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1996 TULAMEEN RIVER WATERSHED STREAM ASSESSMENT

VOLUME 1 - FINAL REPORT

Prepared for:

MINISTRY OF ENVIRONMENT, LANDS AND PARKS
PENTICTON, B.C.

July 1997

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28 July 1997

Ministry of Environment, Lands and Parks
Suite 201 - 3547 Skaha Lake Road
Penticton, B.C.
V2A 7K2

Reference: Final Report of the 1996 Tulameen River Watershed Stream Assessment

Attention: Mr. Steve Matthews, Fisheries Biologist
Fisheries Management Program

Dear Mr. Matthews;

IRC Integrated Resource Consultants Inc. are pleased to present four copies of our final report of the 1996 Tulameen River Watershed Stream Assessment - Volume I, and Appendices - Volume II, one complete copy of the report and appendices in digital format (Microsoft Word 6.0), three copies of the helicopter video of the Tulameen River watershed, one hard copy set of 1:20,000 scale TRIM maps (16) in colour and three sets in black and white, and each of the 1:20,000 scale TRIM maps (16) in digital format (ARCINFO GIS). Please call me at your convenience if you have any questions regarding the contents of this submission.

This fulfills the requirements of our initial contract for the 1996 program in the Tulameen River watershed. We look forward to working with the Ministry of Environment, Lands and Parks again in the future.

Yours truly,

Len Fanning, R.P. Bio.
Senior Biologist, Principal

Executive Summary

IRC Integrated Resource Consultants Inc was contracted to conduct a Fish and Fish Habitat Overview Assessment of the Tulameen River and eleven tributaries. The tributaries included Arrastra, Asp, Champion, Frenchy, Granite, Jim Kelly, Olivine, Otter, Podunk, Spearing and Vuich creeks. Existing historical fish habitat information was compiled and then confirmed and augmented with information extracted from a helicopter video and field analysis. The updated information obtained in October 1996 was utilized to assess the impacts due to logging in the watersheds as well as from the flood event of 1995.

The historical fish habitat information collected in October 1996, suggests some damage to fish habitat caused by logging practices and the flood event of 1995. Barren riparian areas were observed in the headwaters of Arrastra, Champion, Frenchy and Granite creeks. Sediment transport and deposition instream due to logging disturbances and placer mining (Jim Kelly Creek) were observed. Mid-channel bars, the result of mass transport of gravel, were observed in the mainstem of the Tulameen River. Other tributary streams such as Granite Creek and Olivine Creek displayed evidence of mass transport of bedload due to upstream logging and the 1995 flood event. Excessive LWD (logjams), which were observed during the study, were probably formed during the flood event of 1995. Instream LWD becomes detrimental to watercourses when fish movement is impaired. Numerous slides, some which were natural as well as others induced by logging, were observed in the watershed.

Habitat descriptions were made at an overview level by reach. Included in the descriptions were impacts to each reach as a result of logging practices, placer mining and/or flood event. Recommendations for rehabilitation were made by reach for the entire study area.

The analysis of the historical fish information and the fish inventory which was conducted September 23 to October 10, 1996 indicated that rainbow trout, the target species, were present throughout the watershed. The few exceptions were the upper reaches of Champion Creek, Jim Kelly Creek and Olivine Creek where fish presence, upstream of possible migration barriers, has not been confirmed. Longnose dace, sculpin species and Redside shiners were also captured during the fish inventory.

Fish population and standing crop estimates were calculated from data collected in the field during 1996 for all species captured. Data for three sites in the Tulameen River were compared to historical data collected in 1983 by IEC Beak Consultants Ltd. Two of the three sites exhibited an increase in the combined population numbers and two sites exhibited a decrease in rainbow trout standing crop.

Fish ages generally ranged from 0+ year class to 4+ year class. This implies a satisfactory complement of ages throughout the watershed. The few exceptions were Site 1 of Champion Creek, Site 2 of Frenchy Creek, Site 4 of Granite Creek and Site 1 of Jim Kelly Creek where the 0+ year class appeared to be absent.

Fish presence information was mapped onto 1:20,000 scale Terrain Information Resource Maps (TRIM). Habitat attributes such as barriers (cascades, falls, logjams), logging damage (clearcuts, slides), and fish distribution were mapped onto the TRIM maps.

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1.0 INTRODUCTION

Forest Renewal B.C. (FRBC) which was introduced in 1994, is an investment strategy supported by Forest Companies' stumpage fees and royalty revenues to renew the forests resources and ultimately achieve environmental sustainability for British Columbia.

Direction for FRBC programs is derived from the goals established by the Corporation's board of directors and from the statutory responsibilities, policies and practices of the Ministry of Forests (MOF), and the Ministry of Environment, Lands and Parks (MELP). The FRBC plan encompasses five primary categories: Land and Resources, Environment, Value Added, Workforce and Communities. Under the funding category Environment is the program Watershed Restoration. The Watershed Restoration Program is a provincial initiative to restore the productive capacity of fisheries, forests and aquatic resources that have been adversely impacted by forest harvest practices (Johnson and Slaney 1996). Part of the Watershed Restoration Program is the Fish Habitat Assessment Procedure (FHAP). FHAP includes an Overview Fish Habitat Procedure, a Level 1 Field Assessment and a Level 2 Field Assessment. IRC Integrated Resource Consultants Inc. (IRC) were contracted on 26 August 1996 by the Ministry of Environment, Lands and Parks, Penticton, to conduct an Overview Fish Habitat Assessment of the Tulameen River and eleven tributaries. The FHAP Overview includes an assessment of habitat conditions resulting from an extreme flood event that occurred in November, 1995. In addition to the FHAP Overview, are comparisons of present habitat conditions and fish populations to that of 1983 when IEC Beak Consultants Ltd. conducted a fish and fish habitat assessment survey in the Tulameen River.

The watercourses included in the FHAP Overview are the Tulameen River and Asp, Arrastra, Champion, Frenchy, Granite, Jim Kelly, Olivine, Otter, Podunk, Spearing and Vuich creeks. Tolko Industries Ltd., Weyerhauser Canada Forest Company Ltd., and Ardew Forest Company Ltd., are involved in past and present harvesting in the surrounding area. As well as forest harvesting, placer mining practices have degraded portions of several streams in the watershed: Jim Kelly Creek, Olivine Creek and Tulameen River.

1.1 Project Objective

The primary purpose of the Overview Assessment was to compile existing and easily obtained historical information supplemented with limited field checking to identify factors that limit fish production and/or water quality in the watershed. Using the Overview assessment as background information, field assessments and preliminary restoration/rehabilitation plans can be focussed on areas where substantial benefits to the fishery resource and water quality are likely.

The primary objectives of the Overview Fish Habitat Assessment Procedure were:

- to determine trends in habitat quality in the watershed.
- to determine trends in target fish species distribution and abundance in the watershed.
- to determine what life stages of target fish are at risk to the impacts of forest harvesting practices in the watershed.
- to determine if water quality is at risk to the impacts of forest harvesting practices in the watershed.
- to identify areas of fish habitat and water quality concern that need to be examined in quantitative field surveys.
- to identify preliminary restoration strategies (no action, restoration, rehabilitation, mitigation), and
- where appropriate, to identify preliminary project objectives, scope and priorities.

The scope of work, as described in the Service Contract between MELP, Penticton and IRC, outlines the sequence of events to be followed:

Phase 1: Assemble existing information.

Phase 2: Establish stream reaches.

Phase 3: Analyze existing information to:
- identify target fish species;
- summarize trends in fish abundance (if known) for the target species;
- map salmonid distributions (if known) by life stages;
- identify critical or heavily used reaches if known.

Phase 4: From existing information and/or aerial photographs, where possible:
- determine habitat conditions at an overview level;
- evaluate habitat conditions or sensitivity.

Phase 5: Where necessary, supplement existing information by aerial photography to update and complete results of Phases 3 and 4.

Phase 6: Where necessary, supplement existing information by field checking to update and complete results of Phases 3 and 4.

Phase 7: Identify areas of special concern such as fish barriers, unstable channels, lack of riparian cover, etc.

Phase 8: Present findings in a report which includes recommendations on preliminary fish habitat rehabilitation strategies.

The following are the required deliverables for the completion of the project:

- 1:50,000 scale NTS series topographic maps showing watershed boundaries and any subareas such as drainage sub-basins.

- 1:20,000 scale TRIM maps in digital format (ARCINFO GIS) and four hard copies of the same showing graphically, using standard RIC symbols, the detailed results including:
  - reach boundaries;
  - reach numbers;
  - fish distribution by species;
  - barriers (by type) to fish passage;
  - major habitat impacts;
  - significant channel disturbances;
  - priorities for detailed field assessments and preparation of restoration prescriptions;
  - reaches covered by aerial video taping;
  - location of all field inspection sites.

- Four (4) copies of the final report are required, including one (1) unbound master suitable for copying. The report is to include:
  - a full description of methodologies used;
  - trends in fish abundance and distribution for each species as well as habitat quality within the watershed;
  - copies of forms 1, 2 and 3;
  - a brief text summary for each reach, identifying fisheries values, probable habitat impacts (including fish barrier descriptions for locations as per map) and preliminary restoration strategies;
  - recommendations as to future field assessments.

- All reach data compiled on a reach-specific basis (i.e. Forms 1, 2 and 3) shall be presented in a Microsoft Excel 5.0 spreadsheet and submitted on a MS-DOS readable 3.5 inch disk.

- All raw data, field notes and photographs should be included.

1.2 Project Area / Background

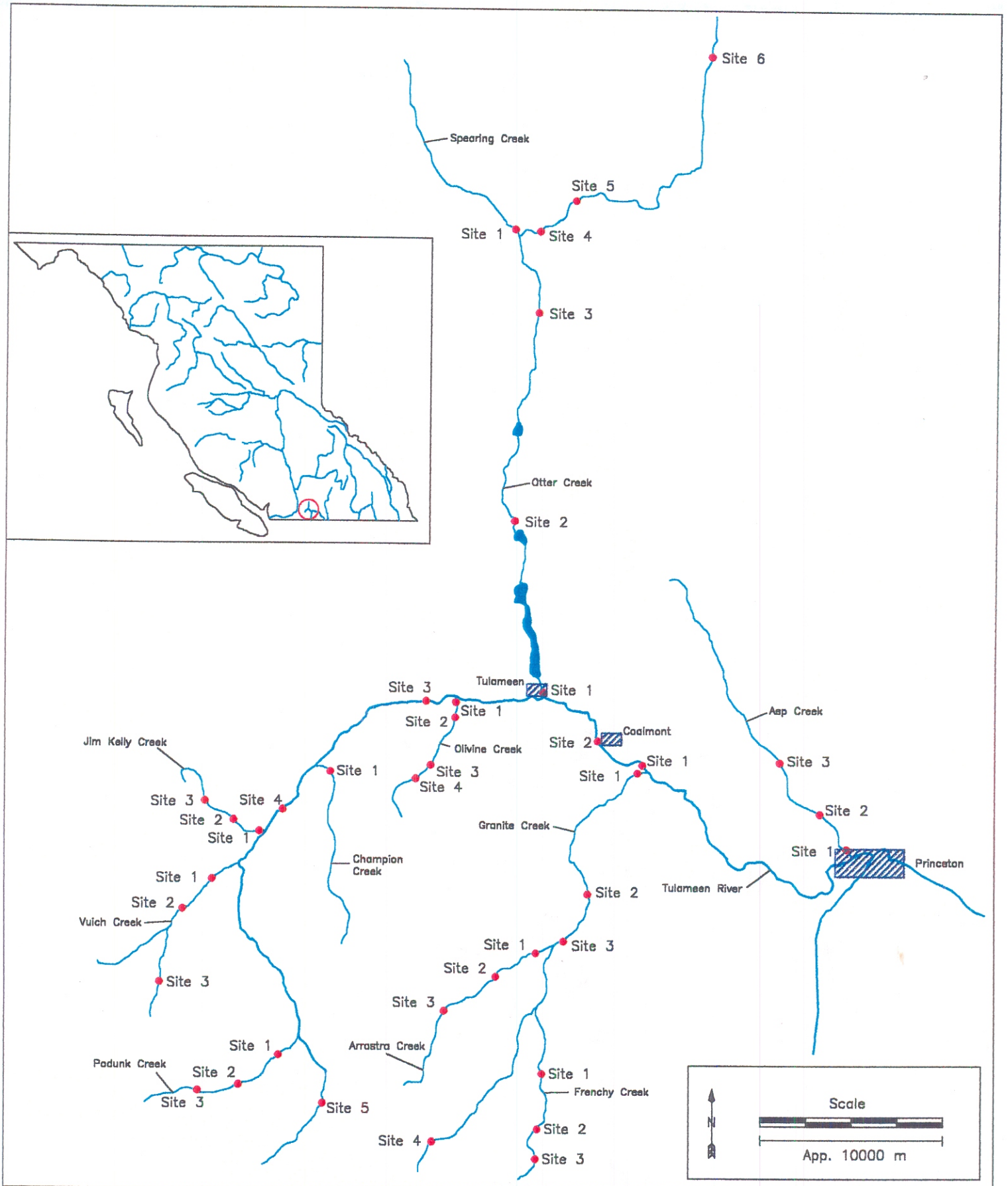
The project area is located in southwest British Columbia in the B.C. Environment Region of Penticton and the Merritt Forest District. Geographically, it lies between Hope and Princeton, north of Manning Park and south of Merritt. The Tulameen River passes through Tulameen and Coalmont before flowing into the Similkameen River at Princeton. The Tulameen River flows in a northeasterly direction from its headwaters atop Snass Mountain to the confluence of Otter Creek where it bends to the southeast and flows to its confluence with Similkameen River. The tributaries included in this report are introduced to Tulameen River in the following sequence commencing from the headwaters to the mouth. Podunk Creek flows east into the headwaters of Tulameen

River and Vuich Creek flows northeast into the river just below Tulameen falls. Jim Kelly Creek flows southeast into the river. Champion Creek and Olivine Creek flow north to their confluences with the river. Otter Creek, into which flows Spearing Creek, flows south and enters Tulameen River in the community of Tulameen. Granite Creek into which flow Frenchy and Arrastra creeks, enters Tulameen River near the community of Coalmont. Asp Creek, which is known locally as China Creek, flows into Tulameen River at Princeton.

Settlement began in Vermillion Forks in 1858, when gold and copper was discovered in the Similkameen River. In 1898, Vermillion Forks became Prince Town, and in 1909 the Great Northern Railway arrived. During World War II, ranching, sawmilling and mining were the main industries in the area. Twenty-one kilometres upstream of Princeton on the Tulameen River lies Coalmont, located east of Tulameen near the confluence of Granite Creek. The Coalmont Hotel, which was the central attraction in Coalmont, was built in 1909 to house the VIP guests of the neighbouring Blakeburn Mine. Established in the early 1900's, the Blakeburn Mine operated until 1940. Gold was discovered in Granite Creek in 1884 and by 1885, Granite City, located west of Coalmont, had a population in excess of 2,000. Granite City which had more than 200 buildings at its prime. Presently Granite City is a ghost town with only a few remaining buildings. Tulameen, formerly known as Otter Flat, was named after the native indian tribe which had previously resided in the Otter Lake area. Tulameen, or 'Red Earth', refers to the red ochre found in the Tulameen River and its tributaries. The town built a sawmill to supply lumber to the growing gold towns in the area and the Kettle Valley Railway laid a spur line to Coalmont in 1812.

Presently, the population of Princeton, which was 2,796 in 1991, was estimated at 3,036 for 1996 (Minister of Finance, 1996). The estimated population of the unincorporated community of Coalmont resulting from the 1991 census was 83 (Minister of Finance, 1996), and Tulameen, also an unincorporated community, has an estimated population of 164 (Statistics Canada, 1991). Princeton, Coalmont and Tulameen are supported by tourism, agriculture, mining and the forest industry. The area offers to the tourism industry ghost towns, abandoned mines and a wealth of recreational opportunities which include fishing, hunting, gold panning, camping, hiking, snowmobiling and downhill skiing. Agriculture exists throughout the area from the Nicola Valley Ranch in the Otter Creek valley to the Tulameen River crown lands which are grazed by cattle during the summer months. The two primary copper mines in the area are Newmont Mines (Similkameen Division 1970 - 1988) and Cassiar Mines Ltd. (Similco Mines) which is currently operating. As well, a number of private placer mine claims exist in the Tulameen River Watershed. The three forest companies operating within the Tulameen River Watershed are Tolko Industries Ltd., Weyerhauser Canada Forest Company Ltd., and Ardew Forest Company Ltd.

According to Canadian Climate Normals, an Environment Canada publication, the Princeton area has an annual precipitation of 343 millimetres. Annual rainfall totals 218.3 millimetres, the majority of which occurs between June and August. Snowfall, which totals 150.4 centimetres annually, begins in November and may continue through until March. Average snowfall for the months of December and January are 45.1



IRC Integrated Resource Consultants Inc.	**Figure #1: Tulameen River Watershed Study Area and Location of Sampling Sites**	**Project: 1996 Tulameen River Watershed Stream Assessment**
	Client: Ministry of Environment, Lands and Parks, Penticton	**Date: July 1997**

centimetres and 46.0 centimetres, respectively. The average summer temperature is 25°C and an average winter temperature is -11°C (Chamber of Commerce, 1996).

In November of 1995, an extreme flood event resulted in tremendous damage impacting Tulameen, Coalmont and Princeton. Bridges and roads were washed out, houses were damaged and property was lost. The highest flow previously recorded in the Tulameen River at a Water Survey of Canada gauging station in Princeton was 374 cubic metres per second in 1972. The flow recorded for the flood event in November of 1995 was 392 cubic metres per second.

2.0 METHODS

2.1 Information Collection

Historical information regarding fish abundance and habitat conditions in the Tulameen River and eleven selected tributaries was collected by conducting interviews with knowledgable personnel associated with the regional Ministry of Environment, Lands and Parks and Ministry of Forests offices, forest companies with an interest in the area and local residents. The Department of Fisheries and Oceans and the Ministry of Environment, Lands and Parks Fish Information Summary System (FISS) data sheets and maps were reviewed and the limited number of previous reports on the Tulameen River were reviewed. The B.C. Conservation Data Center in Victoria was contacted to identify the presence of known red- or blue-listed species in the Tulameen River watershed and surrounding areas. Historical aerial photographs from 1983 and the most recent aerial photographs from 1996 were obtained so that more detailed habitat information could be included in this report.

Colour air photographs at a scale of 15,000 for 1996 were obtained from the Ministry of Forests, Merritt, B.C. A Sokkia stereoscope model MS16, was used to extract detailed information of the study area. Appendix A contains list of the aerial photographs.

A helicopter video reconnaissance of the Tulameen River and the eleven tributaries, approximately six hours in length, was taped on 1 November 1996 by E. Stoof, Eclipse Helicopters Limited, Penticton, B.C. The Tulameen River was taped from its confluence with the Similkameen River at Princeton to its headwaters. The tributaries, which were also taped from their confluences to their headwaters, were videotaped in the following order: Podunk, Vuich, Champion, Jim Kelly, Olivine, Granite, Arrastra, Frenchy, Asp, Otter and Spearing creek. The video recorder, which was anchored to the underside of the helicopter and controlled from the cockpit apparently suffered from minor malfunctioning as the video images displayed evidence of vibration and were unclear. At the cost of some audio damage, the vibrating image was stabilized electronically while dubbing.

2.2 Stream Reach Determination

The Tulameen River and the eleven tributaries were broken into consecutive reaches of relatively homogenous sections of repeating characteristics (or processes) and fish habitat types as described by the Forest Service of British Columbia and British Columbia Ministry of Environment (1995). Key physical factors used to determine reaches were channel pattern, channel confinement, gradient, and streambed and bank materials as well as discharge uniformity. Generally, a repetitive pattern of structural features (e.g. pool-riffle sequences) exist within reaches (B.C. Forest Service 1995). The reach breaks were initially mapped onto 1:20,000 Terrain Resource Information Management (TRIM) maps and subsequently transposed to 1:50,000 topographic maps prior to field evaluation. Subsections of reaches were initially determined using the historical air photos and topographic maps. When the most recent aerial photographs (1996) became available,

necessary adjustments were made. Information from the helicopter video of the river and tributaries identified reaches that were previously divided into subsections inaccurately, or needed to be divided further. Reach and Section breaks were then mapped onto electronic TRIM maps obtained from Maps B.C.

2.3 Survey Site Determination

Sample site locations were determined mainly by the likelihood of fish presence, suitable fish habitat and road access. The Tulameen River and the eleven tributaries were sampled, whenever possible, at three typical sites: lower (near confluence), middle (at approximately 1/2 stream length) and upper (within headwaters). When access was impossible to one of these sites, an alternate site was chosen (ie. on an equivalent tributary). A total of six sites were sampled on Otter Creek as it is more than twice the length of each of the other tributaries and likewise Tulameen River was sampled at five sites. The sample locations and methods outlined in the 1983 Similkameen River Habitat Inventory for Enloe Dam Passage by IEC Beak, were considered to allow for a direct comparison of data between that study and the 1997 Fish Habitat Assessment Procedure (FHAP) Overview Assessment for Tulameen River.

2.4 F.H.A.P. Overview Assessment Forms

2.4.1 Form 1: Fish Distribution Summary Form

Form 1 was initially filled out using existing fish abundance information. Once the field component of this project had been completed, the data in Form 1 for each stream was updated. Where fish were present at adjacent sample sites and barriers to migration between these sites did not exist, fish presence was recorded as 'suspected' as outlined in Watershed Circular No. 9: Fish Habitat Assessment Procedures, by N.T. Johnston and P.A. Slaney (1996).

The Overview Fish Distribution Forms (Form 1) summarize the following fish information:

- Reach Number
- Section Number
- Data Source
  - Stream Inventory Summary System (SISS)
  - Fisheries Information Summary System (FISS)
  - Aquatic Biophysical Maps (ABM)
  - BC Fisheries Branch reports or studies (MELP)
  - Forest Licensee (FOR)
  - Local Knowledge (LKNOW)

- Survey Methods
  - angling (AG)
  - creel census (CR)
  - dip netting (DP)
  - electrofishing (EL)
  - fish traps or fence (FT)
  - gillnetting (GN)
  - minnow traps (MT)
  - seines (SN)
  - swimming / snorkel count (SW)
  - unknown (UN)
  - visual observation (VI)

- Fish Presence
  - not present (N)
  - presence known (K)
  - suspected presence (S)
  - historically present (H)
  - unknown (U)

2.4.2 Form 2a: Habitat Condition Summary Form

Form 2a, which was completed with existing information, information extracted from recent aerial photographs (1996), a helicopter video (1996) and field assessments (1996) represents present habitat conditions in the watershed. The Overview Habitat Condition Summary Forms (Form 2a) summarize the following information:

- Reach Number

- Section Number

- Reach or Section Length (m)
  - The reach and reach section lengths were measured using a map wheel. The average distance as determined by lengths measured in both upstream and downstream directions were recorded.

- Elevation and Channel Gradient (%)
  - Using 1:20,000 hardcopy TRIM maps, the change in elevation over the section was divided by the section length and multiplied by 100%. Where reach or section breaks did not correspond to contour lines, the lower adjacent contour at the upstream end the higher adjacent contour line at the downstream end were used with the intention of biasing the gradient estimate downward.

- Mean Bankfull Channel Width (W_b) in metres
  - The bankfull width is described as the distance between banks defined by the topographic break from a vertical bank to a flat flood plain and/or by a change from no rooted vegetation to rooted perennial vegetation. The bankfull width was estimated using the 1996 aerial photographs.

- Channel Type
  - The following channel types and their associated channel codes were used to assess the generalized overall morphology of the stream channel.
    - Block-step-pool (SPr)
    - Boulder-step-pool (SPb)
    - Debris-boulder-step-pool (SPbw)
    - Riffle-pool (RPcw)
    - Riffle-bar-pool (RPgw)
    - Pond, small lake or marsh (L)
    - Unknown (U)

- Disturbance Indicators
  - The following are indicators of recent channel disturbances and their associated codes that may lower salmonid habitat values.
    - Extensive areas of scour (SC)
    - Extensive areas of unvegetated bar (DW)
    - Large, extensive sediment wedges (WG)
    - Elevated mid-channel bars (MB)
    - Extensive riffle zones (LR)
    - Limited pool frequency and extent (FP)
    - Multiple channels/braiding (MC)
    - Eroding banks (EB)
    - Isolated side channels or back channels (BC)
    - Most LWD parallel to banks (PD)
    - Recently formed LWD jams (JM)

- Potential Barriers
  - The following are potential partial or complete barriers to fish migration
    - culverts (CV)
    - bridges (BR)
    - landslides of banks sloughing (LS). Eroding banks or slides that produce large fans
    - logjams (X). Defined as substantial accumulations of logs that completely cover stream channel
    - beaver dams (BD)
    - falls (F). Vertical drops of greater than 1.0 metre for rainbow trout

- cascades or chutes (C). Appear as white water in steep channels
- gradient barriers (G). Gradients greater than about 20% are often barriers to fish movement. Gradient barriers often encompass velocity barriers
- no barriers (N)
- unknown (U)

- Percent Pools
  - The percentage of pool habitat per reach or section was estimate to the nearest quartile as outlined by the following:
    - 0 = no pools in the reach/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. canopy cover)

- Large Woody Debris (LWD) Amount and Distribution
  - LWD, which refers to logs within the bankfull channel width, were quantified as follows:
    - N = no LWD
    - F = few LWD pieces (generally fewer than 1 piece per W_b of stream length)
    - A = abundant LWD
    - U = unknown
  - The distribution of LWD throughout the reach or section was categorized as follows:
    - C = clumped
    - E = evenly distributed along the channel

- Riparian Vegetation Type
  - Using aerial photographs and forest cover maps, the dominant vegetation type surrounding the reach or section was determined and recorded according to the following categories:
    - Unvegetated, bare soil is visible (N)
    - Non-forested grassland or bog (G)
    - Shrub/herb, herbaceous or shrubby vegetation dominate (S)
    - Conifer-dominated riparian forest (C)
    - Deciduous-dominated riparian forest (D)
    - Mixed conifer-deciduous riparian forest (>25% conifer and deciduous)

IRC

- Riparian Structural Stage
  - The structural stage of the dominant vegetation in the riparian area was measured as follows:
    - Non-vegetated or initial stage following disturbance, with less than 5% cover (INIT)
    - Shrub/herb stage with less than 10% tree cover (SHR)
    - Pole-sapling stage, with trees over topping the shrub layer, usually less than 15 - 20 years old (PS)
    - Young forest. Self thinning is evident and the forest canopy is differentiating into distinct layers. Stand age is 30 - 80 years old (YF)
    - Mature forest with a well developed understorey (MF)

- Canopy Closure (shading)
  - The proportion of the surface area of the stream was estimated using the following criteria as outlined by Johnston and Slaney (1996):
    - 1 = stream surface and banks visible (0-20% shading)
    - 2 = stream banks and surface visible at times (20-40% shading)
    - 3 = Stream surface visible but banks are not visible (40-70% shading)
    - 4 = stream surface slightly visible or visible in patches (70-90% shading)
    - 5 = stream surface not visible (100% shading)

- Off-channel Fish Habitat
  - Extent and accessability of off-channel habitat was estimated using aerial photographs. Low energy areas such as oxbows, pools, side-channels, back channels, etc. were recorded as:
    - Unknown (U)
    - Poor; no off-channel habitat or no access for fish (P)
    - Fair; little off-channel habitat or poor access for fish (F)
    - Moderate; off-channel habitat with access for fish (M)
    - Good; abundant off-channel habitat with access for fish (G)

2.4.3 Form 2b: Habitat Condition Summary Form (Historical)

Form 2b, which was completed with existing information and information extracted from historical aerial photographs (1979), represents historical conditions as well as pre-harvest conditions for many areas. The areas not included in the 1979 air photo collection, mainly headwaters of most of the tributaries, were assessed using aerial photographs from 1966. Photographs from 1979 were obtained from the Province of British Columbia, Ministry of Environment, Victoria, B.C. and photographs from 1966 were assessed while on loan from the Geography Department, University of British Columbia, Vancouver, B.C. The Overview Habitat Condition Summary Form (Historical) (Form 2b) summarizes the information as outlined for Form 2a.

2.4.4 Form 3: Preliminary Habitat Assessment Form

Form 3, the Preliminary Habitat Evaluation Form, was completed with existing information, information extracted from the most recent aerial photographs available (1996), from a video recorded by helicopter during November 1996 and information collected during the field assessment. Subjective assessments were made using information summarized on Forms 1 and 2. The preliminary assessment was based largely on qualitative comparisons and indicators of habitat disturbance by reach or section.

The habitat quality in conjunction with the adverse impacts to habitat features and the risk of further impacts were analyzed to determine the most suitable restoration strategy. Strategies include:

- restoration: Return to a former condition, in the context of this report, it includes rehabilitation
- rehabilitation: Returning to a state of health and useful activity, not necessarily returning to the original condition
- mitigation: activities undertaken to compensate for the impairment of natural resources where restoration or rehabilitation is not feasible
- no action

In addition to the aforementioned strategies, suggestions as to which type of rehabilitation was recommended for a specific reach or section as follows:

- Planting riparian vegetation
- Fish inventory
- Level 1 Field Assessment (or in some cases, an evaluation using the helicopter video tape and limited field assessment)
- Bank stabilization (recommended to follow Level 1 Field Assessment)
- LWD manipulation (recommended to follow Level 1 Field Assessment)
- Instream complexing (recommended to follow Level 1 Field Assessment)
- Armouring vulnerable banks (recommended to follow Level 1 Field Assessment)
- Water quality

2.5 Stream Classification by Reach

Each Reach was classified according to the Fish-stream Identification Guidebook using measurements obtained from the overview assessment. The Forest Practices Code recognizes two broad categories of streams, fish bearing and non-fish bearing, based on the occurrence of certain fish species. Rainbow trout, the target fish species for the Fish Habitat Overview Assessment, is one of the fish utilized to classify a fish bearing stream.

Fish streams (classes S1 to S4) are those streams or specific reaches of streams that:

- are known to contain at any time of the year, rainbow trout (or any other species identified in the Fish-stream Identification Guidebook); or if this information is unknown.

- are <20% average gradient, and flow directly into
  - a fish bearing stream containing the species listed in the section on fish species (Fish-stream Identification Guidebook)
  - the Pacific Ocean
  - a lake known to support fish.

Fish streams are further classified S1 to S4 based on stream width (bankfull width). Bankfull width measurements were extracted from the FHAP Habitat Condition Summary Form (Form 2a in Appendix C - 1). Class S1 streams are greater than 20 metres wide, S2 streams are greater than 5 metres and less than or equal to 20 metres wide, S3 streams are greater than 1.5 metres and less than or equal to 5 metres wide and S4 streams are less than 1.5 metres wide.

Non-fish bearing streams (classes S5 and S6) are those streams or specific reaches of streams that:

- are <20% average gradient but are proven to contain no fish within the categories listed in the section on fish species at any time of the year (Fish-stream Identification Guidebook)
- are > or = to 20% average gradient (with limited exceptions as outlined in the Fish-stream Identification Guidebook.

Non-fish bearing streams are classified S5 or S6. Class S5 streams are greater than 3 metres wide and S6 streams are less than 3 metres wide.

2.6 Field Survey

2.6.1 Fish Inventory

A fish inventory, which extended from 17 September to 10 October, and for Spearing Creek, November 6, 1996, was conducted in conjunction with the habitat survey at each site. Depending on the size of the watercourse, either a 25, 50 or 100 metre beach seine net was stretched across the wetted width at 0 metres (downstream) and 100 metres (upstream) to prevent the escape of fish specimens or to collect any shocked fish as recommended in the Fish-stream Identification Guidebook, (1995 DFO, MOF). The upper net was not used at 100 metres when a natural barrier, such as a chute or falls, was present. The lead line of the net was anchored with cobble or boulders and the float line was propped out of the water with forked poles (Photograph No. 3). Two complete passes with a 24 volt Smith-Root backpack electroshocker model were made of each site. Fishing efficiency, a value defining the number of fish captured relative to the actual number of fish located in the same area, was estimated at 1.0 for all sites (a value of 0.5 indicates that for every one fish captured, two fish would actually be present in that area). Rainbow trout were anesthetized with NS-222, weighed with an Ohaus portable electronic scale, model number S200-02U (+/- 0.001 gram) and measured with a standard ruler (+/- 0.001 metres). Trout too large for the portable scale were weighed with an Ohaus Triple Beam balance, model number 750-S0, 700 series. Scales were removed from rainbow trout for the purpose of aging. Scales were not generally removed from juvenile trout (class: 0+). Length and weight measurements for species

other than rainbow trout were recorded and uncommon specimens were photographed.

2.6.2 Habitat Assessment

The field assessment extended from 17 September to 10 October and included 6 November 1997. The timing coincided with the late summer - fall low flow period. The habitat assessment, which was conducted at each site began by detailed measurements of habitat characteristics for 100 metres of stream in 10 metre intervals. A cross section of habitat was described every 10 metres from 0 metres (downstream) to 100 metres (upstream) for a total of 11 cross-sections at each site. Data collected from each cross-section was analogous to that of the DFO/MOE Stream Summary Forms.

Bankfull and wetted widths were measured with a hand held 100 metre tape (+/- 0.01 metres) and bankfull depth was measured with a metre stick (+/- 0.1 metres). Wetted depth was measured at approximately 1/4, 1/2 and 3/4 of the total wetted width with a standard ruler (+/- 0.01 metres). Pool depths were measured with a metre stick when they were too deep for the ruler. Percent canopy and riparian cover was estimated for the 10 metre interval below the cross section. Percent cover referred to the estimated percent of wetted width that would be covered by foliage during the summer months. The predominant canopy and riparian species were recorded for the 10 metre segments associated with each cross section. Large woody debris (LWD) within the bankfull width was quantified in the 10 metres downstream of each cross section. Percent cover of LWD referred to the percent of wetted width covered by the LWD associated with each cross section. LWD present but outside the bankfull width were noted. The percent composition of substrate type within the bankfull width was estimated for the 10 metres downstream of each cross section. Substrate type was determined visually using the following estimates extracted from FRBC Fish-stream Identification Guidebook (1995):

- br = bedrock
- bd = boulder, >256 mm
- cb = cobble, 64 - 256 mm
- gr = gravel, 2 - 64 mm
- sd = sand, 0.0625 - 2 mm
- fn = fines (silt, clay), <0.0625 mm

Bank descriptions are associated with the 10 metres downstream of each cross-section for which they were recorded. Banks were designated right or left while facing downstream. Biological and physical characteristics such as riparian vegetation, mammal evidence, banks, flood plain and side channels were described.

Habitat types within each 100 metre site were described. Percent gradient (slope) of each site was measured with a Suunto clinometer (PM-5/360 PC). Where vegetation was too dense or the stream meandered so as to prevent the gradient from being measured in one reading, a number of readings were taken.

Photographs of each site, including examples of signs of degradation, habitat types, and sample sites were taken at the time of the habitat assessment and fish inventory.

2.6.3 Water Quality

Water temperature was measured at mid-depth for each sample site using a hand held thermometer. Due to the late timing of the sample period and extreme weather conditions, water samples for total dissolved solids and Nitrate-nitrogen were not collected in the 1996 season. Mean discharge measurements for Tulameen River, Otter Creek and Asp Creek were obtained from Environment Canada, Water Survey of Canada Database. Data was obtained from five stations: Tulameen River at Princeton (station number 08NL024), Tulameen River below Vuich Creek (station number 08NL071), Otter Creek at Tulameen (station number 08NL023), Otter Creek below Spearing Creek (station number 08NL060) and Asp Creek near Princeton (08NL015).

2.7 Preliminary Analysis

Fish density (No. of individuals/area) was calculated for all species in each of the sample sites using species population numbers and average area (m^2). The average area was calculated from measurements recorded during the habitat assessment.

2.7.1 Target Fish Aging

The distribution of rainbow trout life stages throughout the various watersheds was determined after the scales were analyzed for age. Scales removed from the rainbow trout during the fish inventory were processed and aged by D. Shanner and G. Martens of Summerland, B.C.

2.7.2 Condition Factor

The condition factor, which measures the plumpness or condition of fish, was calculated from length and weight measurements as follows:

$$CF = (W \times 100) / L^b$$

where:
- CF = Condition Factor
- W = Weight in Grams
- L = Centimetres
- 100 = A constant placing the CF value closer to unity
- b = 3, used to define isometric growth

(Ricker, 1975; Klak, 1941).

2.8 Habitat Quality Index

A Habitat Quality Index (HQI), developed by the Wyoming Game and Fish Department was utilized to evaluate habitat conditions in 1996 and in 1983 in a similar manner as described by IEC Beak Consultants Ltd. (IEC) so that comparisons could be made. The modifications made by IEC to the original HQI methodology were duplicated by IRC in 1996. The HQI method interprets the actual measurements of nine parameters or attributes as to their suitability, collectively, to support trout populations (IEC Beak,

1984). Table 1 outlines the criterion used for rating the attributes. Criterion ratings ranged from the least optimal condition to support trout (0) to the optimal condition to support trout (4). Criterion were inserted into the following formula to calculate the HQI score:

$$\text{HQI score} = \text{antilog}_{10}(\log_{10}(y+1)) - 1$$

$$\log_{10}(y+1) = (-0.903)+(0.807)\log_{10}(x_1+1) + (0.877)\log_{10}(x_2+1) + (1.233)\log_{10}(x_3+1) + (0.631)\log_{10}(F+1) + (0.182)\log_{10}(S+1)$$

where:

y = Predicted trout standing crop (lbs./acre) (multiply by 1.12085 for kg/ha)
x_1 = Late summer stream flow as calculated in 1983 (CPF)
x_2 = Annual stream flow variation (ASFV)
x_3 = Maximum summer stream temperature as determined in 1983.
x_4 = Nitrate-Nitrogen as determined in 1983.
F = Food Index $(x_3)(x_4)(x_9)(x_{10})$
S = Shelter Index $(x_7)(x_8)(x_{11})$
x_7 = Cover
x_8 = Eroding steam banks
x_9 = Substrate
x_{10} = Water velocity as determined in 1983.
x_{11} = Stream width

2.9 Standing Crop estimates and Fish Population

Estimates for standing crop (kg/ha) were determined using two methodologies. The first included the total weight (kg) of fish species per site recorded in the field divided by the area (ha). The second method included data collected in the field during the habitat survey. This method involved calculating a Habitat Quality Index in trout habitat units, which is equivalent to kilograms per hectare. Areas for these reaches which were calculated by IEC Beak were used in the comparison of estimated values between 1983 and 1996 (available only for the Tulameen River).

Population estimates (No.) were determined for the three reaches on the Tulameen River with duplicated sample sites. Densities (No./m^2) of fish species in each sample site were applied to the entire IEC reach area (m^2) to determine population numbers. Table 5 summarizes the relationship between the three IRC reaches and IEC Beak reaches where the sample sites were located.

2.10 Mapping

Information collected and compiled onto Forms 1, 2 and 3 was mapped onto 1:50,000 NTS maps and 1:20,000 TRIM electronic maps. Information standards were consistent with those recommended by the federal-provincial Resources Inventory Committee (RIC). Included were the following symbols used for Stream Inventory Summary System (SISS) and Fish Information Summary System (FISS) mapping.

- Reach breaks and reach section breaks;
- Reach numbers;
- Fish stream classification by reach;
- Fish distribution by reach;
- Barriers and potential barriers by type;
- Major habitat impacts;
- Significant channel disturbances;
- Priorities for detailed field assessments and preparation of restoration prescriptions;
- Reaches covered by aerial photography;
- Location of field inspection sites.

3.0 RESULTS AND CONCLUSIONS

3.1 Target Fish Species

Rainbow Trout (*Oncorhynchus mykiss*) was identified as the target species for the Fish and Fish Habitat Overview Assessment of the Tulameen River Watershed. Rainbow trout support the local angling interests and are, therefore, of great economical and recreational importance. The Rainbow trout, whose qualities as a sport fish make it a very valuable species (McPhail 1970), is one of the top five sport fishes in North America and the most important, west of the Rocky Mountains (Scott and Crossman 1973).

As with all salmonid fishes, resident rainbow trout in the Tulameen River watershed have population characteristics that are sensitive to alterations in habitat conditions whether they are due to logging practices or to natural events. Trout are particularly sensitive to environmental changes. Increased erosion and sedimentation and removal of stream side vegetation can be devastating to trout populations (Hunter 1991). In the Tulameen River watershed, rainbow trout populations have likely been detrimentally affected by logging practices and placer mining and in 1995 by an extreme flood event.

Rainbow Trout can be identified by small irregular black spots on the back and on most fins, radiating black spots on caudal the fin and a pink stripe on its side (Page and Burr 1991). Rainbow trout colour is variable. There are no striking external differences between sexes, but spawning males have a more vivid red lateral band than females, and often a more pointed or hooked snout (McPhail and Lindsay 1970). Their native range was the eastern Pacific Ocean and the fresh water, mainly west of the Rocky Mountains, from Northwest Mexico to the Kuskokwim River in Alaska (Scott and Crossman 1973). Presently, rainbow trout can be found throughout Canada and the United States. This species has been introduced into New Zealand, Australia and Tasmania, South America, Africa, Japan, southern Asia, Europe, and Hawaii (Scott and Crossman 1973). In British Columbia their range includes all but the northeastern region of the province. Rainbow trout which are coastal and spend at least some of their life history in saltwater are known as Steelhead trout.

Rainbow trout prefer pool-riffle habitat types with gravel bottoms in shallow rivers with moderate flow. They can be found in cold headwaters of small to large rivers (Page and Burr 1991). The temperature which rainbow trout prefer is 21 ^{o}C.

Rainbow trout feed on plankton, insects and their larvae, snails, leeches and sometimes other fishes and fish eggs (Scott and Crossman 1979). Adults feed mainly on aquatic insect larvae. Rainbow trout, which are opportunists and take advantage of drifting prey, rely primarily on bottom foraging (Waters 1969).

Adult rainbow trout, usually 3-4 years of age, may spawn as early as March when the water temperature rises, until August. Spawning intensity is highest between April and June (Scott and Crossman 1973). Rainbow trout prefer to spawn in a temperature range of 10-15 ^{o}C. Spawning occurs on small gravel (2-8 cm), preferably in riffles upstream

of pools in their resident streams. Spawning may also occur at inlets and outlets of lakes. A female may dig several redds and spawn up to 1,000 eggs in each. The total number of eggs from one female may be as high as 12,000.

Eggs are 3-5 mm in diameter, demersal and pink to orange in colour (Scott and Crossman 1979). Alevins will hatch after four to seven weeks and begin feeding approximately two weeks later. The yolk sac, which supplies the alevin with nutrients, will be absorbed in three to seven days after it hatches.

Rainbow trout are territorial and juveniles are fiercely territorial. Generally, where food is abundant, territories are smaller, however as the trout grow, their territory grows. Smaller weaker trout are usually displaced downstream where they establish their own territory. Therefore, in a population of trout, the larger individuals will habituate upstream and the smaller individuals downstream (Hunter 1991).

3.2 Fish Distributions and Trends

The Tulameen River, whose headwaters and numerous tributaries have been subjected to logging, maintains populations of resident fluvial and adfluvial rainbow trout. Rainbow trout presence has been confirmed throughout the majority of tributaries to the Tulameen River. Information from the following sources provided the basis for fish distribution throughout the Tulameen River and tributaries for the FHAP - Overview.

Between 10 August and 10 October 1983, IEC Beak Consultants Limited conducted a biophysical survey which included the determination of rainbow trout population densities and standing crop assessments at sites in the Tulameen and Similkameen rivers as part of a larger project which evaluated the effects of anadromous fish passage at Enloe Dam on resident fish populations. A General Fish Inventory of Streams in the South Okanagan and Similkameen Watersheds, compiled by Ron Johnson in 1994, included a fish survey of Granite Creek, Otter Creek, Champion Creek and the Tulameen River. Tributaries to the Similkameen River Fish Inventory and Habitat Evaluations, a report completed in 1995 by Aquatic Resources Limited, supplied presence/absence data for Asp, Granite, Jim Kelly, Otter and Vuich creeks and the Tulameen River. Updated information pertaining to the implied presence of rainbow trout in Otter Creek and Podunk Creek was extracted from the Fish Inventory Summary System (FISS) Maps, further referenced to High Value Fish Stream maps, Region 8, Ministry of Environment, Lands and Parks, Penticton. The following creeks were not previously assessed in terms of fish populations and distributions: Arrastra Creek, Frenchy Creek and Olivine Creek. The remaining information resulted from the IRC study and the associated helicopter video. Fish distribution for each stream is summarized in Form 1: Fish Distribution Summary Form in Volume 2, Appendix A.

Fish observed in the Tulameen River Watershed were rainbow trout (Target species), Brook trout (*Salvelinus fontinalis*), Lake trout (*Salvelinus namaycush*), Kokanee (*Onchorhynchus nerka*), Mountain whitefish (*Prosopium williamsoni*), Longnose dace (*Rhinichthys cataractae*), Umatilla dace (*R. umatilla*), Prickly sculpin (*Cottus asper*), Torrent sculpin (*C. rhotheus*), Mottled sculpin (*C. bairdi*), Slimy sculpin (*C. cognatus*),

Northern squawfish (*Ptychocheilus oregonensis*), Peamouth chub (*Mylocheilus caurinus*), Redside shiner (*Richardsonius balteatus*), Largescale sucker (*Catostomus macrocheilus*), Bridgelip sucker (*C. columbianus*) and Mountain sucker (*C. platyrhynchus*). See Section 3.4, Rare and Endangered Species for more information regarding the current status of the Mottled sculpin, Mountain sucker and Umatilla dace.

3.2.1 Tulameen River

The Tulameen River supports a variety of fish species. The lower reaches, Reaches 1-6, support populations of rainbow trout, Longnose dace, Prickly sculpin, Torrent sculpin, Mottled sculpin and Slimy sculpin, as do the mid-reaches, Reaches 7-12. The upper reaches, Reaches 13-24, support only rainbow trout. Cascades in Reach 11 and/or lower upstream temperatures are the limiting factors for Longnose dace and sculpins.

Although they prefer the shallow riffle habitat of smaller creeks with moderate flow, rainbow trout are present in small numbers in the lower reaches of the Tulameen River where the flow is far greater and more turbulent than desired. As well, competition for food with other species is greatest in the lower reaches. The mid-reaches appear to support larger populations of rainbow trout than the lower reaches as habitat available is more suitable for rainbow trout and the level of habitat complexity is slightly higher. Reach 11 provides only a few areas of suitable habitat in the form of pools associated with cascades and, although the pools likely support rainbow trout, migration upstream through this reach is improbable. Populations of rainbow trout in the upper reaches,(the only species present), appeared larger than the mid and lower reaches. The upper reaches provide habitat with the greatest complexity, as pools and riparian vegetation are generally more abundant.

Reasoning for the above is as follows. In 1983, IEC Beak observed five rainbow trout in a site in Reach 4. In 1994, one rainbow trout was captured in Reach 4 by R. Johnson. In 1983, IEC Beak electrofished one rainbow trout in Reach 6. A total of five rainbow trout were observed in Reach 7-A in 1996 by IRC. The Department of Fisheries and Oceans/Ministry of Environment, Lands and Parks Stream Inventory Summary System (S.I.S.S.) reported that Reaches 7 and 8 of the Tulameen River were stocked in 1984 with juvenile rainbow trout from the Summerland Trout Hatchery; each outplant was of 36,000 fish. No confirmation could be made of the release. In 1995, Aquatic Resources Limited observed 22 rainbow trout in Reach 9. At similar sites in Reach 10, IEC Beak (1983) observed six rainbow trout and IRC (1996) observed 42 rainbow trout. Two sites in Reach 11 were electroshocked by IEC Beak in 1983, 12 and 10 rainbow trout were observed in the downstream and upstream sites respectively. In Reach 14, IEC Beak (1983) observed 33 rainbow trout and R. Johnson (1994) observed five rainbow trout. IRC, in 1996, observed a total of 63 rainbow trout in Reach 14 at the same site sampled by IEC Beak in 1983. In 1996, IRC electrofished a total of 73 rainbow trout Reach 20.

Information collected depicts Longnose dace presence from the mouth of the river upstream to and including Reach 10. Bridgelip sucker is present in Reach 4, Sections A and B and Mountain sucker is present in Reach 8.

Mountain whitefish, although present during previous surveys, were not observed by IRC in 1996. In 1983, IEC Beak observed Mountain whitefish in Reach 4 in pool habitat during a snorkel count. Mountain whitefish migrate to large pools for overwintering so their absence is probably related to the sampling method (electroshocking) rather than their actual absence in the river.

Several sculpin species are present from the mouth of the river upstream to and including Section B of Reach 11. The species present include the Torrent sculpin, Mottled sculpin and Slimy sculpin. Presence of the Prickly sculpin is presumed from the river mouth to the confluence of Otter Creek as their presence in both Similkameen River and Otter Creek has been confirmed. Population density and standing crop estimates for sculpin species observed by IRC in 1996 are compared to those calculated by IEC Beak in 1983. Section 3.3.3 discusses sculpin population estimates for specific sample sites in greater detail.

3.2.2 Tributaries

Fish presence and distribution data for Arrastra Creek was compiled for the first time by IRC in 1996. IRC observed 45 rainbow trout in Reach 1-A, 72 rainbow trout in Reach 1-B and 80 rainbow trout in Reach 3. Although abundant LWD is present in the creek, potential barriers were not apparent, and therefore, rainbow trout presence is suspected throughout the entire length. Presence of species other than rainbow trout is not expected in Arrastra Creek.

Aquatic Resources Limited electrofished 165 rainbow trout from Reach 1 of Asp Creek in 1995. IRC captured 194 rainbow trout in 1996 in Reach 1. IRC captured 141 rainbow trout in Reach 3-A and 72 rainbow trout in Reach 4. Due to the absence of barriers, rainbow trout presence throughout the system is suspected.

In 1994, R. Johnson electrofished a site in Reach 3 of Champion Creek and found no fish. In 1996, IRC electrofished two sites in Reach 3 and also found no fish. Reach 3, which appears to offer some suitable rainbow trout habitat, is located upstream of a spectacular chute which is a migration barrier at 424 metres from the confluence with Tulameen River. Evidence of rainbow trout presence above the chute does not exist. rainbow trout presence below the chute was confirmed in 1996 when IRC electroshocked 22 rainbow trout in Reach 1.

Although data pertaining to fish presence in Frenchy Creek prior to 1996 does not exist, it appears that historical fish presence throughout the creek is likely. In 1996, IRC captured rainbow trout in Reaches 3, 4 and 5. A definite migration barrier in the form of a recently established logjam exists in Reach 1 and a two metre falls, a probable barrier, exists in Reach 2. These barriers imply the presence of a population of rainbow trout upstream which is isolated from rainbow trout attempting to migrate from the lower reaches. In Reach 3-B, a total of 81 rainbow trout were electroshocked; in Reach 4-B, a total of 47 rainbow trout were captured and in Reach 5, a total of 76 rainbow trout were captured by IRC in 1996. One Brook trout was also observed in Reach 3 (Photograph 59). This individual was the only one of its species to be observed IRC in

the Tulameen River Watershed.

Rainbow trout are present throughout Granite Creek although there may presently be isolated populations where migration was possible prior to the November 1995 flood. Potential migration barriers presently exist in the form of cascades in Reaches 2-B, 3, 4 and 7. Logjams, which occur intermittently from Reach 4 to Reach 9 were likely constructed in 1995 during the flood. The majority of logjams are only partial barriers and fish passage during all flows has not yet been assessed. However, a logjam exists on Granite Creek at the confluence of Newton Creek that renders fish passage impossible. Hundreds of logs are trapped behind three enormous boulders, approximately 4 metres in diameter. See Photograph 149.

In 1994, R. Johnson captured four rainbow trout in Reach 1 and in 1995, Aquatic Resources Limited captured 45 rainbow trout in a site in Reach 1, 300 metres upstream from the confluence of Granite Creek with the Tulameen River. In 1996, IRC electrofished 35 rainbow trout in a site in Reach 1 upstream from a bridge near Coalmont. In 1994, R. Johnson captured eight rainbow trout in Reach 4, and in 1996, IRC electrofished from a site in Reach 5-A and 5-B, a total of 37 and 47 rainbow trout, respectively. A total of 14 rainbow trout were electrofished from Reach 11 in 1996 by IRC.

Longnose dace, Torrent sculpin, Slimy sculpin and Mottled sculpin are present in Granite Creek in Reach 1. None of these species have been observed upstream of Reach 1. Cascades that exist within Reach 2-B are most likely the upper limit for dace and sculpin distributions in Granite Creek.

Historically, Jim Kelly Creek reportedly supported rainbow trout to a headwaters lake atop Jim Kelly Mountain. In 1995, Aquatic Resources Limited captured 44 rainbow trout in Reach 1 and in 1996, IRC electrofished a total of 54 rainbow trout in Reach 2-A. A total of 15 rainbow trout were captured upstream of a series of falls and cascades in Reach 2-B, however IRC did not observe rainbow trout in Site 3 which is in Reach 2-B. Rainbow trout are present upstream of the cascades.

Data on fish presence in Olivine Creek was obtained for the first time in 1996. IRC electrofished four sites in Olivine Creek, two below an impassable falls yielding rainbow trout and two above the falls which yielded no fish. A total of 45 rainbow trout were electroshocked in Reach 1-A, and in Reach 1-B, 56 rainbow trout were captured. This implies rainbow trout presence from the creek mouth to the falls. There is no evidence of rainbow trout presence above the falls.

Where rainbow trout presence is unknown in Otter Creek, it is suspected. Rainbow trout have been observed upstream and downstream of the few existing migration barriers which are in the form of intermittent flows. Otter Lake and Frembd Lake likely support resident populations of rainbow trout.

In 1996, IRC electrofished 100 metres of Reach 1 in Otter Creek and did not capture rainbow trout. Otter Lake is accessible via migration 1000 metres upstream through

Reach 1 from Tulameen River, however due to unsuitable habitat conditions such as little cover and warm temperatures, this reach does not likely support a population of rainbow trout for any significant period of time. In 1994, R. Johnson captured one rainbow trout in Reach 5, and in 1995, within the same reach, Aquatic Resources Limited electrofished 20 rainbow trout and an additional four while angling. In 1996, a total of 32 rainbow trout were electrofished in Reach 5 by IRC. Reach 5 appears successful in supporting a population of rainbow trout.

In 1996, IRC electrofished a site in Reach 10 of Otter Creek which yielded a total of 37 rainbow trout. In 1995, Aquatic Resources captured 11 rainbow trout in a site in Reach 11. In 1996, IRC electrofished two sites in Reach 11. The downstream site yielded 40 rainbow trout and the upstream site yielded 41 rainbow trout. A total of 54 rainbow trout were electrofished by IRC in 1996 in Reach 16 of Otter Creek.

In 1996, IRC captured Torrent sculpin in Reach 1 of Otter Creek. A dam at the outlet of Otter Lake has apparently terminated migration of the Torrent sculpin into Otter Lake and therefore upstream into upper Otter Creek. The Mottled sculpin, however are present throughout the creek. In 1996, IRC captured Mottled sculpin in Reaches 5-C, 10-B and 11-B. They had been observed previously in Reaches 3-B, 5-B, 5-C and 10-C. Due to the absence of permanent barriers, Mottled sculpin presence is suspected throughout. Prickly sculpin have been captured in Reaches 1, 2, 3-B, 5-C and 9-A. Due to the absence of permanent barriers, Prickly sculpin presence is suspected throughout. Slimy sculpin have been observed in Reaches 3-B, 9-B and 11-B. Due to the absence of permanent barriers, Slimy sculpin presence is suspected throughout. Longnose dace presence is suspected throughout the system. Presence has been confirmed in Reaches 1, 3-B, 5-C and 11-B. The Umatilla dace population in Reach 1 was last observed in 1983. Subsequent visits have yielded no specimens (CDC, 1996). Largescale sucker have been observed in Reaches 2, 3-B and 9-A. Presence throughout is suspected.

Fish species present in Otter Lake include rainbow trout, Lake trout, Kokanee, Mountain whitefish, Longnose dace, Prickly sculpin, Northern squawfish, Peamouth chub, Redside shiner and Largescale sucker. Slimy sculpin and Mottled sculpin presence is suspected in Otter Lake.

Rainbow trout presence throughout Podunk Creek was implied by High Value Fish Stream Maps, Ministry of Environment, Lands and Parks, Penticton, B.C. Unfortunately, catch information and dates were not associated with this information. The MOELP/DFO Fish Inventory Summary System (FISS) implied the presence of rainbow trout in Reaches 1, 2 and 3. In 1996, IRC confirmed the presence of rainbow trout in Reaches 2, 3 and 4 of Podunk Creek. A total of 85, 46 and 55 rainbow trout were captured in Reaches 2, 3 and 4 respectively. Reach 6 and Reach 8 present possible gradient barriers, above which the presence of rainbow trout remains unknown.

In November 1996, IRC electrofished Reach 1 of Spearing Creek. One pass yielded 1 rainbow trout. The creek provides what appears to be suitable habitat for rainbow trout although Reach 1 experiences intermittent flows. Rainbow trout presence upstream of Reach 1 is unknown. No other fish species were observed in Spearing Creek, however

the proximity to Otter Creek and the habitat characteristics imply the possible presence of similar species in the marsh areas upstream of Reach 1.

In 1995, Aquatic Resources Limited electrofished 60 rainbow trout from Reach 1 of Vuich Creek. The site was located below a spectacular 10 metre falls which is a migration barrier. In 1996, IRC electrofished 2 sites on Vuich Creek, the first in Reach 3 and the second in Reach 4, both of which were upstream of the falls. A third site was sampled in a tributary equivalent to Reach 6 where a total of 37 rainbow trout were captured. Rainbow trout are present throughout Vuich Creek upstream of the falls. Presumably rainbow trout which migrate from the Tulameen River are present below the falls.

3.3 Fish Abundance and Growth Measurements

The fish inventory, which extended from 23 September to 10 October 1996 was conducted by IRC at the same time as the habitat survey. Spearing Creek which was dry during this period was sampled 6 November 1996 when it was observed to be flowing. The sample site locations are described in Table 2. A total of 42 sites were inventoried in detail.

3.3.1 Rainbow Trout

During the fish inventory, the Tulameen River was sampled by IRC at five sites. All five sites yielded rainbow trout. The numbers of rainbow trout captured in the Tulameen River increased from the lower sites to the upper sites. Figure 2 illustrates the frequency of occurrence of fish species by site in the Tulameen River.

Mean fork lengths of rainbow trout in the Tulameen River ranged from 81 mm (Site 1) to 109 mm (Site 4). Figure 3 graphically portrays the frequency of rainbow trout fork lengths in the watershed. The mean weights of the rainbow trout ranged from 11.22 g (Site 4) to 15.82 g (Site 1). Site 3 yielded rainbow trout with the highest condition factor of all the sample sites (CF = 1.18 g/cm^3). Figure 4 graphically portrays condition factor values and standard deviations of rainbow trout in each watercourse. Table 3 presents, by site, the mean fork length, weight and condition factor with standard deviations for all species. A range of ages were captured at each of the sites in the Tulameen River from class 0+ (juvenile) to class 3+ (adult). Examples of scales, enlarged to facilitate aging, are presented in Volume 2, Appendix B.

Rainbow trout density in the Tulameen River increased from Site 1 (0.003 No./m^2) to Site 5 (0.120 no./m^2). Table 4 lists rainbow trout densities by site.

The standing crop estimates for the sampling sites in the Tulameen River indicate an overall increase of standing crop from Site 1 (0.457 kg/ha) to Site 5 (18.635 kg/ha) for rainbow trout. Table 4 lists the estimated standing crop values, which were derived from actual weight measurements collected during the field survey.

A comparison of standing crop estimates was made for three sites in the Tulameen River between values obtained in 1983 by IEC Beak and values obtained by IRC in 1996. Habitat Quality Index (HQI) values, in trout habitat units, which are comparable to estimated standing crop values, are also compared. These comparisons are summarized in tabular form in Table 5. HQI values are discussed further in Section 2.8. Sites 2, 3 and 4 are located in Reaches 7-B, 10 and 14-B, respectively, as designated by IRC. These reaches correspond to reaches in the same general location but with dissimilar dimensions to reaches assessed by IEC Beak in 1983 (Reaches 4-1, 5 and 8, respectively). The reaches differ in length because the watershed was studied in greater detail by IRC and it was necessary to designate smaller reaches and to further subdivide the reaches into sections. Several sections assigned by IRC fit into one IEC reach.

In Site 2, IRC estimated the standing crop to be 0.9 kilograms per hectare (kg/ha). This value was considerably lower than that estimated by IEC Beak in 1983 (3.1 kg/ha). The related HQI values for this site were 4.0 trout habitat units (IRC, 1996) and 3.0 trout habitat units (IEC Beak, 1983). The extremely low standing crop value calculated by IRC (0.9 kg/ha) from actual field measurements suggests the reach has suffered a decline in rainbow trout standing crop and, as well, the reach is not supporting rainbow trout populations to its estimated potential as calculated by IRC (4.0 trout habitat units).

In Site 3, IRC estimated the standing crop of rainbow trout to be 3.6 kg/ha in 1996, an increase from the estimated standing crop in 1983 (2.9 kg/ha). The HQI values for this reach were 6.9 trout habitat units in 1996 (IRC) and 3.0 trout habitat units in 1983 (IEC). These values suggest an overall increase in trout biomass and in trout habitat value over the thirteen year period.

In Site 4, IRC estimated the standing crop of rainbow trout to be 5.2 kg/ha in 1996. IRC's estimate suggests a drastic decline in rainbow trout standing crop in this reach from the IEC Beak estimate of 13.4 kg/ha in 1983. Alternately, the related HQI values show an increase in habitat quality from 3.0 trout habitat units to 9.0 trout habitat units.

The HQI values suggest an overall increase in potential to sustain rainbow trout in the Tulameen River. The predominant characteristics included in the IRC calculations that differed from the IEC Beak calculations were eroding banks, stream width and vegetative cover. The most significant difference in the stream features between 1983 and 1996, appeared to originate from the estimate of bank erosion. For example, in 1983, IEC Beak estimated the bank erosion in Reach 8 (equivalent to IEC Reach 14-B) to be 95%, where as in 1996 IRC estimated the extent of bank erosion for the same reach to be 15%. Because the values used for the determination of Habitat Quality are subjective (some observations may be generous while others may be conservative), these estimations should be taken lightly.

Population estimates which were calculated for the three comparable sites in the Tulameen River are listed in Table 5. Population densities calculated from the fish inventory data (IRC) were applied to each reach area and compared to populations estimated in 1983 by IEC Beak. Site 2 (IEC Beak Reach 4-1) had an estimated area of 264,842 square metres. The population size of rainbow trout estimated for this reach

was 1,960 individuals in 1996 compared to 1,589 in 1983. This value infers an increase in population size for this reach.

Site 3 (IEC Beak Reach 5) had an estimated area of 51,601 square metres. The population size of rainbow trout estimated for this reach was 1,264 individuals in 1996 compared to 516 in 1983. This value infers an increase in population size for this reach.

Site 4 (IEC Beak Reach 8) had an estimated area of 148,466 square metres. The population size of rainbow trout estimated for this reach was 6,829 individuals in 1996 compared to 8,908 in 1983. This value suggests a decrease in population size for this reach.

All tributaries sampled in the watershed contain rainbow trout. Although the upper reaches of Champion, Jim Kelly and Olivine creeks did not yield fish during the fish inventory, the lower reaches of each of these creeks did yield rainbow trout. The largest mean fork length and weight for rainbow trout (137 mm and 41.20 g, respectively) was observed in Site 5 of Otter Creek. The smallest mean fork length and weight was observed in Site 1 of Olivine Creek (56 mm and 3.72 g, respectively). Age classes of rainbow trout ranged from 0+ to 5+ years in the Tulameen River watershed. Generally scale samples were not removed from the smallest fish, presumably the ones of the 0+ year class. Site 1 of Champion Creek, Site 2 of Frenchy Creek, Site 4 of Granite Creek, Site 1 of Jim Kelly Creek and Site 1 of Spearing Creek did not yield rainbow trout that were smaller (fork length and weight) than those comparable with the 1+ year class. This implies absence of the youngest age class of trout in creeks that have presumably suffered from heavy sedimentation due to upstream disturbances. Reduced trout productivity due to eggs being stifled by sedimentation or the loss of spawning gravel are both possibilities in these watercourses. The results of the fish inventory on Spearing Creek, however, are inconclusive as the only site sampled was in the lowest reach which was dry during the September 23 to October 10 sampling period. Site 1 of Spearing Creek was sampled on November 6, 1996 when flow was observed. One rainbow trout was electrofished. The highest mean condition factor value for rainbow trout captured in the tributaries was calculated for Site 3 of Podunk Creek (1.15 g/cm^3). The lowest condition factor was 0.96 g/cm^3 which was calculated for rainbow trout in Site 3 of Otter Creek. There did not appear to be a definite trend in the condition factors, for the tributaries as they exhibited variability between the reaches and watercourses. Standing crop for each species was estimated by site for each tributary. The highest standing crop was estimated for rainbow trout in Site 3 of Podunk Creek (39.305 kg/ha). Site 1 of Asp Creek had the second highest standing crop estimated at 38.212 kg/ha. The lowest standing crop for rainbow trout in the tributaries of Tulameen River was calculated for Site 1 of Spearing Creek (1.034 kg/ha). Site 2 of Otter Creek exhibited the second lowest standing crop estimate at 1.444 kg/ha.

3.3.2 Sculpin Species

During the fish inventory, the Tulameen River was sampled by IRC at five sites. Only the three lower sites (Sites 1, 2 and 3) yielded sculpin species. A series of cascades and falls in Reach 2-B is a barrier and is therefore the upstream limit of sculpin species

distribution. Figure 2 illustrates the frequency of occurrence of sculpin species by site in the Tulameen River.

Sculpin species density decreased relatively consistently over the three sites, from 0.044 no./m^2 in Site 1, to 0.039 no./m^2 in Site 2, and to 0.020 no./m^2 in Site 3. Table 4 lists fish densities of sculpin species by site.

Sculpin standing crop values displayed an overall decrease from Site 1 (3.065 kg/ha) to Site 3 (1.878 kg/ha). Table 4 lists estimated standing crop, which was derived from actual weight measurements collected during the field survey.

Population estimates which were calculated for the three comparable sites in the Tulameen River are listed in Table 5. Population densities calculated from the fish inventory data (IRC) were applied to each reach area and compared to populations estimated in 1983 by IEC Beak. Site 2 (IEC Beak Reach 4-1) had an estimated area of 264,842 square metres. The estimated population size of sculpin species decreased from 14,566 (IEC Beak) to 10,408 (IRC).

Site 3 (IEC Beak Reach 5) had an estimated area of 51,601 square metres. The estimated population size of sculpin species increased from 155 in 1983 (IEC Beak) to 1,022 in 1996 (IRC).

Subsamples of sculpins were collected from three sites in the Tulameen River so that species identification could be confirmed. Table 6 lists all species collected, the percentage of each species represented by the subsample and the resulting population estimate for that particular site. In the Tulameen River, the Torrent sculpin made up 100% of the sculpin subsample and therefore, the population estimate for Site 1 was 93 Torrent sculpin. The subsample collected from Site 2 contained 50% Torrent sculpin and 50% Mottled sculpin. The resulting population estimate for Site 2 was 26 Torrent sculpin and 26 Mottled sculpin. Site 3 contained 33% Torrent sculpin and 66 % Mottled sculpin. The population estimates were 11 Torrent sculpin and 22 Mottled sculpin for Site 3.

Sculpin species were present throughout Otter Creek. The highest standing crop for sculpin species was in Site 1 of Otter Creek with an estimate of 16.326 kg/ha. Sculpin standing crop estimates decreased from Site 1 to Site 6 (0.290 kg/ha) in Otter Creek.

Subsamples of sculpin species were collected from Sites 1 to 5 of Otter Creek. The subsample collected at Site 1 of Otter Creek contained 100% Torrent sculpin, resulting in a population estimate of 182 individuals. The subsample for Site 2 contained 66% Mottled sculpin and 33% Prickly sculpin. The resulting population estimates for Site 2 were 131 and 66 Mottled sculpin and Prickly sculpin, respectively. The subsample for Sites 3, 4 and 5 contained only Mottled sculpin resulting in population estimates of 35, 11 and 23 individuals, respectively.

3.3.3 Other species

The Tulameen River was sampled by IRC at five sites. Longnose dace were present at the three lower sites (Sites 1, 2 and 3). Figure 2 illustrates the frequency of occurrence of Longnose dace by site in the Tulameen River.

The numbers of Longnose dace captured in the Tulameen River decreased from Site 1 (33 individuals) to Site 3 (11 individuals). Table 3 presents, by site, the mean fork length, weight and condition factor with standard deviations for all species.

The density of Longnose dace decreased from 0.019 no./m^2 in Site 1 to 0.006 no./m^2 in Site 3. The decrease in Longnose dace was not consistent however, as the density for Site 2 was 0.002 no./m^2. Sites 4 and 5 in the Tulameen River did not yield Longnose dace. Table 4 lists fish densities for all species by site.

A comparison of standing crop estimates was made for three sites in the Tulameen River between values obtained in 1983 by IEC Beak and values obtained by IRC in 1996. These comparisons are summarized in tabular form in Table 5. In Site 2, IRC estimated the standing crop to be 0.1 kilograms per hectare (kg/ha). This value was considerably lower than that estimated by IEC Beak in 1983 (3.4 kg/ha). The low standing crop value calculated by IRC (0.1 kg/ha) from actual field measurements suggests the reach has suffered a decline in Longnose dace standing crop.

The standing crop estimates for Longnose dace in Site 3 have also decreased from 5.0 kg/ha in 1983 to 0.6 kg/ha in 1996. Longnose dace were not captured in this reach in 1996.

Population estimates which were calculated for the three comparable sites in the Tulameen River are listed in Table 5. Population densities calculated from the fish inventory data (IRC) were applied to each reach area and compared to populations estimated in 1983 by IEC Beak. Site 2 (IEC Beak Reach 4-1) had an estimated area of 264,842 square metres. The estimated population size of Longnose dace decreased from 5,562 (IEC Beak) in 1983 to 583 (IRC) in 1996.

Site 3 (IEC Beak Reach 5) had an estimated area of 51,601 square metres. The estimated population size for Longnose dace decreased from 516 (IEC Beak) in 1983 to 330 (IRC) in 1996.

Longnose dace were present in Sites 2 and 5 of Otter Creek. Standing crop estimates were 0.118 kg/ha and 0.230 kg/ha, respectively. Density at each site was 0.013 Longnose dace per square metre. Longnose dace were also present at Site 1 of Granite Creek. The density at Site 1 was 0.004 individuals/square metre and the standing crop estimate was 0.263 kg/ha.

Redside shiners were present at two sites in Otter Creek. In Site 5, the density of Redside shiners was 0.004 individuals per square metre. The density of Site 6 was 0.008 Redside shiners per square metre.

One Brook trout was captured in Site 3 of Frenchy Creek. The Brook trout had a fork length of 122 mm and weighed 20.50 g. It was the only specimen of its species that was observed in the study.

3.3.4 Rare or Endangered Species

The B.C. Conservation Data Center in Victoria has identified the presence of known Red- or Blue-listed species in the Tulameen River watershed and surrounding areas. Red-listed species are candidates for legal designation as endangered or threatened and blue-listed species are considered vulnerable species that could become red-listed. Blue- or red-listed species are recorded as they are observed, therefore the absence of records should not be interpreted as the absence of species (CDC 1996).

The Mountain sucker, which was blue-listed as of September 1996 was observed in the Tulameen River at the confluence with Otter Creek in 1956 and 1958. Mottled sculpin, which was blue-listed as of September 1996, was observed in Tulameen River at the confluence with Otter Creek (1956), the confluence with Lawless Creek, and 2 kilometres west of Tulameen (1983). The Mottled sculpin has been observed in Otter Creek at the confluences of Frembd Creek and Manning Creek, and south of Goose Lake (1983). As well, in 1996, the Mottled sculpin was observed in Reaches 7-B and 10 of the Tulameen River, and Reaches 5-C, 10-B, and 11-B of Otter Creek by IRC. Umatilla dace, which was red-listed as of September 1996, was observed in Otter Creek in Tulameen beneath a road bridge and 500 metres upstream to outlet of Otter Lake (1983). A subsequent visit to these sites in 1991 by D. McPhail and G. Haas of the University of B.C. yielded no Umatilla dace (CDC 1996). Volume 2, Appendix B contains the British Columbia Conservation Data Centre Rare Element Report.

3.4 Habitat Survey

The habitat of the Tulameen River exhibited various characteristics which differed, in general, from the mouth of the river to the headwaters. The channel type in the lower reaches of the river were predominantly riffle-pool with an abundance of riffle habitat. The mid-reaches were predominated by cascades and step pools while in the upper reaches, riffle-pool habitat predominated. Substrate in the Tulameen River varied from cobble-gravel in the lowest reaches to boulder and bedrock in the mid-reaches. The substrate of the upper reaches included gravel, cobble and bedrock. Pool habitat was more abundant in the upper reaches as compared to the lower reaches and, similarly, canopy cover was greater in the upper reaches, with the exception of clearcut areas. The overall gradient of the river increased gradually from the mouth (1.2 %) to the headwaters (12.0%) with the exception of a falls located in Reach 17, where the gradient was estimated at 16.7%. Habitat conditions at an overview level for each watercourse is outlined in Section 3.6. A detailed assessment of habitat by reach for each watercourse is presented in Section 3.6: Reach Description.

A total of 41 sites were surveyed in the Tulameen River and eleven tributaries during the habitat assessment. Table 2 describes the location of each site and Volume 2, Appendix C contains the data collected during the habitat assessment. Volume I, Appendix A

contains photographs of each site.

3.4.1 Habitat Quality Index

The habitat assessment and fish inventory conducted in 1996 by IRC for Sites 2, 3 and 4 the Tulameen River in Reaches 7-B, 10 and 14-B, respectively, duplicated three sites that were assessed by IEC Beak in 1983. For these sites, the Habitat Quality Index (HQI) values were calculated as shown in Volume 2, Appendix C.

The HQI value for Site 2 (IRC Reach 7-B) was 4.0 trout habitat units, Site 3 (IRC Reach 10) was 6.9 trout habitat units and Site 4 (IRC Reach 14-B) was 9.0 trout habitat units. Trout habitat units interpret actual measurements as a relative value of the suitability of habitat for sustaining trout populations. These values demonstrate the higher quality of habitat in Site 3 relative to that of Sites 1 and 2. Trout habitat units are equivalent to kilograms per hectare, the units which describe standing crop estimates. Section 3.3 compares HQI values from 1983 (IEC Beak) and 1996 (IRC) with standing crop estimates calculated from actual measurements recorded during fish surveys in 1996 by IRC and in 1983 by IEC Beak. These values are included in Table 5.

3.4.2 Water Quality

Water temperatures measured at each sample site are listed in Table 7. The water temperatures were within the tolerance range for all life stages of rainbow trout but well below optimum temperature for incubation or growth. Sample site temperatures recorded during the field survey period (23 September to 10 October) ranged from 5.0 °C in Site 3 of Tulameen River and a number of tributary sites to 12.0 °C in Site 1 of Otter Creek. Site 1 of Spearing Creek was only 2.0 °C when it was sampled on 6 November 1996.

Mean and total water discharge (m^3/s) for 1993, 1994 and 1995 in the Tulameen River, as reported by Environment Canada, Water Survey of Canada Stations, are summarized by month in Table 8. Tulameen River at Princeton (Station number 08NL024) and Tulameen River below Vuich Creek (Station number 08NL071) demonstrate the magnitude of the flood in November 1995.

Due to extreme weather conditions following all field analysis water samples could not be collected at the scheduled sampling period time. The collection of water samples is recommended for the Tulameen River and all eleven tributaries included in the overview assessment. Nitrate-nitrogen (NO_3-N) and soluble reactive phosphorus (SRP) concentrations should be sampled at the start of the summer growing season (post freshet) near the mouth of the stream and at several sites in the Tulameen River.

3.5 Reach Description

The following is a summary describing habitat characteristics and habitat conditions at an overview level. Habitat conditions are evaluated with respect to disturbances and major impacts caused by forest practices. The reaches are classified according to the Fish-stream Identification Guidebook (MELP,MOF 1995). Non-fish bearing streams do

not exist in the Tulameen River wastershed by the Fish-stream Identification Guidebook definition. Table 10 lists the stream classification for each reach. In this section, fish presence is recognized and where known, critical or heavily used reaches are identified. Rehabilitation strategies are recommended by reach. The following was compiled from existing information, aerial photographs, helicopter video and field analysis. In reaches where IRC sample sites are located, adult or juvenile stages were recorded.

Habitat characteristics and fisheries values, in tabular form, are included in Forms 1, 2a and 3 in Volume 2, Appendix A.

3.5.1 Tulameen River

Reach 1

Reach 1 extends for 2500 metres, has a gradient of 1.2% and an estimated bankfull width of 50 metres. The channel type is riffle-pool with 0% pool habitat by area and no available off-channel habitat. Barriers are not present in this reach. LWD is not present. Disturbance types include extensive areas of unvegetated bar, extensive riffle zones and limited pool frequency and extent, which were exaggerated by the flood of 1995. Other major impacts to this reach include urbanization. Both right and left banks are barren of vegetation. Restoration opportunities include planting riparian vegetation and instream complexing with an aim to armour banks and dissipate energy during high flows. A level 1 Field Assessment of this reach should precede any instream works. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. rainbow trout, Brook trout, Longnose dace and Torrent sculpin are present.

Reach 2

Reach 2 has a total length of 3100 metres and an average gradient of 0%. The channel type is riffle-pool with less than 25% pool habitat by area and limited off channel fish habitat available. Barriers and LWD are not apparent in this reach. The shrub vegetation surrounding the reach provides less than 20% cover.

Section A: Section A extends for 1400 metres and has an estimated average bankfull width of 75 metres. Disturbance types include extensive areas of unvegetated bar, multiple channels/braiding, elevated mid-channel bars and sedimentation. No action is recommended for this reach. Rainbow trout presence is suspected. Mottled sculpin are present.

Section B: Section B extends for 1700 metres and has an estimated average bankfull width of 50 metres. Disturbance types include extensive areas of unvegetated bar and isolated back channels. Major impacts include sediment deposition and an unstable left bank. No action is recommended until upstream reaches have stabilized. A Level 1 Field Assessment and subsequent in stream complexing which will dissipate energy and armour banks, might be considered. Employing the recently taped video of the

creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected. Mottled sculpin are present.

Reach 3

Reach 3 has a total length of 4500 metres and an average gradient of 0.7%. The channel type is riffle-pool with no potential barriers to migration present.

Section A: Section A extends for 700 metres and has an estimated average bankfull width of 50 metres. Pool habitat available in this section is less than 25% by area. Limited off-channel fish habitat is available. LWD is not present. A mixed deciduous/conifer forest provides 20-40% canopy cover. Disturbance types to this section include extensive riffle zones and isolated back channels. Major impact include sediment deposition. No action is recommended until upper reaches have stabilized. Rainbow trout presence is suspected. The presence of Longnose dace and sculpins are is also suspected.

Section B: Section B extends for 600 metres and has an estimated average bankfull width of 45 metres. Pool habitat available in this section is estimated at 26-50% by area. Limited off-channel fish habitat is available. LWD is not present. A conifer forest provides less than 20% canopy cover. Eroding banks and extensive riffle zones are evident. Restoration opportunities include complexing when upstream reaches have stabilized. Rainbow trout presence is suspected.

Section C: Section C extends for 3200 metres and has an estimated average bankfull width of 60 metres. Pool habitat available in this section is estimated to be less than 25% by area. Limited off-channel fish habitat is available. Few LWD are present in this section. Riparian vegetation, which exists in an initial stage of growth, does not provide cover to the creek. Disturbance types to this section include extensive areas of unvegetated bar, extensive riffle zones and elevated mid-channel bars. Major impacts include increased sediment deposition and areas of erosion on the left bank. A Level 1 Field Assessment to determine the most suitable method of stabilization for the left bank is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected. Longnose dace and sculpin species are present.

Reach 4

Reach 4 has a total length 4200 metres and an average gradient of 0.7%. Off-channel fish habitat is not available in Reach 4.

Section A: Section A is 900 metres in length and its estimated average bankfull width is 25 metres. Channel type is boulder-step-pool with 51-75% pool habitat by area. Cascades are potential barriers to migration and few LWD are clumped throughout. Riparian vegetation is absent in this reach due to the extremely steep banks. Disturbances include eroding banks. Major impacts to this section are a road and associated erosion on the left bank. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for this section is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Planting riparian vegetation in barren areas, where applicable, is also recommended. Rainbow trout presence is suspected. Mountain whitefish, Bridgelip sculpin and sculpin species are present.

Section B: Section B extends for 800 metres and has an estimated average bankfull width of 35 metres. The channel type is boulder-cascade-pool with 26-50% pool habitat by area. Few LWD are evenly distributed throughout. Riparian vegetation does not exist in this reach. Disturbance types are eroding banks and extensive areas of unvegetated bar. Major impacts include a slide on the right bank. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for this section is recommended. Consideration should be given to armouring banks with available LWD to reduced future eroding during high flows. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected. Mountain whitefish, Bridgelip sculpin and sculpin species are present.

Section C: Section C extends for 2500 metres and has an estimated average bankfull width of 45 metres. The channel type is riffle-pool with 26-50% pool habitat by area. Few LWD are evenly distributed throughout. A mature conifer forest provides less than 20% cover for this section. Disturbance types are eroding banks, extensive areas of unvegetated bar and extensive riffle zones. Major impacts include an unstable left bank above the road/railway. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for this section is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Consider instream complexing and armouring banks with available LWD. Rainbow trout, Longnose dace and Torrent sculpin are present.

Reach 5

Reach 5 has a total length of 3000 metres and an average gradient of 0%. The channel type is riffle-bar-pool with less than 25% pool habitat by area. Barriers are not present. Few LWD are evenly distributed throughout.

Section A: Section A extends for 2500 metres and has an estimated average bankfull width of 40 metres. The banks of this section are barren of riparian vegetation. Disturbance types include eroding banks, extensive areas of unvegetated bar and multiple channels/braiding. Major impacts include extensive riffle zones, barren and unstable banks and two slides on the left bank. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for this section is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Consideration should be given to armouring banks and instream complexing with available LWD. Rainbow trout presence is suspected. The presence of Longnose dace and sculpins is also suspected.

Section B: Section B extends for 500 metres and has an estimated average bankfull width of 50 metres. A mature conifer forest provides 20-40% canopy cover. Disturbance types include eroding banks, extensive areas of unvegetated bar and elevated mid-channel bars. Major impacts include a road and a slide on the left bank. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for this section is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Consider armouring banks with available LWD. Rainbow trout presence is suspected. The presence of Longnose dace and sculpins is also suspected.

Reach 6

Reach 6 has a total length of 2700 metres and an average gradient of 0%. Barriers are not present in this reach and few LWD are clumped throughout.

Section A: Section A is 550 metres in length and has an estimated average bankfull width of 40 metres. Channel type is riffle-pool with 51-75% pool habitat by area but no available off-channel fish habitat. The surrounding mature conifer forest provides less than 20% canopy cover. Eroding banks are evident. Major impacts include a barren, unstable left bank and increased sediment deposition. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for this section is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Consider armouring banks with available LWD. Rainbow trout, Longnose dace and sculpin species are present.

Section B: Section B is 1600 metres in length and has an estimated average bankfull width of 35 metres. Channel type is riffle-bar-pool with 26-50% pool habitat by area but no available off-channel fish habitat. The surrounding mature conifer forest provides 20-40% canopy cover. Disturbance types include eroding banks, elevated mid-channel bars and extensive riffle

zones. Major impacts include unstable banks and a barren left bank. A Level 1 Field Assessment to determine the most suitable method of bank stabilization and instream complexing for this section is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout, Longnose dace and sculpin species are present.

Section C: Section C is 550 metres in length and has an estimated average bankfull width of 40 metres. Channel type is riffle-bar-pool with less than 25% pool habitat by area and abundant available off-channel fish habitat. The surrounding mature conifer forest provides 0-20% canopy cover. Disturbance types include eroding banks and elevated mid-channel bars. Major impacts include sediment deposition. A Level 1 Field Assessment to determine the most suitable method of bank stabilization. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout, Longnose dace and sculpin species are present.

Reach 7

Reach 7 has a total of 3950 metres and an estimated average gradient of 0.8%. The channel type is riffle-bar-pool with less than 25% pool habitat by area. Limited off-channel fish habitat is present. There are no barriers to migration in this reach. Few LWD are evenly distributed throughout.

Section A: Section A extends for 1100 metres and has a bankfull width of 41 metres. Riparian vegetation is in an initial stage of growth and therefore provides little cover (0-20%) to the creek. Disturbance types include extensive areas of unvegetated bar, elevated mid-channel bars and eroding banks. Major impacts include sediment deposition instream and a vulnerable, unstable left bank from the creek to the road. A Level 1 Field Assessment to determine the most suitable method of bank stabilization and in particular armouring of the bank to road in vulnerable areas. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present. Longnose dace and sculpin species are present.

Section B: Section B extends for 1800 metres and has an estimated average bankfull width of 50 metres. A conifer stand surrounding this section is in an initial stage of growth and therefore provides little cover (0-20%) to the creek. Disturbance to this section is in the form of extensive areas of unvegetated bar. Major impacts include instream sediment deposition and extensive riffle zones. A Level 1 Field Assessment to determine the most suitable method of bank stabilization for vulnerable areas and instream complexing. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1

Field Assessment. Adult and juvenile Rainbow trout, as well as Longnose dace and sculpin species are present.

Section C: Section C extends for 1050 metres and has an estimated average bankfull width of 65 metres. A mixed deciduous/conifer forest provides less than 20% canopy cover. Disturbance types include extensive areas of unvegetated bar and elevated mid-channel bars. Major impacts include extensive riffle zones and a straight uniform channel. A Level 1 Field Assessment to determine the most suitable method of instream complexing. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. The few LWD available in this section might be anchored instream to provide areas of energy dissipation during high flows as well as cover for fish. Presence of Rainbow trout, Longnose dace and sculpin species is suspected.

Reach 8

Reach 8 extends for 4400 metres, and has an average gradient of 0.7% and an estimated average bankfull width of 100 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area and no available off-channel fish habitat. Barriers are not present and few LWD are evenly distributed throughout. The mature mixed deciduous/conifer forest surrounding the reach provides less than 20% canopy cover. Disturbance types include extensive areas of unvegetated bar, elevated mid-channel bars and extensive riffle zones. Major impacts include instream sediment deposition and areas of vulnerable, unstable banks. A Level 1 Field Assessment to determine the most suitable method of armouring vulnerable banks and instream complexing is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. The LWD available in this section should be anchored instream along banks vulnerable to erosion. Instream complexing is secondary to bank stabilization in this section. Adult and juvenile Rainbow trout are present. Longnose dace, sculpin species and Mountain sucker are present.

Reach 9

Reach 9 has a total length of 5450 metres and an average gradient of 0.6%. The channel type is riffle-bar-pool with 0-25% pool habitat by area and no off-channel habitat available. Few LWD are evenly distributed throughout this reach and no barriers are present. Disturbance types are extensive areas of unvegetated bar, elevated mid channel bars and extensive riffle zones.

Section A: Section A extends for 3450 metres and has an estimated average bankfull width of 100 metres. The vegetation surrounding this section is in an initial stage and therefore provides 0-20% cover. Major impacts to this section include sediment deposition and vulnerable banks. A Level 1 Field Assessment to determine the most suitable method of armouring vulnerable banks is recommended. Employing the recently taped video

of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. The LWD available in this section should be anchored instream along banks vulnerable to erosion. Rainbow trout presence is suspected. Sculpin species are present.

Section B: Section B extends for 3450 metres and has an estimated average bankfull width of 100 metres. The vegetation surrounding this section is in an initial stage and therefore provides 0-20% cover. Major impacts to this section include sediment deposition and two slides on the left bank. A Level 1 Field Assessment to determine the most suitable method of armouring vulnerable banks is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Potential slide risk should be assessed prior to any work conducted in this section. Rainbow trout, Longnose dace, Slimy sculpin and Torrent sculpin are present.

Reach 10

Reach 10 extends for 950 metres, and has an average gradient of 3.2% and an estimated average bankfull width of 30 metres. The channel type is riffle-pool with 0-25% pool habitat by area and no available off-channel fish habitat. Neither barriers nor LWD are present in stream although LWD was deposited out of the wetted width just upstream of sample Site 3. Some LWD may therefore be present atop banks that are out of view in the aerial photographs and the videotape. The mature conifer forest surrounding the reach provides 20-40% canopy cover. The predominant disturbance type is extensive riffle zones. Major impacts include sediment deposition. A Level 1 Field Assessment might be considered to determine the extent of damage caused by the mines located upstream. Instream complexing might also be considered. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present. Longnose dace and sculpin species are present.

Reach 11

Reach 11 extends for a total of 5800 metres in length and has an average gradient of 1.0%. Cascades, present in both sections of Reach 11, are migration barriers to fish. A mature conifer forest provides 20-40% canopy cover for the creek. Off-channel habitat is not available for fish. Eroding banks are evident throughout.

Section A: Section A extends for 1200 metres and has an estimated average bankfull width of 20 metres. The channel type is boulder-cascade-pool with 51-75% pool habitat by area. Few LWD are clumped throughout. No action is recommended for this section. Reasoning for the recommendation includes the unstable conditions of the abandoned mines and slides upstream, the limited level of rehabilitation that might be achieved, and very poor and possibly dangerous access. Rainbow trout presence is suspected. Sculpin presence is suspected. Longnose dace presence is

unknown for this section, presence is a possibility.

Section B: Section B extends for 4600 metres and has an estimated average bankfull width of 15 metres. The channel type is debris-cobble-cascade-pool with 26-50% pool habitat by area. Few LWD are evenly distributed. A slide on the left bank is present. No action is recommended for this section. Because abandoned mines are present in this section, the low level of rehabilitation that might be achieved and poor access are reasons for the recommendation. Rainbow trout, Mottled sculpin and sculpin species are present. This section is the upper boundary of Longnose dace and sculpin species in the Tulameen River.

Reach 12

Reach 12 extends for 2900 metres, and has an average gradient of 1.0% and an estimated average bankfull width of 25 metres. The channel type is riffle-bar-pool with 51-75% pool habitat by area and no available off-channel fish habitat. Barriers are not present and few LWD are evenly distributed throughout. The mature conifer forest surrounding the reach provides 20-40% canopy cover. The predominant disturbance types are extensive riffle zones. Major impacts are slides. No action is recommended as unstable conditions predominate. Slides are present in this reach and in upstream reaches. and access is limited. Rainbow trout are present.

Reach 13

Reach 13 extends for 2400 metres, has an average gradient of 1.3% and an estimated average bankfull width of 20 metres. The channel type is cobble-cascade-pool with debris and 26-50% pool habitat by area. Available off-channel fish habitat is not present. Barriers are not present and few LWD are evenly distributed throughout. The mature conifer forest surrounding the reach provides 20-40% canopy cover. No action is recommended due mainly to the unstable conditions that occur upstream. Rainbow trout presence is suspected as presence has been confirmed both upstream and downstream.

Reach 14

Reach 14 is 3300 metres in length and has an average gradient of 0.9%. Barriers are not apparent.

Section A: Section A extends for 1800 metres and has a bankfull width of 20 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area. Off-channel habitat is not available and LWD is abundant and clumped. A mature conifer forest provides 20-40% canopy cover. Disturbances are primarily in the form of eroding banks. Major impacts include a clearcut to the creek on the right bank. Restoration opportunities include planting riparian vegetation in the clearcut to the creek to provide cover for Rainbow trout and to stabilize the banks. Generally, barren banks are prone to degradation and therefore contribute to the sediment load of the

river. Rainbow trout presence is suspected as presence upstream is confirmed.

Section B: Section B extends for 1500 metres and has a bankfull width of 50 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area. Limited off-channel fish habitat is available and few LWD are clumped in this section. A mature conifer forest provides 0-20% canopy cover. Disturbance types are extensive areas of unvegetated bar, isolated back channels and elevated mid-channel bars. Instream deposition in this area appears to be, at least partially, a result of extensive placer mining in Jim Kelly Creek. Major impacts include a clearcut on the right bank to the wetted width and a road and slide on the left bank. Restoration opportunities include planting riparian vegetation in barren riparian zones to provide cover for Rainbow trout. Adult and juvenile Rainbow trout are present.

Reach 15

Reach 15 extends for 2500 metres, has an average gradient of 2.4% and an estimated average bankfull width of 20 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area and no available off-channel fish habitat. Barriers are not present and few LWD are clumped throughout. The mature conifer forest surrounding the reach provides 20-40% canopy cover. Disturbance types are eroding banks, isolated back channels and elevated mid-channel bars. Major impacts include slides on the left bank. No action is recommended. Rainbow trout presence is suspected due to the presence of Rainbow trout and the lack of barriers in Reach 14 - B.

Reach 16

Reach 16 extends for 300 metres, has an average gradient of 0% and an estimated average bankfull width of 10 metres. The channel type is riffle-pool with 26-50% pool habitat by area and little available off-channel fish habitat. Barriers are not present and few LWD are evenly distributed throughout. The mature conifer forest surrounding the reach provides 20-40% canopy cover. Disturbance types are eroding banks and isolated back channels. Major impacts include unstable banks. No action is recommended. Rainbow trout presence is suspected.

Reach 17

Reach 17 extends for 180 metres, has an average gradient of 16.7% and an estimated average bankfull width of 15 metres. The channel type is block-step-pool with 51-75% pool habitat by area and no available off-channel fish habitat. A spectacular falls approximately 30 metres high presents a complete barrier to all fish migration. See photograph 148. LWD is not apparent in this reach. A mature conifer forest surrounding the reach provides 0-20% canopy cover. No action is recommended for this reach. Rainbow trout presence is suspected in the pools associated with the cascades and in the large pool below the falls.

Reach 18

Reach 18 extends for 2000 metres, has an average gradient of 1.5% and an estimated average bankfull width of 20 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area and no available off-channel fish habitat. Barriers are not present and LWD is abundant and evenly distributed throughout. The mature conifer forest surrounding the reach provides 20-40% canopy cover. Disturbance types are extensive areas of unvegetated bar and elevated mid-channel bars. Major impacts include instream sediment deposition. No action is recommended for this reach. Rainbow trout presence is suspected.

Reach 19

Reach 19 is a total of 8750 metres in length and has an average gradient of 1.0%. Potential migration barriers in Reach 19 are not apparent. Access to all sections of Reach 19 is limited. This should be considered when determining rehabilitation strategies.

Section A: Section A extends for 2300 metres and has an estimated average bankfull width of 20 metres. The channel type is riffle-pool with 0-25% pool habitat by area and no off-channel habitat available. Few LWD are evenly distributed throughout. A mature conifer forest provides 40-70% canopy cover. Major impacts include a slide on the right bank. A Level 1 Field Assessment to assess the stability of the bank and to determine the best suitable method of stabilization is recommended. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected.

Section B: Section B extends for 1550 metres and has an estimated average bankfull width of 40 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area and little available off-channel habitat for fish. LWD is abundant and evenly distributed throughout. A mature conifer forest provides 0-20% canopy cover. Disturbance types include extensive areas of unvegetated bar, elevated mid-channel bars and isolated back channels. No action is recommended for this section. Rainbow trout presence is suspected.

Section C: Section C extends for 600 metres and has an estimated average bankfull width of 25 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area and little available off-channel habitat for fish. LWD is abundant and evenly distributed throughout. A mature conifer forest provides 20-40% canopy cover. Major impacts include slides. No action is recommended for this section. Rainbow trout presence is suspected.

Section D: Section D extends for 1700 metres and has an estimated average bankfull width of 25 metres. The channel type is riffle-bar-pool with 26-50% pool

habitat by area and little available off-channel habitat for fish. Few LWD are evenly distributed throughout. A mature conifer forest provides 20-40% canopy cover. Eroding banks are evident. Major impacts include two slides on the left bank and one on the right bank. No action is recommended for this section. Rainbow trout presence is suspected.

Section E: Section E extends for 1100 metres and has an estimated average bankfull width of 25 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area and little available off-channel habitat for fish. LWD is abundant and evenly distributed throughout. A mature conifer forest provides 20-40% canopy cover. Disturbance types are eroding banks and isolated back channels. Major impacts include a slide on the right bank. No action is recommended for this section. Rainbow trout presence is suspected.

Section F: Section F extends for 1400 metres and has an estimated average bankfull width of 15 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area and abundant off-channel fish habitat available. LWD is abundant and evenly distributed throughout. A mature conifer forest provides 20-40% canopy cover. Disturbance types are eroding banks and isolated back channels. Major impacts include a clearcut and a slide. No action is recommended for this section. Rainbow trout presence is suspected.

Reach 20

Reach 20 has a total length of 3450 metres, an average gradient of 2.6% and an estimated average bankfull width of 10 metres. Barriers are absent in this reach. The surrounding mature conifer forest provides 20-40% canopy cover. Disturbance types associated with Reach 20 are isolated back channels, multiple channels/braiding and elevated mid-channel bars.

Section A: Section A extends for 2100 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area and some off-channel fish habitat. LWD is abundant and evenly distributed throughout. Major impacts include a clearcut set back up the slope of the left bank. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B extends for 1350 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area and limited off-channel fish habitat. Few LWD are evenly distributed throughout. Major impacts include a slide. No action is recommended for this section. Rainbow trout presence is suspected as presence has been confirmed upstream and barriers are not apparent.

Reach 21

Reach 21 has a total length of 3400 metres and an average gradient of 1.8%. The channel type is riffle-pool with 26-50% pool habitat by area. Barriers are absent and LWD is abundant and evenly distributed.

Section A: Section A extends 2100 metres and has a bankfull width of 8 metres. Little off-channel fish habitat is available. A mature conifer forest provides the reach with 40-70% canopy cover. No action is recommended. Adult and juvenile Rainbow trout are present. Data from the fish survey associated with this report indicates heavy use of this reach by Rainbow trout.

Section B: Section B extends 1300 metres and has an estimated average bankfull width of 6 metres. Off-channel fish habitat is abundant. A young conifer forest provides the reach with 20-40% canopy cover. No action is recommended. Rainbow trout presence is suspected.

Reach 22

Reach 22 has a total length of 6200 metres and has an average gradient of 6.0%. Barriers in this reach are not apparent.

Section A: Section A extends for 1000 metres and has an estimated average bankfull width of 4 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area and little available off-channel fish habitat. LWD is abundant and evenly distributed throughout. A young conifer forest provides 20-40% cover for the creek. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B extends for 2500 metres and has an estimated average bankfull width of 4 metres. The channel type is riffle-pool with 51-75% pool habitat by area and abundant available off-channel fish habitat. Few LWD are evenly distributed throughout. Riparian vegetation is in an initial stage of growth and therefore provides 0-20% cover for the creek. Isolated back channels are evident. No action is recommended for this section. Rainbow trout presence is suspected.

Section C: Section C extends for 1200 metres and has an estimated average bankfull width of 4 metres. The channel type is riffle-pool with 26-50% pool habitat by area and little available off-channel fish habitat. Few LWD are evenly distributed throughout. A young conifer forest provides 20-40% cover. No action is recommended for this section. Rainbow trout presence is suspected.

Section D: Section D, which extends for approximately 500 metres, is a marsh/lake. No action is recommended for this section. Rainbow trout presence is

suspected.

Section E: Section E extends for 1000 metres and has an estimated average bankfull width of 4 metres. The channel type is riffle-pool with 26-50% pool habitat by area and abundant available off-channel fish habitat. LWD is abundant and evenly distributed throughout. Riparian shrub vegetation provides 20-40% cover for the creek. Isolated back channels are evident. No action is recommended for this section. Rainbow trout presence is suspected.

Reach 23

Reach 23 extends for 850 metres, has an average gradient of 10.6% and an estimated average bankfull width of 3 metres. The channel type is boulder-cascade-pool with 26-50% pool habitat by area and little available off-channel fish habitat. The steep gradient of Reach 23 presents a potential barrier to migration of some individuals. LWD is not present in this reach. The shrub vegetation surrounding the reach provides 40-70% cover. No action is recommended for this section. Rainbow trout presence is suspected.

Reach 24

Reach 24 extends for a total of 1000 metres and has an average gradient of 12.0%. LWD is not present in this reach.

Section A: Section A extends for 600 metres and has an estimated average bankfull width of 2 metres. The channel type is boulder-cascade-pool with 26-50% pool habitat by area and little available off-channel fish habitat. The steep gradient of Section A presents a potential barrier to fish migration. The shrub vegetation surrounding this section provides 40-70% cover. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B, Punchbowl Lake, extends for approximately 400 metres. No action is recommended for this section. Rainbow trout presence is suspected.

3.5.2 Arrastra Creek

Reach 1

Reach 1 of Arrastra Creek extends for 2500 metres and has an average gradient of 2.5%. Average bankfull width for the entire reach is estimated at 10 metres. Channel type is described as riffle-bar-pool, with less than 25% pool area. LWD is abundant and evenly distributed throughout the reach with the exception of a few clumped pieces. Little off-channel habitat is available or accessible.

Section A: Disturbances that are evident in Section A are eroding banks, extensive area of unvegetated bar and channel braiding. The surrounding area is a mature conifer forest, its canopy closure is rated from 20-40%. Major impacts include a clearcut with a set back and a road on the left bank, a second clearcut to the stream also on the left bank and a slide on the right bank. A logjam that exists below Site 2 does not appear to be a migration barrier. Restoration opportunities include planting riparian vegetation in the clearcut to the creek to provide cover and stabilization and on the banks to the road for stabilization. Adult and juvenile Rainbow trout are present.

Section B: Disturbances that are evident in Section B are eroding banks, extensive areas of unvegetated bar and back channels. The surrounding area is a young conifer forest with an estimated canopy closure of 0-20%. Barriers to migration are not present. Major impacts include a clearcut. Restoration opportunities include planting riparian vegetation in the clearcut to the creek. Adult and juvenile Rainbow trout are present.

Reach 2

Reach 2 of Arrastra Creek is 3000 metres in length and has a gradient of 3.0%. The bankfull width is estimated at 7 metres and the channel type is described as riffle-bar-pool with approximately 0-25% pool area. Off-channel habitat is available. LWD is abundant and evenly distributed. There is a logjam in Reach 2, however it does not appear to be a migration barrier. Canopy closure of the surrounding mature conifer forest is less than 20%. Eroding banks, extensive areas of unvegetated bar and braiding are evident. Major impacts include excessive LWD instream and clearcuts on the left and right banks. Restoration opportunities include planting riparian vegetation in clearcut to creek. Rainbow trout presence is suspected.

Reach 3

Reach 3 extends for 3000 metres and has a gradient of 5.9%. The channel type is riffle-bar-pool with 0% significant pool area and little off-channel habitat. Reach 3 has a bankfull width of 5 metres. Logjams, which are present as LWD is abundant and clumped, do not appear to limit migration. A young conifer forest inhabits the surrounding area. Disturbances to the stream include large extensive sediment wedges and braiding as well as the presence of logjams. Major impacts include a clearcut to the creek that has been planted with conifer saplings. Restoration opportunities include planting riparian vegetation in the clearcut at the creek to provide cover as the saplings mature. Adult and juvenile Rainbow trout are present.

Reach 4

Reach 4 extends for 2550 metres, has a gradient of 5.9% and a bankfull width of 2 metres. The channel type is riffle-bar-pool with less than 25% pool area and no off-channel habitat. LWD is abundant and evenly distributed except where it has formed a

logjam. The logjam does not appear to be a barrier. The surrounding area is a mature conifer forest, its canopy closure is estimated at 20-40%. Disturbances include eroding banks and extensive areas of unvegetated bar. Major impacts include excessive LWD in the stream. No action is recommended. Rainbow trout presence is suspected.

Reach 5

Reach 5 extends for 2450 metres and has a gradient of 6.1%. Channel type is riffle-bar-pool with less than 25% pool area and limited off-channel habitat. The bankfull width is approximately 2 metres. The surrounding forest stand is nonexistent. Less than 20% cover is provided by riparian vegetation in Reach 5. LWD, however, is abundant and evenly spaced. Major impacts include clearcuts on both banks to the creek, headwaters are barren of vegetation. Restoration opportunities include planting riparian vegetation in the clearcut to the creek. Rainbow trout presence is suspected.

3.5.3 Asp Creek

Reach 1

Reach 1 extends for a total of 2200 metres and has a gradient of 4.1%. The bankfull width is estimated at 5 metres. Channel type for Reach 1 is described as riffle-bar-pool. No barriers exist in Reach 1 and the few LWD present are evenly distributed. Disturbance in Reach 1 is in the form of eroding banks.

Section A: The length of Section A is 300 metres. This section includes an estimated pool area of 26-50%, with little off-channel habitat. Section A is surrounded by a mature deciduous forest which provides excellent canopy cover: 70-90%. Major impacts include urbanization and unstable banks. Adjacent houses, culverts and garbage debris are urban disturbances. Restoration opportunities include a Level 1 Field Analysis as recommended by the Fish Habitat Assessment Procedure Guidebook to determine the most effective method of bank stabilization. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present.

Section B: Section B extends for 1900 metres. It includes less than 25% pool habitat by area and offers no off-channel habitat. The surrounding mature mixed conifer/deciduous forest provides 70-90% canopy cover. Major impacts to section include unstable banks. Restoration opportunities include a Level 1 Field Analysis as recommended by the Fish Habitat Assessment Procedure Guidebook to determine the most effective method of bank stabilization. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected.

Reach 2

Reach 2 extends for 2800 metres and has a gradient of 3.2%. The channel is riffle-bar-pool, approximately 5 metres bankfull width, with no potential migration barriers present. Off-channel habitat does not exist and the estimated pool habitat by area is less than 25%. Few LWD are evenly distributed throughout the reach. The surrounding mature mixed conifer/deciduous forest provides 70 - 90% canopy cover. Disturbance in Reach 2 is in the form of eroding banks. No action is recommended for this reach. Rainbow trout presence is suspected.

Reach 3

Reach 3 extends 5600 metres and has an average gradient of 3.8%. The channel type is riffle-bar-pool with an estimated average bankfull width of 5 metres. The pool habitat in this reach is estimated at less than 25% and no off-channel habitat is available. LWD is abundant and evenly distributed throughout. The mature mixed conifer/deciduous forest through which the creek flows provides 70-90% canopy cover. Disturbance in this reach is in the form of eroding banks.

Section A: Section A extends for 3100 metres. A slide exists on the right bank. Restoration opportunities include a Level 1 Field Analysis as recommended by the Fish Habitat Assessment Procedure Guidebook to determine the most effective method of bank stabilization. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present.

Section B: Section B extends for 2500 metres. A road and slide exist on the left bank as well as a clearcut with a setback. Restoration opportunities include a Level 1 Field Analysis as recommended by the Fish Habitat Assessment Procedure Guidebook to determine the most effective method of bank stabilization. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected.

Reach 4

Reach 4 extends for 7100 metres and has a gradient of 5.6%. The channel type of Reach 4 is debris-cobble-cascade-pool with an estimated pool habitat area of less than 25% and little off-channel habitat. LWD are few and evenly distributed. No apparent barriers exist. The bankfull width in this reach is estimated at 5 metres. A mature conifer forest surrounds the reach and provides approximately 20-40% canopy cover to the creek. Disturbance in Reach 4 is in the form of eroding banks. Major impacts include a slide on the right bank and excessive LWD instream. No action is recommended. Adult and juvenile Rainbow trout are present.

Reach 5

Reach 5 is 3900 metres in length and has an average gradient of 3.8%. The bankfull width is estimated at 5 metres. The channel type is cobble-cascade-pool with less than 25% pool habitat by area and no off-channel habitat. Few LWD are distributed evenly throughout the reach and potential barriers are not apparent. A mature deciduous forest surrounds the reach and provides 70-90% cover. Disturbance in Reach 5 is in the form of eroding banks. Major impacts include a clearcut on the left bank. No action is recommended. Rainbow trout presence is suspected.

3.5.4 Champion Creek

Reach 1

Reach 1 extends 1600 metres and has an average gradient of 7.5%. The channel type is block-step-pool with an estimated pool habitat area of 25-50% and no available off-channel habitat. There does not appear to be disturbance associated with this reach.

Section A: Section A extends 430 metres from the mouth. The bankfull width is approximately 12 metres, potential barriers do not exist, and few LWD are clumped in this section. The surrounding area is vegetated with a mature deciduous forest which provides less than 20% canopy cover to the creek. No action is recommended for this section. Adult Rainbow trout are present. Juveniles which were present appeared of the same fork length and weight of the 1+ class rather than the 0+ class, many of which were observed in the other tributaries.

Section B: Section B extends for 1076 metres and the bankfull width is approximately 10 metres. The surrounding vegetation is a mature conifer stand which provides less than 20% canopy cover. A chute exists at the downstream section break of Section B. It is a natural barrier extending approximately 20 metres vertically and 40 metres horizontally. A logjam is present downstream of the pool at the outfall of the chute. No action is recommended for this section. Rainbow trout presence is not suspected above the chute.

Reach 2

Reach 2 which extends for 3580 metres and has an estimated bankfull width of 10 metres, has an average gradient of 3.4%. The channel type is step-block-pool, with no available off-channel habitat and no apparent barriers although LWD is abundant and clumped throughout. The area of pool habitat is estimated at less than 25%. The surrounding vegetation for the reach is a mature conifer forest which provides less than 20% canopy cover. Disturbance types associated with this reach are eroding banks, multiple channels/braiding and elevated mid-channel bars. Major impacts include an unstable right bank and excessive LWD instream. No action is recommended. Rainbow trout presence is not suspected.

Reach 3

Reach 3 extends for 5300 kilometres with a gradient of 5.3%. The estimated average bankfull width is 8 metres and the channel type is boulder-cascade-pool with less than 25% pool habitat by area and little off-channel habitat. LWD is abundant and evenly distributed throughout the reach and barriers are not apparent. The conifer forest in the surrounding area is at an initial stage of growth and therefore provides only 0-20% canopy cover to the creek. Disturbance types associated with this reach are eroding banks, multiple channels/braiding and elevated mid-channel bars. Major impacts include three clearcuts on the left bank, excessive LWD instream and possible logjams. No action is recommended. Rainbow trout presence is not suspected.

Reach 4

Reach 4 extends for 2380 metres and has an average gradient of 11.8%. The channel type is boulder-cascade-pool with less than 25% pool habitat by area and little off-channel habitat exists. Barriers do not exist and LWD is abundant and evenly distributed. The surrounding mature conifer forest provides little canopy cover to the stream. Disturbance types associated with this reach are eroding banks, multiple channels/braiding and elevated mid-channel bars. Major impacts include a slide on the right and left banks, a clearcut on the right bank, excessive LWD instream and possible logjams. Bank stabilization might be considered, in which case a Level 1 Field Assessment is recommended. Rainbow trout presence is not suspected.

3.5.5 Frenchy Creek

Reach 1

Reach 1 is 440 metres in length and has an average gradient of 7.5%. The channel type is riffle-bar-pool with an estimated 25-50% pool habitat by area and little off-channel habitat. The bankfull width is estimated to be greater than 5 metres wide and less than 20 metres wide for the purpose of stream classification. LWD, which is abundant and clumped, creates a migration barrier in the form of a logjam. The surrounding conifer forest provides 40-70% canopy cover for the creek. Disturbance types in Reach 1 are logjams and eroding banks. Major impacts include a clearcut, excessive LWD instream and a logjam barrier. Restoration recommendations include a Level 1 Field Assessment which will aid in the evaluation of the logjam and/or methods to manipulate it. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected.

Reach 2

Reach 2 extends 2450 metres and has an average gradient of 4.9%. The channel type is debris-cobble-cascade-pool with less than 25% pool habitat by area. Off-channel habitat is not available in Reach 2. The bankfull width is estimated to be greater than 5 metres wide and less than 20 metres wide for the purpose of stream classification. LWD

is abundant and clumped. The surrounding mature conifer forest provides 40-70% canopy cover. Disturbances experienced by Reach 2 are eroding banks. Major impacts include a clearcut set back from the creek on the right bank, a slide also on the right bank and a logjam that may present a barrier to migration for fish. Rainbow trout presence is suspected.

Reach 3

Reach 3 has a total length of 2600 metres and a gradient of 4.6%. The channel type is debris-cobble-cascade-pool with no available off-channel habitat. Potential barriers do not exist in Reach 3. Disturbances experienced in Reach 3 are eroding banks.

Section A: Section A extends for 1000 metres. Pool habitat in section A is estimated at 25-50% by area. LWD is abundant and evenly distributed throughout. The surrounding mature coniferous forest provides less than 20% canopy cover. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B extends for 650 metres. Pool habitat in section B is estimated at less than 25% by area. LWD is abundant and evenly distributed. The surrounding coniferous vegetation is at an initial stage of growth and provides less than 20% cover to the creek. Major impacts to this section include a clearcut and a slide on the left bank and LWD instream. Restoration recommendations include a Level 1 Field Assessment which will aid in the evaluation of the logjam and/or methods to manipulate it. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present.

Section C: Section C extends for 950 metres. Pool habitat in section C is estimated at 25-50% by area. LWD is abundant and clumped although logjams creating barriers are not apparent. The surrounding mature conifer forest provides approximately 20-40% canopy cover. No action is recommended for this section. Rainbow trout presence is suspected.

Reach 4

Reach 4 extends for a total of 3250 metres and has a gradient of 0.9%. The channel type is riffle-bar-pool with an estimated average bankfull width of 4 metres and no available off-channel habitat. Barriers to migration are not apparent in Reach 4. LWD debris is abundant and evenly distributed. The surrounding mature conifer forest provides less than 20% canopy cover. Disturbances experienced in Reach 4 are eroding banks.

Section A: Section A extends for 400 metres and provides less than 25% pool habitat by area. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B extends for 2850 metres and provides approximately 25-50% pool habitat by area. No action is recommended for this section. Adult and juvenile Rainbow trout are present.

Reach 5

Reach 5 extends 2900 metres with an estimated average bankfull width of 4 metres and a gradient of 1%. The channel type is riffle-bar-pool with abundant off-channel habitat and no apparent fish migration barriers. Pool habitat by area is estimated at less than 20%. LWD is abundant and evenly distributed and canopy cover does not exist in Reach 5. All vegetation has been removed and the creek is completely exposed. Disturbances experienced in Reach 5 are eroding banks. No action is recommended for this section. Adult and juvenile Rainbow trout are present. Brook trout are also present.

Reach 6

Reach 6 extends for a total of 1550 metres.

Section A: Section A extends for 1400 metres and has a gradient of 2.1% and an estimated average bankfull width of 3 metres. The channel type is riffle-bar-pool with no off-channel habitat and less than 25% pool habitat by area. Barriers are not apparent and few LWD are evenly distributed throughout the reach. The surrounding young conifer forest provides less than 20% canopy cover to the creek. Disturbance to this reach is in the form of eroding banks. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B is a marsh/lake and therefore has a gradient of 0%. No action is recommended for this section. Rainbow trout presence is suspected.

3.5.6 Granite Creek

Reach 1

Reach 1 is 600 metres in length, has a gradient of 5% and a bankfull width of 17 metres. The channel type in Reach 1 is riffle-pool with 0% pool habitat by area. Barriers and off-channel habitat do not exist. The surrounding mature deciduous forest provides less than 20% cover to the creek. Few LWD are evenly distributed. Disturbances to this reach are extensive riffle zones, extensive areas of unvegetated bar and limited pool frequency and extent. Major impacts include riprap armoured banks and extensive riffle zones. Restoration opportunities include a Level 1 Field Assessment which will aid in the identification of the most suitable instream complexing method for this reach. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present. Longnose dace, Torrent sculpin, Mottled sculpin and Slimy sculpin are present.

Reach 2

Reach 2 extends for 5150 metres and has an average gradient of 1.4%. Few LWD are evenly distributed throughout Reach 2.

Section A: Section A extends for 3200 metres and has a bankfull width of 20 metres. The channel type is riffle-bar-pool with approximately 26-50% pool habitat by area and no apparent barriers. Little off-channel habitat exists. A mature mixed deciduous/conifer forest provides 20-40% canopy cover. Eroding banks, extensive areas of unvegetated bar and multiple channels/braiding are disturbance types experienced by Section A. Major impacts include unstable banks, a road on the left bank, three slides on the right bank, as well as the possible presence of placer mining. Restoration opportunities include no action at present and bank stabilization when the upstream reaches are more stable. Rainbow trout presence is suspected.

Section B: Section B extends for 1350 metres and has a bankfull width of 15 metres. The channel type is debris-cobble-cascade-pool with approximately 51-75% pool habitat by area. The gradient in section B presents a barrier to migration. Off-channel habitat does not exist in this section. A mature conifer forest provides less than 20% canopy cover. Section B experiences eroding banks. Major impacts include unstable banks and placer mining. No action is recommended for this section. Rainbow trout presence is suspected.

Section C: Section C extends for 600 metres and has a bankfull width of 25 metres. The channel type is riffle-bar-pool with approximately 0-25% pool habitat by area. There are no barriers to migration and little off-channel habitat exists in this section. A mature mixed deciduous/conifer forest provides less than 20% canopy cover. Section C experiences eroding banks and extensive areas of unvegetated bar. Major impacts include unstable banks and placer mining. No action is recommended for this section. Rainbow trout presence is suspected.

Reach 3

Reach 3 extends for 1500 metres and has a gradient of 4.0% and an estimate bankfull width of 20 metres. The boulder-cascade-pool channel has an estimated pool habitat area of 0-25% and off-channel habitat is limited. The cascades present a barrier to migration and the LWD is abundant and clumped. The mature conifer forest which surrounds Reach 3 provides 20-40% canopy cover. Disturbance types for this reach include eroding banks and extensive areas of unvegetated bar. No action is recommended for this reach. Rainbow trout presence is suspected.

Reach 4

Reach 4 which extends for 1100 metres, has a gradient of 5.5% and an estimated average

bankfull width of 20 metres. The boulder-cascade-pool channel has an estimated pool habitat area of 0-25% and off-channel habitat is limited. Cascades, as well as LWD which is abundant and clumped (logjam) present a barrier to migration. The mature mixed deciduous/conifer forest which surrounds Reach 4 provides 20-40% canopy cover. Disturbance types for this reach include eroding banks and back channels. Major impacts include a logjam barrier of more than 100 logs, slides on both banks and excessive LWD instream. No action is recommended, although consideration should be given to assessing the enormous logjam present. Manipulation of the logjam may be extremely dangerous. Adult and juvenile Rainbow trout are present.

Reach 5

Reach 5 has a total length of 5800 metres, an average gradient of 1.6% and little available off-channel habitat.

Section A: Section A extends for 1500 metres. The channel type is boulder-cascade-pool with an estimated 0-25% pool habitat by area and a bankfull width of 20 metres. LWD is abundant and evenly distributed and potential barriers are not apparent. The surrounding mature mixed deciduous/conifer forest provides less than 20% canopy cover. Eroding banks are evident. Major impacts include excessive LWD instream and a slide on the right bank. Restoration opportunities include a Level 1 Field Assessment to determine specific sites at which the LWD should be manipulated/anchored to increase the complexity of the stream or manipulated/removed to eliminate the creation of barriers during high flows. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Rainbow trout presence is suspected.

Section B: Section B extends for 1400 metres. The channel type is boulder-cascade-pool with an estimated 0-25% pool habitat by area and a bankfull width of 19 metres. LWD is abundant and evenly distributed except where it has accumulated into a logjam which is a possible barrier. The surrounding mature mixed deciduous/conifer forest provides less than 20% canopy cover. Disturbance types to this section include eroding banks, multiple channels/braiding and extensive areas of unvegetated bar. Major impacts include excessive LWD instream and a logjam. Restoration opportunities include a Level 1 Field Assessment to determine specific sites at which the LWD should be manipulated/anchored to increase the complexity of the stream or manipulated/removed to eliminate the creation of barriers during high flows. The logjam should be assessed to determine whether or not it is a barrier to migration. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Adult and juvenile Rainbow trout are present.

Section C: Section C extends for 2900 metres. The channel type is riffle-bar-pool with an estimated 26-50% pool habitat by area and a bankfull width of 24 metres. LWD is abundant and clumped. Potential barriers exist in the form of logjams. The surrounding mature mixed deciduous/conifer forest provides 20-40% canopy cover. Disturbance types to this section include eroding banks, multiple channels/braiding and extensive areas of unvegetated bar. Major impacts include a slide, excessive LWD instream and a logjam. Restoration opportunities include a Level 1 Field Assessment to determine specific sites at which the LWD should be manipulated/anchored to increase the complexity of the stream or manipulated/removed to eliminate the creation of barriers during high flows. The logjam should be assessed to determine whether or not it is a barrier to migration. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Adult and juvenile Rainbow trout are present.

Reach 6

Reach 6 extends for 900 metres, has an average gradient of 3.3% and an estimated average bankfull width of 12 metres. The channel type is boulder-cascade-pool with an estimated 26-50% pool habitat by area and available off-channel habitat does not exist. LWD is abundant and clumped but does not appear to present a barrier to migration. The surrounding mature conifer forest provides 40-70% canopy cover to the creek. Disturbance types experienced by Reach 6 include eroding banks, multiple channels/braiding and extensive areas of unvegetated bar. No action is recommended for this reach. Rainbow trout presence is suspected.

Reach 7

Reach 7 extends for 1600 metres, has an average gradient of 7.5% and an estimated average bankfull width of 12 metres. The channel type is boulder-cascade-pool with an estimated 26-50% pool habitat by area and available off-channel habitat does not exist. LWD, abundant and clumped, and areas of steep gradient potentially present barriers to migration. The surrounding mature conifer forest provides 20-40% canopy cover to the creek. Reach 7 experiences eroding banks throughout. Major impacts include excessive LWD, logjams and a slide. Restoration opportunities include a Level 1 Field Assessment to determine specific sites at which the LWD should be manipulated/anchored to increase the complexity of the stream or manipulated/removed to eliminate the creation of barriers during high flows. The logjams should be assessed to determine whether or not they are barriers to migration. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Rainbow trout presence is suspected.

Reach 8

Reach 8 extends for 1500 metres, has an average gradient of 2.0% and an estimated

average bankfull width of 12 metres. The channel type is boulder-cascade-pool with an estimated 26-50% pool habitat by area and little available off-channel habitat. LWD, abundant and clumped, presents a potential barrier to migration. The surrounding mature conifer forest provides 40-60% canopy cover to the creek. Major impacts include excessive LWD and logjams. Restoration opportunities include a Level 1 Field Assessment to determine specific sites at which the LWD should be manipulated/anchored to increase the complexity of the stream or manipulated/removed to eliminate the creation of barriers during high flows. The logjams should be assessed to determine whether or not they are barriers to migration. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Rainbow trout presence is suspected.

Reach 9

Reach 9 extends for 4250 metres, has an average gradient of 3.5% and an estimated average bankfull width of 6 metres. Off-channel habitat in Reach 9 is available in limited quantity.

Section A: Section A extends for 1550 metres. The channel type is boulder-cascade-pool with an estimated 0-25% pool habitat by area. LWD is abundant and clumped. The surrounding mature conifer forest provides 40-60% canopy cover to the creek. Potential barriers are not apparent in this section. Major impacts include excessive LWD and logjams. Restoration opportunities include a Level 1 Field Assessment to determine specific sites at which the LWD should be manipulated/anchored to increase the complexity of the stream or manipulated/removed to eliminate the creation of barriers during high flows. The logjams should be assessed to determine whether or not they are barriers to migration. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Rainbow trout presence is suspected.

Section B: Section B extends for 700 metres. The channel type is boulder-cascade-pool with an estimated 0-25% pool habitat by area. LWD, abundant and clumped, presents potential barriers. The surrounding mature conifer forest provides 40-60% canopy cover to the creek. This section experiences eroding banks. Rainbow trout presence is suspected.

Section C: Section C extends for 2000 metres. The channel type is riffle-bar-pool with an estimated 0-25% pool habitat by area. LWD is abundant and evenly distributed. The surrounding mature conifer forest provides 20-40% canopy cover to the creek. Disturbances to this section include eroding banks, multiple channels/braiding and back channels. The major impact in this section is a logjam. Restoration opportunities A Level 1 Field Assessment to determine whether or not the logjam should be manipulated and the most suitable method of doing so. Employing the

recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment as access may be limited. Rainbow trout presence is suspected.

Reach 10

Reach 10 extends for 5000 metres, has an average gradient of 1.2% and an estimated average bankfull width of 4 metres. The channel type is riffle-bar-pool with an estimated 26-50% pool habitat by area and no available off-channel habitat. LWD is abundant and evenly distributed. The surrounding young conifer forest provides 0-20% canopy cover to the creek. Disturbances to this section include eroding banks. Major impacts to this section include clearcuts with sparse vegetation throughout. Restoration opportunities include planting riparian vegetation in clearcuts so that cover is provided to the creek. Rainbow trout presence is suspected.

Reach 11

Reach 11 extends for 2300 metres, has an average gradient of 5.2 % and an estimated average bankfull width of 2 metres. The channel type is riffle-bar-pool with an estimated 0-25% pool habitat by area and little available off-channel habitat. LWD is abundant and evenly distributed.

Section A: Section A extends for 900 metres. The surrounding vegetation has been removed leaving the creek completely exposed. Disturbances to this section include eroding banks. Major impacts to this section include a clearcut on both the right and left banks. Restoration opportunities include planting riparian vegetation in clearcuts. Adult Rainbow trout are present, juveniles are suspected.

Section B: Section B extends for 1400 metres. The surrounding vegetation is at an initial stage of growth and presently provides 0-20% cover. Rainbow trout presence is suspected. Major impacts include clearcuts with sparse vegetation in leavestrips. Restoration opportunities include planting riparian vegetation to the creek.

3.5.7 Jim Kelly Creek

Reach 1

Reach 1 extends for 300 metres, has a gradient of 6.7% and bankfull width of 20 metres. The channel type is riffle-bar-pool with 0% pool habitat by area and no available off-channel habitat. The few LWD present are clumped. The riparian shrubs provide 0-20% cover to the creek. Barriers to migration do not exist in the mainstem of Reach 1. Disturbances to this section include eroding banks, extended riffle zones and extensive areas of unvegetated bars. Major impacts include sediment deposition due to placer mining. No action is recommended as placer mining is active. Adult Rainbow trout are present.

Reach 2

Reach 2 is 5150 metres in length and has a gradient of 3.1%. The channel type is boulder-cascade-pool with 26-50% pool habitat by area.

Section A: Section A extends for 500 metres and has a bankfull width of 10 metres. Off-channel habitat is limited and few LWD are evenly distributed throughout this section. The surrounding mature mixed deciduous/conifer forest provides 0-20% canopy cover to the creek. Barriers to migration do not exist in this section. Disturbances to this section include eroding banks. Major impacts include sediment deposition due to placer mining. No action is recommended as placer mining is active. Adult Rainbow trout are present. Juvenile Rainbow trout do not appear to be abundant in this reach as trout with fork lengths and weights comparable to class 0+ for the watershed were not observed in Site 1.

Section B: Section B extends for 4650 metres and has a bankfull width of 15 metres. Off-channel habitat is available. LWD is abundant and clumped. Barriers to the section are in the form of cascades/falls. The surrounding mature conifer forest provides 20-40% canopy cover to the creek. Disturbances to this section include eroding banks, extensive areas of unvegetated bar and multiple channels/braiding. Major impacts include sediment deposition, unstable banks and a slide on the right bank. No action is recommended as placer mining is active. Adult and juvenile Rainbow trout are present.

Reach 3

Reach 3 is 2440 metres in length, has a gradient of 4.9% and has an estimated average bankfull width of 10 metres. The channel type is boulder-cascade-pool with 0-25% pool habitat by area. Off-channel habitat is moderate. LWD are few and evenly distributed and barriers in Reach 3 are not apparent. The surrounding mature conifer forest provides 0-20% canopy cover to the creek. Disturbances to this section include eroding banks, extensive areas of unvegetated bars and multiple channels. Major impacts include sediment deposition, unstable banks and a slide on the right bank. No action is recommended. Rainbow trout are present.

Reach 4

Reach 4 is 1420 metres in length, has a gradient of 7.0% and has an estimated average bankfull width of 6 metres. The channel type is boulder-cascade-pool with 0-25% pool habitat by area. Limited off-channel habitat exists in this reach. LWD are few and evenly distributed and barriers in Reach 4 are not apparent. The surrounding mature conifer forest provides 0-20% canopy cover to the creek. Disturbances to this section include eroding banks, extensive areas of unvegetated bar and multiple channels/braiding. No action is recommended for this reach. Rainbow trout are present.

Reach 5

Reach 5 is 450 metres in length, has a gradient of 13.3% and has an estimated average bankfull width of 5 metres. The channel type is boulder-cascade-pool with 0-25% pool habitat by area. Limited off-channel habitat exists in this reach and LWD is not apparent. Potential barriers are in the form of steep gradients. The surrounding mature conifer forest provides 0-20% canopy cover to the creek. Disturbances to this section include eroding banks and multiple channels. No action is recommended for this reach. Rainbow trout are present.

Reach 6

Reach 6 is 1310 metres in length.

Section A: Section A is 930 metres in length, has an average gradient of 30.1% and has an estimated average bankfull width of 2 metres. The channel type is boulder-cascade-pool with 0-25% pool habitat by area. Limited off-channel habitat exists in this reach and LWD is not apparent. Steep gradients present potential barriers to migration. The surrounding mature conifer forest provides 0-20% canopy cover to the creek. Disturbances to this section include eroding banks and multiple channels. No action is recommended for this section. Fish presence is unknown.

Section B: Section B is a marsh/lake and therefore has a gradient of 0%. No action is recommended for this section. Fish presence is unknown.

3.5.8 Olivine Creek

Reach 1

Reach 1 is 400 metres in length, has a gradient of 10% and a bankfull width of 19 metres. The channel type is debris-cobble-cascade-pool with 0-25% pool habitat by area. Off-channel habitat available to fish exists in this reach. LWD is abundant and clumped. A falls / chute is a potential barrier at the upper break of this reach. The surrounding mature mixed deciduous/conifer forest provides 20-40% canopy cover to the creek. Disturbances to this section include eroding banks and recently formed logjams. An enormous logjam and 1 metre falls, which exist in a side channel to Reach 1, present an upstream barrier to migration. No action is recommended for this reach. Adult and juvenile Rainbow trout are present.

Reach 2

Reach 2 extends for 700 metres, has a gradient of 11.4% and a bankfull width of 9 metres. The channel type is debris-cobble-cascade-pool with 0-25% pool habitat by area. Off-channel habitat available to fish exists in this reach. LWD is abundant and clumped. Potential barriers are not apparent in the mainstem of this reach. The surrounding mature mixed deciduous/conifer forest provides 20-40% canopy cover to the creek.

Disturbances to this section include eroding banks and recently formed logjams. No action is recommended for this reach. Adult and juvenile Rainbow trout are present.

Reach 3

Reach 3 extends for 3610 metres, has a gradient of 7.8% and an estimated average bankfull width of 10 metres. The channel type is debris-boulder-step-pool 26-50% pool habitat by area. Limited off-channel habitat available to fish exists in this reach. LWD is abundant and clumped. Falls present a barrier to migration. The surrounding mature mixed deciduous/conifer forest provides 20-40% canopy cover to the creek. Disturbances to this section include eroding banks and recently formed logjams. Major impacts include excessive LWD, a clearcut which is partially regrown and a road on the right bank adjacent to the creek and a slide. No action is recommended for this reach. Rainbow trout presence is unknown.

Reach 4

Reach 4 extends for 1800 metres, has a gradient of 5.6% and a bankfull width of 8 metres. The channel type is debris-boulder-step-pool with 0-25% pool habitat by area. Off-channel habitat available to fish exists in this reach. LWD is abundant and clumped and potential barriers are not apparent. The surrounding mature conifer forest provides 0-20% canopy cover to the creek. Disturbances to this section include eroding banks and recently formed logjams. No action is recommended for this reach. Rainbow trout presence is unknown.

Reach 5

Reach 5 extends for 1100 metres, has a gradient of 7.3% and a bankfull width of 6 metres. The channel type is debris-boulder-step-pool with 0-25% pool habitat by area. Limited off-channel habitat is available in this reach. LWD is abundant and evenly distributed. Potential barriers are not apparent in this reach. The surrounding shrub vegetation provides 0-20% cover to the creek. Disturbances associated with this reach are recently formed logjams. No action is recommended for this reach. Rainbow trout presence is unknown.

Reach 6

Reach 6 extends for 2700 metres, has a gradient of 2.2% and a bankfull width of 5 metres. The channel type is debris-boulder-step-pool with 0-25% pool habitat by area. Off-channel habitat is not available in this reach. Few LWD are evenly distributed throughout this reach. Potential barriers are not apparent. The surrounding shrub vegetation provides 0-20% cover to the creek. Disturbances associated with this reach are recently formed logjams. Major impacts include a clearcut to the right bank and a slide. No action is recommended. Rainbow trout presence is unknown

Reach 7

Reach 7 extends for 1050 metres, has a gradient of 26.7% and a bankfull width of 5 metres. The channel type is debris-boulder-step-pool with 0-25% pool habitat by area. Limited off-channel habitat is available in this reach. Few LWD are evenly distributed throughout. The steep gradient presents a barrier. The riparian zone is barren of vegetation and canopy cover does not exist. No action is recommended. Rainbow trout presence is unknown

3.5.9 Otter Creek

Reach 1

Reach 1 extends for 1000 metres, has a gradient of 0% and a bankfull width of 11 metres. The channel type is riffle-pool with 0-25% pool habitat by area. Off-channel habitat is not available in this reach. Barriers and LWD are not present. The surrounding shrub vegetation provides 0-20% cover to the creek. Disturbances to this reach are extensive riffle zones, limited pool frequency and extent and eroding banks. Major impacts include urbanization and barren riparian zones. Restoration opportunities include planting riparian vegetation. Instream complexing might be considered. Rainbow trout, Longnose dace, Umatilla dace, Prickly sculpin and Torrent sculpin are present.

Reach 2

Reach 2, Otter Lake, is approximately 5400 metres in length. No action is recommended for this reach. Rainbow trout, Lake trout, Kokanee, Mountain whitefish, Prickly sculpin, Northern squawfish, Peamouth chub, Redside shiner and Largescale sucker are present.

Reach 3

Reach 3 extends for 2400 metres and has a gradient of 0%. The channel type is riffle-bar-pool with little off-channel habitat available. LWD and barriers to migration do not exist in this reach. Riparian shrub vegetation provides 0-20% cover, a canopy does not exist.

Section A: Section A is 1600 metres in length with an estimated average bankfull width of 25 metres. Pool habitat for this section is estimated at less than 25% by area. Disturbance types include extensive areas of unvegetated bar, eroding banks and back channels. Major impacts to this section include intermittent flows. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. A minimum flow should be ensured year round. Rainbow trout are suspected.

Section B: Section B is 800 metres in length with an estimated average bankfull width of 10 metres. Pool habitat for this section is estimated at 26-50% by area.

No action is recommended although water quality might be tested to determine the impact of agriculture to the system. Rainbow trout, Kokanee, Longnose dace, Slimy sculpin, Prickly sculpin, Mottled sculpin, Redside shiner and Largescale sucker are present.

Reach 4

Reach 4, Frembd Lake, is approximately 1000 metres in length. No action is recommended although water quality might be tested to determine the impact of agriculture to the lake. Rainbow trout presence is suspected.

Reach 5

Reach 5 is 2720 metres in length, has an average gradient of 0.7% and has a bankfull width of 13 metres. The channel type is riffle-pool with 26-50% pool habitat by area. Off-channel habitat is abundant with good access for fish. Barriers are not present in this reach. The surrounding shrub vegetation provides 20-40% cover.

Section A: Section A extends for 1400 metres. LWD is not present in this section. Disturbances include isolated back channels. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. Rainbow trout presence is suspected.

Section B: Section B extends for 700 metres. Few LWD are distributed evenly throughout this section. Disturbances include isolated back channels and multiple channels/braiding. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. Rainbow trout and Mottled sculpin are present.

Section C: Section C extends for 620 metres. Few LWD are distributed evenly throughout this section. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. Adult and juvenile Rainbow trout are present. Brook trout, Mountain whitefish, Longnose dace, Slimy sculpin, Prickly sculpin, Mottled sculpin and Redside shiner are present.

Reach 6

Reach 6 is 3100 metres in length, has an average gradient of 0.6% and an estimated average bankfull width of 13 metres. The riffle-pool channel in this reach contains no potential barriers. The surrounding shrub vegetation provides 20-40% cover to the channel. Roads and bridges have been washed out by the flood in this reach.

Section A: Section A extends for 400 metres. Pool habitat is estimated at 26-50% by area and off-channel habitat with good access for fish is abundant. Few LWD are evenly distributed throughout this section. No action is recommended although water quality might be tested to determine the

impact of agriculture to the system. Rainbow trout are present.

Section B: Section B extends for 2100 metres. Pool habitat is estimated at 0-25% by area and limited off-channel habitat exists. LWD is not apparent in this section. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. Rainbow trout are present.

Section C: Section C extends for 600 metres. Pool habitat is estimated at 0-25% by area and limited off-channel habitat exists. LWD is not apparent in this section. Intermittent flows are experienced by this section. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. A minimum flow should be ensured year round. Rainbow trout presence is suspected.

Reach 7

Reach 7 has a total length of 600 metres and an average gradient of 0%.

Section A: Section A extends for 250 metres. The channel type is riffle-pool with 0% pool habitat by area and limited off-channel habitat. Barriers and LWD are not apparent in this section. The shrub vegetation surrounding the channel provides 20-40% cover to the creek. Disturbance is present on the form of extensive riffle zones. Intermittent flows are experienced by this section. No action is recommended although water quality might be tested to determine the impact of agriculture to the system. A minimum flow should be ensured year round. Rainbow trout are present.

Section B: Section B is a marsh/lake. No action is recommended. Rainbow trout are present.

Reach 8

Reach 8, Thynne Lake, is approximately 590 metres in length. No action is recommended. Rainbow trout are present.

Reach 9

Reach 9 has a total length of 5400 metres, a gradient of 0% and a bankfull width of 10 metres. Barriers and LWD do not exist in this reach. The surrounding shrub vegetation provides less than 20% cover. Limited off-channel habitat is available.

Section A: Section A which extends for 1600 metres, is comprised of a riffle-pool channel type. Pool habitat is estimated at less than 25% by area. Disturbance types include isolated back channels and multiple channels. Major impacts include intermittent flows. No action is recommended although water quality might be tested to determine the impact of

agriculture to the system. A minimum flow should be ensured year round. Rainbow trout, Prickly sculpin, Redside shiner and Largescale sucker are present.

Section B: Section B extends for 3400 metres. Channel type is riffle-bar-pool with less than 25% pool habitat by area. No action is recommended for this section. Rainbow trout and Slimy sculpin are present.

Reach 10

The total length of Reach 10 is 7940 metres. The average gradient is 0.5% and the bankfull width is 6 metres. The channel type throughout Reach 10 is riffle-pool with less than 20% pool habitat by area. LWD is not apparent.

Section A: Section A extends for 2250 metres. Off-channel habitat is accessible to fish and abundant. The surrounding mature deciduous forest provides less than 20% canopy cover. Barriers to migration are not present. Disturbance types include isolated back channels and multiple channels/braiding. No action is recommended for this section. Rainbow trout are present.

Section B: Section B extends for 700 metres. Limited off-channel habitat is accessible to fish. Barriers to migration are not present. The surrounding mature deciduous forest provides less than 20% canopy cover. No action is recommended for this section. Adult and juvenile Rainbow trout are present. Sculpin species are present.

Section C: Section C extends for 4400 metres. Off-channel habitat is accessible to fish and abundant. The surrounding mature deciduous forest provides less than 20% canopy cover. A beaver dam is a potential barrier in this reach. Disturbance types include isolated back channels, multiple channels/braiding and extensive areas of unvegetated bar. No action is recommended for this section. Rainbow trout Mottled sculpin are present.

Section D: Section D extends for 590 metres. Limited off-channel fish habitat is available. Barriers are not present. The surrounding mature deciduous forest provides 20-40% canopy cover. Disturbance types include extensive areas of unvegetated bar and isolated back channels. No action is recommended for this section. Rainbow trout presence is suspected.

Reach 11

Reach 11 has a total length of 4900 metres and a gradient of 0.8%. Barriers and LWD are not present in Reach 11.

Section A: Section A which extends for 400 metres, has an estimated average bankfull width of 6 metres. The channel type is riffle-pool with less than 25% pool habitat and limited off-channel habitat. The surrounding mature

conifer forest provides 20-40% canopy cover. A road and railway are present. No action is recommended for this section. Rainbow trout presence is suspected.

Section B: Section B which extends for 4500 metres, has an estimated average bankfull width of 5 metres. The channel type is boulder-cascade-pool with less than 25% pool habitat and limited off-channel habitat. The surrounding mature conifer forest provides 0-20% canopy cover. Eroding banks are evident. Major impacts include numerous slides on the left bank, unstable slope above the road and barren riparian zone at the road. Restoration recommendations include planting riparian vegetation at the road and water quality to determine the impact of agriculture on the creek. Adult and juvenile Rainbow trout are present. Longnose dace, Slimy sculpin, and Redside shiner are present.

Reach 12

Reach 12 extends for 2800 metres, has a gradient of 0.7% and a bankfull width of 5 metres. The channel type is riffle-pool with an estimated 26-50% pool habitat by area. Limited off-channel habitat is available. Barriers and LWD are not present in Reach 12. The mature conifer forest provides less than 20% canopy cover. No action is recommended. Rainbow trout and Redside shiner are present.

Reach 13

The total length of Reach 13 is 2600 metres and the average gradient is 0.8%.

Section A: Section A extends for 200 metres and has a bankfull width of 6 metres. The channel type is riffle-pool, with pool habitat estimated at 26-50% by area. Off channel habitat with good access for fish is present. Barriers and LWD are not present in this section. The surrounding shrub vegetation provides 20-40% canopy cover. No action is recommended. Rainbow trout presence is suspected.

Section B: Section B, which is a marsh/lake, extends for approximately 1100 metres. No action is recommended. Rainbow trout presence is suspected.

Section C: Section C extends for 1300 metres and has a bankfull width of 6 metres. The channel type is riffle-pool, with pool habitat estimated at 26-50% by area. Off channel habitat with good access for fish is abundant. Barriers and LWD are not present in this section. The surrounding shrub vegetation provides less than 20% canopy cover. No action is recommended. Rainbow trout presence is suspected.

Reach 14

The total length of Reach 14 is 4050 metres. The average gradient is 0% and the estimated average bankfull width is 5 metres. The channel type is riffle-pool with less than 25% pool habitat by area. Barriers and LWD are not present in this reach.

Section A: Section A which extends for 760 metres, provides limited off-channel habitat for fish. The surrounding shrub vegetation provides 20-40% cover for the creek. No action is recommended. Rainbow trout are present.

Section B: Section B which extends for 1100 metres, provides limited off-channel habitat for fish. The surrounding shrub vegetation provides 40-70% cover for the creek. Isolated back channels are apparent disturbances in this section. No action is recommended although water quality allowing for the determination of impacts due to agriculture might be considered. Rainbow trout are present.

Section C: Section C which extends for 2190 metres, provides some off-channel habitat with good access for fish. The surrounding shrub vegetation provides 40-70% cover for the creek. Isolated back channels are apparent disturbances in this section. No action is recommended. Rainbow trout are present.

Reach 15

The total length of Reach 15 is 5450 metres. The average gradient is 0.4% and the estimated average bankfull width is 5 metres. The channel type is riffle-pool with less than 25% pool habitat by area. Off-channel habitat accessible to fish is present. Barriers and LWD are not present in this reach.

Section A: Section A extends for 2200 metres. The shrub vegetation surrounding this section provides 20-40% cover. Isolated back channels are apparent disturbances in this section. No action is recommended although water quality allowing for the determination of impacts due to agriculture might be considered. Rainbow trout are present.

Section B: Section B extends for 1300 metres. There is no riparian vegetation surrounding this section. Impacts due to cattle are probable. Water quality analysis is recommended. Consider fencing to keep cattle out of creek beds and making water available with troughs so that instream disturbance is minimized. Rainbow trout are present.

Section C: Section C extends for 1950 metres. The mature conifer forest surrounding this section provides less than 20% canopy cover. Isolated back channels are apparent disturbances in this section. Impacts due to cattle are probable. Water quality analysis is recommended. Consider fencing to keep cattle out of creek beds and making water available with troughs so

that instream disturbance is minimized. Rainbow trout are present.

Reach 16

The total length of Reach 16 is 3390 metres, the average gradient is 1.2% and the bankfull width is 2 metres. The channel type is riffle-pool with less than 25% pool habitat by area. Barriers and LWD are not present in Reach 16. The surrounding shrub vegetation provides 40-70% cover.

Section A: Section A extends for 1390 metres and provides little off-channel habitat for fish. Impacts due to cattle are probable. Water quality analysis is recommended. Consider fencing to keep cattle out of creek beds and making water available with troughs so that instream disturbance is minimized. Adult and juvenile Rainbow trout are present. Sculpin species and Redside shiners are present.

Section B: Section B extends for 2000 metres and provides some off-channel habitat with good access for fish. Impacts due to cattle are probable. Water quality analysis is recommended. Consider fencing to keep cattle out of creek beds and making water available with troughs so that instream disturbance is minimized. Rainbow trout are present.

Reach 17

Reach 17 extends for 4750 metres, has a gradient of 1.3% and a bankfull width of 2 metres. The channel type is riffle-pool with an estimated 0-25% pool habitat by area. Limited off-channel habitat is available. Barriers and LWD are not present in Reach 17. The shrub vegetation provides 40-70% cover. No action is recommended. Rainbow trout are present.

Reach 18

Reach 18, Kidd Lake, extends for approximately 500 metres. No action is recommended. Rainbow trout are present.

Reach 19

Reach 19 extends for 5100 metres, has a gradient of 1.2% and a bankfull width of 2 metres. The channel type is riffle-pool with an estimated 0-25% pool habitat by area. Limited off-channel habitat is available. Barriers and LWD are not present in Reach 19. Shrub vegetation surrounding the creek provides 20-40% cover. No action is recommended. Rainbow trout presence is suspected.

3.5.10 Podunk Creek

Reach 1

Reach 1 has a total length of 700 metres and an average gradient of 2.9%. The channel type is riffle-bar-pool with an estimated 0-25% pool habitat by area. Barriers to migration are not present in Reach 1.

Section A: Section A which extends for 200 metres has an estimated average bankfull width of 6 metres. Limited off-channel habitat is available for fish. Few LWD are clumped in this section. The surrounding mature mixed deciduous/conifer forest provides 40-70% canopy cover for the creek. Multiple channels/braiding is the predominant form of disturbance. No action is recommended. Rainbow trout are present.

Section B: Section B, which extends for 500 metres has an estimated average bankfull width of 9 metres. Off-channel fish habitat is abundant. LWD is abundant and clumped in this section. The surrounding mature conifer forest provides less than 20% canopy cover for the creek. Disturbance in this section includes multiple channels/braiding, extensive areas of unvegetated bar and isolated back channels. Major impacts include excessive LWD and logjams. No action is recommended. Rainbow trout presence is suspected.

Reach 2

Reach 2 has a total length of 2500 metres and an average gradient of 1.3%. The channel type is riffle-bar-pool with less than 25% estimated pool habitat by area. Barriers are not present in Reach 2.

Section A: Section A which extends for 1400 metres has a bankfull width of 9.3 metres. Off-channel fish habitat is abundant. LWD is abundant and clumped in this section. The surrounding mature conifer forest provides less than 20% canopy cover for the creek. Disturbance in this section includes multiple channels/braiding, extensive areas of unvegetated bar and large extensive sediment wedges. No action is recommended. Adult and juvenile Rainbow trout are present.

Section B: Section B which extends for 1100 metres has an estimated average bankfull width of 7 metres. Limited off-channel fish habitat is available. Few LWD are evenly distributed throughout this section. The surrounding young conifer forest provides 20-40% cover for the creek. Disturbance in this section includes the presence of extensive areas of unvegetated bar. Major impacts include a clearcut with a setback on the left bank and a logjam. No action is recommended. Rainbow trout presence is suspected.

Reach 3

Reach 3 has a total length of 4800 metres and an average gradient of 1.9%. The channel type is riffle-bar-pool with less than 25% estimated pool habitat by area. Few LWD are clumped and barriers are not present in Reach 3.

Section A: Section A which extends for 1500 metres has an estimated average bankfull width of 7 metres. Off-channel fish habitat is abundant. The surrounding shrub vegetation provides 20-40% cover for the creek. Disturbance in this section includes multiple channels/braiding, extensive areas of unvegetated bar and isolated back channels. Major impacts include a clearcut with a setback on the right bank. No action is recommended. Rainbow trout are present.

Section B: Section B which extends for 3300 metres has a bankfull width of 5 metres. Limited off-channel fish habitat is available. The surrounding shrub vegetation provides 20-40% cover for the creek. Disturbance in this section includes extensive riffle zones and isolated back channels. Major impacts include a clearcut with a setback on the right bank. Restoration opportunities include a Level 1 Field Assessment to determine the best suitable method of instream complexing for this section using the LWD available. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Adult and juvenile Rainbow trout are present.

Reach 4

Reach 4 has a total length of 2900 metres, an average gradient of 2.1%, and a bankfull width of 3.8 metres. The channel type is riffle-bar-pool with less than 25% estimated pool habitat by area. Off-channel fish habitat is abundant. Few LWD are evenly distributed and barriers are not present in Reach 4. The surrounding shrub vegetation provides 20-40% cover. Disturbance types include multiple channels/braiding. The major impact to this section includes a clearcut with setback on the left bank. No action is recommended. Adult and juvenile Rainbow trout are present.

Reach 5

Reach 5 has a total length of 900 metres, an average gradient of 10%, and an estimated average bankfull width of 3 metres. The channel type is described as debris-cobble-cascade-pool with the pool habitat comprising 26-50% by area. Limited off-channel fish habitat is available. Few LWD are evenly distributed and barriers are not apparent in Reach 5. The surrounding shrub vegetation provides 40-70% cover. No action is recommended. Rainbow trout presence is suspected.

Reach 6

Reach 6 has a total length of 350 metres, an average gradient of 34.3%, and an estimated average bankfull width of 3 metres. The channel type is described as debris-cobble-cascade-pool with the pool habitat comprising 26-50% by area. Limited off-channel fish habitat is available and few LWD are evenly distributed. The gradient (34.4%) presents a barrier to fish migration. Shrub vegetation surrounding the reach provides 40-70% cover. The major impact to this reach is a clearcut with setback on the right bank. No action is recommended. Rainbow trout presence is suspected.

Reach 7

Reach 7 has a total length of 600 metres, an average gradient of 5.0%, and an estimated average bankfull width of 1 metre. The channel type is described as debris-cobble-cascade-pool with the pool habitat comprising 26-50% by area. Off-channel fish habitat is abundant and LWD is not present. Barriers are not present in this reach. Vegetation surrounding the reach is in an initial stage of growth and therefore provides less than 20% cover to the creek. No action is recommended. Rainbow trout presence is suspected.

Reach 8

Reach 8 has a total length of 550 metres, an average gradient of 11.3%, and an estimated average bankfull width of 1 metre. The channel type is described as debris-cobble-cascade-pool with the pool habitat comprising approximately 0-25% by area. Off-channel habitat is not available to fish and LWD is not present. The gradient (11.3%) presents a potential barrier to fish migration. A mature conifer forest surrounding this reach provides 40-70% canopy cover. The major impact to this reach is a clearcut with setback on the right bank. No action is recommended. Rainbow trout presence is suspected.

3.5.11 Spearing Creek

Reach 1

Reach 1 has a total length of 2500 metres, an average gradient of 1.2% and a bankfull width of 11 metres. The channel type is riffle-bar-pool with less than 25% pool habitat by area. Off-channel fish habitat is abundant. LWD is abundant and evenly distributed throughout Reach 1. Barriers to migration are not present. The mature conifer forest surrounding this reach provides 20-40% canopy cover. The predominant disturbance type is in the form of extensive areas of scour. Major impacts include intermittent flow, unstable left bank and a slide above the road on the right bank. Restoration opportunities include ensuring a minimum flow, if possible, and planting riparian vegetation at the slide for stabilization. Rainbow trout are present.

Reach 2

Reach 2 has a total length of 600 metres, an average gradient of 5.0% and a bankfull width of 5 metres. The channel type is riffle-bar-pool with 26-40% pool habitat by area. Off-channel fish habitat is abundant. Few LWD are evenly distributed throughout Reach 2. Barriers to migration are not present. The shrub vegetation surrounding this reach provides 20-40% cover. A fish inventory is recommended. Rainbow trout and Slimy sculpin are present.

Reach 3

Reach 3 has a total length of 1100 metres, an average gradient of 0% and a bankfull width of 5 metres. The channel type is riffle-bar-pool with 26-50% pool habitat by area. Off-channel fish habitat is abundant. Few LWD are evenly distributed throughout Reach 3. Barriers to migration are not present. The shrub vegetation surrounding this reach provides 40-70% cover. The predominant disturbance type is in the form of isolated back channels. Major impacts include a slide at the railway line, an unstable left bank and a rock slide on the left bank. Restoration opportunities include a Fish inventory, a Level 1 Field Assessment and bank stabilization. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is suspected.

Reach 4

Reach 4 has a total length of 2500 metres, an average gradient of 1.2% and a bankfull width of 5 metres. The channel type is riffle-bar-pool with less than 25% pool habitat by area. Off-channel fish habitat is abundant. Few LWD are evenly distributed throughout Reach 4. Barriers to migration are not present. The shrub vegetation surrounding this reach provides 0-20% cover. Disturbance types are isolated back channels and extensive areas of unvegetated bar. The major impact is a clearcut to the marsh on the right bank. Planting riparian vegetation is recommended. Rainbow trout presence is suspected.

Reach 5

Reach 5 has a total length of 1000 metres, an average gradient of 0% and a bankfull width of 7 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area. Available off-channel fish habitat and barriers to migration are not present. Few LWD are evenly distributed throughout the reach and the mature conifer forest provides 40-70% canopy cover. A fish inventory is recommended. Rainbow trout presence is suspected.

Reach 6

Reach 6 has a total length of 2200 metres, an average gradient of 8.2% and a bankfull width of 5 metres. The channel type is riffle-bar-pool with 0-25% pool habitat by area. Available off-channel fish habitat and barriers to migration are not present. Few LWD

are evenly distributed throughout the reach and the mature conifer forest provides 40-70% canopy cover. Flow is intermittent. No action is recommended. Rainbow trout presence is unknown.

Reach 7

Reach 7 has a total length of 3200 metres and an estimated gradient of 6.0%. Due to the canopy cover provided by the mature conifer forest (40-70%), the bankfull width, channel type, pool habitat area, LWD, off-channel habitat, barriers and disturbance types of Reach 7 could not be determined. No action is recommended. Rainbow trout presence is unknown.

Reach 8

Reach 8 has a total length of 1400 metres and an estimated gradient of 10.9%. Due to the canopy cover provided by the mature conifer forest (40-70%), the bankfull width, channel type, pool habitat area, LWD, off-channel habitat, barriers and disturbance types of Reach 7 could not be determined. No action is recommended. Rainbow trout presence is unknown.

3.5.12 Vuich Creek

Reach 1

Reach 1 is 1620 metres in length, has a gradient of 2.5% and an estimated average bankfull width of 15 metres. The channel type is boulder-cascade-pool with 26-50% pool habitat by area and no available off-channel habitat. Few LWD are evenly distributed throughout this reach and barriers are not present. The mature conifer forest provides less than 20% canopy cover. Major impacts include a clearcut on the left bank, an unstable right bank and sedimentation instream. A Level 1 Field Assessment is recommended to assess the best suitable methods of bank stabilization for this reach. Employing the recently taped video of the creek, in conjunction with ground truthing, may be an alternative to the Level 1 Field Assessment. Rainbow trout presence is unknown.

Reach 2

Reach 2 is a total of 1860 metres in length and has an average gradient of 4.3%. Few LWD are evenly distributed throughout this reach.

Section A: Section A extends for 1410 metres and has an estimated average bankfull width of 15 metres. The channel type is boulder-cascade-pool with 26-50% pool habitat by area and limited available off-channel fish habitat. No barriers are present. A mature conifer forest provides less than 20% canopy cover. Eroding banks and sedimentation are evident. No action is recommended. Rainbow trout presence is unknown.

Section B: Section B extends for 450 metres and has an estimated average bankfull width of 13 metres. The channel type is block-step-pool with 51-75% pool habitat by area and no available off-channel fish habitat. Cascades and falls in this section present a complete barrier to fish migration. A mature conifer forest provides no canopy cover. Eroding banks, sedimentation and multiple channels/braiding are evident. No action is recommended. Rainbow trout presence is suspected.

Reach 3

Reach 3 is 580 metres in length, has a gradient of 0% and a bankfull width of 12.5 metres. The channel type is riffle-bar-pool with less than 25% pool habitat by area and with limited available off-channel habitat. Few LWD are evenly distributed throughout this reach and barriers are not present. The mature conifer forest provides less than 20% canopy cover. Disturbance types are isolated back channels and extensive areas of unvegetated bar. Major impacts include a slide and unstable banks. No action is recommended. Adult and juvenile Rainbow trout are present.

Reach 4

The total length of Reach 4 is 4350 metres and the average gradient is 4.6%. Barriers are not apparent and few LWD are evenly distributed. Limited off-channel fish habitat is available throughout.

Section A: Section A extends for 1650 metres and has an estimated average bankfull width of 12 metres. The channel type is riffle-bar-pool with less than 25% pool habitat by area. The mature mixed conifer/deciduous forest surrounding this section provides less than 20% canopy cover. Disturbance types include isolated back channels, extensive areas of unvegetated bar and multiple channels/braiding. Major impacts include unstable banks. No action is recommended. Rainbow trout presence is suspected.

Section B: Section B extends for 2300 metres and has a bankfull width of 10 metres. The channel type is boulder-cascade-pool with less than 25% pool habitat by area. The mature mixed conifer/deciduous forest surrounding this section provides 20-40% canopy cover. Disturbance types include isolated back channels and multiple channels/braiding. Major impacts include unstable banks. No action is recommended. Adult and juvenile Rainbow trout are present.

Reach 5

Reach 5 is 1300 metres in length, has a gradient of 5.9% and an estimated average bankfull width of 5 metres. The channel type is riffle-bar-pool with less than 25% pool habitat by area and with abundant off-channel habitat available. Few LWD are evenly distributed throughout this reach and barriers are not present. The young conifer forest

provides 40-70% canopy cover. Disturbance types are isolated back channels and multiple channels/braiding. No action is recommended. Rainbow trout presence is suspected.

Reach 6

Reach 6 is 3900 metres in length, has a gradient of 8.6% and an estimated average bankfull width of 5 metres. The channel type is riffle-bar-pool with less than 25% pool habitat by area. Abundant off-channel habitat is available. LWD and barriers are not present. The young conifer forest provides 40-70% canopy cover. Disturbance types are isolated back channels, multiple channels/braiding and eroding banks. No action is recommended. Rainbow trout presence is suspected.

Reach 7

Reach 7 is 2100 metres in length, has a gradient of 46.5% and an estimated average bankfull width of 5 metres. The channel type is boulder-step-pool with 26-50% estimated pool habitat by area and with abundant off-channel habitat available. LWD is not present in this reach. The gradient (46.5%) presents a barrier to fish migration. The mature conifer forest provides 20-40% canopy cover. No action is recommended. Rainbow trout presence is unknown.

Tributary

The reach observed in an equivalent tributary (stream order 2) to Reach 6 had a channel type of riffle-bar-pool. Limited off-channel habitat is present. LWD is abundant and clumped. The surrounding vegetation consists of a young conifer forest which provides 20-40% cover to the creek and an area completely barren of vegetation. Disturbances associated with the tributary, especially the area void of vegetation are eroding banks and isolated back channels. Major impacts include a clearcut to the creek. Restoration opportunities include planting riparian vegetation. Rainbow trout are present. The Rainbow trout that were aged from the tributary were class 1+ and 2+. Class 0+ appeared to be abundant however class 3+ or older individuals were not observed.

3.6 Heavily Used Reaches

Heavily used reaches were defined as reaches that were suspected to be capable of supporting a density of Rainbow trout greater than 0.100 individuals per square metre. The process by which a specific reach was suspected of heavy use involved locating sample sites which yielded densities greater than 0.100 Rainbow trout per square metre and assessing the surrounding reaches. Because reaches are distinguished by homogenous, a sample site will represent the entire reach. From the information available, reaches adjacent to heavily used reaches were assessed as to their suitability to support high densities of Rainbow trout. Table 4 lists the densities for all sites sampled.

Reaches 20 (A,B), 21 and 22 (A-E) were considered heavily used reaches. Site 5 of Tulameen River was located in Reach 21-A.

The three sites sampled in Arrastra Creek had densities greater than 0.100 Rainbow trout per square metre, and therefore were considered 'heavily used'. Due to lack of complete barriers in the creek, use in its entire length could be considered heavy. Similar to Arrastra Creek, the three sites in Asp Creek yield densities exceeding 0.100 Rainbow trout per square metre. Site 1 of Asp Creek supported the most dense population of Rainbow trout in the watershed. Due to the absence of barriers, all reaches in Asp Creek were considered 'heavily used'.

The entire length of Frenchy Creek above Reach 1 is considered heavily used by Rainbow trout as the three sample sites yielded densities of greater than 0.100 Rainbow trout per square metre and barriers above the falls in Reach 1 are not apparent.

Olivine Creek is heavily used below the falls in Reach 1. Use above the falls is not apparent. Both sample Sites 1 and 2 yielded densities of greater than 0.100 Rainbow trout per square metre.

Site 4 and Site 6 of Otter Creek were both considered heavily used. Many areas of Otter Creek may support higher densities of Rainbow trout. Heavily used reaches probably include all the reaches above Reach 1.

Reaches 1 to 5 of Podunk Creek are probably heavily used by Rainbow trout. The three sites which represent lower, middle and upper Podunk Creek yielded densities of greater than 0.100 Rainbow trout per square metre. The gradient in Reach 6 is a barrier and fish presence upstream is unknown.

Reach 4 of Vuich Creek and the tributary which was sampled, yielded densities greater than 0.100 Rainbow trout per square metre. Heavily used reaches in Vuich Creek are those upstream of the falls / chute in Reach 2.

4.0 SUMMARY

Logging has effected a number of watercourses in the watershed. Clearcuts are present in areas of the Tulameen River and Arrastra, Champion, Frenchy, Granite, Olivine, Podunk, Spearing and Vuich Creeks. The most obvious impacts are clearcut areas in the Granite Creek watershed which includes Arrastra and Frenchy Creeks. In the headwaters of the Granite Creek watershed vast areas of land and stream bank remain barren of vegetation. Champion Creek has, as well, been clearcut to the bankfull width in areas. Although fish are not suspected in these upper reaches of Champion Creek, increased sedimentation and extreme flow fluctuations as a result of clearcutting may have detrimental effects to the lower reaches where rainbow trout are present. Clearcut areas, which have a lower water retention capacity, appear to increase stream water flows. For example, in the Carnation Creek watershed study, water yield of Tributary H was elevated in six out of seven years following clearcutting (Hartman 1990).

Loss of riparian vegetation reduces the overall cover for the stream. Vegetative cover of the wetted width is important for fish populations as cover provides protection, a source of food, bank stability and shade. LWD, which generally replaces riparian vegetation as cover following the clearing of an area, is not sufficient alone as soil is stabilized by rooted vegetation.

Effects of clearcutting and the 1995 flood to the Tulameen River watershed are described below. Each watercourse is given an overall rating which refers to a fisheries value based on the overall condition of fish habitat. The presence of fish was, as well, taken in to account so that for the purpose of this report, a stream that contained low densities of rainbow trout (e.g. Champion Creek) was given a lower rating than a stream yielding high densities of rainbow trout (e.g. Frenchy Creek). Each watercourse was given a priority of rehabilitation value which referred to the relative importance of that particular watercourse in relation to the other watercourses included in the study. Major impacts and rehabilitation opportunities are listed by reach in Form 3 in Volume 2, Appendix A. Table 9 contains Watershed information, including stream lengths and watershed area. Refer to Section 3.6 for habitat descriptions including logging impacts and rehabilitation strategies by reach.

4.1 Tulameen River

Priority of Rehabilitation: Moderate

The Tulameen River, which extends for 82 km and supports rainbow trout throughout, was rated moderate overall in terms of fish habitat value. Constraints to this system are urbanization, unstable banks and bank erosion, extensive areas of sediment deposition (unvegetated midchannel and point bars), logjams, clearcut areas (barren riparian zones), and extensive riffle zones with little habitat diversity. Recommended rehabilitation includes, initially, a Level 1 Field Assessment, the stabilization of unstable slopes and instream complexing. LWD is abundant in this system but at present is too far removed from the wetted width of the river to be of use. Anchoring LWD instream is recommended to stabilize eroding banks and improve habitat conditions. Banks which

are vulnerable to heavy flow conditions should be heavily armoured with boulders and LWD. Complexing areas of extensive riffle in the lower reaches with boulders and LWD might be considered to aid in the dissipation of energy during high flows, however adequate anchoring methods are mandatory to ensure downstream safety. Planting native shrub and herb species in barren riparian zones of clearcuts and on exposed gravel bars is also recommended.

4.2 Arrastra Creek

Priority of Rehabilitation: Moderate - High

Arrastra Creek, which supports rainbow trout throughout, was rated moderate to high overall in terms of fish habitat value. Limitations due to logging practices include primarily clearcut areas lacking riparian vegetation. Bank erosion, sediment deposition, extensive riffles areas and logjams (possible migration barriers) may also be limiting fish production. Recommendations for rehabilitation include a Level 1 Field Assessment and a brief field assessment of logjams that have been located during the overview assessment to determine if they are stable and present a barrier to fish migration. Replanting native riparian vegetation in clearcuts is also recommended to stabilize soils and provide cover for the creeks in the short term, before second growth forests become established.

4.3 Asp Creek

Priority of Rehabilitation: Low

Asp Creek, which supports rainbow trout throughout, was rated high overall in terms of fish habitat value. From data collected during the overview assessment of the Tulameen River watershed and eleven of its tributaries, Asp Creek appeared to be one of the most productive creeks. Impacts to this system include urbanization in the lower reaches, erosion and sedimentation. Recommended rehabilitation to Asp Creek includes stabilization of banks in Reaches 1 and 3 to decrease erosion to the banks and resulting sedimentation. A Level 1 Field Assessment should be conducted in Reaches 1 and 3 to determine the most suitable sites and methods for bank stabilization. Placement of LWD will stabilize banks and reduce impacts downstream due to sedimentation.

4.4 Champion Creek

Priority of Rehabilitation: Low

Champion Creek, which supports rainbow trout to an impassable chute at approximately 430 metres upstream from its confluence with the Tulameen River, was rated low to moderate overall in terms of fish habitat value. Fish presence upstream of the barrier has not been confirmed. Constraints to this system include an impassable chute and, upstream, numerous logging related impacts such as logjams, which are possible fish migration barriers, lack of riparian vegetation, eroding banks and sedimentation. Options for rehabilitation should include a fish inventory of the upper reaches of Champion Creek (especially Reaches 3 and 4) to determine fish presence/absence. If fish are found to be

present, a Level 1 Field Assessment should be carried out with consideration given to the removal of logjams that may be migration barriers and native shrub vegetation should be planted in barren riparian zones of clearcuts. Rehabilitation of fish habitat and stocking is another option for the upper reaches of this watercourse if fish are absent. Stocking of Champion Creek should have very low priority.

4.5 Frenchy Creek

Priority of Rehabilitation: Moderate - High

Frenchy Creek, which supports rainbow trout throughout, was rated high overall in terms of fish habitat value. The falls in Reach 2 and a logjam in Reach 1 may to be barriers to fish migration. In spite of rainbow trout being present throughout the creek upstream of the barriers. Constraints to the system caused by logging include barren riparian zones, slides, sedimentation and logjams. Recommendations for rehabilitation include a Level 1 Field Assessment which should be conducted in Reaches 3 to 5 of Frenchy Creek using stratified systematic subsampling. Included in these assessments should be an evaluation of the logjams that have been identified during the overview assessment to determine if they represent fish migration barriers. Native shrub species should be planted in clearcut riparian zones to reduce erosion and provide shading.

4.6 Granite Creek

Priority of Rehabilitation: Moderate

Granite Creek, which supports rainbow trout throughout, was rated moderate overall in terms of fish habitat value. However, detrimental impacts to the creek due to previous logging practices are apparent throughout the system. These impacts include slides and unstable banks (a number of which are associated with logging roads), clearcut areas with barren riparian zones, logjams (possible fish migration barriers), sediment transport and deposition, and extensive gravel movement creating shallow riffle zones in the lower reaches. Rehabilitation opportunities for Granite Creek include conducting a Level 1 Field Assessment for Reaches 5 to 9 and a fish inventory for Reaches 9 and 10 as fish presence is only suspected. LWD and logjams in these reaches are abundant, may be restricting fish migration and are potentially dangerous if freed without restriction. Future assessments should include assessment of logjam stability and subsequent stabilization or removal of potentially dangerous LWD. LWD removed from the creek may be considered for placement in other creeks where cover or complexity is lacking. Native shrub species should be planted in barren riparian zones of clearcuts.

4.7 Jim Kelly Creek

Priority of Rehabilitation: Low

Jim Kelly Creek, which supports rainbow trout to the cascades and falls present in Reach 2 (section B), was rated low to moderate overall in terms of fish habitat value. Rainbow trout are quite possibly present to the lake however our 1996 field observations did not

confirm this. The limiting factor to fish production in this creek includes active placer mining, unstable banks and sediment deposition. Because this watershed has not been logged and placer mining will continue, the recommendation for habitat rehabilitation is fish inventory or 'no action'.

4.8 Olivine Creek

Priority of Rehabilitation: Low

Olivine Creek, which supports rainbow trout to an impassable falls in Reach 2 was rated low to moderate overall in terms of fish habitat value. Fish presence above the falls is unknown but not suspected. Limitations to the system in terms of fish habitat include clearcuts with barren riparian zones, logjams (possible fish migration barriers) which are present throughout, slide areas and instream sediment deposition. The recommendation for rehabilitation for Olivine Creek is fish inventory or 'no action'.

4.9 Otter Creek

Priority of Rehabilitation: Low

Otter Creek, which supports rainbow trout throughout, was rated high overall in terms of fish habitat value. From data collected during the overview assessment, Otter Creek appeared to be one of the more productive creeks. Constraints to Otter Creek which are few due to logging, include urbanization, irrigation withdrawls, cattle disturbance of riparian areas and possibly contamination of the water, due to fecal loading. Reach 1, which passes through Tulameen, has been channelized and offers little suitable habitat at present for rainbow trout. Agriculture predominates throughout the Otter Creek valley resulting in the diversion of creek flow to adjacent fields for irrigation purposes. Otter Creek is dry in several areas apparently due to these flow diversions. Cattle create disturbances throughout the valley by utilizing creeks as watering areas, and inadvertently may destroy the riparian vegetation, increase erosion and contaminate the water. Some areas of stream bank adjacent to railways and roads, which are associated with urbanization and logging practices, are also unstable and eroding. Recommendations for rehabilitation include planting native shrub vegetation in presently bare riparian zones along roadsides and in pasture lands, fencing exposed streambanks to reduce cattle disturbance and creating water troughs for cattle to discourage utilization of the creek. Water diversions should be restricted to allow minimum flow requirements for salmonid survival.

4.10 Podunk Creek

Priority of Rehabilitation: Low

Podunk Creek, which supports rainbow trout throughout, was rated high overall in terms of fish habitat value. Although evidence of disturbance due to logging is present, the overall priority in terms of rehabilitation of the Tulameen River watershed at this time is low. Clearcut areas that are present have been set back allowing the riparian areas to

continue providing protection and stability to the creek. The lower reaches of Podunk Creek however, are made up of extended riffle areas which appear to lack pools and logjams which are possible fish migration barriers. Recommendations for rehabilitation in Podunk Creek are primarily 'no action' although possible rehabilitation options exist. Options include the placement of anchored LWD to provide protection, shade and pooling for salmonids as well as acting as a sediment catch to relieve downstream reaches of sedimentation which has detrimental effects to water quality and spawning gravel. A Level 1 Field Assessment should precede a rehabilitation project. We recommend that if logging is scheduled for areas adjacent to this creek, wider riparian zones be considered to maintain the soil stability and to decrease sediment transport and deposition.

4.11 Spearing Creek

Priority of Rehabilitation: Moderate

Spearing Creek, which experiences intermittent flows, contains rainbow trout in Reach 1, during periods when the creek is flowing. Fish presence upstream of Reach 1 is presently unknown but suspected. Spearing Creek was rated moderate overall in terms of fish habitat value. Constraints in this system include intermittent flows, slides due to road and railway alignments and lack of riparian vegetation due to clearcutting. Recommended habitat rehabilitation includes minimum flow requirements in areas where fish presence has been confirmed and a fish inventory upstream of Reach 1. Revegetation is recommended for barren riparian zones of Reaches 5 and 6 that have been clearcut and bank stabilization should be considered for unstable areas throughout.

4.12 Vuich Creek

Priority of Rehabilitation: Low

Vuich Creek, which supports rainbow trout throughout, was rated moderate to high overall in terms of fish habitat value. Constraints to this system include bank instability in some areas creating the possibility of slide events, clearcut logging adjacent to the creek and as a result, sedimentation. Fish migration barriers in the creek include a series of cascades and two falls, all of which occur in Reach 2 (Section B). An equivalent tributary to Vuich Creek was sampled due to limited access in the headwaters. An area that was clearcut to the creek and barren of riparian vegetation was observed in the tributary. Erosion in this area was apparent. Recommendations for rehabilitation opportunities in Vuich Creek are predetermined by the steep, bare unstable banks in the upper reaches. These include conducting a Level 1 Field Assessment in Reach 1, to further determine rehabilitation actions such as slope stabilization and LWD and/or log weir placement to create sediment catchment areas. The rehabilitation recommendation for Reaches 2 to 7 is 'no action'. A Level 1 Field Assessment might be considered for reaches upstream of Reach 1, however, access is limited and the priority rating is low. The riparian zone of the tributary to Vuich Creek which flows through the clearcut should be planted with native vegetation.

5.0 RECOMMENDATIONS

IRC Integrated Resources Consultants Inc. recommend the following:

1. Water quality analysis. Water samples should be collected at the start of the summer growing season (post-freshet) at the mouth of each tributary, the Tulameen River at three sites and Otter Creek at three to four sites.

2. Fish inventories. Further investigations of Champion, Jim Kelly and Olivine creeks to confirm presence/absence of fish upstream of barriers. A fish inventory of Spearing Creek to determine fish presence/absence upstream of Reach 1.

3. Revegetation. Native riparian shrub species should be planted where clearcuts and barren areas associated with logging roads are present adjacent to the watercourses: Arrastra, Frenchy and Granite creeks and Tulameen River.

4. Assessment of logjams. Further investigation of logjams that appear to be migration barriers and/or appear unstable and hazardous should be conducted. Procedures outlined Fish Habitat Assessment Procedure Guidebook - Level 1 Assessment should be followed. The helicopter video; recent aerial photographs, as well as an intensive field survey might substitute the Level 1 Field Survey. This analysis should determine the necessity and feasibility, as well as methodology of LWD manipulation, which would ultimately result in fish passage. Included are: Arrastra, Frenchy and Granite creeks. Logjams are present in Champion Creek and Olivine Creek upstream of areas where fish presence is unknown but not expected. The detailed analysis of logjams for these creeks should follow verification of fish presence (recommendation 2) for Champion and Olivine creeks.

5. Bank stabilization. Unstable banks should be assessed as to the necessity, feasibility and methodology of stabilization. A Level 1 Field Assessment (FHAP) or the 1996 video and aerial photographs in conjunction with a field assessment should be completed to determine the best bank stabilization strategy.

   Bank stabilization should be conducted on watersheds as a whole. Priority should be given initially to vulnerable banks supporting active roads such as along the left bank of the Tulameen River. Unstable banks in the upper reaches with a high level of instability should be considered before those in the lower reaches.

6. Instream complexing. A Level 1 Field Assessment should be conducted at each potential site of complexing before formulating specific recommendations regarding instream works.

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Table 1: Habitat Quality Index (HQI) Criterion For Rating HQI Attributes

Habitat Attribute	0 (Least Optimum)	1	2	3	4 (Optimum)
Late Summer Stream Flow (CPF[1])	< 10% ADF[2]	10 - 15 % ADF	16 - 25 % ADF	26 - 55 % ADF	> 55 %
ASFV Ratio[3]	> 500	100 - 499	40 - 99	16 - 39	0 - 15
Maximum Summer Stream Temperature (°C)	< 6° or > 26.4°	6 - 8° or 24.2 - 26.3°	8.1 - 10.3° or 21.5 - 24.1°	10.4 - 12.5° or 18.7 - 21.4°	12.6 - 18.6°
Nitrate - Nitrogen (mg/l)	< 0.01 or > 2.0	0.01 - 0.04, or 0.91 - 2.0	0.05 - 0.09, or 0.51 - 0.90	0.10 - 0.14, or 0.26 - 0.50	0.15 - 0.25
Cover (%)	< 10	10 - 25	26 - 40	41 - 55	>55
Eroding Banks (%)	75 - 100	50 - 74	25 - 49	10 - 24	0 - 9
Substrate[4] (submerged aquatic vegetation)	Lacking submerged aquatic vegetation	Little submerged aquatic vegetation	Occaisional submerged aquatic vegetation	Frequent submerged aquatic vegetation	Abundant submerged aquatic vegetation
Water Velocity (cm/sec)	< 8 or > 122	8 - 15.4, or 106.6 - 122	15.5 - 30.3, or 91.4 - 106.5	30.4 - 45.5, or 76.1 - 91.3	45.6 - 76
Wetted Stream Width (m)	< 0.6 or > 46	0.6 - 2.0, or 23 - 46	2.1 - 3.5, or 15.1 - 22.9	3.6 - 5.3, or 6.7 - 15	5.4 - 6.6

1 - CPF: Critical Period of Flow during late summer period
2 - ADF: Mean Daily Flow for the water year
3 - ASDF Ratio: Annual Stream Flow Variation Ratio = Annual Peak Flow (cfs)/Annual Low Flow (cfs)
4 - A visual assessment of attached submerged aquatic vegetation as an estimate of fish food (macroinvertebrate) occurrance

Table 2: Sample Site Locations

Sample Date	Watershed	Site Number	Reach Number	NTS Map	NTS Coordinates Easting	NTS Coordinates Northing	GPS File Number	File Location
1-Oct-96	Tulameen River	I	7 - A	92H10	666746.8	5486565.7	S100415A	at: 0m (500m west of Coalmont)
1-Oct-96		I	7 - A	92H10	666705.2	5486584.7	S100418A	at: 100m
4-Oct-96		II	7 - B	92H10	668281.8	5486129.4	S100123A	at: 0m
24-Sep-96		III	10	92H10	657654.3	5490137.4	S092500A	at: 0m
24-Sep-96		III	10	92H10	657448.3	5490132.7	S092500B	at: 100m
28-Sep-96		IV	14 - B	92H07	648225.0	5483473.9	S092901B	at: 0m
28-Sep-96		IV	14 - B	92H07	648170.7	5483369.0	S092901A	at: 100m (bridge)
25-Sep-96		V	21 - A	92H07	650711.4	5468318.7	S092523A	at: 10m below 0m
29-Sep-96	Arrastra Creek	I	1	92H07	662899.4	5476348.3	S092923A	at: 0m
29-Sep-96		II	1	92H07	661182.4	5475594.7	S092920A	at: bridge (-10m from 0m)
29-Sep-96		III	3	92H07	658126.9	5476095.8	S092917A	at: road
29-Sep-96		III	3	92H07	657478.8	5472919.1	S092918A	at: 100m
1-Oct-96	Asp Creek	I	1	91H10	679576.0	5481688.1	S100202A	at: road (SE of 0m)
30-Sep-96		II	3 - A	92H07	676411.1	5484782.8	S093021A	at: 0m
30-Sep-96		III	4	92H07	674157.7	5488210.7	S093018A	at: 0m
8-Oct-96	Champion Creek	I	1	92H10	no file			100m at: d/s of pool scoured by chute
29-Sep-96		II	3	92H07	650782.8	5479479.6	S092819A	at: 0m
29-Sep-96		II	3	92H07	650801.3	5479448.9	S092819B	at:100m
28-Sep-96		III	3	92H07	651787.0	5478546.3	S092817A	at: truck (40m NE from creek)
28-Sep-96		III	3	92H07	651761.7	5478523.4	S092817B	at: 0m
28-Sep-96		III	3	92H07	651787.4	5478436.0	S092817D	at: 100m
5-Oct-96	Frenchy Creek	I	3 - B	92H07	662781.2	5469553.8	S100519B	at: 0m
5-Oct-96		I	3 - B	92H07	662805.4	5469466.6	S100519A	at: 100m
5-Oct-96		II	4 - B	92H07	662556.7	5466630.6	S100521A	at: 0m
5-Oct-96		II	4 - B	92H07	662526.4	5466627.3	S100521B	at: 100m
5-Oct-96		III	5	92H07	662543.6	5465088.3	S100523A	at: 0m
5-Oct-96		III	5	92H07	662594.6	5465034.4	S100523B	at: 100m
2-Oct-96	Granite Creek	I	1	92H10	668011.6	5486055.6	S100218A	at: 0m (bridge at -100m)
2-Oct-96		I	1	92H10	667927.4	5485990.4	S100218B	at: 100m
6-Oct-96		II	5 - B	92H07	665277.9	5479083.5	S100620A	at: 0m
6-Oct-96		II	5 - B	92H07	665312.4	5479085.5	S100620B	at: 100m
6-Oct-96		III	5 - C	92H07	663423.5	5476571.3	S100617A	at: 0m

Table 2: Sample Site Locations

Sample Date	Watershed	Site Number	Reach Number	NTS Map	NTS Coordinates Easting	Northing	GPS File Number	File Location
6-Oct-96	Granite Creek	III	5 - C	92H07	663404.2	5476482.2	S100618A	at: 100m
6-Oct-96		IV	11	92H07	657249.4	5465934.3	S100700B	at: 0m
6-Oct-96		IV	11	92H07	657179.5	5465841.5	S100700A	at: 100m
27-Sep-96	Jim Kelly Creek	I	2 - A	92H07	646952.7	5482324.8	S100823A	0m (bridge)
10-Oct-96		II	2 - B	92H07	no file			0m at 330m along road
10-Oct-96		III	2 - B	92H06	no file			0m at 3km along road
23-Sep-96	Olivine Creek	I	1	92H10	657672.7	5489967.4	S092319A	at mouth (-20m)
23-Sep-96		II	2	92H10				at: 0m (site is 300m from mouth)
7-Oct-96		III	4	92H10	656246.0	5485893.0	S100762A	
7-Oct-96	Olivine Creek (trib.)	IV	TRIB	92H10	655666.8	5485420.4	S100719A	at: 0m
9-Oct-96	Otter Creek	I	1	92H10	662522.9	5490306.1	S101000A	at: 0m
9-Oct-96	Otter Creek	I	1	92H10	662457.8	5490366.7	S101000B	at: 100m
2-Oct-96		II	5 - C	92H10	659914.6	5500883.5	S101000C	at: road (0m)
4-Oct-96		III	10 - B	92H10	661620.6	5511151.6	S100419A	
4-Oct-96		III	10 - B	92H10	661632.6	5511256.1	S100419B	
4-Oct-96		IV	11 - B	92H15	661416.7	5515543.6	S100422A	at: 0m
3-Oct-96		V	11 - B	92H15	663222.2	5517041.9	S100321A	at: culvert u/s of 100m
3-Oct-96		VI	16 - A	92H15	671023.9	5526418.9	S100320A	at: 0m
3-Oct-96		VI	16 - A	92H15	671048.2	5526340.2	S100320B	at: 100m
26-Sep-96	Podunk Creek	I	2	92H07	646714.8	5468410.3	S092617A	at: road
26-Sep-96		II	3	92H06	643919.7	5467448.5	S092622A	at: road
27-Sep-96		III	4	92H06	641219.0	5467361.1	S092718A	at: 0m (bridge)
27-Sep-96		III	4	92H06	641147.7	5467340.9	S092718B	at: 100m
3-Oct-96	Spearing Creek	dry	N/A	92H15	660442.9	5515639.7	S100400A	at: bridge - Nicola Ranch
6-Nov-96		I	1	92H15	660627.0	5515435.0	R110619A	at: 30m N of 40m cross section in field
9-Oct-96	Vuich Creek	I	3	92H06	644413.0	5477408.0	S100919A	at: 0m
27-Sep-96		II	4 - B	92H06	642464.4	5474716.1	S092721A	at: 0m (bridge)
27-Sep-96		II	4 - B	92H06	642373.0	5474640.2	S092721B	at: 100m
9-Oct-96	Vuich Creek (trib.)	III	TRIB	92H06	641974.9	5471500.4	S100917A	at: 0m
9-Oct-96		III	TRIB	92H06	641943.2	5471431.3	S100917B	at: 100m

** Site I is the downstream site

Table 3: Fish Inventory Summary

Name	Site[1]	Sample Date	SP[2]	1st pass[3]	2nd pass[4]	Mean Fork Length (mm)	S.D. (mm)	Mean Weight (g)	S.D. (mm)	Mean CF[5] (g/cm^3)	No. of Scales[6]
Tulameen River	1	1-Oct-96	LNC	28	5	52	24	2.76	3.53		0
Tulameen River	1	1-Oct-96	RB	4	1	81	61	15.82	31.68	1.04	1
Tulameen River	1	1-Oct-96	CC	59	17	73	27	6.98	7.54		0
Tulameen River	2	4-Oct-96	LNC	3	0	60	33	3.48	3.73		0
Tulameen River	2	4-Oct-96	RB	8	2	92	45	11.56	11.48	0.98	5
Tulameen River	2	4-Oct-96	CC	39	14	75	23	6.04	4.50		0
Tulameen River	3	24-Sep-96	LNC	8	3	95	15	8.88	3.70		0
Tulameen River	3	24-Sep-96	RB	34	8	92	44	14.64	16.40	1.18	14
Tulameen River	3	24-Sep-96	CC	24	10	85	19	9.44	13.09		0
Tulameen River	4	28-Sep-96	RB	62	1	109	32	11.22	9.25	1.07	32
Tulameen River	5	25-Sep-96	RB	60	13	101	35	15.57	16.59	1.12	28
Arrastra Creek	1	29-Sep-96	RB	39	6	92	27	9.33	12.10	1.04	7
Arrastra Creek	2	29-Sep-96	RB	67	5	110	102	13.28	14.23	0.97	15
Arrastra Creek	3	29-Sep-96	RB	69	11	85	38	10.52	13.10	1.07	6
Asp Creek	1	1-Oct-96	RB	162	32	68	33	7.09	13.28	1.15	15
Asp Creek	2	30-Sep-96	RB	126	15	61	28	4.32	6.78	1.07	15
Asp Creek	3	30-Sep-96	RB	65	7	84	34	9.74	11.23	1.04	15
Champion Creek	1	8-Oct-96	RB	16	6	118	21	17.49	8.21	1.05	15
Champion Creek	2	29-Sep-96	NF								
Champion Creek	3	28-Sep-96	NF								
Frenchy Creek	1	5-Oct-96	RB	67	15	101	31	20.65	14.82	1.10	15
Frenchy Creek	2	5-Oct-96	RB	37	10	103	25	13.08	8.65	1.09	10
Frenchy Creek	3	5-Oct-96	RB	63	13	94	29	11.69	10.05	1.10	9
Frenchy Creek	3	5-Oct-96	EB	1	0	122		20.50		1.01	1
Granite Creek	1	2-Oct-96	LNC	3	0	84	20	7.37	5.30		0
Granite Creek	1	2-Oct-96	RB	27	8	65	58	15.64	50.80	1.01	6
Granite Creek	1	2-Oct-96	CC	5	1	85	7	7.21	1.87		0
Granite Creek	2	6-Oct-96	RB	28	9	121	31	21.09	15.13	1.02	9
Granite Creek	3	6-Oct-96	RB	38	9	109	34	15.61	15.73	0.99	11

Table 3: Fish Inventory Summary (Cont.)

Name	Site[1]	Sample Date	SP[2]	1st pass[3]	2nd pass[4]	Mean Fork Length (mm)	S.D. (mm)	Mean Weight (g)	S.D. (mm)	Mean CF[5] (g/cm^3)	No. of Scales[6]
Granite Creek	4	6-Oct-96	RB	13	1	126	28	25.67	19.16	1.11	10
Jim Kelly Creek	1	27-Sep-96	RB	47	7	113	28	17.56	15.59	1.05	23
Jim Kelly Creek	2	10-Oct-96	RB	14	1	86	55	15.16	18.35	0.99	6
Jim Kelly Creek	3	10-Oct-96	NF								
Olivine Creek	1	23-Sep-96	RB	20	17[7]	56	30	3.72	7.44	1.00	2
Olivine Creek (sc)	1	23-Sep-96	RB	11	0	79	39	8.99	12.54	1.07	5
Olivine Creek	2	23-Sep-96	RB	48	8	87	43	11.72	13.49	1.12	6
Olivine Creek	3	7-Oct-96	NF								
Olivine Creek (trib)	4	7-Oct-96	NF								
Otter Creek	1	9-Oct-96	CC	143	39	77	28	6.91	5.62		0
Otter Creek	2	2-Oct-96	LNC	6	5	44	4	0.90	0.21		0
Otter Creek	2	2-Oct-96	RB	29	3	67	18	3.79	4.68	1.00	3
Otter Creek	2	2-Oct-96	CC	159	40	65	22	4.29	3.76		0
Otter Creek	3	4-Oct-96	RB	29	8	80	38	11.41	14.28	0.96	14
Otter Creek	3	4-Oct-96	CC	30	5	74	16	5.33	3.11		0
Otter Creek	4	4-Oct-96	RB	32	8	84	33	9.03	14.07	0.97	12
Otter Creek	4	4-Oct-96	CC	7	4	58	23	3.36	3.45		0
Otter Creek	5	3-Oct-96	LNC	7	0	52	7	1.78	0.77		0
Otter Creek	5	3-Oct-96	RB	36	5	137	52	41.20	35.96	1.14	15
Otter Creek	5	3-Oct-96	CC	18	5	72	20	6.04	5.44		0
Otter Creek	5	3-Oct-96	RSC	2	0	115		13.40			0
Otter Creek	6	3-Oct-96	RB	39	15	70	22	4.16	3.30	1.04	10
Otter Creek	6	3-Oct-96	CC	0	2	54	25	3.48	2.71		0
Otter Creek	6	3-Oct-96	RSC	2	0	70	21	4.05	3.36		0
Podunk Creek	1	26-Sep-96	RB	72	13	109	113	12.29	11.54	1.09	25
Podunk Creek	2	26-Sep-96	RB	35	11	110	23	17.81	10.64	1.12	30
Podunk Creek	3	27-Sep-96	RB	48	7	112	26	19.30	13.33	1.15	25
Spearing Creek	dry	N/A	NF								
Spearing Creek	1	6-Nov-97	RB	1	0	178		60.00		1.06	1
Vuich Creek	1	9-Oct-96	RB	32	5	126	27	24.84	16.37	1.08	15

Table 3: Fish Inventory Summary (Cont.)

Name	Site[1]	Sample Date	SP[2]	1st pass[3]	2nd pass[4]	Mean Fork Length (mm)	S.D. (mm)	Mean Weight (g)	S.D. (mm)	Mean CF[5] (g/cm^3)	No. of Scales[6]
Vuich Creek	2	27-Sep-96	RB	58	21	106	25	17.47	12.46	1.11	22
Vuich Creek (trib.)	3	9-Oct-96	RB	30	7	87	31	10.41	8.21	1.17	10

1 Sample Site Number:

2 Abbreviations:

RB	Rainbow trout
LNC	Longnose dace
CC	sculpin species
RSC	Redside shiner

3 First pass through site with the electroshocker

4 Second pass through the site with the electroshocker

5 Condition Factor: (Weight (gm) x 100)/(Length (cm))^3

6 Number of Rainbow trout scales collected at sample site

7 Pass 2 and 3 are combined

Table 4: Sample Site Density and Standing Crop Estimates for Tulameen River and Tributaries

Stream Name	Site[1] No.	Reach - Section[2]	Sample Date	Sample Area[3] (m^2)	Species[4]	Total Catch[5] (No.)	Total Weight[6] (g)	Density[7] (No./m2)	Standing Crop[8] (kg/ha)
Tulameen River	1	7 - A	1-Oct-96	1730	LNC	33	91.12	0.019	0.527
Tulameen River	1	7 - A	1-Oct-96	1730	RB	5	79.10	0.003	0.457
Tulameen River	1	7 - A	1-Oct-96	1730	CC	76	530.24	0.044	3.065
Tulameen River	2	7 - B	4-Oct-96	1350	LNC	3	10.45	0.002	0.077
Tulameen River	2	7 - B	4-Oct-96	1350	RB	10	115.63	0.007	0.857
Tulameen River	2	7 - B	4-Oct-96	1350	CC	53	320.38	0.039	2.373
Tulameen River	3	10	24-Sep-96	1710	LNC	11	102.80	0.006	0.601
Tulameen River	3	10	24-Sep-96	1710	RB	42	614.99	0.025	3.596
Tulameen River	3	10	24-Sep-96	1710	CC	34	321.07	0.020	1.878
Tulameen River	4	14 - B	28-Oct-96	1370	RB	63	706.64	0.046	5.158
Tulameen River	5	21 - A	25-Sep-96	610	RB	73	1136.75	0.120	18.635
Arrastra Creek	1	1	29-Sep-96	660	RB	45	897.94	0.068	13.605
Arrastra Creek	2	1	29-Sep-96	440	RB	72	956.40	0.164	21.736
Arrastra Creek	3	3	29-Sep-96	320	RB	80	841.95	0.250	26.311
Asp Creek	1	1	1-Oct-96	360	RB	194	1375.64	0.539	38.212
Asp Creek	2	3 - A	30-Sep-96	380	RB	141	609.01	0.371	16.027
Asp Creek	3	4	30-Sep-96	330	RB	72	701.31	0.218	21.252
Champion Creek	1	1	8-Oct-96	560	RB	22	384.88	0.039	6.873
Champion Creek	2	3	29-Sep-96	400	NF				
Champion Creek	3	3	28-Sep-96	340	NF				
Frenchy Creek	1	3 - B	5-Oct-96	650	RB	82	1672.88	0.126	25.737
Frenchy Creek	2	4 - B	5-Oct-96	380	RB	47	614.83	0.124	16.180
Frenchy Creek	3	5	5-Oct-96	340	RB	76	888.69	0.224	26.138
Frenchy Creek	3	5	5-Oct-96	340	EB	1	20.50	0.003	0.603
Granite Creek	1	1	2-Oct-96	840	LNC	3	22.12	0.004	0.263
Granite Creek	1	1	2-Oct-96	840	RB	35	547.30	0.042	6.515
Granite Creek	1	1	2-Oct-96	840	CC	6	43.26	0.007	0.515
Granite Creek	2	5 - B	6-Oct-96	840	RB	37	780.49	0.044	9.292
Granite Creek	3	5 - C	6-Oct-96	750	RB	47	733.70	0.063	9.783

Table 4: Sample Site Density and Standing Crop Estimates for Tulameen River and Tributaries (Cont.)

Stream Name	Site[1] No.	Reach - Section[2]	Sample Date	Sample Area[3] (m^2)	Species[4]	Total Catch[5] (No.)	Total Weight[6] (g)	Density[7] (No./m2)	Standing Crop[8] (kg/ha)
Granite Creek	4	11	6-Oct-96	210	RB	14	359.32	0.067	17.110
Jim Kelly Creek	1	2 - A	27-Sep-96	780	RB	54	948.01	0.069	12.154
Jim Kelly Creek	2	2 - B	10-Oct-96	680	RB	15	227.45	0.022	3.345
Jim Kelly Creek	3	2 - B	10-Oct-96	510	NF	0			
Olivine Creek	1	1	23-Sep-96	290	RB	37	136.87	0.128	4.720
Olivine Creek	2	2	23-Sep-96	380	RB	56	656.27	0.147	17.270
Olivine Creek	3	4	7-Oct-96	280	NF	0			
Olivine Creek (trib)	4	TRIB	7-Oct-96	200	NF	0			
Otter Creek	1	1	9-Oct-96	770	CC	182	1257.12	0.236	16.326
Otter Creek	2	5 - C	2-Oct-96	840	LNC	11	9.94	0.013	0.118
Otter Creek	2	5 - C	2-Oct-96	840	RB	32	121.26	0.038	1.444
Otter Creek	2	5 - C	2-Oct-96	840	CC	199	853.43	0.237	10.160
Otter Creek	3	10 - B	4-Oct-96	550	RB	37	422.11	0.067	7.675
Otter Creek	3	10 - B	4-Oct-96	550	CC	35	186.38	0.064	3.389
Otter Creek	4	11 - B	4-Oct-96	340	RB	40	352.16	0.118	10.358
Otter Creek	4	11 - B	4-Oct-96	340	CC	11	36.99	0.032	1.088
Otter Creek	5	11 - B	3-Oct-96	540	LNC	7	12.44	0.013	0.230
Otter Creek	5	11 - B	3-Oct-96	540	RB	41	1689.15	0.076	31.281
Otter Creek	5	11 - B	3-Oct-96	540	CC	23	138.89	0.043	2.572
Otter Creek	5	11 - B	3-Oct-96	540	RSC	2		0.004	0.000
Otter Creek	6	16 - A	3-Oct-96	240	RB	54	224.73	0.225	9.364
Otter Creek	6	16 - A	3-Oct-96	240	CC	2	6.95	0.008	0.290
Otter Creek	6	16 - A	3-Oct-96	240	RSC	2	8.09	0.008	0.337
Podunk Creek	1	2	26-Sep-96	320	RB	85	1044.63	0.266	32.645
Podunk Creek	2	3	26-Sep-96	460	RB	46	819.37	0.100	17.812
Podunk Creek	3	4	27-Sep-96	270	RB	55	1061.23	0.204	39.305
Spearing Creek	dry	1	N/A	-	NF	0	-		
Spearing Creek	1	1	6-Nov-97	580	RB	1	60.00	0.002	1.034
Vuich Creek	1	3	9-Oct-96	560	RB	37	894.37	0.066	15.971

Table 4: Sample Site Density and Standing Crop Estimates for Tulameen River and Tributaries (Cont.)

Stream Name	Site[1] No.	Reach - Section[2]	Sample Date	Sample Area[3] (m^2)	Species[4]	Total Catch[5] (No.)	Total Weight[6] (g)	Density[7] (No./m2)	Standing Crop[8] (kg/ha)
Vuich Creek	2	4 - B	27-Sep-96	470	RB	79	1379.78	0.168	29.357
Vuich Creek (trib.)	3	TRIB	9-Oct-96	300	RB	37	385.14	0.123	12.838

1 Site Number

2 Reach - Section (section of reach)

3 Sample Area = length of site (100 m) x average width of site (m)

4 Species Abbreviations

LNC	Longnose dace
RB	Rainbow trout
CC	Sculpin species
RSC	Redside shiner

5 Total Catch - total number of species caught per sample site

6 Total weight of each species captured per site

7 Density = Total catch / Sample area (m^2)

8 Standing Crop = Total weight (kg) / area (hectare)

Table 5: Compared Population and Standing Crop Estimates

IRC Sample Site No.	IRC Reach - Section No.	IEC Reach - Station No.	IEC Reach Area (m^2)	Sp.[1]	IRC Density[2] (No./m^2)	IRC Population[3] Estimate (No.)	IEC Population[4] Estimate (No.)	IRC (HQI)[5] (kg/ha)	IEC (HQI) (kg/ha)	IRC Standing Crop[6] (kg/ha)	IEC Standing Crop[7] (kg/ha)
2	7 - B	4 - 1	264,842	RB	0.0074	1,960	1,589	4.0	3.0	0.9	3.1
			264,842	LNC	0.0022	583	5,562			0.1	3.4
			264,842	CC	0.0393	10,408	14,566			2.4	3.9
3	10	5	51,601	RB	0.0245	1,264	516	6.9	3.0	3.6	2.9
			51,601	LNC	0.0064	330	516			0.6	5.0
			51,601	CC	0.0198	1,022	155			1.9	0.3
4	14 - B	8	148,466	RB	0.046	6,829	8,908	9.0	3.0	5.2	13.4
			148,466	CC	0	0	0			0.0	0.1

1 Species: RB - Rainbow trout, LNC - Longnose dace, CC - sculpin
2 IRC Density calculated for each sample site: Number / area (m^2).
3 IRC Population Estimate: Density (No./m^2) x Reach Area (m^2)
4 Population Estimate calculated by IEC utilized the average density calculated over the entire reach.
5 Habitat Quality Index
6 IRC Standing Crop: total weight of species (kg) / area (ha)
7 IEC Standing Crop: total weight of species (kg) / area (ha)

Table 6: Species Identification and Population Estimates from Subsamples

Sream Name	Reach - Site	Sample Site No.	Date	Total Sculpin spp. (No.)	Species	Common Name	Subsample[1] (No.)	Percent Species[2] (%)	Population by Species[3] (No.)
Tulameen River	7 - A	1	1-Oct	93	*Cottus rhotheus*	Torrent sculpin	2	100	N/A
	7 - B	2	4-Oct	52	*Cottus rhotheus*	Torrent sculpin	12	50	26
					Cottus bairdi	Mottled sculpin	12	50	26
	10	3	24-Sep	34	*Rhinichthys cataractae*	Longnose dace	2	N/A	N/A
					Cottus rhotheus	Torrent sculpin	1	33	11
					Cottus bairdi	Mottled sculpin	2	66	22
Otter Creek	1	1	9-Oct	182	*Cottus rhotheus*	Torrent sculpin	39	100	182
	5 - C	2	2-Oct	199	*Cottus asper*	Prickly sculpin	3	33	66
					Cottus bairdi	Mottled sculpin	6	66	131
	10 - B	3	4-Oct	35	*Cottus bairdi*	Mottled sculpin	11	100	35
	11 - B	4	4-Oct	11	*Cottus bairdi*	Mottled sculpin	11	100	11
	11 - B	5	3-Oct	23	*Cottus bairdi*	Mottled sculpin	5	100	23
					Rhinichthys cataractae	Longnose dace	1	N/A	N/A
					Richardsonius balteatus	Redside shiner	2	N/A	N/A
	16 - A	6	3-Oct	2	*Richardsonius balteatus*	Redside shiner	2	N/A	N/A

* Specimens identified by Dr. A. Peden.

1 Subsample: Number of the individuals in the subsample of that particular species.

2 Percent of that species in subsample

3 Estimate of total population of species in that site: Percent species (No.) x Total sample

Table 7: Sample Site Temperature

Stream Name	Site Number	Sample Date (1996)	Temperature (°C)
Tulameen River	Site 1	1-Oct	10.5
Tulameen River	Site 2	4-Oct	8.0
Tulameen River	Site 3	24-Sep	5.0
Tulameen River	Site 4	28-Sep	9.5
Tulameen River	Site 5	25-Sep	6.0
Arrastra Creek	Site 1	29-Sep	8.0
Arrastra Creek	Site 2	29-Sep	8.0
Arrastra Creek	Site 3	29-Sep	8.0
Asp Creek	Site 2	1-Oct	7.0
Asp Creek	Site 3	30-Sep	7.0
Asp Creek	Site 1	30-Sep	8.0
Champion Creek	Site 1	8-Oct	6.0
Champion Creek	Site 2	29-Sep	5.0
Champion Creek	Site 3	28-Sep	5.0
Frenchy Creek	Site 1	5-Oct	5.0
Frenchy Creek	Site 2	5-Oct	5.0
Frenchy Creek	Site 3	5-Oct	6.0
Granite Creek	Site 1	2-Oct	5.0
Granite Creek	Site 2	6-Oct	7.0
Granite Creek	Site 3	6-Oct	5.0
Granite Creek	Site 4	6-Oct	7.0
Jim Kelly Creek	Site 1	27-Sep	6.0
Jim Kelly Creek	Site 2	10-Oct	6.0
Jim Kelly Creek	Site 3	10-Oct	6.0
Olivine Creek	Site 1	23-Sep	5.0
Olivine Creek	Site 2	23-Sep	5.5
Olivine Creek	Site 3	7-Oct	7.0
Olivine Creek (trib.)	Site 4	7-Oct	6.5
Otter Creek	Site 1	9-Oct	12.0
Otter Creek	Site 2	2-Oct	8.0
Otter Creek	Site 3	4-Oct	9.0
Otter Creek	Site 4	4-Oct	9.0
Otter Creek	Site 5	3-Oct	6.0
Otter Creek	Site 6	3-Oct	6.0
Podunk Creek	Site 1	26-Sep	6.0
Podunk Creek	Site 2	26-Sep	8.0
Podunk Creek	Site 3	27-Sep	6.0
Spearing Creek	Site 1	6-Nov	2.0
Vuich Creek	Site 1	9-Oct	5.0
Vuich Creek	Site 2	27-Sep	7.0
Vuich Creek	Site 3	9-Oct	7.0

Table 8: Water Survey of Canada Total and Mean Daily Discharges for Tulameen River (m^3/s)

	Year	January	February	March	April	May	June	July	August	September	October	November	December
Station 08NL024: Tulameen River at Princeton													
Total	1995	79.20	222.57	301.26	776.50	3007.60	1317.20	225.38	117.65	48.12	225.50	2008.72	957.00
Mean	1995	2.55	7.95	9.72	25.90	97.00	43.90	7.27	3.80	1.60	7.27	67.00	30.90
Total	1994	166.24	142.72	347.15	1561.90	1883.30	636.70	200.75	65.85	46.78	67.24	60.27	82.39
Mean	1994	5.35	5.10	11.20	52.10	60.80	21.20	6.48	2.12	1.56	2.17	2.01	2.66
Total	1993	81.53	77.25	218.51	548.25	2603.50	711.41	340.88	209.95	97.62	117.08	116.06	147.80
Mean	1993	2.63	2.76	7.05	18.30	84.00	23.70	11.00	6.77	3.25	3.78	3.87	4.77
Station 08NL071: Tulameen River below Vuich Creek													
Total	1995	24.57	69.00	82.42	176.48	890.00	455.35	74.90	42.46	13.65	85.78	655.61	334.77
Mean	1995	0.76	2.46	2.66	5.88	28.70	14.80	2.42	1.37	0.46	2.77	21.90	10.80
Total	1994	82.60	84.69	129.98	453.60	618.94	224.08	70.58	15.47	10.27	19.33	17.68	30.09
Mean	1994	2.66	3.02	4.19	15.10	20.00	7.47	2.28	0.53	0.34	0.62	0.59	0.97
Total	1993	25.87	24.23	66.50	164.46	919.70	258.46	13.48	70.16	27.00	49.12	44.86	45.41
Mean	1993	0.84	0.87	2.15	5.48	29.70	8.62	4.21	2.26	0.90	1.58	1.50	1.46

Table 9: Watershed Information

Gazetted Name	Primary Map	Watershed Code	UTM Zone	UTM North	UTM East	Stream Type	Stream Length (m)	Est. Watershed Area* (km^2)	Stream Order	Number of Reaches	Number of Sections
Tulameen River	092H08	310 3678 620	10	5481975	681210	S	82078	1760	5	24	30
Arrastra Creek	092H07	310 3678 620 253 460	10	5476158	663342	S	11948	75	3	5	0
Asp Creek	092H07	310 3678 620 023	10	5481093	679802	S	20880	200	3	5	2
Champion Creek	092H10	310 3678 620 547	10	5485987	650106	S	11840	75	3	4	0
Frenchy Creek	092H07	310 3678 620 253 587	10	5472853	662421	S	14194	50	2	6	7
Granite Creek	092H10	310 3678 620 253	10	5485915	668370	S	31720	300	4	11	9
Jim Kelly Creek	092H07	310 3678 620 615	10	5482004	647229	S	11352	120	2	6	4
Olivine Creek	092H10	310 3678 620 426	10	5489825	657780	S	11736	75	2	8	0
Otter Creek	092H10	310 3678 620 357	10	5489911	662836	S	67632	673	5	19	26
Podunk Creek	092H07	310 3678 620 796	10	5470856	649421	S	15276	75	2	8	0
Spearing Creek	092H15	310 3678 620 357 468	10	5515209	660592	S	14421	150	3	7	0
Vuich Creek	092H07	310 3678 620 647	10	5480146	645950	S	16032	75	3	7	4

Area estimates were within an order of magnitude as taken from 1:100,000 NTS map sheets.

* Drainage areas for Tulameen River and Otter Creek were estimates from stream flow records.

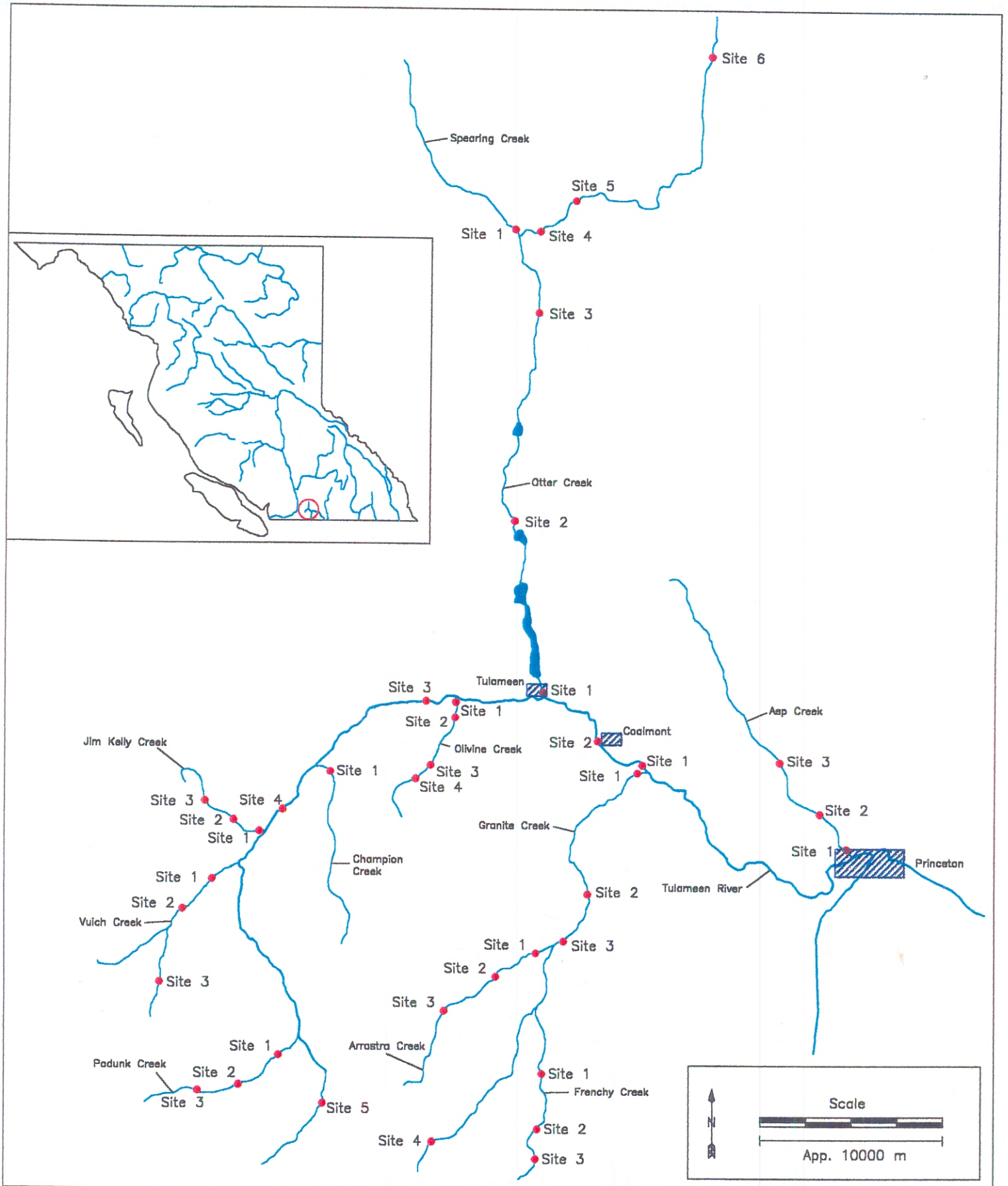
Table 10: Stream Classification by Reach

Stream Name	Reach Number	Section Number	Stream Classification
Tulameen River	1		S1
	2	A	S1
	2	B	S1
	3	A	S1
	3	B	S1
	3	C	S1
	4	A	S1
	4	B	S1
	4	C	S1
	5	A	S1
	5	B	S1
	6	A	S1
	6	B	S1
	6	C	S1
	7	A	S1
	7	B	S1
	7	C	S1
	8		S1
	9	A	S1
	9	B	S1
	10		S1
	11	A	S2
	11	B	S2
	12		S1
	13		S2
	14	A	S2
	14	B	S1
	15		S2
	16		S2
	17		S2
Tulameen River	18		S2
	19	A	S2
	19	B	S1
	19	C	S1
	19	D	S1
	19	E	S2
	19	F	S2
	20	A	S2
	20	B	S2
	21	A	S2
	21	B	S2
	22	A	S3
	22	B	S3
	22	C	S3
	22	D	S3
	22	E	S3
	23		S3*
	24	A	S3*
	24	B	S3*
Arrastra Creek	1	A	S2
	1	B	S2
	2		S2
	3		S3
	4		S3
	5		S3
Asp Creek	1	A	S3
	1	B	S3
	2		S3
	3	A	S3
	3	B	S3
Asp Creek	4		S3
	5		S3
Champion Creek	1	A	S2
	1	B	S5
	2		S5
	3		S5
	4		S5
Frenchy Creek	1		S2
	2		S2
	3	A	S2
	3	B	S2
	3	C	S2
	4	A	S3
	4	B	S3
	5		S3
	6	A	S3*
	6	B	Lake
Granite Creek	1		S1
	2	A	S2
	2	B	S2
	2	C	S1
	3		S2
	4		S2
	5	A	S2
	5	B	S2
	5	C	S1
	6		S2
	7		S2
	8		S2
	9	A	S2

Table 10: Stream Classification by Reach

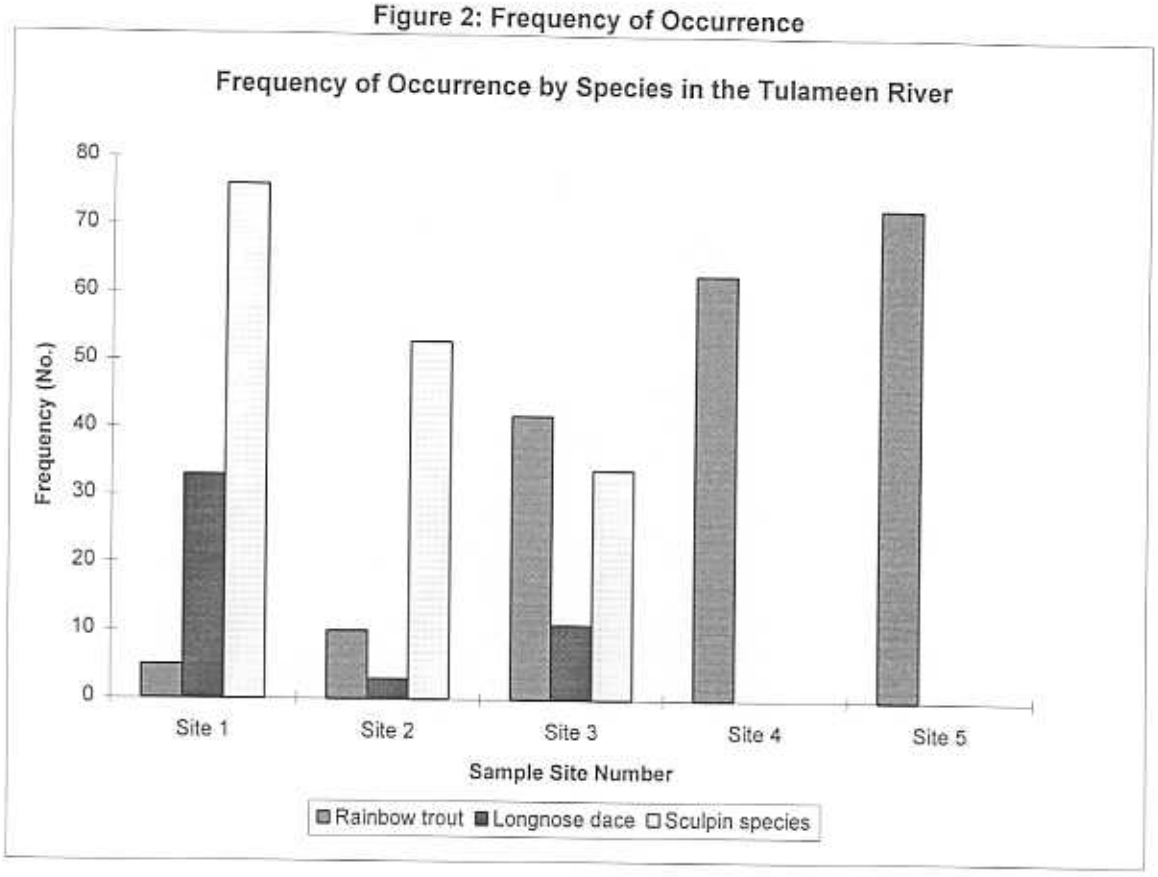
Stream Name	Reach Number	Section Number	Stream Classification
Granite	9	B	S2
Creek	9	C	S2
	10		S3
	11	A	S3
		B	S3
Jim Kelly	1		S2
Creek	2	A	S2
	2	B	S2
	3		S2
	4		S2
	5		S3
	6	A	S3
	6	B	Lake
Olivine	1		S2
Creek	2		S2
	3		S2
	4		S2
	5		S2
	6		S3
	7		S3
Otter	1		S2
Creek	2		Lake
	3	A	S1
	3	B	S2
	4		Lake
	5	A	S2
	5	B	S2
	5	C	S2
	6	A	S2
	6	B	S2
Otter	6	C	S2
Creek	7	A	S2
	7	B	S2
	8		Lake
	9	A	S2
	9	B	S2
	10	A	S2
	10	B	S2
	10	C	S2
	10	D	S2
	11	A	S2
	11	B	S3
	12		S2
	13	A	S2
	13	B	S2
	13	C	S2
	14	A	S3
	14	B	S3
	14	C	S3
	15	A	S3
	15	B	S3
	15	C	S3
	16	A	S3
	16	B	S3
	17		S3
	18		Lake
	19		S3
Podunk	1	A	S2
Creek	1	B	S2
	2	A	S2
Podunk	2	B	S2
Creek	3	A	S2
	3	B	S3
	4		S3
	5		S3
	6		S3
	7		S4
	8		S4
Spearing	1		S2
	2		S3
	3		S3
	4		S3
	5		S2
	6		S3
	7		S3
	8		S3
Vuich	1		S2
Creek	2	A	S2
	2	B	S2
	3		S2
	4	A	S2
	4	B	S2
	5		S3
	6		S3
	7		S3

* NTS maps differ from TRIM maps. Reaches were classified for the stream with the longest mapped length.



IRC Integrated Resource Consultants Inc.	**Figure #1: Tulameen River Watershed Study Area and Location of Sampling Sites**	**Project: 1996 Tulameen River Watershed Stream Assessment**
	Client: Ministry of Environment, Lands and Parks, Penticton	**Date: July 1997**

Figure 2: Frequency of Occurrence



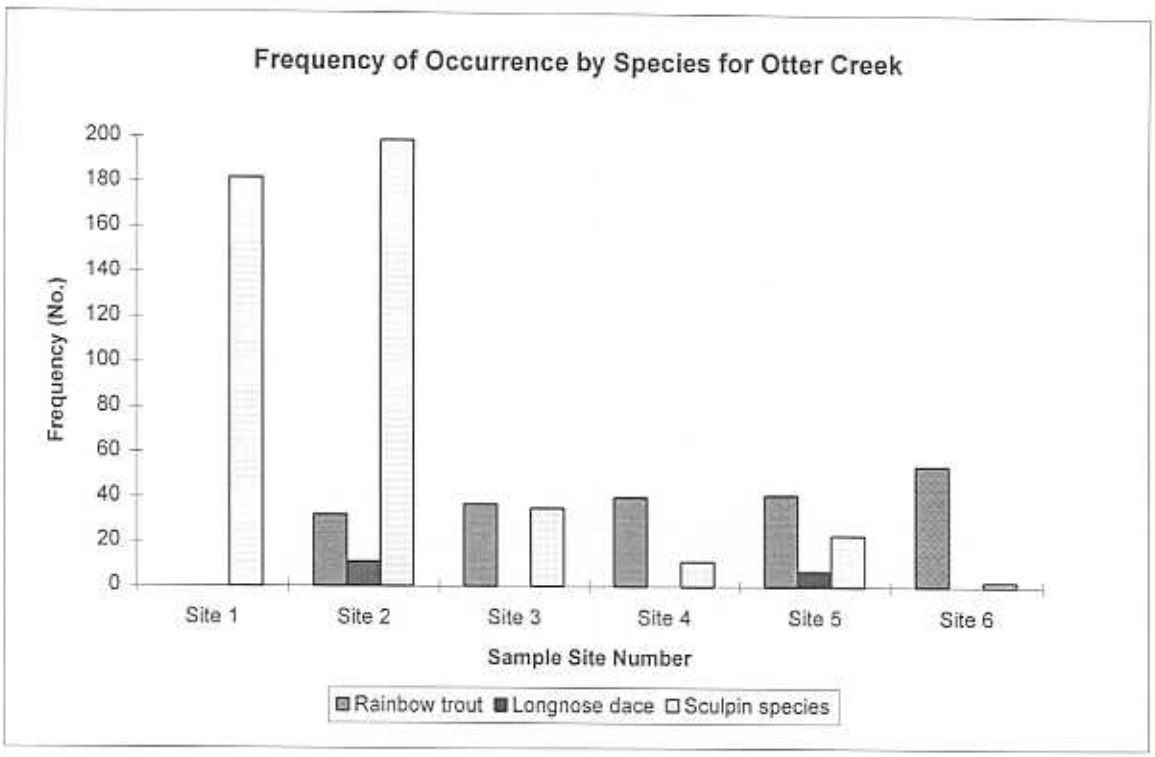
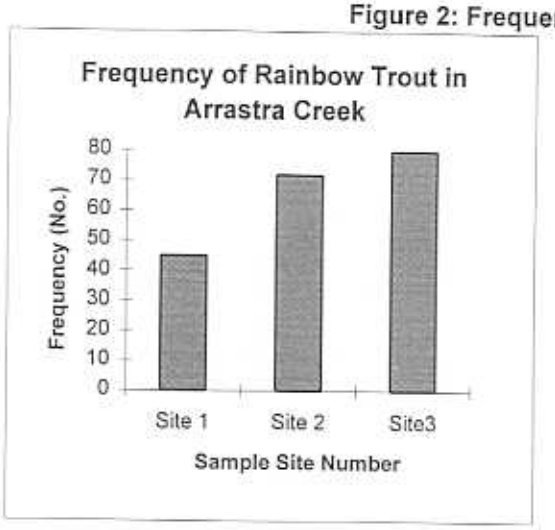
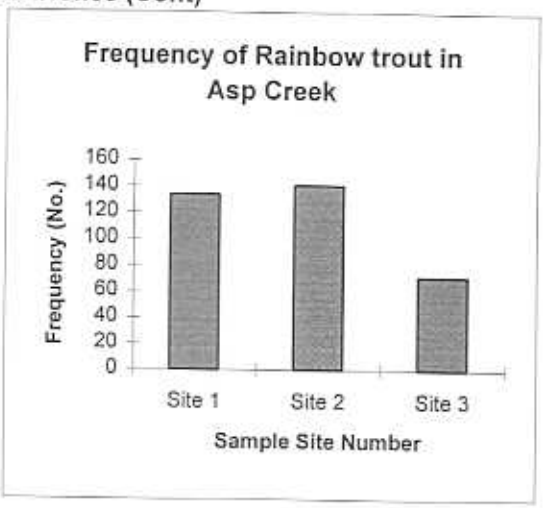
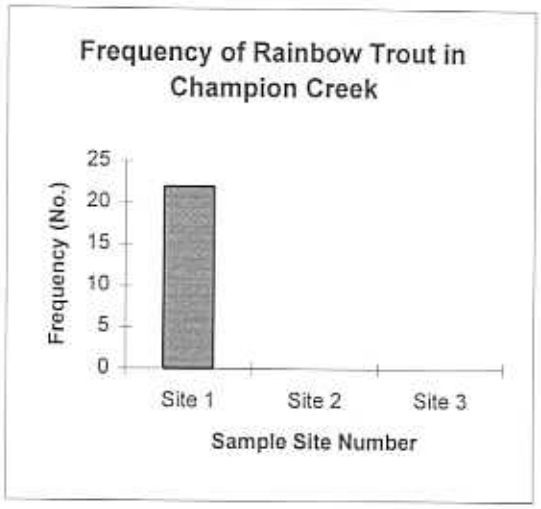
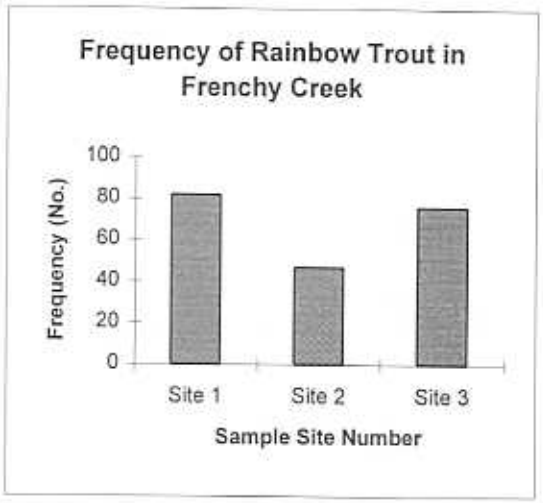


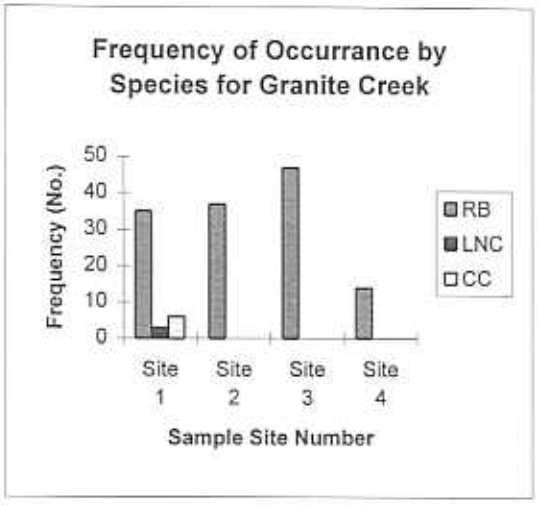
Figure 2: Frequency of Occurrence (Cont)











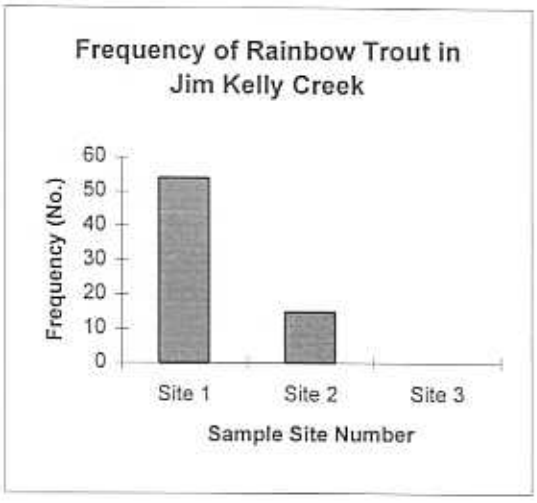
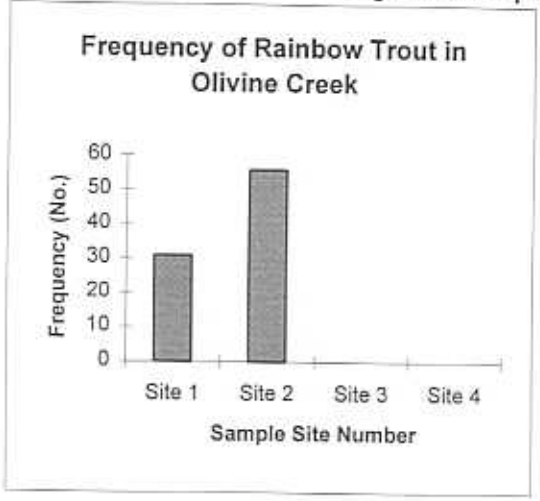
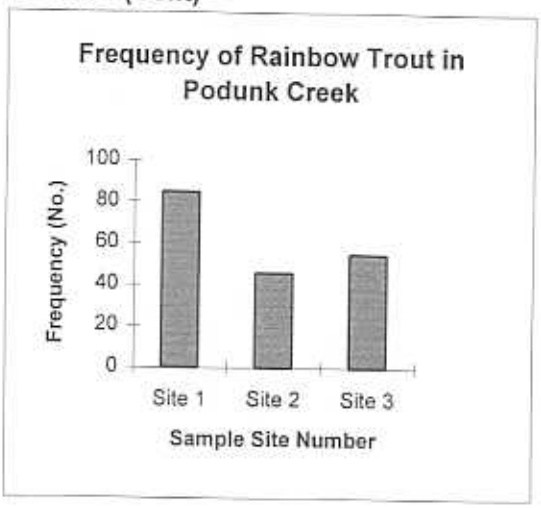


Figure 2: Frequency of Occurrence (Cont)





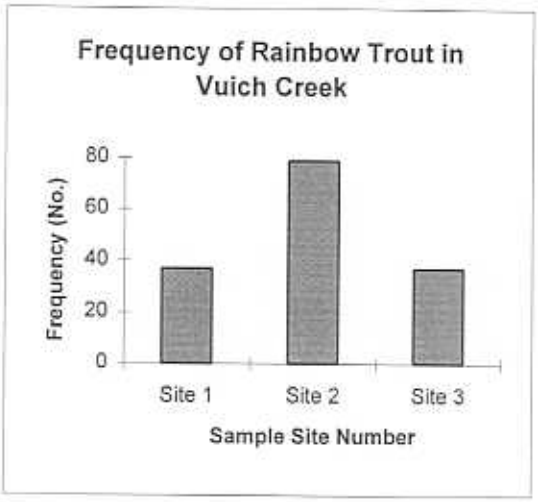
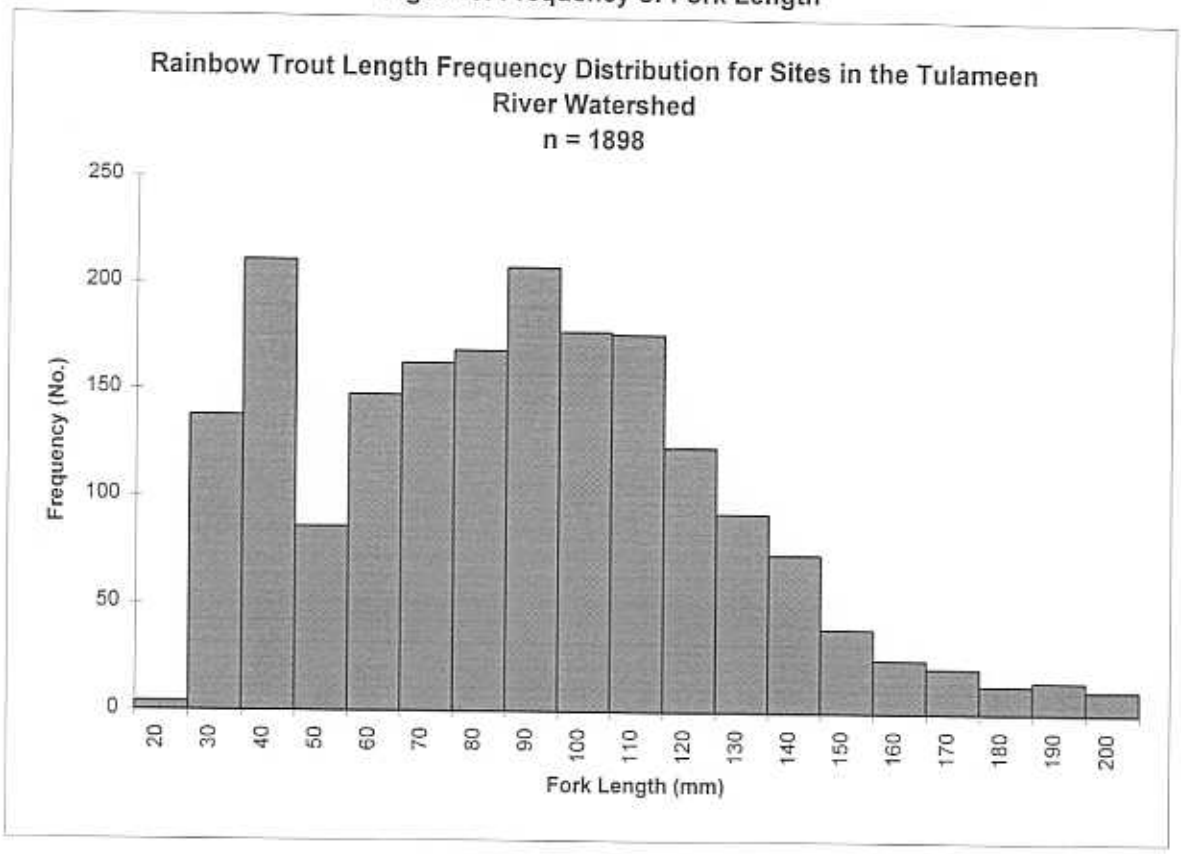


Figure 3: Frequency of Fork Length



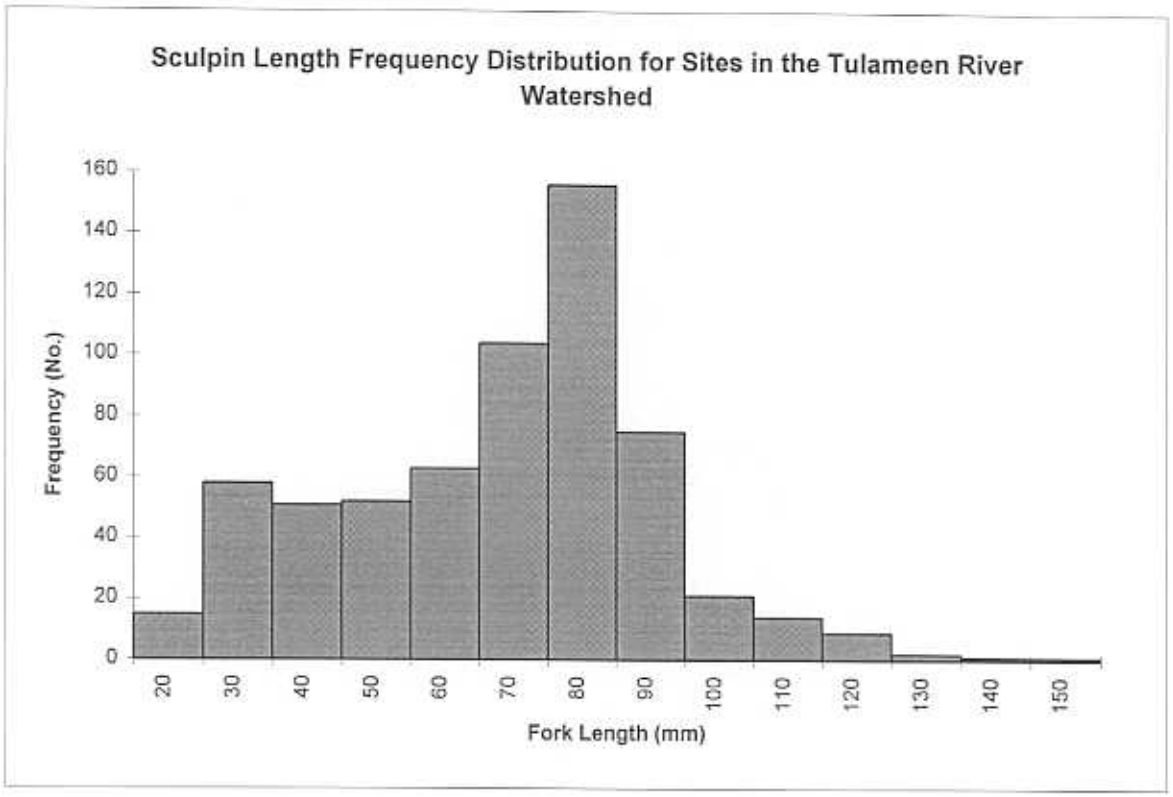


Figure 3: Frequency of Fork Length (Cont)

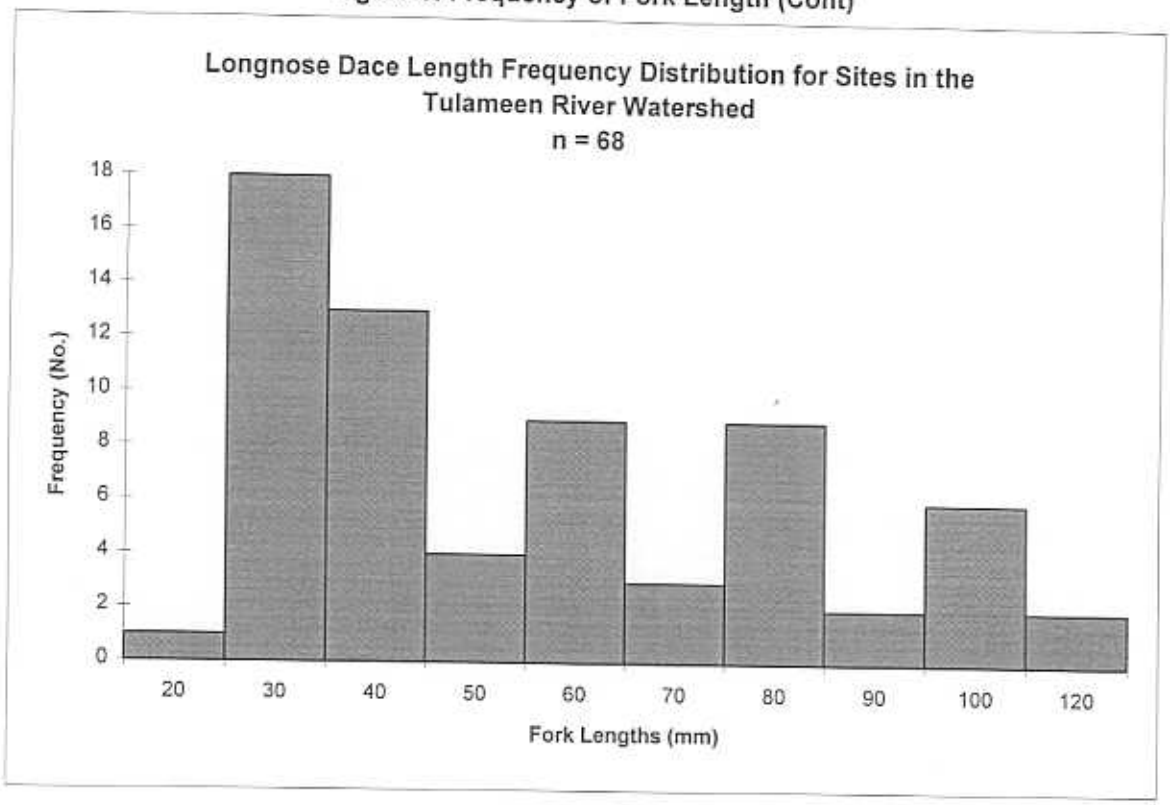
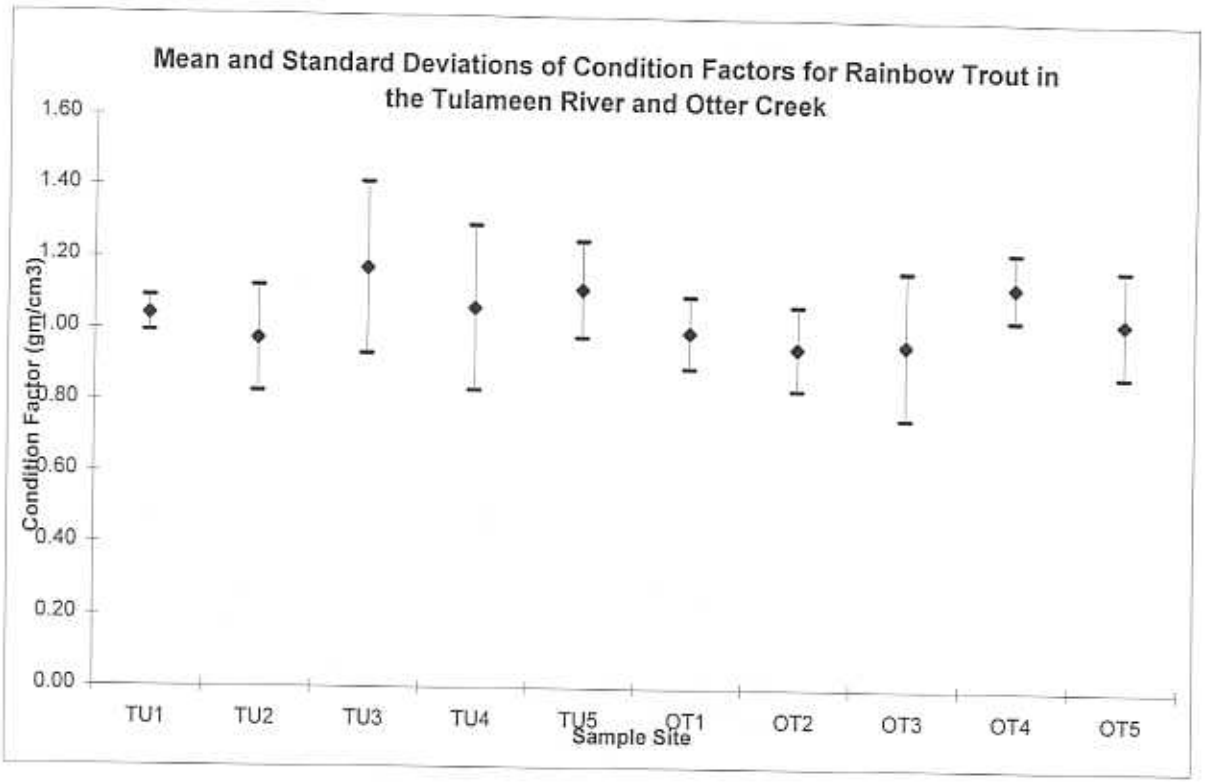


Figure 4: Mean Condition Factors and Standard Deviations



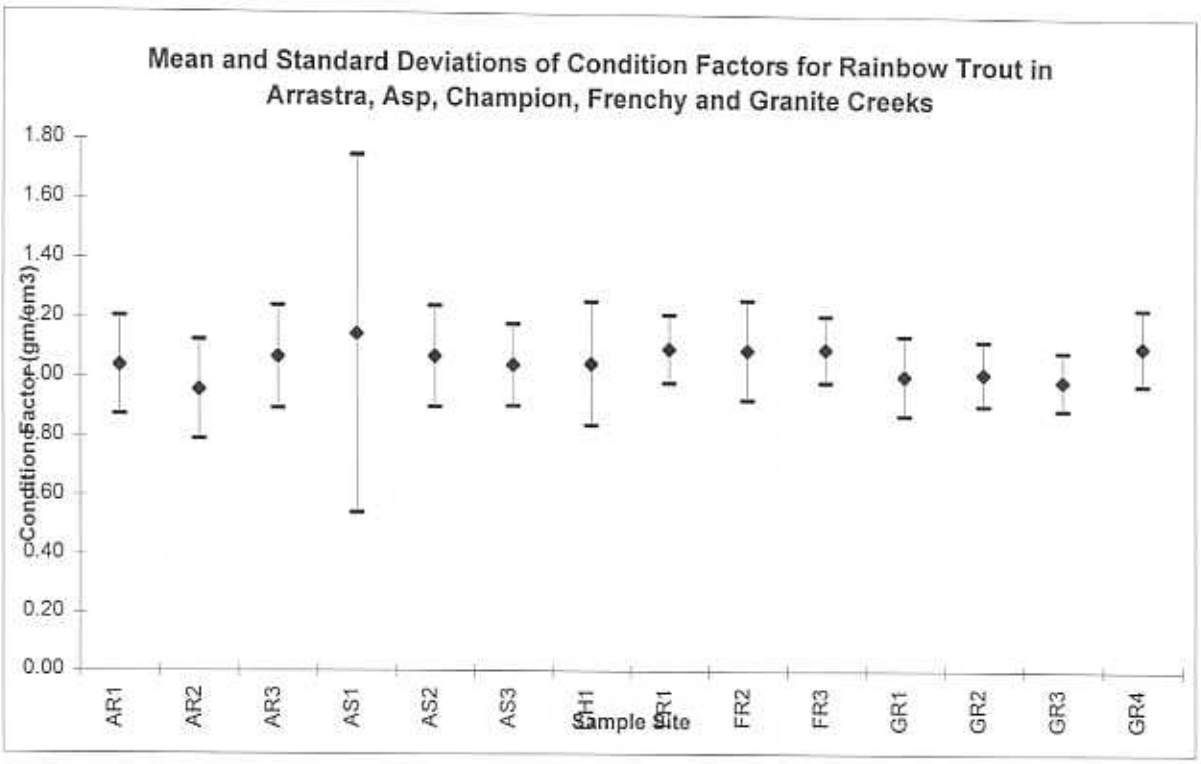
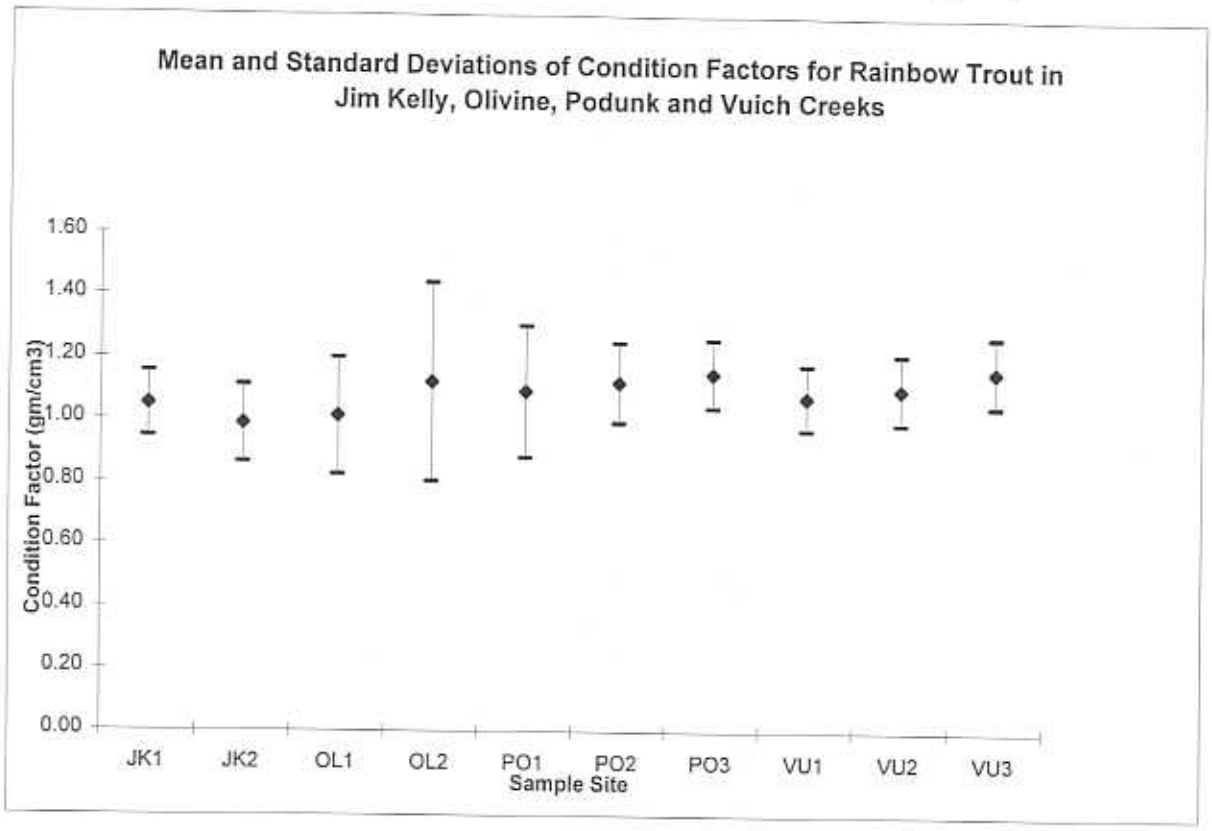


Figure 4: Mean Condition Factors and Standard Deviations (Cont)



Site Abbreviations

Tulameen River	
Site 1	TU1
Site 2	TU2
Site 3	TU3
Site 4	TU4
Site 5	TU5
Otter Creek	
Site 1	OT1
Site 2	OT2
Site 3	OT3
Site 4	OT4
Site 5	OT5
Site 6	OT6
Arrastra Creek	
Site 1	AR1
Site 2	AR2
Site 3	AR3
Site 4	AR4
Asp Creek	
Site 1	AS1
Site 2	AS2
Site 3	AS3
Champion Creek	
Site 1	CH1
Frenchy Creek	
Site 1	FR1
Site 2	FR2
Site 3	FR3
Granite Creek	
Site 1	GR1
Site 2	GR2
Site 3	GR3
Site 4	GR4
Jim Kelly Creek	
Site 1	JK1
Site 2	JK2
Olivine Creek	
Site 1	OL1
Site 2	OL2
Podunk Creek	
Site 1	PO1
Site 2	PO2
Site 3	PO3
Vulch Creek	
Site 1	VU1
Site 2	VU2
Site 3	VU3

Figure 5: Length - Weight Relationship of Rainbow Trout in the Tulameen River

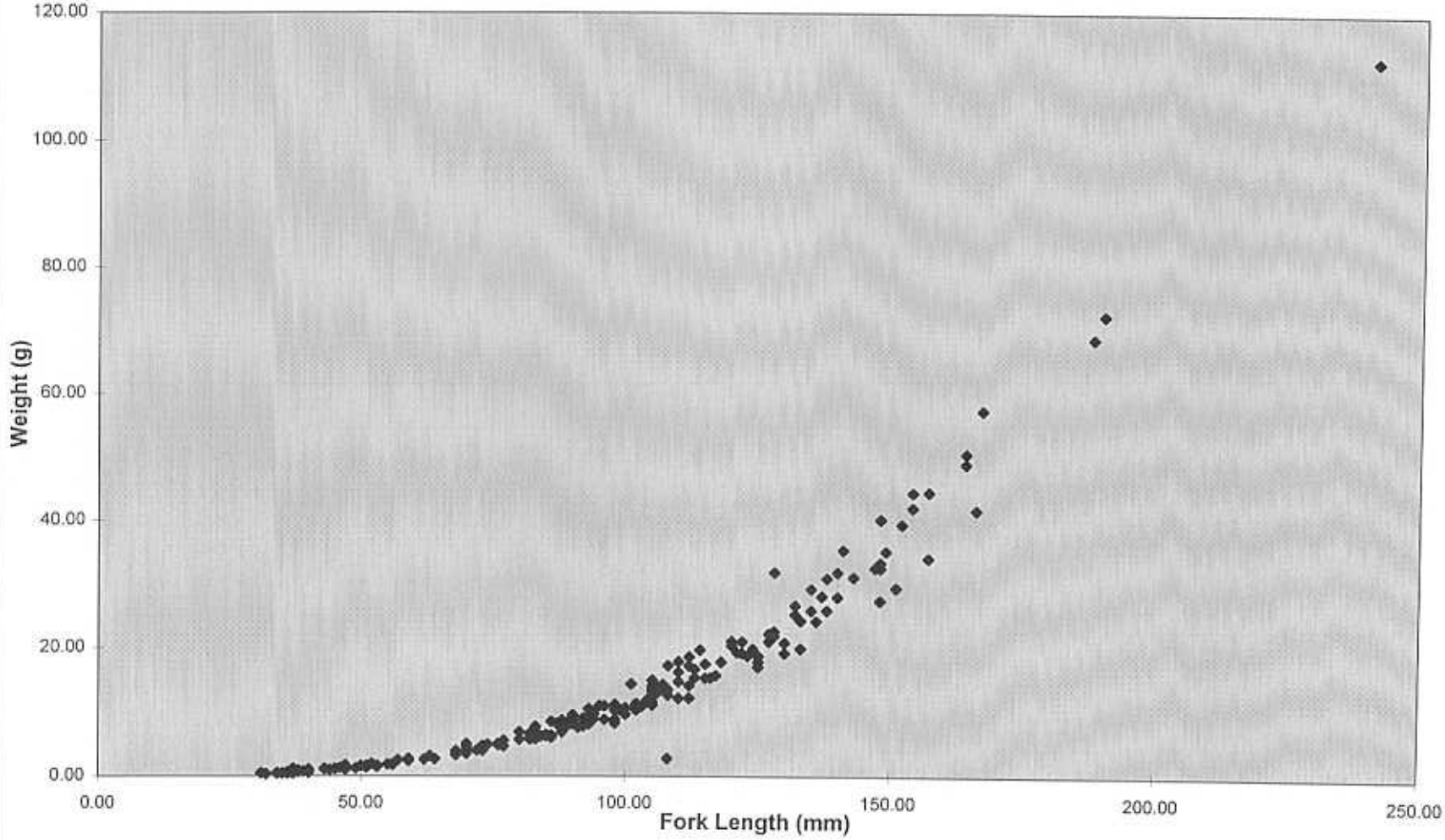


Figure 5: Length - Weight Relationship of Longnose Dace in the Tulameen River

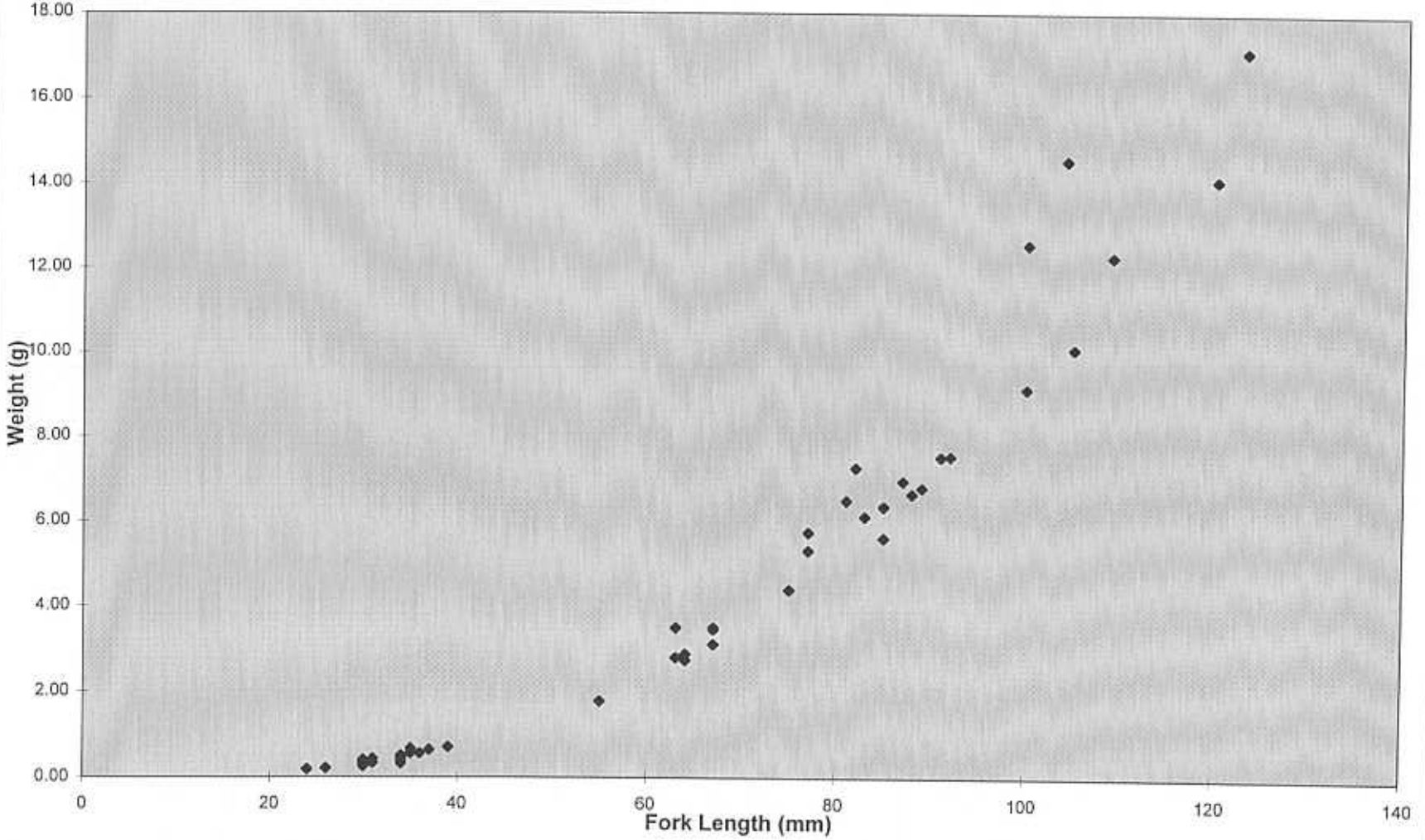
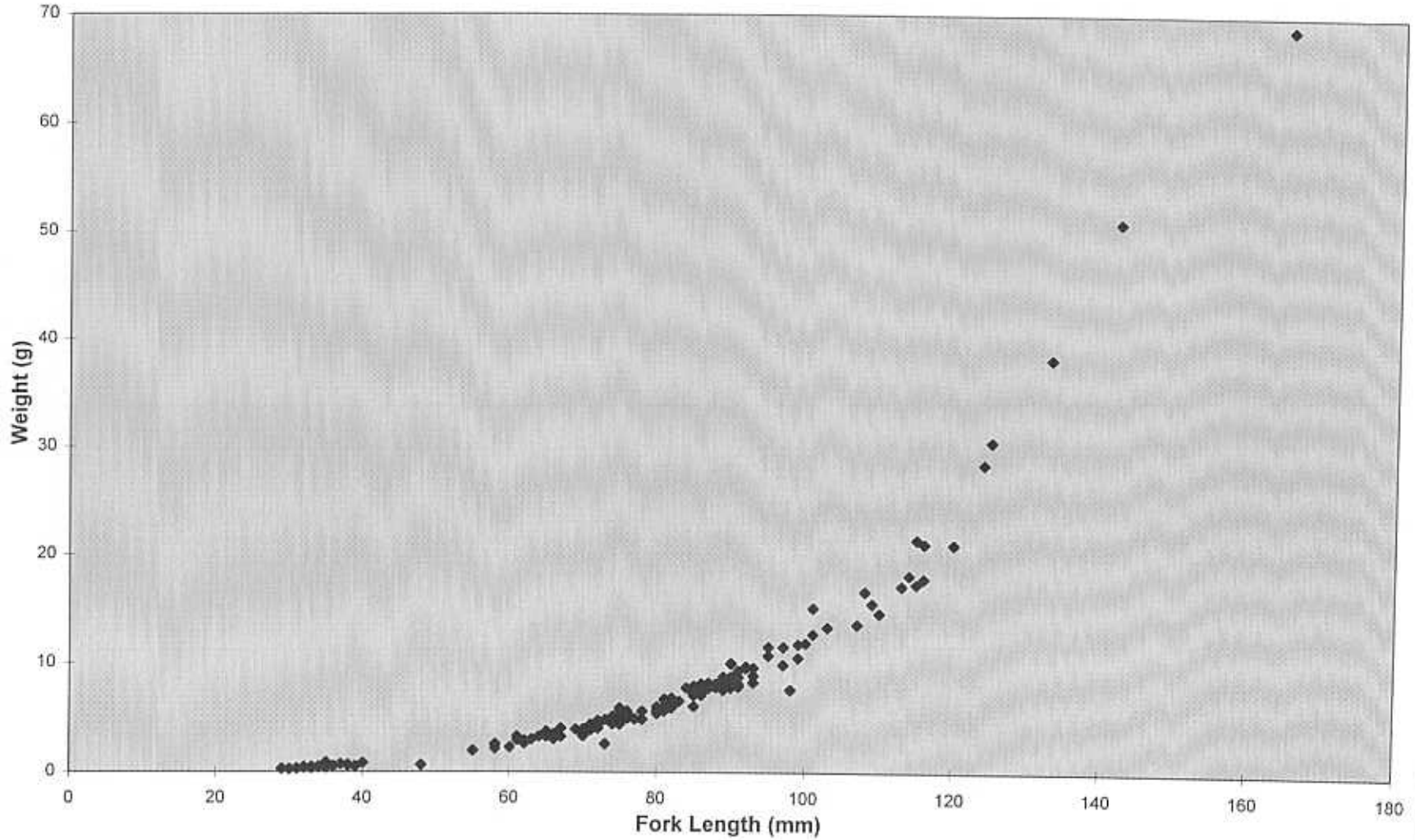


Figure 5: Length - Weight Relationship of Sculpin Sp. in the Tulameen River



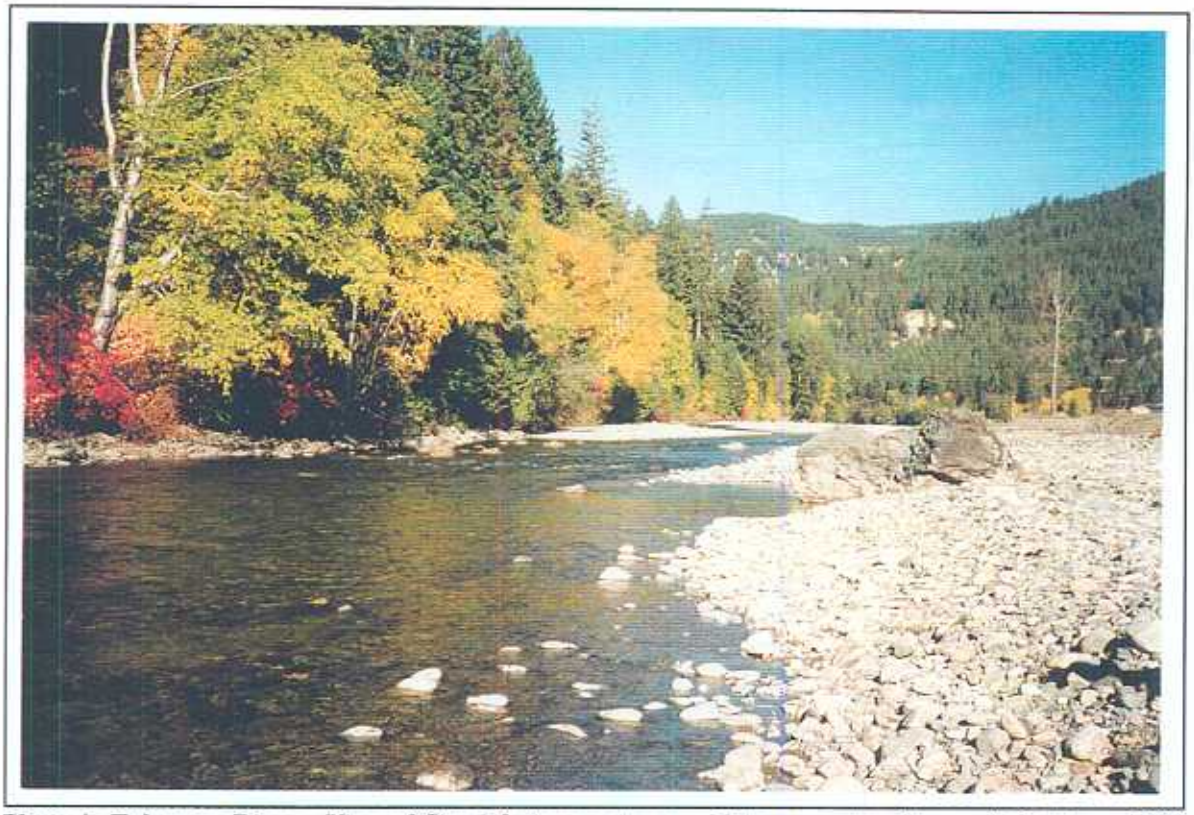


Photo 1: Tulameen River. View of Site 1 facing upstream. Note unvegetated bar. (1 October 1996)

Photo 2: Tulameen River. View of Site 1 facing downstream. Note extensive riffle zones and net. (1 October 1996).

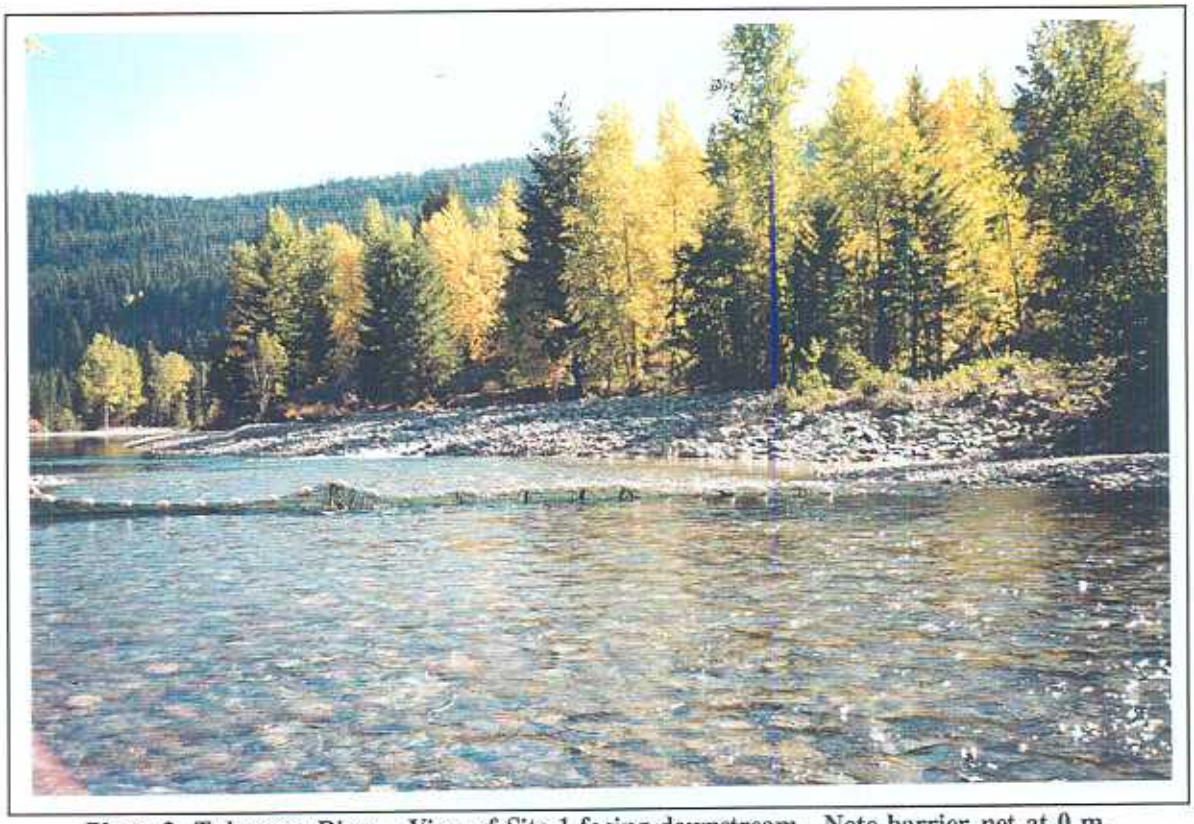


Photo 3: Tulameen River. View of Site 1 facing downstream. Note barrier net at 0 m. (1 October 1996).

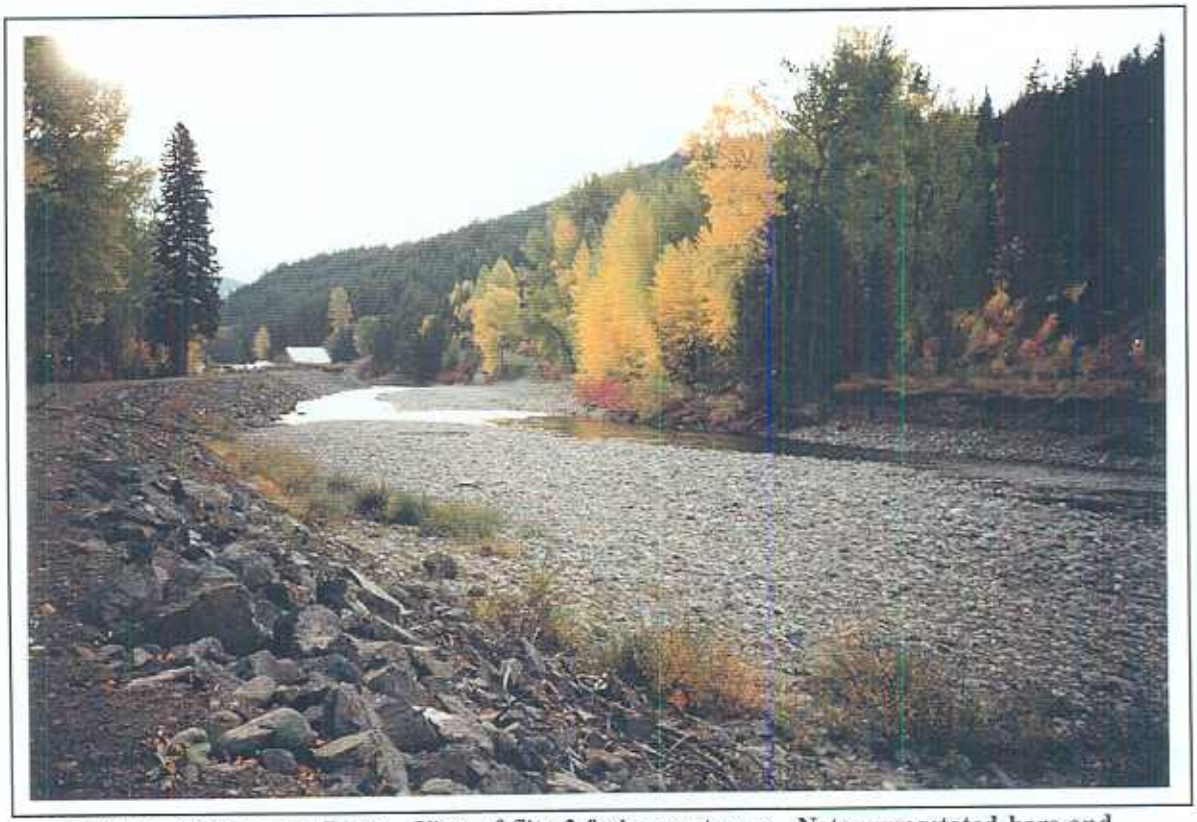


Photo 4: Tulameen River. View of Site 2 facing upstream. Note unvegetated bars and extensive riffle zones. (4 October 1996).

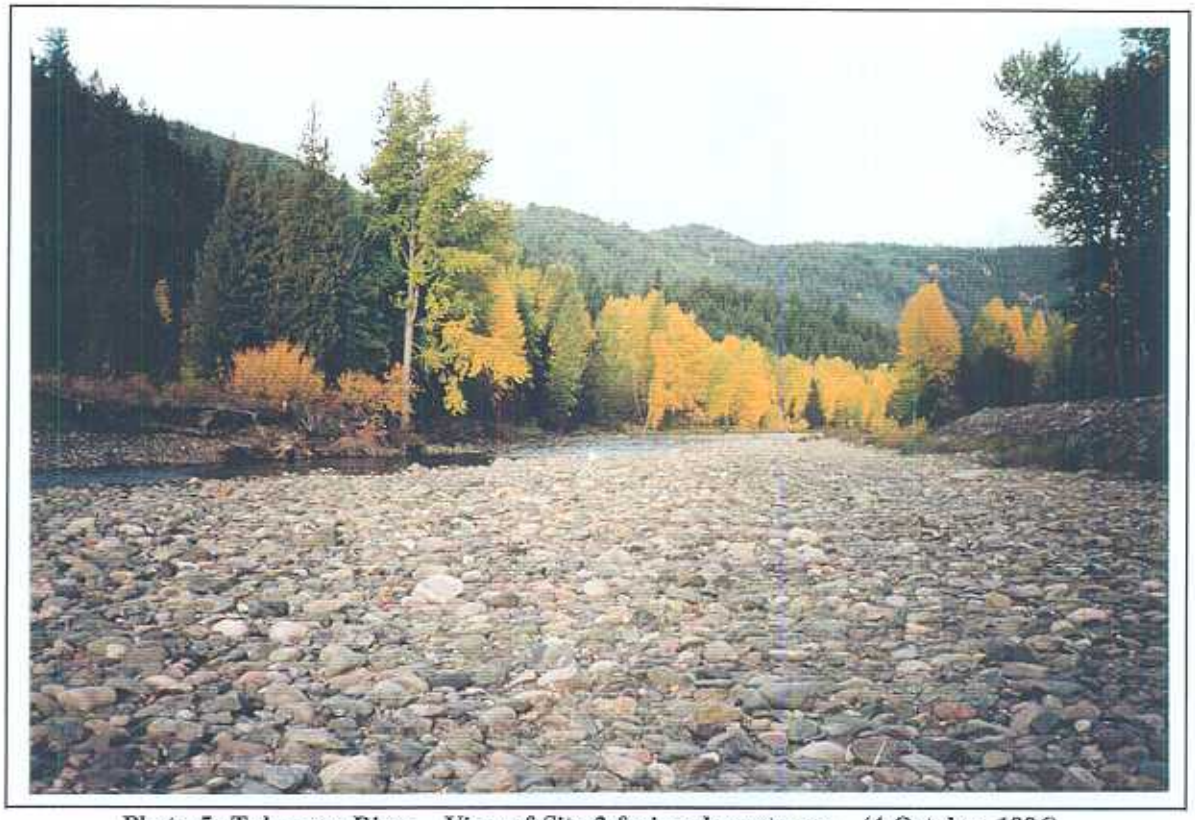


Photo 5: Tulameen River. View of Site 2 facing downstream. (4 October 1996).

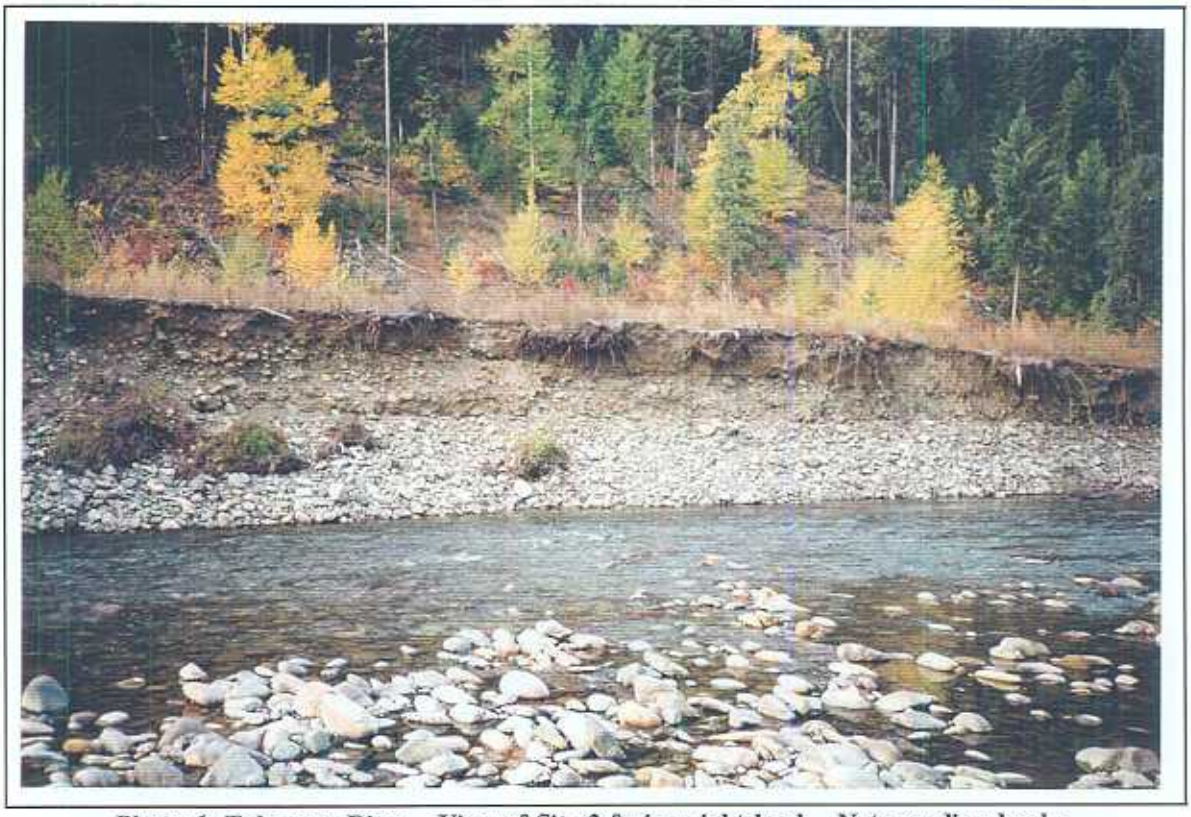


Photo 6: Tulameen River. View of Site 2 facing right bank. Note eroding banks. (4 October 1996).

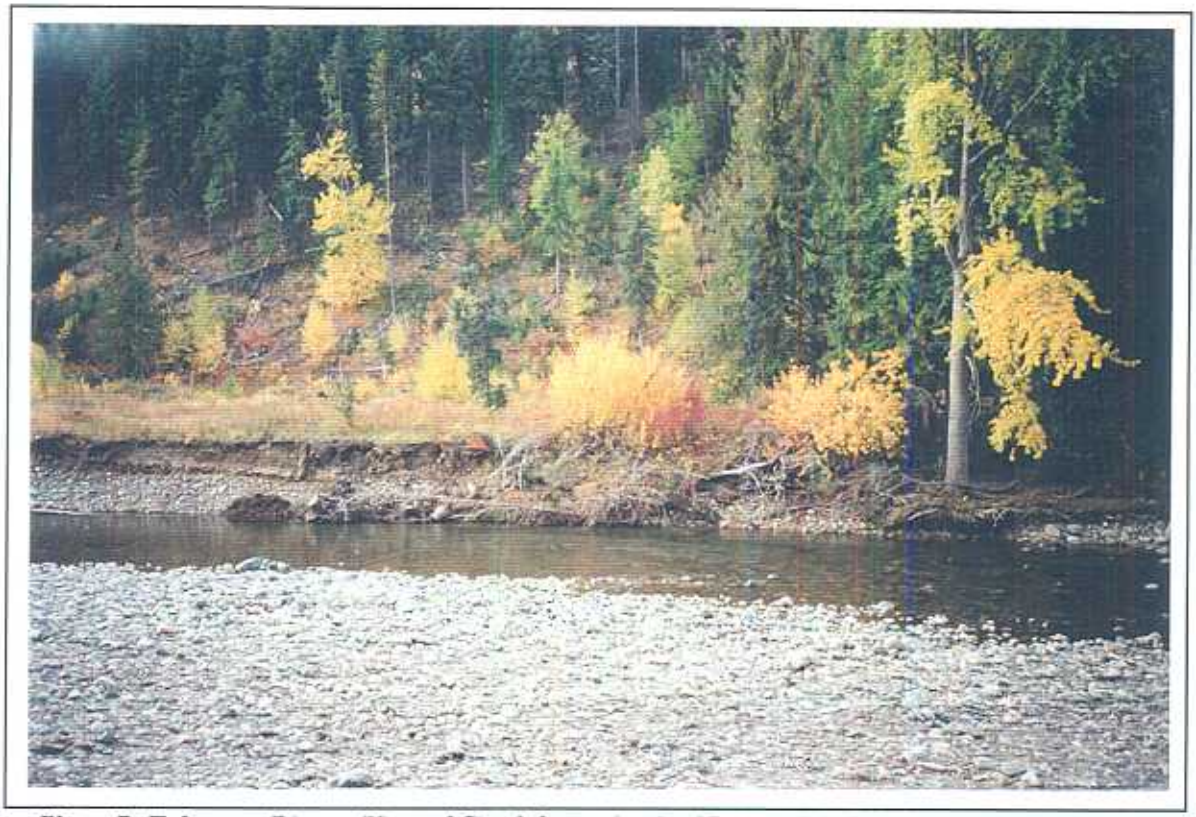


Photo 7: Tulameen River. View of Site 2 facing bank. Note eroding bank. (4 October 1996).

Photo 8: Tulameen River. View of Site 3 facing downstream. (24 September 1996).

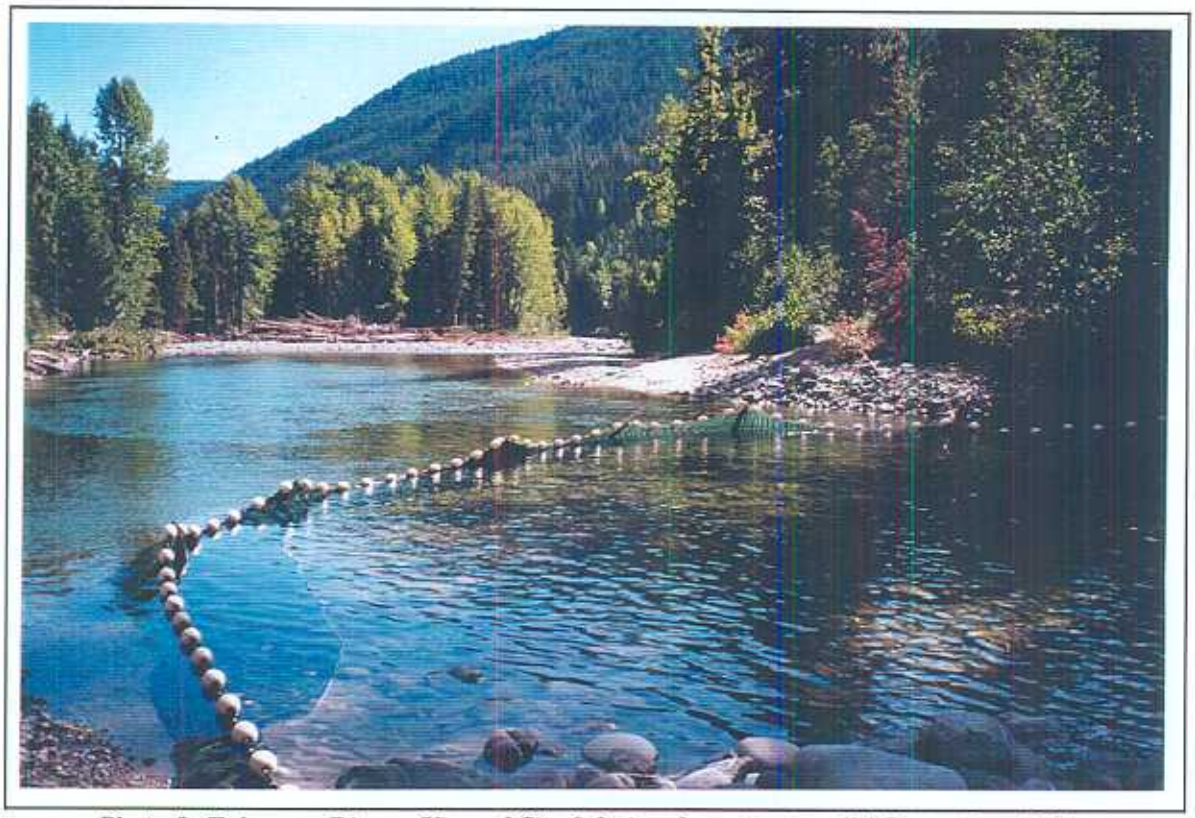


Photo 9: Tulameen River. View of Site 3 facing downstream. (24 September 1996).

Photo 10: Tulameen River. View of Site 3 facing downstream. (24 September 1996).

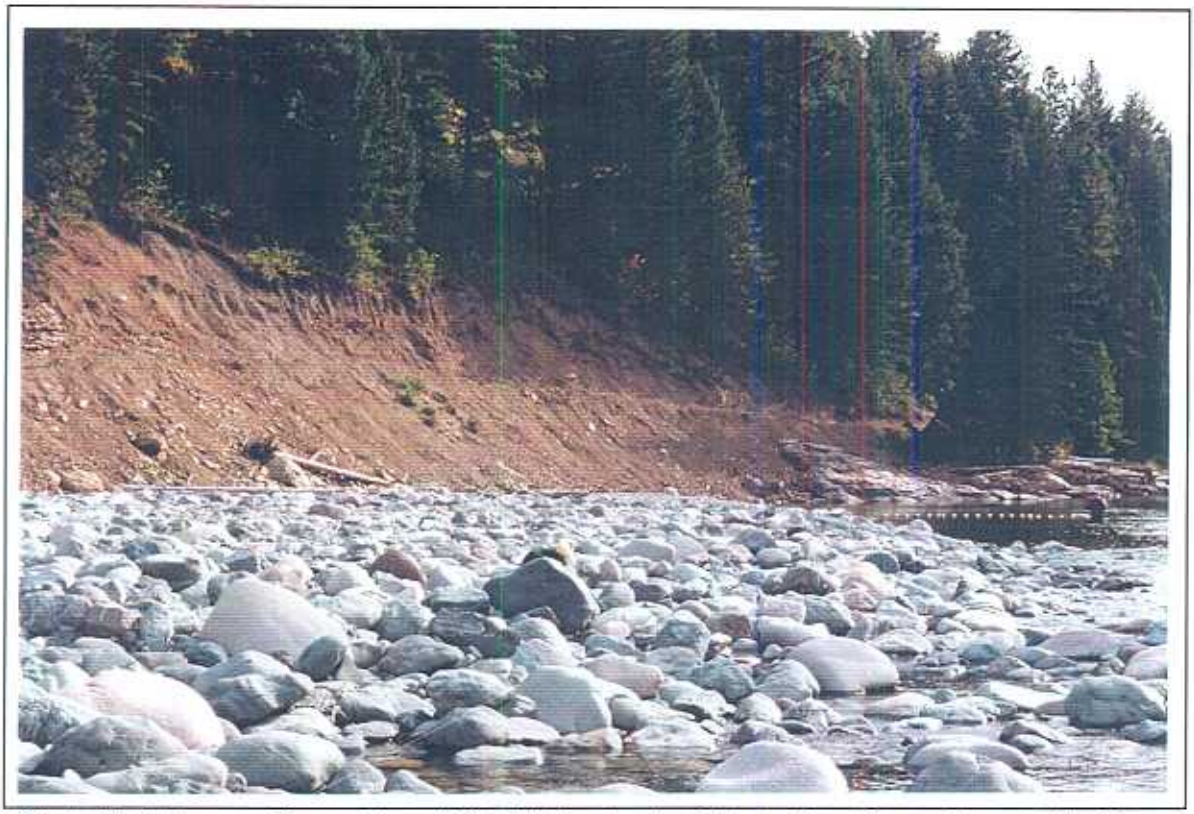


Photo 11: Tulameen River. View of Site 3 facing bank. Note bank erosion and unvegetated bar. (24 September 1996).

Photo 12: Tulameen River. View of Site 3 facing an isolated side channel. (24 September 1996).

Photo 13: Tulameen River. View of Site 3. Note undercut bank. (24 September 1996).

Photo 14: Tulameen River. View of Site 3 facing upstream. Note extensive riffle zone. (24 September 1996)

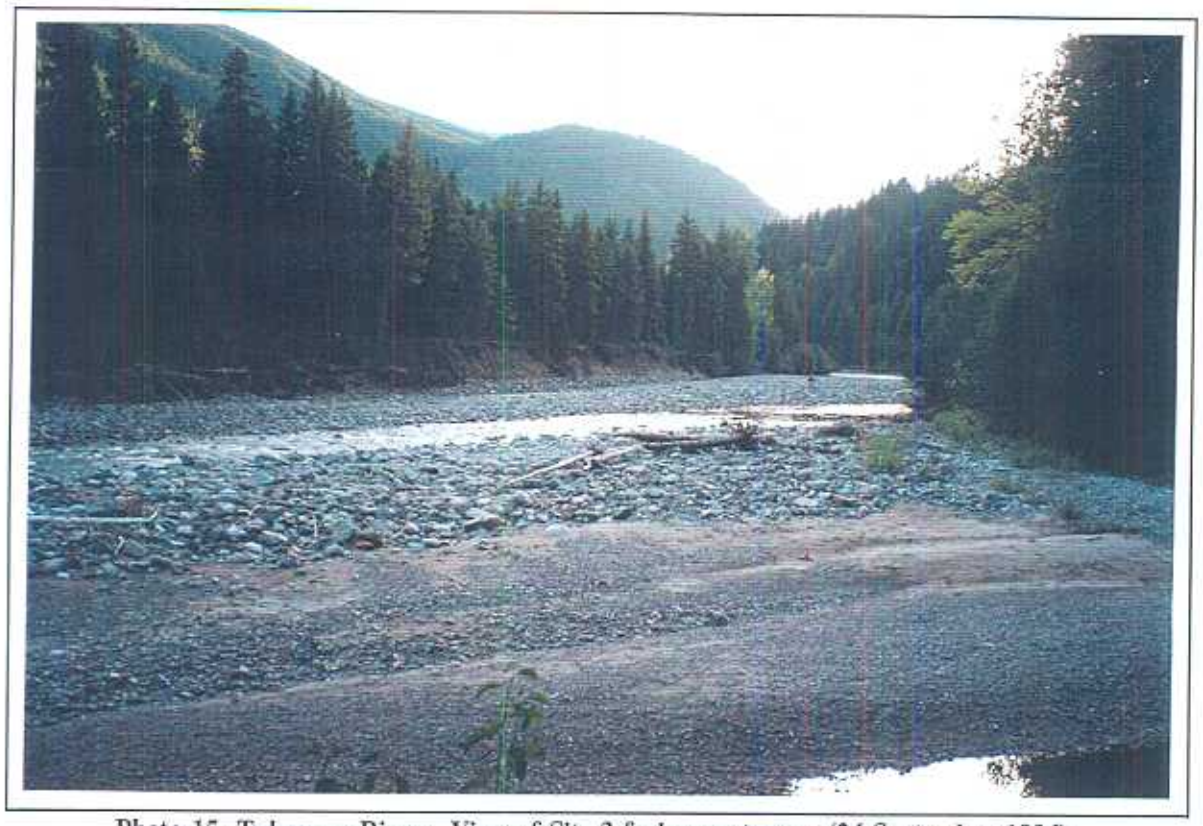


Photo 15: Tulameen River. View of Site 3 facing upstream. (24 September 1996).

Photo 16: Tulameen River. View of Site 4 facing upstream. (28 September 1996)

Photo 17: Tulameen River. View of Site 4 facing downstream from bridge. Note LWD atop right bank. (28 October 1996).

Photo 18: Tulameen River. View of Site 4 facing downstream. Note LWD on right bank. (28 October 1996).

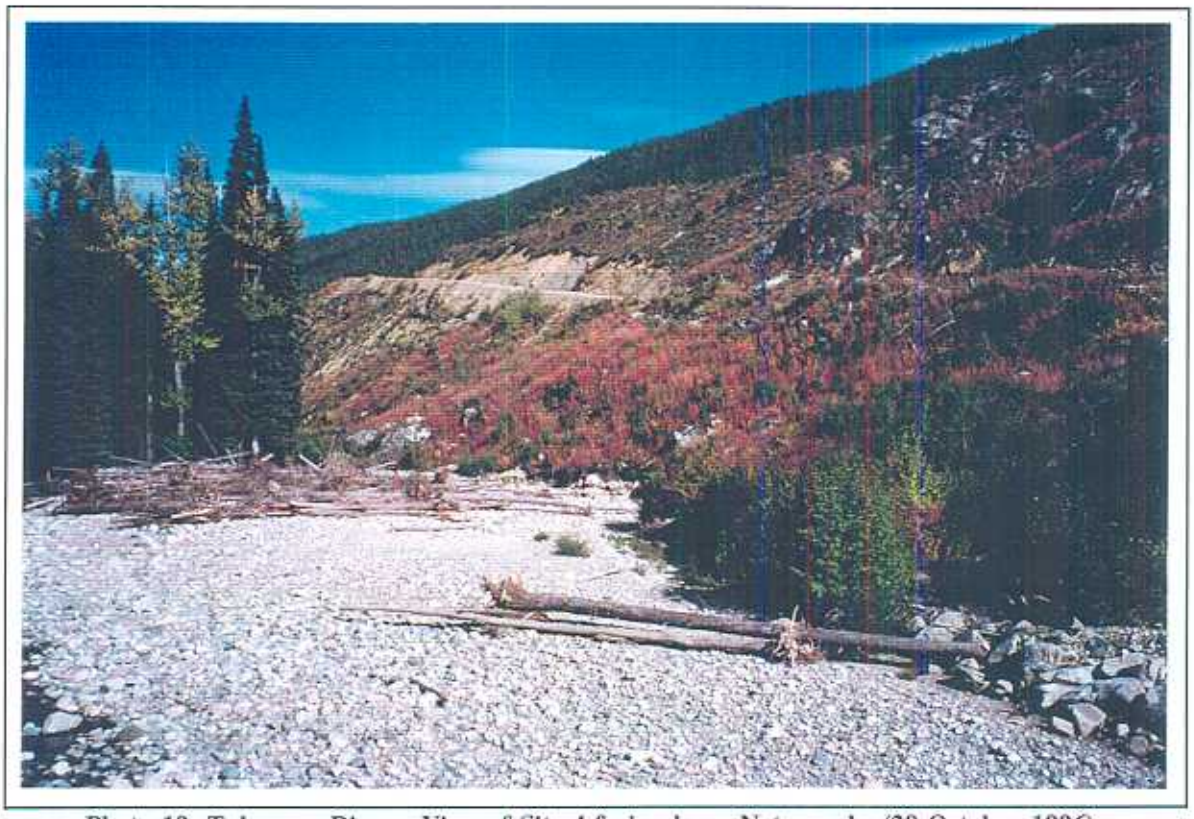


Photo 19: Tulameen River. View of Site 4 facing bar. Note road. (28 October 1996).

Photo 20: Tulameen River. View of Site 5 facing upstream. Note riffle and pool. (25 September 1996).

Photo 21: Tulameen River. View of Site 5 facing upstream. (25 September 1996).

Photo 22: Tulameen River. View of Site 5. Note undercut banks.
(25 September 1996).

Photo 23: Tulameen River. View of Site 5 facing downstream.
(25 September 1996).

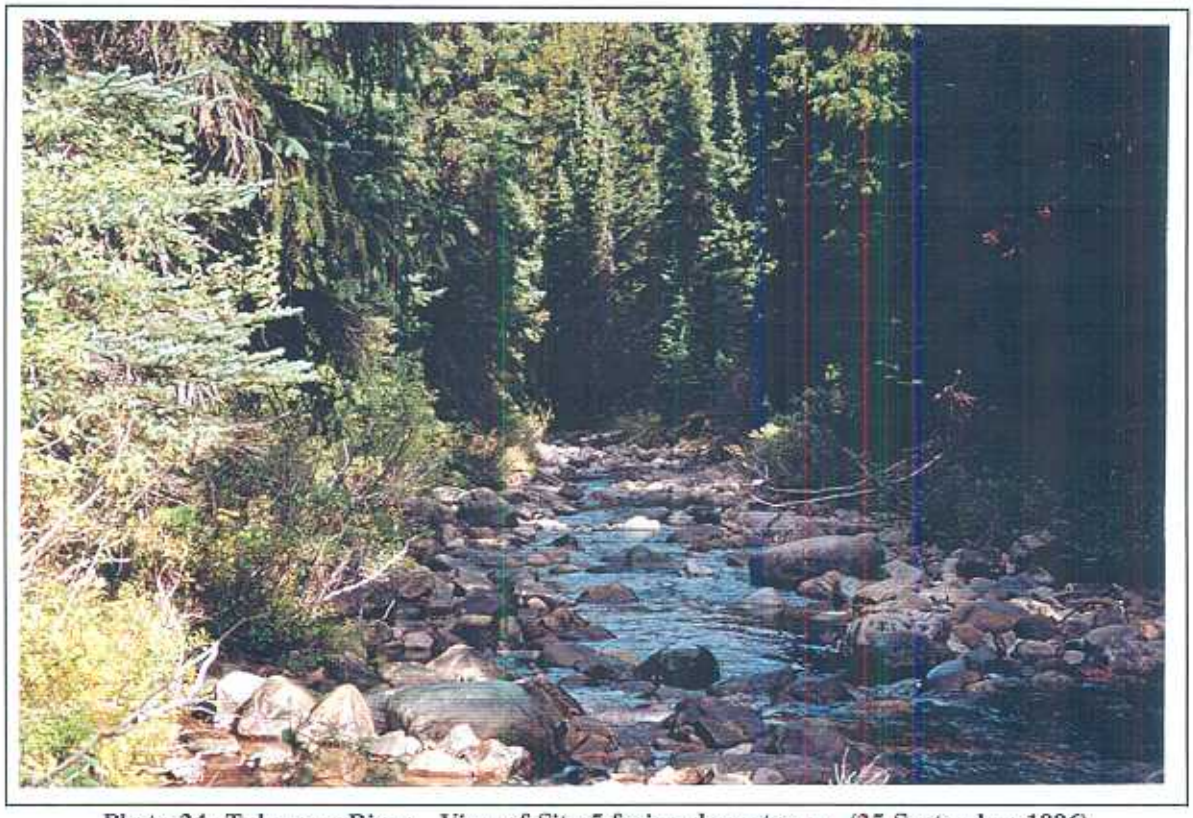


Photo 24: Tulameen River. View of Site 5 facing downstream. (25 September 1996)

Photo 25: Tulameen River. View of Site 5 facing downstream. Note pool. (25 September 1996).

Photo 26: Arrastra Creek. View of Site 1 facing upstream. (29 September 1996).

Photo 27: Arrastra Creek. View of Site 1. (29 September 1996)

Photo 28: Arrastra Creek. View of Site 1. (29 September 1996).

Photo 29: Arrastra Creek. View of Site 1 side channel. (29 September 1996).

Photo 30: Asp Creek. View of Site 1 facing upstream. Note vegetation cover. (1 October 1996).

Photo 31: Asp Creek. View of Site 1 facing downstream. Note woody debris. (1 October 1996).

Photo 32: Asp Creek. View of Site 2 facing downstream. Note undercut bank and vegetated bar. (30 September 1996).

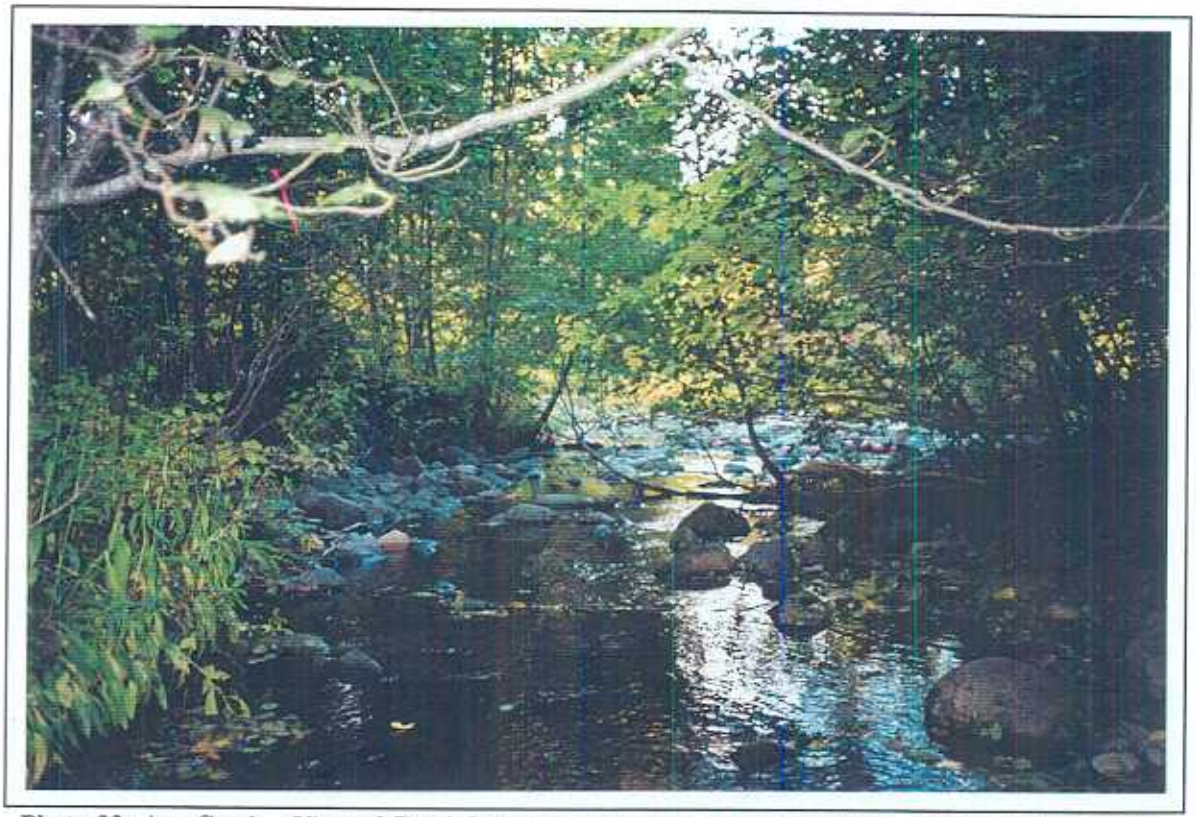


Photo 33: Asp Creek. View of Site 2 facing downstream. Note tree cover. (30 September 1996).

Photo 34: Asp Creek. View of Site 2 facing bank. Note large fallen tree. (30 September 1996).

Photo 35: Asp Creek. View of Site 3 facing downstream. Note riffle-pool. (30 September 1996).

Photo 36: Asp Creek. View of Site 3 facing downstream. Note undercut bank. (30 September 1996).

Photo 37: Champion Creek. View of Site 1 facing upstream. (8 October 1996).

Photo 38: Champion Creek. View of Site 1 upstream of 100 m. Note chute.
(8 October1996).

Photo 39: Champion Creek. View of Site 1 facing bank. Note steep cliffed bank and pool. (8 October 1996).

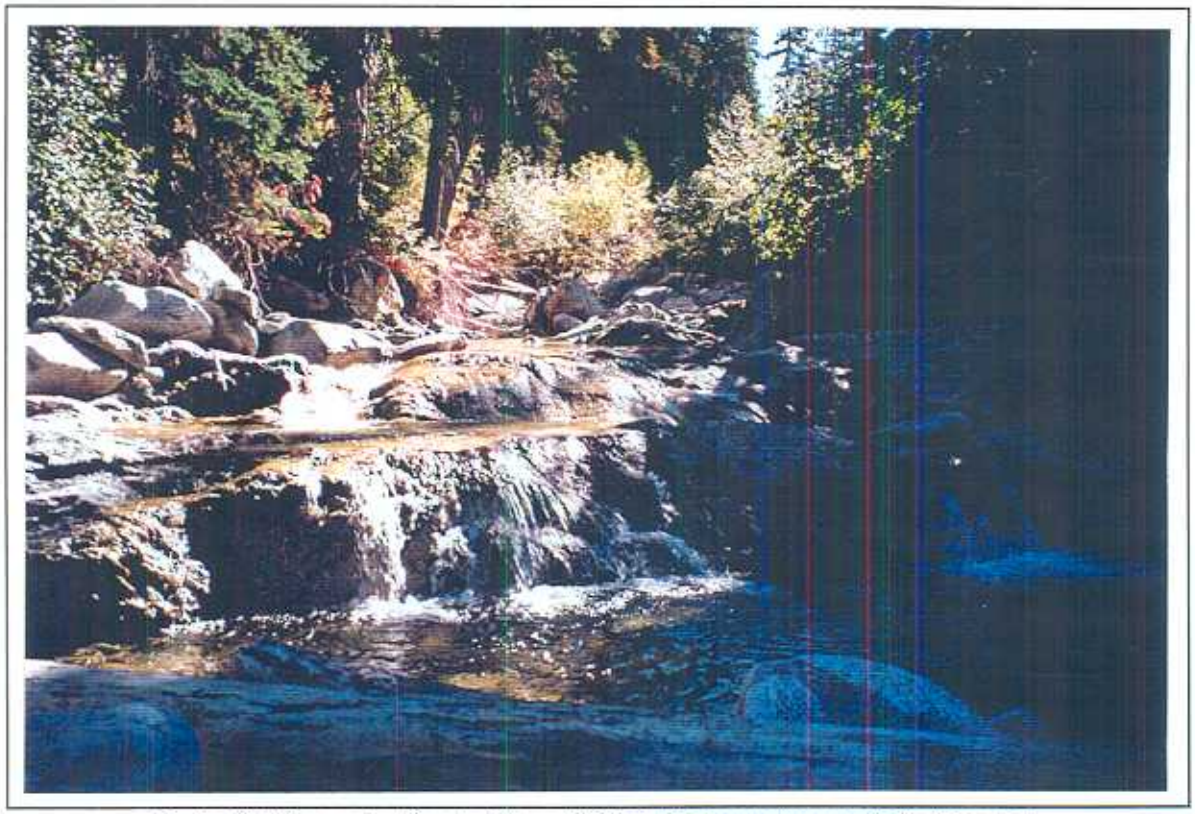


Photo 40: Champion Creek. View of Site 2 facing upstream. Note step pool. (29 September 1996).

Photo 41: Champion Creek. View of Site 2 facing downstream. Note steep rocky banks. (29 September 1996).

Photo 42: Champion Creek. View of Site 3 facing downstream. (28 September 1996).

Photo 43: Champion Creek. View of Site 3 facing upstream. Note LWD. (28 September 1996).

Photo 44: Champion Creek. View of Site 3 facing upstream. Note logjam. (28 September 1996).

Photo 45: Champion Creek. View of Site 3 facing upstream. Note logjam and sediment deposit and undercut banks. (28 September 1996).

Photo 46: Champion Creek. View of Site 3 facing bank. Note bedrock. (28 September 1996).

Photo 47: Frenchy Creek. View of Site 1 facing upstream. Note logjam. (5 October 1996).

Photo 48: Frenchy Creek. View of Site 1 facing upstream. Note logjam. (5 October 1996).

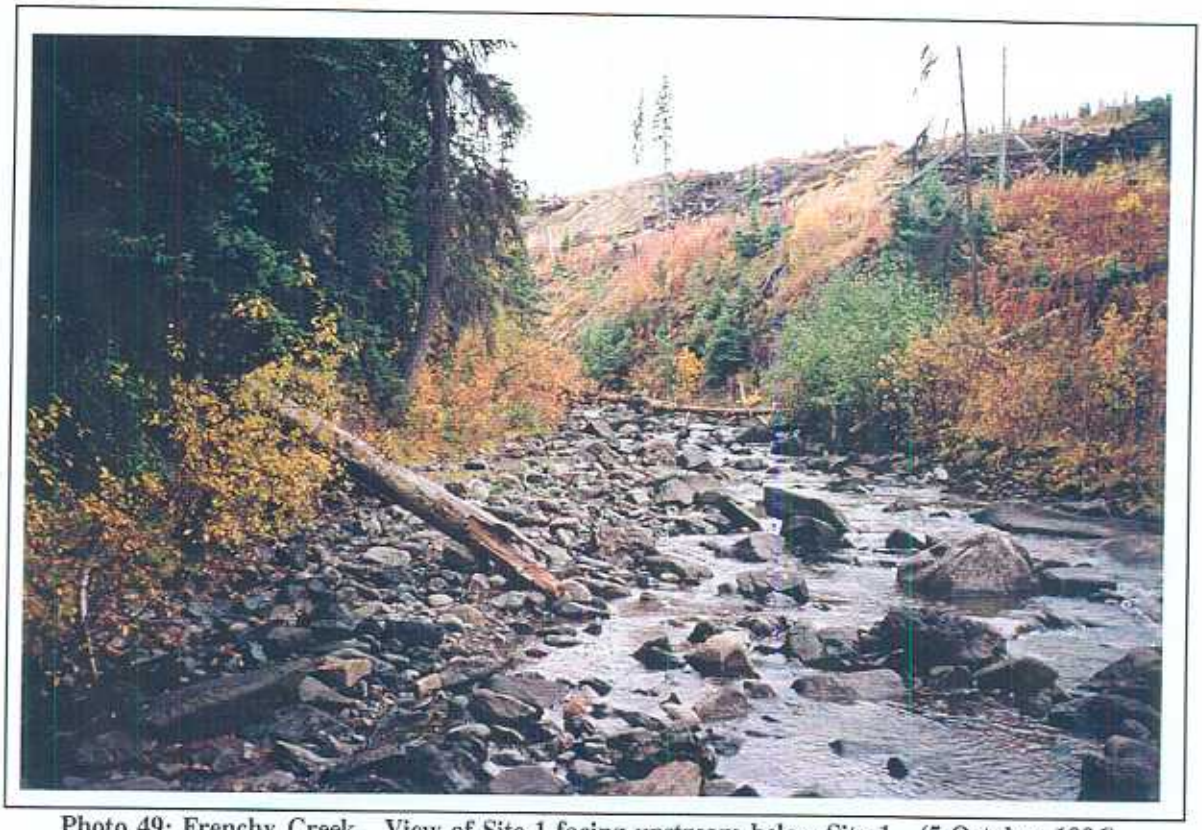


Photo 49: Frenchy Creek. View of Site 1 facing upstream below Site 1. (5 October 1996).

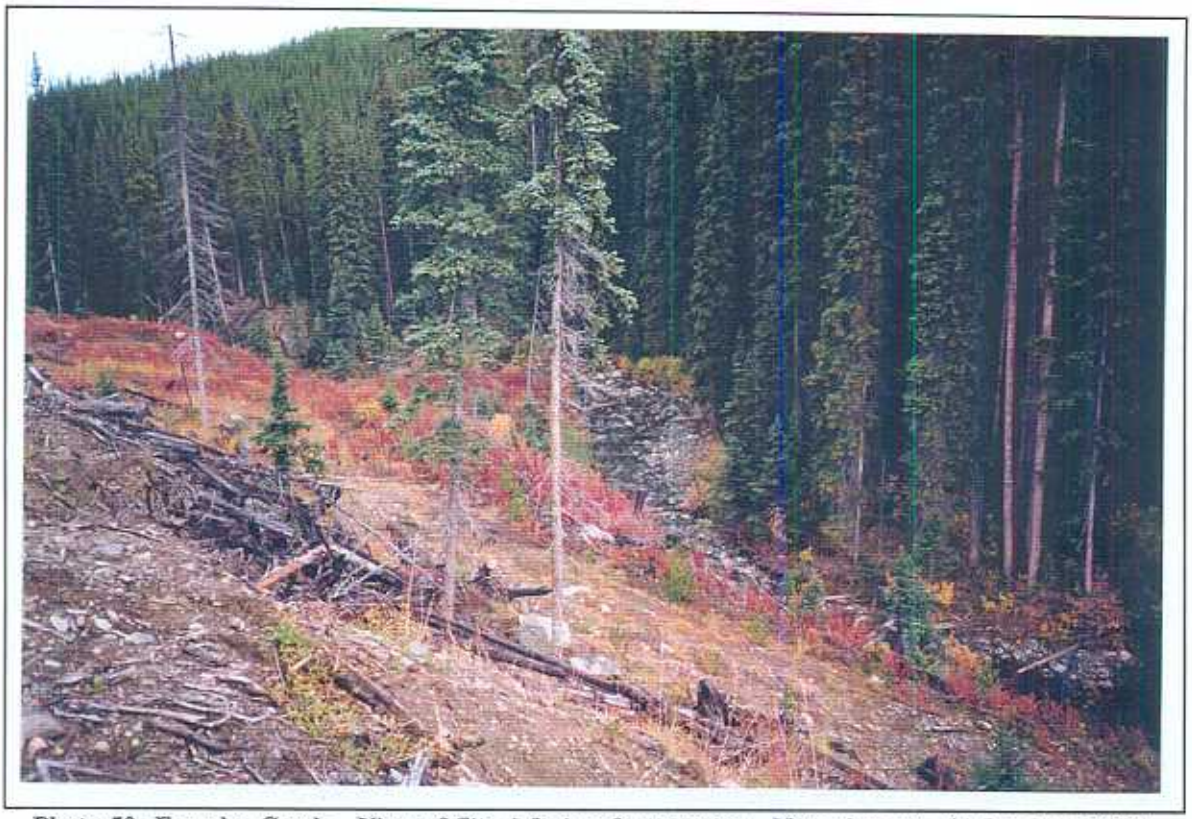


Photo 50: Frenchy Creek. View of Site 1 facing downstream. Note clearcut. (5 October 1996).

Photo 51: Frenchy Creek. View of Site 1 facing left bank at 0 meters. (5 October 1996).

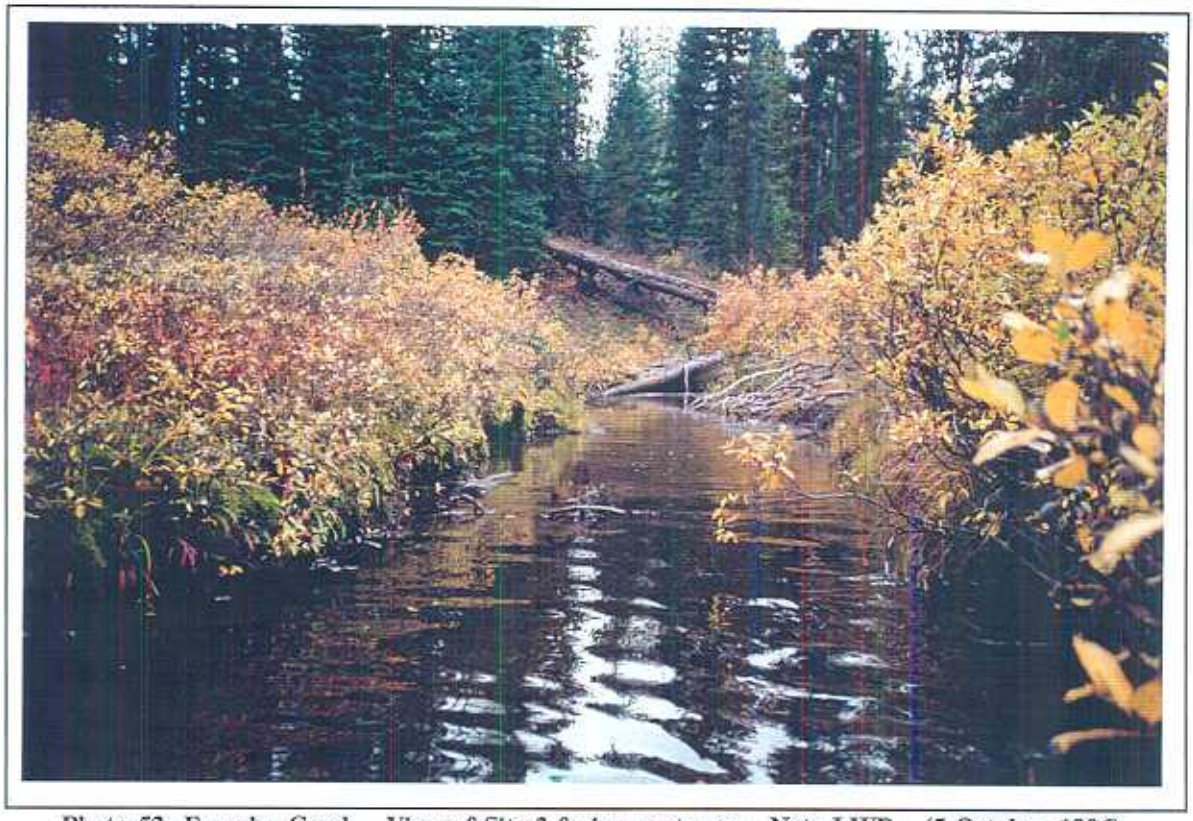


Photo 52: Frenchy Creek. View of Site 2 facing upstream. Note LWD. (5 October 1996).

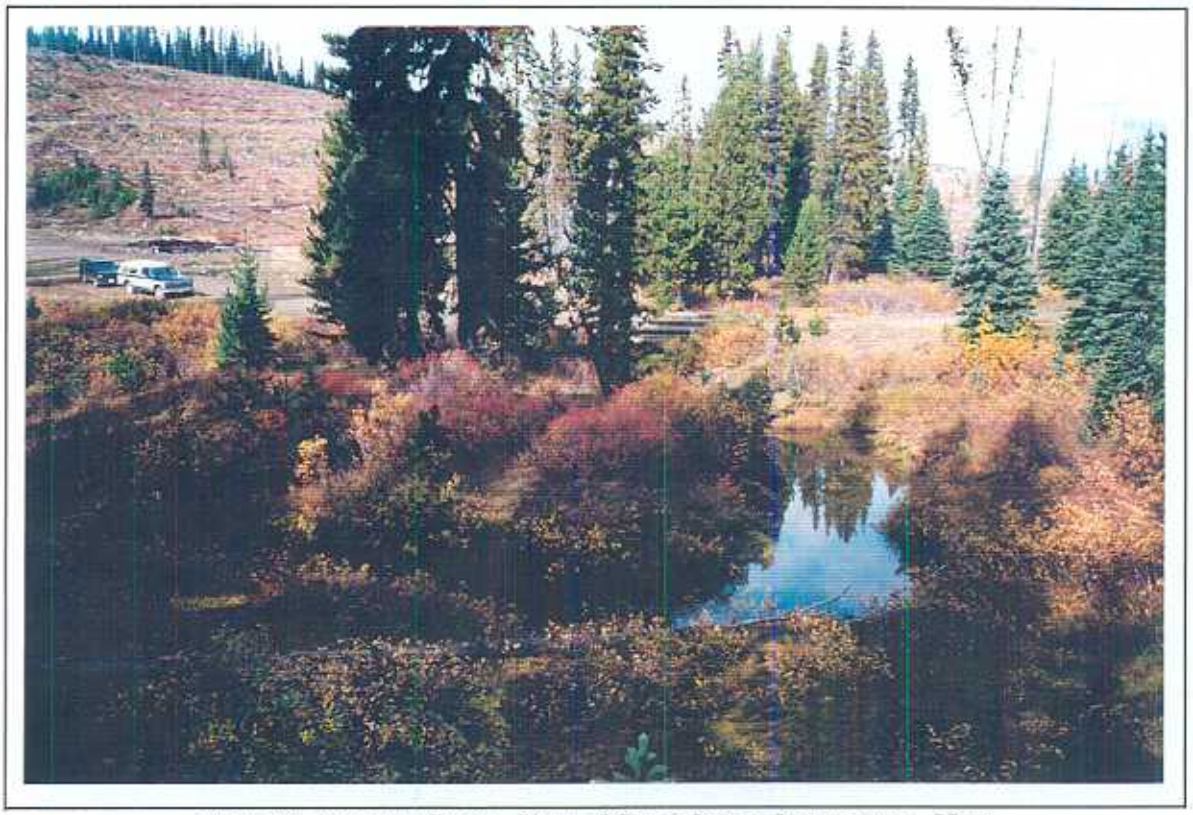


Photo 53: Frenchy Creek. View of Site 2 facing downstream. Note road and clearcut. (5 October 1996).

Photo 54: Frenchy Creek. View of Site 2 facing left bank. (5 October 1996).

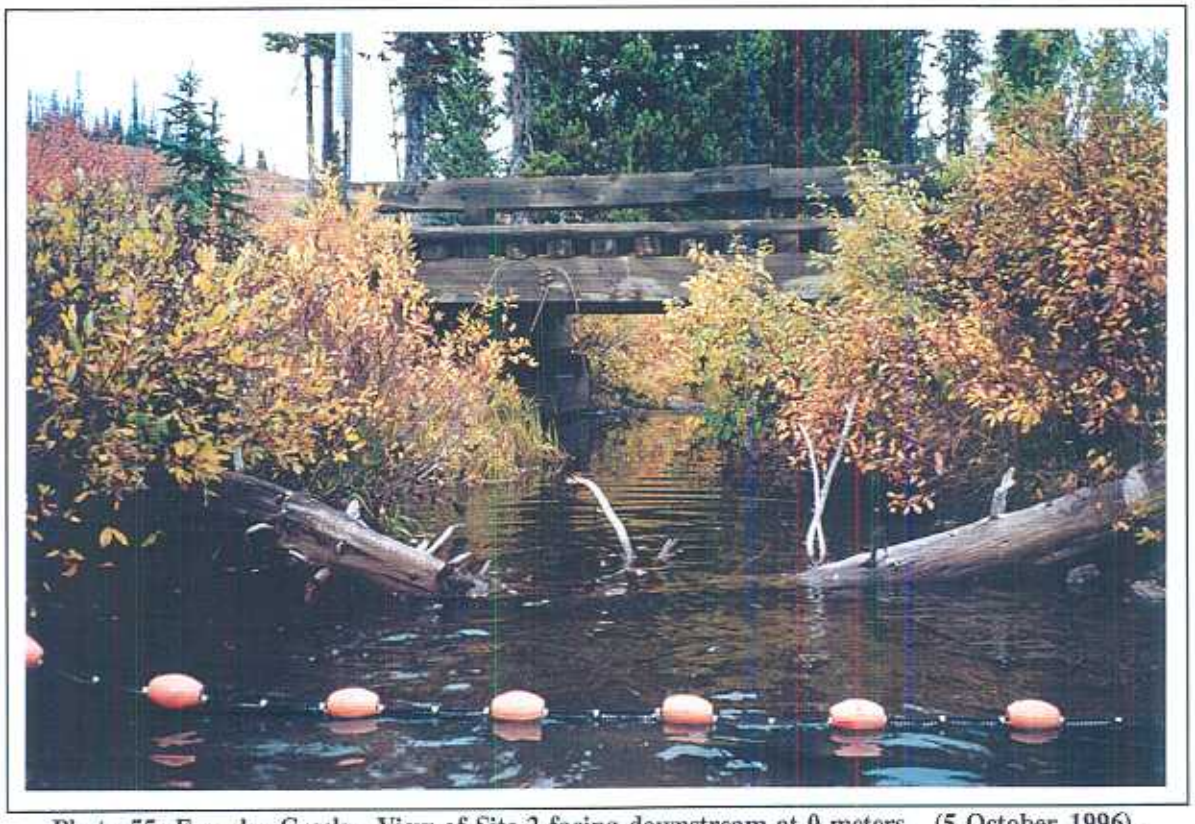


Photo 55: Frenchy Creek. View of Site 2 facing downstream at 0 meters. (5 October 1996).

Photo 56: Frenchy Creek. View of Site 3 facing downstream. Note riffles. (5 October 1996).

Photo 57: Frenchy Creek. View of Site 3 facing upstream. (5 October 1996).

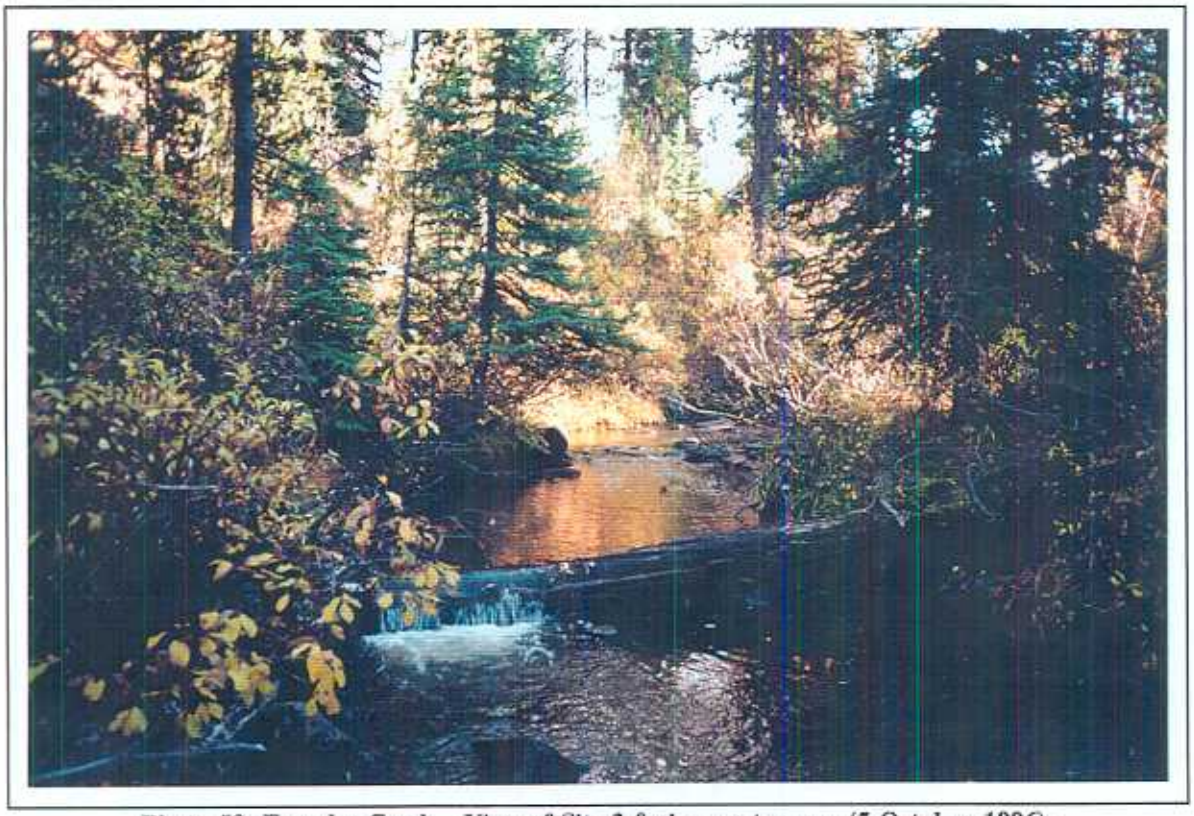


Photo 58: Frenchy Creek. View of Site 3 facing upstream. (5 October 1996).

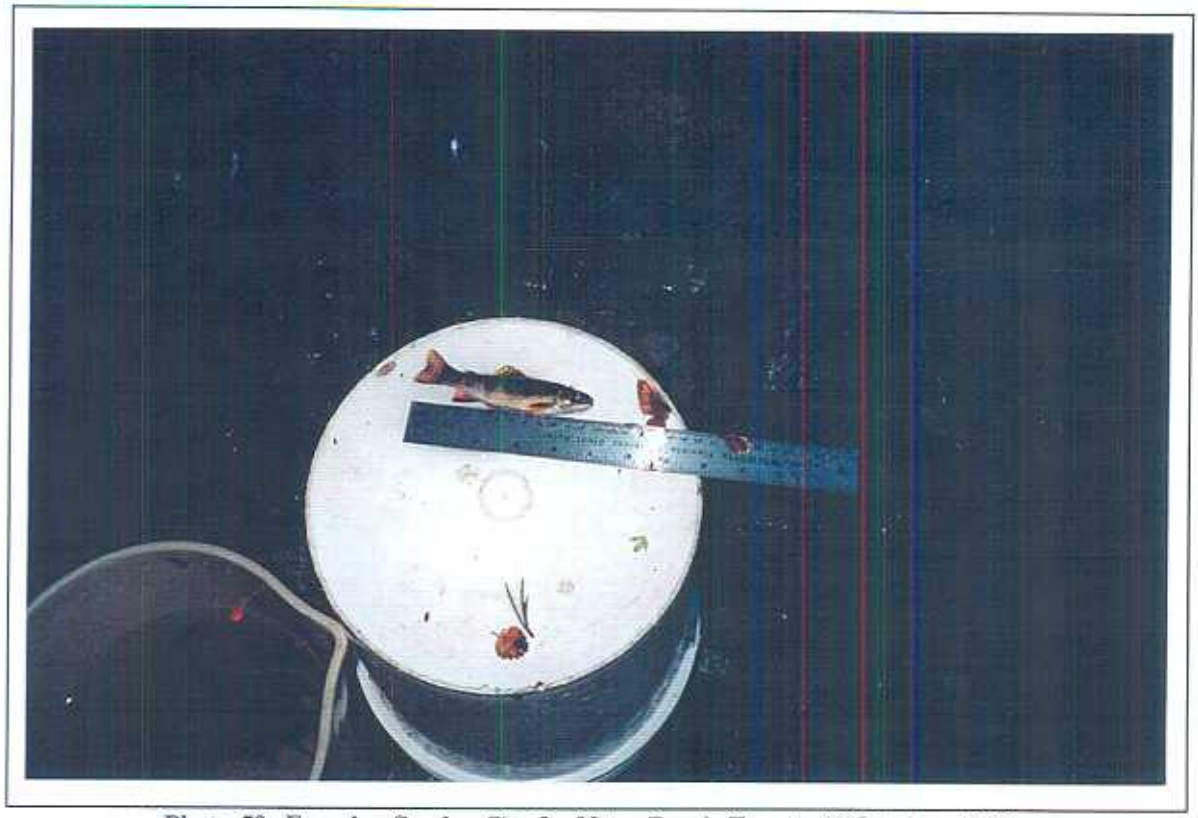


Photo 59: Frenchy Creek. Site 3. Note Brook Trout. (5 October 1996).

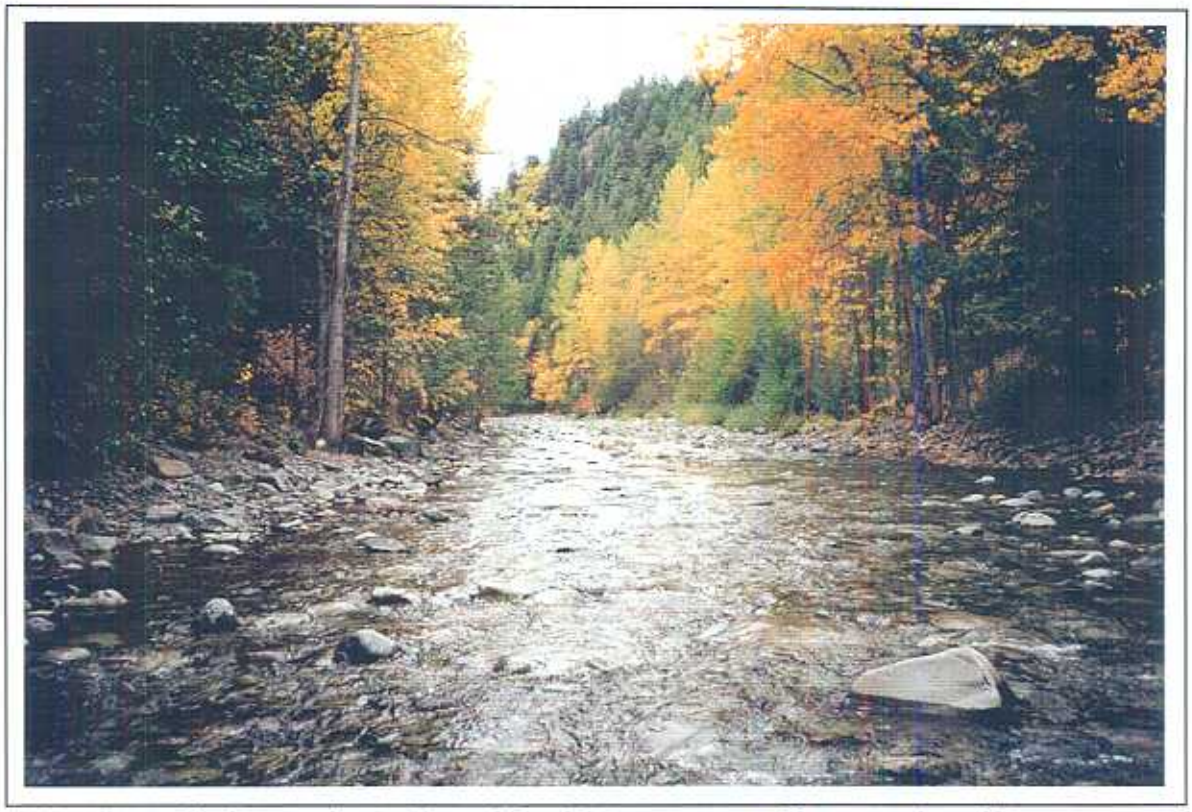


Photo 60: Granite Creek: View of Site 1 facing upstream. Note extensive riffle zone.
(2 October 1996)

Photo 61: Granite Creek. View of Site 1 facing downstream. (2 October 1996).

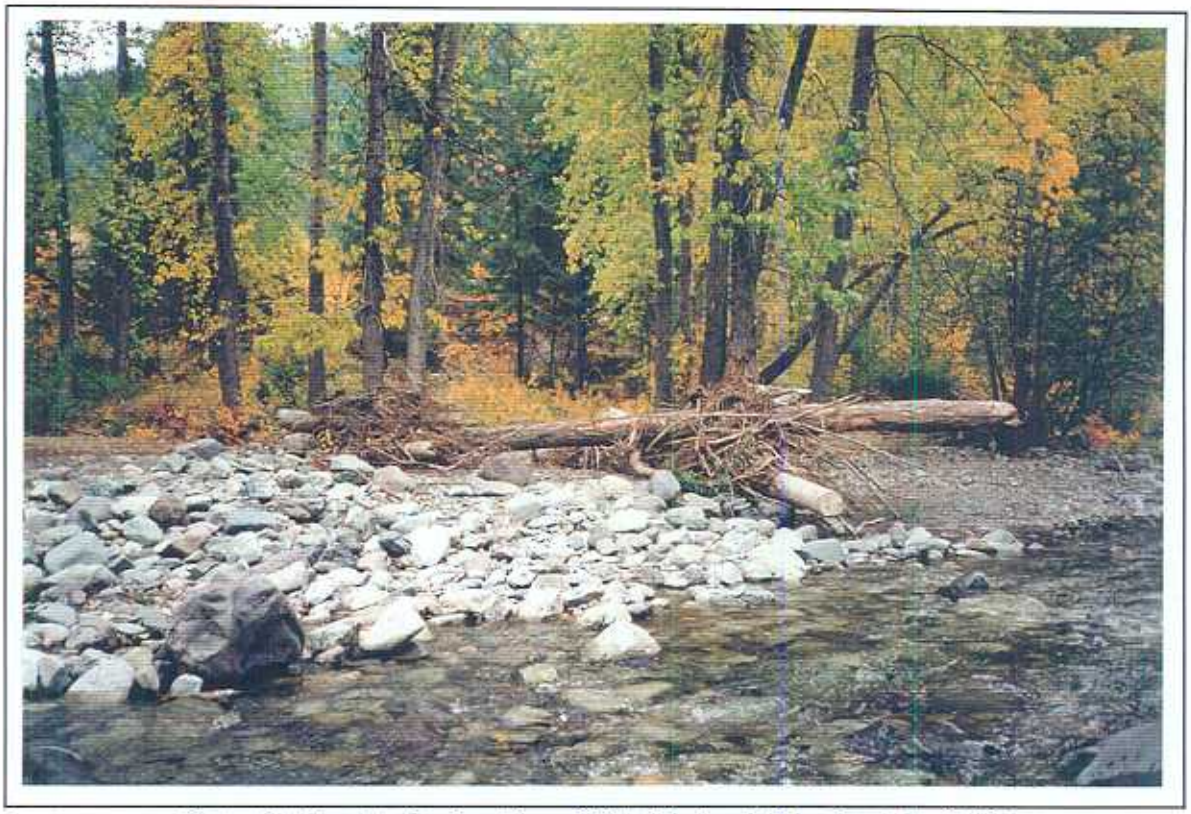


Photo 62: Granite Creek. View of Site 1 facing left bank. Note LWD outside of wetted width. (2 October 1996).

Photo 63: Granite Creek. View of Site 2 facing downstream. (6 October 1996).

Photo 64: Granite Creek. View of Site 2 facing downstream. Note sloughing bank and LWD. (6 October 1996).

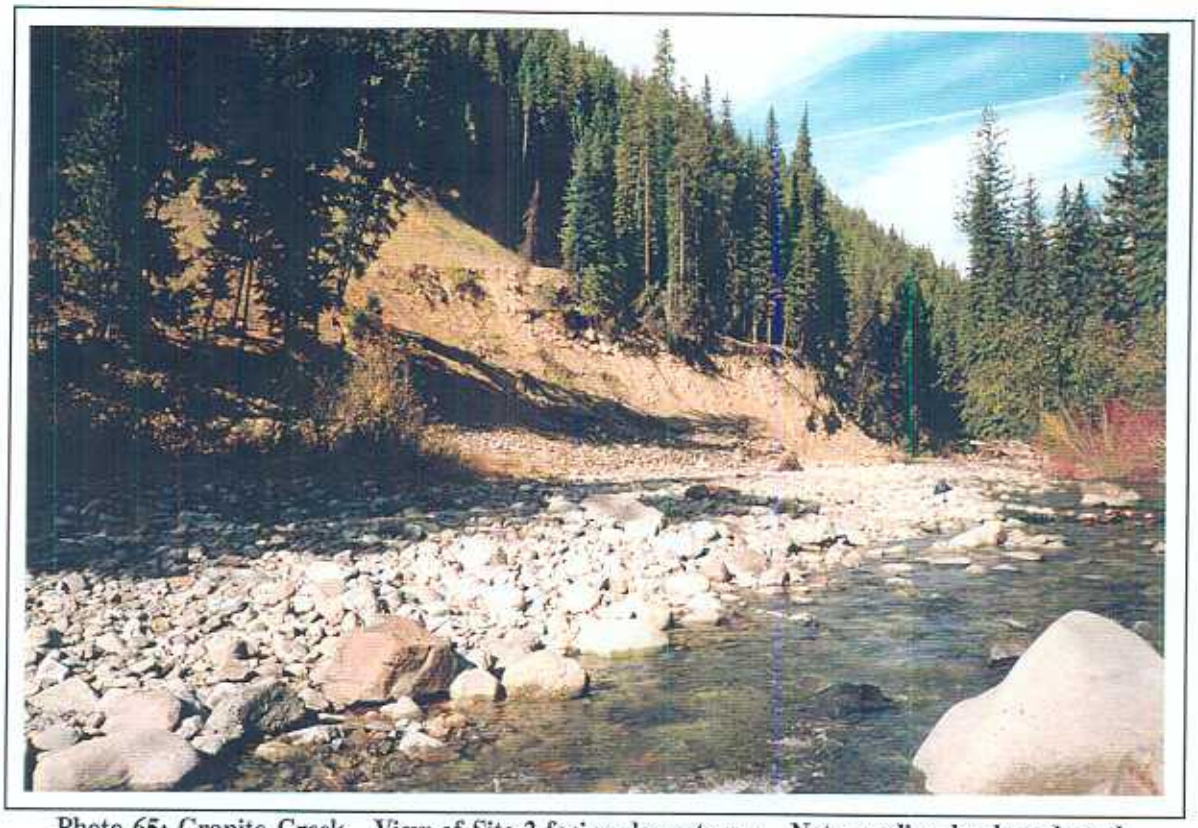


Photo 65: Granite Creek. View of Site 2 facing downstream. Note eroding bank and road. (6 October 1996).

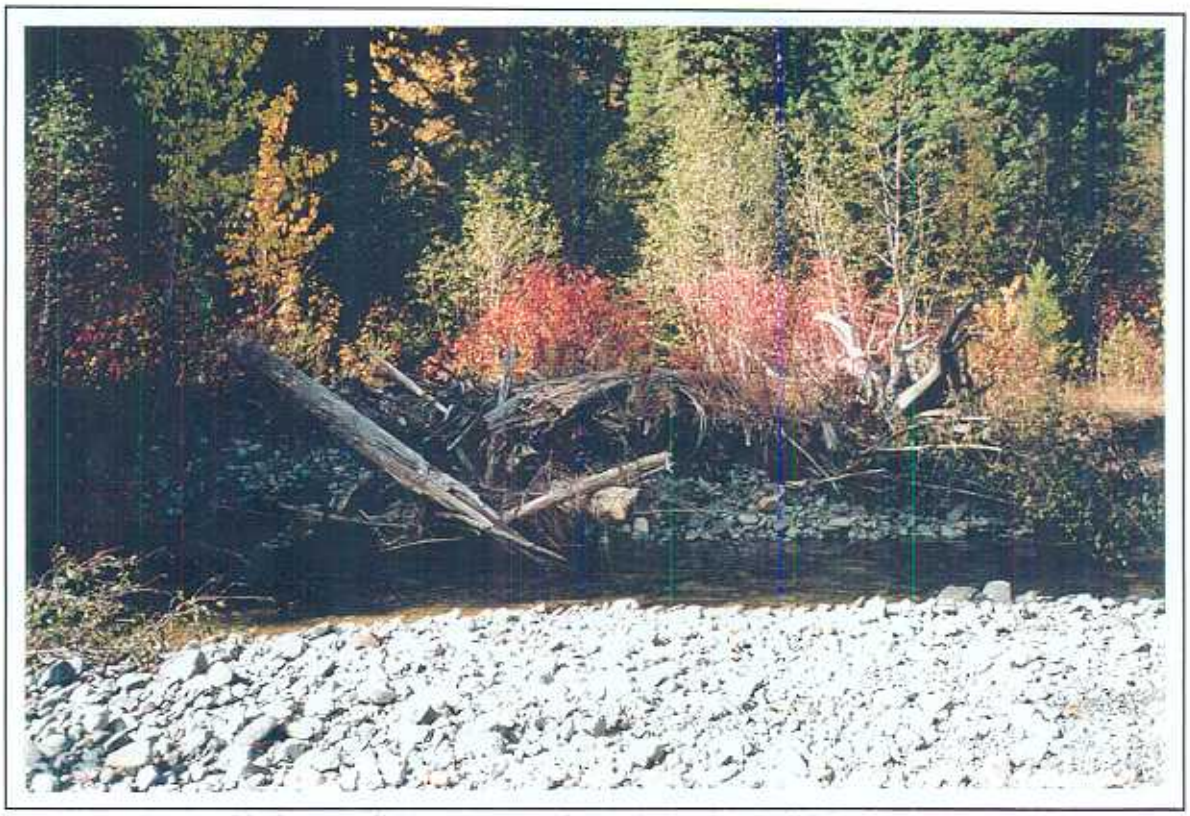


Photo 66: Granite Creek. View of Site 2 facing bank. Note woody debris. (6 October 1996).

Photo 67: Granite Creek. View of Site 3 facing downstream. Note unvegetated bar and sloughing conifer (6 October 1996).

Photo 68: Granite Creek. View of Site 3 facing downstream. Note LWD and debris in stream. (6 October 1996).

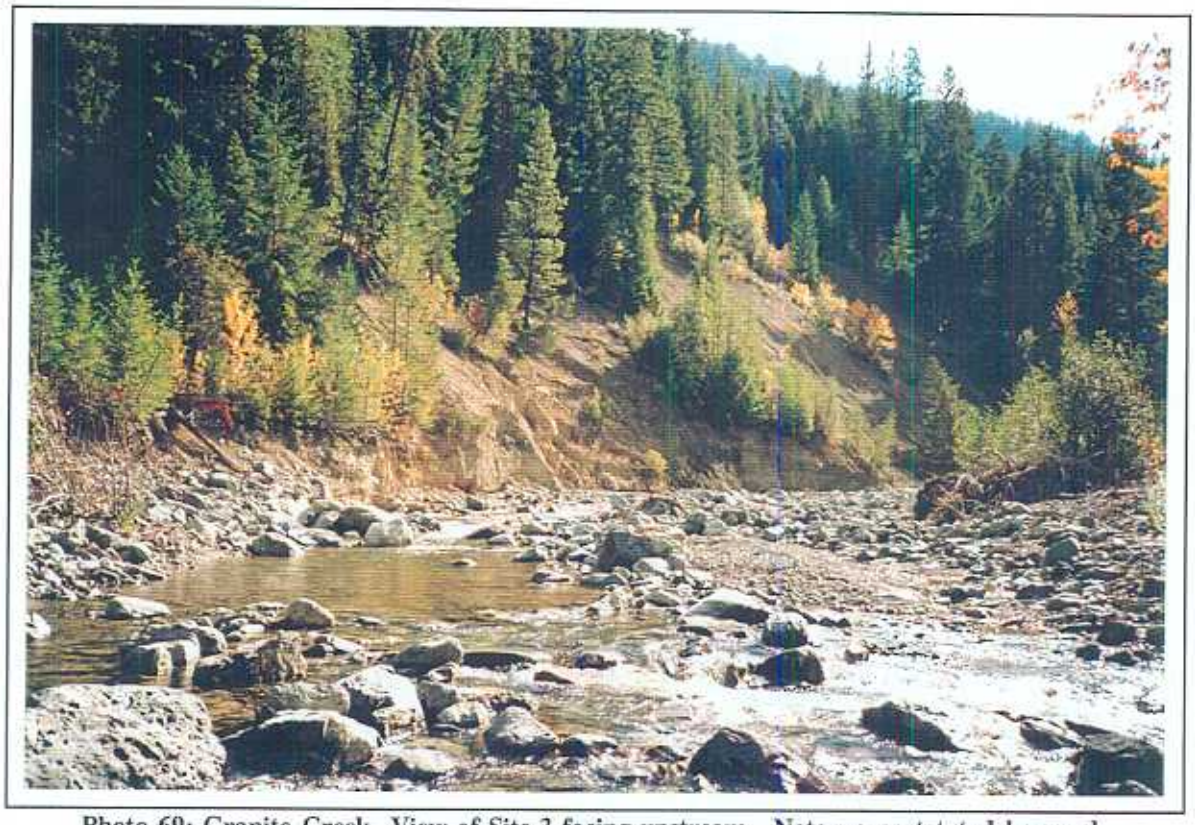


Photo 69: Granite Creek. View of Site 3 facing upstream. Note unvegetetated bar and unstable bank. (6 October 1996).

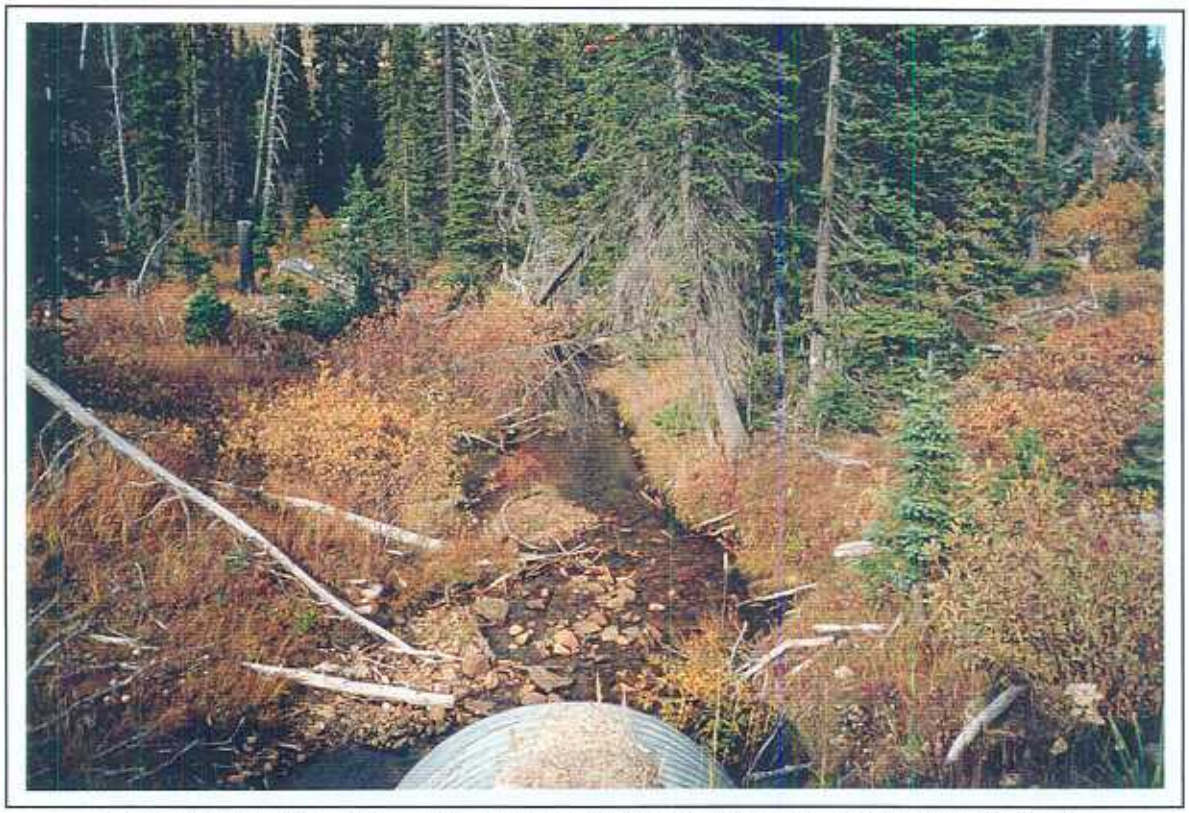


Photo 70: Granite Creek. View of Site 4 facing downstream. Note undercut banks. (6 October 1996).

Photo 71: Granite Creek. View of Site 4 upstream of culvert facing upstream. Note woody debris in channel (6 October 1996).

Photo 72: Granite Creek. View of Site 4 upstream of culvert facing upstream. Note clearcut and undercut banks (6 October 1996).

Photo 73: Granite Creek. View of Site 4 upstream of culvert facing upstream. Note LWD. (6 October 1996).

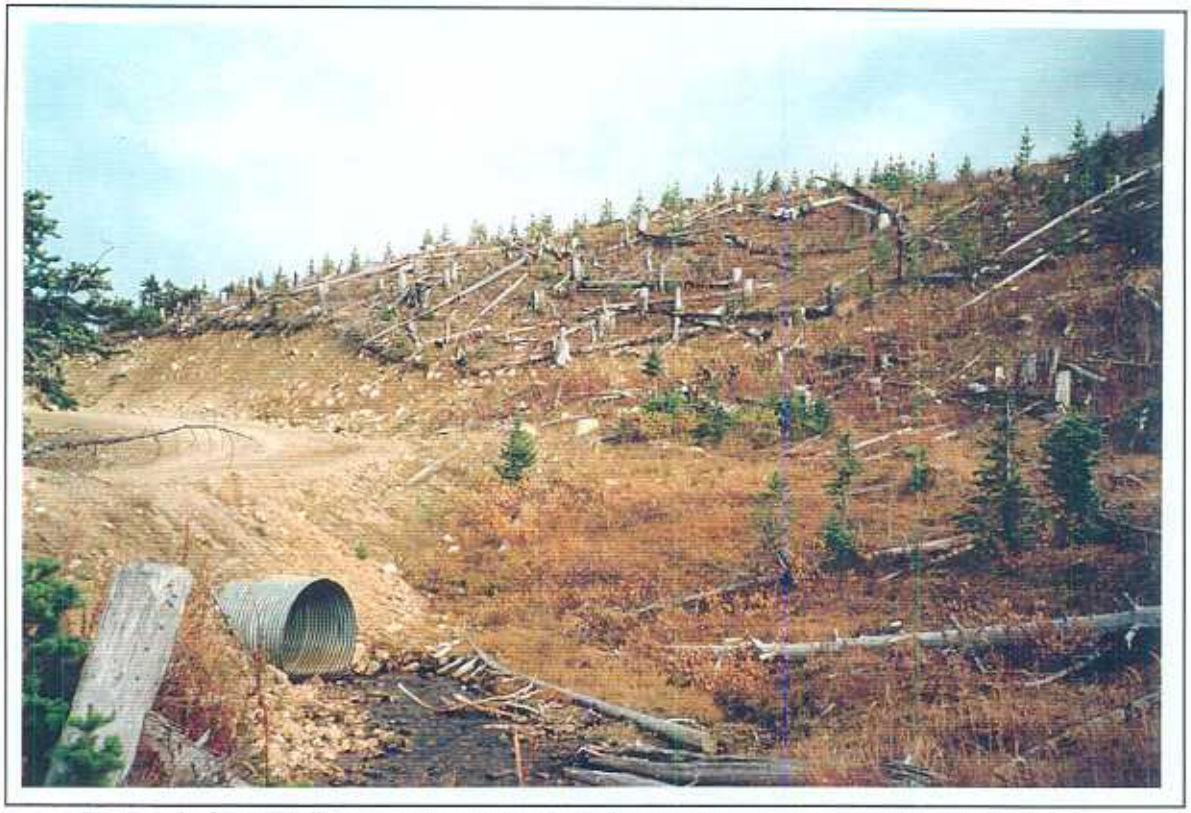


Photo 74: Granite Creek. View of Site 4 facing culvert. Note banks barren at culvert. (6 October 1996).

Photo 75: Granite Creek. View of Site 4 downstream of culvert facing upstream. Note pool completely under bank and debris in stream. (6 October 1996).

Photo 76: Granite Creek. View of Site 4 downstream of culvert facing downstream. Note uncut riparian zone (6 October 1996).

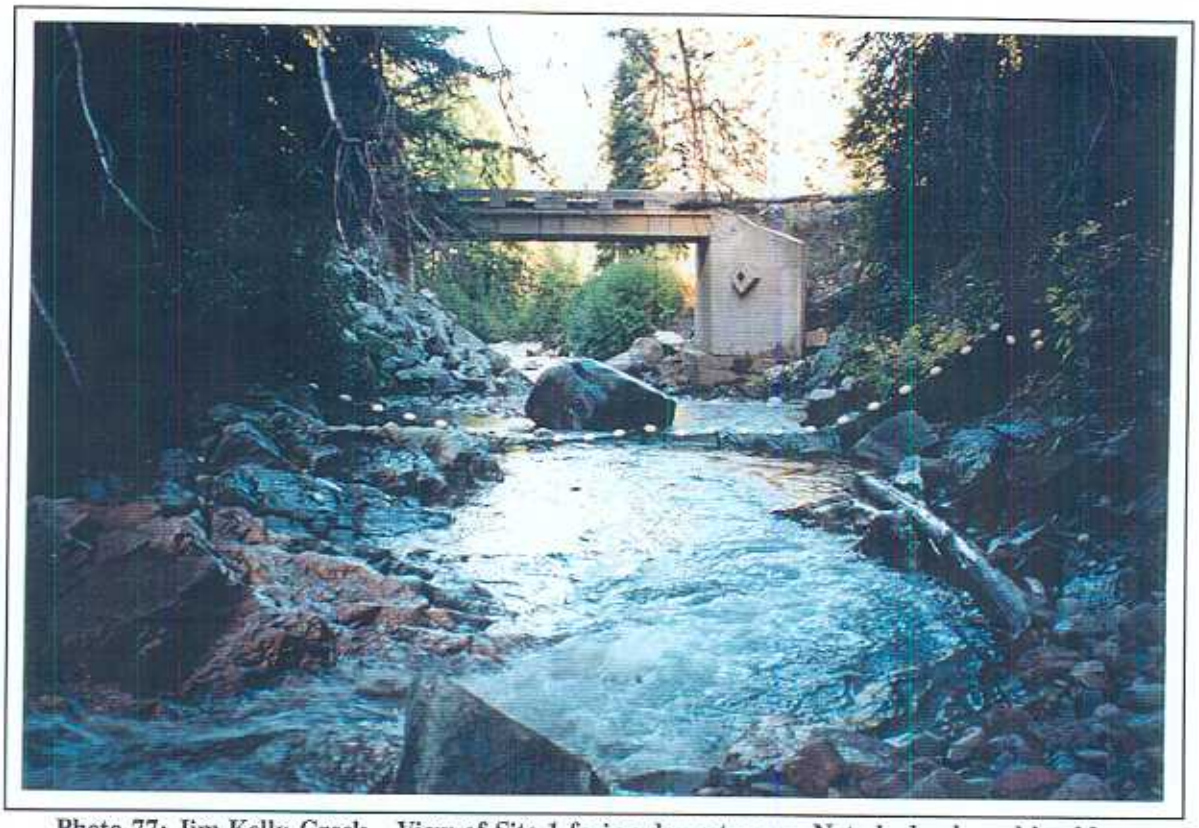


Photo 77: Jim Kelly Creek. View of Site 1 facing downstream. Note bedrock and boulder. (27 September 1996).

Photo 78: Jim Kelly Creek. View of Site 1 facing upstream. (27 September 1996).

Photo 79: Jim Kelly Creek. View of Site 1 facing upstream. Note pool. (27 September 1996).

Photo 80: Jim Kelly Creek. View of Site 2 facing upstream. Note pool.
(10 October 1996).

Photo 81: Jim Kelly Creek. View of Site 2 facing downstream. (10 October 1996).

Photo 82: Jim Kelly Creek. View of Site 2 facing left bank. Note LWD.
(10 October 1996).

Photo 83: Jim Kelly Creek. View of Site 2 facing bank. Note eroding bank. (10 October 1996).

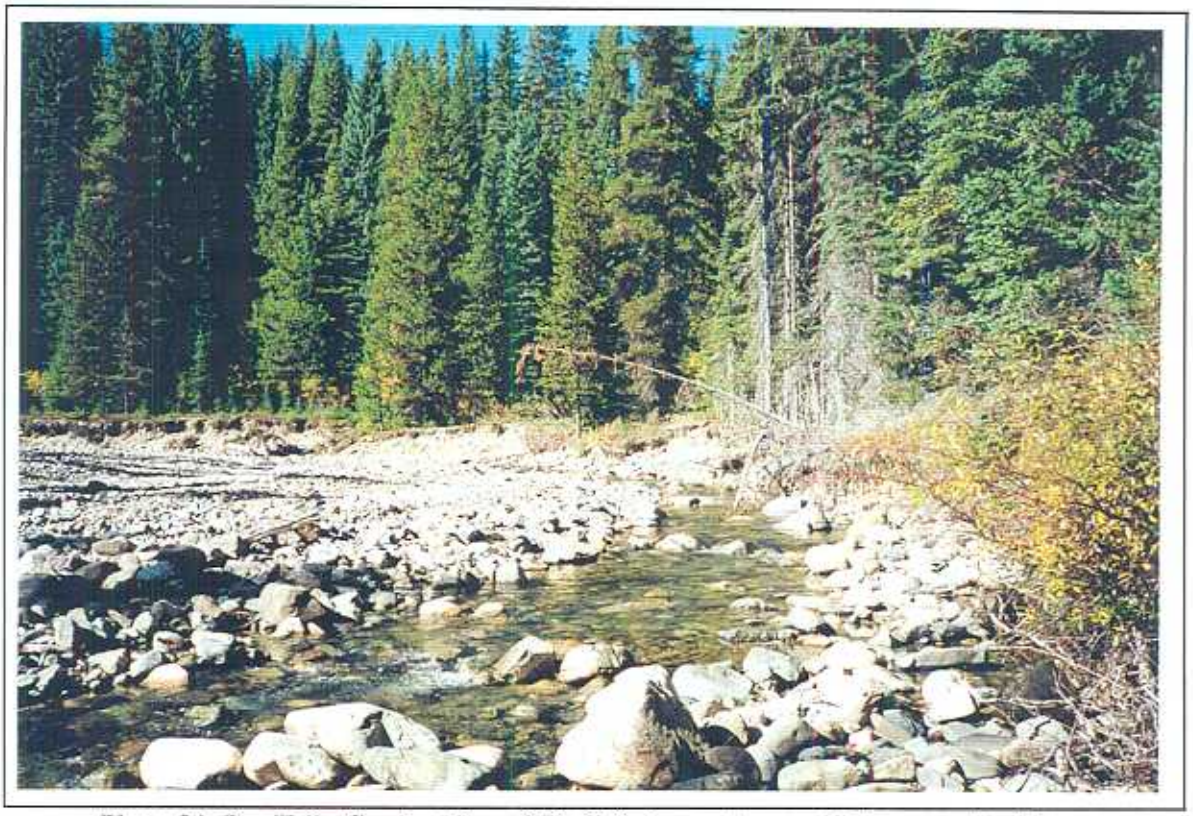


Photo 84: Jim Kelly Creek. View of Site 3 facing upstream. Note unvegetated bar. (10 October 1996).

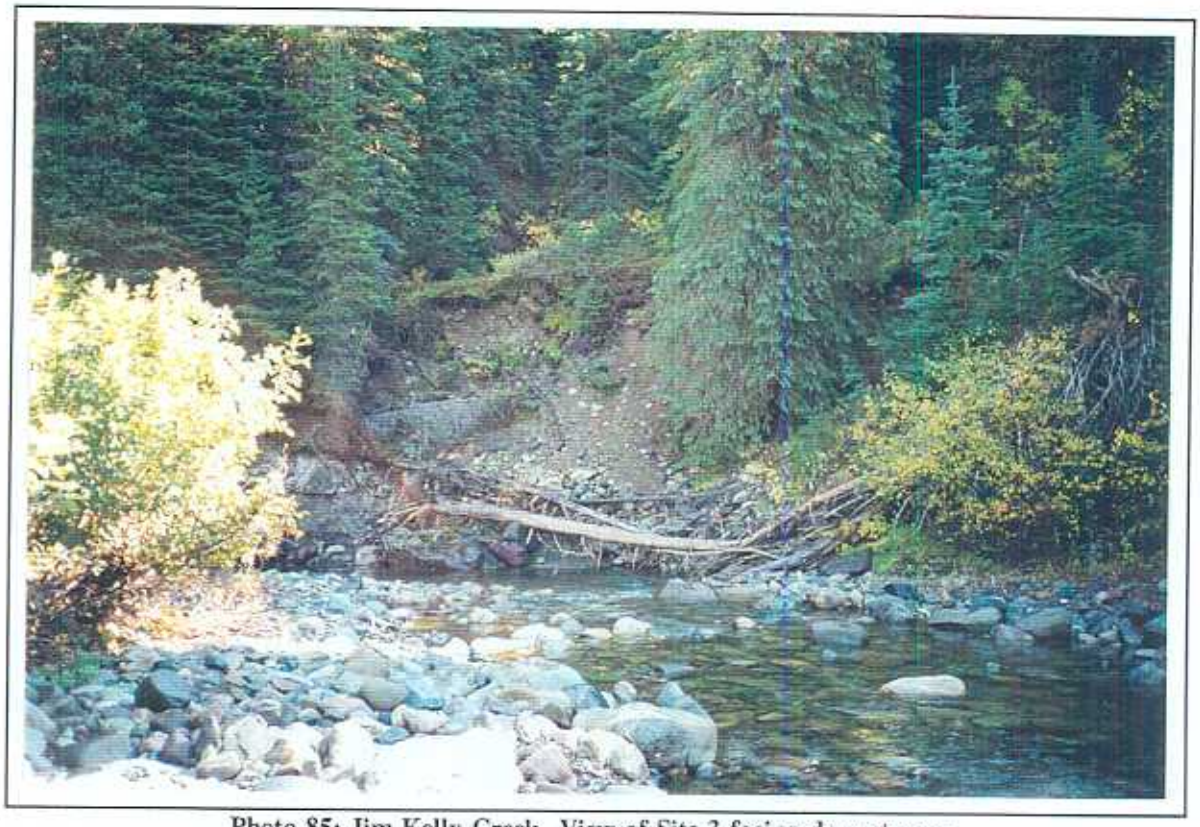


Photo 85: Jim Kelly Creek. View of Site 3 facing downstream.
Note eroding bank. (10 October 1996).

Photo 86: Olivine Creek. View of Site 1 facing upstream. Note riparian cover.
(23 September 1996).

Photo 87: Olivine Creek. View of Site 1 facing downstream. (24 September 1996).

Photo 88: Olivine Creek. View of Site 1 side channel. Note logjam.
(23 September 1996).

Photo 89: Olivine Creek. View of Site 1 facing logjam in side channel. (23 September 1996).

Photo 90: Olivine Creek. Tailed frog. (23 September 1996).

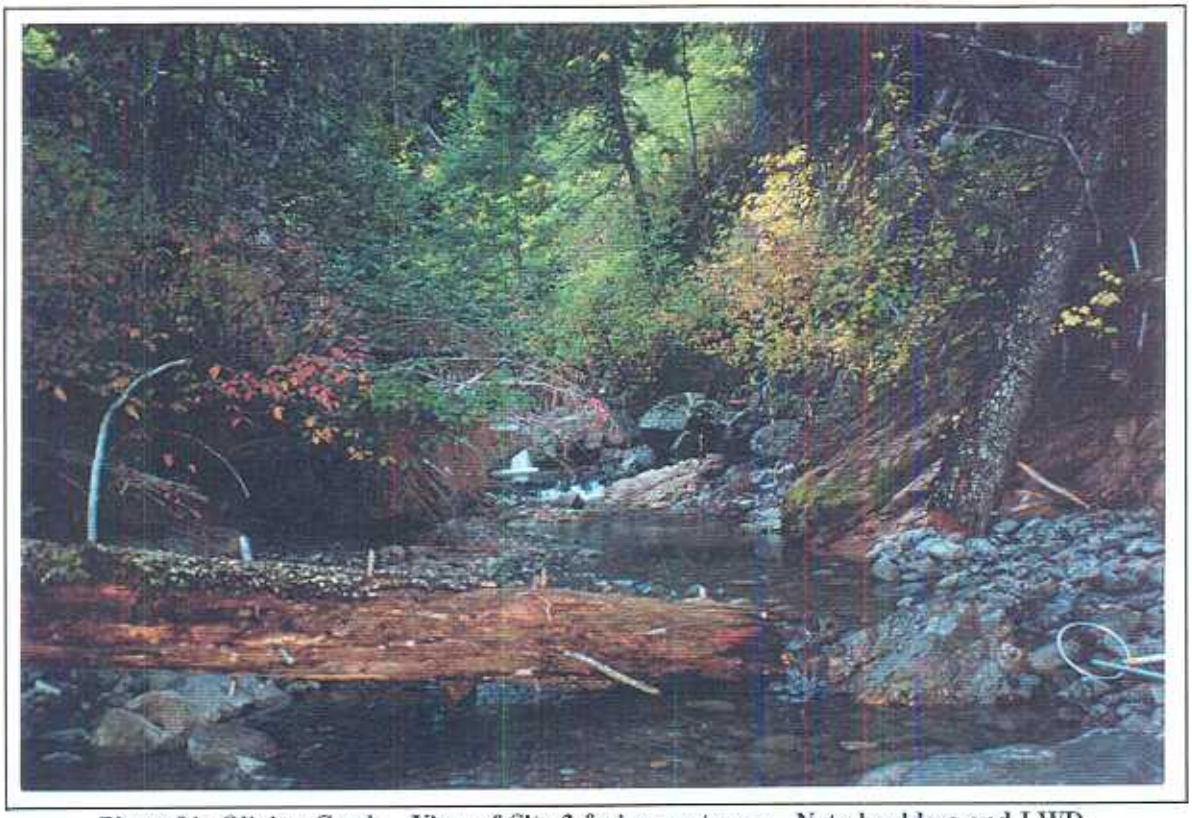


Photo 91: Olivine Creek. View of Site 2 facing upstream. Note boulders and LWD. (2 October 1996).

Photo 92: Olivine Creek. View of Site 3 facing downstream. (7 October 1996).

Photo 93: Olivine Creek. View of Site 3 facing upstream. Note LWD on bank. (7 October 1996).

Photo 94: Olivine Creek. View of Site 3 facing upstream. Note LWD. (7 October 1996).

Photo 95: Olivine Creek. View of Site 3 facing upstream. Note eroding right bank. (7 October 1996).

Photo 96: Olivine Creek. View of Site 3 facing upstream. Note logjam. (7 October 1996).

Photo 97: Olivine Creek. View below Site 3 facing downstream. (7 October 1996).

Photo 98: Olivine Creek. View of Site 4 (Trib.) facing left bank. Note culvert. (7 October 1996).

Photo 99: Olivine Creek. View of Site 4 (Trib.) facing right bank. Note eroding bank. (7 October 1996).

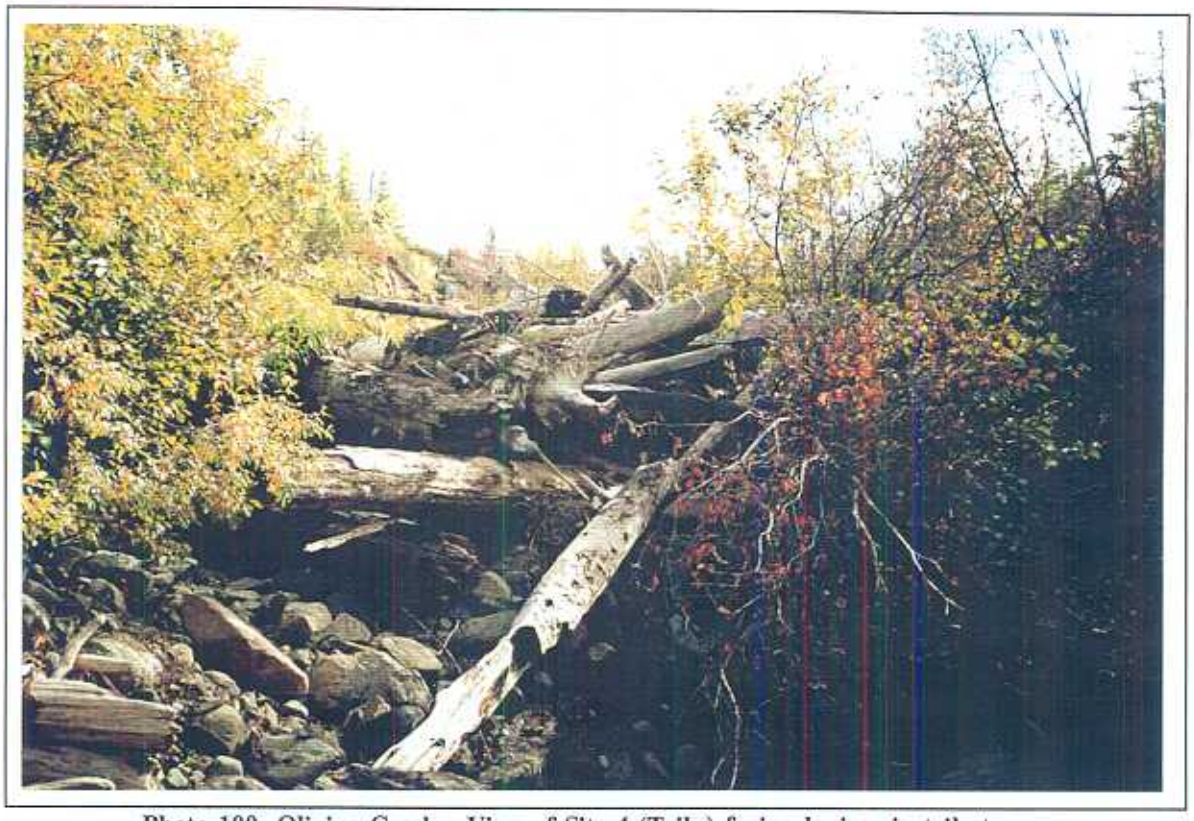


Photo 100: Olivine Creek. View of Site 4 (Trib.) facing logjam in tributary. (7 October 1996).

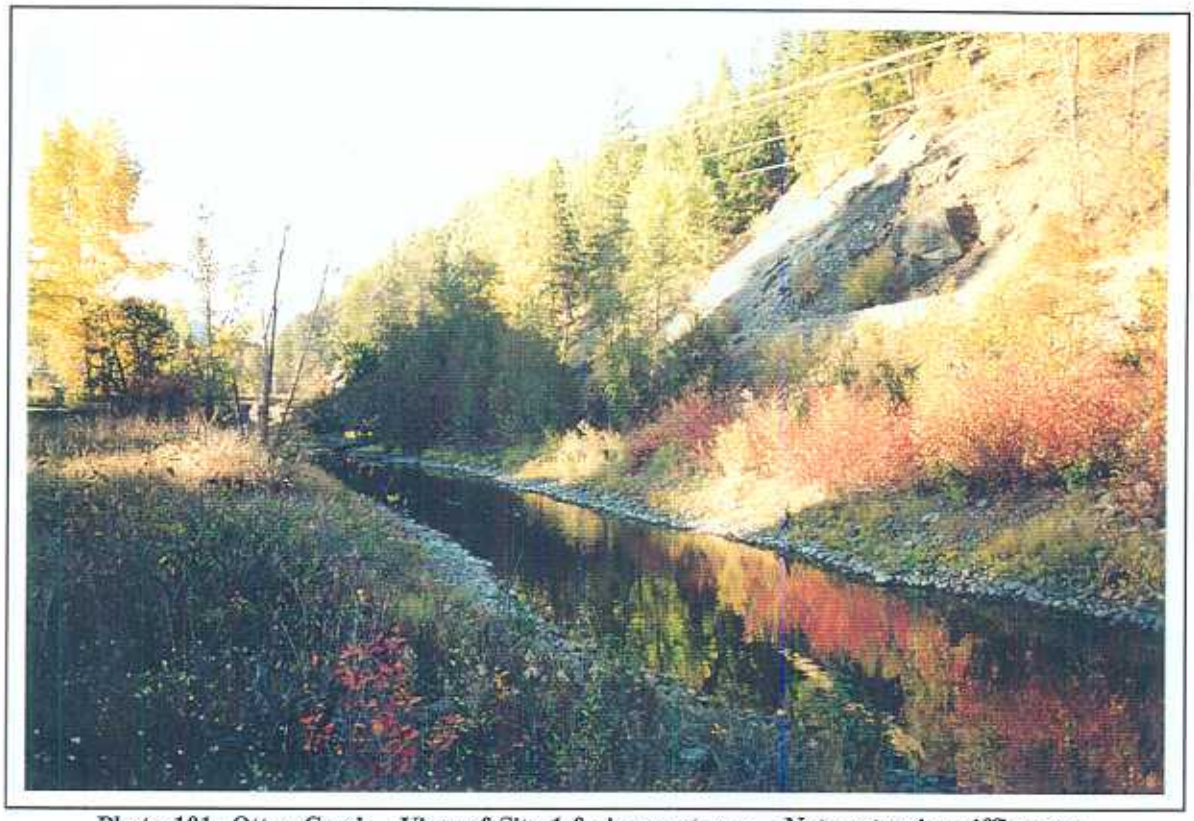


Photo 101: Otter Creek. View of Site 1 facing upstream. Note extensive riffle zone. (9 October 1996).

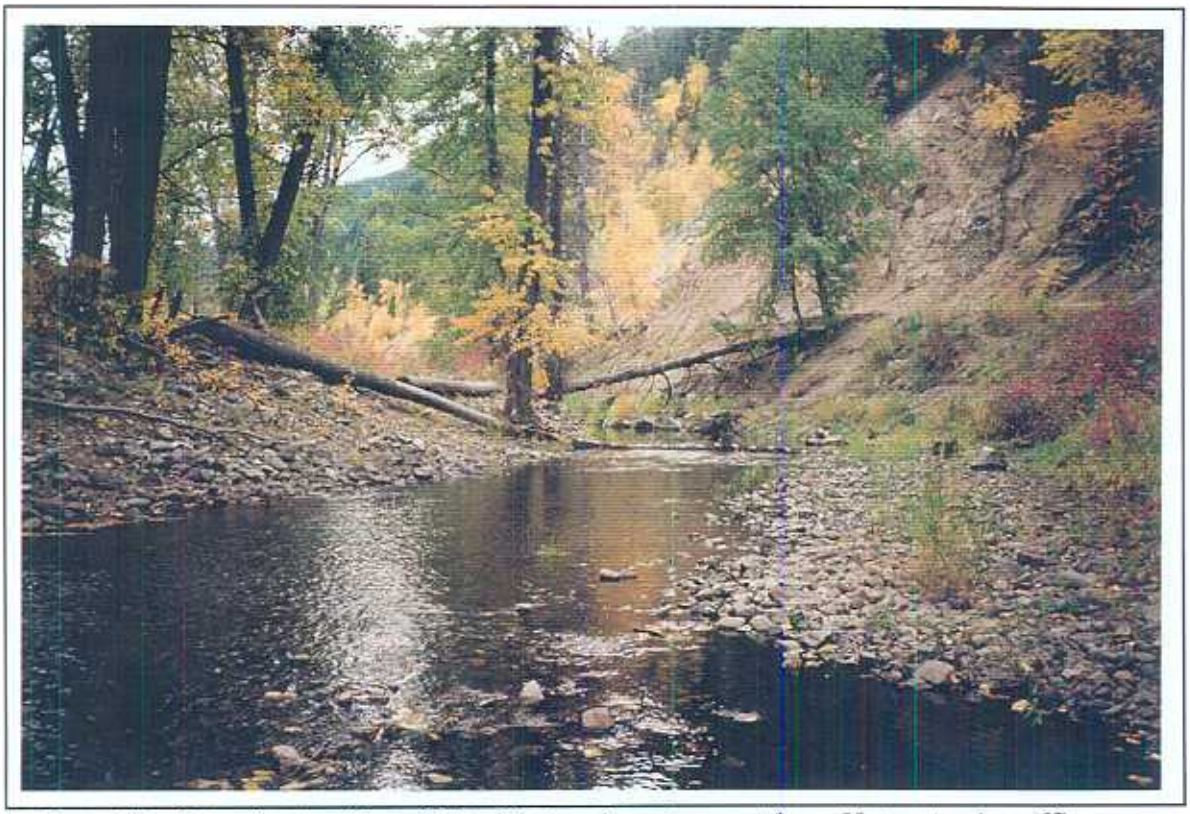


Photo 102: Otter Creek. View of Site 2 facing downstream at 0 m. Note extensive riffle zone. (2 October 1996).

Photo 103: Otter Creek. View of Site 2 facing downstream. (2 October 1996).

Photo 104: Otter Creek. View of Site 2 facing downstream. Note grass in stream. (2 October 1996).

Photo 105: Otter Creek. View of upstream of Site 2 facing upstream. Note log weir at bridge. (2 October 1996).

Photo 106: Otter Creek. View of Site 3 facing downstream. (4 October 1996).

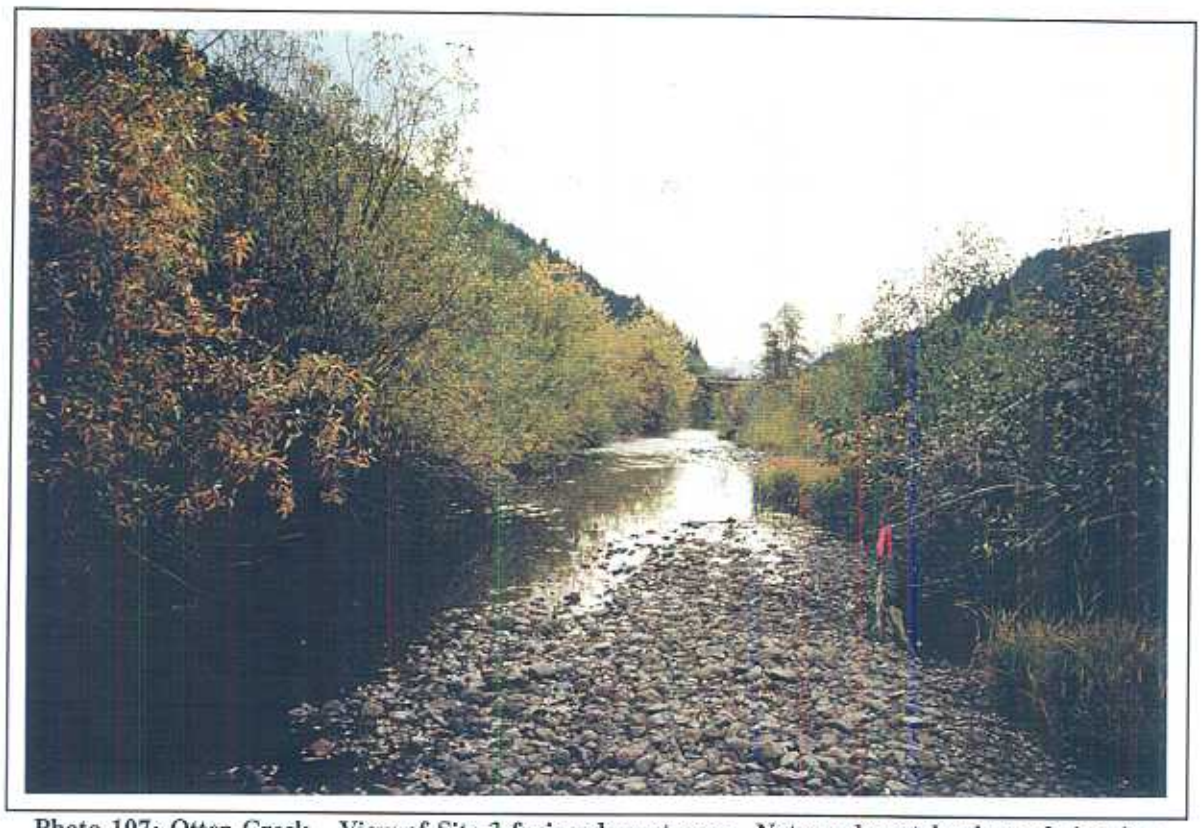


Photo 107: Otter Creek. View of Site 3 facing downstream. Note undercut banks and riparian cover. (4 October 1996).

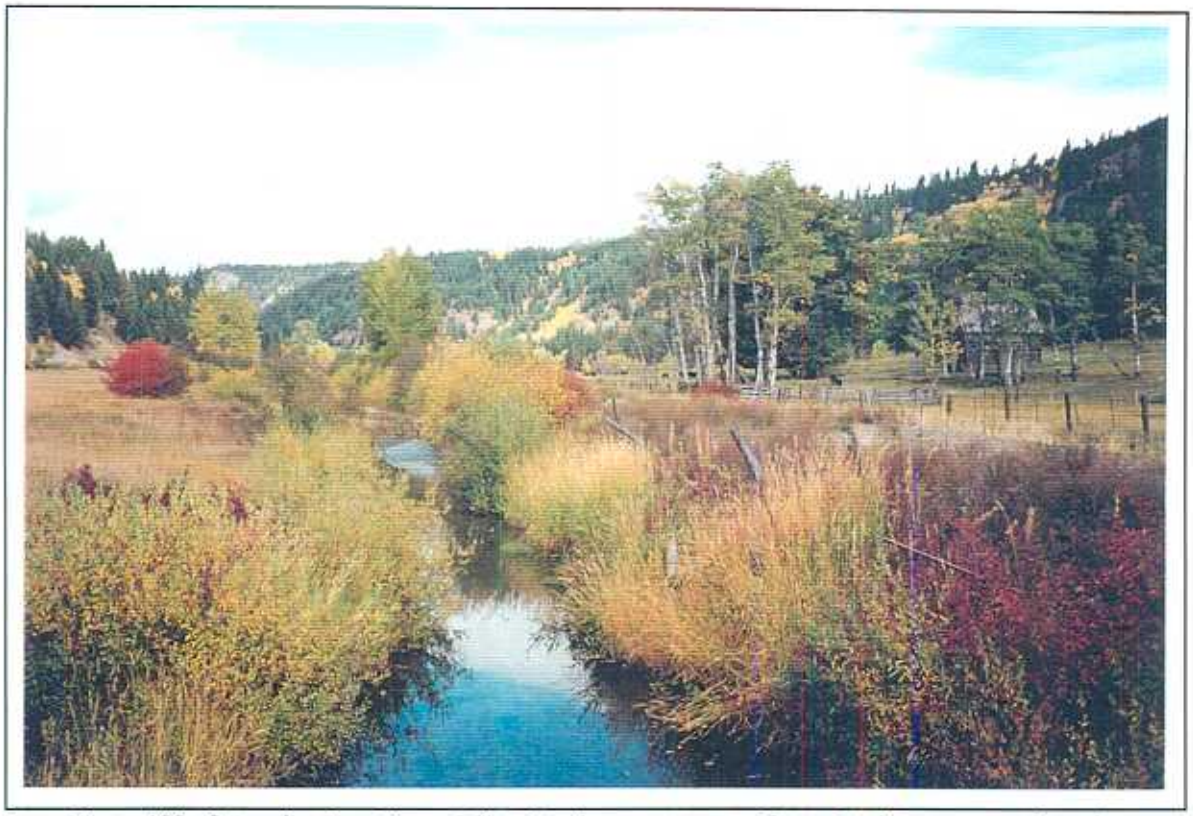


Photo 108: Otter Creek. View of Site 3 facing upstream. Note riparian cover and cattle. (4 October 1996).

Photo 109: Otter Creek. View of Site 3 facing left bank. Note vegetative overhang. (4 October 1996).

Photo 110: Otter Creek. View downstream of Site 4. Note pool. (4 October 1996).

Photo 111: Otter Creek. View of Site 5 facing upstream. Note riffle-pool and riparian cover. (4 October 1996).

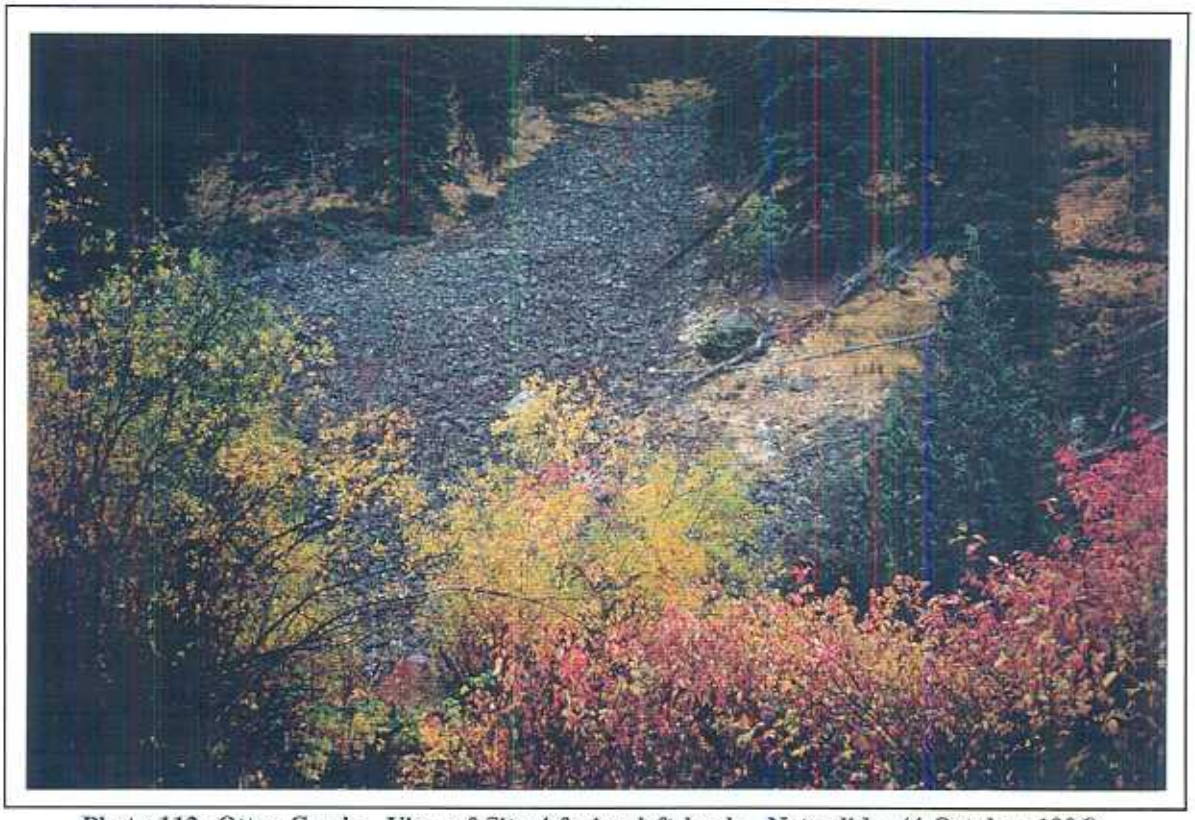


Photo 112: Otter Creek. View of Site 4 facing left bank. Note slide. (4 October 1996).

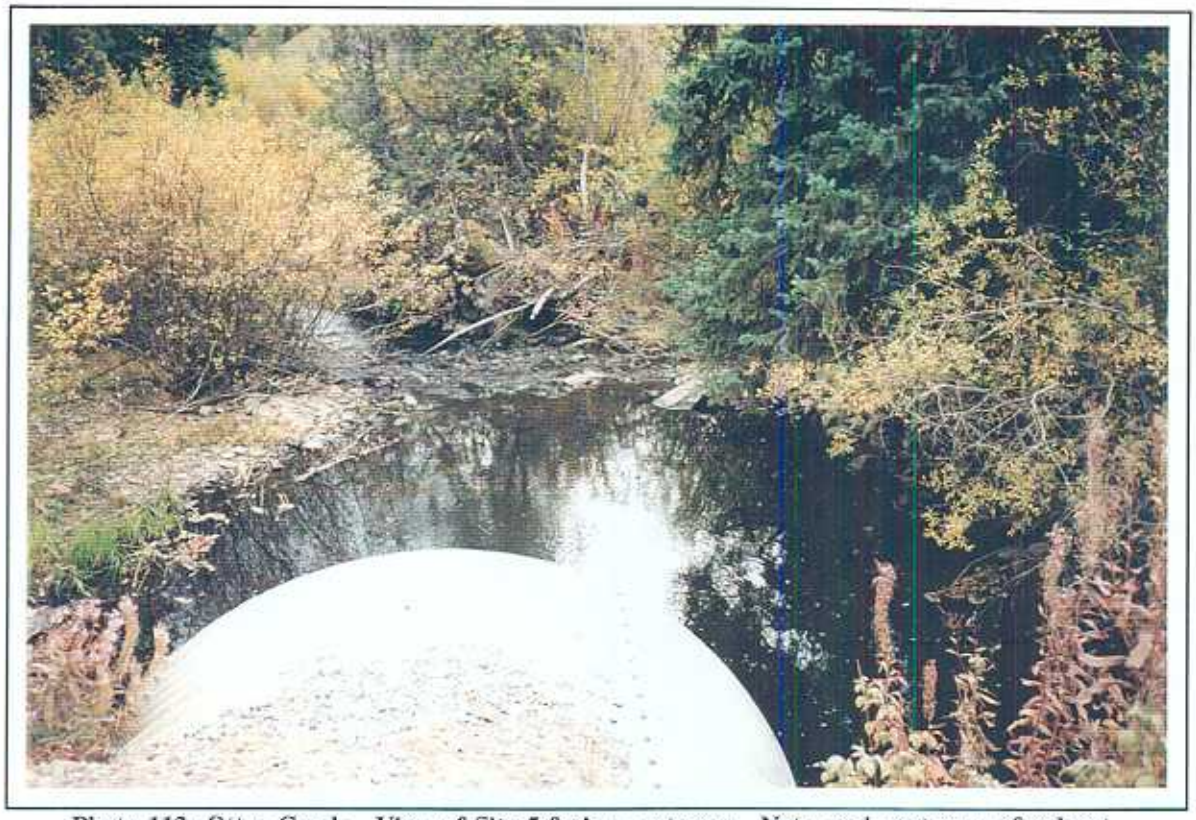


Photo 113: Otter Creek. View of Site 5 facing upstream. Note pool upstream of culvert. (3 October 1996).

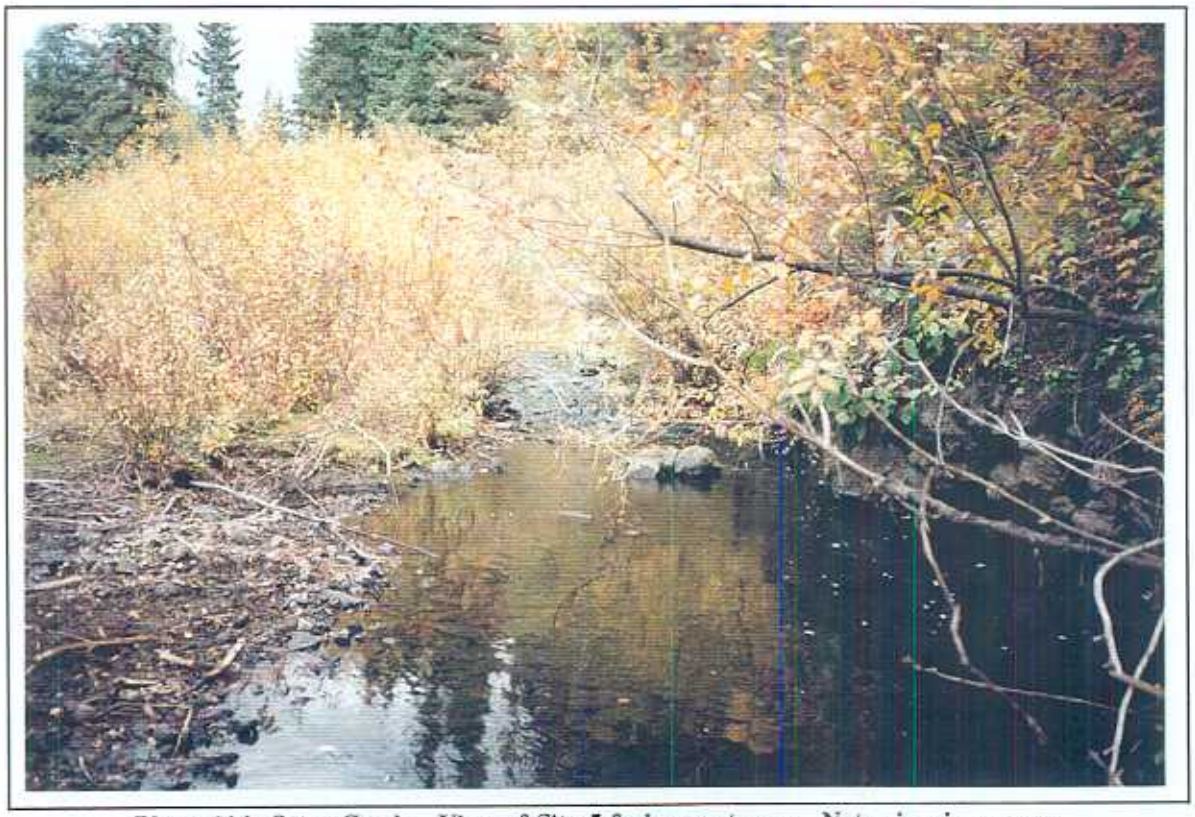


Photo 114: Otter Creek. View of Site 5 facing upstream. Note riparian cover. (3 October 1996).

Photo 115: Otter Creek. View of Site 5 facing upstream through culvert.
(3 October 1996).

Photo 116: Otter Creek. View of Site 5 facing downstream.
(3 October 1996).

Photo 117: Otter Creek. View of Site 5 riparian zone. Note cattle disturbance. (3 October 1996).

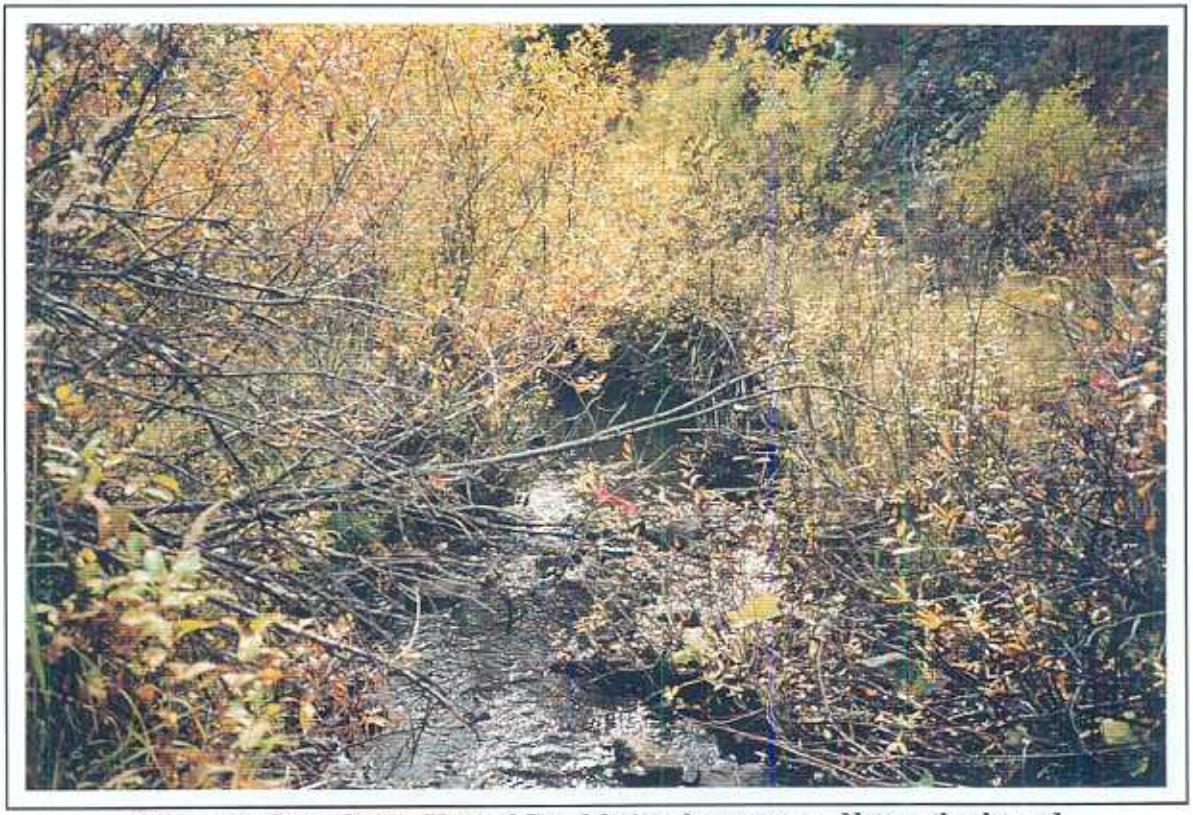


Photo 118: Otter Creek. View of Site 6 facing downstream. Note cutbanks and riparian cover. (3 October 1996).

Photo 119: Otter Creek. View of Site 6 facing banks. Note woody debris in stream and cattle disturbance. (3 October 1996).

Photo 120: Otter Creek. View of Site 6 facing riparian vegetation. (3 October 1996).

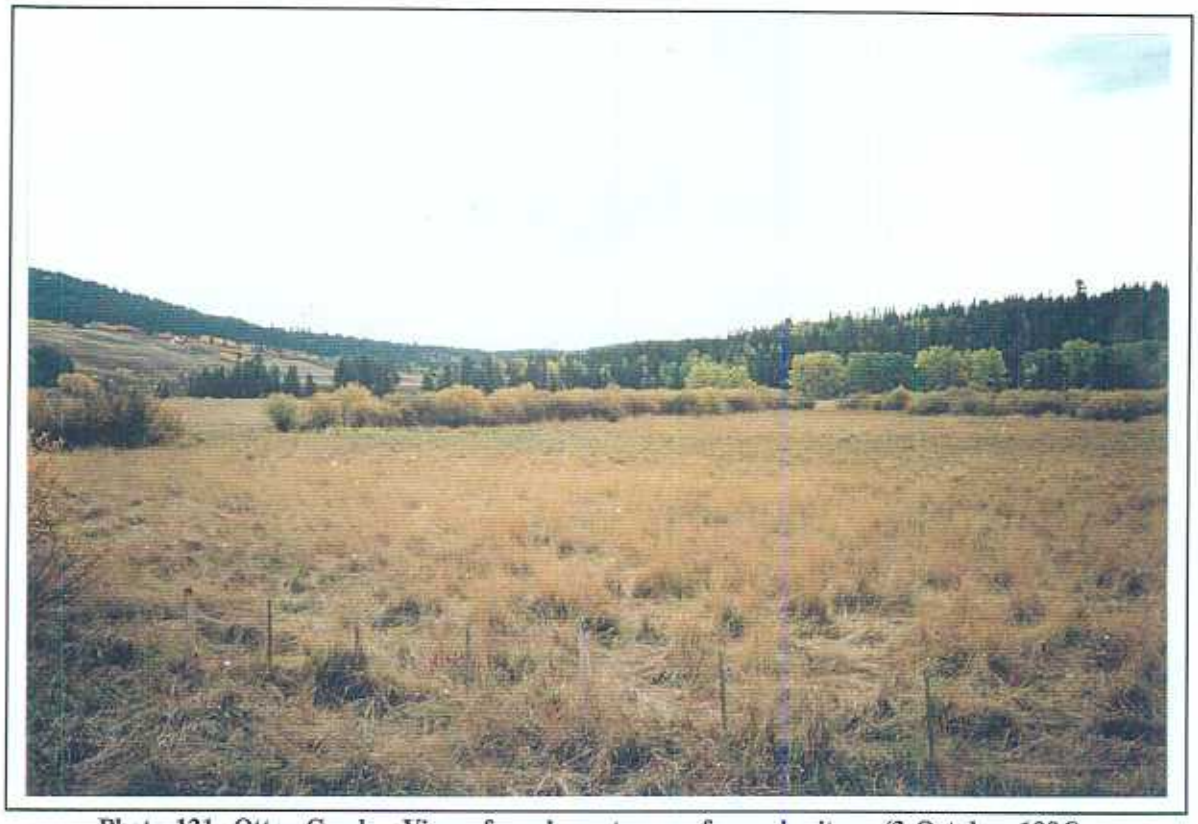


Photo 121: Otter Creek. View of creek upstream of sample sites. (3 October 1996).

Photo 122: Otter Creek. View upstream of Site 6. Note marsh. (3 October 1996).

Photo 123: Podunk Creek. View of Site 1 facing upstream. Note LWD. (26 September 1996).

Photo 124: Podunk Creek. View of Site 1 facing upstream. Note LWD in stream. (26 September 1996).

Photo 125: Podunk Creek. View of Site 1 facing upstream of site at mid channel. Note riffle and unvegetated bar. (26 September 1996).

Photo 126: Podunk Creek. View of Site 1 facing upstream. Note root overhang. (26 September 1996).

Photo 127: Podunk Creek. View of Site 2 facing downstream. Note riffle, pool, undercut banks and vegetation overhang. (26 September 1996).

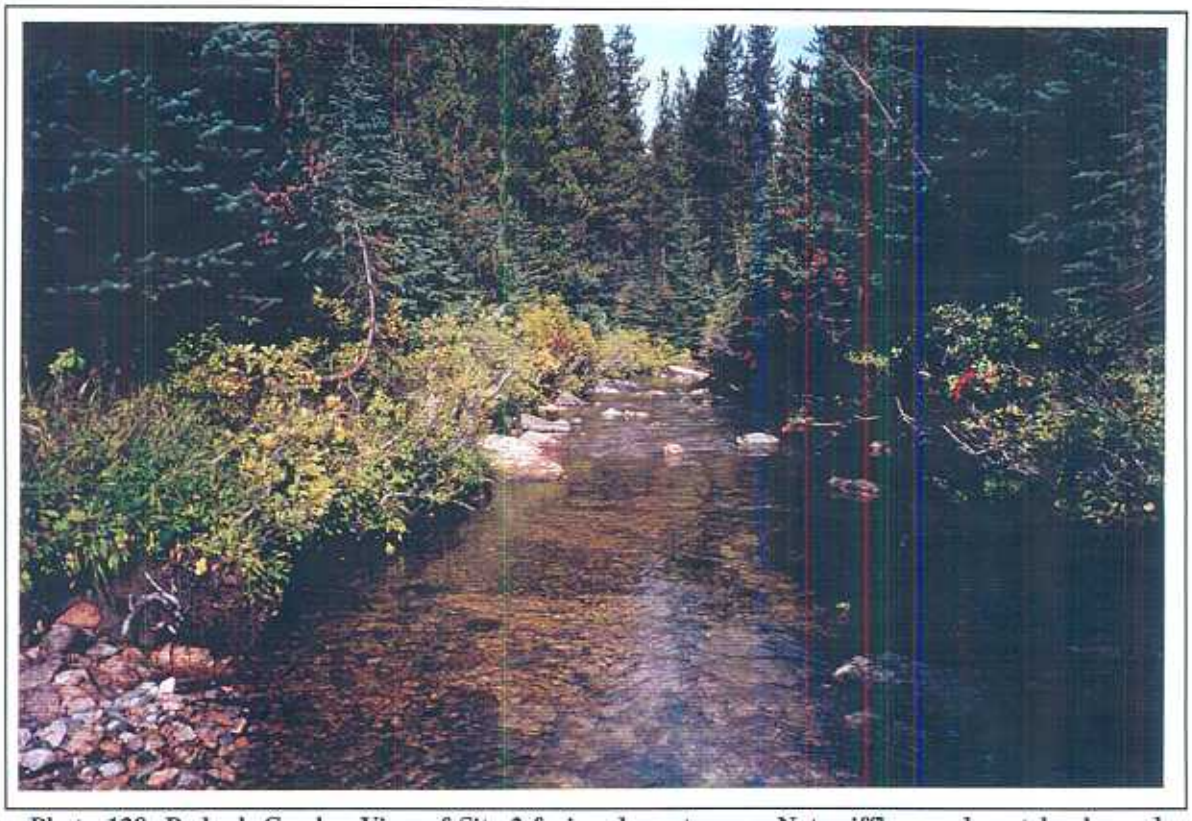


Photo 128: Podunk Creek. View of Site 2 facing downstream. Note riffles, undercut banks and vegetation overhang. (26 September 1996).

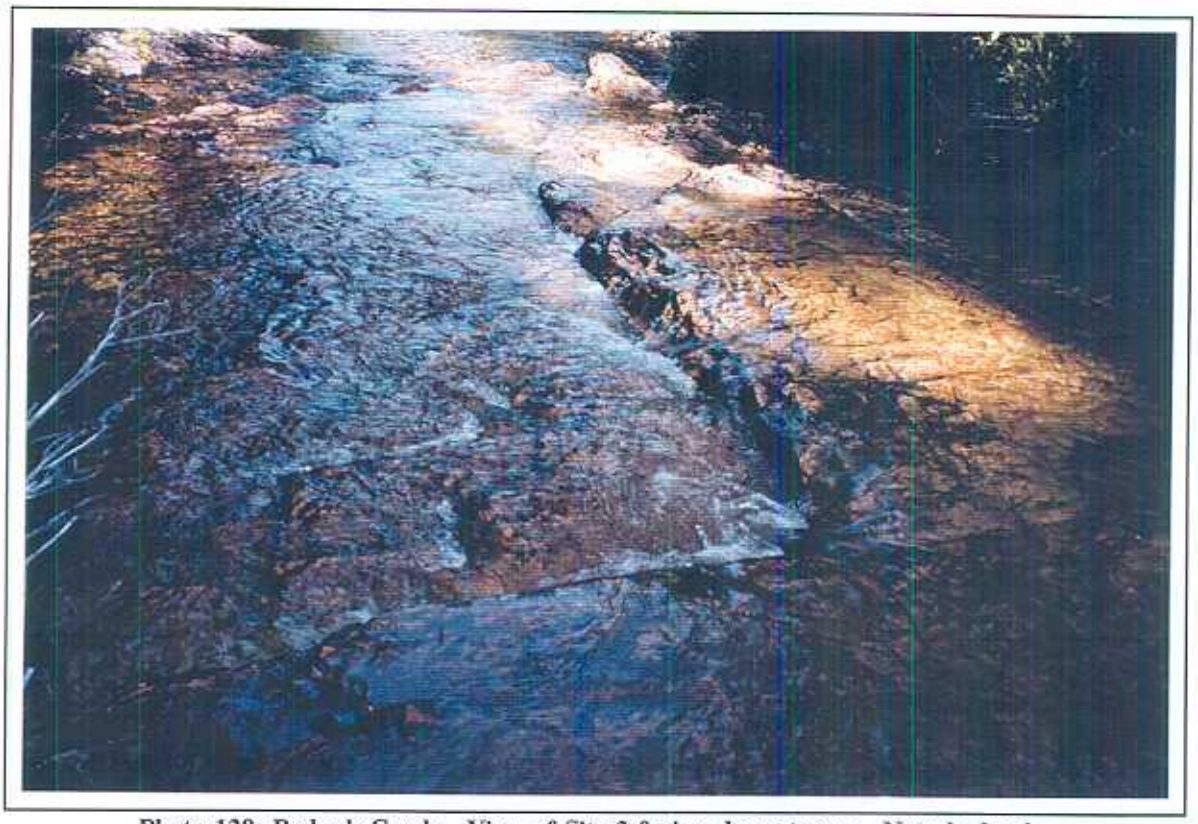


Photo 129: Podunk Creek. View of Site 2 facing downstream. Note bedrock. (26 September 1996).

Photo 130: Podunk Creek. View facing upstream. Note bedrock. (26 September 1996).

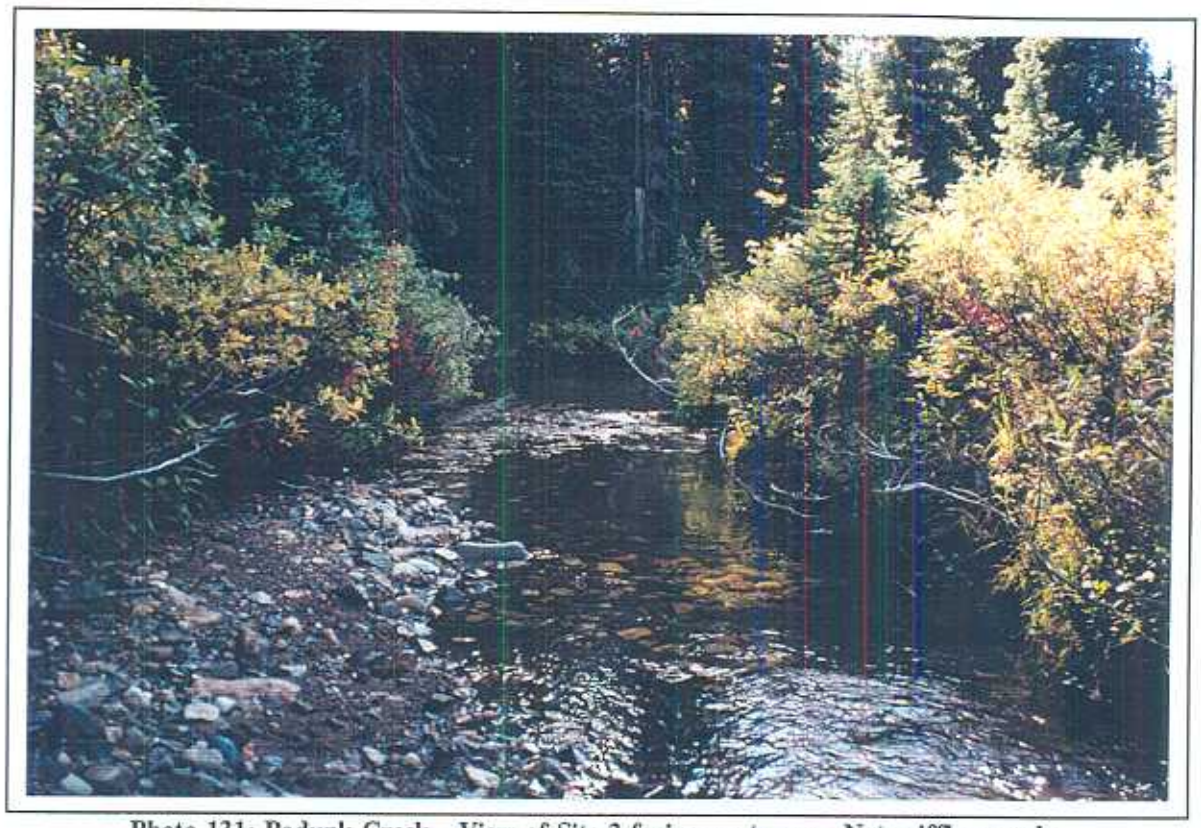


Photo 131: Podunk Creek. View of Site 3 facing upstream. Note riffles, pools, riparian cover and undercut banks. (27 September 1996).

Photo 132: Podunk Creek. View of Site 3 facing upstream. Note side channel re-entering creek. (27 September 1996).

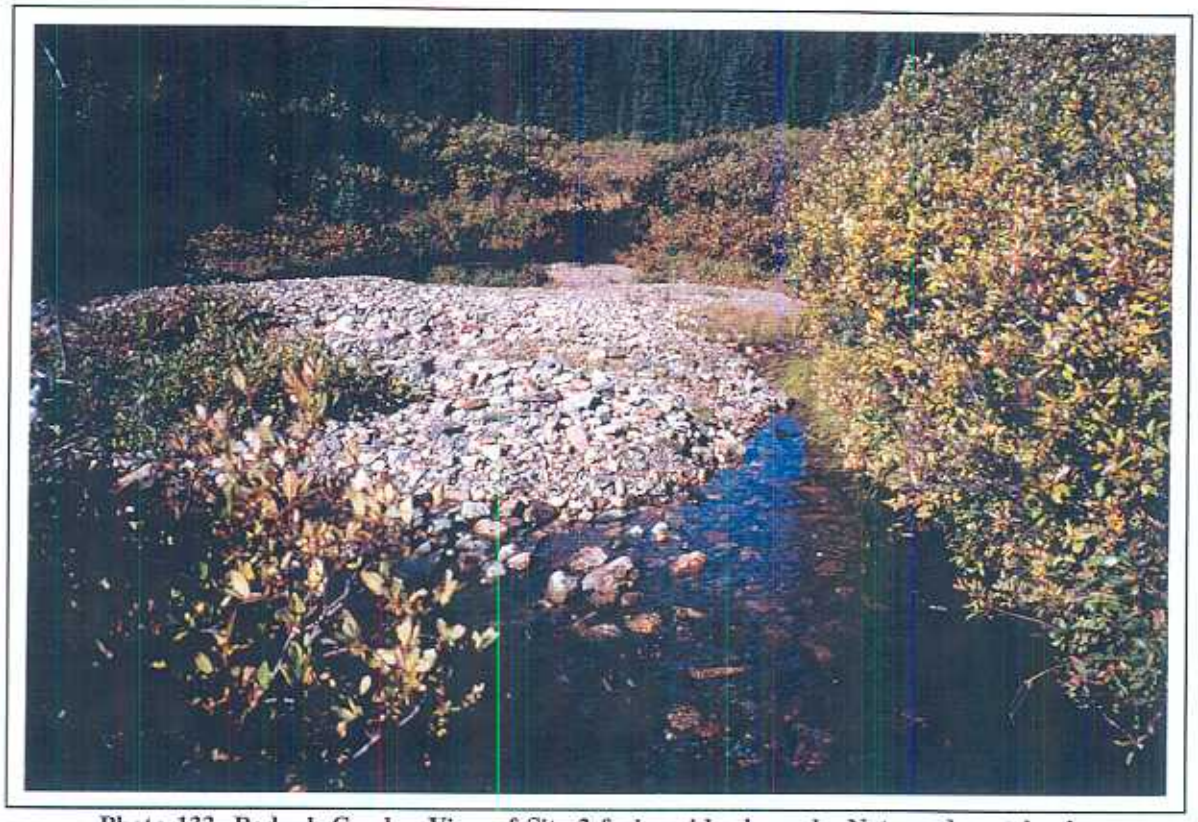


Photo 133: Podunk Creek. View of Site 3 facing side channel. Note undercut bank. (27 September 1996).

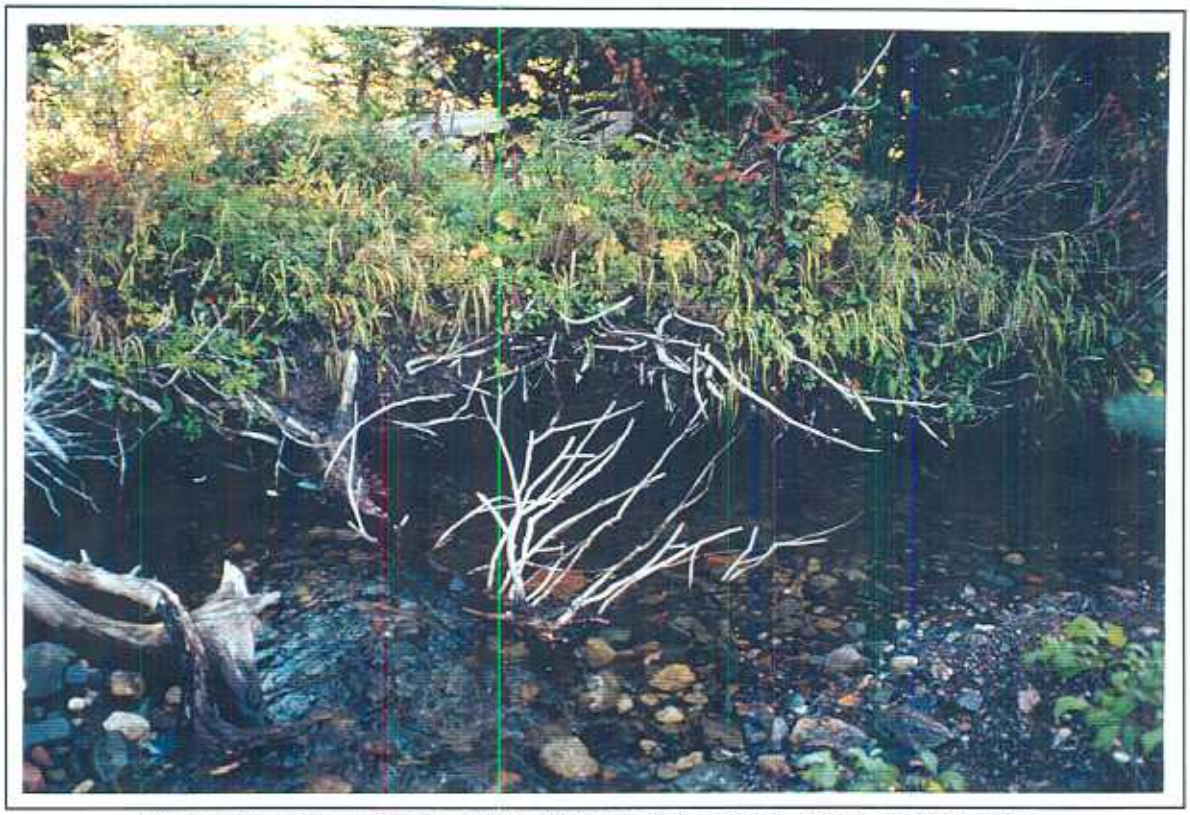


Photo 134: Podunk Creek. View of Site 3 facing bank. Note undercut bank. (27 September 1996).

Photo 135: Spearing Creek. Note dry channel upstream from bridge. (October 1996).

Photo 136: Spearing Creek. View of Site 1 (dry) facing downstream from bridge. (October 1996).

Photo 137: Spearing Creek. View of Site 1 facing upstream. Note extensive riffle zone. (6 November 1996).

Photo 138: Spearing Creek. View of Site 1 facing upstream. (6 November 1996).

Photo 139: Spearing Creek. View of Site 1 facing side channel. Note pooling in side channel and LWD at top of bank. (6 November 1996).

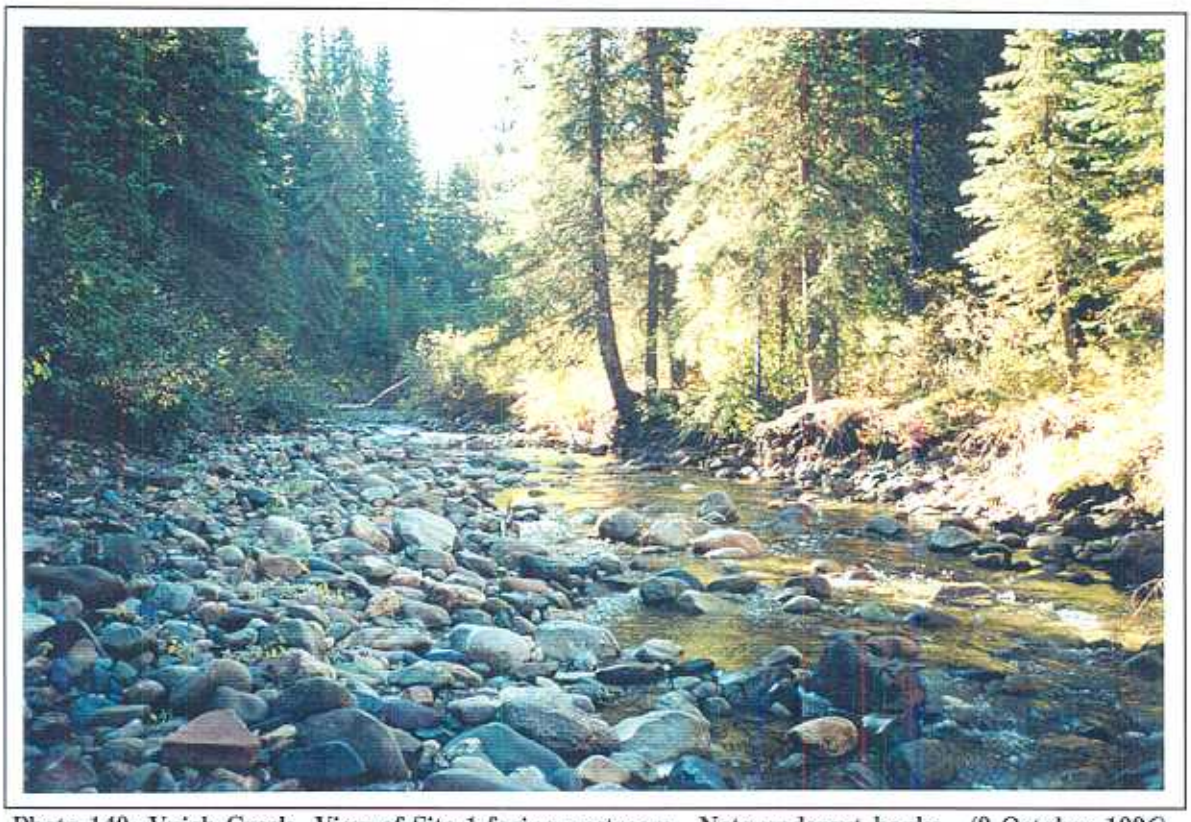


Photo 140: Vuich Creek. View of Site 1 facing upstream. Note undercut banks. (9 October 1996).

Photo 141: Vuich Creek. View downstream of Site 1 facing downstream. Note large boulders. (9 October 1996).

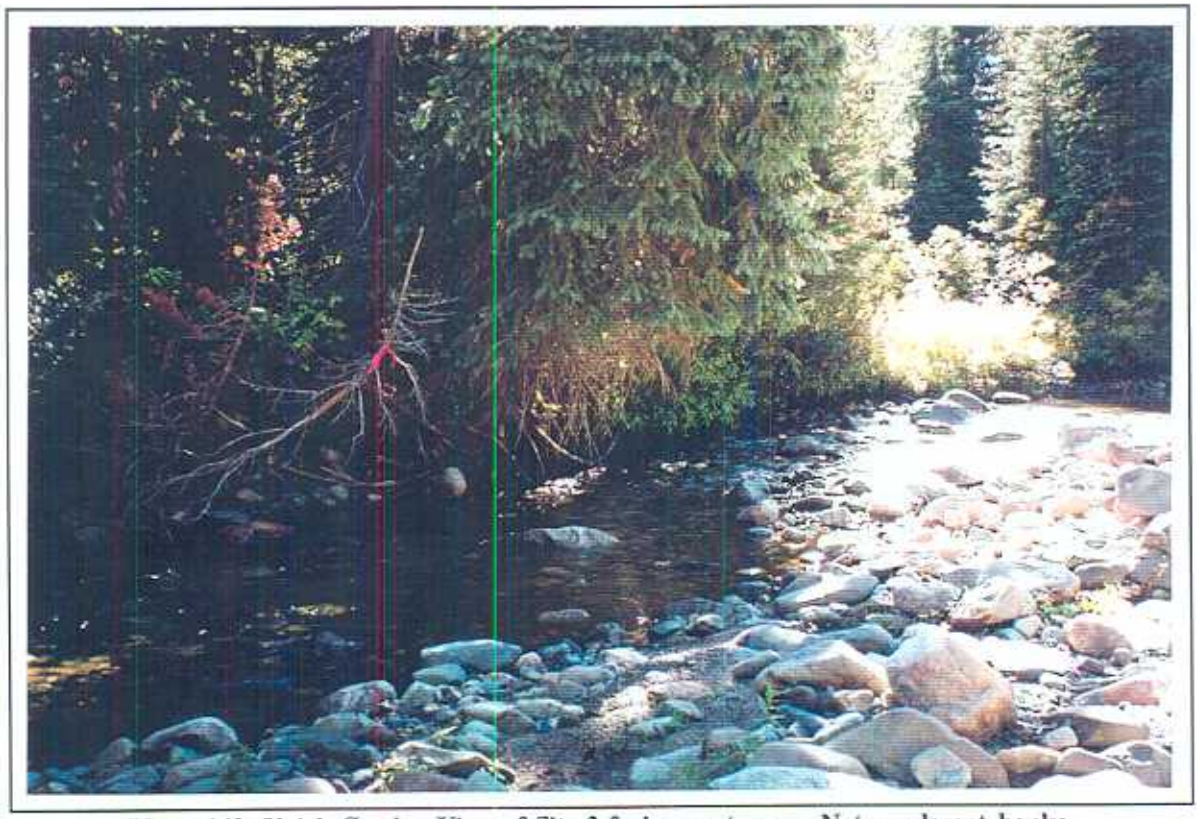


Photo 142: Vuich Creek. View of Site 2 facing upstream. Note undercut banks. (27 September 1996).

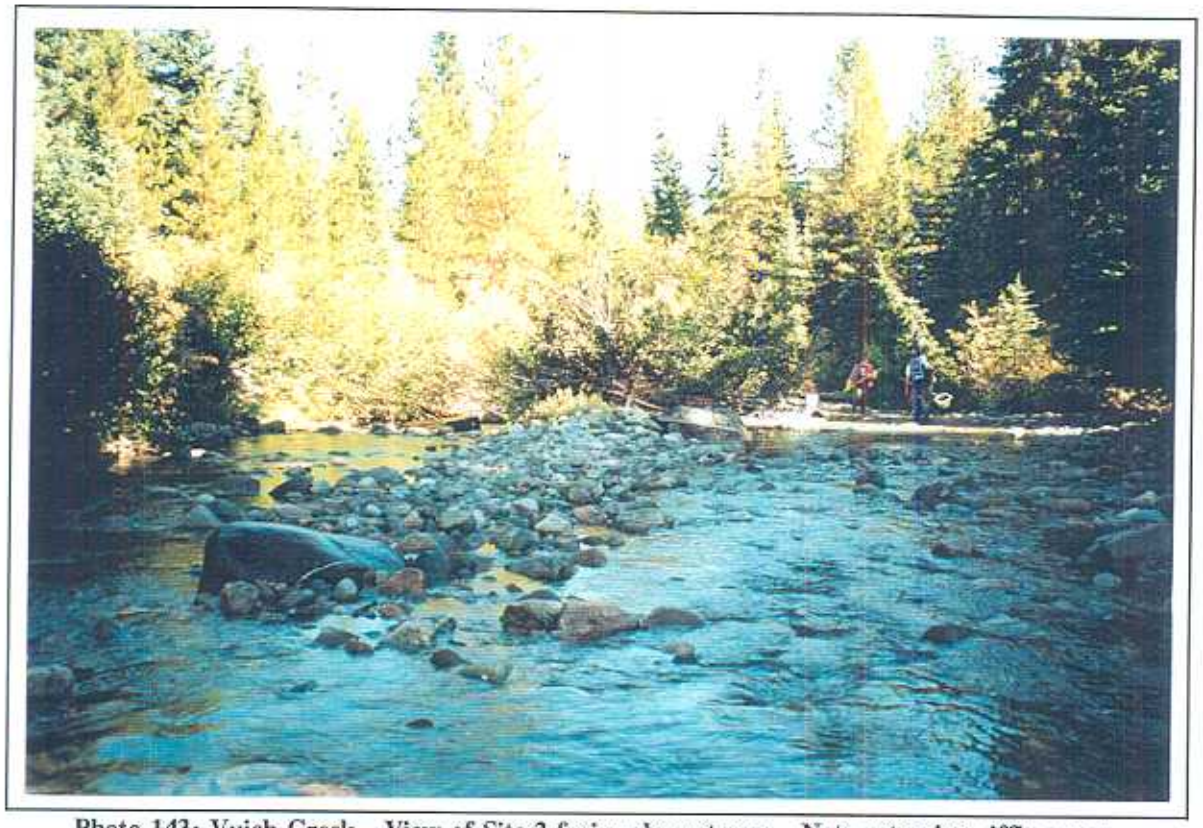


Photo 143: Vuich Creek. View of Site 2 facing downstream. Note extensive riffle zones. (27 September 1996).

Photo 144: Vuich Creek. View of Site 2 facing bank. Note bank eroding beneath woody debris (27 September 1996).

Photo 145: Vuich Creek. View of Site 3 (Trib.) facing downstream. Note LWD. (9 October 1996).

Photo 146: Vuich Creek. View of Site 3 (Trib.) facing upstream. Note riparian cover. (9 October 1996).

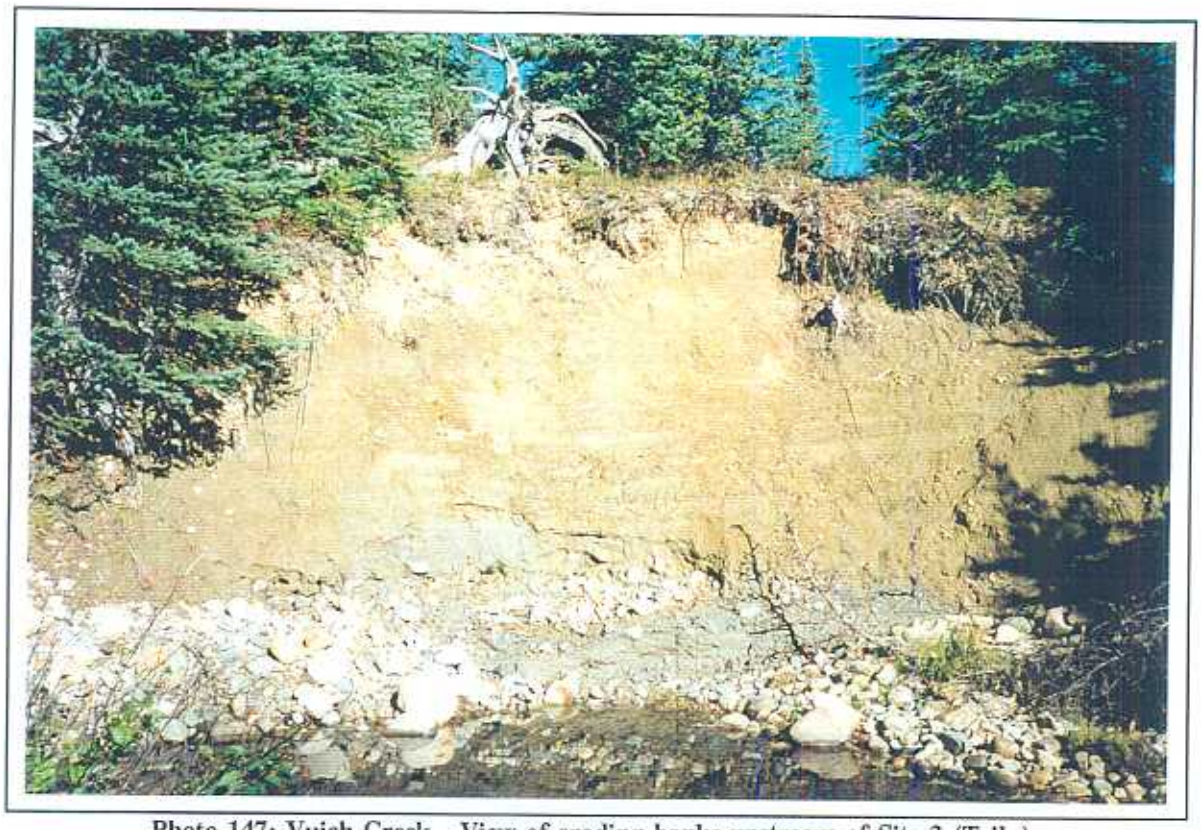


Photo 147: Vuich Creek. View of eroding banks upstream of Site 3 (Trib.).
(9 October 1996).

Photo 148: Tulameen River Falls in Reach 17. Photograph taken from helicopter.
(1 November 1996).

Photo 149: Granite Creek. View of logjam (barrier) in Reach 4. Photograph taken from helicopter. (1 November 1996).

Photo 150: Clear cut area. Photograph taken from helicopter. (1 November 1996).

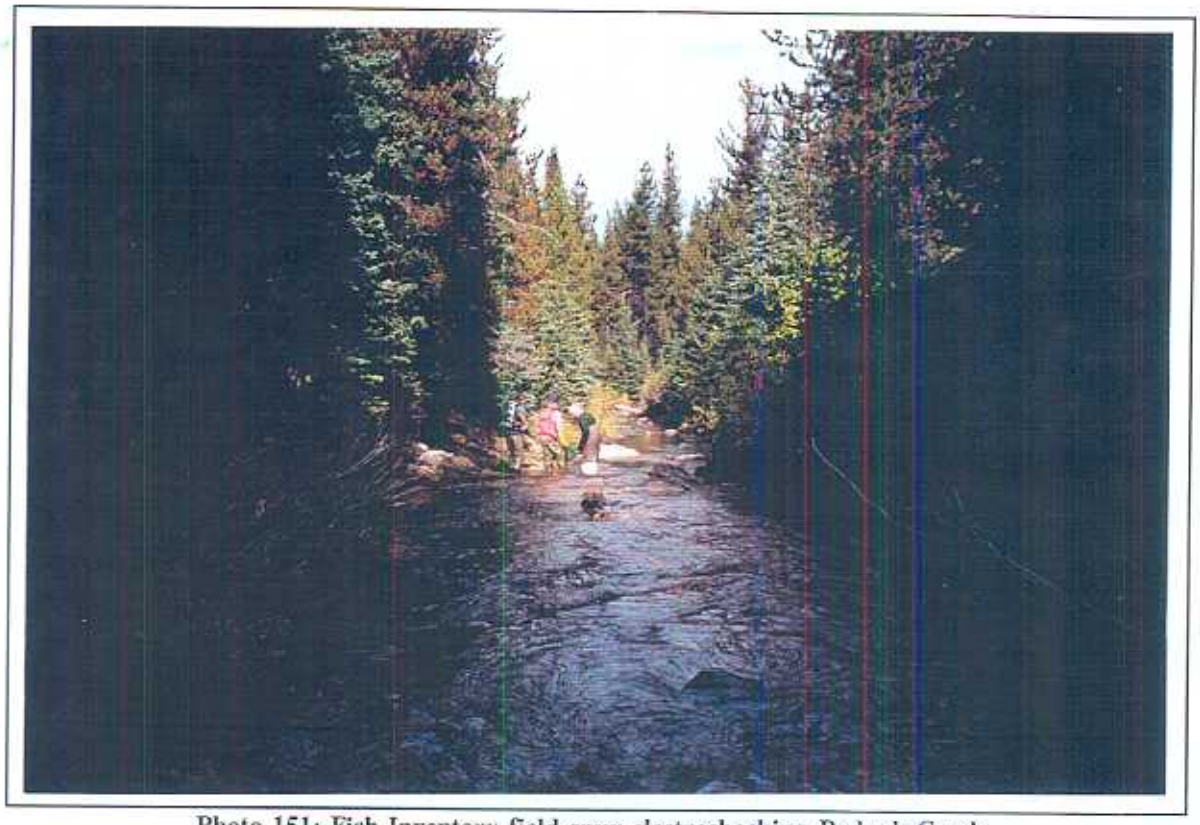


Photo 151: Fish Inventory field crew electroshocking Podunk Creek.
(27 September 1996).