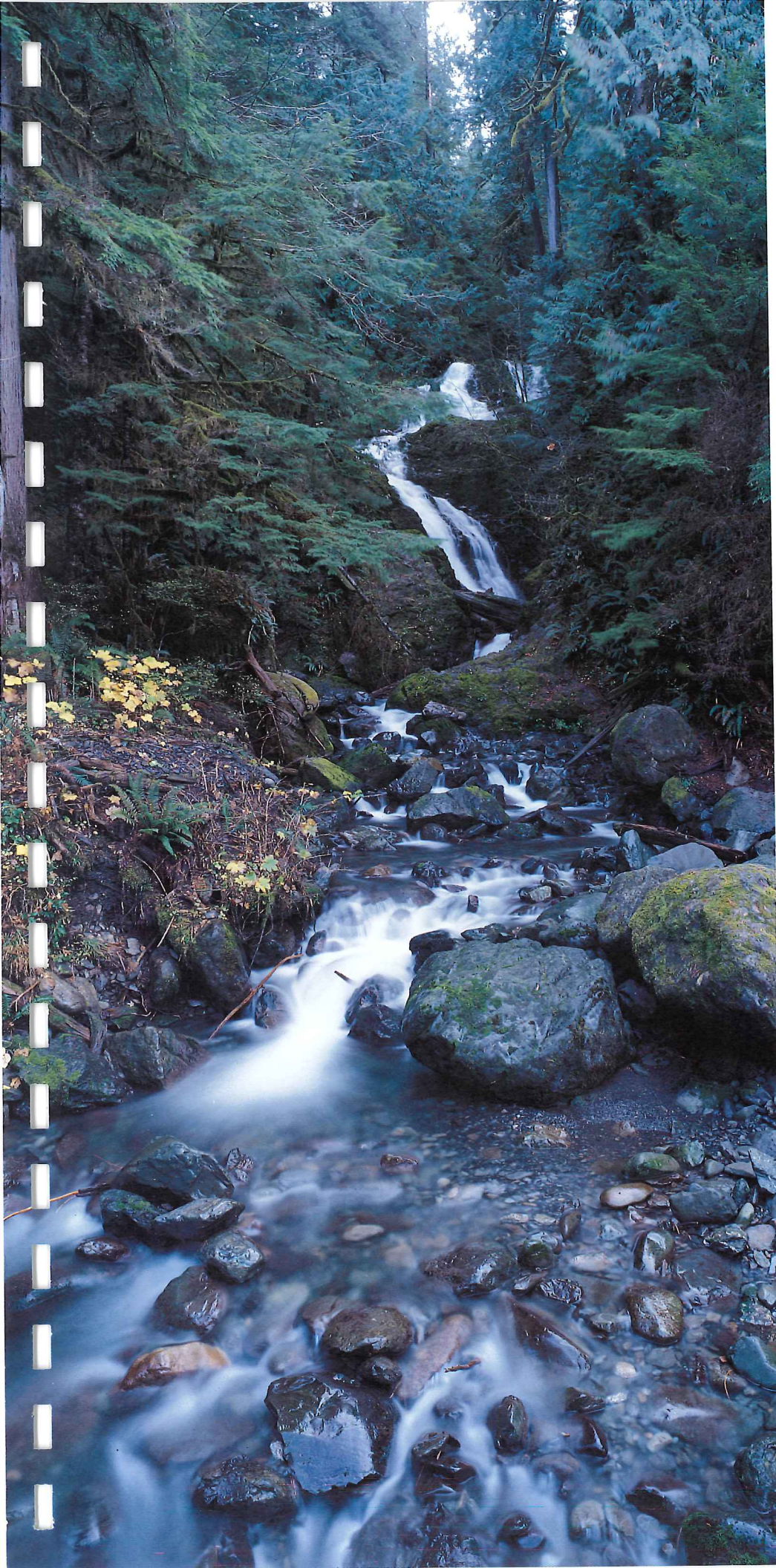




***Level 1 Fish Habitat
Assessment Procedure
of Selected Sub-Basins
Within the Taltapin
Watershed***

Submitted to:

***Babine Forest Products Company
PO Box 4000
Burns Lake BC
VOJ 1E0***

March 1998



Level 1 Report

**Fish Habitat Assessment Procedure of
Selected Sub-Basins Within the
Taltapin Watershed**

Submitted to

Babine Forest Products
PO Box 4000
Burns Lake BC
V0J 1E0

by

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EXECUTIVE SUMMARY

In August of 1997, Carmanah Research was contracted by the Ministry of Environment, Lands and Parks (MELP), Skeena Region, to conduct a Level 1 Fish Habitat Assessment Procedure (FHAP) within the Taltapin watershed, a sub-basin of the Skeena watershed. The Level 1 assessment follows the overview assessment in the Fish Habitat Assessment Procedure, a process that attempts to identify opportunities for fish habitat restoration that are aimed at rejuvenating depressed stocks of fish in British Columbia streams. The objectives of this document are as follows:

- Identify impacted areas,
- Identify habitat limitations which are affecting fish populations,
- Prioritize impacted areas,
- Make recommendations for further assessments (where necessary), and
- Direct the focus of Level 2 assessments (where necessary).

Pinkut, Lord's (local name) and Henrietta creeks were identified by an overview assessment (Babine Forest Products & Ned'u'ten Fisheries Commission, 1996) and a helicopter overflight as exhibiting signs of habitat degradation potentially caused by timber harvesting activities. High priority reaches within the three creeks were defined in consultation with contract monitor Karen Grainger and Habitat Protection Officer Tom Olson.

Description and quantification of fish habitat involved hip-chaining the selected priority reach within each creek and subsampling the individual primary habitat units according to procedures outlined in Johnston and Slaney's WRP Technical Circular No. 8 (1996). Disturbances, subsampled habitat units and offchannel habitat were documented with up- and downstream photographs including scale where possible. Fish habitat was assessed by comparing habitat unit statistics to Johnston and Slaney's diagnostic habitat-rating table (Table 5). Confirmation of fish presence or absence was accomplished using a two pass electroshocking procedure in representative sections of the reaches.

The general fish habitat in Reach 6 of Pinkut Creek (480-9277) is characterized by relatively open meandering channel with long glides and occasional low gradient riffles. Sample site gradients average 0.7% and substrates are dominated by gravel with sand and fines subdominant. Spawning substrates are abundant in most glides and pool tailout areas. At the time of the assessment, large numbers of kokanee (*Oncorhynchus nerka*) were spawning in this reach. Direct logging impacts along this section of stream are minimal and stem mainly from two bridge crossings. Several natural bank failures are active sediment sources. Possible rehabilitation measures are suggested.

The general fish habitat in Reach 1 of Lord's Creek (480-9277-417) is characterized by a shallow, low gradient (average 0.7%) channel with frequent woody debris accumulation and occasional pool cover. The substrates are most often dominated by gravel with cobble subdominant. At the time of assessment, large numbers of kokanee were spawning in this reach. Spawning substrates are present in good quantity throughout the reach, but a large, well established beaver (*Castor canadensis*) dam approximately 1050m upstream of the mouth is the upper limit of kokanee migration. Direct logging impacts along this section of stream stem mainly from a clearcut area and a bridge crossing approximately 2500m upstream of the mouth. Tributaries appear to be transporting surface runoff from the Augier Main logging road. Several natural bank failures are active sediment sources. Possible rehabilitation measures are suggested.

The general fish habitat in Reach 4 of Henrietta Creek (480-9277-234) is characterized by a higher gradient (average 1.3%) channel with more boulder cover than either Pinkut or Lord's creeks. Substrates are most often dominated by gravel with sand subdominant. No kokanee were observed or captured, but their presence downstream in the system suggests the possibility of an impassable barrier downstream, most likely in Reach 3 (Babine Forest Products & Ned'u'ten Fisheries Commission, 1996). Direct logging impacts along this section of stream are minimal and stem mainly from the Hannay Main road bridge crossing. Tributaries appear to be transporting surface runoff from the road. Several bank failures are active sediment sources. Possible rehabilitation measures are suggested.

ACKNOWLEDGEMENTS

Babine Forest Products Ltd. contracted the 1997 Level 1 Fish Habitat Assessment Procedure of the Taltapin watershed to Carmanah Research Ltd., with funding provided by the Forest Renewal British Columbia Watershed Restoration Program (WRP). The senior author of the report was Thomas Roy, BSc., and the co-author was Henrik Liebe-McGinnis, Dipl. Tech. Support and monitoring was provided by Karen Grainger, Babine Forest Products, and Tom Olson (MELP). Thomas Roy led the field crew of Henrik Liebe-McGinnis and Rob Hollingshead. Project guidance was provided by Kevin Brydges. Carmanah Geographic Information Systems (GIS) technicians M. Burrell and A. Dewey produced the maps for this report. R. Pedersen (R.P.Bio) and S. Luzzi performed technical editing and quality assurance duties.

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1.0 INTRODUCTION

1.1 Partners and Funding

Through the auspices of Babine Forest Products Ltd., Carmanah Research Ltd. conducted a Level 1 Fish Habitat Assessment Procedure (FHAP) of the Pinkut, Lord's and Henrietta sub-basins within the Taltapin watershed. This project was undertaken as part of the Watershed Restoration Program (WRP), with funding provided by Forest Renewal BC. The assessment was directed by the results of the Overview Fish Habitat Assessment Procedure (OFHAP) of the Taltapin watershed (Babine Forest Products Ltd. & Ned'u'ten Fisheries Commission, 1996) and conducted from September 8 to 17, 1997. The objective of this project was to conduct Level 1 fish habitat evaluations on sites suggested by the OFHAP and defined by the Babine Forest Products Ltd. contract monitor Karen Grainger, RPBio, and MELP's Senior Habitat Protection Officer for the Skeena Region, Tom Olson. The amount and quality of available fish habitat were assessed and used to prescribe recommendations for rehabilitation or restoration measures within damaged or degraded areas. This report presents the findings of the Level 1 assessment.

1.2 Watershed Description

The Taltapin watershed is part of the Skeena watershed and is located approximately 30km northeast of the town of Burns Lake (Figure 1). It drains an area of over 80,000ha into Babine Lake, which borders it to the north. The watershed is managed almost entirely by Babine Forest Products Ltd. under the terms of Forest License A-16823. A portion is managed under the Small Business Forest Enterprise Program of the Lakes Forest District. Extensive timber harvesting has occurred in the watershed (*Ibid.*).

1.3 Purpose of Level 1 Assessment

The objectives of this FHAP were as follows:

- describe and quantify fish habitat within defined high priority reaches;
- identify and quantify any habitat degradation within these defined reaches;
- determine fish presence for representative sites within the reaches;

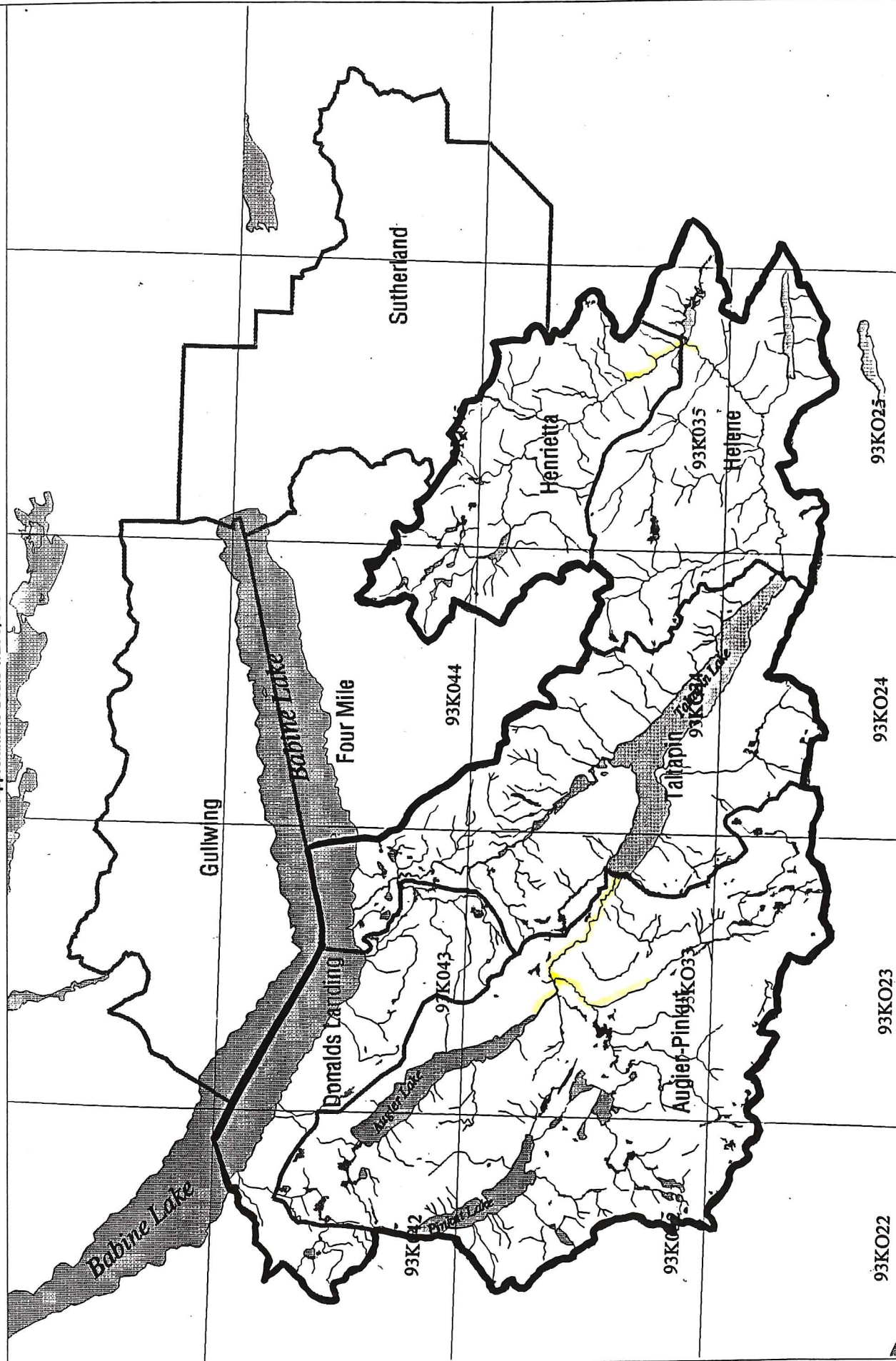
- develop conceptual prescriptions outlining recommended rehabilitation measures for impacted areas within the reaches;
- ground truth OFHAP findings.

Figure 1

Taltapin Watershed

Sub-Drainages

Approximate Scale 1:250,000



2.0 STUDY AREA

Reach 6 (P6) of Pinkut Creek (480-9277) is approximately 7.5km long and flows from Augier Lake to Taltapin Lake. It is known to contain good spawning substrate and is considered to be of high fisheries value (*Ibid.*). Specific concerns to be addressed include potential timber harvesting impacts, bank erosion and sediment introduction that could have a detrimental effect on incubating eggs downstream. There has also been extensive beaver activity along this reach, possibly impairing upstream migration of spawning kokanee.

Lord's Creek (480-9277-417) is the local name of a tributary of Reach 6 of Pinkut Creek. It consists of three reaches and empties into Pinkut Creek between Augier and Taltapin lakes. Reach 1 (Lo1) of Lord's Creek is approximately 7km long and flows parallel to the Augier Main logging road approximately 400m away. It is a productive reach utilized by spawning kokanee, and is considered to be of medium to high fisheries value (*Ibid.*). Specific concerns to be addressed included potential timber harvesting impacts, bank erosion, sediment introduction and extensive beaver activity.

Henrietta Creek (480-9277-234) empties into Taltapin Lake at the southeast end and drains both the Helene and Henrietta sub-drainages. It consists of six reaches. Reach 4 (H4) of Henrietta Creek is approximately 4.4km long and flows roughly parallel to the Hannay Main logging road, which lies 200–400m away. It is considered a productive reach of medium to high fisheries value (*Ibid.*). Specific concerns to be addressed included the possible introduction of sediment from the uphill road and tributaries and a general lack of fisheries related information for the reach.

2.1 Fisheries Background

Pinkut and Lord's creeks have high fisheries values. Anadromous coho (*Oncorhynchus kisutch*) and sockeye salmon (*O. nerka*) utilize reaches 1 and 2 of Pinkut Creek, with the 12m falls at the upper end of Reach 2 acting as an impassable barrier. Removal or alteration of the falls with explosives has been unsuccessful (*Ibid.*). Yearly upstream airlifts and construction of the Pinkut Creek Spawning Channel have increased the recruitment of

sockeye in the system. Rainbow trout (*O. mykiss*) and kokanee (*O. nerka*) are expected throughout the length of the upper fish-bearing reaches of Pinkut Creek. Reach 1 of Lord's Creek contains rainbow trout and is known to be utilized by spawning kokanee (*Ibid.*). At the time of this assessment no fish distribution data were available for Henrietta Creek. Carmichael and Bonner (1977) rated its overall productivity as excellent.

2.2 Migration Barriers

There has been extensive beaver activity within these sub-basins, and the numerous dams may have an adverse effect on the upstream passage of spawning salmonids. According to the 1996 Taltapin OFHAP (Babine Forest Products Co. & Ned'u'ten Fisheries Commission, 1996), beaver populations have increased substantially in recent years. This was verified by Grainger and Olson as one of the potential impacts requiring further investigation during the course of this assessment (pers. comm., September 1997).

3.0 METHODS

3.1 *Fish Habitat Assessment*

Fish habitat assessments were completed for reaches within the Pinkut Creek and Henrietta Creek sub-basins which had been identified as high priority in the OFHAP or by contract monitor Karen Grainger. These included Pinkut Creek Reach 6, Lord's Creek Reach 1 and Henrietta Creek Reach 4. The survey methods used comply with those outlined in Johnston and Slaney's Fish Habitat Assessment Procedures manual, hereafter referred to as Tech. Circ. 8 (WRP Technical Circular No. 8; Johnston and Slaney, 1996).

Reach boundaries were based on the findings of the OFHAP and were verified, when possible, during the field surveys. The Pinkut Creek mainstem was divided into 10 reaches, and Lord's Creek divided into 3 reaches. The Henrietta Creek mainstem was divided into 6 reaches.

The assessed reaches were sampled using a subsampling fraction of 1/3 for each habitat unit. This fraction guaranteed a detailed analysis of at least 33.3% of all pools, glides, riffles and cascades. On occasion, some habitat units were subsampled at 1/2 or 1/1 when stream conditions warranted a higher fraction (e.g. very few pools). Conversely, when habitat units were very short and numerous the subsampling fraction was adjusted to 1/5. Thus, habitat unit averages were extrapolated over the entire reach from our detailed assessments. The surveys of these subsampled units involved the measurement of all physical parameters outlined in Form 4 of Tech. Circ. 8. This process required a crew of two technicians and a biologist to walk the assessed reaches and took 10 days during the period of September 8-17, 1997.

The physical parameters outlined in Form 4 were measured in a two stage process. Initially, while the crew walked the stream, one crew member hip-chained the reach and recorded the length of individual habitat units. This chaining process provided information on the length and frequency at which individual habitat units occurred throughout the reach. During this

process, notations were made of side channels and their length and accessibility, the height and passability of waterfalls, slope or bank failures and signs of habitat degradation. Photographs of subsampled units, representative sections of each reach, migration barriers and degraded habitat units were also taken (Appendix B & G). Photodocumentation procedures followed those outlined in *A Guide To Photodocumentation* (MELP, 1996).

Secondly, when a habitat unit needed to be measured in detail, all physical parameters were measured, not visually estimated. The parameters assessed in each habitat unit and their methods of measurement are shown in Table 1. All habitat data were entered into waterproof field copies of Form 4 to ensure consistency in data collection.

To aid in mapping stream features and disturbances, UTM coordinates were obtained for locations of significant tributaries, reach breaks, slumps etc. Coordinates were gathered and stored in a Trimble GeoExplorer II handheld GPS unit, referenced in a field notebook and later downloaded onto computer disc. After the field assessment the data were corrected and used by Carmanah's Geographic Information Systems (GIS) technicians to generate maps of the study area showing the position of each site.

Table 1. Physical parameters assessed for habitat units within a sample site.

Parameter	Units	Measured(M) or Estimated (E)	Method/Description
Habitat Type	--	--	Pool, glide, riffle, cascade
Length	Meters	M	Hip chain
Bankfull Width	Meters	M	30m fiber tape
Wetted Width	Meters	M	30m fiber tape
Bankfull Depth	Meters	M	Meter stick
Max. Pool Depth	Meters	M	Meter stick
Pool Crest Depth	Meters	M	Meter stick
Residual Pool Depth	Meters	M	Calculated (max. depth-crest)
Pool Type	--	--	Scour, plunge or dam
Bed Material Type	--	E	Anadromous or resident
Substrate Dominance	--	E	Visual
Total LWD Tally	--	--	# of pieces
Functional LWD	--	--	# of pieces by size; 10-20, 20-50,
Tally by Size			>50cm
Cover	Percent	E	%boulder,LWD,overhanging, undercut bank
Offchannel Habitat	--	--	Type; e.g. side channel, slough
Offchannel Length	Meters	E	Visual
Disturbance	--	--	Identify type; e.g. scours,
Indicators			extensive bars, LWD jams
Riparian Type	--	--	Identify dominant veg. type
Riparian Structure	--	--	Identify developmental stage
Canopy Closure	Percent	E	% canopy over stream
Photos	--	--	Roll#,photo#,time,date,orientation
Bank Erosion	Meters	M	Hip chain
Temperature	°C	M	Hand held thermometer

3.2 Fish Use Assessment

Confirmation of the presence or absence of salmonids within Pinkut, Lord's and Henrietta creeks was determined by electrofishing. A two pass removal method recommended by Tom Olson was performed in a riffle, run and pool of each creek, downstream of a disturbance if possible so as to indicate its immediate impact on local fish populations. Pinkut Creek was not sampled this way because large numbers of spawning kokanee were present at the time of sampling. To avoid disturbing them and the numerous redds, the creek was spot shocked for approximately 25m to check for the presence of other species. None were captured, but adult rainbow trout were visually observed.

To begin the process, a section of reach containing the three discrete primary habitat units was chosen. Each end of the upstream unit was netted with small mesh nets (9mm meshed end panels X 6mm meshed mid panels) and a thorough initial pass made with the electroshocker (Smith Root 12-B) toward the downstream stop net. Fish caught were anaesthetized with Bromo Seltzer and sampled for species, fork length and weight. (Due to a scale malfunction, however, weight data obtained were incomplete and considered unreliable.) Once sampled the fish were held separate from the remaining population in a bucket containing stream water to recover. A second pass of approximately equal duration was then conducted through the same site and the catch sampled and recorded as catch two. The upstream net was then removed and placed downstream of the next habitat unit, which was sampled as the first was. Once sampling was completed and the nets removed the fish were returned to the site. Data were recorded in field notebooks and later transferred to waterproof field copies of Form 5 of Tech. Circ. 8.

If the identity of any fish was in doubt, the taxonomic keys in *Field Key to the Freshwater Fishes of British Columbia* (McPhail and Carveth, 1993) and/or *Fresh Water Fishes of Canada* (Scott and Crossman, 1990) were referenced. Detailed methods of electrofishing are outlined in the *Fish Stream Identification Guide Book*, (Anon., 1995) and the *Lake and Stream Inventory, Standards and Procedures* (RIC, 1995).

3.3 Fish Habitat Evaluation

The evaluation of fish habitat in Pinkut, Lord's and Henrietta creeks was based on the calculation of various habitat parameter statistics. By comparing these values to set diagnostic values, fish habitat was rated as "good," "fair" or "poor." The criteria outlined in Table 5 were used except for the habitat parameters listed below:

Percent Pools

Percent pools was calculated based on pool length rather than pool area. This was possible due to the relative homogeneity of stream widths.

Offchannel Habitat

Parameters for offchannel habitats were based on a numerical scale designating “poor,” “fair” and “good” values. These values were <1 per km, between 1 and 3 per km and >3 per km, respectively.

Holding Pools

Parameters for holding pools were also based on a numerical scale using <1 per km for “poor” and >1 for “good.” Pools that were very close to but under minimum residual depth requirements were counted as holding pools when appropriate (e.g. low velocity pool with good overhead cover).

Access to Spawning Areas

Access to spawning areas was based solely on potential barriers or obstacles within the reach, rather than access issues in lower reaches or systems.

Appendix E of Tech. Circ. 8, Questions for Habitat Evaluation, was used to identify potentially degraded or limiting salmonid habitats within the surveyed reaches. All diagnostic values were derived from measurements of primary habitat units, which had been measured for length and width over the entire reach. Habitat parameters included calculations for percent pools, pool frequency, number of LWD pieces per bankfull channel width, percent cover, dominant and subdominant substrates, offchannel habitat, spawning gravel quantity/quality, access for spawning adults and number of adult holding pools. Redd scour was not evaluated due to a lack of historical information on spawning beds. Values for all parameters mentioned above have been entered into Form 6 of Tech. Circ. 8.

4.0 RESULTS

The findings of the assessments of fish habitat in the Pinkut Creek, Henrietta Creek and Lord's Creek sub-drainages are summarized in this section. Digital data from the habitat assessments are in Appendix A. Copies of all original field data and notes are in Appendix F. Table 2 shows habitat diagnosis values and ratings for the surveyed sub-drainages.

4.1 Fish Habitat Characteristics

In all three reaches a total of 249 individual habitat units were sampled in detail. Table 3 shows habitat unit frequencies, average channel characteristics within specified reaches and overall reach lengths.

Table 3. Average channel characteristics of assessed reaches in Pinkut, Lord's and Henrietta creeks.

Reach	Length (m)	Grad (%)	Habitat Unit Frequency (%)				Average Channel Char (m)					Substrate	
			P	R	G	C	Wb	Ww	Depth	Residual	Wb Range	Dom	Sub
P6	8163	0.7	41.3	14.5	44.2	0	12.0	8.4	0.45	0.93	5-35	G	S
Lo1	7071	0.7	20.2	33.3	45.9	0.6	7.3	3.6	0.28	0.73	3.2-25	G	C
H4	4480	1.3	24	45	31	0	8.1	4.7	0.32	0.85	4-15.5	G	S

4.2 Pinkut Creek Reach 6

4.2.1 Biophysical Characteristics

Reach 6 of Pinkut Creek consists of 8,163m of low gradient, unconfined meandering channel that extends between Taltapin and Augier lakes. The water flow volume was measured at 0.29m³/s. Subsampling fractions ranged from 1/1 to 1/3 depending on habitat unit length and occurrence. In this reach a total of 249 habitat units were noted, of which 85 were sampled in detail.

Reach 6 of Pinkut Creek has an average channel gradient of 0.7%, with an average bankfull width (Wb) of 12.0m (Table 3). Bankfull width ranges from 5m to 35m. The average wetted width (Ww) at the time of assessment was 8.4m. The bed material in Reach 6 is predominantly gravel with a subdominant substrate consisting of sand and silt. Substrate compaction varies between low and medium. There are very few large cobble or boulders in the reach. Habitat diversity is moderately distributed (Table 3) between glides (44.2%), pools (41.3%) and riffles (14.5%). Representative photographs of the three habitat unit types are in Appendix B (Plates 1,2 and 3). The average water depth is 0.45m, with an average

residual pool depth of 0.93m. The occurrence of bars varies from low to medium. The total length of side channels and backwater areas is approximately 860m. Disturbance indicators in the reach include elevated mid and side channel bars (MB), eroding banks (EB), most LWD parallel to banks (PD), large sediment wedges (WG) and extensive areas of unvegetated bars (DW).

4.2.2 Organic Debris

Large woody debris (LWD) is moderately abundant in this reach with an extrapolated value of 2.4 (Table 2). This value indicates that there are 2.4 pieces of LWD per average bankfull width (Wb). Most of the debris is small to medium sized and found along the channel edges and in small LWD jams. There is little large debris spanning the width of the channel. The highest concentrations of debris occur in the middle to lower sections of Reach 6 where the channel meanders considerably (see Appendix B; Plate 4). In some sections numerous sawed logs are present. This will be discussed further in the impacts section.

4.2.3 Summer and Winter Rearing Habitat

Percent pools (by length) in Reach 6 of Pinkut Creek is rated “fair,” with a value of 41%. Pool frequency, the distance between pool habitats, is rated “fair” with a value of 3.9. This value indicates that there is approximately 46.6m between pools. The percent wood cover in pools is rated “fair” with a value of 12.9% (Table 2). This value translates into pools having an average of 12.9% LWD cover. Boulder cover in gravel-cobble riffles is rated “poor” with a value of 0%, while overhead cover, comprised of LWD, boulder, cutbanks, and overhanging vegetation is rated “fair” with a value of 17% (Table 2). The dominant and subdominant forms of overhead cover consist of LWD (8.7%) and overhanging vegetation (4%). Substrates in Reach 6 are dominated by gravel and sub-dominated by sand and silt. The presence of sand and silt in the substrate lowers the substrate rating to “fair” due to infilling of interstitial spaces. Offchannel habitat, a measure of the number of offchannel units per km of stream, is rated “fair” with a value of 2.

4.2.4 Adult Migration

Holding pools which function as resting areas during upstream migration, are rated “good,” with a value of 8.1 per km of stream. Access to spawning grounds in Reach 6 of Pinkut Creek is also rated “good,” although the large number of beaver dams in this reach may decrease the number of fish migrating upstream.

4.2.5 Spawning and Incubation

Gravel quantity in Reach 6 of Pinkut Creek is rated “good” due to the nature of the dominant substrate, however gravel quality is rated “poor” due to the amount of sand and silt in the substrate. The large quantities of sand and sediment in this reach can be attributed partially to several large natural slumps which are actively eroding fines into the system.

4.2.6 Valley Wall and Channel Instability

Two major slumps were identified in this reach. The first one measures (height X width) 30m X 100m (Appendix B; Plate 5) and the second one measures 30m X 45m (Appendix B; Plate 6). The locations of these slumps are indicated on map number 93K-033 supplied with this report.

4.2.7 Riparian Vegetation

Riparian vegetation is characterized by mature coniferous forest with a canopy closure value of 1 (Appendix B; Plate 7), indicating an average canopy closure of 0 to 20%.

Six cutblocks border the creek, and due to the presence of tributaries bordering or flowing through them most are considered potential sediment sources. Cutblocks 2101, 2102, 2103 and 00102 lie on the south side of Pinkut Reach 6. Cutblocks 02102 and 02101 lie 200m away, 00102 is 300 m away, 02103 is 450m away and 00101 is 950m away. The latter is quite distant, however two tributaries border it directly, one flowing through the lower

corner. On the north side cutblock 06003 lies 300m away and 06001 lies 200m away. The latter is of questionable priority, as it appears to drain into the lower portion of Augier Lake. Any sediment carried from this block would presumably settle out in the low velocity waters of the lake.

4.3 Lord's Creek Reach 1

4.3.1 Biophysical Characteristics

Reach 1 of Lord's Creek is 7,071m long and flows with a low gradient through confined and semi-confined sections of the Lord's sub-basin. It runs parallel to and within approximately 400m of the Augier Main logging road. Subsampling fractions ranged from 1/1 to 1/5 depending on habitat length and occurrence. In this reach a total of 429 habitat units were noted, of which 103 were measured in detail.

Reach 1 of Lord's Creek has an average channel gradient of 0.7% with an average bankfull width (Wb) of 7.3m (Table 3). Bankfull width varies from 3.2m to 25m. The average wetted width (Ww) at the time of assessment was 3.6m. The bed material is predominantly gravel with a subdominant substrate of cobble. Substrate compaction within the reach varies from medium to low. Larger substrates such as boulder are scarce throughout the reach. Habitat diversity is moderate in Reach 1, being distributed (Table 2) between glides (45.9%), riffles (33.3%) and pools (20.2%). Representative photographs of the three habitat unit types are in Appendix B (Plates 8, 9 and 10). The average water depth is 0.28m, with an average residual pool depth of 0.73m. Bars are most prominent in the middle to lower sections of the reach. The total combined length of side channels and backwater areas is 405m. Disturbance indicators in the reach include elevated mid and side channel bars (MB), extensive sediment wedges (WG) and eroding banks (EB).

4.3.2 Organic Debris

LWD is moderately abundant in Reach 1 of Lord's Creek, with an average extrapolated value of 3.2, indicating approximately 3.2 pieces of LWD per bankfull channel width (Table 2). This is rated "good" for summer and winter rearing habitat. Most of the LWD is small to medium sized, with occasional large pieces spanning the channel width. Most pieces of LWD are evenly distributed except for the occasional LWD jam associated with eroding banks (Appendix B; Plate 11).

4.3.3 Summer and Winter Rearing Habitat

Summer and winter rearing habitat parameters which rate "poor" in Reach 1 of Lord's Creek include percent pools with a value of 20%, percent boulder cover in riffles with a value of 0% and pool frequency with a value of 7.8 (Table 2). The pool frequency value corresponds to a distance of approximately 56.9m between pool habitats. Parameters that are rated "fair" for summer and winter rearing habitat include percent wood cover in pools, with a value of 13.1%. Habitat parameters which rate "good" include overhead cover (comprised of LWD, overhanging vegetation, cutbanks and boulder), with a value of 22.6%. Parameters conducive to winter rearing habitat include substrates and offchannel habitats (1.6 units/km), both with "fair" ratings.

4.3.4 Adult Migration

Upstream migration of adult spawners is rated "poor" in Reach 1 of Lord's Creek due to several beaver dams. One in particular, located approximately 1050m upstream (Appendix B; Plate 25), was impassable by kokanee at the time of assessment and represented the upper limit of kokanee spawning in Reach 1. Holding pools, however, are rated "good," with a value of 13 per km of stream.

4.3.5 Spawning and Incubation

Gravel quantity in Reach 1 is rated “good” due to the nature of the dominant substrate, however gravel quality is rated “fair” due to the amount of sand and silt at some sites.

4.3.6 Valley Wall and Channel Instability

Three major slumps were identified in Reach 1 of Lord’s Creek measuring (height X width) 30m X 100m (Appendix B; Plate 12), 20m X 40m (Appendix B; Plate 13) and 10m X 20m (Appendix B; Plate 14). Not one has reached its angle of repose, and all are actively eroding sediment into the creek. Two of the slumps (sites 7 and 8) are adjacent to a cutblock near the 26km mark of the Augier Main road. There is a reserve zone of riparian vegetation, and regeneration of this block appears to be proceeding well. The presence of the slumps raises the possibility (although unlikely) that altered hydrological regimes may be affecting the stream banks. This will be discussed further in the impacts section.

Other indicators of channel instability include elevated mid-channel bars and multiple channels caused by eroding banks (Appendix B; Plate 14) and associated LWD jams.

4.3.7 Riparian Vegetation

Riparian vegetation in Reach 1 is dominated by mature mixed forest with occasional deciduous pole saplings. The canopy closure value varied between values of 1 and 2. This translates into canopy cover ranging from 0 to 40%.

Three cutblocks border Reach 1 of Lord’s Creek. One, A30412, lies directly above the creek 75m to the east, and an intermittent tributary flows through it. Another large cutblock borders the west side of the creek, and a road joins the two. Extensive blowdown of the large mature trees has occurred along the east bank of Lord’s along the former block, but the understorey is growing well.

Another older cutblock lies on the west side of the creek just before the 26km mark of the Augier Main road. Regeneration appears to be proceeding successfully, but the two large slumps (sites 7 and 8, mentioned above) adjacent to the block raise some potential concerns.

4.4 *Henrietta Creek Reach 4*

4.4.1 Biophysical Characteristics

Reach 4 of Henrietta Creek consists of 4,480m of low gradient channel with both confined and unconfined sections that meander periodically. The flow volume was measured at 0.12m³/s. Subsampling fractions ranged from 1/1 to 1/5 depending on habitat length and occurrence. In this reach a total of 248 habitat units were noted, with 61 measured in detail.

Reach 4 of Henrietta Creek has an average channel gradient of 1.3%, with an average bankfull width (Wb) of 8.1m (Table 3). Bankfull width varies from 4m to 15.5m. The average wetted width (Ww) of the channel at the time of assessment was 4.7m. The bed material is predominantly gravel with a subdominant substrate of sand and cobble. Compaction of substrates within the reach varies from medium to low. Larger substrates such as cobble and boulder are occasionally dominant in some sections of stream. Habitat diversity is quite evenly distributed between riffle (45%), glide (31%) and pools (24%). Representative photographs of the habitat unit types are in Appendix B (Plates 15, 16 and 17). The average water depth is 0.32m, with an average residual pool depth of 0.85m. The occurrence of bars varies from medium in the upper sections of the reach to low in the lower sections. Side channels and backwater areas in the reach are relatively rare, with a total length of 225m. Disturbance indicators in the reach include elevated mid and side channel bars (MB), eroding banks (EB) and sediment wedges (WG).

4.4.2 Organic Debris

LWD is moderately abundant in the reach with an average extrapolated value of 3.1. This value indicates that there are approximately 3.1 pieces of LWD per average bankfull width and is rated “good” for summer and winter rearing habitat. Most of the LWD is in the small to medium size range, with occasional large pieces spanning the channel width. Most LWD pieces are evenly distributed throughout the reach.

4.4.3 Summer and winter Rearing Habitat

Summer and winter rearing habitat parameters which rate “poor” in Reach 4 of Henrietta Creek include percent pools, with a value of 24%, and pool frequency with a value of 6.1 (Table 2). This indicates that there is approximately 49.4m between pool habitats. Habitat parameters for summer and winter rearing which rate “fair” include percent wood cover in pools (13.4%) and percent boulder cover (17%). Overhead cover is dominated by LWD (7.2%) and overhanging vegetation (6.2%). Parameters conducive to winter rearing include both substrates and offchannel habitats with ratings of “fair.” Substrates are rated “fair” due to the presence of sand and silt, and offchannel habitats are rated “fair” with a value of 1.8 units/km (Table 2).

4.4.4 Adult Migration

Access to spawning grounds and holding pools are both rated “good” within the parameters set for adult migration. This is due to an absence of barriers within the reach and an adequate number of holding pools (8/km) for upstream migration. However, it is important to bear in mind that although access to spawning grounds is rated “good” (Table 2), a migration barrier noted during a 1995 overflight (possible chute or small falls) is likely present directly downstream in Reach 3 of Henrietta Creek.

4.4.5 Spawning and Incubation

Gravel quality in Reach 4 of Henrietta Creek is rated “good” due to the nature of the dominant substrate, however gravel quality is rated “fair” due to the presence of sand and silt at some sites (Table 2). The presence of sand and silt is most likely attributed to several natural slumps in the reach and from tributaries draining through existing cutblocks in Reach 4 and above.

4.4.6 Valley Wall and Channel Instability

Three major and one minor slump were identified in Reach 4 of Henrietta Creek. These measure (height X width) approximately 10m X 15m (Appendix B; Plate 19), 30m X 40m (Appendix B; Plate 20), 12m X 20m and 3m X 5m (Appendix B; Plate 21). These slumps appear natural and unrelated to past timber harvesting activities (see map number 93K-033). Other areas of channel instability within Reach 4 include multiple channels. These channels are most often associated with LWD jams and eroding banks.

4.4.7 Riparian Vegetation

Riparian vegetation in Reach 4 of Henrietta Creek is characterized by mature coniferous forest with canopy closure values of 1 to 2 in the upper sections and 1 in the lower sections. These values correspond to average canopy closures of 15 to 30% and 20%, respectively.

Four cutblocks border Reach 4 of Henrietta Creek, with more located upstream. Cutblocks 01401, 01402 and 01404 lie on the north side of the creek, at distances of 250m, 400m and 600m respectively. Cutblock 04501 lies 400m to the south. Further upstream, cutblock 01403 lies 800m to the north and 34730A11 lies 200m to the south. All the aforementioned cutblocks except 01401 have tributaries either bordering or running through them and are therefore considered potential sediment sources. Cutblock 01401 lies directly above the creek on a relatively steep slope.

5.0 DISCUSSION

The results of these assessments are to be used to assist in determining the focus of, and to provide guidance for, the development of feasible and effective restoration prescriptions. It is important to note, therefore, that the diagnostic table (Table 5 in Tech. Circ. 8) was developed with coastal streams in mind and is therefore not always directly applicable to interior watersheds. All three creeks sampled in the Taltapin drainage are in relatively good shape, and in some cases could be classified as index streams. Therefore values of “poor” and “fair” are likely indicative of normal conditions in this drainage, and should not necessarily be interpreted as indicators of stream degradation. A more appropriate alternative may be to base the rating system on pristine reaches of this or a neighbouring watershed. However, no pristine reaches were surveyed in this assessment, and surveying of neighbouring watersheds was outside the scope of the project.

Rainbow trout were present throughout the surveyed reaches of Pinkut, Lord’s and Henrietta creeks. Spawning kokanee were present throughout the accessible portions of the surveyed reaches of Pinkut and Lord’s creeks. The logging related impacts mentioned above do not appear to be significantly affecting fish habitat in any of the three drainages. Impacts responsible for habitat degradation appear to be natural and should decrease over time as bank slumps eventually reach their angles of repose. It is important to remember, though, that human activity may accelerate processes such as subsurface water flow, resulting in a subtly altered “natural process” that is detrimental to fish habitat. This may apply to sites 7 and 8, large slumps adjacent to a cutblock with generous riparian reserve zones and successful regrowth. The detailed site-specific analysis required to determine whether this is the case here was beyond the scope of this project.

In all three sub-drainages, the main fish-bearing areas impacted by timber harvesting activities are associated with logging roads and bridge crossings. It is likely that runoff from these roads transports sediment and fines into creeks via their tributaries. In addition to diminishing cover and rearing habitat, sediment input from these sources can fill interstices and starve incubating eggs of oxygen, thereby decreasing the overall productivity of a reach.

Bridge crossing impacts in all three creeks include riparian vegetation removal, point sediment sources and channel confinement.

Streamside timber harvesting has only directly affected the upper section of Reach 1 of Lord's Creek. The Riparian reserve zone associated with cutblock A30412 on the east side of the creek is being blown across and into the channel (Appendix B; Plate 24). Blowdown at this site is causing LWD/debris jams, multiple channels and other forms of channel instability. There is also a large block on the east side of the channel. Its reserve zone appears unaffected. A road joins the blocks and crosses the creek immediately upstream of the blowdown. It appears that any sediment running alongside this road will enter the creek.

Most impacts to the three creek systems delineated for assessment appear to be natural. Bank slumps and an absence of boulder in the substrate are responsible for most of the "poor" ratings in the three creeks. Bank slumps cause habitat infilling, and an absence of boulder reduces the potential for scour pool development. These two characteristics are a natural result of glacial till deposition and the geological nature of the Taltapin drainage.

Another non-forestry related impact common to all three creeks is the presence of beaver colonies. Beaver dams on Pinkut and Lord's creeks have affected upstream migration of spawning kokanee. The largest impact is in Lord's Creek, where a large, well-established dam approximately 1050m upstream of the mouth prevents access to almost 6km of spawning grounds. However, in many cases beaver dams create excellent settling ponds that help reduce the impacts of siltation and provide high quality rearing habitat. The dams are also not permanent barriers, and can be considered a natural component of an ecosystem. Bearing this in mind, any proposed dam removal should be thoroughly examined.

The most important issue facing the watershed in the future is the maintenance of Riparian reserve zones along the sensitive glacial till stream bank slopes.

5.1 Rearing Habitat

Rainbow trout utilize waters of low velocity and relatively shallow depths for summer rearing. Stream edges and protected pools usually provide this habitat. Boulder and cobble are the preferred cover types, however LWD, undercut banks and other types are utilized if they are available (Burt, 1996). The absence of interstitial and pool habitat (percent pool) suggests that summer fry habitat is limited. Thus fry production has been affected and likely reduced. The scarcity of pools may be due to the inherent nature of the system, as all three creeks are relatively undisturbed by timber harvesting activities. This deficiency is likely a result of the infilling of existing pools by sediment transported from natural sources upstream.

Juvenile rainbow trout normally move into the interstitial spaces of the substrate, use offchannel areas or migrate into accessible lakes during the winter months. Streambeds of established cobble/boulder substrate with minimal infilling of interstices and numerous offchannel areas provide the ideal overwintering habitat (*Ibid.*). All three surveyed creeks rate “fair” for these parameters, and a high proportion of fish likely migrate into Taltapin, Augier and Hannay lakes. Because of this, overwintering habitat may not be a serious limitation to fish production even though infilling of interstices and pool habitat has occurred.

Kokanee usually migrate upon emergence to larger bodies of water such as lakes or large slow moving rivers. Mature rainbow trout, on the other hand, utilize the deeper and higher velocity sections of streams for summer rearing. Boulder and whitewater are the preferred forms of cover, although other types will be used (*Ibid.*). Boulder glides and riffles, as well as pools with moderate velocities and good cover, provide excellent habitat for this life stage. All three creeks fail to provide these types of habitat due to a natural absence of boulders and the probable infilling of pools by sediment from upstream sources. Despite these conditions, productivity may be at an acceptable level due to other forms of cover, which rate “fair” to “good,” and the use of Taltapin and Augier lakes as nurseries for fry and parr.

5.2 Spawning Habitat

Adult kokanee, and rainbow trout to a lesser extent, require deep, cool holding pools during upstream migration. The three reaches surveyed have adequate amounts of holding pools.

Rainbow trout and kokanee spawn in loose gravel and small cobble ranging from 0.6 to 10.2cm in diameter (Reiser and Bjornn, 1991; Scott and Crossman, 1990; Whyte et. al., 1996). Spawning gravel is present in moderate to high quantities and is of fair to poor quality. Quality of spawning gravel is diminished by the presence of fines in the substrate. Input of the majority of the fines into the system is attributed to glacial till deposits and associated bank slumps. It is likely that roads and creek crossings contribute sediment as well, but amounts are undetermined at this time.

Incubation success seriously diminishes when excessive amounts of fines are present in the substrate (Whyte et. al., 1996). Oxygen supply to and waste removal from the eggs are diminished in such cases. In all three reaches fines are present and accumulating in the slower portions of the channels. It is likely that some infilling of the interstices is occurring, impairing gas exchange efficiency.

The major limitations to fish production in the surveyed creeks appear to be the gravel quality and absence of some forms of cover, especially boulder and pool cover.

6.0 FISHERIES ASSESSMENT

Henrietta Creek was sampled for fish at the bottom of Reach 4, directly upstream of the Hannay Main logging road bridge crossing. The sample site was located approximately 50m downstream of a heavily aggraded and braided section of stream. Table 4 shows the physical dimensions of the site and associated data. Electroshocker settings were held at phase J, 6 amps and 200v for the entire site.

Lord's Creek was sampled approximately 2900m into Reach 1, at and immediately downstream of a slump at the border of a cutblock. Table 4 shows the physical dimensions of the site and associated data. Electroshocker settings were held at phase J, 6 amps and 300v for the entire site.

At the time of assessment, large numbers of spawning kokanee were present in Reach 6 of Pinkut Creek. To avoid disturbing them and the many redds, this reach was not sampled with the same intensity as the others. Instead it was spot shocked for approximately 25m to determine the presence of other species. No fish were captured, but adult rainbow trout were visually observed.

Table 4. Physical measurements of sample sites and associated data.

Creek	Henrietta Reach 4			Lord's Reach 1		
UTM	N/A			10 336124.0 U 6025325.8		
Date (d/m/y)	16/9/97			17/9/97		
Water Temp (°C)	8			7		
	Area (m ²)	Shocking Time (s)		Area (m ²)	Shocking Time (s)	
		Pass 1	Pass 2		Pass 1	Pass 2
Riffle	92.3	311	284	62.2	148	151
Glide	90	231	231	164.4	301	311
Pool	26.3	136	136	55	205	208

Henrietta Creek electroshocking results are in Appendix E. They confirm the suspected presence of resident fish populations, namely rainbow trout. No kokanee were captured or observed, which is notable considering their presence downstream in the system. Whether their absence was due to run timing or downstream barriers to migration is not known, and was not investigated as this was beyond the scope and budget of the contract. It is possible that a small chute or falls barrier in Reach 3 noted during the overview assessment (1996:27) is responsible.

Lord's Creek electroshocking results are in Appendix E. They confirm the suggestions of the 1996 OFHAP that resident rainbow trout inhabit the reach. They also indicate that beaver activity has prevented spawning kokanee from accessing upstream habitat. At the time of assessment a large, well established dam approximately 1050m upstream of the confluence with Pinkut Creek was the upper limit of spawning kokanee migration. The value of the inaccessible habitat upstream of Reach 1 is not known. Further investigation is warranted, as large numbers of spawning kokanee were observed up to the base of the dam.

7.0 IMPACT DESCRIPTIONS

Impact descriptions are described below on a site by site basis for Category 1 impacts, which are isolated impacts to the drainage that require non-professional prescriptions. Examples include, but are not necessarily limited to, perched culverts, fish access issues and slope revegetation and stabilization. No definite Category 2 impacts were noted during the assessment. Supplied with this report are map numbers 93K-033 and 93K-035, which show the locations of the impacted sites in the Pinkut, Lord's and Henrietta sub-basins, respectively.

7.1 *Pinkut Creek Reach 6*

In some of the middle to lower sections of Reach 6 there are large accumulations of LWD (e.g. Appendix B; Plate 4). Within these accumulations there are numerous sawed logs and boomsticks. Other than Lord's Creek, there isn't a creek with enough volume and energy to transport LWD of this size and number into Reach 6 of Pinkut Creek. The presence of the boomsticks, in particular, suggests Augier Lake as the origin. These LWD accumulations are providing good cover, and do not present barriers to fish passage.

Sites 1 and 2

Both logging bridges on Pinkut Creek (Appendix B; Plate 22) have resulted in channel confinement and a loss of riparian cover over a cumulative distance of approximately 75-100m. Surface runoff and unvegetated banks at both sites are contributing fines into both the upper and lower sections of Pinkut Creek.

Sites 3 and 4

Sites 3 and 4 are slumps actively eroding fines into Pinkut Creek. Neither has reached its angle of repose. Site 3 measures (height X width) approximately 30m X 100m (Appendix B;

Plate 5), and Site 4 measures approximately 30m X 45m (Appendix B; Plate 6). Both slumps are natural and do not appear to be logging related.

7.2 Lord's Creek Reach 1

Site 5

Site 5 is a bridge crossing between two cutblocks located approximately 2500m upstream of the Pinkut Creek confluence. Air photo and map analysis suggests that sediment from the blocks may be directed along the road and enter the creek directly above an area of blowdown from the Riparian reserve zone, LWD/debris jams and eroding banks (Appendix B; Plate 24). Other impacts at this site include channel confinement, loss of riparian cover and surface runoff from unvegetated banks (Appendix B; Plate 23). These cover a linear distance of approximately 100-150m.

Sites 6, 7 and 8

Sites 6, 7 and 8 are large slumps measuring (height X width) approximately 30m X 100m (Appendix B; Plate 12), 10m X 20m (Appendix B; Plate 14) and 20m X 40m (Appendix B; Plate 13), respectively. All three are actively eroding fines and larger substrates into the system and have not yet reached their angles of repose. Sites 7 and 8 are adjacent to an old cutblock at the 26km mark of the Augier Main road. A riparian reserve zone has been maintained, and regeneration of the block appears to be successful. There is a slight possibility that these slumps were caused by a change in hydrological patterns associated with the harvesting activity in the area.

Site 9

Site 9 on Lord's Creek is a large beaver dam that is presently acting as an impassable barrier to spawning kokanee (Appendix B; Plate 25). This dam is located approximately 1050m

upstream and represents the upper limit of kokanee spawning. The result is a loss of approximately 6.0km of kokanee spawning grounds in Reach 1.

7.3 *Henrietta Creek Reach 4*

Sites 10, 11 and 12

Sites 10, 11 and 12 are slumps that are actively eroding fines and other substrates into the channel. These slumps measure (height X width) approximately 10m X 15m (Appendix B; Plate 19), 30m X 40m (Appendix B; Plate 20) and 12m X 20m (Appendix B; Plate 21), respectively. These slumps are actively eroding and have not yet reached their angles of repose. All three are natural and do not appear to be logging related.

Site 13

Site 13 is a logging bridge on the Hannay Main logging road which crosses Henrietta Creek. The bridge encroaches on the stream channel and has resulted in channel confinement, a loss of riparian cover and a point sediment source (Appendix B; Plates 26 and 27) over a linear distance of approximately 50-75m.

8.0 RESTORATION PRESCRIPTIONS

Instream habitat restoration of the assessed reaches in the Pinkut, Lord's and Henrietta sub-basins should be directed at areas revealing the most habitat damage and which, presently or historically, are utilized by anadromous and resident fish species.

The three reaches assessed are lacking in pool and interstitial habitat, high quality spawning gravel and boulder cover in riffles. The absence of these habitat types appears to be a normal result of the geology of the Taltapin watershed. The loss of pool and interstitial habitat in all three reaches is most likely attributed to natural slumps and associated pool infilling. Instream work, such as creation of pool habitat, should only progress after implementation of slope stabilization measures. Other areas of concern in all three creeks center around logging bridges and the associated network of roads. These areas often input large amounts of sediment and contribute to channel confinement, habitat infilling and loss of riparian vegetation. Cutblocks in general do not appear to be having a serious impact on the specified reaches, although tributaries directly bordering and running through them should be examined as part of a sediment source survey (Appendix I). Finally, impassable beaver dams, especially in Lord's Creek, are decreasing the amount of available kokanee spawning grounds.

The problems described above warrant the following restoration activities for the specified creeks and reaches within the Taltapin watershed:

- Sediment source survey (Appendix I) of all specific sites (excluding site 9), cutblocks and road networks.
- Partial LWD/debris jam removal at site 5.
- Level 2 assessments of upslope areas and slope failures thought to be contributing most of the sediment to the creek system. Specifically, in order of importance, sites 6, 3, 8, 11, 4, 7, 10 and 12
- Increase habitat complexity (specifically pools) in all three reaches with LWD placement and/or boulder groupings (where they are naturally present) to encourage scour pool

formation. This should only be attempted once slope stabilization measures are implemented upstream.

8.1 Proposed Site-Specific Rehabilitation Prescriptions

Sites 3, 4, 6, 7, 8, 10, 11 and 12 (Slumps)

Habitat Concerns

- Lack of pool habitat and infilling.

Potential Rehabilitation Prescriptions

- Water deflectors, such as rock toe keys and LWD placement coupled with bank revegetation to decrease bank undercutting. See Appendix D, Fig. 1 to 4 for diagrams of rehabilitative techniques for sites 6, 7, 8 and 3, respectively.

Recommendations

- The slumps mentioned are the result of natural undercutting of sensitive glacial till streambanks. Although this is a natural process, possible alterations in hydrological cycles due to cutblocks and road networks may have accelerated it. This should be assessed as part of a sediment source survey (Appendix I) to determine the exact nature of impacts on these areas.
- Level 2 assessments of individual sites to determine appropriate remedial action (if any).

Cost

- Sediment source survey—approximately \$500 to \$1000 per hectare (Appendix I).
- Level 2 assessment of slumps—approximately \$1000 to \$2000 per day.

Sites 1, 2 and 13 (Bridge crossings)

Habitat Concerns

- Loss of fish habitat due to sediment input and loss of riparian cover.

Potential Rehabilitation Prescriptions

- Revegetate impacted areas with mixed coniferous and deciduous trees to provide cover.
- Install buffers to reduce sediment input from roads.

Recommendations

- Conduct a sediment source survey (Appendix I) to determine the amount of sediment input from these three sources and suggest site-specific rehabilitative techniques, if any.

Cost

- Sediment source survey—approximately \$500 to \$1000 per hectare (Appendix I).

Site 5

Habitat Concerns

- Loss of fish habitat due to high levels of LWD accumulation and sediment input.

Potential Rehabilitation Prescriptions

- Install buffers to reduce sediment input from roads.
- Revegetate impacted areas with mixed coniferous and deciduous trees to provide cover.
- Reduce the amount of LWD associated with blowdown in riparian reserve zone.

Recommendations

- Conduct a sediment source survey (Appendix I) to determine the amount of sediment input from cutblocks and associated roads.
- Remove selected LWD with winches, horses etc.

Cost

- Sediment source survey—approximately \$500 to \$1000 per hectare (Appendix I).
- LWD/debris jam removal – approximately \$2000 to \$4000

Site 9

Habitat Concerns

- Beaver dam is an obstruction to upstream migration of spawning kokanee.

Potential Rehabilitation Prescriptions

- Trap beavers and/or remove or alter impassable dams during spawning period.

Recommendations

- Although beaver dams are impeding fish passage, the ponds also act as settling ponds and therefore improve the quality of downstream spawning gravel. They also produce much needed pool rearing habitat. Only dams shown to be impassable and impeding access to high quality spawning sites should be considered for removal.
- Note: Techniques described in Tech. Circ. 9 are not recommended in this case due to lack of access for heavy machinery.

Cost

- Approximately \$1000-\$5000 per dam.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 *Pinkut Creek Reach 6*

Conclusions

- With the exception of bridge crossings, logging activity has not significantly affected Reach 6 of Pinkut Creek.
- Most habitat impacts were associated with natural slumps and beaver dams.
- The two target species in Reach 6 are rainbow trout and kokanee. Data on the distribution of adult and juvenile rainbow trout in Reach 6 were not gathered due to the presence of large numbers of spawning kokanee and their redds.
- The most significant habitat constraints for rearing fish in Reach 6 appear to be the lack of boulder cover in riffles and the high level of sand in the substrate.
- LWD associated with past logging is presently not affecting Reach 6, and in some cases provides additional habitat and cover for the middle and upper sections of the reach.

Recommendations

- Perform a sediment source survey (Appendix I) to confirm sources of sediment from upstream areas, cutblocks, roads and bridge crossings.
- Habitat enhancement work in Reach 6 is not recommended until sediment sources are identified in a sediment source survey and, if necessary, Level 2 assessments of slumps are undertaken to determine the feasibility of slope stabilization measures.
- It is recommended that slope stabilization measures be implemented where warranted and feasible. Stabilization of slumping banks could improve gravel quality for spawning fish. However, the effects of this work would not be immediate, and considerable time would be required before natural flushing of existing fine sediment deposits occurs.
- The removal of beaver dams is not recommended due to the ponds' function as sediment traps and pool rearing habitat.

Cost

- Sediment source survey—approximately \$500 to \$1000 per hectare (Appendix I).

9.2 Lord's Creek Reach 1

Conclusions

- Slumps and eroding banks in Reach 1 appear to be natural, but rates of erosion may be influenced by logging activity.
- Beaver dams in Lord's Creek are directly affecting access to upstream kokanee spawning grounds.
- Logging activity has not significantly affected Reach 1 of Lord's Creek.
- The two target species for Reach 1 are rainbow trout and kokanee salmon.
- Logging related impacts to Reach 1 include a bridge and LWD/debris jams related to a clearcut area.
- The most significant habitat constraints for rearing fish in Reach 1 appear to be low gravel quality, a lack of pool habitat and a lack of boulder cover in riffles.

Recommendations

- Perform a sediment source survey (Appendix I) to confirm sources of sediment from upstream areas, associated cutblocks, roads and bridge crossings. If necessary, conduct Level 2 assessments of slumps to determine appropriate detailed site-specific rehabilitative prescriptions.
- Reduce the amount of LWD below first logging bridge (Site 5).
- It is recommended that slope stabilization measures be implemented. Stabilization of slumping banks could improve gravel quality for spawning fish. However, the effects of this work would not be immediate, and considerable time would be required until natural flushing of existing fine sediment deposits occurs.
- It is recommended the additional studies be undertaken to evaluate the feasibility of creating pool habitats complexed with LWD/boulder complexes throughout Reach 1 of Lord's Creek. Instream work of this nature should not be attempted until upstream sediment sources have been stabilized.
- Replanting of mixed riparian vegetation along edge of creek adjacent to first logging bridge is recommended.

Cost

- Sediment source survey—approximately \$500 to \$1000 per hectare (Appendix I).

9.3 *Henrietta Creek Reach 4*

Conclusions

- Logging activity does not appear to have significantly affected Reach 4 of Henrietta Creek.
- All impacts to Reach 4 appear to be natural.
- The most significant habitat constraints for rearing fish in Reach 4 appear to be an absence of pool habitat and a lack of interstitial space in the substrate.
- The only target species present in Reach 4 is rainbow trout.

Recommendations

- Perform a sediment source survey (Appendix I) to confirm sources of sediment from upstream areas, associated cutblocks, roads and bridge crossings.
- Further inspection of lower reaches is needed to determine the presence of possible kokanee migration barriers.
- Habitat enhancement work in Reach 4 is not recommended until upstream sediment sources are stabilized. However, the effects of this work would not be immediate, and considerable time would be required before natural flushing of existing fine sediment deposits occurs.
- Spawning habitat capabilities could be improved through stabilization of upstream sediment sources.

Cost

- Sediment source survey—approximately \$500 to \$1000 per hectare (Appendix I).

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Appendix A
Level 1 Forms - Digital

Overview Assessment - Habitat Condition Summary Form (2 of 3)

Disturbance Indicators

Use the presence of indicator features (Table 2) to diagnose recent channel disturbances that may lower salmonid habitat values. Record the most evident disturbances, using the codes listed in Table 2. Consult Technical Circular No. 7 for photographed examples and detailed descriptions of the disturbance indicators.

Table 2. Indicators of recent channel disturbance (from Hogan and Bird 1995).

Code	Indicator Feature
SC	Bed 1. Extensive areas of scour
DW	Bed 2. Extensive areas of (unvegetated) bar
WG	Bed 3. Large, extensive sediment wedges
MB	Bed 4. Elevated mid-channel bars
LR	Bed 5. Extensive riffle zones
FP	Bed 6. Limited pool frequency and extent
MC	Channel 1. Multiple channels (braiding)
EB	Banks 1. Eroding banks
BC	Banks 2. Isolated sidechannels or backchannels
PD	LWD 1. Most LWD parallel to banks
JM	LWD 2. Recently formed LWD jams

Barriers

Distinguish the following types of potential barriers:

distinguish all barriers.

BD	Beaver dams - identified as pools behind a channel-spanning structure of mud and interleaved trees and rocks, usually in low to moderate gradient areas.
BR	Bridges - road crossings that constrict the channel can be barriers to fish movement
C	Cascades or chutes - appear as white water in steep channels.
CV	Culvert - Check the road condition assessment to judge the status of culverts, or examine them directly.
F	Falls - vertical drops greater than about 2 m.
G	Gradient barriers - gradients greater than about 20% are often barriers to fish movement.
LS	Landslides or bank sloughing - unvegetated actively eroding banks or slopes that produce large fans of sediment or abrupt changes in stream course.
N	No barriers
U	Unknown.
X	Log jams - substantial accumulations of logs that completely cover the stream channel.

Percent Pools

Estimate to the nearest quartile the proportion of the section area that consists of pools. Note that pool areas vary with flow. Percent pool data are most useful when they refer to low flow conditions. Code the percentage pool as:

0	no pools in the section
1	1-25% pool by area
2	26-50% pool by area
3	51-75% pool by area
4	76-100% pool by area
9	unable to estimate pool area (e.g., because of canopy closure).

Large Woody Debris (LWD) Amount and Distribution

Logs within the bankfull channel width that can be seen individually on the air photos are LWD. Score the amount of LWD in the section as:

AC	abundant LWD - clumped distribution of LWD pieces
AE	abundant LWD - LWD is evenly-distributed along the channel
FC	few LWD pieces - clumped distribution of LWD pieces
FE	few LWD pieces - LWD is evenly-distributed along the channel
N	no LWD
U	unknown.

Overview Assessment - Habitat Condition Summary Form (3 of 3)

Riparian Type

Determine the composition of the dominant vegetation type immediately adjacent the stream channel (i.e., in the FPC riparian management area, RMA). If a riparian assessment is being done, obtain vegetation type and stand structure data from the riparian assessment. Otherwise, use both air photos and forest cover maps (obtainable from the licensee or MoF district offices) to identify the dominant vegetation type. The 1:5,000 forest cover maps provide considerable information on vegetation type and structure beyond that extractable from the air photos. If forest cover maps are available in digital format, merge them with the TRIM base maps to delineate vegetation types within the RMA. Record the dominant riparian vegetation type as:

C	conifer-dominated riparian forest
D	deciduous-dominated riparian forest
G	non-forested grassland or bog (<10% tree cover)
M	mixed conifer-deciduous riparian forest (>25% conifer and deciduous)
N	unvegetated. Much bare mineral soil is visible,
S	shrub/herb. Herbaceous or shrubby vegetation dominate.

Stand Struc.

Record the structural stage of the dominant vegetation in the RMA as:

INIT	- the non-vegetated or initial stage following disturbance, with less than 5% cover.
MF	- mature forest with well-developed understory. Conifer-dominated mature forests (MFc) have greater than 50% conifers in the sub-canopy layers while mixed forests (MFm) have greater than 25% component of both coniferous and deciduous trees in all canopy layers.
PS	- pole-sapling stage, with trees overtopping the shrub layer, usually less than 15-20 years old.
SHR	- shrub/herb stage. Less than 10% tree cover.
YF	- young forest. Self-thinning is evident and the forest canopy is differentiating into distinct layers. Stand age is 30-80 years.

Canopy Closure (shading)

Categorize the proportion of the surface area of the stream covered by the riparian canopy as (Anonymous 1993):

1	stream surface and banks visible (0-20% shade)
2	stream surface and banks visible at times (20-40%)
3	stream surface visible but banks are not visible (40-70%)
4	stream surface slightly visible or visible in patches (70-90%)
5	stream surface not visible (>90% shade)

Off-channel Fish Habitat

Determine the extent of and access to off-channel fish habitat adjacent to the stream section. Include low-energy waters such as pools, sidechannels, oxbows, and other backwaters that are accessible at high discharge, although they may be dry at low flow. Also note backwaters that are isolated from the main stream channel by roads, berms, debris or changes in channel position. Record off-channel fish habitat as:

F	fair. Little off-channel habitat or poor access for fish.
G	good. Abundant off-channel habitat with good access for fish.
M	moderate. Some off-channel habitat with good access for fish.
P	poor. No off-channel habitat or no access for fish.
U	unknown.

on 1:15000

1mm = 15m
~~1mm = 15m~~

Appendix B

Plates

List of Photographs

Photo #1: Typical pool habitat in Pinkut Creek Reach 6. Note elevated mid channel bar and sand in substrate.

Photo #2: Typical glide habitat in Pinkut Creek Reach 6. Note sand and silt in substrate.

Photo #3: Typical short riffle habitat in Pinkut Creek Reach 6.

Photo #4: LWD jam in middle of Of Pinkut Creek Reach 6.

Photo #5: Natural slope failure on Pinkut Creek Reach 6 (Site #3).

Photo #6: Natural slope failure on Pinkut Creek Reach 6. Note revegetation on lower half (Site#4).

Photo #7: Typical riparian growth along Pinkut Creek Reach 6. Note elevated mid channel bar.

Photo #8: Typical glide section of Lord's Creek Reach 1.

Photo #9: Typical riffle section of Lord's Creek Reach 1. Note gravel cobble substrate.

Photo #10: Typical pool section of Lord's Creek Reach 1.

Photo #11: LWD accumulation along Pinkut Creek Reach 6.

Photo #12: Natural slope failure on Lord's Creek Reach 1 (Site #6).

Photo #13: Natural slope failure on Lord's Creek Reach 1 (Site #8).

Photo #14: Natural eroding banks on Lord's Creek Reach 1.

Photo #15: Typical riffle section on Henrietta Creek Reach 4.

Photo #16: Typical glide section on Henrietta Creek Reach 4.

Photo #17: Typical pool section on Henrietta Creek Reach 4.

Photo #18: Typical LWD cover on Henrietta Creek Reach 4.

Photo #19: Natural slope failure on on Henrietta Creek Reach 4 (Site #10).

Photo #20: Natural slope failure on Henrietta Creek Reach 4 (Site #11).

Photo #21: Natural slope failure on Henrietta Creck Reach 4 (Site#12).

Photo #22: Logging bridge on Pinkut Creek Reach 6 (Site #11).

Photo #23: Logging bridge on Lord's Creek Reach 1 (Site #5).

Photo #24: Blowdowns to Riparian Reserve Zone on Lord's Creek Reach 1 (Site #5).

Photo #25: Impassable beaver dam on Lord's Creek Reach 1. Upper limits of spawning kokanee salmon (Site #9).

Photo #26, 27: Logging bridge on Henrietta Creek Reach 4 (Site #13).

Photo #28: Typical beaver dam on Pinkut Creek Reach 6.



Plate #1: Typical pool section in Pinkut Creek Reach 6. Note elevated mid channel bar and sand in substrate.



Plate #2: Typical glide section in Pinkut Creek Reach 6. Note sand and silt in substrate.



Plate #3: Typical short riffle section in Pinkut Creek Reach 6.



Plate #4: LWD jam in middle of Pinkut Creek Reach 6.



Plate #5: Natural slope failure on Pinkut Creek Reach 6 (Site #3).



Plate #6: Natural slope failure on Pinkut Creek Reach 6. Note revegetation on lower half (Site#4).



Plate #7: Typical riparian growth along Pinkut Creek Reach 6. Note elevated mid channel bar.



Plate #8: Typical glide section of Lord's Creek Reach 1.



Plate #9: Typical riffle section of Lord's Creek Reach 1. Note gravel cobble substrate.



Plate #10: Typical pool section of Lord's Creek Reach 1.



Plate #11: LWD accumulation along Pinkut Creek Reach 6.



Plate #12: Natural slope failure on Lord's Creek Reach 1 (Site #6).



Plate #13: Natural slope failure on Lord's Creek Reach 1 (Site #8).



Plate #14: Eroding banks on Lord's Creek Reach 1 (Site #7).



Plate #15: Typical riffle section on Henrietta Creek Reach 4.



Plate #16: Typical glide section on Henrietta Creek Reach 4.



Plate #17: Typical pool section on Henrietta Creek Reach 4.



Plate #18: Typical LWD cover on Henrietta Creek Reach 4.



Plate #19: Natural slope failure on on Henrietta Creek Reach 4 (Site #10).



Plate #20: Natural slope failure on Henrietta Creek Reach 4 (Site #11).



Plate #21: Natural slope failure on Henrietta Creek Reach 4 (Site#12).



Plate #22: Logging bridge on Pinkut Creek Reach 6 (Site #11).



Plate #23: Logging bridge on Lord's Creek Reach 1 (Site #5).



Plate #24: Blowdown in Riparian Reserve Zone on Lord's Creek Reach 1 (Site #5).



Plate #25: Impassable beaver dam on Lord's Creek Reach 1. Upper limits of spawning kokanee (Site #9).



Plate #26: Logging bridge on Henrietta Creek Reach 4 (Site #13).



Plate #27: Logging bridge on Henrietta Creek Reach 4 (Site #13).



Plate #28: Typical beaver dam on Pinkut Creek Reach 6.

Appendix C

Fish Distribution Data

Overview Assessment - Fish Distribution Summary Form

Sub Basin Name

Name of Stream or Tributary

Reach Number

From the channel assessment procedure.

Section

Within the reach (if necessary).

Data Source

Note the source of the information, as:

ABM	aquatic biophysical maps
DFO	Canada Department of Fisheries and Oceans reports or special studies
FISS	fisheries information summary system
FOR	forest licensee
LKNOW	local knowledge
MELP	BC Fisheries Branch reports or studies
SEDS	spawning escapement data system
SISS	stream inventory summary system
TG	tribal group or aboriginal fisheries council records

Survey Methods

Code the methods used to obtain the original juvenile and adult fish distribution information as:

AC	aerial count
AG	angling
AR	angler report
BL	blasting
CR	creel census
DC	dead capture
DN	dip netting
EL	electrofishing
FT	fish traps or fence
GN	gillnetting
MT	minnow traps
PO	poison
SA	stomach analysis
SL	set line
SN	seines
SW	swimming (snorkel count)
UN	unknown
VO	visual observation (i.e., shore count)

Fish Presence

SK - Sockeye, CH - Chinook, CO - Coho, PK - Pink, ST - Steelhead, RB - Rainbow, CT - Cutthroat, DV - Dolly Varden, BT - Bull Trout

For each salmonid species and life stage (juvenile, adult, spawner), record the presence of the species in the reach and section as:

H	historically present
K	presence known
N	not present
S	suspected presence
U	unknown

Appendix D

Diagrams of Conceptual Restoration Techniques and Cost Estimates for Specific Sites

Level 2 Assessment Cost Breakdown for Five Sites in the Taltapin Watershed

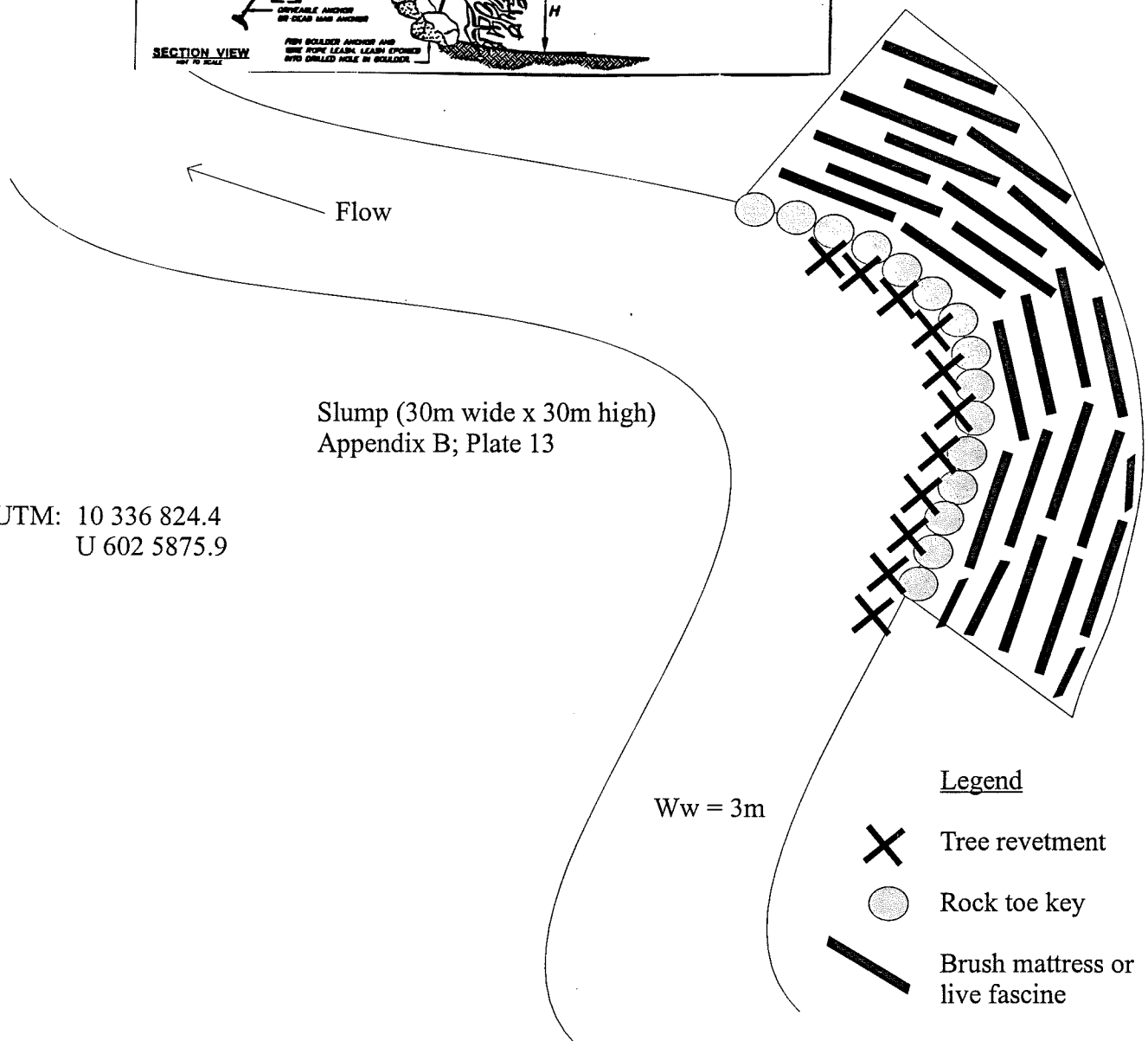
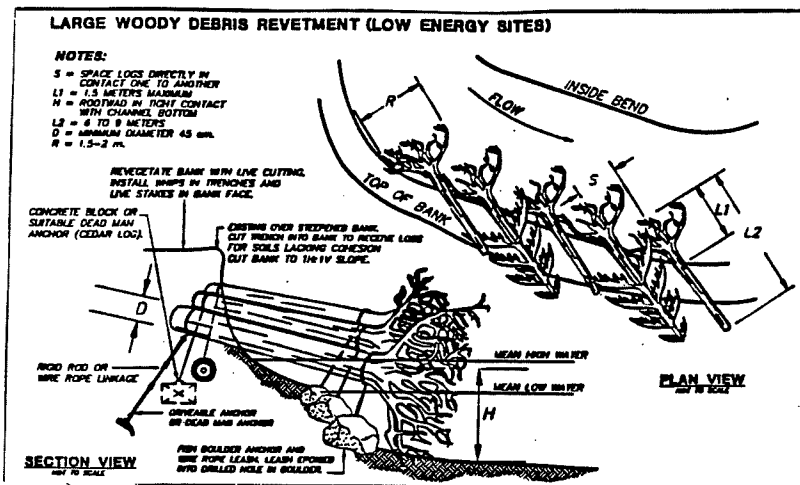
COST COMPONENT	HOURS, RATES AND COST	COST
Professional Fees		
1 P. Eng. or P. Geo. (field)	2 days @ \$750/day	\$1500
1 Biologist (field)	5 days @ \$450/day	\$2250
1 Technician (field)	5 days @ \$350/day	\$1750
1 Biologist (office)	6 days @ \$400/day	\$2400
Total Professional Fees		\$7900
Disbursements		
Helicopter	1 hr @ \$1200/hr + fuel	\$1400
Truck	\$40/day X 5 days	\$200
Mileage	750km @ \$0.36/km	\$270
Lodging	12 nights @ \$70/night	\$840
Meals	12 days @ \$40/day	\$480
Photocopying	\$100 (est.)	\$100
Photographs	\$100 (est.)	\$100
Phone/Fax/Courier	\$150 (est.)	\$150
Miscellaneous	\$150 (est.)	\$150
Total Disbursements		\$3690
ESTIMATED TOTAL		\$11590

Note: This is an estimate of costs, which includes detailed site surveys, prescriptions and fish abundance for specified areas.

Figure 1

Site 6. Slope failure on Lord's Creek Reach 1 (See Figures A-C)

Figure A



Site 6. Slope failure on Lord's Creek Reach 1

Figure B

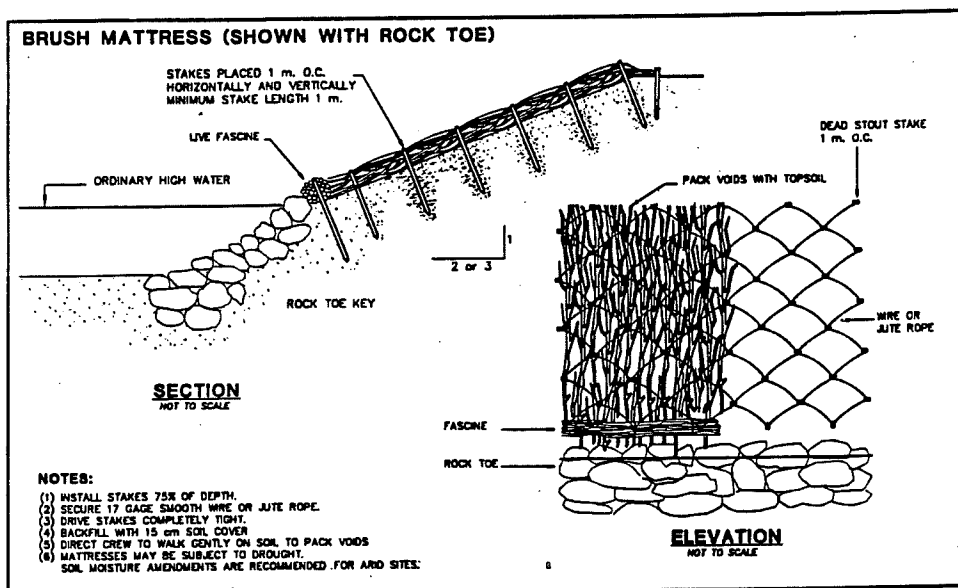
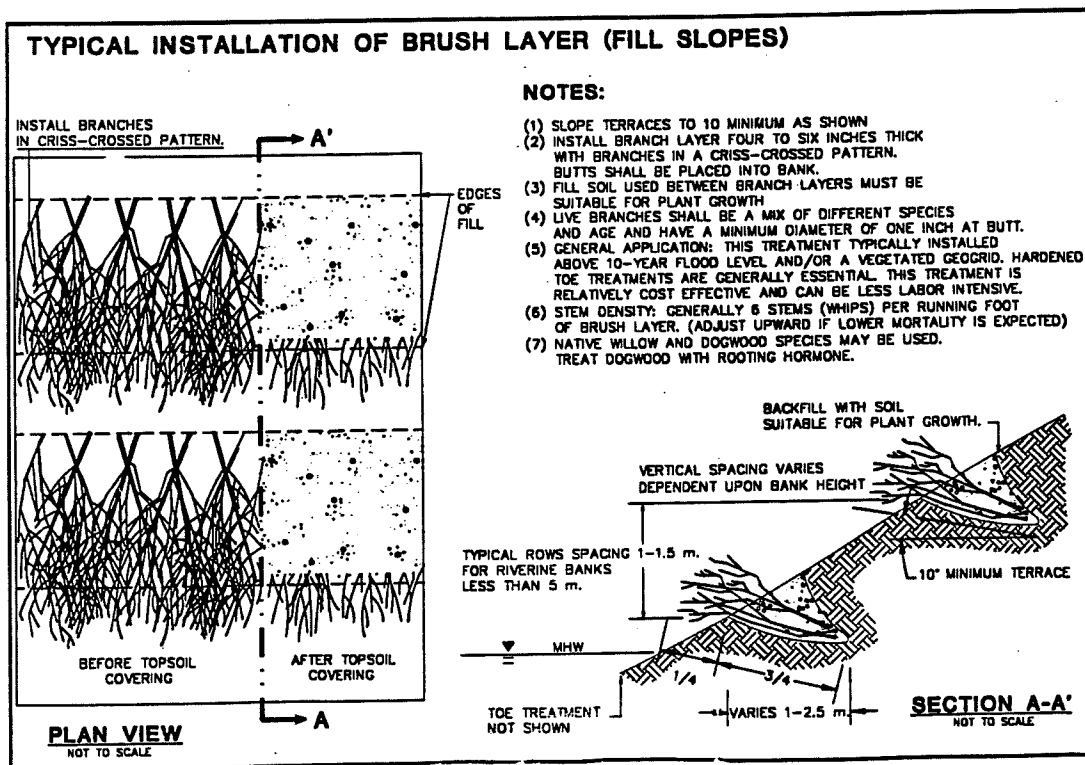


Figure C



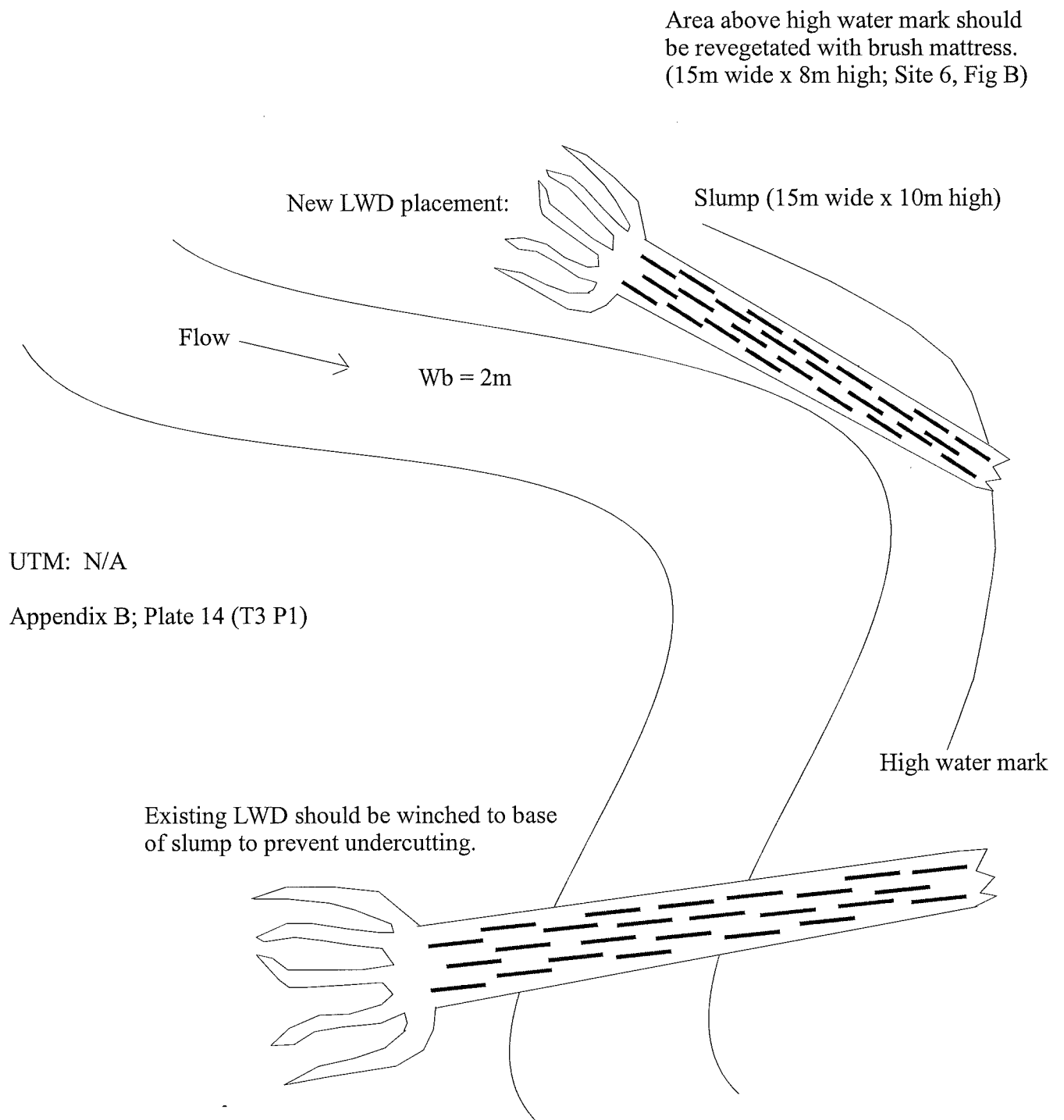
Site 6 (Slump) Cost Estimate

COST COMPONENT	HOURS, RATES AND COST	COST
Professional Fees		
1 P. Eng. or P. Geo.	1 day @ \$750/day	\$750
1 Biologist	3 days @ \$450/day	\$1350
2 Laborers	3 days @ \$300/day x 2	\$1800
Total Professional Fees		\$3900
Disbursements		
Helicopter	1 hr @ \$1200/hr + fuel	\$1400
Winch rental	3 days @ \$200/week	\$86
Boulders	\$200	\$200
Cable	\$300	\$300
Epoxy	\$300	\$300
Drill Rental	3 days @ \$300/week	\$129
Truck	3 days @ \$40/day	\$120
Mileage	150km/day x 3 days @ \$0.36/km	\$162
Electroshocker & nets	3 days @ \$500/week	\$214
Horse rental	3 days @ \$2000/week	\$857
Brush mattress materials or live fascines	\$1000	\$1000
Lodging	10 nights @ \$70/night	\$700
Meals	10 days @ \$40/day	\$400
Photographs	\$150 (est.)	\$150
Miscellaneous	\$200 (est.)	\$200
Total Disbursements		\$6218
ESTIMATED SITE TOTAL		\$10118

These cost estimates are based on the supplied conceptual drawings and may change once Level 2 or other site-specific assessments have been completed.

Figure 2

Site 7. Slope failure on Lord's Creek Reach 1



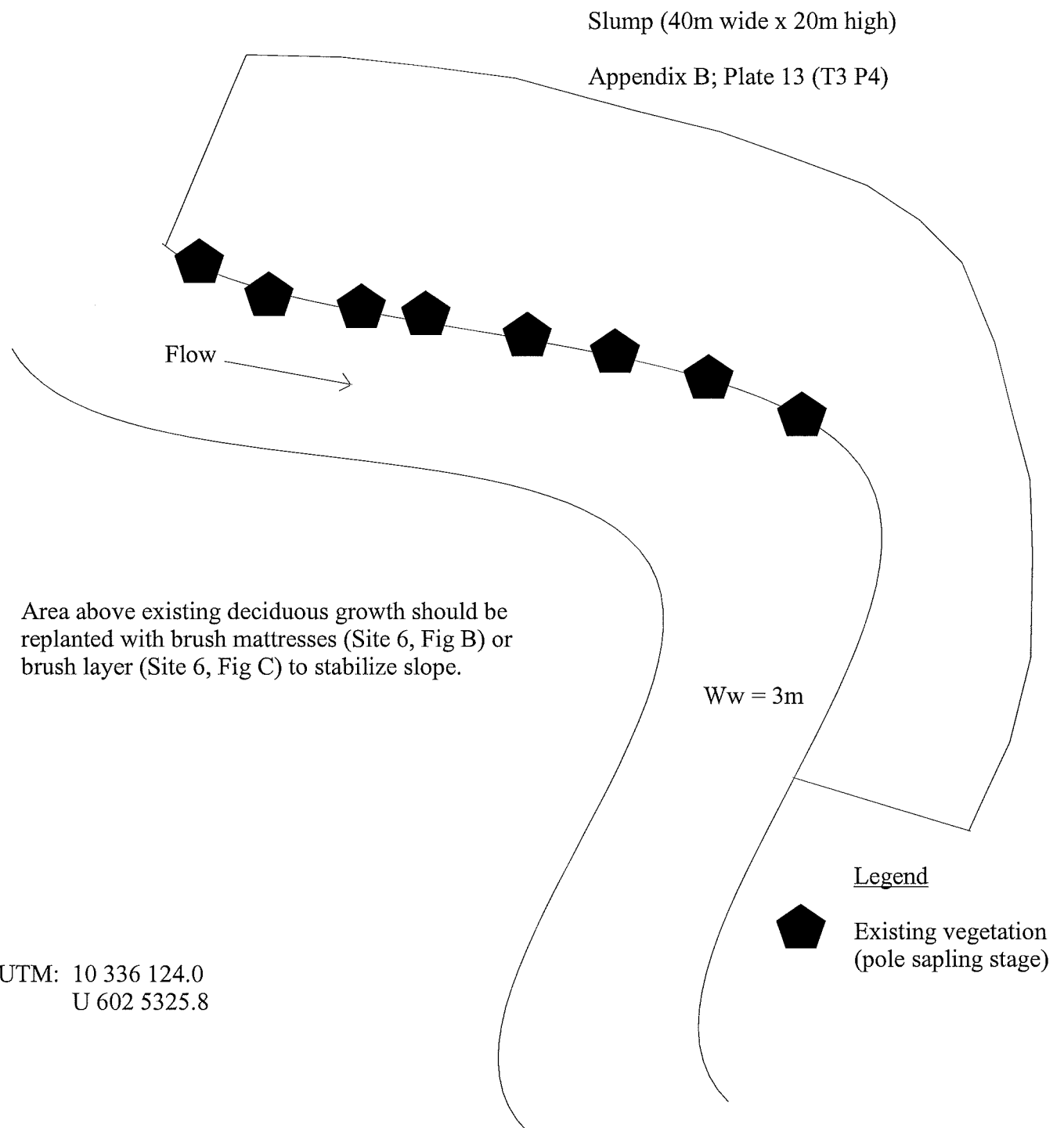
Site 7 (Slump) Cost Estimate

COST COMPONENT	HOURS, RATES AND COST	COST
Professional Fees		
1 P. Eng. or P. Geo.	1 day @ \$750/day	\$750
1 Biologist	3 days @ \$450/day	\$1350
2 Laborers	3 days @ \$300/day x 2	\$1800
Total Professional Fees		\$3900
Disbursements		
Winch rental	3 days @ \$200/week	\$86
Cable	\$300	\$300
Epoxy	\$300	\$300
Drill Rental	3 days @ \$300/week	\$129
Truck	3 days @ \$40/day	\$120
Mileage	150km/day x 3 days @ \$0.36/km	\$162
Electroshocker & nets	3 days @ \$500/week	\$214
Horse rental	3 days @ \$2000/week	\$857
Lodging	10 nights @ \$70/night	\$700
Meals	10 days @ \$40/day	\$400
Photographs	\$150 (est.)	\$150
Miscellaneous	\$200 (est.)	\$200
Total Disbursements		\$3618
ESTIMATED SITE TOTAL		\$7518

These cost estimates are based on the supplied conceptual drawings and may change once Level 2 or other site-specific assessments have been completed.

Figure 3

Site 8. Slope failure on Lord's Creek Reach 1



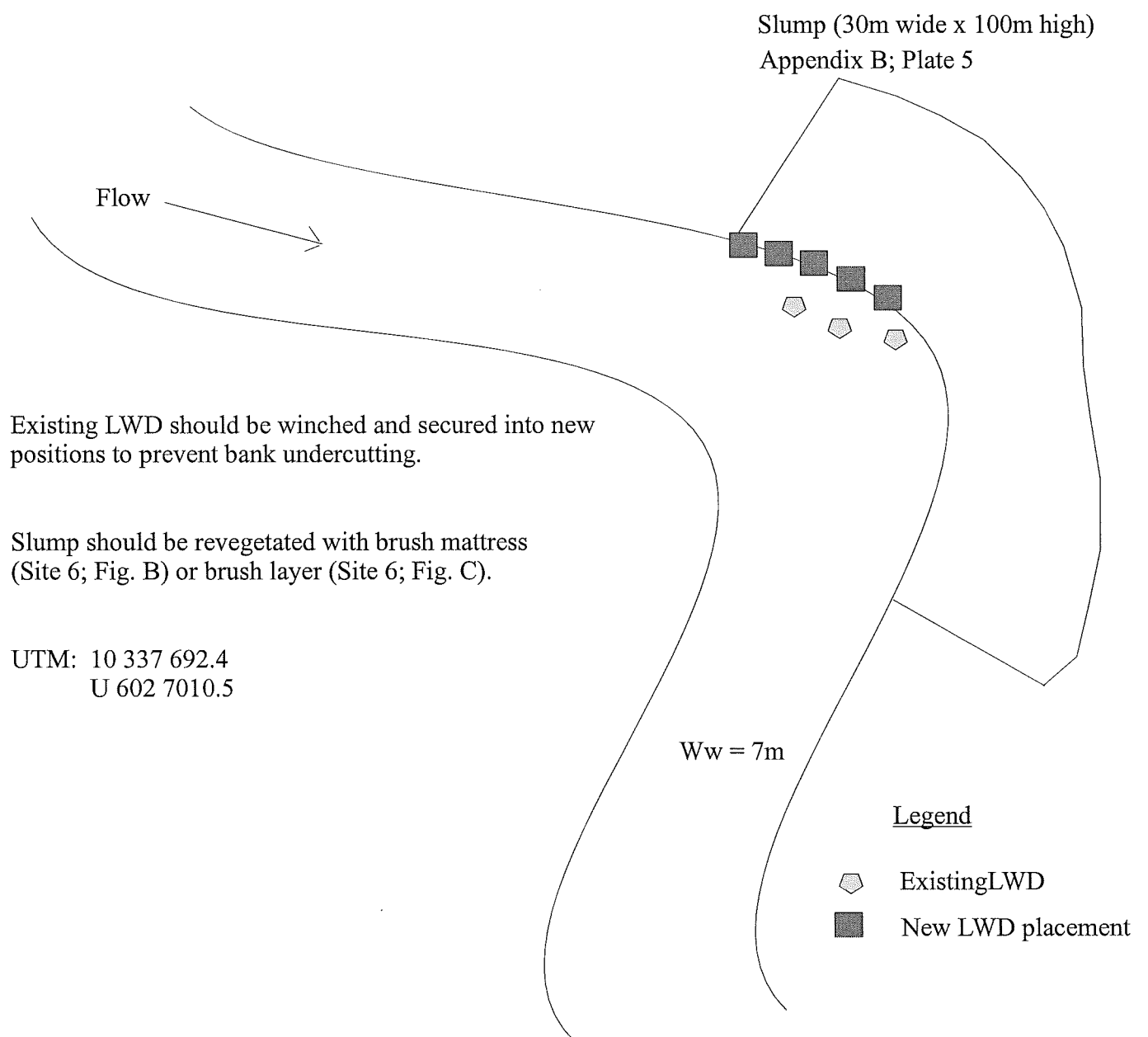
Site 8 (Slump) Cost Estimate

COST COMPONENT	HOURS, RATES AND COST	COST
Professional Fees		
1 P. Eng. or P. Geo.	1 day @ \$750/day	\$750
1 Biologist	3 days @ \$450/day	\$1350
2 Laborers	3 days @ \$300/day x 2	\$1800
Total Professional Fees		\$3900
Disbursements		
Truck	3 days @ \$40/day	\$120
Mileage	150km/day x 3 days @ \$0.36/km	\$162
Brush mattress materials or live fascines	\$1500	\$1500
Lodging	10 nights @ \$70/night	\$700
Meals	10 days @ \$40/day	\$400
Photographs	\$150 (est.)	\$150
Miscellaneous	\$200 (est.)	\$200
Total Disbursements		\$3232
ESTIMATED SITE TOTAL		\$7132

These cost estimates are based on the supplied conceptual drawings and may change once Level 2 or other site-specific assessments have been completed.

Figure 4

Site 3. Slope failure on Pinkut Creek Reach 6



Site 3 (Slump) Cost Estimate

COST COMPONENT	HOURS, RATES AND COST	COST
Professional Fees		
1 P. Eng. or P. Geo.	1 day @ \$750/day	\$750
1 Biologist	3 days @ \$450/day	\$1350
2 Laborers	3 days @ \$300/day x 2	\$1800
Total Professional Fees		\$3900
Disbursements		
Helicopter	1 hr @ \$1200/hr + fuel	\$1400
Winch rental	3 days @ \$200/week	\$86
Boulders	\$200	\$200
Cable	\$400	\$400
Epoxy	\$400	\$400
Drill Rental	3 days @ \$300/week	\$129
Truck	3 days @ \$40/day	\$120
Mileage	150km/day x 3 days @ \$0.36/km	\$162
Electroshocker & nets	3 days @ \$500/week	\$214
Horse rental	3 days @ \$2000/week	\$857
Brush mattress materials or live fascines	\$1500	\$1500
Lodging	10 nights @ \$70/night	\$700
Meals	10 days @ \$40/day	\$400
Photographs	\$150 (est.)	\$150
Miscellaneous	\$200 (est.)	\$200
Total Disbursements		\$6198
ESTIMATED SITE TOTAL		\$10818

These cost estimates are based on the supplied conceptual drawings and may change once Level 2 or other site-specific assessments have been completed.

Site 5 (LWD Removal) Cost Estimate

COST COMPONENT	HOURS, RATES AND COST	COST
Professional Fees		
1 Biologist	2 days @ \$450/day	\$900
2 Laborers	2 days @ \$300/day x 2	\$1200
Total Professional Fees		\$2100
Disbursements		
Helicopter	1 hr @ \$1200/hr + fuel	\$1400
Winch rental	2 days @ \$200/week	\$57
Cable	\$100	\$100
Truck	2 days @ \$40/day	\$80
Mileage	150km/day x 2 days @ \$0.36/km	\$108
Horse rental	2 days @ \$2000/week	\$571
Lodging	6 nights @ \$70/night	\$420
Meals	6 days @ \$40/day	\$240
Photographs	\$150 (est.)	\$150
Miscellaneous	\$200 (est.)	\$200
Total Disbursements		\$3326
ESTIMATED SITE TOTAL		\$5426

These cost estimates are based on the supplied conceptual drawings and may change once Level 2 or other site-specific assessments have been completed.

Appendix E

Fish Capture Data

Appendix D: Standard Fish Species Codes

CODE	COMMON NAMES	LATIN NAMES
Fish (General)		
AF	All Species	
SP	Species Present, not identified	
NF	No Fish	
Salmonids (Salmon, Trout, Char)		
SA	Salmon (General)	<i>Oncorhynchus</i> spp., <i>Salmo salar</i>
AO	All Salmon	<i>Oncorhynchus</i> spp., <i>Salmo salar</i>
AS	Atlantic Salmon	<i>Salmo salar</i>
GB	Brown Trout, German Brown Trout	<i>Salmo trutta</i>
AGB	Anadromous Brown Trout, Anadromous German Brown Trout	<i>Salmo trutta</i>
CM	Chum Salmon, Dog Salmon	<i>Oncorhynchus keta</i>
CH	Chinook Salmon, Spring Salmon, King Salmon, Tyee	<i>O. tshawytscha</i>
PK	Pink Salmon, Humpback Salmon	<i>O. gorbuscha</i>
CO	Coho Salmon	<i>O. kisutch</i>
SK	Sockeye Salmon	<i>O. nerka</i>
KO	Kokanee	<i>O. nerka</i>
CT	Cutthroat Trout (General)	<i>O. clarki</i> (formerly <i>Salmo clarki</i>)
ACT	Anadromous Cutthroat Trout	<i>O. clarki</i> (formerly <i>Salmo clarki</i>)
CCT	Coastal Cutthroat Trout	<i>O. clarki clarki</i> (formerly <i>Salmo clarki clarki</i>)
WCT	Westslope Cutthroat Trout (preferred) Yellowstone Cutthroat Trout	<i>O. clarki lewisi</i> (formerly <i>Salmo clarki lewisi</i>)
RB	Rainbow Trout, Kamloops Trout	<i>O. mykiss</i> (formerly <i>Salmo gairdneri</i>)
ST	Steelhead	<i>O. mykiss</i> (formerly <i>Salmo gairdneri</i>)
AC	Arctic Char	<i>Salvelinus alpinus</i>
BT	Bull Trout	<i>S. confluentus</i>
DV	Dolly Varden, Dolly Varden Char	<i>S. malma</i>
ADV	Anadromous Dolly Varden, Anadromous Dolly Varden Char	<i>S. malma</i>
EB	Brook Trout, Eastern Brook Trout	<i>S. fontinalis</i>
AEB	Anadromous Eastern Brook Trout	<i>S. fontinalis</i>
SPK	Splake	<i>Salvelinus fontinalis</i> x <i>namaycush</i>

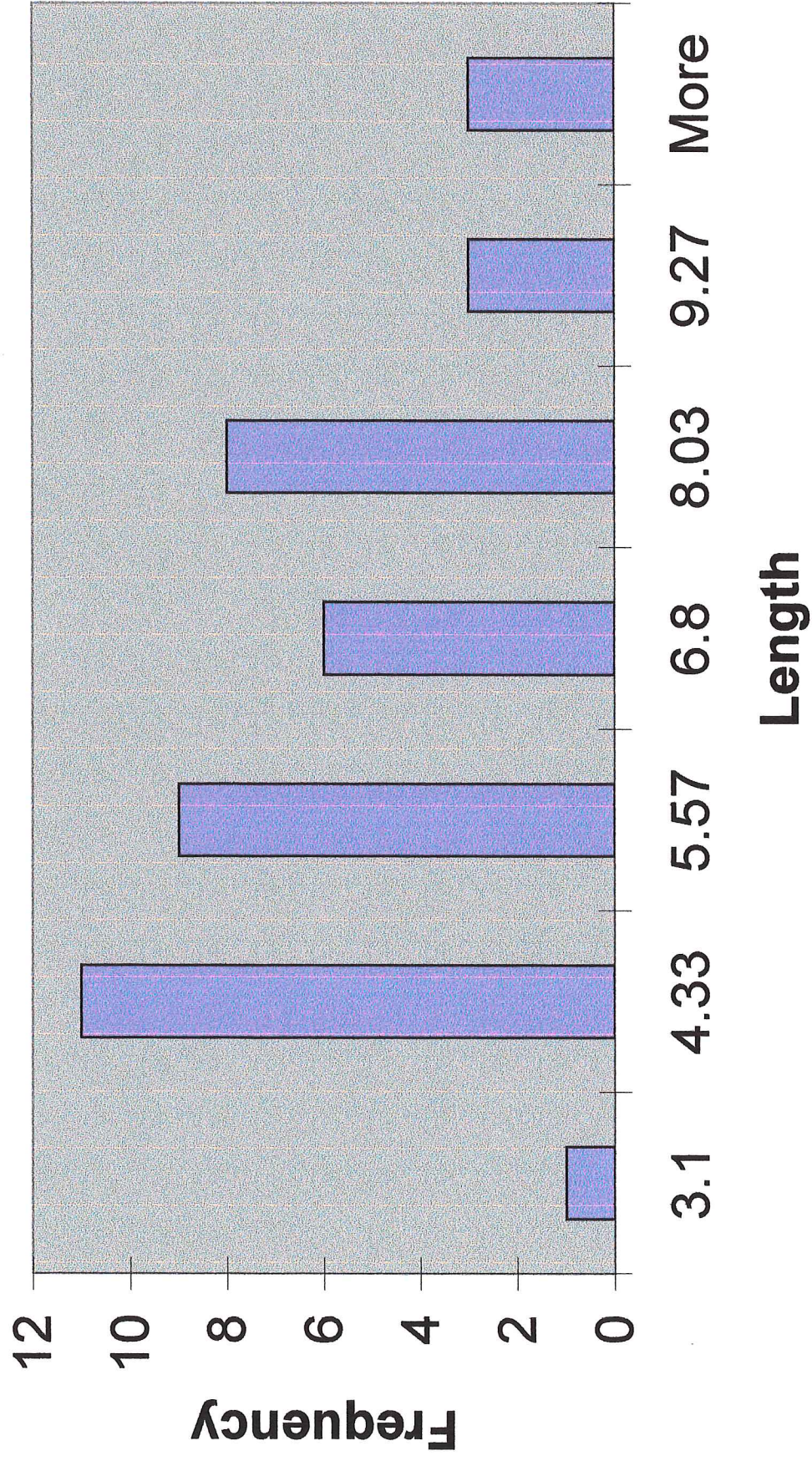
Lord's Creek Fish Capture Data

Survey Crew: TR/HLM/RH
Electroshocker Settings: 300 V, J6

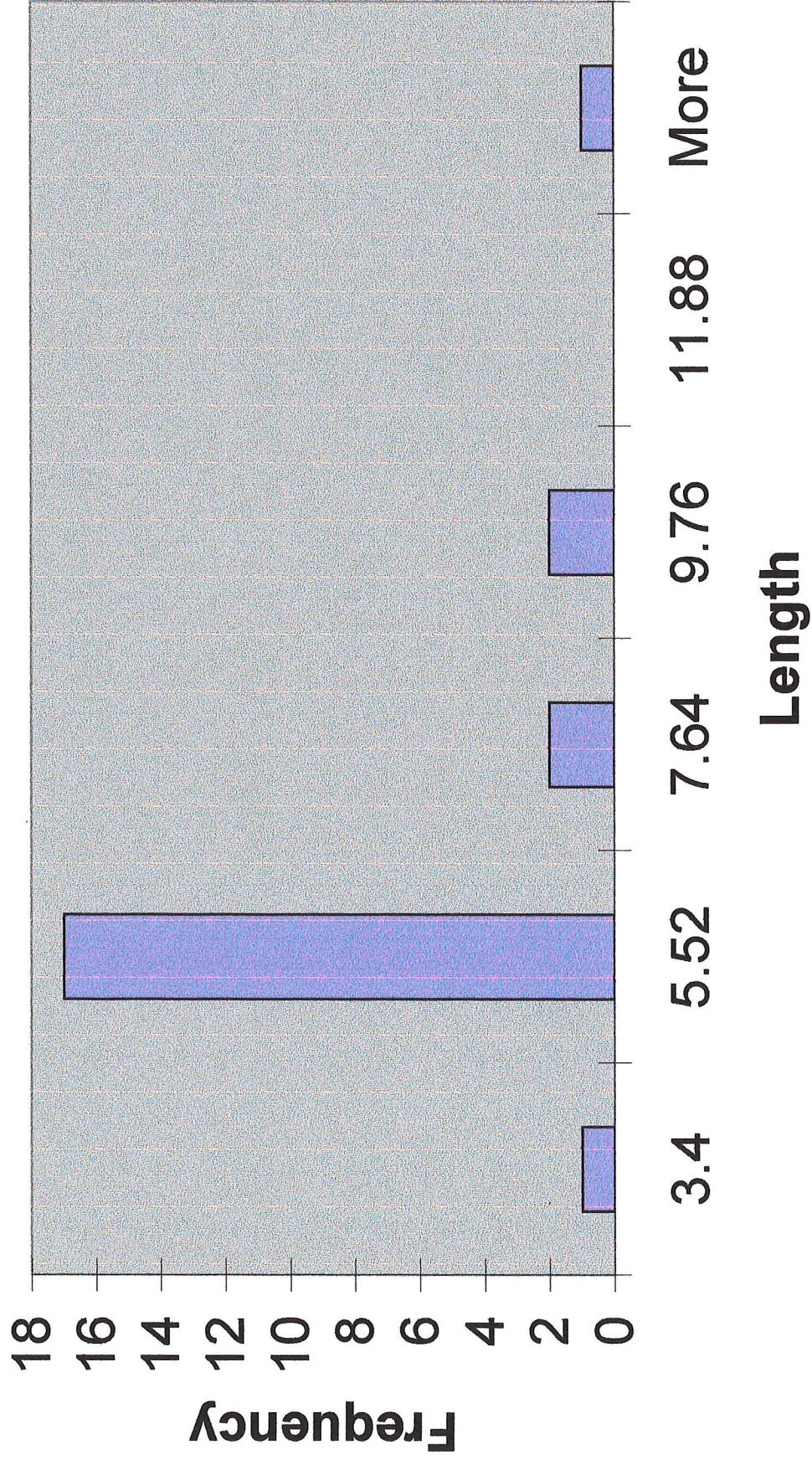
Date: 17/9/97
Weather: Rain/Overcast
Water Temp: 7°C

Habitat	Pass	Time (s)	Species	Length (cm)	Pass	Time (s)	Species	Length (cm)
Pool	1	205	RB	3.1	2	208	RB	3.4
			RB	3.8			RB	3.6
			RB	4.3			RB	4.2
			RB	4.5			RB	4.4
			RB	4.5			RB	4.7
			RB	4.6			RB	4.9
			RB	6.5			RB	6.8
			RB	7			RB	8
			RB	7.3			RB	9.7
			RB	8.5			RB	14
			RB	9.2				
			RB	9.4				
Glide	1	301	RB	3.9	2	311	RB	3.6
			RB	4.1			RB	4.1
			RB	4.2			RB	4.4
			RB	4.3			RB	4.4
			RB	4.5			RB	4.7
			RB	5.6			RB	5.4
			RB	6.3			RB	6
			RB	6.5				
			RB	7.2				
			RB	7.3				
			RB	7.5				
			RB	7.9				
			RB	8.2				
			RB	10.2				
Riffle	1	148	RB	3.2	2	151	RB	3.7
			RB	3.7			RB	4
			RB	3.8			RB	4.3
			RB	4			RB	4.4
			RB	4.3			RB	4.8
			RB	4.4			RB	4.9
			RB	4.4				
			RB	4.7				
			RB	4.8				
			RB	5.4				
			RB	6.4				
			RB	6.8				
			RB	7.1				
			RB	8				
			RB	10.5				

Lord's Pass 1



Lord's Pass 2



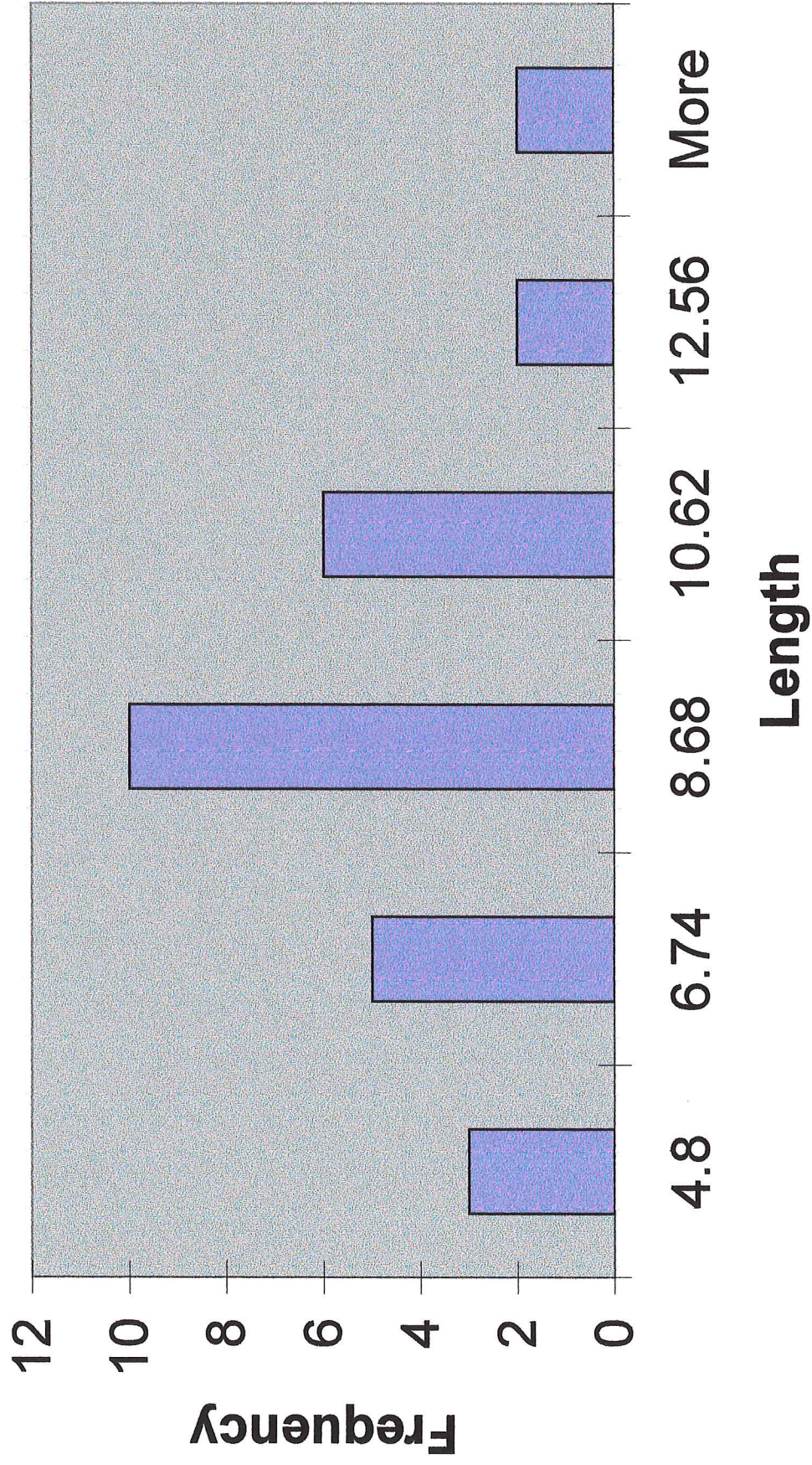
Henrietta Creek Fish Capture Data

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Electroshocker Settings: 200 V, J6

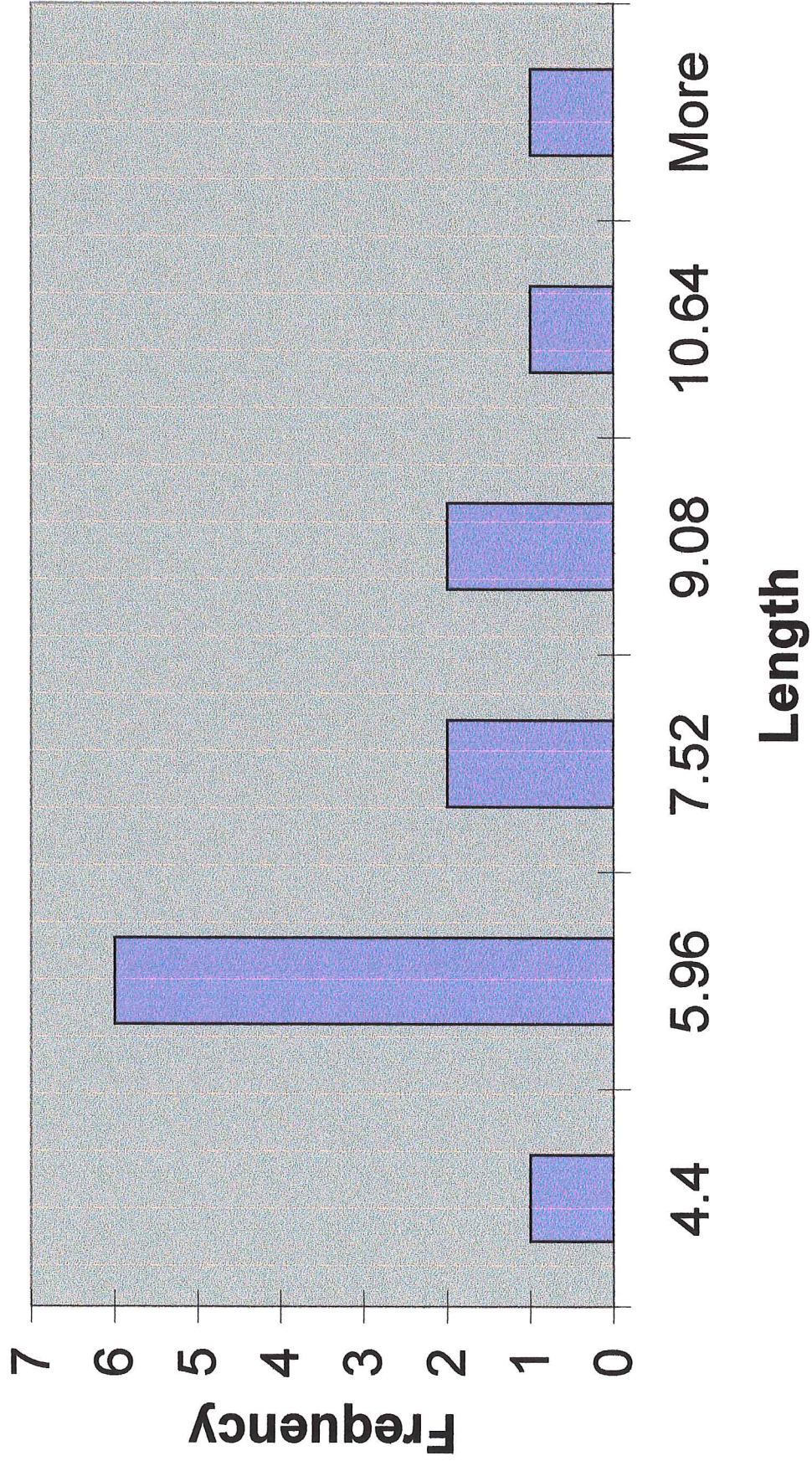
Date: 16/9/97
Weather: Overcast
Water Temp: 8°C

Habitat	Pass	Time (s)	Species	Length (cm)	Pass	Time (s)	Species	Length (cm)
Pool	1	136	RB	4.8	2	136	RB	4.4
			RB	5.1			RB	4.9
			RB	6.7			RB	5.7
			RB	7.3			RB	7.4
			RB	9.7			RB	7.9
			RB	10.4				
			RB	10.7				
			RB	12.1				
			RB	14.5				
Glide	1	231	RB	5	2	231	RB	4.6
			RB	5.8			RB	4.9
			RB	6.5			RB	8
			RB	7.2			RB	12.2
			RB	7.6				
			RB	7.7				
			RB	8.4				
			RB	8.5				
			RB	8.8				
			RB	9.2				
			RB	10.6				
Riffle	1	311	RB	4.8	2	284	RB	5.2
			RB	4.8			RB	5.6
			RB	7.2			RB	7.2
			RB	7.2			RB	9.1
			RB	8.3				
			RB	8.3				
			RB	9.5				
			RB	12.9				

Henrietta Pass 1



Henrietta Pass 2



Appendix I

Specific Details Regarding Sediment Source Survey and Level 2 Assessments

9.0 Phase 2: Conduct Overview Assessments

9.1 Interior Watershed Assessment Procedure (IWAP)

9.1.1 **Purpose of an IWAP:** If there is little information about the potential for successful resource restoration in the watershed, an IWAP is commonly necessary to identify the general nature of the cumulative impacts of forest harvest activities in the watershed.

9.1.2 All sub basin boundaries are to be approved by the MOF Regional Hydrologist or Contract Officer before any IWAP work commences.

9.1.3 **The Contractor will:**

- (a) complete a watershed assessment for each watershed according to the requirements of the Forest Practices Code of British Columbia: *Interior Watershed Assessment Procedure Guidebook (IWAP)* to determine the hazard indices for all the sub-basins (*i.e. completion of forms 1 to 11*)
- (b) Determine the Percent Equivalent Clear-cut Area (% ECA) for each sub-basin and entire watershed
- (c) interpret the results to determine the cumulative impacts of past forest development on the watershed;
- (d) document the results of the IWAP in an Appendix to the report prepared under Phase 5 of this contract.
- (e) Incorporate IWAP information into the "Existing Watershed Condition & IWAP Map" under Phase 5 of this contract.

Note: Consultation with a Stakeholders Group consisting of the project partners, MoF, MELP, and licensee(s) is required in this Watershed Assessment Procedure. This consultation process will replace the multi-agency round table identified in the IWAP Guidebook.

9.2 Sediment Source Survey (SSS)

9.2.1 **Purpose of Sediment Source Survey (Roads, Hillslopes and Gullies):**

Sediment Source Surveys of roads, hillslopes and gullies are overview examinations of the condition status of roads, hillslopes and gullies. Most Sediment Source Surveys involve a combination of aerial imagery analysis, aerial reconnaissance and field assessments to confirm the nature, locations, and severity of impacts. The Sediment Source Survey of roads, landings, hillslopes landslides and gullies is necessary to identify deficiencies and problem, and to determine sites that require prescriptions for rehabilitation or restoration works. It will also indicate areas of concern that may be dealt with through restoration projects.

The overall objectives are:

- to identify or verify the nature, extent and severity of negative impacts of past forest harvesting activities on all forest resources within the work area, and to identify the environmental, social and economic values at risk; and
- to provide sufficient information to identify and prioritize initial project scope, objectives and restoration strategies for inclusion in the Integrated Watershed Restoration Plan; and
- to identify inactive roads and active roads that are eligible for funding according to the Forest Renewal BC 1996/97 Handbook for Land-based Programs; and
- to assess the eligibility of hillslopes and gullies for funding according to the Forest Renewal BC 1996/97 Handbook for Land-based Programs; and
- to prepare accurate inventory maps of all inactive roads and active roads that are eligible for funding within the watershed, and to integrate these maps with maps of other active road networks that are not eligible for funding; and
- to determine present and future needs for access to areas of harvesting, silviculture, other forest management uses, and recreation uses within the watershed based on existing planning documents and maps. Information gathered in the Sediment Source Survey will be used to complete the WRP Access Management Map as specified; and
- to review road & landings within the work area that are eligible for funding, and to identify and inventory sites of road related mass wasting, surface erosion, and stream sedimentation hazards, and to suggest restoration options for inclusion in the Integrated Watershed Restoration Plan; and
- to identify and inventory hillslope related hazards or problem sites that are eligible for funding, to identify and prioritize those sites that require further assessment and restoration work, and to suggest restoration options for inclusion in the Integrated Watershed Restoration Plan; and
- to identify and inventory gully related hazards or problem sites, to identify and prioritize those sites that require further assessment and restoration work, and to suggest restoration options for inclusion in the Integrated Watershed Restoration Plan; and

- to confirm the priorities of the areas for future prescription work for road, hillslope and gully components, to suggest specific needs for the Prescription Phase, and to identify the need for professional (geotechnical, hydrological, and silvicultural) involvement based on the level of potential risk to environmental, social and economic values; and
- to prepare initial schedules and budget estimates for future prescription work for road, hillslope and gully components.

9.2.2 Pre-Field Work Procedures for Sediment Source Survey

The Contractor shall conduct the following:

- (a) Prior to conducting the field work, the Contractor will:
 - (i) interpret and analyze all the available information, as needed to address the approved objectives of this Sediment Source Survey, and will discuss and clarify any discrepancies or uncertainties with the Ministry Representative.
 - (ii) assemble preliminary base maps at 1:15,000 or 1:20,000 scale and aerial photographs showing the following:
 - the road inventory with the location and status (inactive or active) of all existing roads within the work area

Note: All roads that exit the watershed/project area must be examined to determine if they are dead end roads or are the only source of access into an area. If so, then that entire length of road and any connecting roads outside the watershed must be included in the project and corresponding overview assessments, access management strategies, etc.

- the location of landslide tracks, surface erosion, and gully problems, noting which are road related, harvesting related or natural occurrences
 - the boundaries of existing community watersheds, the fish stream classifications as per the Forest Practices Code, the concerns related to the environment, and areas (such as recreational sites) that could be negatively impacted by removal of current road access
- (b) It is recommended that Base Preliminary Access Management Strategy Maps be prepared prior to conducting the Sediment Source Survey. This process is defined in Section 11.1. Doing so will provide field assessors with preliminary information on road status and access requirements prior to conducting field assessments.

9.2.3 The Components be assessed are:

Road Related Components:

- forest roads
- bridge sites
- landings
- bladed logging trails and fireguards
- quarries, gravel, and borrow pits

Hillslope Related Components:

- sites of road related or cut block related slope instability/failures/landslide tracks
- harvested areas
- sites of natural slope failures identifiable by helicopter flight or air photo interpretation

Gully Components:

- significant gullies and water flow paths
- gullies with existing or high potential for instability

9.2.4 Field Work Procedures For Sediment Source Survey

For those components and areas to be assessed, the Contractor will carry out overview field inspections to confirm the nature, extent, severity, and locations of impacts, and to document the problems observed on field data sheets. To achieve these objectives, and the overall objectives of the Sediment Source Survey, the Contractor will carry out the following tasks:

- (a) verify and augment the road, landslide, and gully inventory information, and update the preliminary base maps, as necessary. Work under this section includes mapping of any and all roads not previously identified

- (b) Identify and record information on existing and potential problems from surface erosion, mass wasting and stream sedimentation, including their causes, and consider factors such as water, sediment and debris sources, and transport pathways and sediment deposition sites, and identify potential restoration strategies
- (c) overview field checks of all road networks, (Include Forest Service Roads, roads under Road Permits, roads under Special Use Permits and non-status roads.), using the guidelines for field work related to roads as given on pages 22 and 23 of Watershed Restoration Technical Circular No. 3: *Resource Road Rehabilitation Handbook: Planning and Implementation Guidelines (Interim Methods)*, July 1994, and adjust them as necessary to meet the objectives of this Sediment Source Surveys, and to meet the information needs of the Integrated Watershed Restoration Plan

It is important to note the location of all major structures (eg old bridges and deep fill wood or damaged culverts) which if removed as part of semi-permanent deactivation, will prevent 4WD access beyond that point.

- (d) overview field checks of landslides, recording information such as failure type, initiation point, delivery route, surficial materials, disturbed area, and degree of revegetation
- (e) overview field checks of gullies, recording indicators of potential water flow and debris transport (e.g., contributing drainage area, upslope instability, past debris flow activity, road gully crossings, degree of revegetation or soil exposures on gully sidewalls, channel gradient, and bed material, in-channel sediment deposits, and organic debris loads)
- (f) conduct overview risk assessments for each site or road visited on the ground, and for specific sites assessed through helicopter overflights and aerial photographs, and assign preliminary work priorities for the components to be examined based on an assessment of how quickly the problem must be addressed. Identify and list separately the problem sites on roads that are currently under tenure (i.e group the sites on Forest Service Roads, roads under Road Permits, and Roads under Special Use Permits together on a separate list, than the sites on non-status roads). Divide the watershed into road sections, or hillslope portions, or specific sites, as appropriate to graphically illustrate the information on maps.
- (g) conduct risk rating and work priority rating work for all sites according to the guidelines below (again keep the tenured road sites separate from the non-status road sites). Use other more scientific methods where warranted:
 - (i) Assess the potential risk to the environment and to social and economic values by considering the factors listed in Table 3 on page 25 of Watershed Technical Circular No. 3, and by using the risk rating classification system given in Tables 2, 3A, 3B, and 4 of the Watershed Restoration Technical Circular No. 3, Appendix E. Use the following risk rating system:
 - Very High (VH)
 - High (H)
 - Moderate (M)
 - Low (L)
 - (ii) Prioritize the implementation of restoration work by considering the factors listed in Table 3 on page 25 of Watershed Technical Circular No. 3, and based on the guidelines given in Table 4 on page 26, respectively, of Watershed Technical Circular No. 3. Use the following work sequence priority rating system:
 - High (H)
 - Medium (M)
 - Low (L)
 - No Work Necessary (N)
- (h) meet with the Contract Monitor to determine which problem sites on tenured roads are eligible for further assessment and works under WRP.
- (i) identify all eligible sites that will require prescriptions for the following components:
 - (i) inactive and active roads that require detailed assessment in accordance with the specifications for Road Deactivation/Repair Prescriptions
 - (ii) gullies which require detailed assessment and prescriptions in accordance with the Forest Practices Code of British Columbia, *Gully Assessment Procedure Guidebook*.

- (iii) hillslope sediment sources and landslide sites which require detailed assessment in accordance with the Watershed Restoration Technical Circular No. 4: *Forest Site Rehabilitation for Coastal British Columbia (Interim Methods)*, July 1994, or other technical specifications.
- (j) specify which sites will require the involvement of a professional, as necessary under the terms of this contract
- (k) record all relevant observations and interpretations in field notes, and take photographs of impacted sites as necessary
- (l) collect sufficient field information to identify and prioritize initial project scope, objectives, and restoration options for the components that require assessment
- (m) prepare initial work schedules, and cost estimates, for the eligible sites that will require prescriptions

9.2.5 Preliminary Access Management Strategies

The Contractor will propose preliminary access management strategies for all roads except those on private land, considering the existing condition and status of the roads, the potential risks to environmental, social and economic values, and the future access needs within the watershed based on existing planning documents and maps. The results obtained will be included in the Integrated Watershed Restoration Plan.

- (a) Recommended preliminary access strategies must also consider the Forest Renewal eligibility guidelines. (Note that temporary deactivation is not eligible for WRP funding). These strategies may include, but are not limited to:
 - structural repairs to high risk sections of eligible active roads to mitigate damage environmental damage where such damage is occurring, or is likely to occur
 - repairs or replacements of structures of eligible active roads in cases where it is necessary to alleviate environmental damage
 - reactivation of eligible inactive roads for access to eligible Forest Renewal BC projects
 - semi-permanent (4WD access wherever possible) road deactivation of eligible inactive roads

It is important to note the location of all major structures (eg old bridges and deep fill wood or damaged culverts) which if removed as part of semi-permanent deactivation, will prevent 4WD access beyond that point.

- permanent road deactivation (with road closure) of eligible inactive roads
- permanent road deactivation (with reforestation) of eligible inactive roads
- do nothing with the road if developing access along the road is likely to cause more damage than is prevented by repair or deactivation

- (b) The Contractor will complete Table 1: *Road Inventory and Recommended Access Strategy*. The Contractor will provide the completed Table 1 sheets as an Appendix to the report produced under Phase 5.

9.2.6 High Priority Sites

If at any time during the field assessment, there is a perceived or identified threat to areas along road corridors that contain domestic dwellings, rural or industrial development, highways, public utilities, water supplies or fisheries habitat, the Contractor will immediately notify the Ministry Representative.

Level 2 Field Assessment

Aims of the Level 2 Assessment

You will conduct level 2 field assessments where you require additional site-specific information to diagnose the nature of the habitat impairment, to identify or plan effective restoration or mitigation prescriptions, or to confirm or revise the initial statements of project scope, objectives and priorities.

The objectives of level 2 assessments are:

- *to identify appropriate restoration options and priorities, and*
- *to provide detailed site information needed to prepare rehabilitation prescriptions.*

Scope of the Level 2 Assessment

Level 2 field assessments are (usually) limited in scope to specific sites that the level 1 assessment has identified as potentially impaired and where you require additional information to identify or to plan appropriate rehabilitation activities. A level 2 assessment consists normally of detailed measurements or inspections at particular sites to provide the specific information needed to develop appropriate habitat rehabilitation plans. Any surveys that are required as part of level 2 assessments should provide precise, quantitative data to address specific uncertainties in the design of the fish habitat rehabilitation program. For example, you may need an accurate estimate of the size of a remnant fish population to assess the likely benefits of a costly habitat rehabilitation program; a basin-wide survey of fish abundance might then be appropriate. Or, for example, you may need to survey a detailed channel profile to design a groundwater-channel rearing project. Use the results of the level 2 assessment to clarify the objectives and scope of restoration activities at specific locations, and to provide necessary detailed site information.

Assessment Methods

You will usually design a level 2 assessment to provide the specific information needed to select, plan and implement a habitat rehabilitation project that a level 1 assessment has suggested. The exact nature of the assessment depends upon your information needs. Consult WRP Technical Circular No. 9, which specifies the information requirements of common rehabilitation techniques. Manuals such as Newbury and Gaboury (1993) also describe in detail the information needed to plan certain types of restoration projects.

In general, you will require more precise, site-specific information on stream

channel morphology and fish use than that provided by the level 1 assessment. Detailed plans of rehabilitation sites or analogous undisturbed reference sites will be a common requirement; refer to Newbury and Gaboury (1993) for sketch plan and plane table survey methods. Use the quantitative methods specified in the MoELP "Lake and stream inventory standards and procedures" manual to acquire any additional information. We recommend Hankin and Reeves' (1988) two-stage sampling design for quantitative estimates of fish abundance, where these are needed for restoration planning (note that other management needs for detailed fish abundance or habitat condition information should be addressed through the FRBC fisheries inventory program). Dolloff et al. (1993) give a clear description and a worked example of the method. Note that you can substitute other rapid quantitative estimation methods for the visual estimates used by Hankin and Reeves. Have your regional WRP Fisheries Specialist review and approve the methods that you propose to use in a level 2 assessment before embarking on the work.

To increase the utility of level 2 field assessments, you should review initial statements of project objectives and scope from the level 1 assessment to **direct the level 2 field assessments to high priority sites**. Ensure that those doing the assessments have the training, experience and a sufficient understanding of the project scope and objectives to accurately document and correctly interpret present conditions and to recommend suitable prescriptions for restoration.

Restoration Prescriptions

The prescriptive phase of project planning involves identifying and evaluating habitat problems, and determining a "best" course of action to address them. Use the results of the level 2 assessments to clarify the objectives and scope of restoration activities at specific locations. The recommended prescriptions must be consistent with the higher level objectives of the integrated watershed restoration plan and with regional management plans for the area. Make sure that your prescriptions conform to current standards for the activities (e.g., with Forest Practices Code regulations).

The set of proven, effective methods for fish habitat rehabilitation is limited. Typical prescriptions will entail one or more of:

- restoring fish access and spawning sites
- streambank rehabilitation
- off-channel habitat rehabilitation
- restoration of LWD
- accelerating the recovery of log jam habitat
- boulder clusters to restore rearing habitat
- deflectors and weirs to rehabilitate mainstem rearing habitat

- re-constructing channelized habitat
- inorganic nutrient additions to restore productivity, or
- minimum flow augmentation.

You should discuss novel restoration methods with district WRP staff and with appropriate regional WRP technical experts before prescribing them.

Establishing suitable restoration prescriptions involves both formal analyses and professional judgement, and is often best done on-site. Try to write clear and detailed prescriptions that can be used as technical specifications for the on-site work. Clear, detailed prescriptions also facilitate accurate budget estimates. Photographs, sketches and drawings are useful aids to formulating clear prescriptions. Try to avoid costly engineering drawings unless they are essential.

Describe the purpose of any proposed restoration and the specific concerns to be dealt with at each site. Using Technical Circular No. 9, identify effective restoration prescriptions to attain the desired site objectives. Where several corrective actions are possible, provide a rationale for the recommended prescription. Predict the likely resource benefits of the work, using published biostandards (Adams and Whyte 1990; also see WRP Technical Circular No. 9) and identify any constraints that may influence the effectiveness of the work.

Refer to Technical Circular No. 9 (Fish Habitat Rehabilitation Procedures) for appropriate formats to prepare and present restoration prescriptions. Summarize the necessary restoration work on a site-by-site basis in a concise overview table that indicates:

- the exact location of the site
- the boundaries of the work site
- the nature of the problem
- the precise objectives of the work
- the recommended prescription(s)
- the work sequence priority of the site works
- special concerns (safety, environmental protection, timing)
- labour and materials requirements
- estimated costs
- the expected benefits of the work

It is important to locate work sites accurately. If possible, use Global Positioning Systems to obtain UTM coordinates for the site. Record the distance to the site from some well defined location (e.g., along a road) and accurately indicate the site on large scale maps (e.g., 1:5,000 or 1:20,000 as appropriate). You may want to lay out the work site with flagging tape, painted marks, or boundary stakes at the same time that you develop the prescription. Having an accurate location will be important for post-

implementation monitoring when the problem that initiated the restoration work may no longer be visible to mark the site.

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