TOLKO INDUSTRIES LTD.

Nicola Valley Division

COLDWATER WATERSHED

LEVEL I - IWAP ASSESSMENT

BY: BORRETT ENGINEERING INC.

1998 March 31

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

LIST OF MAPS
(Attached Separately)

1. EXECUTIVE SUMMARY

The Coldwater River drainage is approximately 908 square kilometers in area, lying south of the City of Merritt, B.C. Tolko Industries Ltd., Nicola Valley Divison, (Tolko) is the principal forest licensee operating in this drainage area. Tolko retained Borrett Engineering Inc. (BEI) on November 16, 1995 to undertake a Level 1 IWAP Watershed Assessment Analysis for the drainage area.

The project team committed to the project includes the following key personnel. Hugh Borrett, P.Eng. has overall project responsibility; D.S.Cunliffe, P.Eng., responsible for project management and specialist in road and bridge, maintenance and construction matters; Karl Ricker, P. Geo., responsible for production of the surficial geology mapping; Norm Hansen, R.P.F., of Nicola Valley Forest Consultants Ltd., specialist in forestry; and Ken Ward of KDW Geographic Solutions, specialitst for production of the GIS analysis and maapping. A fisheries overview was provided by Coast River Environmental Services Ltd., with assistance from Ova Tech Limited of Merritt.

A principal component of the project was the creation of surficial geology mapping for the areas within the watershed south of 50 degrees north latitude. The product of this component of the work was mapping related to slope stability and soil erosion classes at map scales of 1:20,000. Surficial geology mapping in the watershed areas north of 50 degrees north latitude, at a scale 1:50,000 was do previously by others.

The study has examined the erosion and slope instability problems within the Coldwater drainage in relation to past activities due to forest harvesting, highway, railway, and pipeline construction over the last century. The Level 1 Assessment provides a coarse screening process to identify problem areas recommended for subsequent Level 2 Assessments. One of the benefits of this study process is the creation of a data base for efficient integrated resource management in the future.

The Coldwater River and tributaries provide habitat for ten identified fish species including coho and chinook salmon, steelhead, rainbow trout, bull trout and mountain whitefish. Opportunities to improve fish production on the Coldwater River have been identified. Production levels for coho salmon and steelhead for example, are currently estimated to be at one half the potential.

Enhancement projects to date, have been described and studies for additional future enhancement projects have been identified. The effects of human activities and/or structures such as timber harvesting, highways, pipelines, non-maintained railways and power lines will require further study in specific areas. There is a need for research to determine the relationship, if any, between logging and winter flooding with ice jams.

The results of the IWAP Level 1 analysis indicate a high priority to carry out further study throughout the watershed, to program improvements to the water resource within the Coldwater River drainage.

2. OBJECTIVES:

The objectives of this study are summarized as follows.

1. To begin the process to determine and implement appropriate treatments of problem areas, for the improvement of the water resource within the Coldwater River drainage area.

2. Perform a Level 1 Assessment of the total drainage area as set out in the Interior Watershed Assessment Procedure which is part of the Forest Practices Code. This process will examine the relative priorities within the watershed for future watershed restoration activities.

3. Identify opportunities to enhance water quality in the community water sheds of Kwinshatin and Brook Creek.

4. Identify opportunities to improve the aquatic habitat in the Coldwater watershed to support all aquatic life forms including salmon, steelhead and resident sport fish.

3. BACKGROUND:

The Coldwater River source is on the rugged east slope of the Cascade Range, From here, it runs northerly for 60 kilometres to its confluence with the Nicola River near the City of Merritt. The western half of the 908 square kilometre drainage, has a relatively high annual precipitation including winter storms with flood and ice jam potential. The east half of the drainage, is off the Interior Plateau, with deeply incised valleys and a relatively low annual precipitation. The area is within the Kamloops Forest Region and Merritt Forest District. The Ministry of Forest (MOF), District office is in Merritt, and it is responsible for administering the forest and range operations in the Coldwater River drainage.

The Merritt area is heavily dependent upon forestry for its economy. According to the recent Merritt TSA Socio-Economic Analysis, the population is approximately 6500, and it is estimated that approximately 22% of the experienced labour force works in the logging, forestry and manufacturing industries including sawmills. This includes the six First Nations Bands, who have members employed in these industries.

Logging in this drainage over the years, has been principally by Tolko and their predecessor companies, as well as Small Business. In addition, several other user groups also have interests in the use of the land area.

These include the following:

Ranching Community	Crown grazing leases
Coldwater Indian Band	Kwinshatin community watershed, traditional food fisheries, spiritual sites, food hunting and gathering.
Brookmere Community	Brook Creek community watershed
Recreational Users	Hunting, fishing, snowmobiling, cabin and resort owners.
Ministry of Transportation and Highways	Coquihalla Highway
Crown Lands	Kettle Valley Railway grade
West Coast Transmission	Transmission pipeline
B.C. Gas Company Limited	Transmission pipeline
BC Hydro Power Authority	Transmission lines
Ministry of Mines	Mineral claims
Department of Federal Fisheries	Migratory Fish
Ministry of Environment	Non-migratory fish and all wildlife

The nature and extent of the Coldwater Band's cultural interest in the Coldwater River draiange was not evaluated as part of this report.

The Coldwater valley has a long history of use as a transportation corridor. Ranchers used the route to drive cattle to market in the mid 1800's. The turn of the century brought the Kettle Valley Railroad which operated until the mid 1950's. Active current users include the Coquihalla Highway, oil and gas pipelines, as well as a hydro transmission line which crosses the Coldwater River. Each of these transportation uses has created problem erosion areas and unstable slopes.

4. BASE DATA AVAILABILITY:

The area is covered by forest cover mapping at a scale of 1:15,000 which requires 11 maps to cover the area. TRIM mapping is also available for the area at a scale of 1:20,000.

Soils classification of the local Merritt area and north is available in the Terrain Inventory and Quaternary Geology reports by J.M. Ryder for Lytton and Robert J. Fulton for the Nicola-Vernon Area.

The soils were previously studied in the past by Ministry of Transportation and Highways in planning for the Coquihalla Highway. Surficial strip maps were prepared for the corridor along the Coldwater River as well as for the `Kingsvale Connector' route through the Voght Valley.

Comprehensive surficial geological mapping for the southern portion of the watershed south of 50 degrees north latitude, was completed under this contract. The mapping work completed at a scale of 1:20,000 by the surficial geologist, included completion of the surficial geology and terrain stability classification for the following areas.

92 H 056	92H 075
92 H 065	92H 076
92 H 066	92H 086
92 H 096	92H 097

An extension to the contract was made on 1996 June 6, to include the following maps in the Tulameen drainage area adjacent and south east of the Coldwater River drainage.

West half of 92 H	087
West half of 92 H	077
West half of 92 H	067
West half of 92 H	057
East half of 92 H	055

There are also two community water sheds in the area, Brookmere and Kwinshatin who have an interest in the water quality of the region. The Coldwater Indian Band has two subsurface wells utilized as their domestic water supplies.. Examples of the water licensed intakes are included in Appendix 3.

Digitized mapping of Tolko's logging operations had been previously by Silvatech of Salmon Arm.

All of the available data has been compiled into one integrated GIS file. This has been used in the calculation of the various watershed IWAP assessment indices. It is also available as a data base, to help manage the watershed in the future.

5. FORESTRY

To put the extent and nature of the proposed study area into perspective, some of the statistics are given in Table 1. These figures are in relation to the larger Merritt Timber Supply area of which the Coldwater drainage is a part. It is apparent from this information, that the Coldwater River area has been logged more heavily than the average for the TSA.

Logging prior to 1965 was mainly restricted to select logging on the lower elevations in Douglas fir, and therefore would have had a limited effect on runoff. Clearcut logging at the higher elevations started in the 1965 - 1970 period, in the higher elevation even size spruce and pine stands. The effect of the accumulating area of clear cuts since 1965 is of concern to fish managers.

TABLE 1
STATISTICAL SUMMARY

	Coldwater (hectares)	Total TSA (hectares)
Total Area	90,805*	1,115,914
Crown Productive Area		812,512
Net Productive Forest	61,873	511,020
Logged area	15,746	58,256
Percent of Productive Land Logged	25.4%	11.4%

(Information from the Merritt TSA Socio-Economic Study
- except for total area determined from this study.)

The Kamloops Forest Region, Integrated Resource Management Timber Harvesting Guidelines, indicate that the maximum harvest logged area allowed in a community watershed is 20% of the forest area. For other areas the maximum clear cut allowed is 30%.

With the allowance for regeneration, those subbasins with an equivalent clear cut area (ECA) in excess of 10% are calculated by the GIS procedures, to be as follows.

Subbasin	Name	Subbasin Area (km^2)	Percent ECA of total subbasin area
2	Midday Creek	85.7	19.4
3	Mid Coldwater River West	91.5	19.2
4	Juliet Creek	96.0	10.1
6	Upper Coldwater	68.2	16.3
7	Mid Coldwater East	88.9	14.1
8	Brook Creek	30.8	19.2
9		48.6	18.4
10	Voght Creek	215.1	21.0
11		5.1	80.0
14	Godey Creek	45.9	11.3

The Upper Coldwater and Juliet/July Creeks are in the Cascade Range with steep terrain and stability classes IV and V.

The Coldwater River has also displayed a repeated tendency to form ice jams. When this occurs, large areas of the river are backed up, with resultant loss in the use of land and erosion damage. This issue is of significant concern to both the valley residents and those concerned with fish management.

This study initiative is also supported by the Nicola Watershed Stewardship and Fisheries Authority (Nicola Valley Tribal Council). Through enhanced watershed management techniques, the value of the scarce water resource can be improved for all users. This includes the fisheries resource.

6. FISHERIES:

The fisheries section of this report was prepared by Coast Environmental Services Ltd. This is an overview report, intended to document the existing fish habitat and populations, so that problems can be identified and solutions developed. Historical data has be utilized to characterize the condition of the fisheries resource, as outlined in the Level 1 IWAP. Additional information will have to be collected during field programs of the Level 1 and 2 fish habitat surveys. The report is contained in Appendix 2, and a brief summary is given below.

The information for the report was compiled during a review of relevant government and private sector reports, interviews with the Ministry of Environment Lands and Parks (MELP), Department of Fisheries and Oceans (DFO), Environment Canada (EC) and Aboriginal Fisheries Councils.

The Coldwater River flows from its headwaters on the eastern slopes of the Cascade Mountains for approximately 60 km before it joins the Nicola River at Merritt. It has 85 mapped tributaries. The river has been characterized as having a relatively low to moderate gradient, (average 0.6%), with a channel width between 2 and 25 metres. The physical characteristics of the Coldwater River and its major tributaries are described in the Fisheries report. 91.68 km

The Coldwater River is an important aquatic habitat and spawning area for both salmon and trout. Salmon spawn along the main river stem to the headwaters and up many of the tributary streams. Trout also spawn extensively throughout the system. Fish species reported within the watershed include coho salmon, chinook salmon, rainbow trout/steelhead, bull trout, mountain whitefish, longnose dace, prickly sculpin, pacific lamprey, river lamprey and western brook lamprey. Estimates of the fish populations are given as well as timing and general stream habitat preferences.

There are several limiting factors affecting the production of fish, both natural and anthropogenic. These include widespread substrate sedimentation and consolidation, lack of rearing habitat complexity in some areas, seasonal low flows, scouring by ice flows and losses of habitat due to river training works, channel migration and bank destabilization.

Suggestions for restoration and enhancement projects are reviewed. One of the concepts is to increase the low flow rates through water storage and controlled release.

7. LOGGING ACTIVITIES

7.1. GENERAL

The equivalent clear cut area (ECA) is approximately 145 km^2, or 16% of the total 908 km^2 of the Coldwater River drainage. ECA is the area of forest actually clear cut, less a percentage for hydrologic recovery due to forest regeneration. The percent reduction varies, starting at 3 metres height growth up to 9 m height. Height growths are theoretically projected from tables since field data is not available. Therefore, the earliest logged areas are reduced the most, due to projected height growth. Reforestation of the clear cuts generally has been successful.

Approximately 1,268 km of roads have been constructed within the watershed. The majority of these roads are in need of maintenance or deactivation. 500 km or approximately 40 percent of these roads are above the H_{60} elevation of 1168 m.

7.2. ROAD MAINTENANCE/DEACTIVATION

The following impressions and conclusions have been made based on the field reconnaissance.

7.2.1. Culverts

Culvert spacing averages about 300 metres, with the minimum on some spurs at 50 metres and the maximum at 500 metres. It is estimated that 10 to 20 percent of the culverts are plugged to some degree.

The area contains generally silty loams with varying clay content. Culvert spacing required by the MoF Engineering Manual for the various soil types and road grades, ranges from 50 metres to 200 metres. A rough conclusion concerning culverts is that only about one half the culverts are in place for adequate water management. Also most road surfaces are concave shaped and often have an outside berm. The result is that surface erosion is common. Road surface erosion ditches 10-30 centimetres deep have been observed.

Road maintenance or deactivation requires berm removal, surface shaping (crowned or sloping) and/or water bars, maintenance of existing culverts or cross ditches, and placement of culverts or cross ditches at all gullies that have the potential of carrying water. Fifty and 100 year return period floods have to be considered as well as the increased run off from past and future logged/burned areas.

7.2.2. Main Road Creek Crossings

Some major creek crossings on the main roads have a high risk of plugging at the crossing inlet with the resulting flow being directed down the road surface. There is a need to determine site specific projects for roads not covered by road permits.

7.2.3. Side Cut Sloughs

Some roads on steep side slopes (50%+) may have been constructed by placing fill on stumps and logs to hold the fill. The steeper the side slope, the greater is the dependence on stumps and logs to stabilize the fill. The rotting wood in the fills may be contributing to the current active sloughs, and to unknown future failures.

The subjective conclusion is that the steep side hill cuts on the 50-80% side hills on the deeply incised creek gullies have priority because of the high probability of slides delivering sediment directly into running water. Stabilization of some of these cuts and fills may require full restoration of the original slope, and if required, relocation of the road to a stable location.

7.2.4. Current Road Maintenance

Current maintenance practices need to be improved. Graders often leave a 20-30 cm high berm on the outside shoulder that directs surface water to run off onto deep fills with resulting erosion. Crowning and/or sloping of road surfaces is needed to direct water away from fills and into ditches and seasonal gullies. Grass seeding is needed in the current brush removal operations to control surface erosion. Culvert maintenance, rip rapping of culvert outfalls and installation of culverts in blocked off gullies is needed on some active roads. Additional culverts should also be used to direct water away from sensitive fills.

7.3. SKID ROADS

Skid roads and fireguards have commonly been cut into 40%+ side slopes and the fill placed on stumps and logs. This study has not addressed the need for site-specific skid trail deactivation or rehabilitation.

7.4. LOG LANDINGS

Log landings have been constructed on steep side hills and occasionally in creek gullies. Logging debris was used to build up the fills. Side slopes on these fills are 80%+. Landings should receive a Level 2 assessment to determine risk of side slope failure and initiation of slides.

8. SURFICIAL GEOLOGY MAPPING

8.1. GENERAL

The following is a summary of the geological work conducted to date by Karl Ricker, F.G.S.C., for the preparation of the surficial geology mapping.

- Site visit and project overview (October, 1995)
- Cursory review of available aerial photographs and available information. Collection and review of background map and database information to assess the quantity and quality of information already available
- Field work during 1995, 1996 and 1997
- Office compilation of the data and the preparation of the surficial geology, soil erosion and slope stability maps,

8.2. REFERENCES

The surficial geology report by Karl Ricker utilized the following resource material from previous studies.

- Ryder, J.M. - 1981:
  Terrain Inventory & Quaternary Geology, Lytton, B.C.
  Geological Survey of Canada, Paper 79-25 (20 pages & map)

- Fulton, R.J., 1975
  Quaternary Geology & Geomorphology
  Nicola - Vernon Area, British Columbia
  Geological Survey of Canada, Memoir 380 (50 pages & maps)

- Lord, T.M. and A.J. Green
  Soils of the Tulameen Area of B.C. 1974
  Canadian Department of Agriculture, British Columbia
  Soils Report No. 13, (163 pages & maps)

  Young, G., M.A. Fenger & H.A. Luttermerding 1992
  Soils of the Ashcroft Map Area
  B.C. Environment
  Integrated Management Branch
  B.C. Soils Survey Report No. 26, (233 pages & maps)

8.3. PHYSIOGRAPHIC SETTING

The Coldwater River Watershed Project is an assemblage of 14 sub-basins covering about 90,800 hectares. The Coldwater River watershed is a transition from the Interior Plateau to the Cascade mountains. This is reflected in the underlying geology. Upland surface topography is quite variable, ranging from generally flat to undulating to steep.

The Coldwater River forms the central spine of this watershed flowing in a direction approximately from south to north. Tributaries from the east and west include the following significant streams;

- community watersheds Kwinshatin and Brook Creeks
- known fish bearing streams Midday Valley, Voght, Bottle Top, Juliet, July and Mine Creeks.

8.4. GEOLOGICAL OVERVIEW

The following is a geological overview of the Coldwater River study area. A full detailed report describing the surficial geological work done for this project will be submitted separately.

The Tulameen-Otter, Coquihalla-Coldwater, and Maka/Spius valley corridors lie in the transition zone of Interior Plateau to the east and within the east slope to the Pacific divide of the Cascade Mountains to the west (Mathews, 1986; Holland, 1964; Bostock, 1948; Camsell, 1913 and Dawson, 1879). Accordingly, the underlying geology and the evolution of the terrain to its present form is complex, with its beginnings rooted in the new accepted concepts of plate tectonics (Monger, 1989; Gabrielse and Yorath, 1991). The project area in fact is underlain by a "collage" of "micro"-plates, termed terranes (note spelling), which "grew" out of the oceanic floor as chains of linked volcanoes (island arcs). Several such arcs at several locations in the Pacific Ocean, including areas south of the present day equator, began their rise hundreds of millions of years ago. Reaching oceanic surface, the volcanoes were subjected to atmospheric erosion, shedding sediment into the ocean, only to be buried by a new pulse of volcanism, as seen, for example, on the island arc of Japan. The style of volcanism and sedimentation can change over the tens of millions of years as each arc system drifts slowly across the Pacific Ocean at rates of a few millimetres to a few centimetres per year. Some island arcs amalgamated, in transit, "mixing" paleontologic faunas of diverse palaeoecological settings together, before final "docking: against the "accreting" western edge of the North American continent (or craton). Other island arc micro-continental assemblages arrived on their own. Adding these terranes to one another, each of their own diverse geologic histories, at the edge of the continent was an intense series of events. Over the last 100 million years or so these tectonic events have generated the eventual buckling of the new crustal components into a Cascade Mountain and Interior Plateau, which was accompanied by more erosion and volcanism (terrestrial) and the intrusion of smaller granitic bodies. Our project area is underlain by the volcanic arc terrane of Quesnellia, considerably modified during and after its arrival to North America, and a neighbouring Methow-Tyaugton Terrane which slid in on its west side through most peculiar circumstances.

So what kind of rocks underlie the project area? The full range of lithologic diversity is present: intrusive rocks of mantle (hypabyssal) to high level granitics; volcanic rocks of fluid to explosive (basalts to rhyolites) origin, with a variety of associated pyroclastic or fragmented debris (breccias to tuff and ash); marine to terrestrial sediments varying in texture from conglomerate-breccias to muddy siltstone-claystone or shales, with precipitates and bioclastic accumulations of lime stones and dolomites: and all ranks of metamophism of the above in zones of dynamic and/or thermal alteration (slate, phyllite, schists, amphibolite, hornfels, gneiss, etc.). The erosion characteristics of each rock type (and its age) has a significant bearing on the character of the surficial debris which overlies them. Physical parameters of grain size, strength, cohesion-adhesion, grain fraction characteristics, water absorption, permeability, among other things will vary; and the chemical make-up of the particles (mineralogy) has a direct relationship to pedogenic soil forming processes. Moreover, the structural geological history of a particular rock type or formation has a direct-indirect relationship to terrain stability, as well as to the overall evolution of the landscape, as seen today.

The terrain today, together with the underlying terrane, has been modified by at least four widespread climatic episodes of glaciation, the oldest two occurring prior to 790,000 years ago (Fulton et al 1992; Fulton, 1989). The ice sheet in each case grew out of the surrounding mountains to cover the Interior Plateau, and in extreme cases "the saucer" was filled to the point whereby ice "in situ" generated its own weather systems to add to an increasingly thick ice sheet until a dome-like feature covered the interior of the province. The ice sheet egressed slowly to its southern (warmer) and northern (dryer) margins (Jackson and Claque, 1991) by virtue of its own rheology. Each succeeding glacial episode blanketed or scraped away the evidence of its predecessor, and thus only the landforms and history of evolution and removal of the last ice age, the Fraser Glaciation, come 29,000 to 10,000 years before present (1950 A.D.= B.P.), is known in any detail. Within the project area, ice arrived about 23,000 years ago and was completely removed (except for isolated shady alpine pockets) by 11,400 years ago (Mathewes and Rouse, 1975). Ice levels reached and covered all peaks with the possible exception of Coquihalla Mountain. (2157 m) and Needle Peak (2090 m) at the south edge of the study area. Ice sheet disappearance began at about 14,500 years ago along its southern edge in the state of Washington which was likely accompanied by surface melt ("downwasting") within the project area. Accumulation of downwasting or surface run-off around emerging mountains and ridge tops (nanataks) lead to the development of landforms eroded or deposited in an environment of run-off channels and adjacent areas of "dead" ice blocks, with local ponding of meltwater between "stagnating" ice and valley wall, or other topographic obstacle. The combination of downwasting, in situ, and the gradual south to north disappearance of ice yielded a meltwater run-odd regime directed into the re-exposed Coquihalla Valley. A chain of glacial lakes, blocked by ice to the north and valley walls to the south, "spilled over" into this valley, beginning first in the southern-most upper Tulameen Basin, but progressing northward in a counterclockwise arrangement (and concommittant lowering of lake levels) into the Otter, Coldwater-Maka, Nicola, Thompson and finally the Fraser, in succession, where residual ice in the canyon of the lattermost finally gave way to drain the last glacial lake of consequence ("Glacial Lake Fraser").

Plant colonization of the exposed barren landscape quickly followed, as shown by study of pollen assemblages in peat bogs near Yale, Aspen Grove and on Stoyoma Mountain. That of the latter, by Pellatt (1996), shows a cold late-glacial zone of 10,000+ (to 11,400?) years ago, followed by: a warm-dry climate (Xerothermic) assemblage of flora (9000 to 7000 years B.P.), a warm wet climate (Mesothermal) assemblage (7000 to 4800 ± B.P.), a cooling and wetter early Neoglacial phase (4800 - 2400 years B.P.) and a wettest and cool middle to late Neoglacial phase (2400 - ca 100± years B.P.) Within this same overall time span, covered by the bog core pollen assemblages, pedogenic soil processes began. Development of soil horizons is not only a function of time, but also parent material and ongoing geological processes. Topography and climate (and elevation) are some other important factors. Development of a climax soil type, therefore, is dependent on these parameters and within the project area there are several climax Great Soil Groups present. On the grasslands about Aspen Grove to the northeast there are several types of dark chernozems (thick organic surface horizons). On lower mid mountain slopes there are brunisols (light brown 'B' horizon), while podsols lie in the wettest zones near timberline where leaching activity is most intense (deep red 'B' horizon with white or "bleached out" 'A' horizon). On youthful surfaces, or where drainage does not exist, the climax soil profile will not (or has not had time enough to) develop. There are low terraces, fans and flood plains of only a few hundred (or less) years in age (regosols), poorly drained older flood plain surfaces or other depressions (reducing conditions, gleysols), and depressions filled with accumulation of organics (organic soils) such as peat bogs, marshes, fens and swamps. The pedogenic soil development is important to the silvaculturist and agriculture people, whereas the "subsoil" is of importance to the engineer. "Subsoil" in this project area includes bedrock, where there is little intervening layers of glacial deposits or other deposits of post-glacial origin (floodplains, fans, talus aprons, etc.).

Within the project area, bedrock exposure is greater than what the casual observation would suggest - probably 35% or greater. Elsewhere, there is a ubiquitous presence of glacial (ground moraine) deposits with intermingled colluvium (mass wasting rock detritus) and the proportion of one to the other is quite variable, defying easy estimate in areas of forest covered terrain. De-glacial deposits occur in unpredictable "pockets" in this terrain type as well, but such along with river and fan deposits are mainly confined to the overall very narrow valley corridors. Consequently, valley walls usually harbour the more complex array of surficial deposits, while valley bottom with large rivers have a rather monotonous series of flood plain generated features, which include low terraces and fans. Lithology of the floodplain sequence usually reveals a full display of the bedrock types of the entire basin, above the point of inspection; but the weaker rocks are represented by only their "breakdown" components, found in the fine sediment fractions, which can be complex layered clay minerals, micas, feldspars, quartz and lesser mineral fractions. What minerals that are to be expected is determined by review of the upstream or subsurface geology, and hence the necessity of reviewing bedrock geological reports for all geotechnical or pedological oriented tasks

9. COMMUNITY WATERSHEDS

9.1. Kwinshatin Community Watershed

The logging in the watershed was mainly select logging with some residual forest cover left to reduce the runoff effect. The last logging occurred over five years ago. Efforts are currently in progress to reforest this community watershed area.

No road or skid road deactivation has been done. Many culverts are undersized and improperly installed. A road and skid road deactivation project is needed to prevent future water quality problems.

9.2. Brookmere Community Watershed

Water quality has been a problem for the Brookmere residents for many years. The coliform count has been too high for use as potable water and water users are on a boil alert. The source of the coliform has not been identified.

A project is being developed to replace the surface water source with drilled wells. Three partners who use the watershed are involved; the Brookmere Water Association, Tolko Industries Ltd. and Quilchena Cattle Co.

The watershed was heavily logged due to the salvage of windfall and spruce bark beetle attacked trees. Tolko has fully restocked the logged areas and the spruce bark beetle is on the decline. Quilchena Cattle Company has eliminated cattle grazing subject to the occasional stray. Tolko has deactivated roads to a stable condition required under the Forest Practices Code of B.C.

10. GEOGRAPHIC INFORMATION SYSTEMS

A Level I Watershed Assessment has been applied to the Coldwater River Drainage Watershed in order to gain an understanding of the type and extent of current water related problems in the watershed and the possible hydrologic implications of proposed forestry related development. Geographical Information Systems (GIS) have been utilized to determine the indicators adopted in the assessment procedure for the basin and sub-basin watershed characteristics. The thirteen indicators are listed as follows, and the results are tabulated in Forms 1 to 9 attached to this report.

INDICATOR	DESCRIPTION
1.	The peak flow index.
2.	The road density above H_{60} line.
3.	The total road density (used for assessing peak flow changes).
4.	The density of roads on erodible soils.
5.	The density of roads less than 100m distance from a stream.
6.	The density of roads on erodible soils less than 100m distance from a stream.
7.	The density of stream crossings.
8.	The total road density. (used for assessing surface erosion).
9.	The portion of the stream that has been logged to the stream bank.
10.	The portion of Class A streams that have been logged to the stream bank.
11.	The density of landslides in the watershed.
12.	The density of roads on unstable terrain.
13.	The portion of stream banks that have been logged on slopes that are greater than 60%.

The digital data files are completed in the Ministry Digital Standard Format, Intergraph Design File (IGDS) format, version 8.0 or later, as required by the contract.

11. RESULTS

The data determined through the GIS procedure has been assembled in tabular form in conformance with the IWAP manual. The following tables have been developed.

11.1. Peak Flow

Form 1 — "Area Measurements by Elevation Band and Sub-basin": The H60 elevation of the main watershed is 1168 metres. This is the elevation for which 60 percent of the watershed area is above.

Form 2 — "Peak Flow Index": The equivalent clear-cut area (ECA) is the area that has been clear cut, with a reduction factor to account for the hydraulic recovery due to forest regeneration. The effects of canopy closure on radiation penetration and snow interception, stand growth curves relating tree height and canopy closure and snow data are provided for in the estimated recovery. The result is Indicator #1.

Form 3 "Road Inventory and Density": This table determines road densities above the H60 line and for the entire sub-basin. Indicators #2, #3 and #8 are derived.

11.2. Surface Erosion

Form 4 "Roads Adjacent to Streams": This information tabulates the length of roads on erodible soils, the length of roads within 100 m of a stream, the length of roads within 100m of stream on erodible soils, and the number of stream crossings. From this data densities are calculated with respect to the areas of each sub-basin, resulting in Indicators #4, #5, #6 and #7.

11.3. Riparian Buffers

Form 5 "Riparian Buffer Impacts": In this table, the length of stream logged, total stream length as well as the length of fish bearing stream logged and total length of fish bearing streams are given. Assumptions were made as to the location and extent of fish bearing streams due to the absence of firm data. Indicators #9 and #10 give the estimated densities of the above factors.

11.4. Landslides

Form 6 "Landslide Hazard": The number of landslides, length of road on unstable terrain and the length of streams whose banks have been logged and are on slopes greater than 50%, is given for each sub-basin. Corresponding densities provide Indicators # 11, #12 and #13.

11.5. Other Land Uses

Form 7 "Other Land Uses": Activities on Crown land such as livestock grazing, all terrain vehicle recreation, and mining within close proximity to streams, are indicated subjectively.

11.6. Watershed Characteristics

Form 8 "Watershed Characteristics": This table indicates the percent crown land, private land, and operable land by subdivision.

Form 9 "Watershed Characteristics": Tabulation of the following are given for each sub-basin:

- Area with unstable slopes
- Area with erodible soils
- Fisheries temperature concerns
- Hydrological zone
- Dominant bedrock geology
- Presence/absence of glaciers

11.7. IWAP Conversion Table

From the preceding raw data, the information is rescaled to fit between the range of 0 to 1.0 . A value of 1.0 indicates high impact, a 0.5 indicates moderate impact, and a 0 indicates no impact. We have utilized the electronic spreadsheets to calculate the impact scores. This information is given on a separate sheet for each of the 14 sub-basins, as contained in Appendix 1.

Form 10 tabulates the relative scores for each of the 13 indicators within each sub-basin. This summary indicates that in general the subbasins with indicators having a value of 0.5 or higher are:

	INDICATOR	SUBBASIN
#1	Peak flow index	11
#2	Road density above the H60 line	2, 5, 8, 10, 11, 12, 14
#3 & #8	Road density for the entire sub-basin	All subbasins
#5	Roads less than 100 m from a stream	1, 2, 8, 9, 10, 12, 13, 14
#7	Number of stream crossing per km^2	All except 4 (which is 0.49)

The implications of these scores relative to a comparison between categories, are discussed in the next section.

12. INTERPRETATIONS AND RECOMMENDATIONS

There are five impact categories used in the IWAP procedure. These are:

1. Peak Flows
2. Surface Erosion
3. Riparian Buffers
4. Mass Wasting
5. Channel Instability

The electronic spreadsheets (from Section 7) have already calculated the hazard index for each of these impact categories by sub-basin. The results are tabulated in Form 11. It is noted from the IWAP manual that if any hazard index is greater than 0.5 then a Level 2 analysis must be completed. It is evident from the results in Form 11, that a Level 2 analysis will be required for all sub-basins within the watershed.

As stated in the IWAP manual, each Hazard Index by itself does not provide optimum information. Five matrices are therefore provided to consider the inter-related effects. These are:

Interaction matrix	Categories compared
1	Peak flow vs. channel instability
2	Peak flow vs. surface erosion
3	Peak flow vs. mass wasting
4	Mass wasting vs. channel instability
5	Riparian vs. channel instability

However, at the time of writing this report, interaction matrices 1, 4, and 5 could not be completed since information concerning channel instability was not available. When this information becomes available, the spreadsheets can be easily rerun.

The results for interaction matrices 2 and 3 are as follows:

INTERACTION MATRIX # 2

Peak Flow Versus Surface Erosion

Value = 1:
- There are no ECA implications
- ***None of the subbasins qualify for this category.***

Value = 2:
- No additional harvesting above and around sensitive soils
- Rehabilitate roads near streams, and avoid construction of more roads on sensitive soils or adjacent to RMA's. Minimize additional stream crossings.
- Initiate a Level II assessment of sediment sources
- ***8 Sub-basins affected: 1, 2, 3, 4, 5, 6, 7 and 13***

Value = 3
- Do not increase current ECA levels, particularly above and around sensitive soil types
- No additional roads should be constructed before the existing ones are properly de-activated
- Initiate a Level II assessment of sediment sources
- ***None of the sub-basins are affected.***

Value = 4
- Reduce ECA over the entire watershed
- No additional roads in sensitive areas
- Initiate a Level II assessment of sediment sources
- ***8 Sub-basins affected: 8, 9, 10, 11, 12 and 14.***

INTERACTION MATRIX # 3

Peak Flow Versus Mass Wasting

Value = 1:
- There are no ECA implications
- ***8 sub-basins are affected: 1, 5, 8, 10, 11, 12, 13 and 14.***

Value = 2:
- A detailed site assessment is required on any potentially unstable slope.
- There should be no logging or road building on Class IV and V slopes
- Initiate a road deactivation and landslide rehabilitation program
- ***3 Sub-basins affected: 2, 4 and 6.***

Value = 3
- Restrict harvesting to a maximum of 20% on areas draining onto or above Class IV or V slopes.
- Complete terrain mapping and detailed field assessments on any Class IV or V slopes prior to logging.
- ***1 Sub-basin affected: 7.***

Value = 4
- Reduce ECA in the watershed to at least a moderate hazard level.
- Rehabilitate and restore landslides
- No logging on or above slopes of Class IV and V
- ***1 Sub-basin affected: 9.***

From the above analysis therefore, it appears that all subbasins require further analysis. Our ranking of those subbasins in most need of further review are, in decreasing order of priority:

Nos. 9
Nos. 8, 10, 11, 12, and 14
Nos. 3 and 7
Nos. 2, 4 and 6
Nos. 1,5, and 13

END OF REPORT

COLDWATER RIVER DRAINAGE - IWAP

BORRETT ENGINEERING INC.

1998 MARCH 31

Form 1. Area Measurements by elevation band and sub-basin

H60 of Coldwater Watershed: 1168 m

Sub-basin name	Area below H60 line (km^2)	Area above H60 line (km^2)	Total area of sub-basin (km^2)	PRIVATE LAND (km2)	ADJUSTED AREA (km2)
1	53.70	10.68	64.38	12.47	64.38
2	47.63	38.04	85.67	8.63	77.04
3	38.63	52.82	91.45	1.73	89.72
4	8.98	87.01	95.99	0.31	95.68
5	0.65	12.38	13.03	0.00	13.03
6	9.42	58.81	68.23	0.04	68.19
7	30.66	58.21	88.87	1.00	87.87
8	2.03	28.73	30.76	0.01	30.75
9	32.49	16.13	48.62	9.81	48.62
10	76.56	138.52	215.08	51.27	215.08
11	2.66	2.45	5.11	0.00	5.11
12	8.88	19.44	28.32	0.00	28.32
13	18.38	8.29	26.67	1.91	24.77
14	24.25	21.62	45.87	5.78	40.09
Total Watershed	354.92	553.13	908.05	92.96	888.64

COLDWATER RIVER DRAINAGE - IWAP

BORRETT ENGINEERING INC. 1998 MARCH 31

Form 2. Peak flow index (indicator #1) calculations by sub-basin:

Sub-basin name	Total Area of sub-basin (km^2)	Below H_{60} Line			Above H_{60} Line			Peak Flow index *Indicator #1*
		A ECA (km^2)	B ECA÷ total sub-basin (km^2/km^2)	C Weighted ECA (Bx1)	D ECA (km^2)	E ECA÷ total sub-basin (km^2/km^2)	F Weighted ECA (Ex1.5)	(C+F)
1	64.380	4.193	0.065	0.078	0.646	0.010	0.015	0.093
2	85.670	7.208	0.084	0.151	9.365	0.109	0.164	0.315
3	91.450	8.067	0.088	0.209	9.458	0.103	0.155	0.364
4	95.990	1.823	0.019	0.203	7.835	0.082	0.122	0.325
5	13.030	0.141	0.011	0.217	0.943	0.072	0.109	0.325
6	68.230	1.921	0.028	0.204	9.167	0.134	0.202	0.405
7	88.870	3.866	0.044	0.126	8.667	0.098	0.146	0.272
8	30.760	0.013	0.000	0.006	5.895	0.192	0.287	0.294
9	48.620	7.401	0.152	0.228	1.536	0.032	0.047	0.275
10	215.080	15.594	0.073	0.204	29.602	0.138	0.206	0.410
11	5.110	1.364	0.267	0.513	2.725	0.533	0.800	1.313
12	28.320	0.540	0.019	0.061	0.517	0.018	0.027	0.088
13	26.670	1.183	0.044	0.064	0.034	0.001	0.002	0.066
14	45.870	0.941	0.021	0.039	4.227	0.092	0.138	0.177
Total Watershed	908.050	54.255	0.060	0.153	90.616	0.100	0.150	0.303

COLDWATER RIVER DRAINAGE - IWAP

BORRETT ENGINEERING INC. 1998 MARCH 31

Form 3. Road Inventory and density (indicators #2, #3 and #8) (see Appendix 9)

Sub-basin name	Sub-basin area (km²)	Road above H_{60} line		Road for entire sub-basin	
		Length (km)	*Indicator #2* Density (km/km²)	Length (km)	*Indicator #3 and #8* Density (km/km²)
1	64.38	12.26	0.190	95.77	1.488
2	85.67	43.33	0.506	137.56	1.606
3	91.45	31.94	0.349	140.87	1.540
4	95.99	40.28	0.420	68.59	0.715
5	13.03	7.16	0.550	9.63	0.739
6	68.23	31.64	0.464	52.91	0.775
7	88.87	20.99	0.236	76.24	0.858
8	30.76	40.61	1.320	40.64	1.321
9	48.62	19.22	0.395	110.94	2.282
10	215.08	192.69	0.896	338.66	1.575
11	5.11	4.73	0.926	11.39	2.229
12	28.32	25.91	0.915	52.19	1.843
13	26.67	0.71	0.027	38.88	1.458
14	45.87	29.07	0.634	93.91	2.047
Total Watershed	908.05	500.55	0.551	1,268.18	1.397

COLDWATER RIVER DRAINAGE - IWAP

BORRETT ENGINEERING INC.

1998 MARCH 31

Form 4. Roads adjacent to streams (indicators #4, #5, #6 and #7)

Sub-basin name	Sub-basin area (km²)	Road on erodible soils		Road within 100m of a stream		Road within 100m of stream on erodible soils		Density of Stream crossings	
		Length (km)	*Indicator #4* Density (km/km²)	Length (km)	*Indicator #5* Density (km/km²)	Length (km)	*Indicator #6* Density (km/km²)	Number (no.)	*Indicator #7* Density (#/km²)
1	64.38	5.89	0.092	38.63	0.600	1.71	0.027	94	1.460
2	85.67	2.90	0.034	56.18	0.656	1.73	0.020	103	1.202
3	91.45	16.62	0.182	44.50	0.487	6.67	0.073	70	0.765
4	95.99	20.85	0.217	22.54	0.235	8.15	0.085	47	0.490
5	13.03	2.15	0.165	4.13	0.317	0.56	0.043	9	0.691
6	68.23	11.88	0.174	19.90	0.292	2.82	0.041	35	0.513
7	88.87	9.94	0.112	28.54	0.321	4.42	0.050	66	0.743
8	30.76	12.98	0.422	17.38	0.565	7.58	0.246	34	1.105
9	48.62	12.18	0.250	30.25	0.622	3.25	0.067	72	1.481
10	215.08	8.07	0.038	129.83	0.604	3.21	0.015	241	1.121
11	5.11	0.30	0.058	2.02	0.395	0.00	0.000	3	0.587
12	28.32	1.67	0.059	16.85	0.595	0.84	0.030	22	0.777
13	26.67	3.12	0.117	16.33	0.612	1.98	0.074	42	1.575
14	45.87	0.06	0.001	31.30	0.682	0.00	0.000	69	1.504
Total Watershed	908.05	108.61	0.120	458.36	0.505	42.91	0.047	907	0.999

COLDWATER RIVER DRAINAGE - IWAP

BORRETT ENGINEERING INC. 1998 MARCH 31

Form 5. Riparian buffer impacts (indicators #9 and #10)

Sub-basin name	Length of stream logged (km)	Total stream length (km)	*Indicator #9* Portion of stream logged (km/km)	Length of fish-bearing stream logged (km)	Total length of fish-bearing stream (km)	*Indicator #10* Portion of fish-bearing stream logged (km/km)
1	35.83	130.74	0.274	24.67	98.42	0.251
2	36.99	168.84	0.219	32.90	114.36	0.288
3	20.42	114.59	0.178	10.76	47.83	0.225
4	6.22	133.43	0.047	2.75	54.71	0.050
5	1.40	32.52	0.043	0.43	12.75	0.034
6	4.43	148.61	0.030	3.10	55.31	0.056
7	16.86	158.44	0.106	10.87	86.64	0.125
8	10.93	54.68	0.200	6.08	29.65	0.205
9	9.08	81.82	0.111	5.91	59.45	0.099
10	131.29	350.83	0.374	117.26	319.41	0.367
11	2.44	6.05	0.403	1.12	2.88	0.390
12	17.08	35.92	0.476	13.60	27.69	0.491
13	10.20	63.27	0.161	6.09	40.06	0.152
14	26.13	89.74	0.291	20.34	72.55	0.280
Total	329.30	1,569.47	0.210	255.86	1,021.69	0.250

COLDWATER RIVER DRAINAGE - IWAP

BORRETT ENGINEERING INC.

1998 MARCH 31

Form 6. Landslide Hazard (indicators #11, #12 and #13)

Sub-basin name	Sub-basin area	Landslides in sub-basin (use air photos)		Road on unstable terrain		Streams whose banks have been logged & are on slopes >60%	
	(km²)	Number (no.)	*Indicator* #11 Density (no./km²)	Length (km)	*Indicator* #12 Density (km/km²)	Length (km)	*Indicator* #13 Density (km/km²)
1	64.38	1	0.016	5.89	0.092	0.00	0.000
2	85.67	13	0.152	0.57	0.007	0.00	0.000
3	91.45	23	0.252	16.14	0.176	0.00	0.000
4	95.99	17	0.177	13.97	0.146	0.54	0.006
5	13.03	1	0.077	0.59	0.045	0.00	0.000
6	68.23	14	0.205	2.06	0.030	0.00	0.000
7	88.87	29	0.326	4.05	0.046	0.00	0.000
8	30.76	2	0.065	7.09	0.230	0.00	0.000
9	48.62	19	0.391	6.19	0.127	0.00	0.000
10	215.08	12	0.056	6.59	0.031	0.00	0.000
11	5.11	0	0.000	0.00	0.000	0.00	0.000
12	28.32	2	0.071	0.00	0.000	0.00	0.000
13	26.67	2	0.075	3.13	0.117	0.00	0.000
14	45.87	1	0.022	0.06	0.001	0.00	0.000
Total	908.05	136	0.150	66.31	0.073	0.54	0.001

COLDWATER RIVER DRAINAGE

BORRETT ENGINEERING INC. 1998 MARCH 31

Form 7. Other land uses (appendix 14)

Sub-basin name	Range use close to streams? (yes or no)	Mining close to streams? (yes or no)	All terrain vehicles close to streams? (yes or no)
1	YES	YES	YES
2	YES	YES	YES
3	YES	YES	YES
4	NO	NO	YES
5	NO	NO	YES
6	NO	NO	YES
7	YES	YES	YES
8	NO	NO	YES
9	YES	NO	YES
10	YES	NO	YES
11	NO	NO	YES
12	YES	NO	YES
13	YES	NO	YES
14	YES	NO	YES
Total watershed			

COLDWATER RIVER DRAINAGE

BORRETT ENGINEERING INC. 1998 MARCH 31

Form 8. Watershed Charateristics by sub-basin.

Sub-basin name	Sub-basin area	% Crown land		% Private Land		% Operable land	
	(km²)	area (km²)	%	area (km²)	%	area (km²)	%
1	64.38	51.91	80.63%	12.47	19.37%	64.38	100.00%
2	85.67	77.04	89.93%	8.63	10.07%	85.67	100.00%
3	91.45	89.72	98.11%	1.73	1.89%	91.45	100.00%
4	95.99	95.68	99.68%	0.31	0.32%	95.99	100.00%
5	13.03	13.03	100.00%	0.00	0.00%	13.03	100.00%
6	68.23	68.19	99.94%	0.04	0.06%	68.23	100.00%
7	88.87	87.87	98.87%	1.00	1.13%	88.87	100.00%
8	30.76	30.75	99.97%	0.01	0.03%	30.76	100.00%
9	48.62	38.82	79.83%	9.81	20.17%	48.62	100.00%
10	215.08	163.81	76.16%	51.27	23.84%	215.08	100.00%
11	5.11	5.11	100.00%	0.00	0.00%	5.11	100.00%
12	28.32	28.32	100.00%	0.00	0.00%	28.32	100.00%
13	26.67	24.77	92.86%	1.91	7.14%	26.67	100.00%
14	45.87	40.09	87.39%	5.78	12.61%	45.87	100.00%
Total	908.05	815.09	89.76%	92.96	10.24%	908.05	100.00%

COLDWATER RIVER DRAINAGE

BORRETT ENGINEERING INC. 1998 MARCH 31

Form 9. Watershed Charateristics by sub-basin.

Sub-basin name	Sub-basin area (km²)	Area with unstable slopes Appendix 5 (km²)	% Area with unstable slopes	Area with erodible soils Appendix 6 (km²)	% Area with erodible soils	Does Fisheries (DFO/MoE) have temperature concerns Appendix 7	Hydrological zone Appendix 12	Dominant Bedrock Geology	Are there Glaciers in the sub-basin Y/N
1	64.38	3.95	6.14%	3.95	6.14%	NO	31	5a	NO
2	85.67	2.06	2.40%	2.06	2.40%	NO	31	5a	NO
3	91.45	5.64	6.17%	5.64	6.17%	NO	32	5a, 4	NO
4	95.99	14.41	15.01%	14.41	15.01%	NO	32	1	YES
5	13.03	0.62	4.72%	0.62	4.72%	NO	32	1	NO
6	68.23	4.09	5.99%	4.09	5.99%	NO	32	1	YES
7	88.87	14.76	16.60%	14.76	16.60%	NO	32	5a,4	NO
8	30.76	2.81	9.14%	2.81	9.14%	NO	32	5a	NO
9	48.62	2.93	6.03%	2.93	6.03%	NO	31	1	NO
10	215.08	4.03	1.87%	4.03	1.87%	NO	31	10	NO
11	5.11	0.12	2.29%	0.12	2.29%	NO	31	10	NO
12	28.32	0.85	2.98%	0.85	2.98%	NO	31	10	NO
13	26.67	5.04	18.88%	5.04	18.88%	NO	31	10	NO
14	45.87	0.73	1.58%	0.73	1.58%	NO	31	10	NO
Total Watershed	908.05	62.02	6.83%	62.02	6.83%				

Form 10. Watershed report card

Impact Category	Indicators	Sub-basin name													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Peak Flow	1) peak flow index	0.08	0.25	0.24	0.14	0.12	0.23	0.19	0.29	0.20	0.28	1.07	0.05	0.05	0.16
	2) road density above H_{60}line (km/km^2)	0.19	0.51	0.35	0.42	0.55	0.46	0.24	1.32	0.40	0.90	0.93	0.91	0.03	0.63
	3)road density for entire sub-basin (km/km^2)	1.49	1.61	1.54	0.71	0.74	0.78	0.86	1.32	2.28	1.57	2.23	1.84	1.46	2.05
Surface Erosion	4) roads on erodible soils (km/km^2)	0.09	0.03	0.18	0.22	0.16	0.17	0.11	0.42	0.25	0.04	0.06	0.06	0.12	0.00
	5) roads <100m from a stream (km/km^2)	0.60	0.66	0.49	0.23	0.32	0.29	0.32	0.56	0.62	0.60	0.39	0.60	0.61	0.68
	6) roads on erodible soils <100m from a stream (km/km^2)	0.03	0.02	0.07	0.08	0.04	0.04	0.05	0.25	0.07	0.01	0.00	0.03	0.07	0.00
	7) no. of stream crossings (no./km^2)	1.46	1.20	0.77	0.49	0.69	0.51	0.74	1.11	1.48	1.12	0.59	0.78	1.57	1.50
	8) road density for entire sub-basin (km/km^2)	1.49	1.61	1.54	0.71	0.74	0.78	0.86	1.32	2.28	1.57	2.23	1.84	1.46	2.05
Riparian buffer	9) portion of stream logged (km/km^2)	0.27	0.22	0.18	0.05	0.04	0.03	0.11	0.20	0.11	0.37	0.40	0.48	0.16	0.29
	10) portion of fish-bearing stream logged (km/km^2)	0.25	0.29	0.22	0.05	0.03	0.06	0.13	0.21	0.10	0.37	0.39	0.49	0.15	0.28
Mass wasting	11) no. of landslides (no./km^2)	0.02	0.15	0.25	0.18	0.08	0.21	0.33	0.07	0.39	0.06	0.00	0.07	0.07	0.02
	12) roads on unstable soils (km/km^2)	0.09	0.01	0.18	0.15	0.05	0.03	0.05	0.23	0.13	0.03	0.00	0.00	0.12	0.00
	13) streambanks logged on slopes >50% (km/km^2)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Land-uses	Crown range use? (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	All-terrain vehicles? (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Mining? (Y/N)														

FORM 11

HAZARD INDICIES

IMPACT CATEGORY

SUBBASIN	WATERSHED AREA	PEAK FLOWS	SURFACE EROSION	RIPARIAN BUFFERS	LANDSLIDES	FURTHER WATERSHED ANALYSIS REQ'D
	(sq. km.)					
1	64	0.27	1.00	0.91	0.15	Yes
2	86	0.48	1.00	0.73	0.59	Yes
3	91	0.42	0.93	0.59	0.75	Yes
4	96	0.3	0.58	0.16	0.63	Yes
5	13	0.33	0.76	0.14	0.38	Yes
6	68	0.38	0.65	0.11	0.68	Yes
7	89	0.32	0.79	0.35	0.88	Yes
8	31	0.64	1.00	0.67	0.33	Yes
9	49	0.50	1.00	0.37	0.98	Yes
10	215	0.63	1.00	1.00	0.28	Yes
11	5	1.00	0.86	1.00	0.00	Yes
12	28	0.54	0.94	1.00	0.35	Yes
13	27	0.20	1.00	0.54	0.37	Yes
14	46	0.53	1.00	0.97	0.11	Yes
TOTAL	**908.1**	**6.5**	**12.5**	**8.5**	**6.5**	

COLDWATER IWAP - LEVEL 1

INTERPRETATION WORKSHEETS

PF-Peak Flow
SE-Surface Erosion
LS-Landslides
CI- Channel Instability

FILE: COLDINTR
PROJECT: 1550
DATE: 98 MARCH 12

IMPACT CATEGORY

SUB-BASIN	WATERSHED AREA (sq. km.)	INTERACTION	HAZARD CATEG. 1st Interaction: Hazard Index		HAZARD CATEG. 2nd Interaction: Hazard Index		VALUE (1,2,3 or 4)	COMMENTS
1	64	1 PF/CI	0.27	Low				
		2 PF/SE	0.27	Low	1	High	2	
		3 PF/LS	0.27	Low	0.15	Low	1	No ECA Implications
		4 LS/CI	0.15	Low				
2	86	1 PF/CI	0.48	Low				
		2 PF/SE	0.48	Low	1	High	2	
		3 PF/LS	0.48	Low	0.59	Medium	2	
		4 LS/CI	0.59	Medium				
3	91	1 PF/CI	0.42	Low				
		2 PF/SE	0.42	Low	0.93	High	2	
		3 PF/LS	0.42	Low	0.75	High	3	
		4 LS/CI	0.75	High				
4	96	1 PF/CI	0.3	Low				
		2 PF/SE	0.3	Low	0.58	Medium	2	
		3 PF/LS	0.3	Low	0.63	Medium	2	
		4 LS/CI	0.63	Medium				
5	13	1 PF/CI	0.33	Low				
		2 PF/SE	0.33	Low	0.76	High	2	
		3 PF/LS	0.33	Low	0.38	Low	1	No ECA Implications
		4 LS/CI	0.38	Low				
6	68	1 PF/CI	0.38	Low				
		2 PF/SE	0.38	Low	0.65	Medium	2	
		3 PF/LS	0.38	Low	0.68	Medium	2	
		4 LS/CI	0.68	Medium				
7	89	1 PF/CI	0.32	Low				
		2 PF/SE	0.32	Low	0.79	High	2	
		3 PF/LS	0.32	Low	0.88	High	3	
		4 LS/CI	0.88	High				
8	31	1 PF/CI	0.64	Medium				
		2 PF/SE	0.64	Medium	1	High	4	
		3 PF/LS	0.64	Medium	0.33	Low	1	No ECA Implications
		4 LS/CI	0.33	Low				
9	49	1 PF/CI	0.5	Medium				
		2 PF/SE	0.5	Medium	1	High	4	
		3 PF/LS	0.5	Medium	0.98	High	4	
		4 LS/CI	0.98	High				
10	215	1 PF/CI	0.63	Medium				
		2 PF/SE	0.63	Medium	1	High	4	
		3 PF/LS	0.63	Medium	0.28	Low	1	No ECA Implications
		4 LS/CI	0.28	Low				

SUB-BASIN	WATERSHED AREA	INTERACTION	HAZARD CATEG. 1st Interaction		HAZARD CATEG. 2nd Interaction		VALUE (1,2,3 or 4)	COMMENTS
11	5	1 PF/CI	1	High				
		2 PF/SE	1	High	0.86	High	4	
		3 PF/LS	1	High	0	Low	1	No ECA Implications
		4 LS/CI	0	Low				
12	28	1 PF/CI	0.54	Medium				
		2 PF/SE	0.54	Medium	0.94	High	4	
		3 PF/LS	0.54	Medium	0.35	Low	1	No ECA Implications
		4 LS/CI	0.35	Low				
13	27	1 PF/CI	0.2	Low				
		2 PF/SE	0.2	Low	1	High	2	
		3 PF/LS	0.2	Low	0.37	Low	1	No ECA Implications
		4 LS/CI	0.37	Low				
14	46	1 PF/CI	0.53	Medium				
		2 PF/SE	0.53	Medium	1	High	4	
		3 PF/LS	0.53	Medium	0.11	Low	1	No ECA Implications
		4 LS/CI	0.11	Low				
=	=	=	=	=	=	=	=	
TOTAL	908.1							

Appendix 1

IWAP Version 1.02 Data Entry Sheets

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 1			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	64.38	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	0.6456	sq.km.	*	
ECA below H60?	4.193	sq.km.	*	
Road length above H60?	12.258	km.	*	
Road length below H60?	83.52	km.	*	
Surface Erosion				
Length of road on erodable soils?	5.891	km.	*	
Length of road within 100 m. of stream?	38.627	km.	*	
Length of road on erodable soils within 100 m. of stream?	1.707	km.	*	
Number of active stream crossings?	94		*	
Riparian Buffer				
Total stream length?	130.743	km.	*	
Length of stream logged?	35.826	km.	*	
Total length of fish bearing streams?	98.417	km.	*	
Length of fish bearing streams logged?	24.666	km.	*	
Landslides				
Number of landslides?	1		*	
Length of road on unstable slopes?	5.891	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	80.63%			
Percent area of private land?	19.37%			
Percent area with unstable slopes?	6.14%			
Percent area with erodable soils?	6.14%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 1
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.02		
Index below H60	0.07		
1 Total Peak Flow Index	0.08	0.13	
2 Road density above H60	0.19 km/sq.km.	0.19	
3 Total road density (See note below)	1.49 km/sq.km.	0.50	0.27
Surface Erosion			
4 Roads on erodable soils	0.09 km/sq.km.	0.18	
5 Roads within 100 m of a stream	0.60 km/sq.km.	1.00	
6 Roads that are both of the above	0.03 km/sq.km.	0.13	
7 Active stream crossings	1.46 no./sq.km.	1.00	
8 Total road density (See note below)	1.49 km/sq.km.	0.50	1.00
Riparian Buffer			
9 Portion of stream logged?	0.27 km/km.	0.91	
10 Portion of fish bearing streams logged?	0.25 km/km.	0.50	0.91
Landslides			
11 Landslide density	0.02 no./sq.km.	0.08	
12 Roads on unstable slopes	0.09 km/sq.km.	0.31	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.15

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 1

Watershed area	64.38	sq.km.
Elevation of H60	1168	m.
ECA above H60	0.646	sq.km.
ECA below H60	4.193	sq.km.
Road length above H60	12.26	km.
Road length below H60	83.52	km.
Length of road on erodable soils	5.891	km.
Length of road within 100 m. of stream	38.63	km.
Length of road on erodable soils within 100 m. of stre	1.707	km.
Number of active stream crossings	94	
Total stream length	130.7	km.
Length of stream logged	35.83	km.
Total length of fish bearing streams	98.42	km.
Length of fish bearing streams logged	24.67	km.
Number of landslides	1	
Length of road on unstable slopes	5.891	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.02		
Index below H60	0.07		
1 Total Peak Flow Index	0.08	0.13	
2 Road density above H60	0.19 km/sq.km.	0.19	
3 Total road density	1.49 km/sq.km.	0.50	0.27
Surface Erosion			
4 Roads on erodable soils	0.09 km/sq.km.	0.18	
5 Roads within 100 m of a stream	0.60 km/sq.km.	1.00	
6 Roads that are both of the abov	0.03 km/sq.km.	0.13	
7 Active stream crossings	1.46 no./sq.km.	1.00	
8 Total road density	1.49 km/sq.km.	0.50	1.00
Riparian Buffer			
9 Portion of stream logged?	0.27 km/km.	0.91	
10 Portion of fish streams logged?	0.25 km/km.	0.50	0.91
Landslides			
11 Landslide density	0.02 no./sq.km.	0.08	
12 Roads on unstable slopes	0.09 km/sq.km.	0.31	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.15

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 2			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	85.67	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	9.365	sq.km.	*	
ECA below H60?	7.208	sq.km.	*	
Road length above H60?	43.332	km.	*	
Road length below H60?	94.23	km.	*	
Surface Erosion				
Length of road on erodable soils?	2.902	km.	*	
Length of road within 100 m. of stream?	56.183	km.	*	
Length of road on erodable soils within 100 m. of stream?	1.731	km.	*	
Number of active stream crossings?	103		*	
Riparian Buffer				
Total stream length?	168.837	km.	*	
Length of stream logged?	36.985	km.	*	
Total length of fish bearing streams?	114.362	km.	*	
Length of fish bearing streams logged?	32.897	km.	*	
Landslides				
Number of landslides?	13		*	
Length of road on unstable slopes?	0.566	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	89.93%			
Percent area of private land?	10.07%			
Percent area with unstable slopes?	2.40%			
Percent area with erodable soils?	2.40%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 2
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.16		
Index below H60	0.08		
1 Total Peak Flow Index	0.25	0.41	
2 Road density above H60	0.51 km/sq.km.	0.51	
3 Total road density (See note below)	1.61 km/sq.km.	0.54	0.48
Surface Erosion			
4 Roads on erodable soils	0.03 km/sq.km.	0.07	
5 Roads within 100 m of a stream	0.66 km/sq.km.	1.00	
6 Roads that are both of the above	0.02 km/sq.km.	0.10	
7 Active stream crossings	1.20 no./sq.km.	1.00	
8 Total road density (See note below)	1.61 km/sq.km.	0.55	1.00
Riparian Buffer			
9 Portion of stream logged?	0.22 km/km.	0.73	
10 Portion of fish bearing streams logged?	0.29 km/km.	0.58	0.73
Landslides			
11 Landslide density	0.15 no./sq.km.	0.59	
12 Roads on unstable slopes	0.01 km/sq.km.	0.02	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.59

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

				Indicator		Score	Hazard Index
Coldwater 2							
Watershed area	85.67	sq.km.					
			Peak Flow				
Elevation of H60	1168	m.	Index above H60	0.16			
ECA above H60	9.365	sq.km.	Index below H60	0.08			
ECA below H60	7.208	sq.km.	1 Total Peak Flow Index	0.25		0.41	
Road length above H60	43.33	km.	2 Road density above H60	0.51	km/sq.km.	0.51	
Road length below H60	94.23	km.	3 Total road density	1.61	km/sq.km.	0.54	0.48
			Surface Erosion				
Length of road on erodable soils	2.902	km.	4 Roads on erodable soils	0.03	km/sq.km.	0.07	
Length of road within 100 m. of stream	56.18	km.	5 Roads within 100 m of a stream	0.66	km/sq.km.	1.00	
Length of road on erodable soils within 100 m. of stre	1.731	km.	6 Roads that are both of the abov	0.02	km/sq.km.	0.10	
Number of active stream crossings	103		7 Active stream crossings	1.20	no./sq.km.	1.00	
			8 Total road density	1.61	km/sq.km.	0.55	1.00
			Riparian Buffer				
Total stream length	168.8	km.					
Length of stream logged	36.99	km.					
Total length of fish bearing streams	114.4	km.	9 Portion of stream logged?	0.22	km/km.	0.73	
Length of fish bearing streams logged	32.9	km.	10 Portion of fish streams logged?	0.29	km/km.	0.58	0.73
			Landslides				
Number of landslides	13		11 Landslide density	0.15	no./sq.km.	0.59	
Length of road on unstable slopes	0.566	km.	12 Roads on unstable slopes	0.01	km/sq.km.	0.02	
Length of stream with logged banks and on slopes > 6	0	km.	13 Streams >60% and banks logge	0.00	km/sq.km.	0.00	0.59

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 3			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	91.45	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	9.458	sq.km.	*	
ECA below H60?	8.067	sq.km.	*	
Road length above H60?	31.938	km.	*	
Road length below H60?	108.94	km.	*	
Surface Erosion				
Length of road on erodable soils?	16.622	km.	*	
Length of road within 100 m. of stream?	44.496	km.	*	
Length of road on erodable soils within 100 m. of stream?	6.673	km.	*	
Number of active stream crossings?	70		*	
Riparian Buffer				
Total stream length?	114.580	km.	*	
Length of stream logged?	20.419	km.	*	
Total length of fish bearing streams?	47.833	km.	*	
Length of fish bearing streams logged?	10.761	km.	*	
Landslides				
Number of landslides?	23		*	
Length of road on unstable slopes?	16.137	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	98.11%			
Percent area of private land?	1.89%			
Percent area with unstable slopes?	6.17%			
Percent area with erodable soils?	6.17%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 3
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.16		
Index below H60	0.09		
1 Total Peak Flow Index	0.24	0.41	
2 Road density above H60	0.35 km/sq.km.	0.35	
3 Total road density (See note below)	1.54 km/sq.km.	0.51	0.42
Surface Erosion			
4 Roads on erodable soils	0.18 km/sq.km.	0.36	
5 Roads within 100 m of a stream	0.49 km/sq.km.	1.00	
6 Roads that are both of the above	0.07 km/sq.km.	0.36	
7 Active stream crossings	0.77 no./sq.km.	0.87	
8 Total road density (See note below)	1.54 km/sq.km.	0.52	0.93
Riparian Buffer			
9 Portion of stream logged?	0.18 km/km.	0.59	
10 Portion of fish bearing streams logged?	0.22 km/km.	0.45	0.59
Landslides			
11 Landslide density	0.25 no./sq.km.	0.75	
12 Roads on unstable slopes	0.18 km/sq.km.	0.55	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.75

Notes:

The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 3

Watershed area	91.45	sq.km.		Indicator		Score	Hazard Index
			Peak Flow				
Elevation of H60	1168	m.	Index above H60	0.16			
ECA above H60	9.458	sq.km.	Index below H60	0.09			
ECA below H60	8.067	sq.km.	1 Total Peak Flow Index	0.24		0.41	
Road length above H60	31.94	km.	2 Road density above H60	0.35	km/sq.km.	0.35	
Road length below H60	108.9	km.	3 Total road density	1.54	km/sq.km.	0.51	0.42
			Surface Erosion				
Length of road on erodable soils	16.62	km.	4 Roads on erodable soils	0.18	km/sq.km.	0.36	
Length of road within 100 m. of stream	44.5	km.	5 Roads within 100 m of a stream	0.49	km/sq.km.	1.00	
Length of road on erodable soils within 100 m. of stre	6.673	km.	6 Roads that are both of the abov	0.07	km/sq.km.	0.36	
Number of active stream crossings	70		7 Active stream crossings	0.77	no./sq.km.	0.87	
			8 Total road density	1.54	km/sq.km.	0.52	0.93
Total stream length	114.6	km.	**Riparian Buffer**				
Length of stream logged	20.42	km.					
Total length of fish bearing streams	47.83	km.	9 Portion of stream logged?	0.18	km/km.	0.59	
Length of fish bearing streams logged	10.76	km.	10 Portion of fish streams logged?	0.22	km/km.	0.45	0.59
			Landslides				
Number of landslides	23		11 Landslide density	0.25	no./sq.km.	0.75	
Length of road on unstable slopes	16.14	km.	12 Roads on unstable slopes	0.18	km/sq.km.	0.55	
Length of stream with logged banks and on slopes > 6	0	km.	13 Streams >60% and banks logge	0.00	km/sq.km.	0.00	0.75

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 4			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	95.99	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	7.835	sq.km.	*	
ECA below H60?	1.823	sq.km.	*	
Road length above H60?	40.278	km.	*	
Road length below H60?	28.32	km.	*	
Surface Erosion				
Length of road on erodable soils?	20.851	km.	*	
Length of road within 100 m. of stream?	22.538	km.	*	
Length of road on erodable soils within 100 m. of stream?	8.147	km.	*	
Number of active stream crossings?	47		*	
Riparian Buffer				
Total stream length?	133.429	km.	*	
Length of stream logged?	6.222	km.	*	
Total length of fish bearing streams?	54.707	km.	*	
Length of fish bearing streams logged?	2.746	km.	*	
Landslides				
Number of landslides?	17		*	
Length of road on unstable slopes?	13.972	km.	*	
Length of stream with logged banks and on slopes > 60%	0.536	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	NO			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	99.68%			
Percent area of private land?	0.32%			
Percent area with unstable slopes?	15.01%			
Percent area with erodable soils?	15.01%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 4
Map units were identified as: km. and sq.km.

	Indicator		(5) Score	(6) Hazard Index
Peak Flow				
Index above H60	0.12			
Index below H60	0.02			
1 Total Peak Flow Index	0.14		0.24	
2 Road density above H60	0.42	km/sq.km.	0.42	
3 Total road density (See note below)	0.71	km/sq.km.	0.24	0.30
Surface Erosion				
4 Roads on erodable soils	0.22	km/sq.km.	0.43	
5 Roads within 100 m of a stream	0.23	km/sq.km.	0.57	
6 Roads that are both of the above	0.08	km/sq.km.	0.42	
7 Active stream crossings	0.49	no./sq.km.	0.59	
8 Total road density (See note below)	0.71	km/sq.km.	0.24	0.58
Riparian Buffer				
9 Portion of stream logged?	0.05	km/km.	0.16	
10 Portion of fish bearing streams logged?	0.05	km/km.	0.10	0.16
Landslides				
11 Landslide density	0.18	no./sq.km.	0.63	
12 Roads on unstable slopes	0.15	km/sq.km.	0.49	
13 Streams >60% and banks logged	0.01	km/sq.km.	0.02	0.63

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

					Indicator		Score	Hazard Index
Coldwater 4								
Watershed area	95.99	sq.km.						
			Peak Flow					
Elevation of H60	1168	m.		Index above H60	0.12			
ECA above H60	7.835	sq.km.		Index below H60	0.02			
ECA below H60	1.823	sq.km.	1	Total Peak Flow Index	0.14		0.24	
Road length above H60	40.28	km.	2	Road density above H60	0.42	km/sq.km.	0.42	
Road length below H60	28.32	km.	3	Total road density	0.71	km/sq.km.	0.24	0.30
			Surface Erosion					
Length of road on erodable soils	20.85	km.	4	Roads on erodable soils	0.22	km/sq.km.	0.43	
Length of road within 100 m. of stream	22.54	km.	5	Roads within 100 m of a stream	0.23	km/sq.km.	0.57	
Length of road on erodable soils within 100 m. of stre	8.147	km.	6	Roads that are both of the abov	0.08	km/sq.km.	0.42	
Number of active stream crossings	47		7	Active stream crossings	0.49	no./sq.km.	0.59	
			8	Total road density	0.71	km/sq.km.	0.24	0.58
			Riparian Buffer					
Total stream length	133.4	km.						
Length of stream logged	6.222	km.						
Total length of fish bearing streams	54.71	km.	9	Portion of stream logged?	0.05	km/km.	0.16	
Length of fish bearing streams logged	2.746	km.	10	Portion of fish streams logged?	0.05	km/km.	0.10	0.16
			Landslides					
Number of landslides	17		11	Landslide density	0.18	no./sq.km.	0.63	
Length of road on unstable slopes	13.97	km.	12	Roads on unstable slopes	0.15	km/sq.km.	0.49	
Length of stream with logged banks and on slopes > 6	0.536	km.	13	Streams >60% and banks logge	0.01	km/sq.km.	0.02	0.63

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 5			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	13.03	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	0.943	sq.km.	*	
ECA below H60?	0.141	sq.km.	*	
Road length above H60?	7.16	km.	*	
Road length below H60?	2.47	km.	*	
Surface Erosion				
Length of road on erodable soils?	2.148	km.	*	
Length of road within 100 m. of stream?	4.128	km.	*	
Length of road on erodable soils within 100 m. of stream?	0.562	km.	*	
Number of active stream crossings?	9		*	
Riparian Buffer				
Total stream length?	32.515	km.	*	
Length of stream logged?	1.401	km.	*	
Total length of fish bearing streams?	12.747	km.	*	
Length of fish bearing streams logged?	0.43	km.	*	
Landslides				
Number of landslides?	1		*	
Length of road on unstable slopes?	0.587	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	NO			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	100.00%			
Percent area of private land?	0.00%			
Percent area with unstable slopes?	4.72%			
Percent area with erodable soils?	4.72%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 5
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.11		
Index below H60	0.01		
1 Total Peak Flow Index	0.12	0.20	
2 Road density above H60	0.55 km/sq.km.	0.55	
3 Total road density (See note below)	0.74 km/sq.km.	0.25	0.33
Surface Erosion			
4 Roads on erodable soils	0.16 km/sq.km.	0.33	
5 Roads within 100 m of a stream	0.32 km/sq.km.	0.73	
6 Roads that are both of the above	0.04 km/sq.km.	0.22	
7 Active stream crossings	0.69 no./sq.km.	0.79	
8 Total road density (See note below)	0.74 km/sq.km.	0.25	0.76
Riparian Buffer			
9 Portion of stream logged?	0.04 km/km.	0.14	
10 Portion of fish bearing streams logged?	0.03 km/km.	0.07	0.14
Landslides			
11 Landslide density	0.08 no./sq.km.	0.38	
12 Roads on unstable slopes	0.05 km/sq.km.	0.15	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.38

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 5

Watershed area	13.03	sq.km.
Elevation of H60	1168	m.
ECA above H60	0.943	sq.km.
ECA below H60	0.141	sq.km.
Road length above H60	7.16	km.
Road length below H60	2.47	km.
Length of road on erodable soils	2.148	km.
Length of road within 100 m. of stream	4.128	km.
Length of road on erodable soils within 100 m. of stre	0.562	km.
Number of active stream crossings	9	
Total stream length	32.52	km.
Length of stream logged	1.401	km.
Total length of fish bearing streams	12.75	km.
Length of fish bearing streams logged	0.43	km.
Number of landslides	1	
Length of road on unstable slopes	0.587	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.11		
Index below H60	0.01		
1 Total Peak Flow Index	0.12	0.20	
2 Road density above H60	0.55 km/sq.km.	0.55	
3 Total road density	0.74 km/sq.km.	0.25	0.33
Surface Erosion			
4 Roads on erodable soils	0.16 km/sq.km.	0.33	
5 Roads within 100 m of a stream	0.32 km/sq.km.	0.73	
6 Roads that are both of the abov	0.04 km/sq.km.	0.22	
7 Active stream crossings	0.69 no./sq.km.	0.79	
8 Total road density	0.74 km/sq.km.	0.25	0.76
Riparian Buffer			
9 Portion of stream logged?	0.04 km/km.	0.14	
10 Portion of fish streams logged?	0.03 km/km.	0.07	0.14
Landslides			
11 Landslide density	0.08 no./sq.km.	0.38	
12 Roads on unstable slopes	0.05 km/sq.km.	0.15	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.38

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 6			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	68.23	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	9.167	sq.km.	*	
ECA below H60?	1.921	sq.km.	*	
Road length above H60?	31.644	km.	*	
Road length below H60?	21.27	km.	*	
Surface Erosion				
Length of road on erodable soils?	11.877	km.	*	
Length of road within 100 m. of stream?	19.902	km.	*	
Length of road on erodable soils within 100 m. of stream?	2.822	km.	*	
Number of active stream crossings?	35		*	
Riparian Buffer				
Total stream length?	148.666	km.	*	
Length of stream logged?	4.427	km.	*	
Total length of fish bearing streams?	55.313	km.	*	
Length of fish bearing streams logged?	3.098	km.	*	
Landslides				
Number of landslides?	14		*	
Length of road on unstable slopes?	2.055	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	NO			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	99.94%			
Percent area of private land?	0.06%			
Percent area with unstable slopes?	5.99%			
Percent area with erodable soils?	5.99%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 6
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.20		
Index below H60	0.03		
1 Total Peak Flow Index	0.23	0.38	
2 Road density above H60	0.46 km/sq.km.	0.46	
3 Total road density (See note below)	0.78 km/sq.km.	0.26	0.38
Surface Erosion			
4 Roads on erodable soils	0.17 km/sq.km.	0.35	
5 Roads within 100 m of a stream	0.29 km/sq.km.	0.68	
6 Roads that are both of the above	0.04 km/sq.km.	0.21	
7 Active stream crossings	0.51 no./sq.km.	0.61	
8 Total road density (See note below)	0.78 km/sq.km.	0.26	0.65
Riparian Buffer			
9 Portion of stream logged?	0.03 km/km.	0.10	
10 Portion of fish bearing streams logged?	0.06 km/km.	0.11	0.11
Landslides			
11 Landslide density	0.21 no./sq.km.	0.68	
12 Roads on unstable slopes	0.03 km/sq.km.	0.10	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.68

Notes:

The calculations of scores for #3 and #8 above are slightly different.

This spreadsheet is based on the IWAP Guidebook dated September 1995.

However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 6

Watershed area	68.23	sq.km.
Elevation of H60	1168	m.
ECA above H60	9.167	sq.km.
ECA below H60	1.921	sq.km.
Road length above H60	31.64	km.
Road length below H60	21.27	km.
Length of road on erodable soils	11.88	km.
Length of road within 100 m. of stream	19.9	km.
Length of road on erodable soils within 100 m. of stre	2.822	km.
Number of active stream crossings	35	
Total stream length	148.6	km.
Length of stream logged	4.427	km.
Total length of fish bearing streams	55.31	km.
Length of fish bearing streams logged	3.098	km.
Number of landslides	14	
Length of road on unstable slopes	2.055	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator		Score	Hazard Index
Peak Flow				
Index above H60	0.20			
Index below H60	0.03			
1 Total Peak Flow Index	0.23		0.38	
2 Road density above H60	0.46	km/sq.km.	0.46	
3 Total road density	0.78	km/sq.km.	0.26	0.38
Surface Erosion				
4 Roads on erodable soils	0.17	km/sq.km.	0.35	
5 Roads within 100 m of a stream	0.29	km/sq.km.	0.68	
6 Roads that are both of the abov	0.04	km/sq.km.	0.21	
7 Active stream crossings	0.51	no./sq.km.	0.61	
8 Total road density	0.78	km/sq.km.	0.26	0.65
Riparian Buffer				
9 Portion of stream logged?	0.03	km/km.	0.10	
10 Portion of fish streams logged?	0.06	km/km.	0.11	0.11
Landslides				
11 Landslide density	0.21	no./sq.km.	0.68	
12 Roads on unstable slopes	0.03	km/sq.km.	0.10	
13 Streams >60% and banks logge	0.00	km/sq.km.	0.00	0.68

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 7			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	88.87	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	8.667	sq.km.	*	
ECA below H60?	3.866	sq.km.	*	
Road length above H60?	20.99	km.	*	
Road length below H60?	55.25	km.	*	
Surface Erosion				
Length of road on erodable soils?	9.942	km.	*	
Length of road within 100 m. of stream?	28.536	km.	*	
Length of road on erodable soils within 100 m. of stream?	4.42	km.	*	
Number of active stream crossings?	66		*	
Riparian Buffer				
Total stream length?	158.444	km.	*	
Length of stream logged?	16.859	km.	*	
Total length of fish bearing streams?	86.637	km.	*	
Length of fish bearing streams logged?	10.868	km.	*	
Landslides				
Number of landslides?	29		*	
Length of road on unstable slopes?	4.049	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	98.87%			
Percent area of private land?	1.13%			
Percent area with unstable slopes?	16.60%			
Percent area with erodable soils?	16.60%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 7
Map units were identified as: km. and sq.km.

	Indicator		(5) Score	(6) Hazard Index
Peak Flow				
Index above H60	0.15			
Index below H60	0.04			
1 Total Peak Flow Index	0.19		0.32	
2 Road density above H60	0.24	km/sq.km.	0.24	
3 Total road density (See note below)	0.86	km/sq.km.	0.29	0.32
Surface Erosion				
4 Roads on erodable soils	0.11	km/sq.km.	0.22	
5 Roads within 100 m of a stream	0.32	km/sq.km.	0.74	
6 Roads that are both of the above	0.05	km/sq.km.	0.25	
7 Active stream crossings	0.74	no./sq.km.	0.84	
8 Total road density (See note below)	0.86	km/sq.km.	0.29	0.79
Riparian Buffer				
9 Portion of stream logged?	0.11	km/km.	0.35	
10 Portion of fish bearing streams logged?	0.13	km/km.	0.25	0.35
Landslides				
11 Landslide density	0.33	no./sq.km.	0.88	
12 Roads on unstable slopes	0.05	km/sq.km.	0.15	
13 Streams >60% and banks logged	0.00	km/sq.km.	0.00	0.88

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 7		
Watershed area	88.87	sq.km.
Elevation of H60	1168	m.
ECA above H60	8.667	sq.km.
ECA below H60	3.866	sq.km.
Road length above H60	20.99	km.
Road length below H60	55.25	km.
Length of road on erodable soils	9.942	km.
Length of road within 100 m. of stream	28.54	km.
Length of road on erodable soils within 100 m. of stre	4.42	km.
Number of active stream crossings	66	
Total stream length	158.4	km.
Length of stream logged	16.86	km.
Total length of fish bearing streams	86.64	km.
Length of fish bearing streams logged	10.87	km.
Number of landslides	29	
Length of road on unstable slopes	4.049	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.15		
Index below H60	0.04		
1 Total Peak Flow Index	0.19	0.32	
2 Road density above H60	0.24 km/sq.km.	0.24	
3 Total road density	0.86 km/sq.km.	0.29	0.32
Surface Erosion			
4 Roads on erodable soils	0.11 km/sq.km.	0.22	
5 Roads within 100 m of a stream	0.32 km/sq.km.	0.74	
6 Roads that are both of the abov	0.05 km/sq.km.	0.25	
7 Active stream crossings	0.74 no./sq.km.	0.84	
8 Total road density	0.86 km/sq.km.	0.29	0.79
Riparian Buffer			
9 Portion of stream logged?	0.11 km/km.	0.35	
10 Portion of fish streams logged?	0.13 km/km.	0.25	0.35
Landslides			
11 Landslide density	0.33 no./sq.km.	0.88	
12 Roads on unstable slopes	0.05 km/sq.km.	0.15	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.88

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 8			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	30.76	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	5.895	sq.km.	*	
ECA below H60?	0.013	sq.km.	*	
Road length above H60?	40.614	km.	*	
Road length below H60?	0.03	km.	*	
Surface Erosion				
Length of road on erodable soils?	12.982	km.	*	
Length of road within 100 m. of stream?	17.378	km.	*	
Length of road on erodable soils within 100 m. of stream?	7.578	km.	*	
Number of active stream crossings?	34		*	
Riparian Buffer				
Total stream length?	54.681	km.	*	
Length of stream logged?	10.934	km.	*	
Total length of fish bearing streams?	29.645	km.	*	
Length of fish bearing streams logged?	6.082	km.	*	
Landslides				
Number of landslides?	2		*	
Length of road on unstable slopes?	7.09	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	NO			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	99.97%			
Percent area of private land?	0.03%			
Percent area with unstable slopes?	9.14%			
Percent area with erodable soils?	9.14%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 8
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.29		
Index below H60	0.00		
1 Total Peak Flow Index	0.29	0.48	
2 Road density above H60	1.32 km/sq.km.	1.00	
3 Total road density (See note below)	1.32 km/sq.km.	0.44	0.64
Surface Erosion			
4 Roads on erodable soils	0.42 km/sq.km.	0.69	
5 Roads within 100 m of a stream	0.56 km/sq.km.	1.00	
6 Roads that are both of the above	0.25 km/sq.km.	1.00	
7 Active stream crossings	1.11 no./sq.km.	1.00	
8 Total road density (See note below)	1.32 km/sq.km.	0.44	1.00
Riparian Buffer			
9 Portion of stream logged?	0.20 km/km.	0.67	
10 Portion of fish bearing streams logged?	0.21 km/km.	0.41	0.67
Landslides			
11 Landslide density	0.07 no./sq.km.	0.33	
12 Roads on unstable slopes	0.23 km/sq.km.	0.66	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.33

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 8

Watershed area	30.76	sq.km.
Elevation of H60	1168	m.
ECA above H60	5.895	sq.km.
ECA below H60	0.013	sq.km.
Road length above H60	40.61	km.
Road length below H60	0.03	km.
Length of road on erodable soils	12.98	km.
Length of road within 100 m. of stream	17.38	km.
Length of road on erodable soils within 100 m. of stre	7.578	km.
Number of active stream crossings	34	
Total stream length	54.68	km.
Length of stream logged	10.93	km.
Total length of fish bearing streams	29.65	km.
Length of fish bearing streams logged	6.082	km.
Number of landslides	2	
Length of road on unstable slopes	7.09	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.29		
Index below H60	0.00		
1 Total Peak Flow Index	0.29	0.48	
2 Road density above H60	1.32 km/sq.km.	1.00	
3 Total road density	1.32 km/sq.km.	0.44	0.64
Surface Erosion			
4 Roads on erodable soils	0.42 km/sq.km.	0.69	
5 Roads within 100 m of a stream	0.56 km/sq.km.	1.00	
6 Roads that are both of the abov	0.25 km/sq.km.	1.00	
7 Active stream crossings	1.11 no./sq.km.	1.00	
8 Total road density	1.32 km/sq.km.	0.44	1.00
Riparian Buffer			
9 Portion of stream logged?	0.20 km/km.	0.67	
10 Portion of fish streams logged?	0.21 km/km.	0.41	0.67
Landslides			
11 Landslide density	0.07 no./sq.km.	0.33	
12 Roads on unstable slopes	0.23 km/sq.km.	0.66	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.33

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 9			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	48.62	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	1.536	sq.km.	*	
ECA below H60?	7.4011	sq.km.	*	
Road length above H60?	19.22	km.	*	
Road length below H60?	91.72	km.	*	
Surface Erosion				
Length of road on erodable soils?	12.178	km.	*	
Length of road within 100 m. of stream?	30.251	km.	*	
Length of road on erodable soils within 100 m. of stream?	3.248	km.	*	
Number of active stream crossings?	72		*	
Riparian Buffer				
Total stream length?	81.822	km.	*	
Length of stream logged?	9.076	km.	*	
Total length of fish bearing streams?	59.447	km.	*	
Length of fish bearing streams logged?	5.908	km.	*	
Landslides				
Number of landslides?	19		*	
Length of road on unstable slopes?	6.185	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	79.83%			
Percent area of private land?	20.17%			
Percent area with unstable slopes?	6.03%			
Percent area with erodable soils?	6.03%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 9
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.05		
Index below H60	0.15		
1 Total Peak Flow Index	0.20	0.33	
2 Road density above H60	0.40 km/sq.km.	0.40	
3 Total road density (See note below)	2.28 km/sq.km.	0.76	0.50
Surface Erosion			
4 Roads on erodable soils	0.25 km/sq.km.	0.50	
5 Roads within 100 m of a stream	0.62 km/sq.km.	1.00	
6 Roads that are both of the above	0.07 km/sq.km.	0.33	
7 Active stream crossings	1.48 no./sq.km.	1.00	
8 Total road density (See note below)	2.28 km/sq.km.	0.86	1.00
Riparian Buffer			
9 Portion of stream logged?	0.11 km/km.	0.37	
10 Portion of fish bearing streams logged?	0.10 km/km.	0.20	0.37
Landslides			
11 Landslide density	0.39 no./sq.km.	0.98	
12 Roads on unstable slopes	0.13 km/sq.km.	0.42	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.98

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 9

Watershed area	48.62	sq.km.
Elevation of H60	1168	m.
ECA above H60	1.536	sq.km.
ECA below H60	7.401	sq.km.
Road length above H60	19.22	km.
Road length below H60	91.72	km.
Length of road on erodable soils	12.18	km.
Length of road within 100 m. of stream	30.25	km.
Length of road on erodable soils within 100 m. of stre	3.248	km.
Number of active stream crossings	72	
Total stream length	81.82	km.
Length of stream logged	9.076	km.
Total length of fish bearing streams	59.45	km.
Length of fish bearing streams logged	5.908	km.
Number of landslides	19	
Length of road on unstable slopes	6.185	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.05		
Index below H60	0.15		
1 Total Peak Flow Index	0.20	0.33	
2 Road density above H60	0.40 km/sq.km.	0.40	
3 Total road density	2.28 km/sq.km.	0.76	0.50
Surface Erosion			
4 Roads on erodable soils	0.25 km/sq.km.	0.50	
5 Roads within 100 m of a stream	0.62 km/sq.km.	1.00	
6 Roads that are both of the abov	0.07 km/sq.km.	0.33	
7 Active stream crossings	1.48 no./sq.km.	1.00	
8 Total road density	2.28 km/sq.km.	0.86	1.00
Riparian Buffer			
9 Portion of stream logged?	0.11 km/km.	0.37	
10 Portion of fish streams logged?	0.10 km/km.	0.20	0.37
Landslides			
11 Landslide density	0.39 no./sq.km.	0.98	
12 Roads on unstable slopes	0.13 km/sq.km.	0.42	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.98

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 10			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	215.08	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	29.602	sq.km.	*	
ECA below H60?	15.594	sq.km.	*	
Road length above H60?	192.688	km.	*	
Road length below H60?	145.87	km.	*	
Surface Erosion				
Length of road on erodable soils?	8.068	km.	*	
Length of road within 100 m. of stream?	129.828	km.	*	
Length of road on erodable soils within 100 m. of stream?	3.207	km.	*	
Number of active stream crossings?	241		*	
Riparian Buffer				
Total stream length?	350.826	km.	*	
Length of stream logged?	131.294	km.	*	
Total length of fish bearing streams?	319.408	km.	*	
Length of fish bearing streams logged?	117.258	km.	*	
Landslides				
Number of landslides?	12		*	
Length of road on unstable slopes?	6.586	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	76.16%			
Percent area of private land?	23.84%			
Percent area with unstable slopes?	1.87%			
Percent area with erodable soils?	1.87%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 10
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.21		
Index below H60	0.07		
1 Total Peak Flow Index	0.28	0.46	
2 Road density above H60	0.90 km/sq.km.	0.90	
3 Total road density (See note below)	1.57 km/sq.km.	0.52	0.63
Surface Erosion			
4 Roads on erodable soils	0.04 km/sq.km.	0.08	
5 Roads within 100 m of a stream	0.60 km/sq.km.	1.00	
6 Roads that are both of the above	0.01 km/sq.km.	0.07	
7 Active stream crossings	1.12 no./sq.km.	1.00	
8 Total road density (See note below)	1.57 km/sq.km.	0.53	1.00
Riparian Buffer			
9 Portion of stream logged?	0.37 km/km.	1.00	
10 Portion of fish bearing streams logged?	0.37 km/km.	0.73	1.00
Landslides			
11 Landslide density	0.06 no./sq.km.	0.28	
12 Roads on unstable slopes	0.03 km/sq.km.	0.10	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.28

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 10

Watershed area	215.1	sq.km.
Elevation of H60	1168	m.
ECA above H60	29.6	sq.km.
ECA below H60	15.59	sq.km.
Road length above H60	192.7	km.
Road length below H60	145.9	km.
Length of road on erodable soils	8.068	km.
Length of road within 100 m. of stream	129.8	km.
Length of road on erodable soils within 100 m. of stre	3.207	km.
Number of active stream crossings	241	
Total stream length	350.8	km.
Length of stream logged	131.3	km.
Total length of fish bearing streams	319.4	km.
Length of fish bearing streams logged	117.3	km.
Number of landslides	12	
Length of road on unstable slopes	6.586	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator		Score	Hazard Index
Peak Flow				
Index above H60	0.21			
Index below H60	0.07			
1 Total Peak Flow Index	0.28		0.46	
2 Road density above H60	0.90	km/sq.km.	0.90	
3 Total road density	1.57	km/sq.km.	0.52	0.63
Surface Erosion				
4 Roads on erodable soils	0.04	km/sq.km.	0.08	
5 Roads within 100 m of a stream	0.60	km/sq.km.	1.00	
6 Roads that are both of the abov	0.01	km/sq.km.	0.07	
7 Active stream crossings	1.12	no./sq.km.	1.00	
8 Total road density	1.57	km/sq.km.	0.53	1.00
Riparian Buffer				
9 Portion of stream logged?	0.37	km/km.	1.00	
10 Portion of fish streams logged?	0.37	km/km.	0.73	1.00
Landslides				
11 Landslide density	0.06	no./sq.km.	0.28	
12 Roads on unstable slopes	0.03	km/sq.km.	0.10	
13 Streams >60% and banks logge	0.00	km/sq.km.	0.00	0.28

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 11			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	5.11	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	2.725	sq.km.	*	
ECA below H60?	1.364	sq.km.	*	
Road length above H60?	4.73	km.	*	
Road length below H60?	6.66	km.	*	
Surface Erosion				
Length of road on erodable soils?	0.298	km.	*	
Length of road within 100 m. of stream?	2.018	km.	*	
Length of road on erodable soils within 100 m. of stream?	0	km.	*	
Number of active stream crossings?	3		*	
Riparian Buffer				
Total stream length?	6.053	km.	*	
Length of stream logged?	2.441	km.	*	
Total length of fish bearing streams?	2.88	km.	*	
Length of fish bearing streams logged?	1.123	km.	*	
Landslides				
Number of landslides?	0		*	
Length of road on unstable slopes?	0	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	NO			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	100.00%			
Percent area of private land?	0.00%			
Percent area with unstable slopes?	2.29%			
Percent area with erodable soils?	2.29%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 11
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.80		
Index below H60	0.27		
1 Total Peak Flow Index	1.07	1.00	
2 Road density above H60	0.93 km/sq.km.	0.93	
3 Total road density (See note below)	2.23 km/sq.km.	0.74	1.00
Surface Erosion			
4 Roads on erodable soils	0.06 km/sq.km.	0.12	
5 Roads within 100 m of a stream	0.39 km/sq.km.	0.89	
6 Roads that are both of the above	0.00 km/sq.km.	0.00	
7 Active stream crossings	0.59 no./sq.km.	0.69	
8 Total road density (See note below)	2.23 km/sq.km.	0.83	0.86
Riparian Buffer			
9 Portion of stream logged?	0.40 km/km.	1.00	
10 Portion of fish bearing streams logged?	0.39 km/km.	0.78	1.00
Landslides			
11 Landslide density	0.00 no./sq.km.	0.00	
12 Roads on unstable slopes	0.00 km/sq.km.	0.00	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.00

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 11

Watershed area	5.11	sq.km.
Elevation of H60	1168	m.
ECA above H60	2.725	sq.km.
ECA below H60	1.364	sq.km.
Road length above H60	4.73	km.
Road length below H60	6.66	km.
Length of road on erodable soils	0.298	km.
Length of road within 100 m. of stream	2.018	km.
Length of road on erodable soils within 100 m. of stre	0	km.
Number of active stream crossings	3	
Total stream length	6.053	km.
Length of stream logged	2.441	km.
Total length of fish bearing streams	2.88	km.
Length of fish bearing streams logged	1.123	km.
Number of landslides	0	
Length of road on unstable slopes	0	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.80		
Index below H60	0.27		
1 Total Peak Flow Index	1.07	1.00	
2 Road density above H60	0.93 km/sq.km.	0.93	
3 Total road density	2.23 km/sq.km.	0.74	1.00
Surface Erosion			
4 Roads on erodable soils	0.06 km/sq.km.	0.12	
5 Roads within 100 m of a stream	0.39 km/sq.km.	0.89	
6 Roads that are both of the abov	0.00 km/sq.km.	0.00	
7 Active stream crossings	0.59 no./sq.km.	0.69	
8 Total road density	2.23 km/sq.km.	0.83	0.86
Riparian Buffer			
9 Portion of stream logged?	0.40 km/km.	1.00	
10 Portion of fish streams logged?	0.39 km/km.	0.78	1.00
Landslides			
11 Landslide density	0.00 no./sq.km.	0.00	
12 Roads on unstable slopes	0.00 km/sq.km.	0.00	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.00

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 12			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	28.32	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	0.517	sq.km.	*	
ECA below H60?	0.54	sq.km.	*	
Road length above H60?	25.911	km.	*	
Road length below H60?	26.28	km.	*	
Surface Erosion				
Length of road on erodable soils?	1.668	km.	*	
Length of road within 100 m. of stream?	16.853	km.	*	
Length of road on erodable soils within 100 m. of stream?	0.836	km.	*	
Number of active stream crossings?	22		*	
Riparian Buffer				
Total stream length?	35.918	km.	*	
Length of stream logged?	17.083	km.	*	
Total length of fish bearing streams?	27.69	km.	*	
Length of fish bearing streams logged?	13.602	km.	*	
Landslides				
Number of landslides?	2		*	
Length of road on unstable slopes?	0	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	100.00%			
Percent area of private land?	0.00%			
Percent area with unstable slopes?	2.98%			
Percent area with erodable soils?	2.98%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 12
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.03		
Index below H60	0.02		
1 Total Peak Flow Index	0.05	0.08	
2 Road density above H60	0.91 km/sq.km.	0.91	
3 Total road density (See note below)	1.84 km/sq.km.	0.61	0.54
Surface Erosion			
4 Roads on erodable soils	0.06 km/sq.km.	0.12	
5 Roads within 100 m of a stream	0.60 km/sq.km.	1.00	
6 Roads that are both of the above	0.03 km/sq.km.	0.15	
7 Active stream crossings	0.78 no./sq.km.	0.88	
8 Total road density (See note below)	1.84 km/sq.km.	0.66	0.94
Riparian Buffer			
9 Portion of stream logged?	0.48 km/km.	1.00	
10 Portion of fish bearing streams logged?	0.49 km/km.	0.98	1.00
Landslides			
11 Landslide density	0.07 no./sq.km.	0.35	
12 Roads on unstable slopes	0.00 km/sq.km.	0.00	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.35

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 12

Watershed area	28.32	sq.km.
Elevation of H60	1168	m.
ECA above H60	0.517	sq.km.
ECA below H60	0.54	sq.km.
Road length above H60	25.91	km.
Road length below H60	26.28	km.
Length of road on erodable soils	1.668	km.
Length of road within 100 m. of stream	16.85	km.
Length of road on erodable soils within 100 m. of stre	0.836	km.
Number of active stream crossings	22	
Total stream length	35.92	km.
Length of stream logged	17.08	km.
Total length of fish bearing streams	27.69	km.
Length of fish bearing streams logged	13.6	km.
Number of landslides	2	
Length of road on unstable slopes	0	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.03		
Index below H60	0.02		
1 Total Peak Flow Index	0.05	0.08	
2 Road density above H60	0.91 km/sq.km.	0.91	
3 Total road density	1.84 km/sq.km.	0.61	0.54
Surface Erosion			
4 Roads on erodable soils	0.06 km/sq.km.	0.12	
5 Roads within 100 m of a stream	0.60 km/sq.km.	1.00	
6 Roads that are both of the abov	0.03 km/sq.km.	0.15	
7 Active stream crossings	0.78 no./sq.km.	0.88	
8 Total road density	1.84 km/sq.km.	0.66	0.94
Riparian Buffer			
9 Portion of stream logged?	0.48 km/km.	1.00	
10 Portion of fish streams logged?	0.49 km/km.	0.98	1.00
Landslides			
11 Landslide density	0.07 no./sq.km.	0.35	
12 Roads on unstable slopes	0.00 km/sq.km.	0.00	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.35

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 13			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	26.67	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	0.0339	sq.km.	*	
ECA below H60?	1.183	sq.km.	*	
Road length above H60?	0.714	km.	*	
Road length below H60?	38.17	km.	*	
Surface Erosion				
Length of road on erodable soils?	3.123	km.	*	
Length of road within 100 m. of stream?	16.329	km.	*	
Length of road on erodable soils within 100 m. of stream?	1.981	km.	*	
Number of active stream crossings?	42		*	
Riparian Buffer				
Total stream length?	63.267	km.	*	
Length of stream logged?	10.197	km.	*	
Total length of fish bearing streams?	40.056	km.	*	
Length of fish bearing streams logged?	6.086	km.	*	
Landslides				
Number of landslides?	2		*	
Length of road on unstable slopes?	3.128	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	32			
Percent area of crown land?	92.86%			
Percent area of private land?	7.14%			
Percent area with unstable slopes?	18.88%			
Percent area with erodable soils?	18.88%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 13
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.00		
Index below H60	0.04		
1 Total Peak Flow Index	0.05	0.08	
2 Road density above H60	0.03 km/sq.km.	0.03	
3 Total road density (See note below)	1.46 km/sq.km.	0.49	0.20
Surface Erosion			
4 Roads on erodable soils	0.12 km/sq.km.	0.23	
5 Roads within 100 m of a stream	0.61 km/sq.km.	1.00	
6 Roads that are both of the above	0.07 km/sq.km.	0.37	
7 Active stream crossings	1.57 no./sq.km.	1.00	
8 Total road density (See note below)	1.46 km/sq.km.	0.49	1.00
Riparian Buffer			
9 Portion of stream logged?	0.16 km/km.	0.54	
10 Portion of fish bearing streams logged?	0.15 km/km.	0.30	0.54
Landslides			
11 Landslide density	0.07 no./sq.km.	0.37	
12 Roads on unstable slopes	0.12 km/sq.km.	0.39	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.37

Notes:
The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 13		
Watershed area	26.67	sq.km.
Elevation of H60	1168	m.
ECA above H60	0.034	sq.km.
ECA below H60	1.183	sq.km.
Road length above H60	0.714	km.
Road length below H60	38.17	km.
Length of road on erodable soils	3.123	km.
Length of road within 100 m. of stream	16.33	km.
Length of road on erodable soils within 100 m. of stre	1.981	km.
Number of active stream crossings	42	
Total stream length	63.27	km.
Length of stream logged	10.2	km.
Total length of fish bearing streams	40.06	km.
Length of fish bearing streams logged	6.086	km.
Number of landslides	2	
Length of road on unstable slopes	3.128	km.
Length of stream with logged banks and on slopes > 6	0	km.

	Indicator	Score	Hazard Index
Peak Flow			
Index above H60	0.00		
Index below H60	0.04		
1 Total Peak Flow Index	0.05	0.08	
2 Road density above H60	0.03 km/sq.km.	0.03	
3 Total road density	1.46 km/sq.km.	0.49	0.20
Surface Erosion			
4 Roads on erodable soils	0.12 km/sq.km.	0.23	
5 Roads within 100 m of a stream	0.61 km/sq.km.	1.00	
6 Roads that are both of the abov	0.07 km/sq.km.	0.37	
7 Active stream crossings	1.57 no./sq.km.	1.00	
8 Total road density	1.46 km/sq.km.	0.49	1.00
Riparian Buffer			
9 Portion of stream logged?	0.16 km/km.	0.54	
10 Portion of fish streams logged?	0.15 km/km.	0.30	0.54
Landslides			
11 Landslide density	0.07 no./sq.km.	0.37	
12 Roads on unstable slopes	0.12 km/sq.km.	0.39	
13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.37

OK

Data Entry Sheet - IWAP Version 1.03 - November 1995

Enter watershed data in column 1.
Read scores and hazard indices in columns 5 and 6 on next page.

	(1)	(2)	(3)	(4)
Watershed Name?	Coldwater 14			
Map units are in: (1=km. and sq.km.; 2=m. and ha.)	1			
Watershed area?	45.87	sq.km.	*	
Peak Flow and Surface Erosion				
Elevation of H60?	1168	m.		
ECA above H60?	4.2269	sq.km.	*	
ECA below H60?	0.9405	sq.km.	*	
Road length above H60?	29.074	km.	*	
Road length below H60?	64.84	km.	*	
Surface Erosion				
Length of road on erodable soils?	0.063	km.	*	
Length of road within 100 m. of stream?	31.297	km.	*	
Length of road on erodable soils within 100 m. of stream?	0	km.	*	
Number of active stream crossings?	69		*	
Riparian Buffer				
Total stream length?	89.74	km.	*	
Length of stream logged?	26.131	km.	*	
Total length of fish bearing streams?	72.551	km.	*	
Length of fish bearing streams logged?	20.339	km.	*	
Landslides				
Number of landslides?	1		*	
Length of road on unstable slopes?	0.063	km.	*	
Length of stream with logged banks and on slopes > 60%	0	km.	*	
Other Land Use and Watershed Characteristics				
Is there range use next to streams?	YES			
Is there mining close to streams?				
Is there ATV use close to streams?				
Hydrologic zone?	31			
Percent area of crown land?	87.39%			
Percent area of private land?	12.61%			
Percent area with unstable slopes?	1.58%			
Percent area with erodable soils?	1.58%			
Dominant bedrock geology?				
Is there a fisheries (DFO or MoE) thermal concern?				

Notes:
(2) Enter data in units shown in this column.
(3) An asterisk in this column indicates essential data for calculations.
(4) "err" message in this column indicates an inconsistency in the data.

All cells except B6..B44 are protected.

Calculation Sheet

Coldwater 14
Map units were identified as: km. and sq.km.

	Indicator	(5) Score	(6) Hazard Index
Peak Flow			
Index above H60	0.14		
Index below H60	0.02		
1 Total Peak Flow Index	0.16	0.26	
2 Road density above H60	0.63 km/sq.km.	0.63	
3 Total road density (See note below)	2.05 km/sq.km.	0.68	0.53
Surface Erosion			
4 Roads on erodable soils	0.00 km/sq.km.	0.00	
5 Roads within 100 m of a stream	0.68 km/sq.km.	1.00	
6 Roads that are both of the above	0.00 km/sq.km.	0.00	
7 Active stream crossings	1.50 no./sq.km.	1.00	
8 Total road density (See note below)	2.05 km/sq.km.	0.75	1.00
Riparian Buffer			
9 Portion of stream logged?	0.29 km/km.	0.97	
10 Portion of fish bearing streams logged?	0.28 km/km.	0.56	0.97
Landslides			
11 Landslide density	0.02 no./sq.km.	0.11	
12 Roads on unstable slopes	0.00 km/sq.km.	0.00	
13 Streams >60% and banks logged	0.00 km/sq.km.	0.00	0.11

Notes:

The calculations of scores for #3 and #8 above are slightly different.
This spreadsheet is based on the IWAP Guidebook dated September 1995.
However, the spreadsheet is subject to change. Please contact a Forest Service regional hydrologist to ensure that you are using the latest version.

Summary of Level 1Scores in the file IWAP103.XLS

Coldwater 14

Watershed area	45.87 sq.km.		Indicator	Score	Hazard Index
		Peak Flow			
Elevation of H60	1168 m.	Index above H60	0.14		
ECA above H60	4.227 sq.km.	Index below H60	0.02		
ECA below H60	0.941 sq.km.	1 Total Peak Flow Index	0.16	0.26	
Road length above H60	29.07 km.	2 Road density above H60	0.63 km/sq.km.	0.63	
Road length below H60	64.84 km.	3 Total road density	2.05 km/sq.km.	0.68	0.53
		Surface Erosion			
Length of road on erodable soils	0.063 km.	4 Roads on erodable soils	0.00 km/sq.km.	0.00	
Length of road within 100 m. of stream	31.3 km.	5 Roads within 100 m of a stream	0.68 km/sq.km.	1.00	
Length of road on erodable soils within 100 m. of stre	0 km.	6 Roads that are both of the abov	0.00 km/sq.km.	0.00	
Number of active stream crossings	69	7 Active stream crossings	1.50 no./sq.km.	1.00	
		8 Total road density	2.05 km/sq.km.	0.75	1.00
Total stream length	89.74 km.	**Riparian Buffer**			
Length of stream logged	26.13 km.				
Total length of fish bearing streams	72.55 km.	9 Portion of stream logged?	0.29 km/km.	0.97	
Length of fish bearing streams logged	20.34 km.	10 Portion of fish streams logged?	0.28 km/km.	0.56	0.97
		Landslides			
Number of landslides	1	11 Landslide density	0.02 no./sq.km.	0.11	
Length of road on unstable slopes	0.063 km.	12 Roads on unstable slopes	0.00 km/sq.km.	0.00	
Length of stream with logged banks and on slopes > 6	0 km.	13 Streams >60% and banks logge	0.00 km/sq.km.	0.00	0.11

OK

Appendix 2

Coldwater River Watershed
Overview of the FisheriesResources
by
Coast Environmental Services Ltd.

COLDWATER RIVER WATERSHED:

OVERVIEW OF THE FISHERIES RESOURCES

Prepared by:

Coast River Environmental Services Ltd.
1672 West 75th Avenue
Vancouver, B.C.
V6P 6G2

Prepared for:

Borrett Engineering Ltd.
5 - 970 Laval Crescent
Kamloops, B.C.
V2C 5P5

July 15, 1996

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Coldwater River has been documented as an important aquatic habitat for fish including both salmon and trout. The Coldwater watershed, like many areas of British Columbia, has been impacted by past timber harvesting practices and by other land use activities including agriculture, urbanization and linear corridor developments (ie. highways, pipelines, powerlines and railroads). In response to problems related to timber harvesting, Forest Renewal BC has implemented the Watershed Restoration Program (WRP). One of the primary goals of the WRP program is to restore and protect fisheries and aquatic resources in timber harvest areas. The first stage in restoring and protecting the fisheries resource is to document the existing condition of fish habitats and fish populations in the watershed so that the problems can be identified and solutions can be developed.

The purpose of this report is to use existing historical data to characterize the condition of the fisheries resource in the Coldwater watershed as outlined in the Level 1 Interior Watershed Assessment Procedure. In addition, this report identifies additional information required for collection during field programs (Level 1 and 2 fish habitat surveys) in order for specific restoration programs to be properly identified and designed.

2.0 METHODOLOGIES

All the information summarized in this report was obtained from data compiled during the review of relevant government and private sector reports as well as through interviews with representatives of the Ministry of Environment, Lands and Parks (MELP), the Department of Fisheries and Oceans (DFO), Environment Canada (EC) and Aboriginal Fisheries Councils. A reference list is provided in section 8.0.

All mapping was completed as per the guidelines outlined in the Watershed Restoration Technical Circular #8: Fish Habitat Assessment (Interim Methods) (MOELP/MOF, 1994) and in the Forest Practices Code of British Columbia Fish - Stream Identification Guidebook (FRBC, 1995).

3.0 GENERAL CHARACTERISTICS OF THE COLDWATER RIVER WATERSHED

3.1 Physical Characteristics of the Coldwater River and Major Tributaries

3.1.1 Coldwater River

Originating from the northeastern slopes of the Cascade Mountains, the Coldwater River flows northeast for approximately 95 km before it joins the Nicola River at Merritt (see Figure 1). The Coldwater has 85 mapped tributaries (56 intermittent streams and 24 permanent streams on 1:20,000 TRIM maps) and drains an area of approximately 914 km^2. The river can be generally characterized as being a relatively low to moderate gradient stream (average 0.6%) with a channel width between 2 and 25 metres. The Coldwater River passes through two major biogeoclimatic zones: the Interior Douglas Fir Zone in the middle and upper areas of the watershed, and the Ponderosa Pine/Bunch Grass Zone in its lower reaches between Kingsvale and Merritt (Wightman, 1979). Precipitation ranges from over 1,000 mm per year in the upper watershed to approximately 255 mm annually at Merritt. Major tributaries of the Coldwater which have been historically reported as being fish bearing include Midday, Voght, Brook, Bottletop, Juliet and July Creeks. Other major tributaries of the Coldwater which may be fish bearing include Godey, Kwinshatin, Castillion, Salem, Gillis, Kingsvale, Fig Lake, Shouz, Mine, and Little Douglas Creeks. The general physical characteristics of the Coldwater River and its major tributaries are summarized in Table 1.

3.1.1.1 Discharge, Temperature and Water Quality in the Coldwater River

Mean annual flow for the Coldwater between 1962 and 1994 was 8.2 m^3/s (see Figure 2). Peak discharge (freshet) in the Coldwater generally occurs between April and July while low flows occur during the summer months between July and September (see Figure 3). However, it must also be noted that very high flows have occurred on the Coldwater during winter months, especially over the last 20 years (see section 5.4). Mean maximum flood flows between 1968 and 1994 were 72 m^3/s (see Figure 4). Average minimal flows between 1962 and 1994 was 0.52 m^3/s (see Figure 5). Average, maximum and minimum discharge levels appear to be similar between reported years (1962-1994). All discharge data has been based on data collected at Water Survey of Canada Stations located at Merritt (WSC Station #08LG010).

Average mean water temperature of the Coldwater river has been calculated to be 6.6 °C (Sebastian, 1982). Scott and Olmsted (1985) measured daily maximum and minimum water temperatures at two different locations on the Coldwater between the months of April and June 1984. Average water temperature during these months was found to be 6.1 °C (see Table 2). Beniston et. al (1988) measured water temperatures on the Coldwater River through May to mid-September and found that late summer water temperatures ranged from 11.0 to 12.9 °C. Based on this data, it appears that excessive water temperatures are not a constraint to fish populations on the mainstem Coldwater.

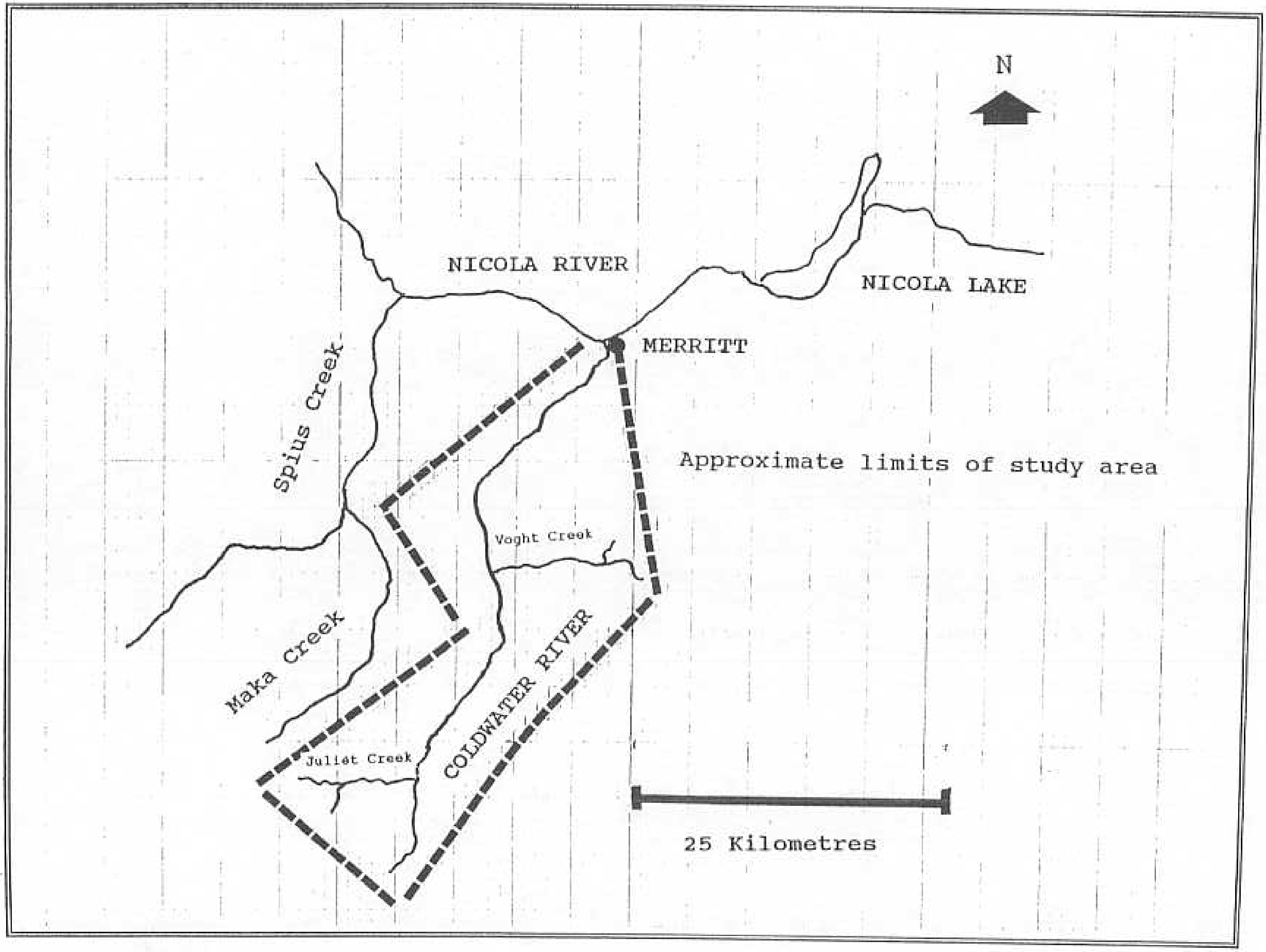

Figure 1. Map showing study area.

Table 1. General physical characteristics of the Coldwater River and its major tributaries.

River/Stream	Watershed Code #	Length (km)	Channel Width (m)*	Average Gradient	Fish Bearing**
Coldwater	02-2500-360	94.0	10-25	0.6 %	yes
Midday Creek	02-2500-240	11.1	8-12	2.8 %	yes
Voght Creek	02-2500-300	23.5	8-12	2.1%	yes
Brook Creek	02-2500-400	19.2	2-8	5.3%	yes
Bottletop Creek		4.0	1-4	3.0%	yes
Juliet Creek	02-2500-550	14.0	2-6	3.9 %	yes
July Creek		8.5	1-4	7.5 %	yes
Mine Creek		7.0	1-2	7.4 %	yes
Godey Creek		5.6		7.1%	unknown
Kwinshatin Creek	02-2500-150	3.1		3.8 %	unknown
Castillion Creek		4.5		11.5 %	unknown
Salem Creek		5.0	1-2	14.8%	unknown
Gillis Creek		4.0	1-2	8.5 %	unknown
Kingsvale Creek		6.5	1-2	12.3%	unknown
Fig Lake Creek		3.4	1-2	9.4%	unknown
Shouz Creek		3.6	1-2	8.3 %	unknown
Little Douglas Creek		2.8	1-2	4.3%	unknown

* Channel width - approximate range of widths at medium flows.

** Based on historical inventory data only (see section 4.0).

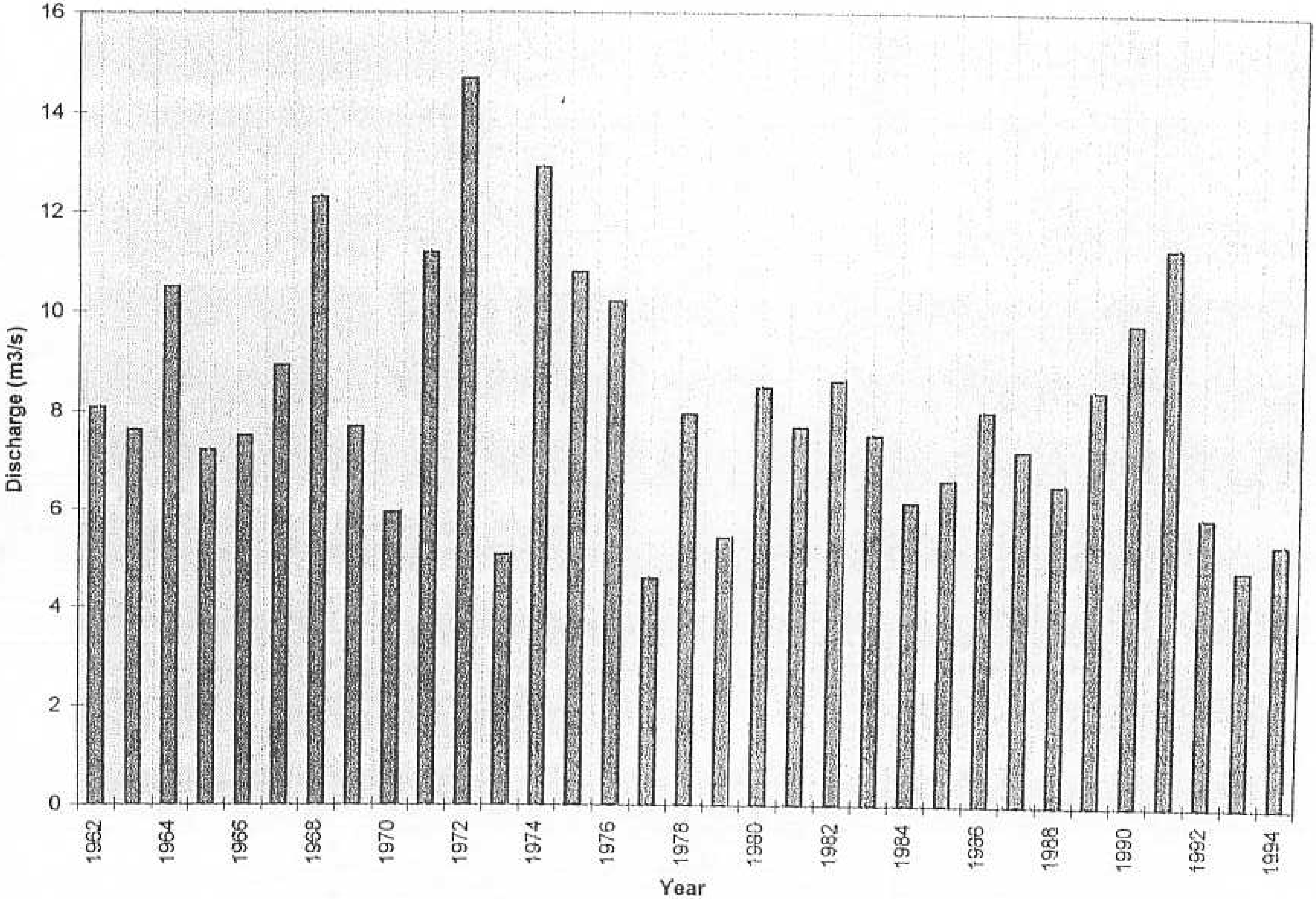

Figure 2. Average discharge in the Coldwater River between 1962 and 1994.

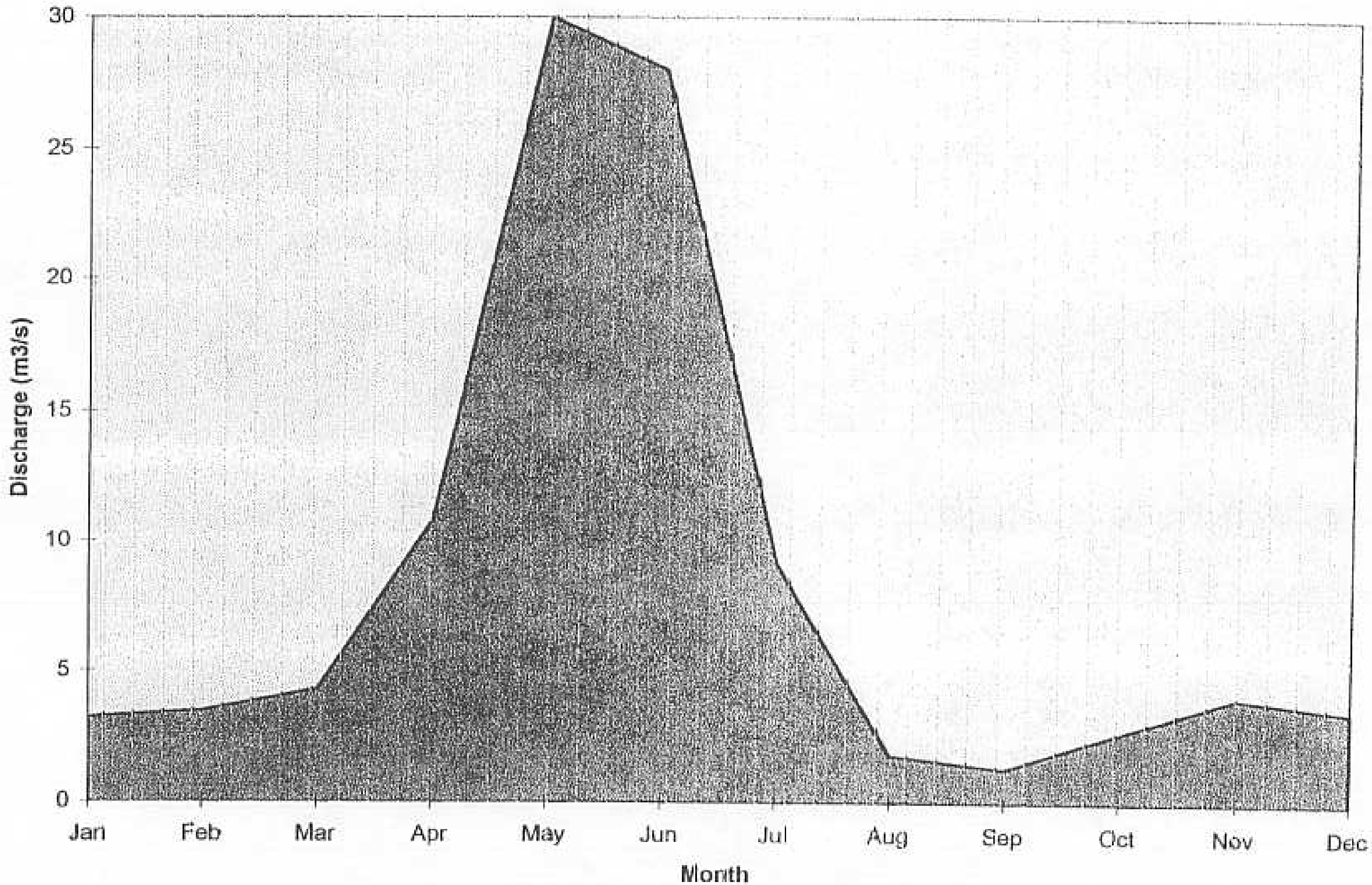

Figure 3. Average monthly discharge for the Coldwater River between 1962 and 1994.

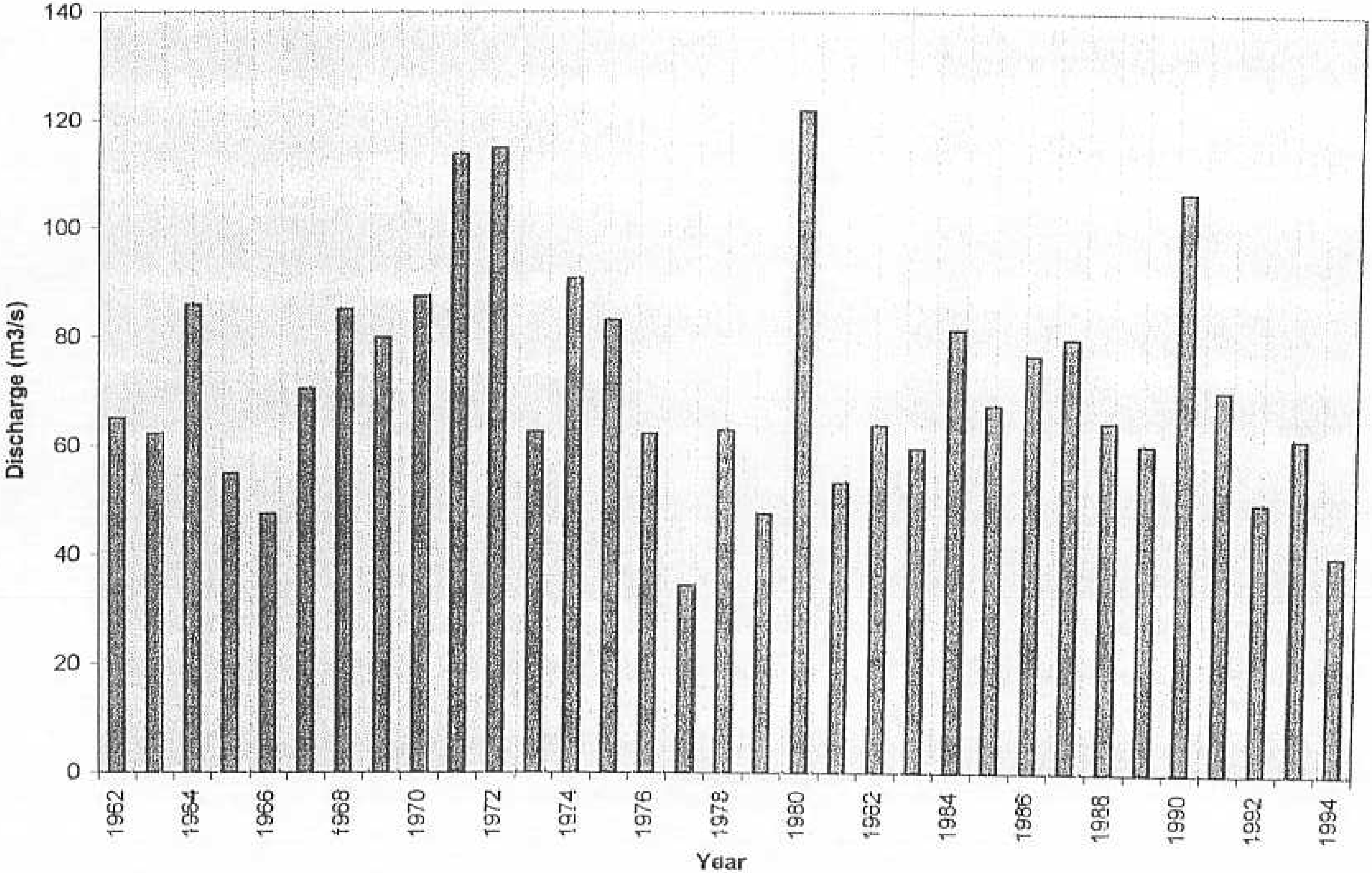

Figure 4. Maximum annual recorded discharge on the Coldwater River between 1962 and 1994.

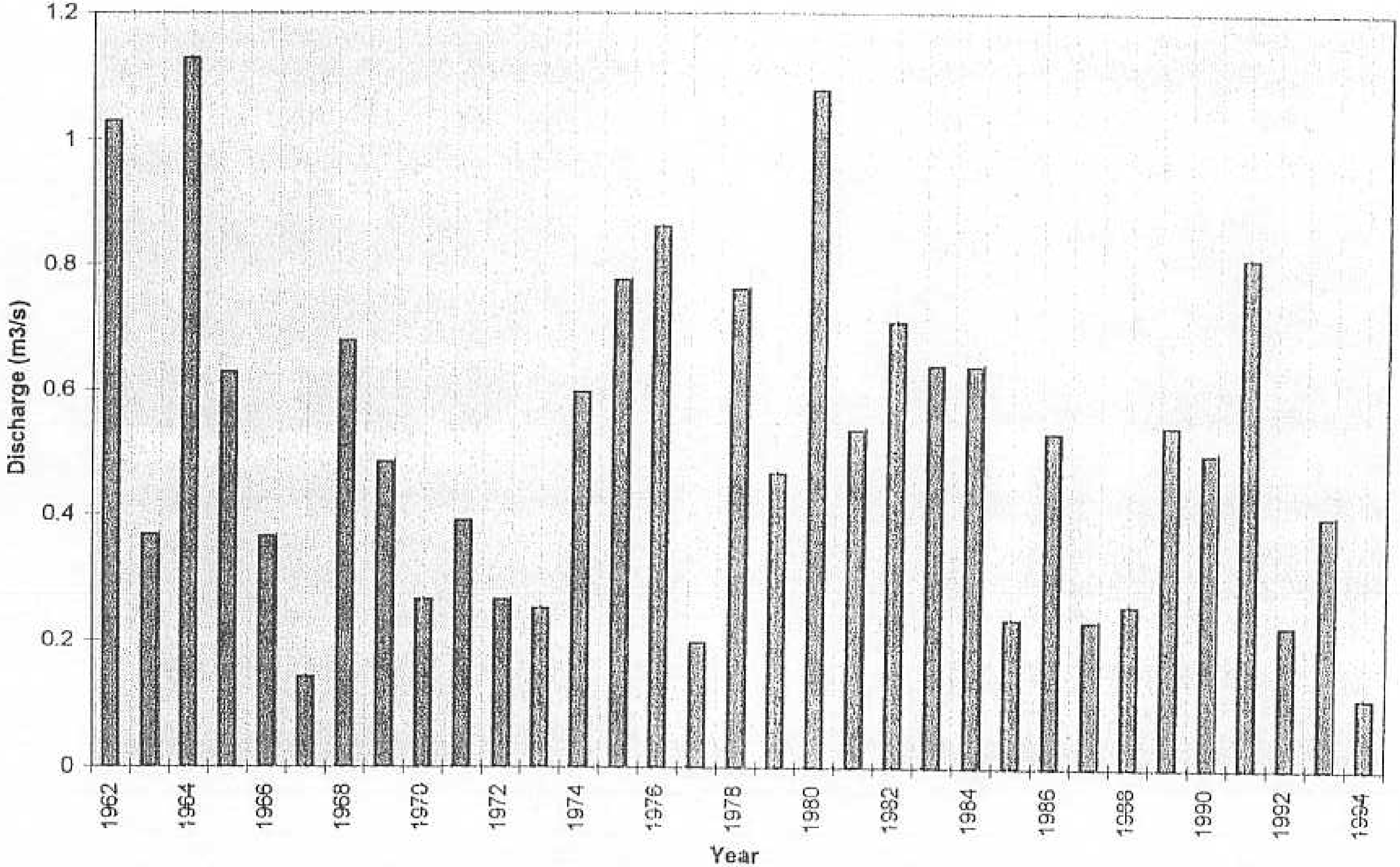

Figure 5. Minimum annual recorded discharge on the Coldwater River between 1962 and 1994.

A wide range of water quality parameters were analyzed by Scott and Olmstead (1985) in 1984 (see Appendix 1). They reported that the Coldwater River was slightly alkaline and turbid during their study period (spring run-off in 1984). The dominant ions were calcium, magnesium, silica and sodium. Nutrient levels were low with the exception of total phosphate which may be a result of agricultural run-off. Metal concentrations (aluminum, copper, iron and manganese) were reported to be high.

Table 2. Water temperatures (°C) on the Coldwater (April to June 1984). (Data from Scott and Olmsted, 1985).

Parameter	Coldwater River (near Kingsvale)			Coldwater River (15 km upstream from Merritt)		
	April	May	June	April	May	June
Maximum	--	10.0	9.5	12.0	13.0	12.5
Minimum	--	2.5	1.5	1.5	3.0	2.0
Mean	--	5.9	6.4	4.9	7.1	6.2

3.1.2 Midday Creek

Midday Creek enters the Coldwater approximately 25 km upstream of the Nicola - Coldwater confluence. Midday Creek flows in a south-west direction for approximately 11 km and has an average gradient of 1.4%. An irrigation dam and a reservoir located on Midday Creek approximately 2 km upstream of the Coldwater-Midday confluence has blocked upstream fish passage in the past. The present status of the irrigation dam and reservoir is unknown. A Ducks Unlimited water storage dam approximately 6 km upstream currently presents a barrier to fish passage. The substrates in the lower reach of Midday Creek are predominantly mud/silt with some sandy gravel patches (Wightman, 1979). Wightman (1979) also reported that Midday creek has extremely low flows during the summer months (eg. 0.002 m^3/s). More recent observations over the last several years have confirmed that Midday Creek runs almost completely dry in August and September (Neil Todd, NWSFA representative, pers. comm.).

3.1.3 Voght Creek

Voght Creek flows in an east to west direction and enters the Coldwater River at Kingsvale approximately 10 km upstream from the confluence of Midday Creek and the Coldwater River. Although, Voght Creek is approximately 23 km long, Wightman (1979) reported that only the first 0.85 km of the stream are accessible to fish migrating upstream due to an impassable waterfall. Wightman (1979) also reported that the stream typically has extremely low flows by early August as a result of irrigation water withdrawal for agriculture.

3.1.4 Brook Creek

Brook Creek flows in a westerly direction and joins the Coldwater River approximately 3 km upstream of Kingsvale. According to Wightman (1979), Brook Creek has two distinct reaches. The lower reach has a sand/silt substrate that extends from Brook Creek's confluence with the

Coldwater to a series of beaver dams approximately 3 km upstream. The upper reach is characterized by a steep gradient streambed with cobble/boulder substrates.

3.1.5 Bottletop Creek

Bottletop Creek flows in a south-east direction and enters the Coldwater approximately 58 km upstream of the Nicola-Coldwater Confluence. According to Wightman (1979), only 100 m to 125 m of the stream is accessible to fish migrating upstream from the Coldwater due to an impassable culvert. Further field investigations are required to verify if this culvert is still impassable.

3.1.6 Juliet - July Creeks

Juliet and July Creeks combine to form one of the largest tributaries to the mainstem Coldwater. Both streams have relatively steep gradients and predominantly cobble/boulder substrates (Wightman, 1979). Despite being relatively steep, Wightman (1979) indicated that the streams are "stepped" and thus pose no serious barriers to upstream fish passage. Very little is known about flow levels in this system; however, Juliet and July Creeks are reported to contribute high levels of silt to the Coldwater during rain events (Neil Todd, NWSFA representative, pers. comm.).

3.1.7 Mine Creek

Mine Creek flows in an easterly direction and enters the Coldwater approximately 7 km upstream of Juliet Creek. According to Wightman (1979), only the lower 2 km of this tributary is accessible to fish migration due to a series of impassable falls and cascades. Substrates below the falls have been reported to be highly consolidated. Mine Creek may also flow subsurface below the falls during the summer months of some years (Neil Todd, NWSFA representative, pers. comm.).

3.1.8 Godey Creek

Godey Creek flows in a north-west direction and enters the Coldwater approximately 4 km upstream of the Nicola-Coldwater confluence. Godey Creek is 5.6 km long and has an average gradient of 7.1%. Flow and substrate characteristics of Godey Creek are unknown. Based on gradient criteria alone, the creek may be fish bearing.

3.1.9 Kwinshatin Creek

Kwinshatin Creek flows in a north-west direction and enters the Coldwater approximately 12 km upstream of the Nicola-Coldwater confluence. Kwinshatin Creek is approximately 3.1 km long with an average gradient of 3.8%. Flow and substrate characteristics of Kwinshatin Creek are unknown. Based on gradient criteria alone, the creek may be fish bearing.

3.1.10 Castillion Creek

Castillion Creek flows in a north-west direction and joins the Coldwater approximately 18 km upstream of the Nicola-Coldwater confluence. Castillion Creek is approximately 4.5 km long with an average gradient of 11.5%. Flow and substrate characteristics of Castillion Creek are unknown. Based on gradient criteria alone, the creek may have fish bearing sections.

3.1.11 Salem Creek

Salem Creek flows in an westerly direction and enters the Coldwater approximately 500 m north of the Midday-Coldwater confluence. Salem Creek is approximately 5 km long with an average gradient of 14.8%. Flow and substrate characteristics of Salem Creek are unknown. Based on gradient criteria alone, the lower sections of this creek may be fish bearing.

3.1.12 Gillis Creek

Gillis Creek flows from Gillis Lake in an easterly direction and enters the Coldwater approximately 1 km north of Kingsvale. Gillis Creek is approximately 4 km long and has an average gradient of 8.5%. Flow and substrate characteristics of Gillis Creek are unknown. Based on gradient criteria alone, this creek may be fish bearing.

3.1.13 Kingsvale Creek

Kingsvale Creek flows in an easterly direction and enters the Coldwater just south of Kingsvale. Kingsvale Creek is approximately 6.5 km long and has an average gradient of 12.3%. Flow and substrate characteristics of Kingsvale Creek are unknown. Based on gradient criteria alone, this creek may have fish bearing sections.

3.1.14 Fig Lake Creek

Fig Lake Creek flows in a north-east direction from Fig Lake and joins the Coldwater approximately 2 km south of the Kingsvale-Coldwater confluence. Fig Lake Creek is approximately 3.4 km long and has an average gradient of 12.3%. Flow and substrate characteristics of Fig Lake Creek are unknown. Based on gradient criteria alone, this creek may have fish bearing sections.

3.1.15 Shouz Creek

Shouz Creek flows east to west out of a series of lakes and joins the Coldwater approximately 3 km upstream of Kingsvale. Shouz Creek is approximately 3.6 km long and has an average gradient of 8.3%. Flow and substrate characteristics of Shouz Creek are unknown. Based on gradient criteria alone, this creek may be fish bearing.

3.1.16 Little Douglas Creek

Little Douglas Creek flows north out of a relatively large lake (Little Douglas Lake) and joins the Coldwater approximately 12 km upstream of the confluence of Mine Creek with the Coldwater. Little Douglas Creek is approximately 2.8 km long and has an average gradient of 4.3%. Flow and substrate characteristics of Little Douglas Creek are unknown. Based on gradient criteria and the fact that fish have been reported in Little Douglas Lake (Neil Todd, NWSFA representative, pers. comm.), this creek is expected to be fish bearing.

3.2 Land Use In The Coldwater Watershed

An assessment of resource uses in the Coldwater watershed was conducted by SIGMA Engineering for the Department of Fisheries and Oceans (DFO) and the Fraser River Environmentally Sustainable Development Task Force (FRESDTF) in 1991 for the Coldwater watershed. The results of this study are summarized in Table 3.

Table 3. A summary of land and resource use in the Coldwater watershed. (All data is from SIGMA, 1991).

Characteristic	Value	Comments
Watershed Area	915 km^2	
Population in watershed	4,750	1991 census
% non-forested area	5%	includes ice fields, treeless biogeoclimatic zones, lakes, rivers, agricultural development, urban areas, roads and hydro right of ways
% of watershed potentially forested	90%	the potential area of the watershed that could be forested
% of the forest with no visible logging history	60%	% of the forest in the watershed that appears untouched by logging in recent times
% farmland	1.04%	estimated for 1990
animal units per km^2	2.97	estimate of livestock population densities with in the watershed. One animal unit is the equivalent of one mature cow
highways (km)	58	the length of highway in the watershed (Coquihalla)
railways (km)	46	the length of railways in the watershed (no longer used)
power lines (km)	33	the length of power lines in the watershed
pipelines (km)	38	the length of pipelines in the watershed
number of recreational sites	10	includes fishing lodges and resorts
provincial parks	1	Coldwater Provincial Park

3.3 Division of the Coldwater River into Homogeneous Reaches

The mainstem of the Coldwater was divided into reaches based on gradient and channel width. Figure 6 illustrates that the river's gradient, from its confluence with the Nicola (elevation 600 m), to the 1200 m contour line is remarkably uniform at approximately 0.6%. The upper few kilometres of the Coldwater are significantly steeper (see Figure 6). Therefore, based on gradient criteria, the Coldwater can be divided into two distinct reaches (see Figure 6).

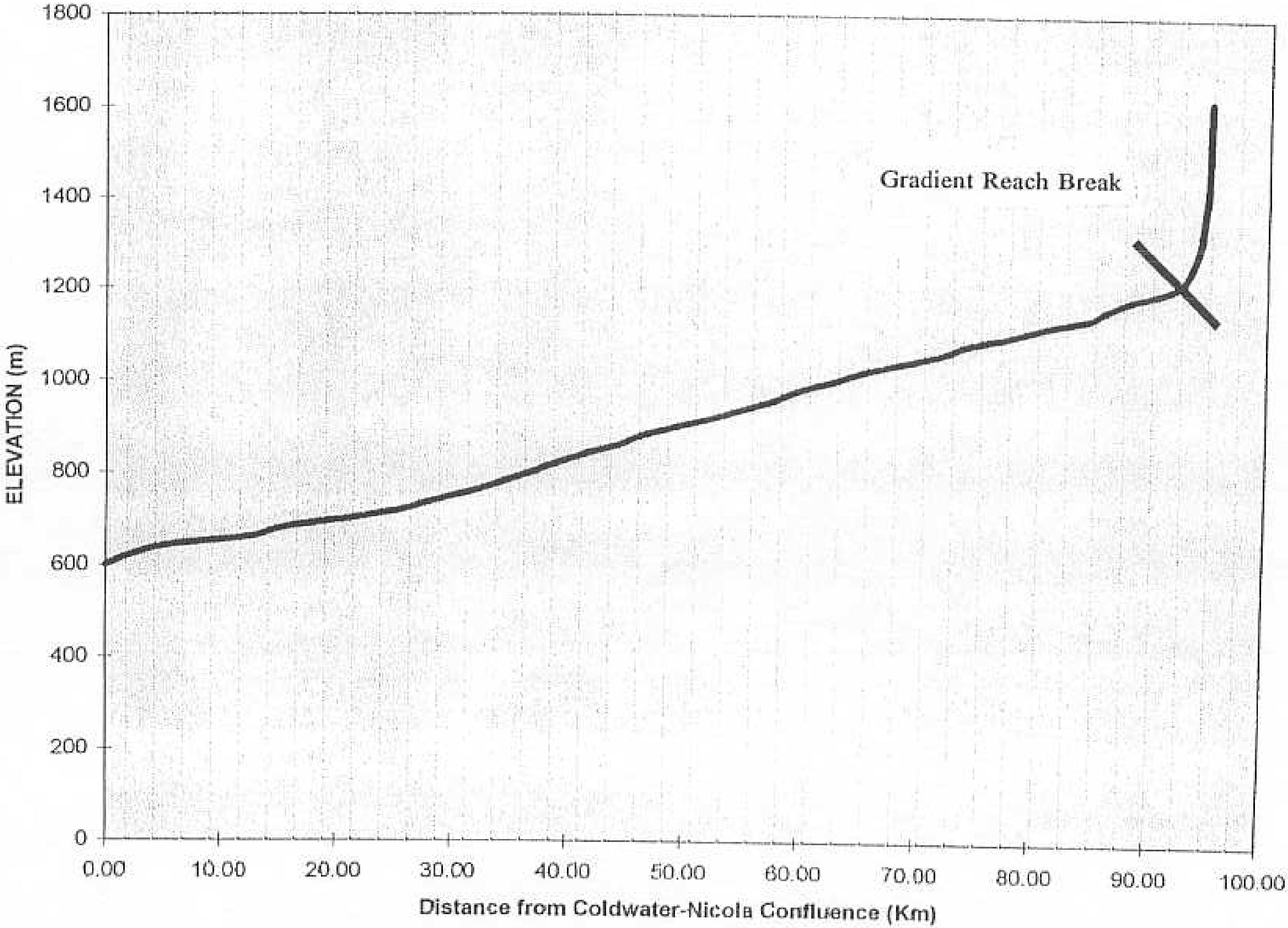

Figure 6. Graph showing gradient of the Coldwater River.

The Coldwater can be further divided into reaches based on channel size and characteristics. Most notably are the doubling of the Coldwater's channel width at its confluence with Juliet Creek and a canyon section located immediately downstream from Brodie (see Figure 7).

Juliet Creek is the largest tributary to the Coldwater and its discharge effectively doubles the size of Coldwater River. The only canyon on the Coldwater mainstem lies north of Brodie. The Coldwater flows through the canyon for approximately 7 km. The canyon section of the river is characterized by drop pools while most other areas of the Coldwater are characterized by long sections of riffles.

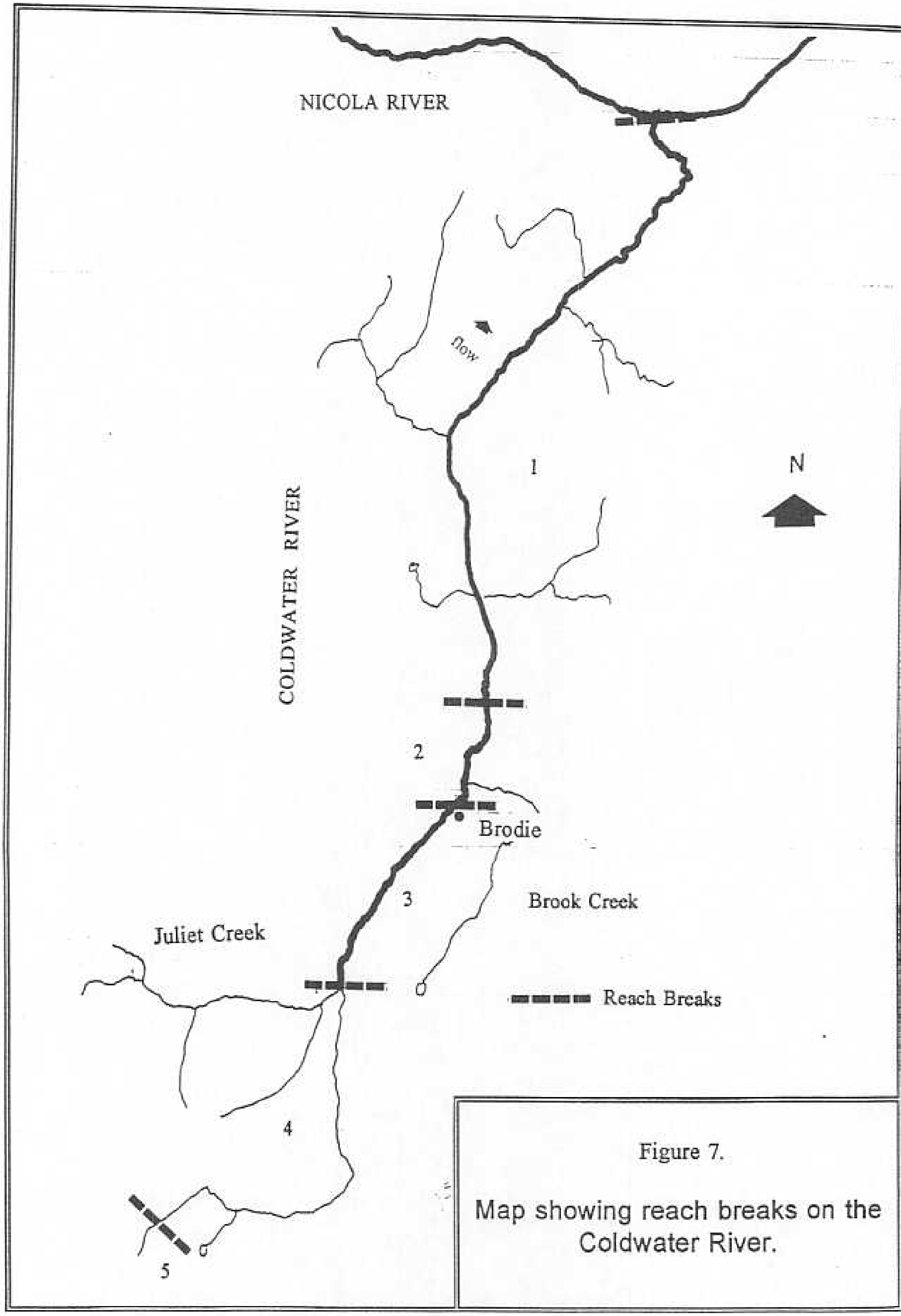

Figure 7.

Map showing reach breaks on the Coldwater River.

4.0 FISH ABUNDANCE AND DISTRIBUTION IN THE COLDWATER WATERSHED

The following species of fish have been reported in the Coldwater Watershed (Wightman, 1979; Sebastian and Yaworski, 1984; Scott and Olmsted, 1985):

a) Coho Salmon (*Oncorhynchus kisutch*)
b) Chinook Salmon (*O. tshawytscha*)
c) Rainbow Trout/Steelhead (*O. mykiss*)
d) Bull Trout (*Salvelinus confluentus*)/Dolly Varden Char (*S. malma*)
e) Mountain Whitefish (*Prosopium williamsoni*)
f) Longnose Dace (*Rhinichthys cataractae*)
g) Prickly Sculpin (*Cottus asper*)
h) Pacific Lamprey (*Lampetra tridentata*)
i) River Lamprey (*Lampetra ayresi*)
j) Western Brook Lamprey (*Lampetra richardsoni*)

Historical population data, species distribution, life history, timing and habitat preferences for each species are presented below.

4.1 Coho Salmon

Population Abundance and Distribution

Coho salmon (juveniles and adults) are found throughout the Coldwater River (Sebastian and Yaworski, 1984; Scott and Olmsted, 1984) but are principally found in the Coldwater upstream from Midday Creek (Sebastian and Yaworski, 1984). Coho have also been reported on the lower reaches of Juliet, Voght, Midday and Bottletop Creeks (Wightman, 1979). Approximately 10,000 coho per year are out-planted to upper Voght Creek under the Spius Creek Hatchery program (Neil Todd, NWSFA representative, pers. comm.).

Historical data for coho populations of the Coldwater River are summarized in Table 4 and in Figure 8. The mean escapement rates for coho over a 41 year period (1953-1994) is 1321 fish (SISS, 1992; DFO, 1995). Coho escapement rates on the Coldwater over the last five years (mean of 2800 fish) has been generally higher than those reported in the previous 10 to 15 years (see Figure 8). This is believed to be a direct result of the coho enhancement program (see section 6.2). Late summer populations of juvenile coho ranged from 34,000-125,000 in the Coldwater between 1980 and 1983 (Sebastian and Yaworski, 1984).

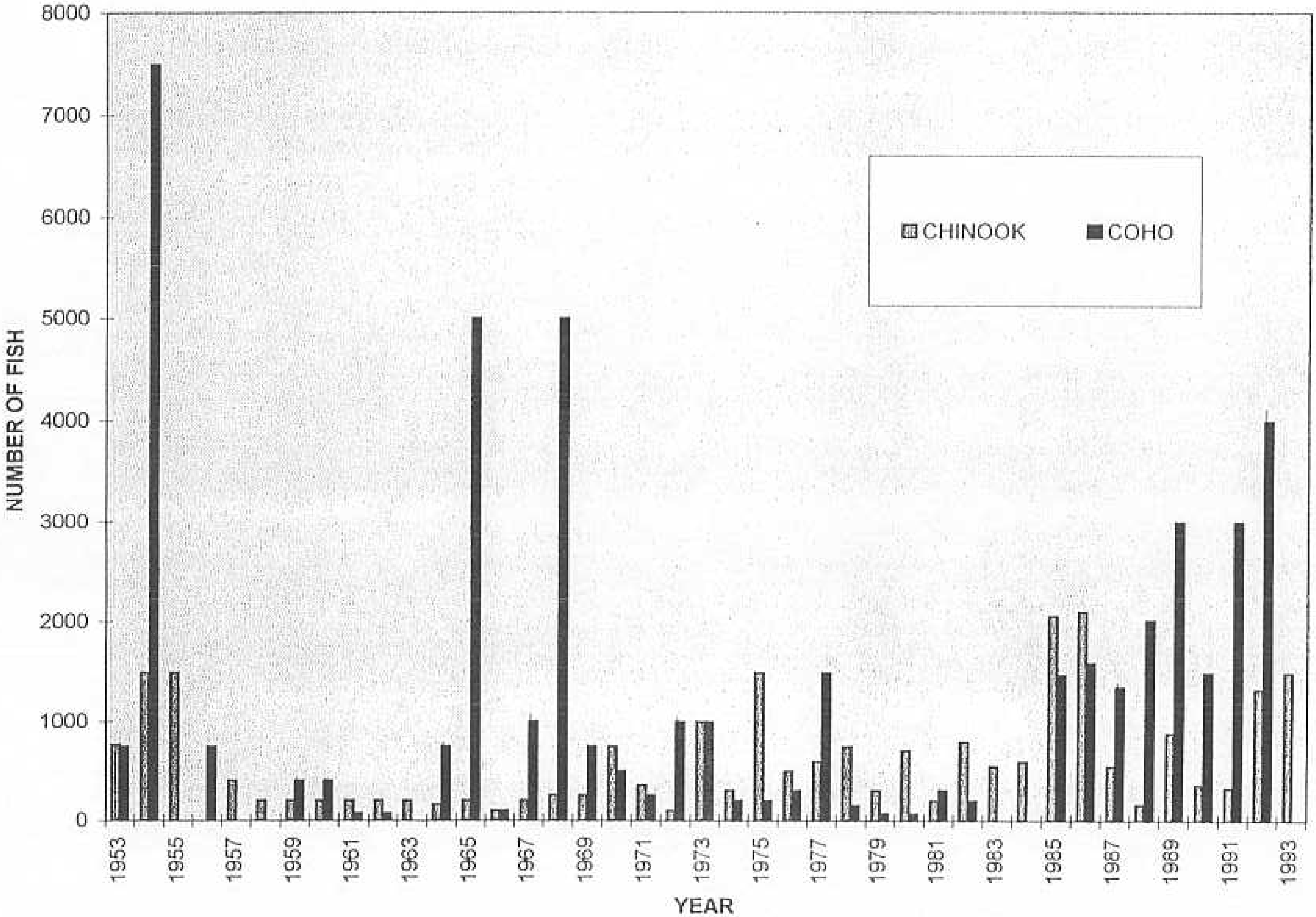

Figure 8. Escapement numbers for coho and chinook salmon between 1953 and 1994.

Timing

Coho salmon enter the Coldwater from mid-September through late November. Spawning commences in October and extends throughout November, with the peak of spawning occurring about mid-November (Harding et.al., 1981; Scott and Olmsted, 1984). Depending on stream flows and weather conditions, coho may also enter the Coldwater as late as early December and spawn throughout the month (Neil Todd, NWSFA representative, pers. comm.). Coho fry emerge from the gravel in early May, usually peaking by mid-May (Harding et. al., 1981; Scott and Olmsted, 1984). The fry spend the remainder of the summer and the following winter in the stream. In the spring the smolts migrate to the ocean where they spend 1.5 years, returning as 3 year old adults.

Stream Habitat Preferences in the Coldwater

Coho fry generally prefer low velocity areas associated with stream margins in small sidechannels, backchannels and ponds. Coho fry overwinter in the deeper areas of ponds and wetlands in low velocity areas adjacent to debris piles, logs, root-wads and undercut banks as well as within beaver dams. Rearing of coho is reported to mostly take place on the upper Coldwater River above Brodie where this type of habitat is abundant (Sebastian, 1982; Scott and Olmsted, 1984). Recent observations suggest that coho fry also rear in the Kingsvale to Midday Creek area (Neil Todd, NWSFA representative, pers. comm.). Sebastian and Yaworski (1984) suggested that the best opportunities for coho enhancement on the Coldwater were to out-plant fry above Brodie to increase habitat utilization and to protect coho rearing and refuge areas (sidechannels, backchannels, ponds and oxbows) from channelization. Highway and pipeline encroachments along the Coldwater and its tributaries have adversely impacted habitat capability for juvenile coho production in the watershed.

According to Harding et. al. (1981), coho spawn throughout the Coldwater River system including the headwater regions. Scott and Olmsted (1984) reported that the majority of coho spawning occurs on the Coldwater mainstem between Kingsvale and Juliet Creeks. Significant coho spawning does, however, occur upstream from Juliet Creek beyond Little Douglas Creek (Neil Todd, NWSFA representative, pers. comm.). It has also been suggested that very limited coho spawning occurs in the tributaries of the Coldwater (Neil Todd, NWSFA representative, pers. comm.).

Table 4. Population data for coho salmon of the Coldwater River.

Population Parameter	Number	Source
Mean annual escapement (1953-1994)	1321	SISS (1992), DFO (1995)
Juvenile population estimate for 1980	125,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1981	79,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1982	34,400	Sebastian and Yaworski (1984)
Juvenile population estimate for 1983	114,000	Sebastian and Yaworski (1984)

Table 5. Life history timing for coho salmon of the Coldwater River.

Life History	Timing	Source
Adult immigration	Mid-September through early December	Scott and Olmsted (1984) Neil Todd (pers. comm.)
Spawning	October-December (peak mid-November)	Harding et. al. (1981) Scott and Olmsted (1984)
Emergence	late April to early May	Harding et. al. (1981) Scott and Olmsted (1984)
Rearing	1 year	Harding et. al. (1981)
Juvenile emigration	May-June	Scott and Olmsted (1984)

4.2 Chinook

Population Abundance and Distribution

Chinook salmon are reported to spawn throughout the Coldwater River system (Scott and Olmsted, 1984). Late summer populations of juvenile chinook were estimated to be between 50,000 and 224,000 between 1980 and 1983 (Sebastian and Yaworski, 1984; see Table 5). DFO (SISS, 1992; DFO, 1995) reported a mean annual escapement rate of 613 chinook over a 41 year period (1953-1994). A chinook spawner count was undertaken in 1994 by the Nicola Watershed & Stewardship Fisheries Authority (NWSFA). Based on data collected between Emcon Maintenance Yard (upstream of the Highway 5 crossing) and the Coldwater IR #1 bridge, the NWSFA estimated a spawner escapement count of 253 fish. In 1995, the count was 680 adult fish.

Barry Rosenberger (Fisheries Manger, Kamloops Area, DFO) has also suggested that Nicola chinook, which are also known as "late" chinook, may spawn in the Coldwater River between Midday Creek and the mouth of the Coldwater. While the Nicola stock spawns during mid-September, the Coldwater chinook finish spawning by the end of August. Neil Todd (NWSFA representative, pers. comm.) has observed that the Nicola chinook generally do not migrate far up the Coldwater except during years of high abundance, when they may travel as far upstream as IR #1 or Midday Creek.

Juvenile chinook have also been documented on the lower reaches of Voght Creek and Bottletop Creek (Wightman, 1979).

Timing

Chinook salmon enter the Coldwater River from late June through to mid-September, with spawning occurring from early August to late September (Harding et.al., 1981; Scott and Olmsted, 1984). The fry emerge from the gravel in late April and rear in the stream for one year before migrating to the ocean in spring (May to July) as one year old smolts. This chinook stock spends two years in the ocean before returning to spawn.

Stream Habitat Preferences in the Coldwater

Chinook fry prefer low velocity areas and are thus found along the stream margins and within backwater areas on the Coldwater. As chinook fry increase in size, they may be found in deeper and faster areas of the main river channel. In the Coldwater River, this shift in habitat preference generally occurs in mid-August when the fish are between 55 to 66 mm in length (Harding et.al., 1981). Overwintering habitat for chinook on the Coldwater is believed to be amongst debris jams and within the interstitial spaces of large boulders and cobble (Harding et. al., 1981).

Table 6. Population data for chinook salmon of the Coldwater River.

Population Parameter	Number	Source
Spawner escapement count (1994)	253	NWSFA (1995)
Mean annual escapement (1953-1994)	613	SISS (1992)
Juvenile population estimate for 1980	50,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1981	5,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1982	47,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1983	224,000	Sebastian and Yaworski (1984)

Table 7. Life history timing for chinook salmon of the Coldwater River.

Life History	Timing	Source
Adult immigration	May-July	Neil Todd (pers.comm)
Spawning	July-September	Harding et. al. (1981) Scott and Olmsted (1984)
Emergence	late April- early May	Harding et. al. (1981) Scott and Olmsted (1984)
Rearing	1 year	Harding et. al. (1981)
Juvenile emigration	May-July	Harding et. al. (1981) Scott and Olmsted (1984)

4.3 Steelhead/Rainbow Trout

Population Abundance and Distribution

The lower Coldwater River (below Kingsvale) is important for steelhead production (Sebastian, 1982). Population age structures and fry:parr biomass ratios over a four year sampling period between 1980 and 1983 suggest that the majority of juvenile rainbow trout in the lower reaches of the Coldwater are anadromous (75:25) (Sebastian and Yaworski, 1984). The proportion of resident fish relative to anadromous fish was found to increase in the upper reaches of the Coldwater (Sebastian and Yaworski, 1984). Steelhead have also been reported on the lower reaches of Brook, Midday, and Voght Creeks (MELP, 1995). Steelhead/rainbow juveniles have also been reported in Voght Creek and in beaver impoundments on Brook

Creek (Neil Todd, NWSFA representative, pers. comm.). The average escapement rate for steelhead on the Coldwater between 1990 and 1995 was 448 fish (see Table 8 and Figure 9). Estimates of steelhead and rainbow juveniles for 1980 to 1983 varied from 131,600 to 267,000 per year (Sebastian and Yaworski, 1984; see Table 8). According to Sebastian and Yaworski (1984), steelhead smolt production in the Coldwater River is relatively low compared to its calculated habitat capability.

Timing

Steelhead enter the Coldwater River between April and early June and spawn between early-May and mid-June (Harding et. al., 1981). Steelhead eggs remain in the gravel for 2 to 3 months and the fry typically emerge between mid- and late-July. The juveniles rear in the stream for up to 3 years before smolting and migrating to the ocean. Steelhead adults return to spawn after 2 to 3 years at sea. No information regarding multiple spawning for this steelhead stock was uncovered through our literature search.

Stream Habitat Preferences in the Coldwater

In general, steelhead juveniles prefer relatively high velocity areas with a coarse cobble/boulder substrate. When preferred habitats are not present, steelhead will use the head ends of pools, undercut banks and debris jams. According to Harding et. al. (1981), the highest densities of steelhead fry on the Coldwater are found downstream of Kingsvale.

Based on the location of fry emergence, Harding et. al. (1981) suggests that almost all of the steelhead spawning occurs downstream of Kingsvale. More recent observations suggest that in any given year, 80-90% of the adult steelhead population spawns in the Coldwater River between Kingsvale and the Nicola-Coldwater confluence (Steve Maricle, MELP, pers. comm.).

Table 8. Population data for steelhead/rainbow trout of the Coldwater River.

Population Parameter	Number	Source
Mean annual escapement (1990-1995)	448	MELP
Mean annual escapement (1979-1982)	316	Sebastian and Yaworski (1984)
Juvenile population estimate for 1980	267,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1981	131,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1982	218,000	Sebastian and Yaworski (1984)
Juvenile population estimate for 1983	205,000	Sebastian and Yaworski (1984)

Table 9. Life history timing for steelhead/rainbow trout of the Coldwater River.

Life History	Timing	Source
Adult immigration	April - June	Neil Todd (pers.comm) Harding et.al. (1981)
Spawning	May - June	Harding et.al. (1981)
Emergence	July	Harding et.al. (1981)
Rearing	2-3 years	Harding et.al. (1981)
Juvenile emigration	May -June	Scott and Olmsted (1984)

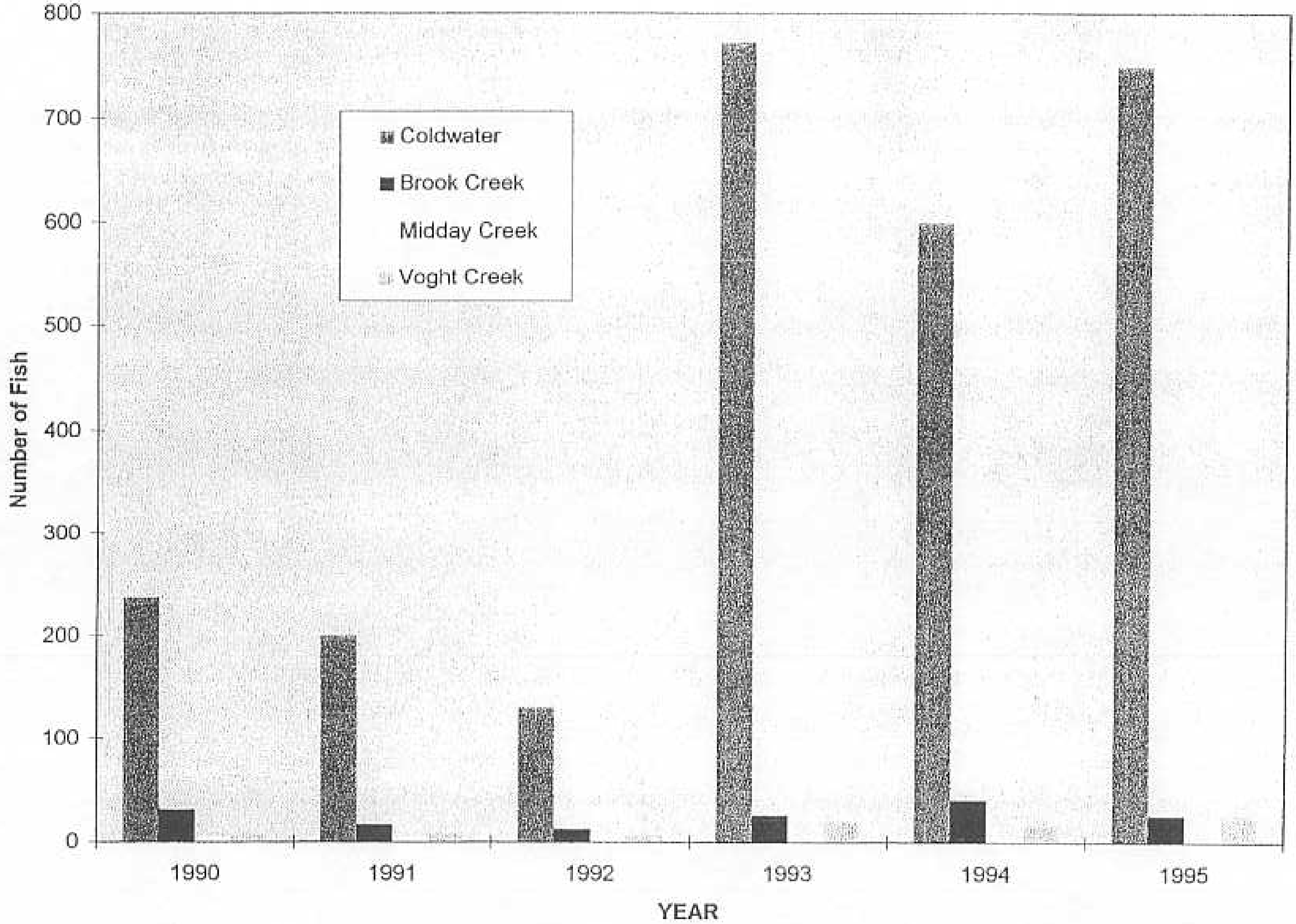

Figure 9. Escapement numbers for steelhead to the Coldwater River, Brook Creek, Midday Creek and Voght Creek between 1990 and 1995.

4.4 Bull Trout (Dolly Varden Char)

Dolly Varden char are found in the Coldwater River upstream of Midday Creek. Mean biomass densities of Dolly Varden char were reported to be 0.4 g/m^2 on the Coldwater River (Sebastian, 1982). According to Harding et. al. (1981), Dolly Varden spawn in the Coldwater in August and September and the fry emerge in April.

Juvenile bull trout occur in the Coldwater River near and above the confluence of Juliet Creek (Stephen Maricle, MELP, pers. comm.). We note that bull trout and Dolly Varden char cannot be effectively differentiated in the field. Given that bull trout are resident fish whereas Dolly Varden char are anadromous, historically what has been reported as Dolly Varden char on the Coldwater would be referred to today as bull trout.

4.5 Mountain Whitefish

According to Harding et. al. (1981), mountain whitefish are abundant throughout the Coldwater River system. No specific information on distribution, population size, spawning areas or timing was uncovered through our literature review.

4.6 Non-Salmonid Species

Bridgelip sucker (*Catostomus columbianus*) reportedly occur in the lower reaches of the Coldwater River in very low densities (0.5 to 1.5 g/m^2) (Sebastian, 1982). Similarly, the longnose dace is also found in the lower reaches of the Coldwater (<0.4 g/m^2; Sebastian, 1982). Prickly sculpin is believed to occur throughout the Coldwater system.

5.0 LIMITING FACTORS AND HABITAT CONCERNS FOR FISH

Fish populations and their distribution are limited in the Coldwater River by natural conditions (eg. gradient, geology, water temperature) as well as past anthropogenic activities and development. Based on information gathered from past reports and on discussions held with representatives from DFO, MELP and the NWSFA, the major limiting factors to fish production in the Coldwater appear to be:

- widespread substrate sedimentation and consolidation;
- lack of rearing habitat complexity in some areas;
- seasonal low flows in the lower Coldwater and in some tributaries;
- scouring of stream banks and stream beds by ice flows; and,
- loss of side and backchannel areas due to river training works, and abrupt river channel migration and bank destabilization.

5.1 Substrate Sedimentation and Consolidation

According to studies done in the late seventies and early eighties (Wightman, 1979; Harding et.al., 1981; and Sebastian, 1982), the majority of the substrates in the Coldwater River are highly consolidated. This condition is partially a result of the geological formations of the area which consist of glaciofluvial and lacustrine deposits containing a high percentage of fines. This geology combined with a relatively low river gradient has resulted in sedimentation and consolidation of the river's substrate. The abundance of fines in the river has also been attributed to increased soil disturbance from agriculture, logging, roads and pipeline construction. In particular, there is recent evidence of heavy sediment loading in both Juliet and July Creeks (Steve Maricle, MELP, pers. comm.).

Past stream studies have demonstrated that sedimentation of stream substrates can severely reduce salmonid spawning and incubation success, depress benthic invertebrate production and eliminate or diminish summer and particularly winter habitat for salmonids. In addition, salmonids require unconsolidated gravels for spawning. Gravel or coarse bed material embedded with fine gravels or sands becomes unsuitable for building nests (redds) and reduces water and gas exchange between developing eggs and interstitial water. Studies have also indicated that streams with unconsolidated sediment generally have a higher abundance of benthic insects than streams with consolidated substrates. Widespread sedimentation of the mainstem Coldwater may be limiting benthic production and thus food abundance for fish. Highly consolidated substrate in the Coldwater may also reduce over-wintering survival of juvenile salmonids. Salmonids like steelhead trout are known to overwinter underneath cobble and in between rocks. Bustard (1973) suggested that the ability of juvenile steelhead to enter relatively large, stable bed materials may be extremely important for steelhead over-winter survival.

Biophysical reconnaissance performed throughout the drainage by Wightman (1979), indicated that there are very few areas in the Coldwater system that have unconsolidated gravels with the exception of the lower mainstem canyon above Brookmere. Wightman (1979) suggested that the relatively narrow channel width at this location promotes annual scouring of bed materials during the freshet period.

Neil Todd (NWSFA representative, pers. comm.) has suggested that as a result of recent scouring from ice jams and winter floods, the stream bed on the lower Coldwater has been disturbed and appears to be less consolidated than reported in the past.

5.2 Rearing Habitat Complexity

Wightman (1979) indicated that one of the main factors that may be limiting salmonid production in the mainstem Coldwater is a lack of instream habitat diversity between Merritt and Kingsvale. The Coldwater River in this section consists mainly of long stretches of shallow riffle-glide habitat that lacks cover elements and deep pools.

5.3 Low Water Flows

Low water flows can occur in the Coldwater during poor snowpack years, during periods of low rainfall, and as a result of water withdrawal for agriculture (ie. irrigation).

According to Harding et. al. (1981), water withdrawal on the Coldwater causes two main problems for fish: (1) reduction of available rearing areas as a result of low water flows, and, (2) stranding of fish in irrigation ditches. The majority of the water withdrawals occur on the lower Coldwater below Kingsvale. Sebastian (1982) recommended that irrigation systems adjacent to the mainstem Coldwater be properly screened to prevent losses of emergent chinook and steelhead fry.

During low flow periods, rearing habitat in the middle and upper Coldwater is greatly reduced. Water levels in the wetlands and sidechannels, where a large portion of coho salmon rear, are dependant on discharge levels in the main stem. During low water years, many of the ponds and sidechannels completely dry up stranding and eventually killing fry which utilize this habitat.

Sebastian (1982) recommended that a study be undertaken to determine the feasibility of creating headwater storage and flow regulation on the Coldwater River.

5.4 Ice Flows

Annual peak discharge on the Coldwater River generally occurs in the spring (see Figure 3); however, run-off from large rain events during the winter can also cause high flow events in the Coldwater. Such events, if large enough, can cause the break up of the ice cover on the river and cause ice flows and ice jams. Large ice flows have been documented on the Coldwater during the winters of 1979, 1980, 1984, 1991 and 1995 (Doyle, 1988; Paul Doyle, MELP, pers. comm.). These ice flow events generally occur when a warm moist Pacific weather system moves into the interior following a period of cold weather and snow. The combination of rain and melting snow produces flows large enough to cause the break up of ice on the river. The ice blocks scour stream banks and stream beds causing severe erosion and often damaging river training structures (ie. riprap), water intakes and bridges (Doyle, 1988). In some instances, the ice flows jam causing local flooding and sediment deposition within the flood plain. Although not officially documented, these ice flow events are most certainly very damaging to fish and fish habitat. The scouring of the stream banks and stream beds by the ice can damage and destroy developing fish eggs, crush rearing fish, destroy riparian vegetation and destabilize bank and stream bottom sediments.

5.5 Loss of Sidechannel and Pond Habitat

Sidechannels and ponds adjacent to the Coldwater mainstem provide important habitat for coho salmon. It has been suggested that much of this habitat has been lost during railway construction, pipeline crossings and more recently, during the construction of the Coquihalla Highway.

In 1986, the British Columbia Ministry of Transportation and Highways (MOTH) completed construction of the Coquihalla Highway through the Coldwater River valley. The highway closely parallels the Coldwater river for nearly 39 km between Henning Bridge (the fist bridge crossing east of Coquihalla lakes) and Kingsvale. The construction of the highway required six river crossings (bridges), three river diversions as well as several encroachments into the river channel (Beniston et.al., 1987). In addition, Juliet and Mine Creeks were also affected by channelization and diversion respectively. In general, river diversions and bridge construction required extensive armouring along the Coldwater River banks. At each bridge site, the river was also channelized for some distance upstream and downstream. In response to the anticipated loss of fish habitat on the Coldwater system, MOTH installed structures in the river mainstem and developed a number of compensatory rearing channels adjacent to the main river. In particular, a large off-channel habitat called the Zoltan Kuun Channel (81,000 m^2) was constructed (see section 6.3).

5.6 Abrupt River Channel Migration and Bank Destabilization

The Coldwater River is subject to rapid channel migration and bank destabilization between Kingsvale and the Nicola confluence, especially downstream of Midday Creek. This is a result of several factors which include the following:

- stability of the riparian area has been compromised by the removal of natural vegetation and its replacement with agricultural fields; and,

- high flows (ie. spring freshet and fall/winter freshets (rain on snow events) combined with ice jams appear responsible for the severe channel shifts and failing stream banks, particularly in areas of poor riparian cover. The high flows are undoubtedly due to extreme weather conditions; however, significantly reduced forest canopy in some portions of the upper reaches and tributaries would aggravate this problem.

The abrupt channel shifts and bank failures can negatively affect fish in the following ways:

- bank failures can result in heavy downstream sedimentation which can suffocate developing eggs and clog the interstitial spaces of cobble and gravel substrates compacting these substrates and reducing the quality of spawning and overwintering habitat;
- excessive substrate and bank movement can cause the physical destruction of eggs, alevins, juvenile fish and benthic invertebrates; and,
- abrupt shifts of the river channel can result in the dewatering of areas where spawning took place (killing eggs or stranding fry).

The above limiting factors affect fish at various stages of their life cycle. Table 10 summarizes the effects of each limiting factor by life history stage.

Table 10. Summary of limiting factors on the Coldwater by life history stage.

Limiting Factors	Location of Limiting Factor	Description of Limiting Factor	Species Most Affected
Upstream Migration			
Passage Barriers	Midday Creek - 2 km upstream of Midday-Coldwater confluence	Irrigation dam presents a migration barrier.	all species
	Voght Creek - 0.85 km upstream of Voght-Coldwater confluence	Large natural waterfall.	all species
	Bottletop Creek - 125 m upstream of Bottletop-Coldwater confluence	Impassable culvert.	all species
Low Water Levels	Coldwater, Midday Creek, Voght Creek	Extreme low flows due to low snowpacks and high agricultural water withdrawals.	chinook
Spawning and Incubation			
Consolidated Substrates	watershed	Substrates consolidated by fines reduce spawning habitat quality.	all species
Ice Jams	lower Coldwater	Ice scours bottom substrates destroying redds.	all species
Abrupt River Channel Migration and Bank Destabilization	lower Coldwater	Dewaters spawning areas and produces sediment.	all species
Low Flows	Coldwater, Midday Creek, Voght Creek	Low flows may expose summer spawning chinook redds.	chinook
Summer Rearing			
Low flows	Coldwater and tributaries	Reduces habitat availability and complexity.	all species (coho)
Consolidated Substrates	watershed	Reduces benthos production and thus food availability for fish.	all species
Winter Rearing			
Loss of Ponds and Sidechannel	Coldwater	Important over-wintering habitat for coho.	coho
Ice Jams	lower Coldwater	Can injure or kill overwintering fish.	all species

6.0 PREVIOUSLY IDENTIFIED RESTORATION OR ENHANCEMENT PROJECTS

6.1 Fish Production

Based on field investigations conducted in 1981 and 1982, Sebastian (1982) identified several opportunities to improve fish production on the Coldwater. Sections 6.1.1 through 6.1.3 summarize his recommendations by fish species.

6.1.1 Steelhead

Sebastian (1982) estimated the potential production of steelhead smolts on the Coldwater by comparing the "carrying capacity" of other similar streams. He concluded that there was a potential to double the steelhead smolt production on the Coldwater River (See Table 10) by taking the following steps in order of priority:

1) maintain adequate flows in the Coldwater (minimum flows of 1.42 m^3/s);
2) fry stocking;
3) increase water storage capacity and control release rates; and,
4) develop on-site fry production facilities.

6.1.2 Chinook

Sebastian (1982) also suggested that chinook smolt populations could be doubled on the Coldwater system through enhancement opportunities in the following priorities:

1) fry stocking;
2) maintain adequate flows in the Coldwater (minimum flows of 1.42 m^3/s);
3) increase water storage capability and control release rates; and,
4) develop on-site fry production facilities.

6.1.3 Coho

Sebastian (1982) indicated that there are extensive areas of excellent rearing habitat for coho on the Coldwater that appeared under-utilized. However, due to low juvenile coho populations on the Coldwater during his study period, he was unable to estimate potential coho production through enhancement opportunities. He recommended the following steps to increase coho populations on the Coldwater:

1) fry stocking;
2) maintain adequate flows in the Coldwater (minimum flows of 1.42 m^3/s); and,
3) develop on site fry production facilities.

6.2 Stocking Enhancements

A steelhead stock enhancement program has been in effect on the Coldwater River from 1978 through to 1995. This program was discontinued by the Provincial Government in 1996. The program consisted of an annual release of approximately 100-120,000 steelhead fry in September of each year (Neil Todd, NWSFA representative, pers. comm.). It is not known if this program was beneficial as no comprehensive monitoring or evaluation programs were undertaken.

A coho and chinook stock enhancement program was implemented in 1984 by DFO. The early run component of the Coldwater chinook has been enhanced using two different smolt release strategies (0+ and 1+ age at release). The yearling (1+) strategy has yielded positive results and has been further strengthened through an imprinting program undertaken by the Nicola Watershed Stewardship and Fisheries Authority (NWSFA). Approximately 60,000 chinook are released each year (Neil Todd, NWSFA representative, pers. comm.).

The coho enhancement program includes both fry and smolt releases. Both strategies have yielded positive results. The fry release strategy is considered to have the highest benefit-to-cost ratio and, as such, is now being emphasized. Approximately 120-150,000 fry are released each spring (Neil Todd, NWSFA representative, pers. comm.).

6.3 Instream Enhancement Projects

The Coldwater First Nation has invested some effort toward bank stabilization using tree revetments on IR1. The current status of these works is unknown. The NWSFA has also carried out bank stabilization work on IR2 using rip rap treatments. DFO constructed a spawning and fry rearing/refuge channel near Juliet Creek in association with Trans-Mountain Pipeline.

During the construction of the Coquihalla Highway, the Coldwater River was disturbed or impacted at numerous sites (see section 5.5). To mitigate for these impacts, MOTH installed and/or created mitigative features at all significantly altered sites on the Coldwater (see Appendix 2).

Compensatory off-channel habitats were constructed at 5 separate sites: Juliet Creek, Bridge 3, near bridge 4 (Zoltan Kuun Channel), near Diversion 3 and at Bridge 5 (see Appendix 2). The rearing channels are groundwater fed and total approximately 12,000 m^2 in area (Beniston, 1988).

Instream rock features were installed at bridge sites and river diversion sites (see Appendix 2). Instream rock features installed along the river bank included large boulders, either placed singly or in clusters, and spurs (groins).

7.0 ADDITIONAL INFORMATION REQUIRED AND RECOMMENDATIONS FOR FIELD ASSESSMENTS

The following section provides an outline of additional information that is required to properly identify and design specific watershed restoration projects to protect or restore fish habitat in the Coldwater watershed. This section also summarizes the additional information that is required to properly classify the major streams in the watershed as outlined by the Forestry Practice Code.

7.1 Ground Truthing of Habitat Concerns

Numerous fish habitat concerns and limiting factors have been documented in the literature for the Coldwater River (see section 5.0). However, most of the studies that have documented fish habitat problems on the Coldwater were undertaken over 14 years ago. Discussions held with government personnel and NWSFA representatives have indicated that many of the events that have potentially altered the Coldwater, such as large winter floods, ice jams and the Coquihalla Highway construction project, have occurred since the majority of these studies were undertaken. It is therefore recommended that a fish habitat overview be conducted on the Coldwater to ground truth the habitat concerns outlined in this report. More specifically, the following issues need to be re-evaluated:

- the extent of substrate consolidation on the Coldwater;
- stream bank and bed stability;
- rearing habitat complexity between Merritt and Kingsvale; and
- the status of the sidechannel, off-channel and deep pool habitat along the Coldwater.

Specific habitat concerns on major tributaries to the Coldwater also need to be investigated further or ground truthed. These include the:

- status of an impassable culvert on Bottletop Creek;
- source or cause of recent heavy sedimentation on Juliet/July Creeks; and,
- cause of extremely low flows on Midday Creek and Voght Creek.

7.2 Further Identification of Fish Bearing Streams, Riparian Classes and Habitat Concerns

In general, there is a relatively good historical data base available to characterize and classify fish distribution and habitat concerns in the mainstem Coldwater. However, there is a lack of information about fish distribution and biophysical habitat characteristics for many of the Coldwater's tributaries. For example, very little is known about the following tributaries to the Coldwater that are potentially fish bearing, based on gradient analysis:

- Salem Creek
- Gillis Creek
- Kingsvale Creek
- Fig Lake Creek
- Little Douglas Creek
- Godey Creek
- Kwinshatin Creek
- Castillion Creek
- Shouz Creek

In addition, although known to be fish bearing, the limits of fish distribution in the following streams are generally not very well known or documented:

- Midday Creek
- Brook Creek
- Juliet Creek
- July Creek
- Mine Creek
- Bottletop Creek
- Voght Creek

We recommend that biophysical surveys be undertaken on the tributaries listed above to document their physical characteristics, to identify extent of fish distribution and to identify habitat concerns. Information required for each stream includes:

- flow characteristics;
- stream gradient;
- stream width;
- stream bank stability;
- riparian status;
- identification of fish barriers;
- fish habitat distribution (pools, cover);
- stream bed substrate types;
- water clarity and temperature; and,
- fish presence/absence (upper/lower limits).

The above information is required to classify the streams as outlined in the Forestry Practice Code and to better assess the need for restoration projects on these streams. As indicated in the Forestry Practice Code Fish Stream-Identification Guidelines (1995), the riparian classes should be identified concurrently with the determination of fish distribution. Riparian classification of the Coldwater mainstem from its headwaters to its confluence with the Nicola River should also be undertaken.

7.3 Research

One of the major problems within the Coldwater River watershed is the recurrent fall and winter flooding which can cause ice jams or ice flows that damage stream banks and bottoms. It is believed that these flood events may be occurring more frequently now than in the past (Neil Todd, pers. comm). Research needs to be conducted to determine if, in fact, winter flooding is occurring more frequently now than in the past. If this is the case, what the implications to fish and fish habitat are and what is causing the increased flooding can be determined. The possible causes of the increased flooding include:

- changing weather patterns (ie increased rainfall, warmer winters, etc.); and/or,
- altered surface water hydrology due to changing landscapes through timber harvesting, linear developments, agriculture or other land uses.

8.0 REFERENCES

Beniston, R.J., Dunford, W.E., and Lister, D.B. 1987. Coldwater River Juvenile Salmonid Monitoring Study - Year 1 (1986 - 87). D.B. Lister & Associates LTD. Prepared for Ministry of Transportation and Highways, Victoria, B.C. 130 pp.

Beniston, R.J., Dunford, W.E., and Lister, D.B. 1988. Coldwater River Juvenile Salmonid Monitoring Study - Year 2 (1987 - 88). D.B. Lister & Associates LTD. Prepared for Ministry of Transportation and Highways, Victoria, B.C. 269 pp.

Deleeuw, A.D. 1981. A British Columbia stream habitat and fish population inventory system. Fish and Wildlife Branch, Victoria, B.C.

Doyle, P.F. 1988. Damage resulting from a sudden river ice breakup. Canadian Journal of Civil Engineering. Vol 15:4: 609-615.

FRBC. 1995. Fish-stream Identification Guidebook. Forest Civic of British Columbia and BC Environment. 39 pp.

Harding, E., Kellerhals, R. and Miles, M. 1981. Hydrology and fisheries study of the Coldwater River (vols. 1-3). Prepared for Ministry of Transportation and Highways, Victoria, B.C.

Scott, K.J. and Olmsted, W.R. 1985. Migration of juvenile chinook and coho salmon and steelhead trout in the Nicola River drainage. Prepared for the Department of Fisheries and Oceans.

Sigma Engineering Ltd. 1991. Assessment of Resource Uses in the Thompson-Nicola Habitat Management Area. Prepared for the Department of fisheries and Oceans and the Fraser River Environmentally Sustainable Development Task Force. 28 pp.

Sebastian, D.C. 1982. Nicola Fisheries Assessment: Preliminary Enhancement Opportunities and Recommendations Based on 1980 Investigations. Fish Habitat Improvement Section, Fish and Wildlife Branch, Ministry of Environment.

Sebastian, D.C. and Yaworski, B.A. 1984. Summary of Nicola Fisheries Assessment, 1980-83. Fish Habitat Improvement Section, Fish and Wildlife Branch, Ministry of Environment.

MOELP/MOF. 1994. Watershed Restoration Technical Circular No.8. Watershed Restoration Program, Ministry of Environment, Lands and Parks and Ministry of Forests. 40 pp.

Wightman, J.C. 1979. Fish production characteristics of the Coldwater River drainage, with reference to construction of the Hope-Merritt Highway and enhancement opportunities under the Salmonid Enhancement Program. B.C. Ministry of Environment, Fish & Wildlife Branch, Victoria. 107 pp.

Appendix 1: Water Quality Data From Scott and Olmsted (1985)

Table 6. Results of chemical analyses of water quality samples, Spius Creek, Coldwater and Nicola River, April-June, 1984.
(underlined values exceed recommended limits)

Parameter	Recommended Levels*	Spius Creek 29/04	Spius Creek 20/05	Spius Creek 17/06	Coldwater River 29/04	Coldwater River 20/05	Coldwater River 17/06	Nicola River 29/04	Nicola River 20/05	Nicola River 17/06
pH	7.2 - 8.5	7.5	7.2	7.3	7.8	7.4	7.5	7.7	7.8	7.9
Hardness (as $CaCO_3$)	>20	35.8	25.2	18.6	50.1	39.9	28.8	95.8	84.0	82.7
Total Alkalinity (as $CaCO_3$)	>20	34.0	20.0	14.0	58.0	36.0	24.0	91.0	78.0	77.0
Conductivity (umhos/cm)	150 - 2000	81.0	51.1	35.5	127.1	84.2	58.6	213.2	184.0	123.0
Filterable Residue (mg/L)	<2000	72.0	54.0	38.0	90.0	69.0	42.0	144.0	128.0	121.0
Non-filterable Residue (mg/L)	<65	<5.0	56.0	14.0	8.0	326.0	137.0	18.0	84.0	108.0
Turbidity (FTU)	<60	0.4	20.0	5.0	0.3	50.0	28.0	3.1	28.0	32.0
Sulfate (SO_4) (mg/L)	<90	3.8	3.5	3.0	4.0	3.9	3.0	13.3	16.5	12.0
Total PO_4 (P) (mg/L)	<0.05	0.007	0.072	0.024	0.008	0.347	0.12	0.047	0.159	0.13
Nitrite (N) (mg/L)	<0.015	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrate (N) (mg/L)	<0.12	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.005	<0.005	<0.005
Ammonia (N) (mg/L)	<0.05	0.005	0.011	0.006	<0.005	00.006	0.010	0.005	0.005	0.010
Chloride (Cl) (mg/L)	<250	1.6	0.60	<0.5	1.0	0.70	0.5	<0.05	1.3	1.3
Fluoride (F) (ppm)	<1.0	0.03	0.03	<0.03	0.04	0.06	0.03	0.06	0.07	0.07
Aluminum (Al) (ppm)	<0.10	0.09	0.56	0.31	0.06	1.42	0.96	0.15	0.52	0.92
Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As) (ppm)	<1.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium (Ba) (ppm)	<1.0	0.015	0.023	0.011	0.03	0.069	0.036	<0.031	0.04	0.042
Beryllium (Be) (ppm)	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B) (ppm)	<1.0	<0.001	0.007	0.009	0.005	<0.001	0.016	<0.001	<0.001	<0.001
Cadmium (Cd) (ppm)	<0.0004	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Calcium (Ca) (ppm)	<200	10.7	7.6	5.0	18.4	12.5	8.9	27.0	20.8	21.6
Chromium (Cr) (ppm)	<0.040	<0.005	0.016	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005
Cobalt (Co) (ppm)	<0.01	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	0.006	<0.005
Copper (Cu) (ppm)	<0.005	<0.001	0.002	<0.001	0.001	0.007	0.002	0.002	0.005	0.002
Iron (Fe) (ppm)	<1.0	0.069	0.493	0.221	0.08	1.18	0.99	0.195	0.663	1.1
Lead (Pb) (ppm)	<0.004	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
Magnesium (Mg) (ppm)	<150	2.2	1.5	1.0	3.2	2.1	1.6	6.9	7.9	7.0
Manganese (Mn) (ppm)	<0.01	0.002	0.032	0.009	0.01	0.146	0.064	0.033	0.077	0.08
Mercury (Hg) (ppm)	<0.0002	<0.00005	<0.00005	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0000
Molybdenum (Mo) (ppm)	<0.01	<0.005	<0.005	<0.005	<0.001	<0.005	<0.005	<0.005	0.007	<0.005
Nickel (Ni) (ppm)	<0.045	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorous (P) (ppm)		<0.05	0.07	<0.05	<0.05	0.28	0.10	0.06	0.13	0.12
Potassium (K) (ppm)	<50	0.46	0.45	0.25	0.65	0.72	0.40	1.7	1.58	1.60
Selenium (Se) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silica (Si) (ppm)	<60	5.3	5.4	3.6	4.4	5.8	4.1	3.3	4.1	3.8
Sodium (Na) (ppm)	<50	2.4	1.1	1.2	2.7	1.3	1.2	5.7	5.3	5.3
Strontium (Sr) (ppm)		0.065	0.051	0.031	0.102	0.092	0.058	0.14	0.144	0.132
Tin (Sn) (ppm)		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Titanium (Ti) (ppm)		<0.002	0.017	0.005	<0.002	0.023	0.014	0.002	0.015	0.016
Vanadium (V) (ppm)		<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Zn) (ppm)	<0.05	0.006	<0.002	<0.002	0.006	0.004	0.003	0.009	<0.002	0.04

* from Sigma Environmental Consultants (1983)
U.S. Environmental Protection Agency (1976)

Appendix 2: Maps showing location of Coquihalla mitigation sites on the Coldwater River From Beniston et.al (1988).

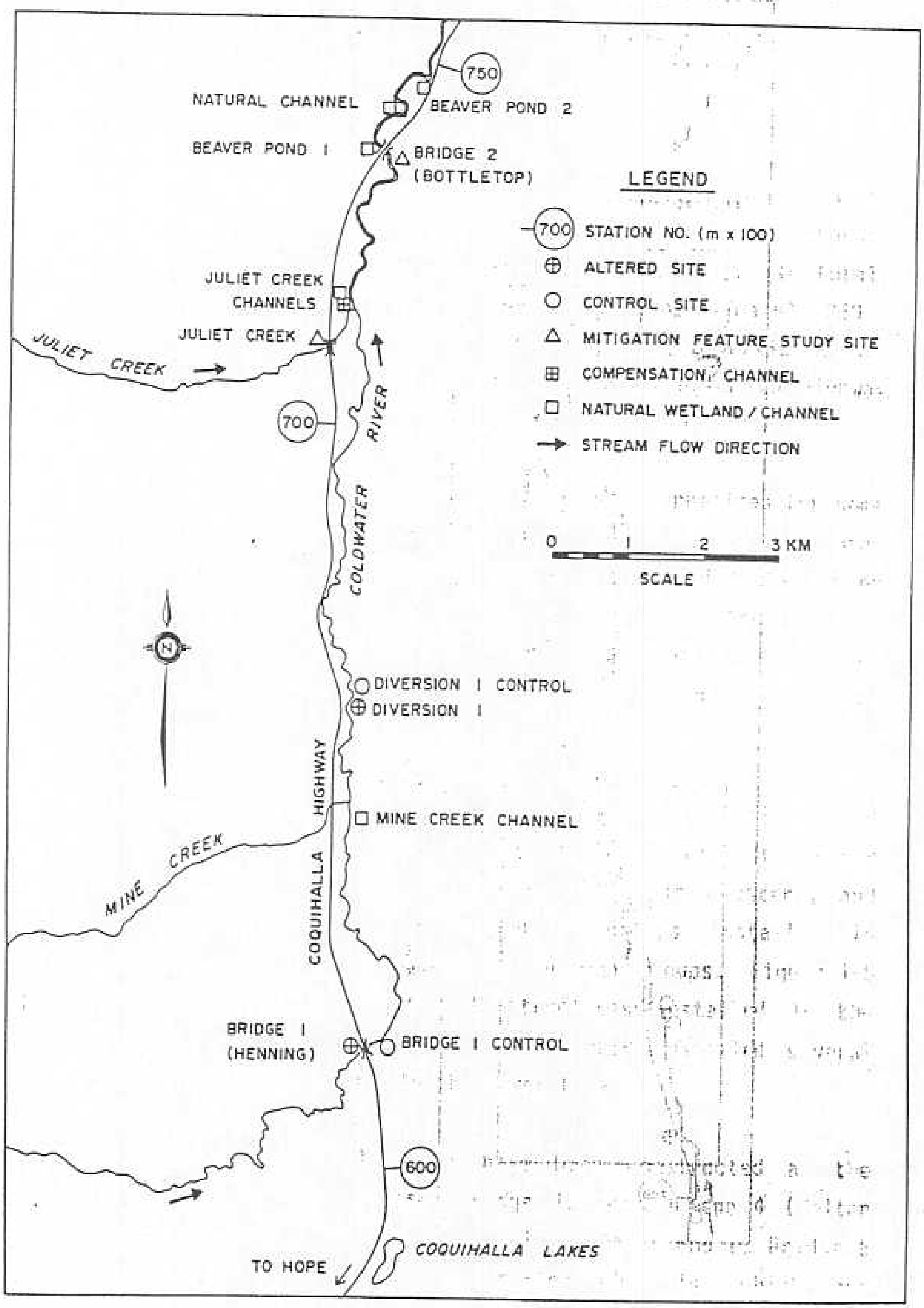

FIGURE 1-2A. Map of the upper section of the Coldwater River study area (Bridge 1 to Bridge 2), showing study site locations.

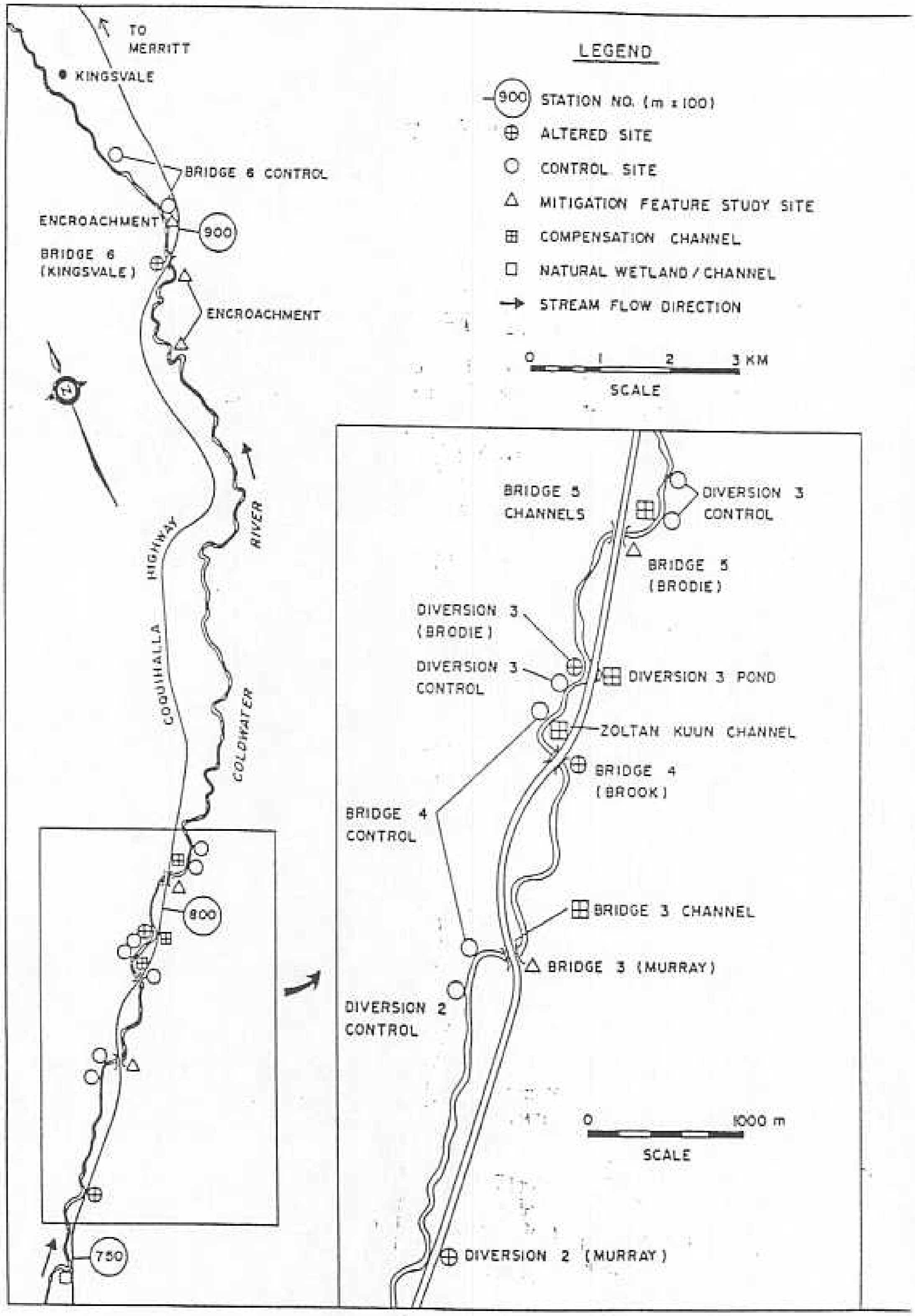

FIGURE 1-2B. Map of the lower section of the Coldwater River study area (Bridge 2 to Kingsvale), showing study site locations.

Appendix 3

Water Licenses
Brook Creek and Kwinshatin Creek

Water Rights Information System

WLIS2E00 Production

Client Water Licence Summary

Operator Id MAIRD

Client Number 008389

Client Name BROOKMERE WUC

Licence Number	Status	File Number	Purpose	Licenced Quantity	Units	Source Reference
C062998	CURRENT	0046437	WATERWORKS (OTHER)	43.500.000	GD	Brook Creek

------------ END OF REPORT WLIS2E00 ------------

	Priority Date	Licence Number		File Number	PUC	Quantity/Units	Licensee/Applicant
01	19230430	C040084	C	0309343	DOM	500.000 GD	MURRAY WILLIAM J & S
02	19230430	C040329	C	0309805	DOM	500.000 GD	BOND LORNE A & LINDA
03	19230430	C040334	C	0310828	DOM	500.000 GD	GOTT GARRIE N & ELLE
04	19230430	C040336	C	0310830	DOM	500.000 GD	JOHNSTON WILLIAM K &
05	19230430	C062998	C	0046437	WWKOT	43500.000 GD	BROOKMERE WUC
06	19230430	C062999	C	0355299	DOM	500.000 GD	ALBERT ROSS H & ANDE
07	19230430	C063000	C	0366129	DOM	500.000 GD	BOND LORNE A & LINDA
08	19230430	C063001	C	0366659	DOM	500.000 GD	BERG KENNETH
09	19230430	C063002	C	0370570	DOM	1000.000 GD	STRAND DOUG & BARBAR
10	19230430	C063003	C	0370571	DOM	500.000 GD	MURPHY JACK L & KATI
11	19230430	C063004	C	0370572	DOM	500.000 GD	MCCOOL GAEL B
12	19230430	C063005	C	0370573	DOM	500.000 GD	RICHARDSON BARBARA

	Priority Date	Licence Number		File Number	PUC	Quantity/Units	Licensee/Applicant
01	19230430	C063006	C	0370574	DOM	500.000 GD	NORMAN ANNE
02	19230430	C063553	C	0310827	DOM	500.000 GD	O'SULLIVAN M BERYL
03	19230430	F017295	C	0204737	DOM	500.000 GD	BUIS CHRISTOPHER A
04	19230430	F017297	C	0208731	DOM	500.000 GD	SCHOOL DISTRICT NO 5
05	19230430	F050532	C	0309346	DOM	500.000 GD	ROSE JOCELYN K
06	19230430	F050533	C	0309347	DOM	500.000 GD	PERCIVAL MATILDA L
07	19230430	F050534	C	0309349	DOM	500.000 GD	BENNETT NELLIE
08	19230430	F050535	C	0309350	DOM	500.000 GD	PARKHILL KIM
09	19230430	F050536	C	0309369	DOM	500.000 GD	JACKSON MICHAEL E
10	19230430	F050537	C	0310824	DOM	500.000 GD	BARBER EDWARD A & SH
11	19230430	F050538	C	0310825	DOM	500.000 GD	HARRISON ROGER D
12	19230430	F050539	C	0310826	DOM	500.000 GD	SANFORD BARRIE W

	Priority Date	Licence Number		File Number	PUC	Quantity/Units	Licensee/Applicant
01	19230430	F050540	C	0310829	DOM	500.000 GD	GOTT GARRIE N & ELLE
02	19230430	F050541	C	0328371	DOM	500.000 GD	ROGERS DIXIE L
03	19230430	F050542	C	0328610	DOM	500.000 GD	SANFORD BARRIE W
04	19230430	F050543	C	0329304	DOM	500.000 GD	JOHNSTON WILLIAM K &
05	19230430	F051112	C	0309352	DOM	500.000 GD	HENDRICKS VERNON V &
06	19230430	F051171	C	0309344	DOM	500.000 GD	BENNETT NELLIE
07	19230430	F051647	C	0309341	DOM	500.000 GD	MURRAY WILLIAM J & S
08	19230430	F063065	C	0309351	DOM	500.000 GD	HARRER MANFRED & SHE
09	19531209	F017294	C	0202380	DOM	500.000 GD	MURRAY WILLIAM J & S
10	19720310	F063066	C	0370635	IRR	6.000 AF	HARRER MANFRED & SHE
11	19880516	Z103134	Z	3001275	DOM	100.000 GD	BROWNLEE ORVAL D & S
12	19920624	Z105095	Z	3002292	DOM	500.000 GD	ESAU ALLAN D & ANNE

	Priority Date	Licence Number		File Number	PUC	Quantity/Units	Licensee/Applicant
01	19941003	Z108769	Z	3002798	DOM	500.000 GD	O'SULLIVAN M BERYL
02	19950714	Z109945	Z	3002963	DOM	1000.000 GD	MACDONALD HERRIOT &
03							
04							

Water Rights Information System

WLIS2E00 Production Client Water Licence Summary Operator Id MAIRD

Client Number 028355
Client Name COLDWATER INDIAN BAND
981-693-7197

Licence Number	Status	File Number	Purpose	Licenced Quantity	Units	Source Reference
C030077	CURRENT	0245176	IRRIGATION	40.000	AF	Lemoto Creek
						Oluk Creek
						Talapus Creek
F011230	CURRENT	0241033	IRRIGATION	205.000	AF	Coldwater River
F019456	CURRENT	0047607	IRRIGATION	91.700	AF	Skuagam Creek
F019457	CURRENT	0241033	IRRIGATION	165.400	AF	Kwinshatin Creek
F049866	CURRENT	0257313	WATERWORKS (OTHER)	5,000.000	GD	Kwinshatin Creek
F049867	CURRENT	0257312	WATERWORKS (OTHER)	2,500.000	GD	Skuagam Creek

------------ END OF REPORT WLIS2E00 ------------