo 11). During Level 2 FHAP surveys (July 7 to 17, 1999) the right bank of Subreach 12-2 exhibited signs of increased erosion since Level 1 FHAP surveys (September, 1998). Approximately 45 m of bank was eroding and sloughing into the stream channel. The area immediately downstream provided suitable spawning and rearing habitat for resident fish, and was situated upstream of the relatively silt-laden confluence of Valleau Creek. The site was located adjacent to a public road and accessible for machine placed LWD and rootwad revetments to stabilize the stream bank and increase localized stream cover. Bioengineering and riparian planting of this section subsequent to in-stream bank stabilization was also recommended.

Table 4 identifies locations along Reaches 10, 11, and 12 that may benefit from bank stabilization measures. One riparian planting site (with associated bioengineering prescriptions) was identified in Reach 9 and was included in this table due to its proximity to Reach 10. Appendix 1 provides typical details of bioengineering and in-stream requirements prescribed for these sites and Appendices 2 and 3 provide bioengineering and riparian planting prescriptions and details where required. Bioengineering prescriptions would not require machinery and would provide field crews access to these points directly from the river channel. A majority of materials required for site specific (bioengineering) were available locally (e.g., live staking materials). It is recommended that access to bioengineering sites (i.e., Sites M-1 to M-5) be gained from the stream channel with reference to GPS coordinates and approximate distance from reach breaks, as road access was limited.

Table 4: Mosley Creek Bank Stabilization Points

Suited to FHAP Restoration (Reaches 10, 11 &12)

Site	UTM	Reach	Distance Up Stream from Reach Break (m)[1]	Priority	Area (m^2)	Prescription
M-1	10.374528.5729451	9	870	High	75	Live stake stream bank, plant conifer tree species in riparian area
M-2	10.377200.5730710	11-1	320	Moderat e	50	Live stake localized bank failure
M-3	10.378891.5731850	12-1	50	Moderat e	50	Live stake localized bank failure
M-4	10.379262.5732109	12-1	392	High	350	Live stake and place live fascine at toe of slope
M-5	10.379425.5732574	12-1	1,000	High	400	Live stake and place live fascine at toe of slope
M-6	10.379562.5732875	12-2	25	High	500	Live stake stream bank, plant conifer tree species in riparian area subsequent to in-stream bank stabilization

[1] Distance (in metres) from described site to the downstream reach break.

5.0 Culvert Inspections

Restoring fish passage at culvert crossings is generally not within the scope of Level 2 FHAP; however, in the interest of the fisheries resource, one culvert in the Mosley Creek subbasin was examined during this Level 2 study, given its proximity to other selected sites.

When developing prescriptions to restore fish passage at culverts, consideration was given to the potential benefit to fish from access to habitat (upstream of the culvert). Only where notable fish habitat was determined to exist upstream, was restoration of fish passage prescribed.

5.1 Cherry Creek Culvert

A 1,200 mm corrugated steel pipe culvert located on Cherry Creek, approximately 25 m upstream from its confluence with Mosley Creek at Reach Break 12-1/12-2, was a barrier to fish passage and recommended for replaced. Although a complete Fish Passage Culvert Inspection (FPCI) was not conducted (i.e., FPCI forms were not used) culvert characteristics (e.g., gradient, water velocity, outlet drop, culvert length and out let pool dimensions) were recorded.

At the time of inspection (July 15, 1999) water levels in Cherry Creek were near bankfull capacity and discharge considered high (approximately 1.5 m^3/s to 3 m^3/s). The culvert was approximately 11 m long, with a gradient between 4.0% and 6.0% with an upward bend near its inlet. Water velocity exceeded 2.0 m/s within the culvert, while stream velocity was estimated at approximately 1.75 m/s. The outlet drop was approximately 0.10 m, and outlet pool depth approximately 0.48 m (Photo 13).

While it appeared the minimal culvert outlet drop (0.10 m in high water conditions) would enable fish to enter the culvert water velocity and culvert slope would likely pose at least a partial barrier to fish under noted conditions. In addition to fish passage concerns, the culvert was out of alignment with the existing stream channel, as Cherry Creek appeared to have changed course since initial culvert placement. Fish passage parameters (i.e., slope, water velocity, etc.) coupled with culvert alignment issues, suggest that the culvert be replaced by a bridge or installed properly (Photo 14). Therefore, it is recommended that the culvert be replaced.

The relative qualitative and quantitative increment in fish habitat resulting from restoring fish passage was assessed during Level 1 FHAP surveys (G3 Consulting Ltd., 1999). Approximately 1,000 m of fish habitat would be readily-accessible to fish upstream of the culvert. Potentially, more habitat existed upstream of 1,000 m as gradient did not appear to become a natural barrier (i.e., the stream channel was noted as <20% gradient; G3 Consulting Ltd., 1998), and bull trout were observed to utilize habitat of Cherry Creek during Level 1 FHAP surveys (G3 Consulting Ltd., 1998).

6.0 Prescription Synopsis

Stream reaches for which prescriptions were developed pursuant to Level 2 FHAPs and RAPPs require variable levels of effort to restore stream channel, bank stabilization and riparian vegetation function and associated fish habitat. Four types of remediation have been prescribed in this report:

1. bank stabilization;
2. restoration of primary, secondary and tertiary fish habitat;
3. riparian vegetation rehabilitation; and,
4. fish passage restoration at culverts.

Expeditious program planning and implementation by the Tatlayoko Woodlot Association, G3 Consulting Ltd., Environmental Youth Team, MELP and various stakeholders enabled approval-in-principle of several restoration prescriptions, which, in turn, resulted in several areas to be restored during the 1999 field season (August 16 to September 3, 1999). While prescriptions for a majority of "high" priority bank stabilization and riparian rehabilitation sites were completed in 1999, it is further recommended that remaining prescriptions be implemented in the year 2000 to complete these prescribed restorations. Appendix 5 presents a summary of fish and riparian habitat restoration completed in 1999.

Bank stabilization prescriptions for remaining Homathko River sites and Site M-6 of Mosley Creek require moderate-to-extensive use of heavy machinery and in-stream work, while bioengineering sites would require little or no machinery or in-stream work. Several sites along Mosley Creek (i.e., Sites M-1 to M-5) are suited to bioengineering and would not require in-stream work. Therefore, these sites are likely suitable for immediate implementation (where field conditions permit), pending MELP and DFO notification and approval. Where bioengineering has been prescribed at other sites (e.g., Homathko River sites) work should be implemented in conjunction with in-stream restoration prescribed for the site.

Literature Sources

BC Government. 1995.
Cariboo-Chilcotin Land-Use Plan, ninety-day implementation process final report. Victoria; 207 pp.

Babakaiff, S., D. Hay, and C. Fromuth. 1997.
Rehabilitating stream banks. *In*: Slaney, P.A., and D. Zaldokas (eds.) Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. MELP. Vancouver.

Beese, W.J., T.P. Rollerson, and R.N. Green. 1994.
Forest site rehabilitation for coastal British Columbia (interim methods). Watershed Restoration Program Technical Circular No. 4. MELP and MOF. Victoria.

Décamps, H., and E. Tabacchi. 1992.
Species richness in vegetation along river margins. *In*: P.S. Giller, A.G. Hildrew, and D.G. Raffaelli (eds.). *Aquatic Ecology. Scale, Pattern and Process*. Blackwell Scientific Publications. Oxford; pp. 1-20.

DFO and MELP. 1998.
Fisheries Inventory Summary System (FISS) database. Internet search conducted August, 1998.

Dolihan, R. 1999.
Zone Supervisor, Horsefly and Chilcotin Forest Districts. Fisheries Branch. MELP. Section 9 (BC Water Act) Approval. Williams Lake. August.

Donat, M. 1995.
Bioengineering techniques for streambank restoration, a review of Central European practices. Watershed Restoration Program Report No. 2. MELP and MOF. Victoria.

Dunster, J.A., and K.J. Dunster1996.
Dictionary of natural resource management. UBC Press. Vancouver.

G3 Consulting Ltd. 1998.
Homathko River & Mosley Creek, Overview fish habitat assessment procedure. Prepared for the Tatlayoko Woodlot Association. Richmond, BC.

G3 Consulting Ltd. 1998a.
Homathko River & Mosley Creek, Watershed-Level riparian assessment. Prepared for the Tatlayoko Woodlot Association. Richmond, BC.

G3 Consulting Ltd. 1999. Homathko River & Mosley Creek, Level 1 fish habitat and riparian assessment. Prepared for the Tatlayoko Woodlot Association. Richmond, BC.

Gray, D.H., and A.T. Leiser. 1982.
Biotechnical slope protection and erosion control. Van Nostrand Reinhold Company. New York.

Johnston N.T., and Slaney. 1996.
Fish Habitat Assessment Procedures. Watershed Restoration Program. Technical Circular No. 8. MELP. Vancouver.

Koning, W. C. (ed.). 1999.
Riparian Assessment and Prescription Procedures. Watershed Restoration Technical Circular No. 6. MELP. Vancouver.

MELP. 1998.
Habitat restoration prescription guidebook. Vancouver Island Region 1. Victoria.

MOF and MELP. 1995. Riparian management area guidebook. FPCBC. Victoria; 68 pp.

Newbury, R.W., and M.N. Gaboury. 1993.
Steam analysis and fish habitat design, a field manual. Newbury Hydraulics Ltd., The Manitoba Habitat Heritage Corporation, and Manitoba Fisheries Branch. Winnipeg.

Schiechtl, H.M. 1980.
Bioengineering for land reclamation and conservation. University of Alberta Press. Edmonton.

Slaney, P.A., and D. Zaldokas (eds.). 1997.
Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. MELP. Vancouver.

Glossary

Aggradation	Geologic process by which stream beds, floodplains and bottom of other water bodies are raised in elevation through deposition of eroded and transported material (opposite of degradation).
Anadromous	Species that incubate and rear in freshwater, migrate to the ocean for additional rearing, then return to freshwater for spawning.
Anthropogenic	Human-caused.
Aquatic Vegetation	Plant life growing in or on the water, excluding algae.
Armouring	Application of various materials to protect stream banks from erosion, may be a natural or anthropogenic process.
Average Depth	Average depth of water at a sample site cross-section.
Back Channel	A pool type formed by an eddy along channel margins downstream of channel obstructions (e.g., boulders, root-wads, bars, etc.) or resulting from acute upstream flooding of the stream channel due to obstructions; may be separated from the main channel by sand or gravel bars (MELP, 1995).
Backflooding (Culverts)	Flooding of the culvert pipe through creation of a pool at the culvert outlet which has a mean water surface level higher than the bottom of the culvert pipe. Backflooded culverts generally allow fish passage.
Bankfull Channel	The area of stream channel that contains water, or potentially contains water, during non-flooding maximum discharges (see *bankfull channel width*).
Bankfull Channel Width	Channel width measured between the tops of the most pronounced banks on either side of the stream.
Bar	Alluvial deposit or bank of sand, gravel or other material, at the mouth of the stream, or at any other point, that obstructs flow and induces deposition.
Bioengineering	The use of living plant material as a component of site engineering and landscape construction in order to stabilize and conserve soils (Dunster and Dunster, 1996).
Boulder	Stream substrate particle larger than 256 mm in diameter.
Braided	A stream reach that divides into an interlaced network of reuniting channels, separated by channel bars.
Canopy	The main treetop layer of a forest.
Canopy Density	Percentage of the stream covered by a canopy of plants.
Cascade	Stream segment with a stepped series of drops characterized by exposed rocks and boulders, high gradient and swift current.
Channel	A natural or artificial waterway which continually or periodically contains water confined between bed and banks.
Channel Cover	Vegetation projecting over the channel width, completely or partially, at a given point.

Channel Pattern

The configuration of a stream described in terms of relative curvature (MELP, 1995):

- **straight**: very little curvature within a reach;
- **sinuous**: slight curvature within a length of less than two channel widths;
- **irregular**: no repeatable pattern;
- **irregular meander**: a repeated pattern vaguely present in the channel plan;
- **regular meander**: a clearly repeated pattern; and,
- **tortuous meander**: a repeated pattern characterized by angles >90°.

Channel Stability

A measure of resistance of a stream to erosion, determining adjustment to and recovery from changes in flow or sediment transport.

Channel Width

Horizontal distance from bank to bank at high water marks, measured perpendicular to stream flow.

Chute

A confined cascade or riffle which presents increased gradient due to confinement or vertical drop.

Clay

Fine-textured inorganic material less than 0.004 mm in diameter.

Cobble

Bed or bank material between 64 mm and 256 mm intermediate diameter.

Confinement

The degree to which a river channel is limited to lateral movement by terraces or valley walls (MELP, 1995). The channel may be:

- **entrenched**: the stream bank is in constant contact with valley walls or terraces;
- **confined**: in continuous or repeated contact at the outside of major meander bends;
- **frequently confined**: frequently confined by valley walls or terraces;
- **occasionally confined**: occasionally confined by valley walls or terraces; and,
- **unconfined**: not in contact with valley walls or terraces.

Coniferous

Refers to any tree or shrub species of the class Gymnospermae (naked seeds) which do not flower and whose seeds are borne in cones.

Cover

Objects providing protection from predators or moderating adverse conditions of stream flow; may be for the purpose of escape, feeding, hiding or resting.

Cross-section

The wetted cross-sectional area of a stream at the time and point of survey.

Debris

Organic material deposited in the floodplain or within the channel.

Deciduous

Refers to any tree or shrub species which loses its leaves annually during winter or periods of drought; used loosely as the opposite of “coniferous”, though a small minority of conifers, such as larches, are deciduous.

Degradation	The geological process by which stream beds and floodplains are lowered by removal of bed material.
Depth	The vertical distance from the water surface to the stream bed.
Discharge	Volume of water flowing in a given area of a stream over a given time, expressed as m^3/s.
Enhancement	In this report, the outcome of any method or process by which the quality or carrying capacity of a habitat unit is improved beyond natural levels.
Entrenchment	Channel incision resulting from degrading fluvial processes, resulting in extreme channel confinement.
Ephemeral Stream	A stream without surface flow in all or part of its channel length during periods of low precipitation or runoff.
Fascine (Live)	A cluster of living plant stems grouped together in an elongated bundle and placed in a shallow trench to promote plant growth for bank stabilization. May be several metres in length.
FHAP	Fish Habitat Assessment Procedure as defined by the Watershed Restoration Program.
Fisheries Sensitive Zones	Permanently or seasonally wetted off-channel habitat that provide aquatic environments important in life cycles of some fish species.
Flood	A flow that exceeds the bankfull capacity of a stream or channel.
Flow	(i) movement of a stream of water from place to place; (ii) the movement of water, and the water itself; (iii) the volume of water passing a given point per unit of time (discharge).
Flow Regime	The normal pattern which water follows, defined by natural steam channel patterns.
Glide	A slow-moving, relatively shallow section of water with little or no surface turbulence.
Gradient	Rate of change of any characteristic per unit of length.
Gravel	Substrate particle size between 2 mm and 64 mm diameter.
Habitat	The place where a population lives and its surroundings, both living and non-living; includes the provision of life requirements such as food and shelter.
In-stream Cover	Areas of shelter within a stream channel providing cover (see *cover*).
Left Bank	The left-hand side of a watercourse if one is facing downstream.
Level 1 Assessment (FHAP)	The stage of FHAP which follows Overview Assessment. Sites determined to require collection of habitat and preliminary restoration-specific data are assessed during field surveys at this stage of work.
LWD	Large Woody Debris; fallen tree trunks and large limbs in watercourses and riparian areas, important to stream morphology and fish habitat, and as nutrient sources; in this report, LWD availability as stream inputs is one of the criteria used to quantify the health of a riparian zone.

Mainstem	The principal, largest or dominating stream channel of a drainage system.
Off-Channel Habitat	Small areas containing fish habitat outside the main channel of a stream system (MELP and MOF, 1995).
Parameter	Any member of the set of biogeochemical factors under study.
Peak Flow	Greatest stream discharge recorded over a specified period of time, usually one year.
Overview Assessment (FHAP)	Preliminary assessment of fish habitat through air photo, biophysical map and data report interpretation, involving limited site reconnaissance. Intended to direct FHAP Level 1 surveys.
Perennial (stream)	A stream that flows continuously throughout the year (permanent).
Pool	Portion of a stream with reduced current velocity, low gradient, often with deeper water than surrounding areas and with a smooth surface.
Rapids	Stream sections with considerable surface agitation, swift current and drops of up to 1 m.
Reach	A homogeneous segment of a drainage network, characterized by uniform channel pattern, gradient, substrate and channel confinement (Johnston and Slaney, 1996).
Reach Break	The boundary between two reaches of a watercourse; usually defined by a clear change in channel morphology (e.g., a falls), hydrology (e.g., entry of major tributary) or an anthropogenic structure (e.g., a bridge or weir).
Reach Number	The alphanumeric label assigned to a reach for purposes of identification. This convention is used to number reaches sequentially from mouth to source.
Rehabilitation	Describes environmental design measures which stabilize and improve the condition of disturbed sites; according to Johnston and Moore (1995), "returning to a state of health and useful activity...producing conditions more favourable to particular groups of organisms, especially the economically valuable or aesthetically desired components of the native flora and fauna, without necessarily returning the system to its undisturbed condition" (see *restoration*).
Resident (fish)	Non-anadromous fish, spending entire life histories in freshwater systems.
Restoration	Describes environmental design measures aimed at rehabilitating disturbed sites to the point at which they resemble the pre-disturbance condition to the extent practicable.
Revetment (LWD/Boulder)	A layer of large logs or rocks placed along a stream bank to prevent erosion (Dunster and Dunster, 1996).
Riffle	Shallow section of a stream channel with rapid current and a surface broken by gravel, cobble or boulders.
Right Bank	The right-hand side of a watercourse if one is facing downstream.

Riparian Synonym of *streamside*; riparian zones may be defined functionally as zones of direct interaction between the terrestrial and aquatic environments; those portions of the floodplain submerged annually.

Run Swiftly flowing stream reach with little surface agitation and no major flow obstructions, often appears as a flooded riffle.

Scour Local removal of stream bed by flowing water.

Scour Pool Pool formed by scour of water which is deflected or diverted by stream banks or channel obstructions.

Sediment Fragmental material resulting from weathering of rocks and organic materials, transported, suspended and deposited by water (or air).

Side Channel A lateral channel with ephemeral or perennial flow roughly parallel to the mainstem, which may contain habitat.

Silt Inorganic bed material between 0.004 mm and 0.062 mm diameter.

SOD Small Organic Debris; SOD availability as stream inputs is one of the criteria used to quantify the health of a riparian zone.

Spawning The reproductive process of fish (salmonids for the purpose of this report) involving redd digging, egg deposition and fertilization. This is a general term describing the entire process of reproduction.

Spawning Gravel Gravel substrate required for redd construction, egg deposition, incubation and emergence of fish in (salmonid) reproduction cycles; optimum gravel size will vary with species.

Species (Either singular or plural) the smallest discrete unit of biological classification; organisms are said to belong to the same species if they are members of a population which breeds and produces viable (i.e., fertile) offspring; standardized Latin scientific nomenclature specifies both genus and species in a binomial descriptor.

Stream A natural watercourse with an alluvial channel formed when water flows between continuous, definable banks.

Stream Bank The rising ground bordering a stream channel below the level of normal rooted terrestrial vegetation and above the normal stream bed.

Stream Bed The substrate plane, bounded by stream banks, over which the water column moves.

Stream Order (Drainage Basin) Designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network. The smallest unbranched perennial tributaries are designated order 1: the junction of two first-order streams produces a stream of order 2: the junction of two second-order streams produces a stream of order 3: etc. Classification is commonly done on 1:50,000 scale maps (BCE, 1995).

Stream Shading Stream shading from riparian vegetation is one of the criteria used to quantify the health of a riparian zone.

Target Fish Species (FHAP)	Economically or culturally important salmonids whose abundance has declined following past timber harvest or which are known to be sensitive to the affects of logging. Exceptionally may include rare, threatened, endangered or regionally significant non-salmonids (Johnston and Slaney, 1996).
Thalweg	The line connecting the deepest or lowest points along a stream bed.
Tributary	A stream feeding, joining or flowing into another stream.
Watershed	The geographic area defined by the boundary within which all surface and subsurface runoff enters a given watercourse; also called *catchment area*, *drainage* or *basin*.
Wetted Width	The width of the water surface measured at right angles to the direction of flow and at a specific discharge, widths of multiple channels are summed to represent total wetted width.
Windthrow	The uprooting and felling of trees by strong gusts of winds.

Appendix

Appendix 1.0 Restoration Techniques
- Fish Habitat Restoration Techniques
- Bank Stabilization Techniques

Appendix 2.0 Fish Habitat Restoration Prescriptions
- Homathko River, Reach 4
- Homathko River, Reaches 5 & 6
- Homathko River, Reach 10
- Homathko River, Reach 11
- Mosley Creek, Reach 12

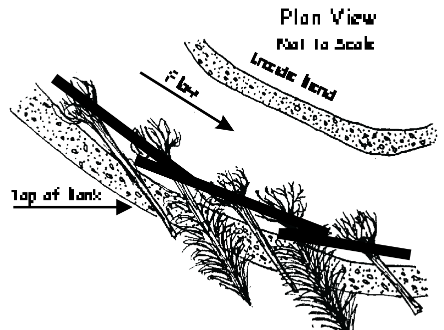
Appendix 3.0 Riparian Habitat Restoration Prescriptions
Appendix 4.0 Restoration Material Requirements
Appendix 5.0 Summary of Completed Prescriptions (1999)

Note: hard copy of full appendices available for viewing at Tatla Lake Public Library, or contact Tatlayoko Woodlot Association.
Exerts of Appendix 2.0 are provided below for site reference information.

Reach 4: Bank Stabilization & Fish Habitat Restoration Prescriptions

G3 Consulting Ltd.
Innovation & Excellence in Environmental Science

Date:	July 20, 1999	Stream Name:	Homathko River	Watershed:	Homathko	Reach:	4 & 5
Project:	9H	Survey Crew	FK/DB	Comments:	Created from airphoto and Level 2 FHAP surveys. Approximate scale, 1:35,000		



Typical live-tree revetment using coniferous tree species

Natural template of live-tree revetment occurring on outside of river bend

Typical candidate area for live-tree revetment prescription

Site	Length	Opportunity	Prescription
4-A-1	10 m	bank stabilization, increased pool cover	LWD complexing, live staking
4-A-2	35 m	bank stabilization, increased pool cover	live-tree revetment, rootwad placement
4-A-3	70 m	bank stabilization, increased pool cover	LWD/Live-tree revetment
4-B-1	30 m	bank stabilization	LWD/Live-tree revetment, live staking
4-B-2	20 m	bank stabilization, increased pool cover	live-tree revetment, rootwad placement, live staking
4-C	45 m	bank stabilization, increased pool cover	live fascine, reef development, rootwad placement
4-D	40 m	bank stabilization, increased fish habitat cover (pool and glide)	live-tree revetment, live staking
4-E	42 m	bank stabilization, increased fish habitat cover (pool and glide)	live-tree revetment, rootwad placement, live staking
4-F	22 m	increased pool/glide cover	rootwad placement
4-G	15 m	bank stabilization, increased pool cover	live-tree revetment, rootwad placement, live staking
4-H	10 m	bank stabilization	live-tree revetment, live fascine
4-I	40 m	bank stabilization, increased pool cover	live-tree revetment, rootwad placement, live staking

Legend:

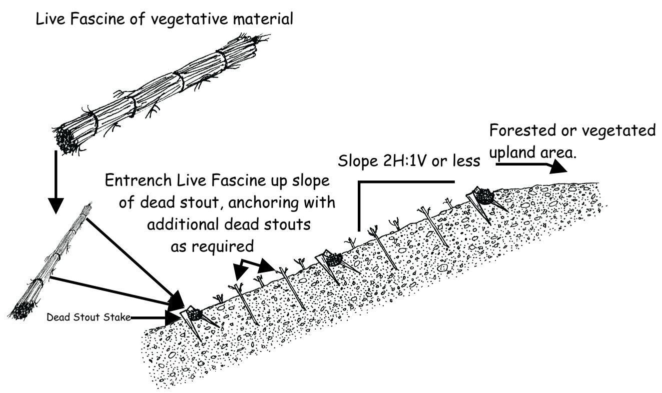
- Main public road
- Secondary public/private road
- Private or seasonal road
- Building
- Site 6-D — Level 2 Prescription site

Technical Notes: Well developed pools observed throughout surveyed section. Riparian vegetation limited in some areas of agricultural development. Opportunity to stabilize stream banks on several outside stream bends. Property boundaries not depicted.

REACHES 5 & 6 : Bank Stabilization & Fish Habitat Restoration Prescriptions

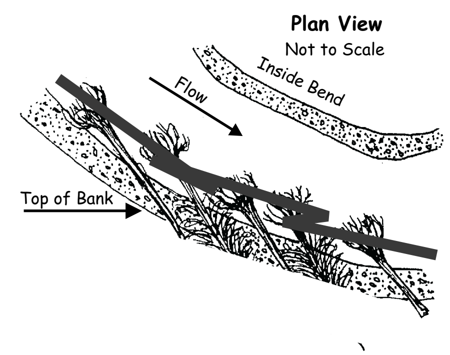
G3 Consulting Ltd.
Innovation & Excellence in Environmental Science

Date:	July 20, 1999	Stream Name:	Homathko River	Watershed:	Homathko	Reach:	5, 6 & 7
Project:	9H	Survey Crew:	FK/DB	Comments:	Created from air photo and Level 2 FHAP surveys. Approximate scale 1:35,000		



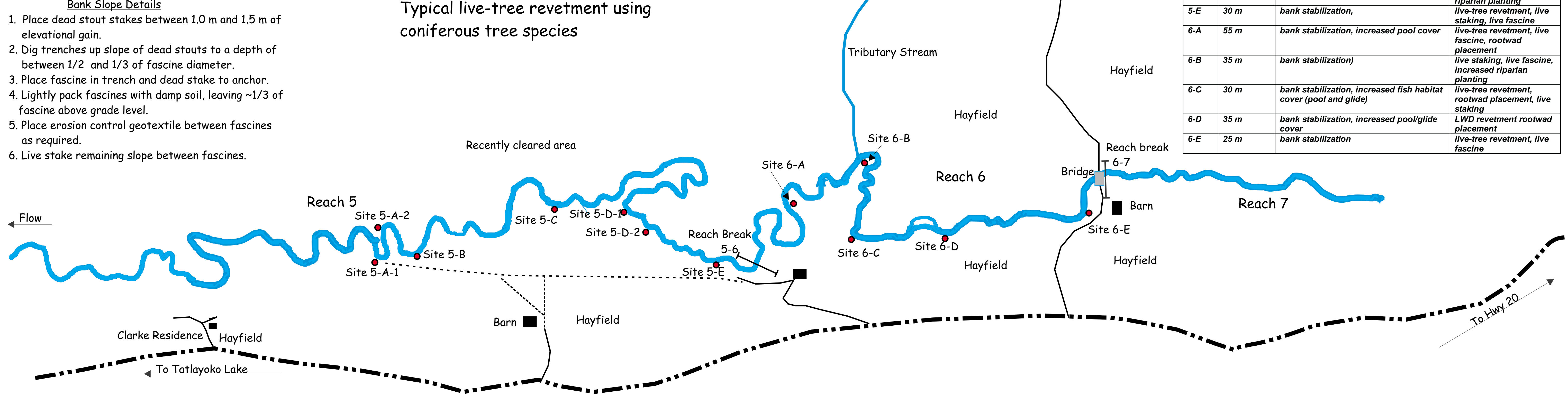
Bank Slope Details

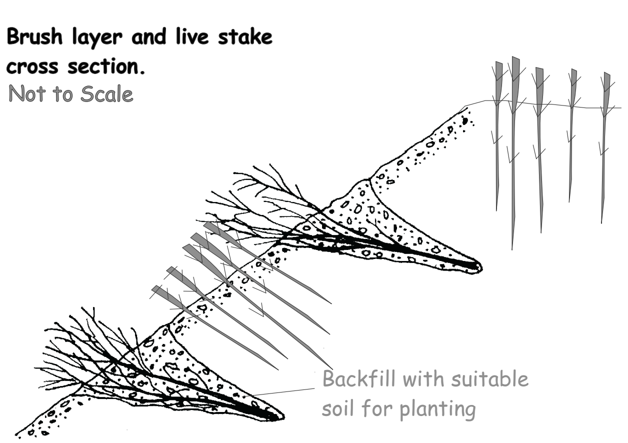
1. Place dead stout stakes between 1.0 m and 1.5 m of elevational gain.
2. Dig trenches up slope of dead stouts to a depth of between 1/2 and 1/3 of fascine diameter.
3. Place fascine in trench and dead stake to anchor.
4. Lightly pack fascines with damp soil, leaving ~1/3 of fascine above grade level.
5. Place erosion control geotextile between fascines as required.
6. Live stake remaining slope between fascines.



Typical live-tree revetment using coniferous tree species

Site	Length	Opportunity	Prescription
5-A-1	35 m	bank stabilization, increased pool cover	live-tree revetment, live staking
5-A-2	45 m	bank stabilization, increased pool cover	live-tree revetment, live staking
5-B	35 m	bank stabilization, increased pool cover	live-tree revetment, live fascine and staking
5-C	25 m	bank stabilization, increased pool cover	LWD/Live -tree revetment, rootwad
5-D-1	35 m	bank stabilization	LWD/Live-tree revetment, live staking, riparian planting
5-D-2	10 m	bank stabilization	LWD/Live-tree revetment, live staking, riparian planting
5-E	30 m	bank stabilization,	live-tree revetment, live staking, live fascine
6-A	55 m	bank stabilization, increased pool cover	live-tree revetment, live fascine, rootwad placement
6-B	35 m	bank stabilization)	live staking, live fascine, increased riparian planting
6-C	30 m	bank stabilization, increased fish habitat cover (pool and glide)	live-tree revetment, rootwad placement, live staking
6-D	35 m	bank stabilization, increased pool/glide cover	LWD revetment rootwad placement
6-E	25 m	bank stabilization	live-tree revetment, live fascine





Use willow, cottonwood or aspen whips. Ensure whips contain buds, plant at least 2/3 of whip in soil.

Legend:

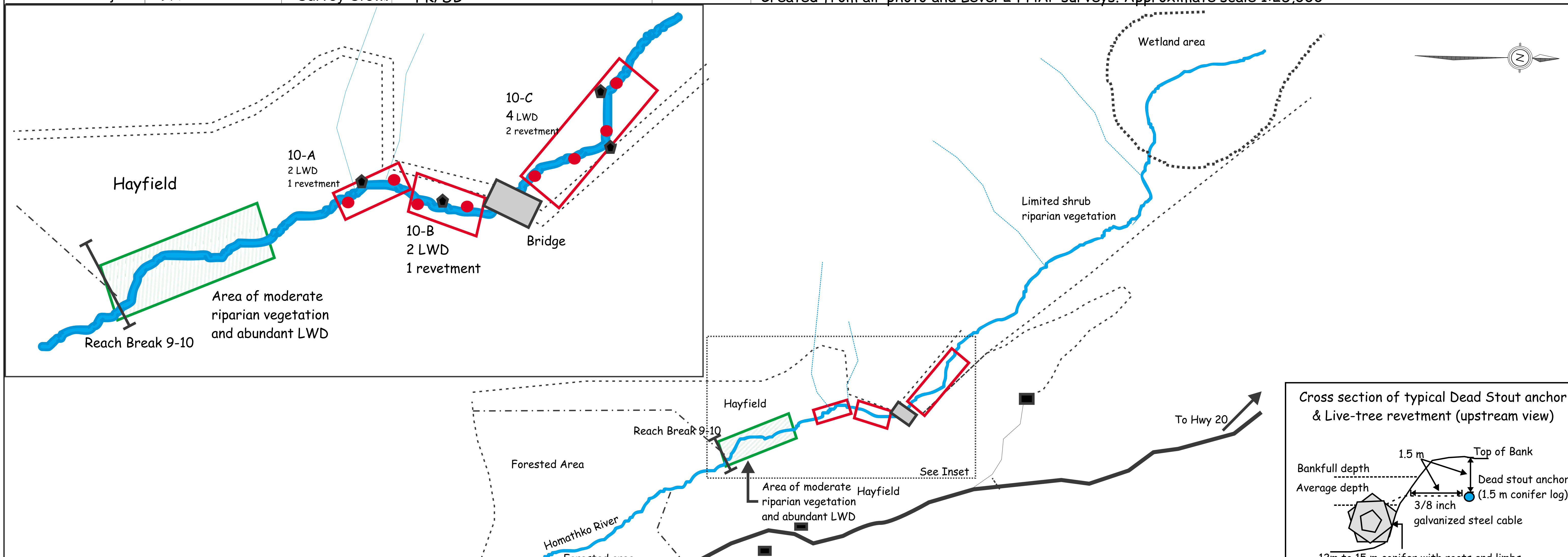
- Main public road
- Secondary public/private road
- Private or seasonal road
- Building
- Site 6-D — Level 2 Prescription site

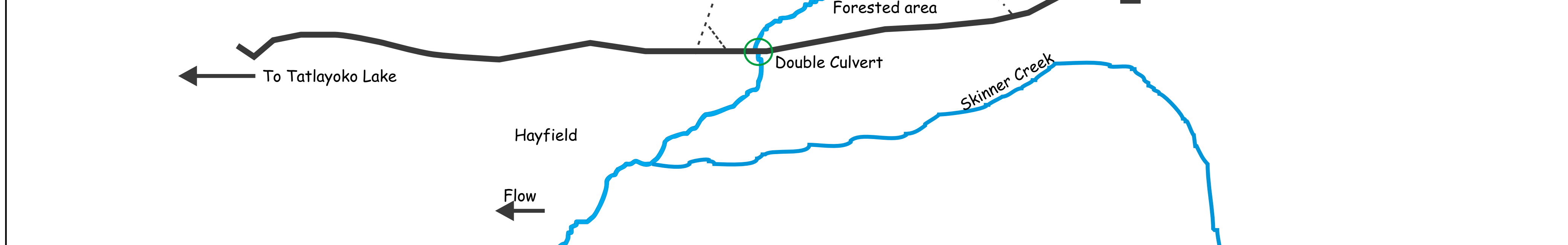
Technical Notes: Well developed pools observed throughout surveyed section. Riparian vegetation limited in some areas of agricultural development. Opportunity to stabilize stream banks on several outside stream bends. Property boundaries not depicted.

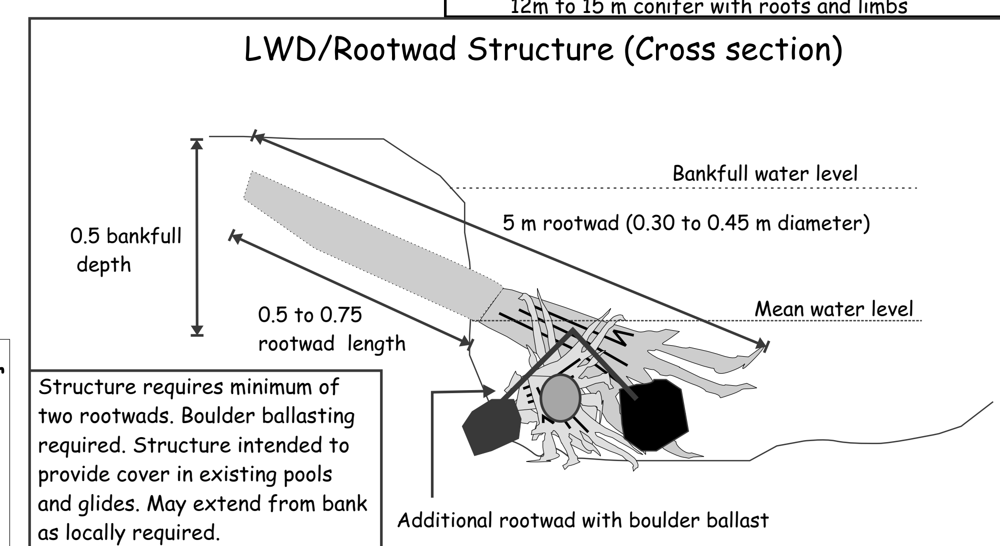
Reach 10: Fish Habitat Restoration Prescription

G3 Consulting Ltd.
Innovation & Excellence in Environmental Science

Date:	July 20, 1999	Stream Name:	Homathko River	Watershed:	Homathko	Reach:	10
Project:	9H	Survey Crew:	FK/DB	Comments:	Created from air photo and Level 2 FHAP surveys. Approximate scale 1:25,000		







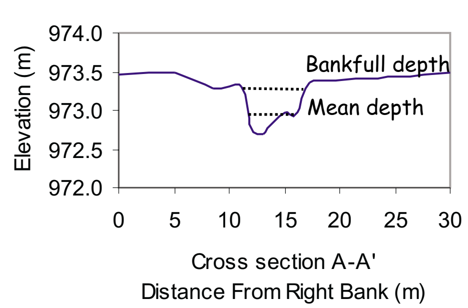
Legend:
- Main public road
- Secondary public/private road
- Private or seasonal road
- Building
- Site 6-D — LWD structure
- LWD revetment

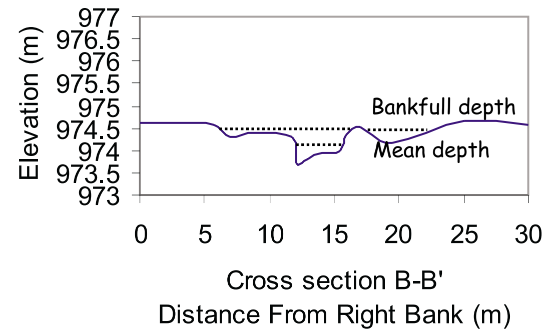
Technical Notes: Well developed glides and pools observed throughout surveyed section. In-stream cover was limited in areas of reduced riparian vegetation. Downstream sections exhibited moderate coniferous riparian vegetation and increased in-stream complexing (LWD). Opportunity to increase in-stream cover with clustered LWD placement. Limited bioengineering required. Riparian prescriptions developed for lower stream sections. Property boundaries not depicted.

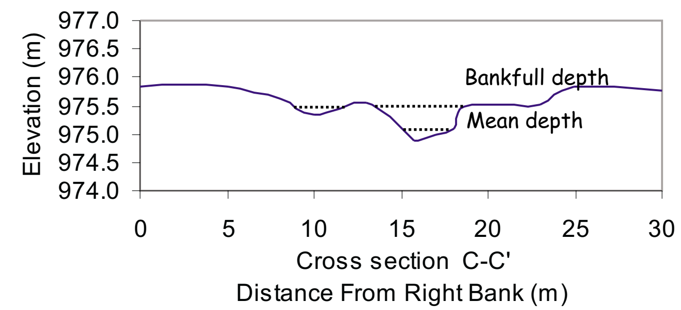
Reach 11, Fish Habitat Restoration Prescription

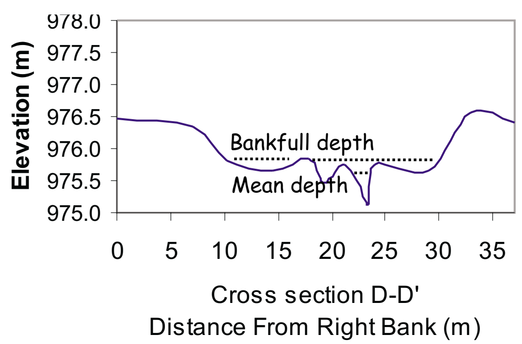
G3 Consulting Ltd.
Innovation & Excellence in Environmental Science

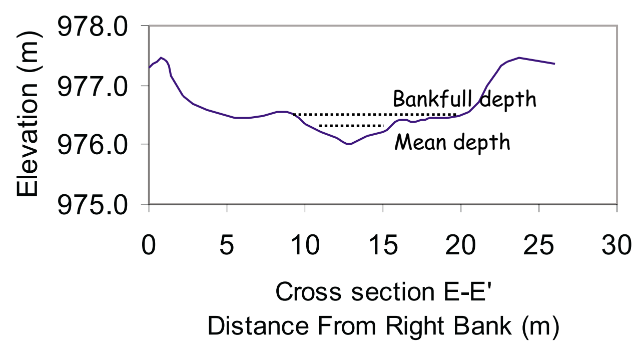
Date:	July 11-12, 1999	Stream Name:	Homathko River	Watershed:	Homathko	Reach:	11-2	Chainage:	0+200-1+000
Project:	9H	Survey Crew:	FK/DB	Comments:	Created from air photo and Level 2 FHAP surveys				





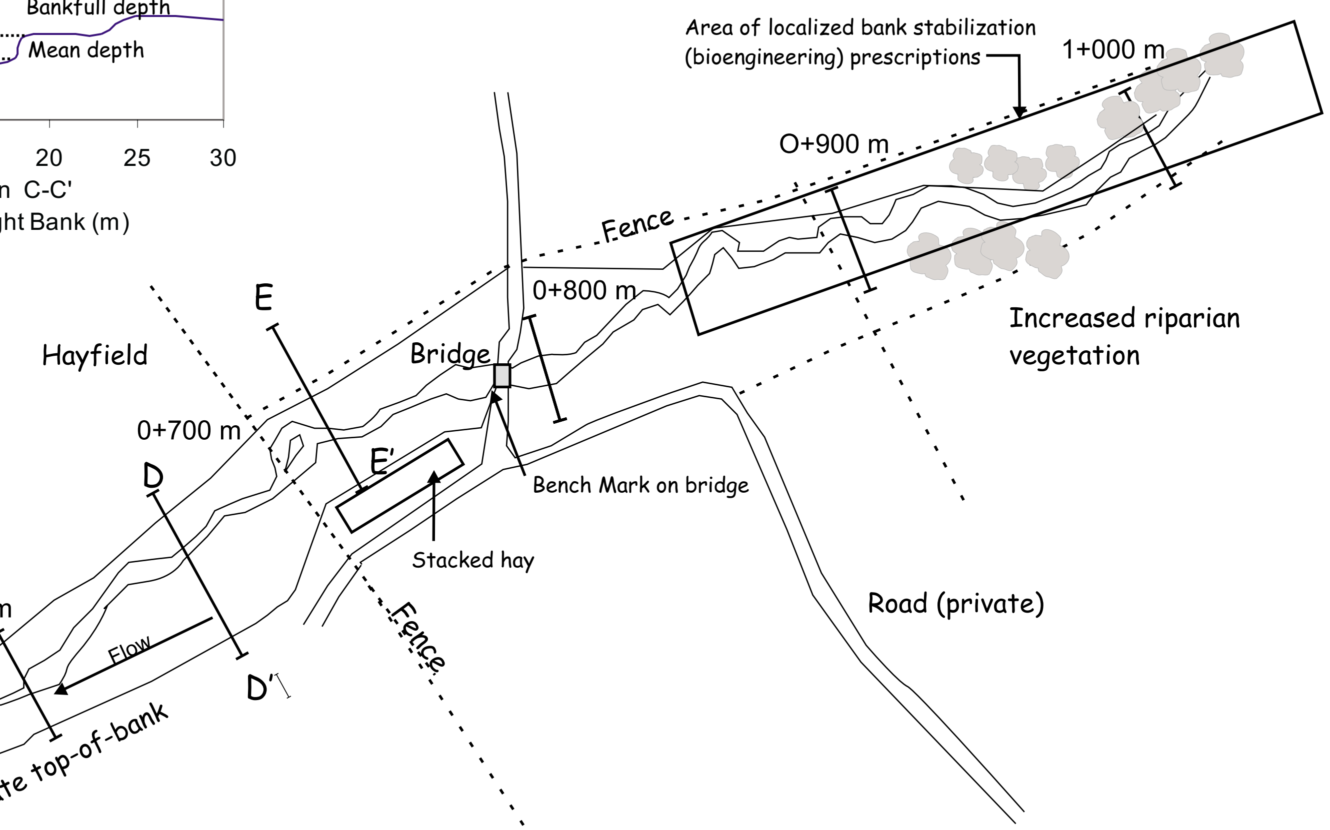
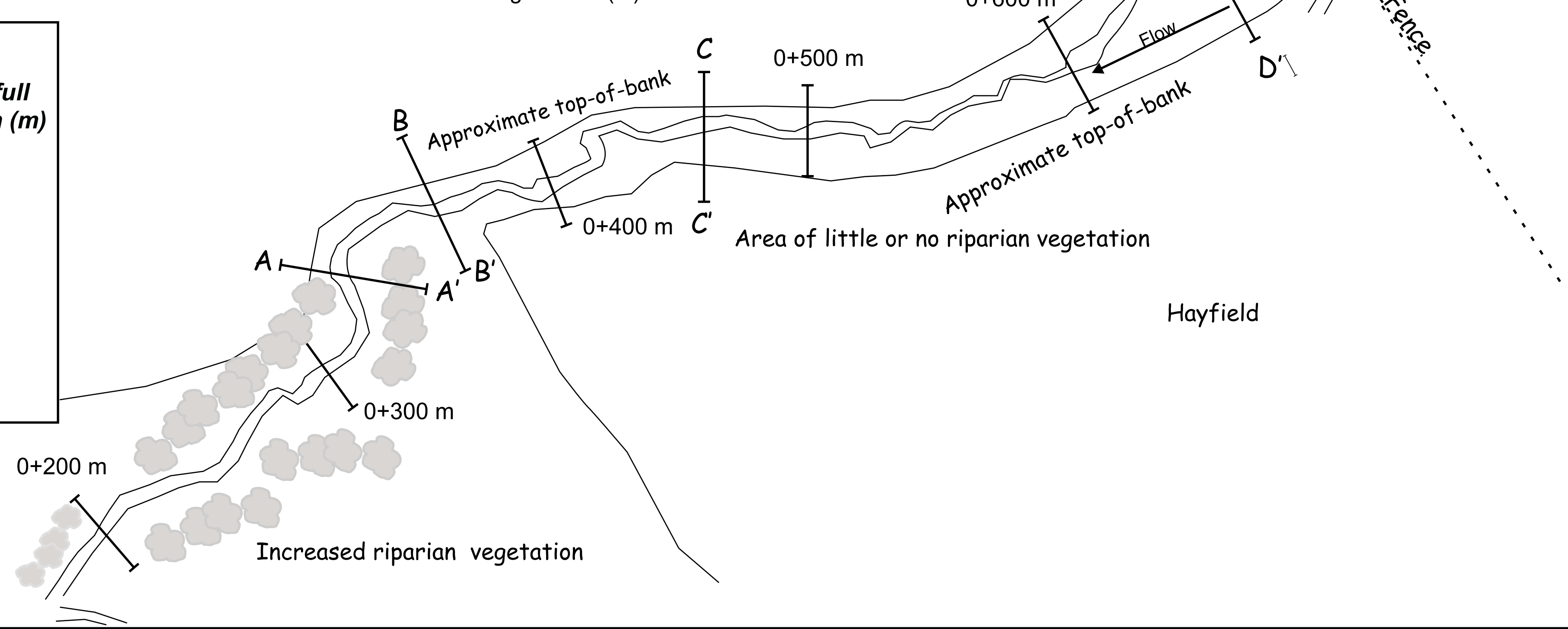


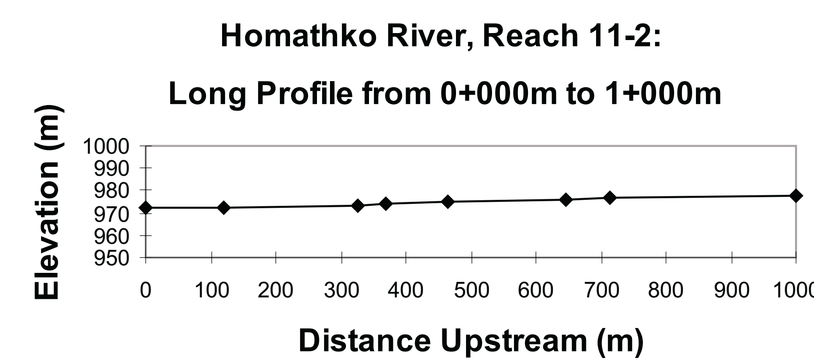




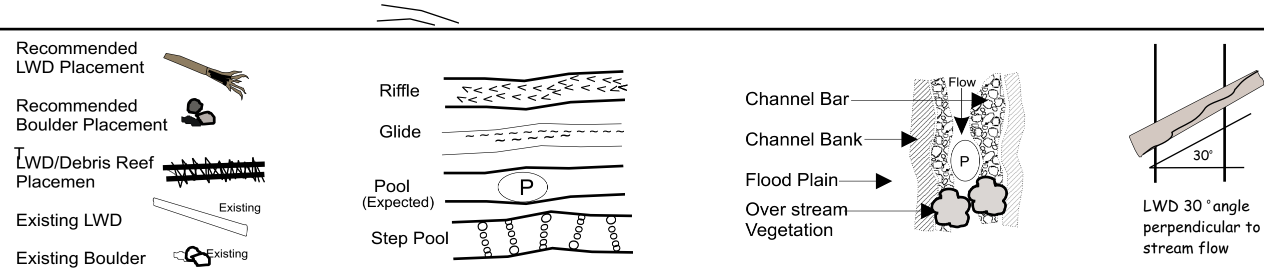
Stream Dimensions

Chainage	*Bankfull Width (m)*	*Bankfull Depth (m)*
0+200	2.8	0.80
0+300	4.4	0.70
0_400	4.6	0.75
0+500	3.7	0.65
0+600	5.7	0.50
0+700	7.5	0.80
0+800	6.5	1.00
0+900	8.1	0.55
1+000	8.5	0.50
AVERAGE	***5.75***	***0.69***



Notes:
1) Vertical exaggeration depicted.
2) Profile based on survey conducted on July 11, 1998.
3) Average reach gradient is 0.6%.



Technical Notes: Well developed pools observed throughout surveyed section. Riparian vegetation limited from 0+360 m to 0+800 m. Recommended to increase riparian vegetation and in-stream cover throughout Reach 11-2. LWD, rootwads and in-stream reefs are recommended to provide cover in pools..