Environment Canada
Conservation & Protection

Environnement Canada
Conservation et Protection

WATER AND RELATED RESOURCES IN THE UPPER KOOTENAY RIVER BASIN

PREPARED BY

JAN SHELTINGA
DEBORAH SHERWOOD

FEBRUARY 1988

Inland Waters and Lands
Pacific and Yukon Region
Vancouver , B.C.

ENVIRONMENT CANADA
CONSERVATION AND PROTECTION

WATER AND RELATED RESOURCES IN THE UPPER KOOTENAY RIVER BASIN

PREPARED BY
JAN SHELTINGA
DEBORAH SHERWOOD

INLAND WATERS AND LANDS
PACIFIC AND YUKON REGION
VANCOUVER, BRITISH COLUMBIA

FEBRUARY 1988

ABSTRACT

The Upper Kootenay River drains 20 000 square kilometres of southeastern British Columbia. Rising in the Rocky Mountains near Banff, Alberta the Upper Kootenay River flows south through Lake Koocanusa, crosses the international boundary into Montana, then swings northwest through Idaho before re-entering Canada. The Lower Kootenay River then flows north into Kootenay Lake and finally southwest from the lake to its confluence with the Columbia River near Trail, British Columbia.

Three distinct physiographic units dominate the topography of the Kootenay River Basin: the Rocky Mountains to the east, the Purcell Mountains to the west, and the Rocky Mountain Trench which runs north to south between the two. The climate is characterized by hot summers with sporadic rain showers and long, cold winters. Portions of the Basin lie in zones of relatively high snowfall. Streamflow generally peaks with snowmelt in May or June.

The Basin supports a variety of wildlife, particularly ungulates. Competition for habitat between big game and livestock has been exacerbated by the formation of Lake Koocanusa, as well as by increasing forestry and mining activities. Some of the Basin's headwater lakes and streams support good sport fisheries which are supplemented by an active stocking program. There are no anadromous fish in the Upper Kootenay River.

Mining provided the earliest economic activity in the Basin. A gold rush in the mid-1860's was followed by the discovery of sizeable lead, zinc and silver ore bodies. Today coal mining is the Basin's major economic activity, with further exploration and development expected in response to improved world market prices. Forestry is also important to the

regional economy: eight permanent sawmills are located in the Basin. Tourism and recreation, mostly revolving around summer water-based activities or wilderness experiences, are gaining in importance. Agriculture is limited to ranching within the Basin. Federal lands include several small Indian Reserves scattered through the southern portion of the Basin and Kootenay National Park to the north.

There are several areas of resource competition but most are the responsibility of the provincial government. Routine federal and provincial water monitoring programs should be adequate to detect changes in water quality and quantity within the Basin. At the present time, there are no apparent areas of concern for Inland Waters and Lands, although increased involvement in water resource management may be necessary in the future as the Kootenay is an international river.

RESUME

La partie supérieure de la rivière Kootenay draine une superficie de 20,000 kilomètres carrés de la région sud-est de la Colombie-Britannique. La rivière débute dans les montagnes Rocheuses près de Banff, en Alberta et s'écoule vers le sud, traversant le lac Koocanusa et la frontière de l'état de Montana. Ensuite, elle se dirige vers le nord-ouest, traversant l'état d'Idaho et pour enfin retourner en Colombie-Britannique. De là, elle est considérée comme la partie inférieure et coule vers le nord, traversant ainsi le lac Kootenay, puis tourne vers le sud-ouest pour rejoindre le fleuve Columbia près de Trail, en Colombie-Britannique.

La topographie du bassin est distinguée par trois unités physiographiques, dont les montagnes Rocheuses à l'est, les montagnes Purcell à l'ouest et la fosse Rocheuses. Cette dernière longe du nord au sud entre les deux chaînes de montagnes. Le climat se distingue par des étés chauds avec des averses sporadiques et des longs hivers froids. Il y a aussi des parties du bassin qui reçoivent un montant de neige relativement élevé. La crue maximum est atteinte généralement en mai ou en juin durant les fontes des neiges.

La faune de ce bassin est très variée, spécialement pour les animaux ongulés. Cependant la concurrence entre ces ongulés et le bétail pour l'habitat s'est aggravée avec la création du réservoir (lac) Koocanusa et aussi avec l'augmentation d'exploitation minière et de sylviculture. La partie supérieure de la rivière Kootenay n'a pas de poisson anadrome. Par contre, quelques-uns des lacs et des cours d'eau de tête du bassin soutiennent de bonnes pêches sportives et cette productivité est activement maintenue par un programme d'ensemencement.

L'exploitation minière fut la première à stimuler l'activité économique du bassin -- notamment par la ruée vers l'or de la mi-1860 -- suivi par des découvertes considérables de minerais de plomb, de zinc et d'argent.

Aujourd'hui c'est l'exploitation du charbon qui domine l'activité économique du bassin. On s'attend à une augmentation d'exploration et de développement, si le marché mondial s'améliore. La sylviculture est aussi importante pour l'économie de la région et on y trouve huit scieries. Le tourisme et le loisir deviennent plus importants et se composent surtout de divertissement aquatiques estivals et de randonnées à la découverte de la nature sauvage. L'agriculture se limite à l'élevage sur des ranchs. Le bassin a des terres fédérales dont plusieurs petites réserves indiennes éparpillées dans le sud du bassin et le parc national Kootenay au nord.

Il existe de la concurrence entre plusieurs domaines d'utilisation des ressources de ce bassin mais la plupart se trouve sous la jurisdiction provinciale. A propos de ce sujet, le programme fédéral et provincial de monitorage de routine d'eau devrait être suffisant pour discerner s'il y a des problèmes de qualité ou de quantité d'eau dans le bassin. En ce moment, les Eaux intérieures et terres n'a pas d'intérèt dans la gestion de ressource en eau pour ce bassin. Mais étant donné que la rivière Kootenay est une rivière internationale, il est possible que dans le futur, elle s'implique davantage.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

A. Study Area

The study area for this report is the Upper Kootenay River Basin in southeastern British Columbia, or, that portion of the Kootenay River Basin which drains the headwaters to the international boundary. The Lower Kootenay River Basin is the drainage area from the international boundary near Rykerts, British Columbia, to the Kootenay River's confluence with the Columbia River near Trail, British Columbia. The Lower Kootenay Basin will be described in a separate background report.

The Kootenay River originates in the Rocky Mountains approximately 65 kilometres west of Banff, Alberta, and flows in a southerly direction for approximately 300 kilometres. The river then widens to form Lake Koocanusa, a 148-kilometre reservoir created in 1972 by the construction of the Libby Dam in the United States and bisected by the international boundary. For the next 350 kilometres, the Kootenay River swings west then northwest through the States of Montana and Idaho, once again crossing the international boundary near Rykerts, British Columbia. The lower reaches of the Kootenay River flow into Kootenay Lake and southwest from the lake to the Columbia River near Trail, British Columbia (Figure 1).

The Upper Kootenay River Basin is bounded on the west and north by the Columbia River Basin, on the east by the Continental Divide and the Flathead River Basin, and on the south by the Clark Fork-Pend d'Oreille River Basin.

Its major tributaries are the Vermilion, White, Palliser, Lussier, St. Mary, Bull and Elk Rivers. The Upper Kootenay River has a drainage area of approximately 20 000 square kilometres at the international boundary (Canada 1985).

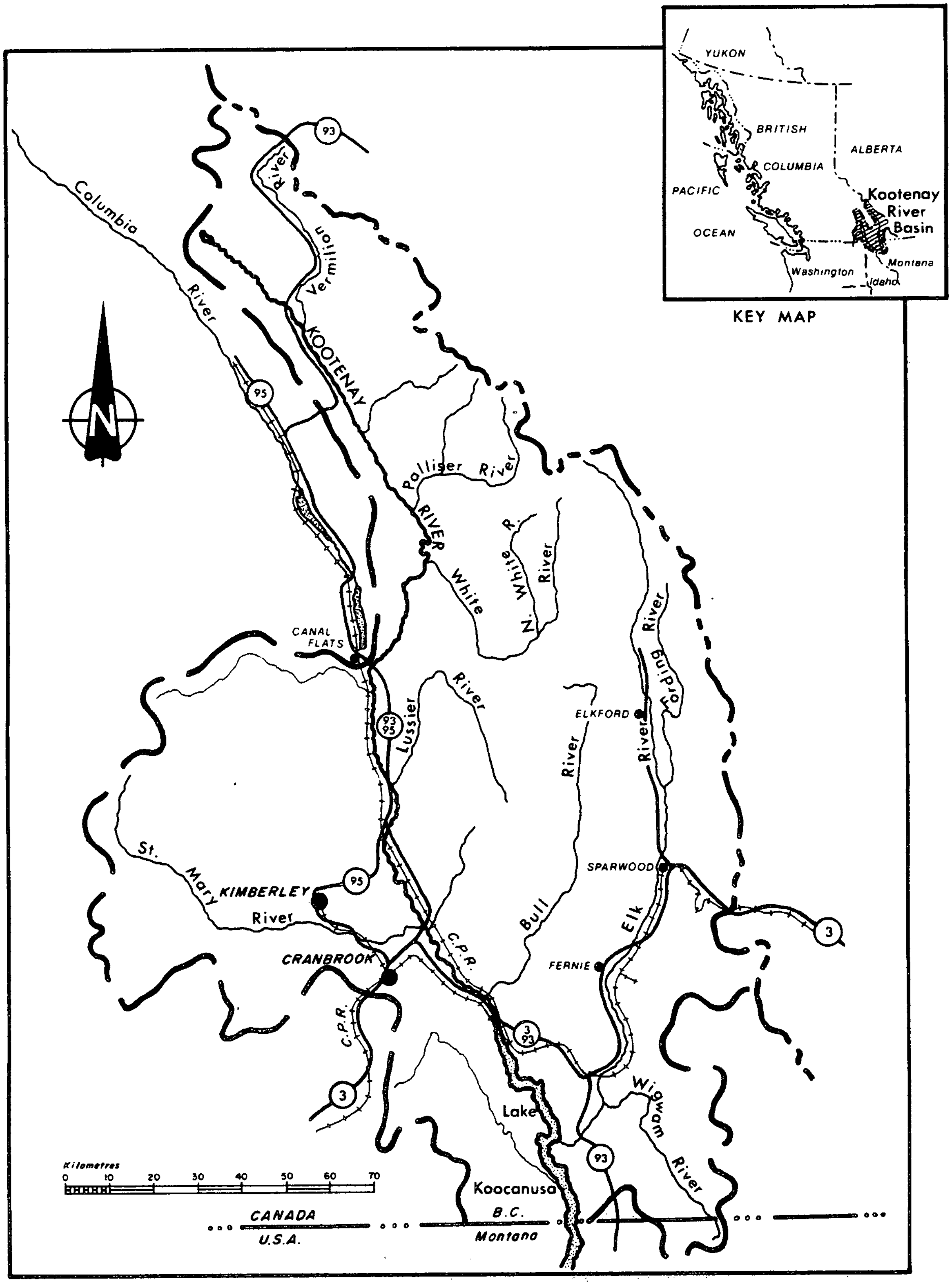


Figure 1 The Upper Kootenay River Basin

B. Objectives and Outline

The objectives of this report are to summarize the physical, biological and socio-economic resources of the Upper Kootenay River Basin and identify potential areas of concern or involvement for Inland Waters and Lands, Environment Canada.

Chapter Two of the report provides an overview of the Basin's water and related resources, including physiography, climate, soils, vegetation, wildlife and fisheries. Chapter Three discusses the use of the Basin's natural resources. It also provides an historical perspective and description of the area's communities and amenities. The Basin's major industries are discussed with particular attention directed to any water quality or quantity questions that may be of concern. The closing chapter offers a summary and recommendations.

2. WATER AND RELATED RESOURCES

A. Physiography

There are three physiographic regions in the Upper Kootenay River Basin: the Rocky Mountains in the east, the Purcell Mountains in the west, and the Rocky Mountain Trench which runs north to south between the two (Figure 2). The present landforms and surficial materials of the Basin date from glaciations in the latter part of the Pleistocene Period and recent post-glacial time. The physiographic subdivisions of the Canadian Cordillera within the three regions as described by Holland (1976) are outlined in the following table.

TABLE 1. PHYSIOGRAPHIC SUBDIVISIONS OF THE CANADIAN CORDILLERA IN THE BASIN

System	Area	Subdivision	Unit
Eastern	Rocky Mountain Area	Rocky Mountains	Border Ranges
Interior	Southern Plateau and Mountain Area	Columbia Mountains	Purcell Mountains
	Rocky Mountain Trench		

(Holland 1976)

The Rocky Mountains occupy the eastern two-thirds of the Basin. These dramatic mountains consist of numerous elongated ranges aligned approximately from north-northwest to south-southeast and vary in elevation from 750 to 1850 metres, with summit elevations between 2000 and 3600 metres. The Rocky Mountains, which consist predominantly of sedimentary rocks, can be further subdivided into the Continental Ranges consisting of the Park, Kootenay and Border Ranges. The Fernie Basin, a structural depression with downfolded and downfaulted rock, is found within the Continental Range. Relatively resistant rock formations such as limestone, dolomite and quartzite are also widespread in the

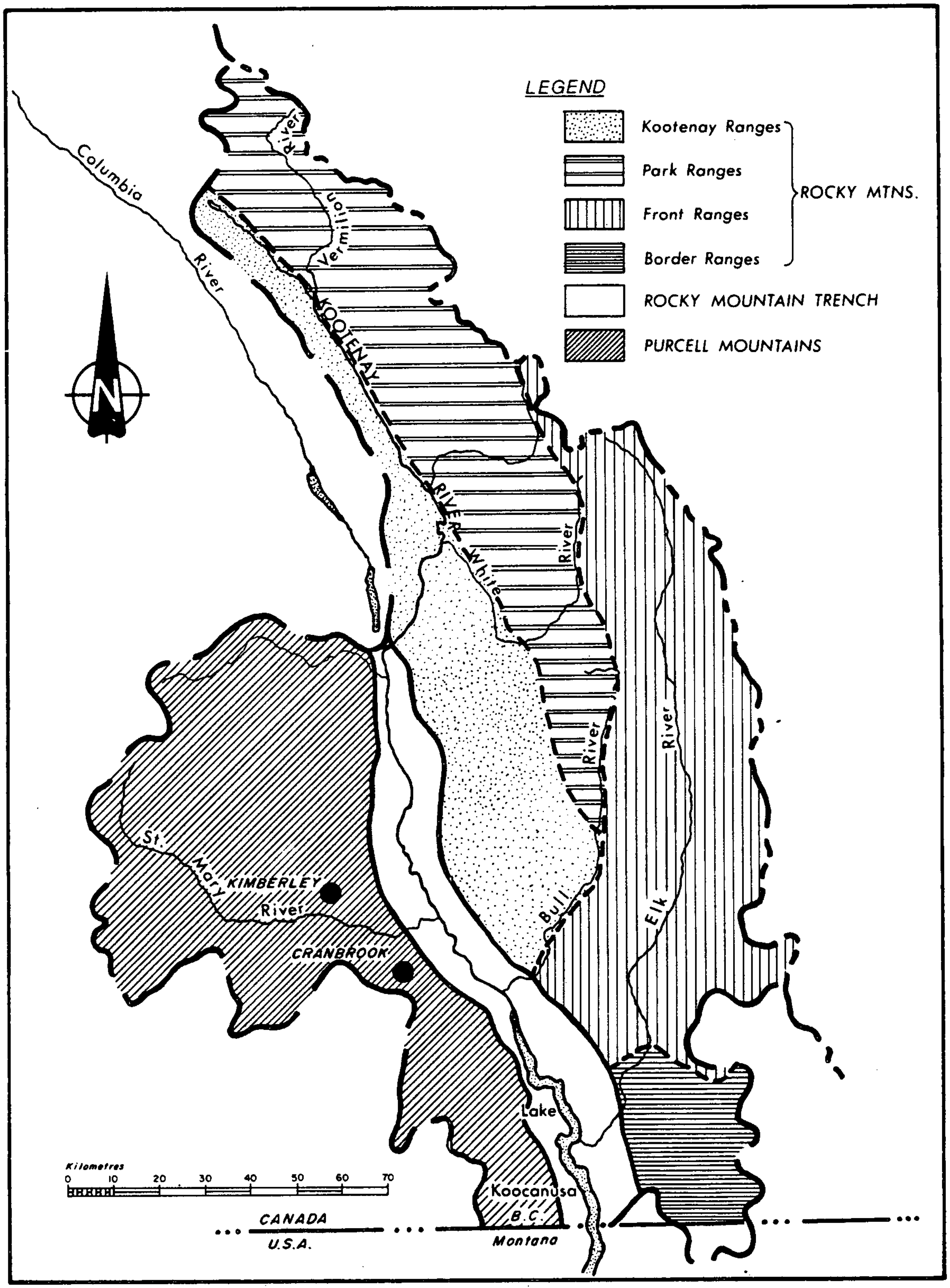


Figure 2 Physiographic Regions

Continental Ranges. These rock formations form tall peaks which are surrounded by steep ridges and high cliffs. Within the same area, there are outcroppings of less resistant rock such as shale and phyllite but the dominant terrain is characterized by broad eroded valleys such as evidenced in the Kootenay, White and Upper Elk Rivers. Most rivers and streams are swift-flowing and downcut into glacial drift. As a consequence, their floodplains are commonly confined and gravelly or sandy in texture with large fluvial fans.

The Purcell Mountains have relatively subdued topography and lack the dramatic cirques or peaks of the Rockies; their broad, rounded summits rise to 2200 metres above sea level. The Purcell Mountains are underlain by metamorphic and sedimentary rocks. Quartzite, limestone and argillite are the chief rock types in this area. Narrow belts of flat land are situated along most valley floors. Creeks of moderate size flow on narrow, poorly-drained floodplains, although some of the larger watercourses adjacent to the Rocky Mountain Trench are deeply incised. The lower eastern slopes of the Purcell Mountains are traversed by many glacial meltwater channels which are steep-sided and range in depth from a few metres to over 300 metres. Adjacent spreads of fluvioglacial gravel are common. The main ranges of the Purcells lie west of the Basin.

The Rocky Mountain Trench is a broad downfaulted lowland of flat to hilly terrain that has been considerably modified by erosion and infilled to varying depths with glacial drift. The Trench consists of undulating drift terrain with occasional bedrock hills, crossed by shallow, flat-floored valleys. The Trench is 8 to 25 kilometres wide and lies at approximately 760 metres elevation for most of its length in the East Kootenay region, although somewhat higher in elevation at its southern end. It is bounded to the east by a fault scarp which rises about 1500 metres above the Trench floor, creating one of the most significant viewing corridors in the province. In general, the bedrock surface rises gradually westwards into the hilly terrain of the eastern Purcell Mountains. The Trench is generally an extensive area of hilly moraine, with gravelly glaciofluvial meltwater channel deposits, terraces and fans interspersed between the hills. It is drained by the Kootenay River in the south and the Columbia River in the north. The broad Kootenay Valley grasslands of the south are separated from the extensive wetlands of the Upper Columbia Valley by the Columbia-Windermere lake and marsh system.

B. Climate

The Upper Kootenay Basin is characterized by hot summers with sporadic rain shower activity and long, cold winters. The Basin's climate is predominantly influenced by maritime air masses from the Pacific which have been considerably dried while traversing British Columbia and occasional influxes of cold continental Arctic air in the winter. Climatic variations within the region are largely determined by differences in topography and elevation.

The area's warmest and driest conditions prevail in the Rocky Mountain Trench, where the mean annual precipitation is approximately 400 to 500 millimetres; cooler and wetter conditions are evident in side valleys and at higher elevations. Air flow over the Basin is generally west to east due to the presence of prevailing westerly winds; valley winds tend to blow north or south, due to the orientation of the main valleys, and increase in velocity upslope. The windward side of the Rocky and Purcell Mountains experiences greater cloud cover and precipitation, both in the form of rain and snow, than do the lee or eastward-facing slopes. Within the Basin, the greatest precipitation occurs at mid to upper elevations along west-facing slopes of the Purcell Mountains. Reduced amounts at similar elevations occur along the west-facing slopes of the Rocky Mountains.

The general distribution of snow within the East Kootenays increases in depth south to north, east to west, and with increasing elevation. The average maximum snow depth reaches 35 centimetres by early March at an elevation of 1000 metres. There is a reduction in snow cover along the Rocky Mountain Trench and Kootenay and lower Elk River valleys. A relatively high snowfall zone exists in the Morrissey-Fernie area, corresponding to the area of high precipitation caused by the uplifting of semi-dried Pacific air over the west-facing slopes of the Rocky Mountain Trench.

Winters throughout the Basin generally last from October through April. The occasional Arctic system brings cold, clear days. At the Cranbook Airport, the month of June receives the most rainfall (55.1 cm) and December and January the most snow (44.2 cm and 45.5 cm respectively). Mean monthly temperatures range from a maximum of 17.8 degrees Celsius in July, to a minimum of -8.9 degrees Celsius in January. The northern most communities in the Rocky Mountain Trench receive about 2000 hours of sunshine annually, increasing to around 2300 hours at the southern end of the region. The winter months of November through February characteristically receive the least direct sunshine. The frost-free season is approximately 96 days.

Climatological data is available from the Atmospheric Environment Service (AES) of the Department of the Environment for twenty stations operated within the Basin. Historical data for five selected climatological stations are given in Appendix 1; stations are located on Figure 3.

C. Water

The drainage area for the entire Kootenay River Basin is 49 200 square kilometres. The Upper Kootenay River Basin drains approximately 20 000 square kilometres and has a mean annual flow of 298 cubic metres per second (m^3/s) (Canada 1984). The mean annual discharge recorded near the headwaters of the Kootenay River is 4.98 m^3/s, increasing to 88.1 at Canal Flats following the addition of discharge from the Vermilion, Palliser and White Rivers. At Fort Steele, below the confluence of the St. Mary River, the mean annual discharge is 179 m^3/s. The Elk River and its tributaries contribute 76.7 m^3/s to the Upper Kootenay River. The annual mean discharge of the Bull River into Lake Koocanusa is 33.3 m^3/s (Canada 1985k).

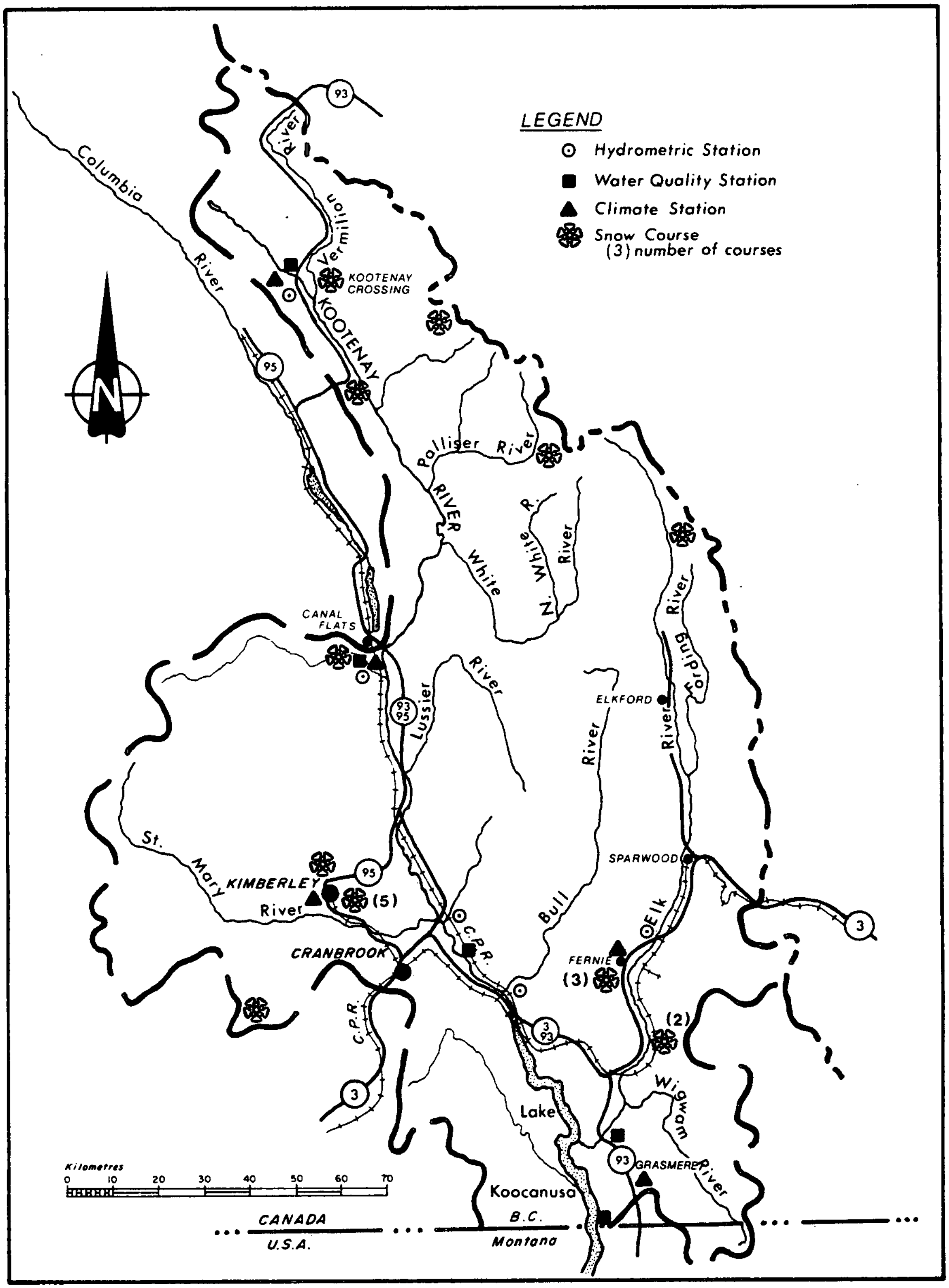


Figure 3 Selected Climate, Hydrometric and Water Quality Stations

Those reaches of the Kootenay River and its tributaries located in the Rocky Mountain Trench flow in broad flat valleys, with generally moderate slopes. In stretches where the rivers cut across mountain ranges, the rivers flow in narrow, steep-sided valleys, generally with decided slopes and rapids or waterfalls. Many of the sources of the Kootenay's tributaries are permanent snow fields and glaciers found on mountain peaks.

Analysis of discharge data indicates a seasonal flow pattern characterized by spring flood peaks in May and June due to snowmelt and spring rains. Three-quarters of the annual flow occurs during this period (British Columbia 1976b). Discharge steadily declines during summer and early fall, creating water deficits in smaller tributaries. Winter flows are generally low. Water Resources Branch of Environment Canada currently operates 24 hydrometric stations in the Upper Kootenay Basin with additional historical data available for several inactive stations. Data for five representative stations are provided in Table 2 and their locations are given in Figure 3.

Groundwater

Groundwater is not a major source of water supply in the East Kootenays nor has it been extensively studied (RDEK 1983). Over 2000 existing or potential wells are recorded with the provincial Water Investigations Branch (British Columbia 1987j); however, not all wells are recorded. The distribution of wells in the Basin is given in Table 3. Most wells supply minor amounts of water for domestic purposes.

Over 50 percent of groundwater wells are located near Cranbrook. The remainder of the wells are scattered throughout the smaller settlements in the Basin. In the Cranbrook area, the quantity of water obtained from groundwater sources has been extremely variable, ranging from wells that were dry to others producing up to 1,500 gallons per minute (six m^3/min) (British Columbia 1976b). The groundwater of the Cranbrook area is very hard, in contrast to the surface waters from the Purcell Range which are generally very soft.

TABLE 2

MONTHLY AND ANNUAL MEAN DISCHARGES AND EXTREMES OF DISCHARGE FOR SELECTED STATIONS

Station #		08NF002	08NF001	08NG065	08NG002	08NK005
Station Name		Kootenay R. at Canal Flats	Kootenay R. at Kootenay Crossing	Kootenay R. at Fort Steele	Bull R. near Wardner	Elk R. at Phillips Bridge
Per. of Record		1939–1984	1939–1984	1963–1984	1914–1984	1924–1984
Drainage Area (sq km)		5 390	420	11 400	1 530	4 450
Monthly Mean Discharge (m^3/s)	Jan	20.2	0.332	41.4	7.72	21.4
	Feb	18.7	0.226	37.7	7.40	20.6
	Mar	18.4	0.177	39.0	8.68	23.3
	Apr	29.9	1.08	73.1	30.3	68.1
	May	180.0	12.0	351.0	99.6	230.0
	Jun	300.0	19.9	684.0	111.0	264.0
	Jul	205.0	12.5	410.0	53.9	114.0
	Aug	105.0	5.12	187.0	22.0	50.2
	Sep	66.7	3.24	119.0	16.0	38.6
	Oct	46.0	1.95	86.9	14.4	35.9
	Nov	32.4	0.982	62.0	11.9	30.4
	Dec	23.3	0.574	46.7	9.35	25.0
Mean Annual Discharge (m^3/s)		88.1	4.98	179.0	33.3	76.7
Total Mean Annual Discharge (dam^3)		2 780 000	157 000	5 630 000	1 050 000	2 420 000
Maximum Daily Discharge (m^3/s)		841 (May 48)	53.0 (June 61)	1 820 (June 74)	388 (June 74)	949 (May 48)
Minimum Daily Discharge (m^3/s)		8.7 (Jan 68)	0.0 (Apr 45)	19.4 (Jan 80)	0.878 (Jan 67)	5.66 (Dec 30)

TABLE 3. DISTRIBUTION OF GROUNDWATER WELLS

LOCATION	# OF WELLS
Wasa Lake	172
Skookumchuck/Canal Flats	143
Cranbrook Area	1226
Kimberley Area	135
Waldo/Galloway	127
Jaffray/Wardner/Elko	225
Grasmere/Newgate	21
Fernie	37
Total	2086

(B.C. 1987j)

Speculation based on the general physiographic nature of the area, precipitation data and borehole analysis indicates that the Rocky Mountain Trench should be capable of producing up to 500 gpm per borehole (British Columbia 1976b). In the portion of the Trench near Tobacco Plains, groundwater may be available in deeper sediments, but deep and costly wells would be required. Groundwater sources in the Elk River valley are located in alluvial deposits (British Columbia 1976c).

Groundwater quality is sampled at several wells during spring freshet and when the water table is low in autumn. Data is available from the provincial Water Management Branch.

Dams and Diversions

Libby Dam and Lake Koocanusa

In March 1972 the Kootenay River was impounded by the construction of Libby Dam 30 kilometres south of the international boundary in north-western Montana. The dam formed Lake Koocanusa, a 148-kilometre transboundary reservoir which is operated to provide flood storage, hydroelectric power and recreation benefits. The international boundary divides the reservoir roughly in half. Construction of Libby Dam was agreed to by the United States and Canada in the Columbia River Treaty (1961) which provides for the cooperative development of water resources of the international Columbia River Basin.

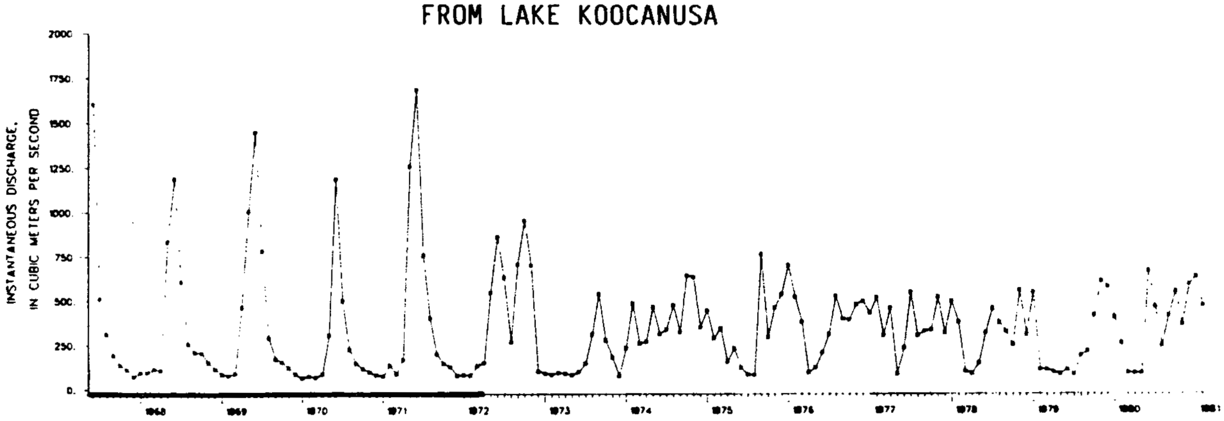
A cyclic pattern of May to June inflow and winter drawdown produces large fluctuations in reservoir volume and surface areas each year. Lake Koocanusa generally has a maximum yearly volume during July through September and a minumum volume during March and April. At a maximum pool elevation of 749.50 metres, the reservoir contains 7.16 cubic kilometres and has a surface area of 188 square kilometres. Minimum operational pool is at an elevation of 697.08 metres and yields a volume of 1.08 cubic kilometres and a surface area of 59.10 square kilometres (Whitfield & Woods 1984).

The effects of impoundment on water quantity and quality, vegetation, fisheries and wildlife, as described by Whitfield & Woods (1984) and others (Canada 1980; Langin & Carswell 1974), were dramatic (Figure 4). Prior to impoundment, about 70 percent of the river's annual mean discharge occurred in spring and early summer as a result of snowmelt; following impoundment, most of the spring snowmelt was temporarily stored in Lake Koocanusa for flood control and hydroelectric power production. As a result, May through July discharges were reduced and September through March discharges were increased after impoundment because the volume of Lake Koocanusa had to be reduced to provide adequate storage for the next year's snowmelt.

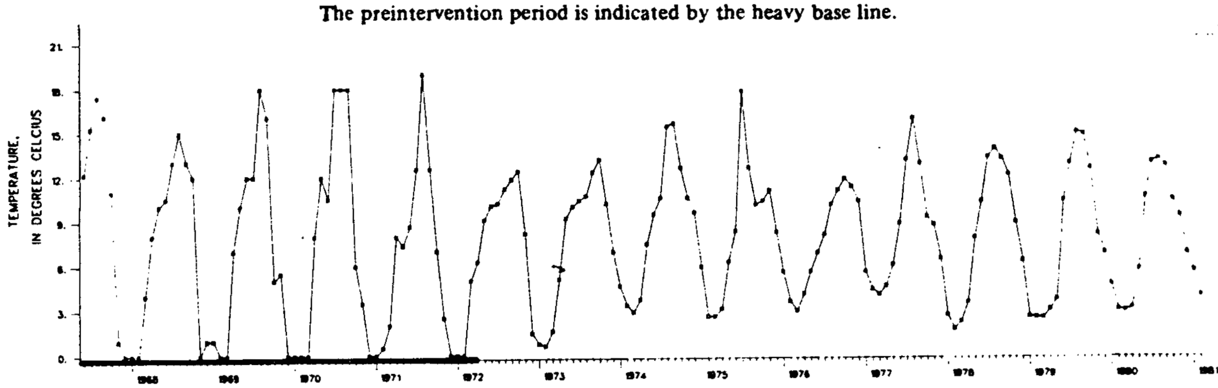
Water temperatures were also altered by impoundment. Post-impoundment temperatures were higher than pre-impoundment temperatures in October through February, and lower in April through September. The seasonal patterns of specific conductance and nitrate and nitrite concentrations were also altered. Silicate and orthophosphorus concentrations after impoundment were generally lower. The pH of the water discharged from Lake Koocanusa tended to be higher than the pH of the Kootenay River prior to impoundment. Changes observed downstream were attributed to the depth of withdrawal from the reservoir and the reservoir's ability to store and mix various influent water masses (Whitfield & Woods 1984). Effects on the portion of the Kootenay River upstream from Lake Koocanusa have also been noted (British Columbia 1976b).

Additionally, changes in biological productivity of the Kootenay River occurred (British Columbia 1981). Despite high initial phosphorus loadings to the reservoir in 1974, biological productivity was estimated to be low in 1981 due to a number of factors including thermal instability allowing deep mixing of the water, turbidity brought in from the Kootenay River limiting light penetration, loss of phosphate from the water column, and inflow of river water along the bottom of the reservoir keeping nutrients below the photic zone.

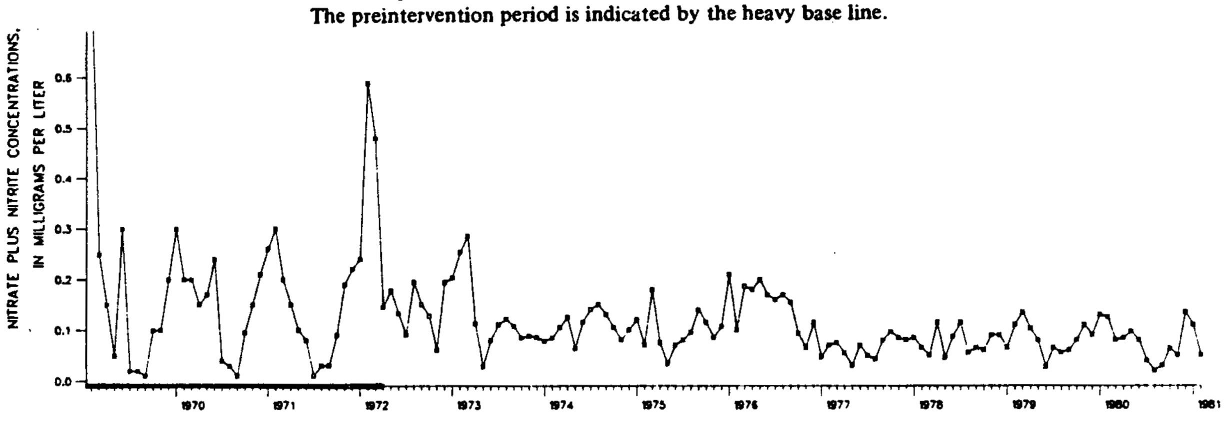
FIGURE 4 WATER QUALITY ANALYSIS DOWNSTREAM FROM LAKE KOOCANUSA



Monthly Instantaneous Discharges for the Kootenai River Downstream from Libby Dam Site. The preintervention period is indicated by the heavy base line.



Monthly Temperatures of the Kootenai River Downstream from Libby Dam Site. The preintervention period is indicated by the heavy base line.



Monthly Nitrate Plus Nitrite Concentrations from the Kootenai River Downstream of Libby Dam Site. The preintervention period is indicated by the heavy base line.

(Whitfield and Woods 1984)

Average drawdowns of 60 to 100 metres during winter months expose large areas of the reservoir bottom to freezing temperatures resulting in severe erosion and increased sediment loads. Runoff also increases as a result of the lack of vegetation over the drawdown surface.

The impoundment of the Upper Kootenay River resulted in the destruction of approximately 7300 hectares of habitat for wildlife, including ungulates, waterfowl, furbearers, upland game birds and other species. This resulted in increased competition between livestock and big game for critical winter range. Grazing competition is currently managed by the provincial Ministry of Forests and Lands through Coordinated Resource Management Plans and Range Unit Plans. Several mitigation possibilities for ungulates, waterfowl and furbearers have been considered since the construction of the Libby Dam; integrated resource use for the region is discussed in the Southern Rocky Mountain Trench Crown Land Plan (1984) available from the Ministry of Forests and Lands.

The formation of Lake Koocanusa also affected fish populations. Initially, it was believed that increased biological productivity in the reservoir would lead to an increase in the size, weight and growth rate of most fish, followed by a decline in desirable fish species three to five years after impoundment (British Columbia 1976b). However, there is no evidence to date that this has occurred; indeed, angling success has increased within the region, possibly attributable to an accidental Kokanee release in 1985 from the provincial hatchery in Wardner (British Columbia 1987g).

Kootenay River Diversion

The Columbia River Treaty permits the diversion of the Kootenay River into Columbia Lake at Canal Flats, the headwaters of the Columbia River. The proposed diversion, which has been postponed indefinitely by B.C. Hydro, would divert up to two-thirds of the average annual flow of the Kootenay River leaving only one-third of the flow for downstream use (British Columbia 1986b). The increased flow in the Columbia River would result in additional hydroelectric power generation at the Revelstoke and Mica Dams.

Effects of the proposed diversion on natural and human resources are described in detail in preliminary assessment reports available from B.C. Hydro.

Other Diversions

There are approximately 2,500 water use licences in the Basin which permit licence holders to withdraw water, create storage reservoirs or construct appropriate works for water diversion, use or storage. Most of these licences are for small volumes and apply to domestic use and irrigation purposes. In settled areas on the upper reaches of minor tributary streams, surface water is already over-licensed. Expansion of water supply in most areas of the Basin will likely become much more expensive due to the cost of drilling wells or providing lengthy water supply lines and pumps (RDEK 1983).

Major water users within the Basin include: municipalities; Cominco Limited in Kimberley which uses water in its metal ore refining plant; and B.C. Hydro which operates small dams for hydroelectric power generation at Aberfeldie and Elko and on the Bull River. The total installed capacity of the Aberfeldie Dam is 5000 kilowatts. The reservoir behind the Aberfeldie Dam is relatively small (seven hectares) and confined mainly to the natural river channel. Its usable storage capacity is 503 acre-feet in summer and 700 acre-feet in winter (British Columbia 1976b). The reservoir at Elko on the Elk River is even smaller at six hectares with a usable storage capacity of 510 acre-feet in winter (Canada 1975); thus, the ill effects associated with large storage reservoirs are minimized in the Basin.

Snowpack

Since the greatest proportion of the Basin's streamflow originates from snowmelt, measurement of the snowpack prior to spring melt is a good indicator of subsequent streamflow. The provincial Water Management Branch (MOEP) operates eighteen snow courses in the Basin (Figure 3). The Branch publishes monthly snow survey bulletins from January to June with streamflow forecasts given in the April and May editions.

Water Quality

Water Quality is sampled by both federal and provincial agencies. Stations are listed in Table 3 and federal and federal/provincial stations are located on Figure 3. The Water Quality Branch, Inland Waters and Lands, Environment Canada, currently operates one station in Kootenay National Park which is sampled every two weeks and an additional four water quality stations are sampled under a joint federal-provincial government agreement (Canada 1987a). Historical information is available for over thirty inactive federal or federal/provincial stations in the Basin.

In addition, nine provincial water quality stations located upstream and downstream of development activities such as mines and tailings ponds, sawmills and landfills are sampled nine times a year by the provincial Waste Management Branch (MOEP). The location of provincial stations may change yearly according to priorities determined by Regional staff. The locations of effluent discharge points and monitoring stations are shown on 1:50 000 scale maps and data are available on computer files from the Branch. Limited information on inactive provincial water quality stations is also available.

Water in the Basin is generally of good quality, although there have been some problems in the past. Parks occupy much of the northern half of the Basin and historically have not experienced problems associated with poor water quality. The major influences on water quality in the southern portion of the Basin have been discharges from the Cominco Limited mine and phosphate fertilizer operation at Kimberley, the discharge from the Crestbrook Forest Industry Limited pulp mill at Skookumchuck, and, as previously discussed, Libby Dam in Montana. The addition of a wastewater treatment facility at the Cominco mine site between 1975 and 1980 helped alleviate water quality problems in the St. Mary River (Canada 1976a). Also, the reduction in nutrient load from Cominco's operations contributed to the reduction in the potential for algal blooms in Lake Koocanusa. An effluent abatement program has been implemented by Crestbrook Forest Industries to address colour, toxicity and fish

TABLE 4. WATER QUALITY STATIONS

	STATION	LOCATION
FEDERAL	00BC08NF	Kootenay River at Kootenay Crossing
FEDERAL/	00BC08NF0006	Kootenay River at Canal Flats Bridge
PROVINCIAL	00BC08NF0009	Kootenay River near Fenwick Station
	00BC08NK0003	Elk River at Highway 93 Bridge
	01BC08NG0001	Koocanusa Lake at U.S. Border
PROVINCIAL		Elk River upstream of Elkford STP
		Elk River above Sparwood STP
		Line Creek near the Mouth
		Fording River at the Mouth
		Michel Creek upstream of Alexander Creek
		Michel Creek at Natal Bridge
		Elk River dowmstream of Lizard Creek
		Elk River above Michel Creek
		Elk River above Grave Creek

(Canada 1987a)

tainting problems previously associated with effluent discharge from their pulp mill on the Kootenay River.

In the Elk River Basin, potential water quality problems are associated with mining exploration, coal mining and related operations such as coal washing and coking. Water quality parameters that most often exceed recognized standards are suspended solids and turbidity: effects are most pronounced during spring runoff (British Columbia 1987i). There is no evidence of acid mine drainage or discharge of toxic materials in significant amounts (British Columbia 1976b).

D. Soils and Vegetation

Soils

The landforms, surficial deposits and soils of the Upper Kootenay River Basin strongly reflect the influence of glaciation. In many areas, the mantle of glacial drift deposited over the Basin forms the parent material on which present soils have developed. Rock outcrops, talus and shallow soils derived from glacial till are common on steep slopes at high elevations. As a result of erosion, bedrock is exposed or has been covered with material eroded from mountain sides. Brunisolic and podzolic soils have developed on gentler slopes mantled by colluvium. At lower elevations and in valley bottoms, surficial materials include glaciofluvial outwash, kame and laqcustrine materials. A variety of soils have developed on these parent materials.

A comprehensive soil survey of the Basin was undertaken in 1956. The report contains detailed descriptions of all of the soils within the Basin having capability for agricultural use (Kelley & Sprout 1956). Additional information on soils and terrain of the East Kootenay area is available from the Assessment and Planning Division of the provincial Ministry of Environment and Parks (British Columbia 1981d).

Vegetation

Vegetative cover is influenced by climate, soils, geology, topography and disturbance history. The Atlas of British Columbia (1979) delineates six broad biogeoclimatic zones in the Upper Kootenay River Basin: Interior Douglas Fir, Subalpine Engelmann Spruce-Subalpine Fir, Ponderosa Pine-Bunchgrass, Boreal White and Black Spruce, Interior Western Hemlock and Alpine Tundra (Figure 5).

The Interior Douglas Fir Zone covers most of the river valleys and lower slopes (below 1216 metres in the Basin). The dominant vegetation in the drier portion of this zone is a medium dense forest of Rocky Mountain Douglas fir usually with an understorey of birch-leaved spirea and pine grass; under cooler and moister conditions within the zone, lodgepole pine, ponderosa pine and western larch are found.

The Subalpine Engelmann Spruce-Subalpine Fir Zone, occurs at elevations of 1200 - 2400 metres and covers a substantial portion of the Basin. This zone is subject to higher precipitation, lower temperatures and a shorter growing season than the Interior Douglas Fir zone. Englemann spruce and alpine fir are the climax species for this zone, with alpine fir appearing on a wider variety of sites than Engelmann spruce. Varying amounts of both species are usually found on most intermediate sites. At elevations near tree line, alpine fir dominates with Engelmann spruce, alpine larch and whitebark pine also present. The understory vegetation of climax stands varies with elevation but commonly is dominated by smooth Pacific menziesia and grouseberry with various other shrubs and herbs and continuous moss cover.

The Ponderosa Pine-Bunchgrass Zone is found in a small portion of the Basin, specifically along the eastern shores of Lake Koocanusa, below the confluence of the Elk River. It is the warmest and driest zone in the Basin and is characterized by open grasslands and semi-open dry forest of ponderosa pine and, occasionally, Rocky Mountain Douglas fir. Characteristic plants include bluebunch wheat grass, Idaho and rough fescue and lupines.

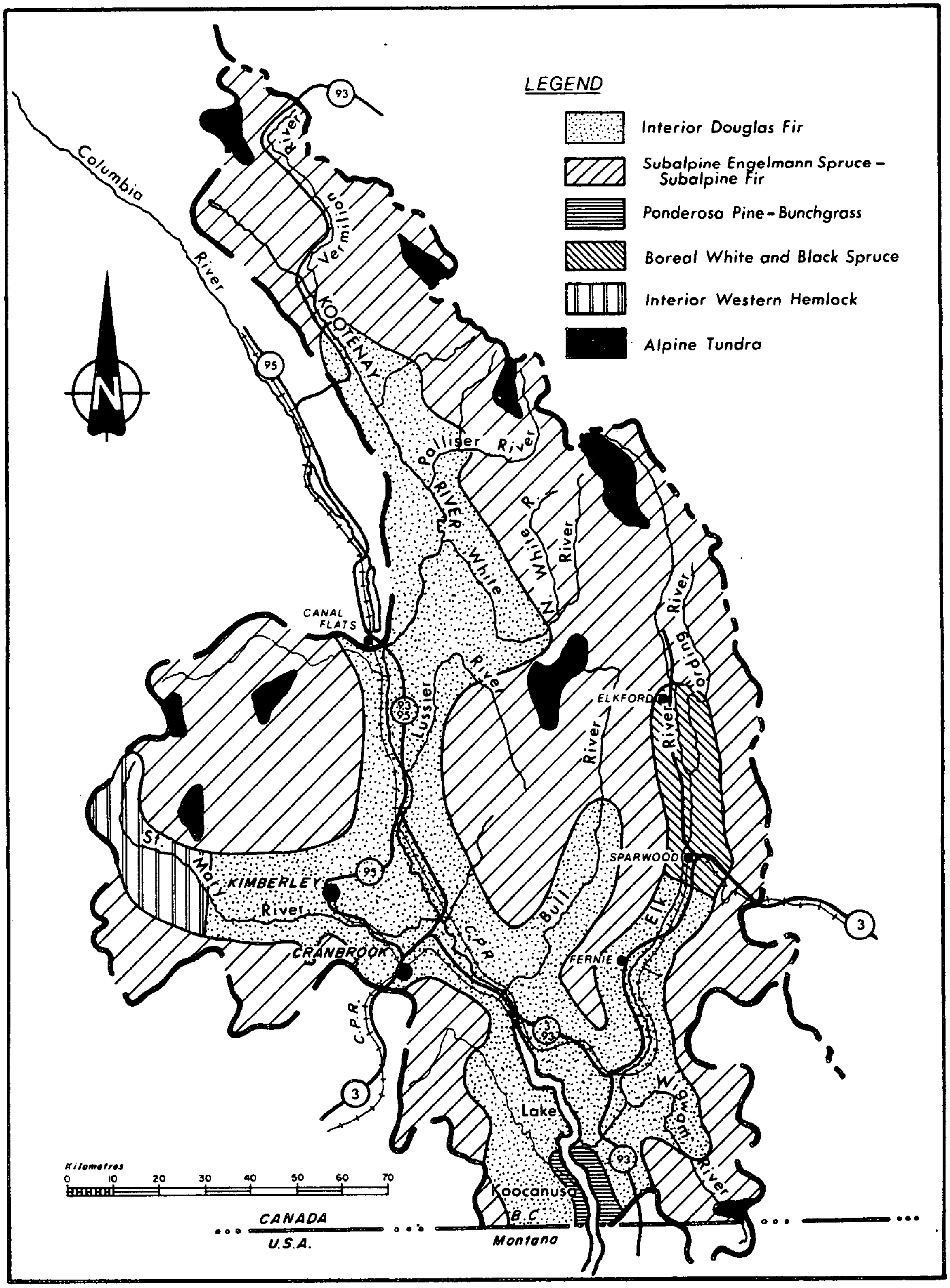


Figure 5 Biogeoclimatic Zones

The Boreal White and Black Spruce Zone is limited to the valleys of the lower Elk and Fording Rivers. Aspen is abundant on the heavy soils, while lodgepole pine is common on sandy and gravelly areas.

The Interior Western Hemlock Zone is found near the headwaters of the St. Mary River, west of Kimberley. The forests are more dense and productive than elsewhere in the Basin, consisting of interior Douglas fir, lodgepole pine, western hemlock, western red cedar, Engelmann spruce, white and black spruce and subalpine fir.

The sixth zone, Alpine Tundra, occupies mountain ridges above 2450 metres. Vegetative growth is limited by the severe climate. Dominant species include sedges, grasses, rushes and dwarf willow. Alpine tundra vegetation is found in Mount Assiniboine Provincial Park and in other small, scattered, high elevation locations throughout the Basin.

Areas of natural grassland are small, the two most important being St. Mary's Prairie, between Cranbrook and Marysville, and Tobacco Plains near the international boundary. Since these areas have been overgrazed, it is difficult to determine the nature of the original vegetation.

A comprehensive survey of vegetation in the Basin is available from the Surveys and Resource Mapping Branch of the provincial Ministry of Environment and Parks (British Columbia 1984b).

E. Wildlife and Fisheries

Wildlife

The East Kootenay region has the highest capability to support wildlife in Canada (Canada 1970). Eleven big game species are found within 26 000 square kilometres. The total big game population is over 100,000 yielding densitites of approximately four animals per square kilometre (B.C. 1987e). Big game found in the Basin include whitetail and mule deer, elk, moose, mountain goat, mountain sheep and caribou.

The Rocky Mountain Trench provides critical winter range due to limited snow depths, protective cover and adequate food supplies. Generally, big game capability increases from north to south in the Trench, other important areas in the Trench are adjacent to Premier Lake, the lower Bull River and the confluence of the Elk and Wigwam Rivers (Class 1W rating). The remainder of the Trench has been rated as Class 2W or Class 3; the Class 2W lands provide good winter range for deer and elk, the Class 3 lands are mainly used as summer habitat by white-tailed deer, although the tree-line zone also supports mountain goat and bighorn sheep. The slopes facing east, south and west in these areas provide the best range.

The predominance of lower capability Class 3 land in the mountains east of the Rocky Mountain Trench and Class 4 land in the Purcell Mountains reflects the large extent of alpine in these areas (Canada 1968a). The Rocky and Purcell Mountains provide excellent summer range but due to deep snowfalls migration by most ungulates to lower elevations is necessary in winter. Most of the main valleys at lower elevations in the Rocky Mountains have been rated Class 3W, indicating moderate capability as winter range. The deep snow in these valleys excludes winter use by species other than moose and elk.

Rocky Mountain elk are the most plentiful and widely distributed ungulate in the Upper Kootenay Basin. The most important winter range for elk is found in the Rocky Mountain Trench as well as portions of the Elk Valley. Mule deer are distributed throughout the Basin but are most abundant in the Trench; current population trends indicate their habitat is not fully utilized (British Columbia 1986d). Moose are sparsely distributed throughout the area, with the greatest numbers occurring in the vicinity of subalpine lakes and streams. In the summer, moose may be found in wet bottomlands and alpine meadows; most winter along the slopes and bottomlands of main valleys between 1200 and 1650 metres elevation. Mountain goats and sheep are found in moderate numbers, generally in the rugged, alpine areas of the Rocky Mountains.

Black bears, wolves and coyotes are other big game animals common to the area. Grizzly bears and cougars occur in moderate numbers in remote mountainous regions. Smaller fur-bearers are widely distributed in varying numbers throughout the Basin.

Capability for waterfowl production is ranked as occasionally to moderately good, limited by the number and quality of wetlands in the Basin (Canada 1968b). While most of the wetland classes are present, those ranking higher than Class 6 form less than one percent of the total Basin's land mass. Topography, type of vegetation surrounding wetlands in the Basin and the intermittent nature of wetland distribution within the region combine to discourage waterfowl production. The places most productive for waterfowl are shallow lakes or potholes formed in the open, undulating floodplain of the Kootenay River or on terraces above valley bottoms. Such lands currently exist between Cranbrook and Skookumchuck, and formerly existed along the portion of the Upper Kootenay River which now forms Lake Koocanusa. River bottomlands also have potential for waterfowl production within the Basin, however, fluctuating water levels during spring and early summer adversely affect nesting and productive capability. Waterfowl common to the Basin include Mallard, Baldpate, teal, pintail and golden-eye ducks and small numbers of Canada geese.

Most of the wetlands within the Basin are readily accessible by primary or secondary roads. But most wetlands are surrounded by agricultural development, thus restricting public access. In addition, freezing weather generally drives most of the birds from the Basin in mid or late November. As a consequence of the restricted public access and short season, waterfowl hunting in the East Kootenay area is relatively light.

"British Columbia Hunting Regulations Synopsis 1986-87" outlines designated quotas, open seasons, hunting areas and big game and waterfowl reserves within the province. The booklet is available from the Fish and Wildlife Branch of the provincial Ministry of Environment and Parks.

Fisheries

Most streams and lakes within the Basin support sport fisheries. Dolly Varden char, Yellowstone cutthroat trout, mountain whitefish and lesser numbers of eastern brook trout make up the majority of summer river catches in the Kootenay River and its tributaries. The Basin's streams also serve as important spawning and rearing areas for these species. There is an important recreational winter whitefish and ling fishery in the Basin.

There are currently no water quality problems affecting the fisheries; however, increased lakeshore development, fishing pressure and mining and logging activities are potential concerns. The number and distribution of fish species within Lake Koocanusa is being closely monitored by the provincial Fish and Wildlife Branch.

Many of the lakes are stocked with fish from the provincial hatchery near Wardner. Information on demand statistics, stocking histories, fishing regulations and limnological data are also available from the Fish and Wildlife Branch. There are no anadromous fish within the Basin.

3. EXISTING AND POTENTIAL RESOURCE USE

A. Historical Perspective

There are indications that aboriginal people have lived in the Kootenays for at least 7,000 years and evidence that the Rocky Mountain Trench was used as a thoroughfare for original immigrants to North America.

European explorations began in 1807 when David Thompson, on behalf of the North West Fur Company, established the area's first fur trading post near Invermere. The fur trade flourished until the early 1860's when the search for gold began. Gold was first discovered in 1862 and by 1864 over 3,000 miners were prospecting in the area. The boom town, Wild Horse, later to become Fort Steele, was established at this time and by 1886 steamboats were plying the Columbia and Kootenay Rivers to Fort Steele via locks at Canal FLats.

Placer mining continued in the Basin until the late 1880's when railway construction made lode mining and lumbering more profitable. Construction of the B.C. Southern Railroad (commonly referred to as the Crowsnest Pass Railway) in 1898 marked the decline of Fort Steele and the emergence of Cranbrook as the Basin's commercial centre.

Development of lead, zinc and silver deposits in the western portion of the Basin lead to the establishment of Kimberley in 1896. Subsequently, coal deposits in the Elk Valley were developed and towns established at Fernie, Michel and Natal. By 1903, six mines had opened in the Coal Creek Valley and were worked continuously to 1958; eight mines opened near Morrissey and ran until 1909. The Cabin Creek Colliery, the site of the Basin's first surface mine, opened in 1913 and has operated intermittently since then. Several companies such as Kaiser Coal and Fording Coal obtained licences to mine in the late 1960's and early 1970's. This and other mining activity lead to the establishment of the communities of Sparwood and Elkford.

B. Communities, Population and Employment

The principal communities in the Upper Kootenay River Basin are Cranbrook, Kimberley, Fernie, Sparwood and Elkford (Figure 6). Cranbrook is the largest community with a population of 15,893 in 1986 or 30 percent of the Basin total. As well as being an administrative centre, Cranbrook serves a regional market area of approximately 55,000 people--although many goods and services are obtained from southern Albertan communities which are in close proximity. The other communities have populations between 3,000 and 7,000 each (British Columbia 1987b).

Table 4 indicates population change in the Basin's major communities from 1981 to 1986. The highest rates of growth have occurred in the Elk Valley at 3.7 percent per year between 1966 and 1981 giving a total population of 13,000. The new towns of Sparwood and Elkford absorbed most of this growth. The in-migration of population has contributed to a relatively young population structure: in 1981, nearly half of the region's inhabitants were younger than 25 years of age. There is also a slightly higher male population. The number of inhabitants in Kimberley has declined, although it still remains the Basin's second largest community with 13.7 percent of the population (RDEK 1983).

In the Elk Valley, coal mining is the dominant activity and a high percentage of secondary and tertiary employment is dependent upon exploitation of the vast coal resources. The Cranbrook-Kimberley area enjoys a broader economic base; commerce and administration, transportation, farming, logging, and sawmilling activities are widespread. At Kimberley, the Cominco mining/fertilizer complex accounts for most of the city's employment, directly as well as indirectly--although the fertilizer plant shut down indefinitely in May 1987. A pulpmill is located at Skookumchuck.

The relative importance of various industries is revealed by the employment pattern. In 1981, the regional experienced labour force numbered 26,535 or 1.9 percent of the provincial total. Approximately 30

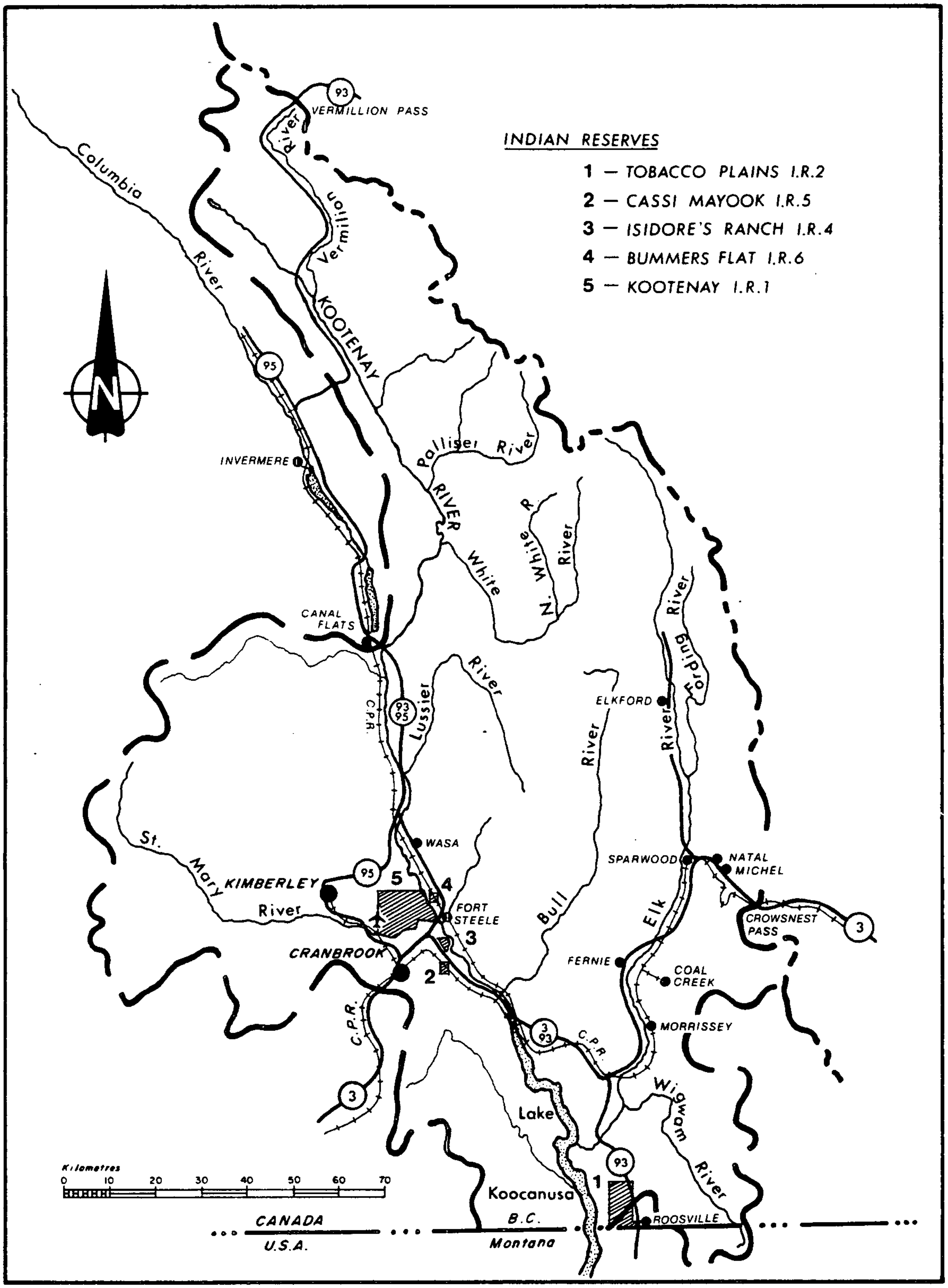


Figure 6 Communities and Transportation

TABLE 5. POPULATION CHANGE

Name	1981 Population	1986 Population	% Change	1986 Occupied Private Dwellings
Cranbrook	15,941	15,893	-0.3	5,734
Elkford	3,126	3,187	2.0	1,051
Fernie	5,444	5,198	-4.7	1,834
Kimberley	7,375	6,732	-8.7	2,612
Sparwood	4,161	4,540	9.1	1,546
Tobacco Plains	68	94	38.2	28
East Kootenay Regional District	53,723	53,089	-1.2	18,901

(British Columbia 1987b)

percent were employed in tertiary (service) industries, followed by mining and quarrying (17.1 percent), wholesale and retail trade (15.1 percent), manufacturing (10.2 percent) and construction (8.2 percent). Forestry directly employs only 3.3 percent of the working population. A detailed breakdown of the labour force is found in Table 6 (British Columbia 1986b). Due to falling world coal market prices, increased mechanization and lower reserves in Cominco's lead/zinc mine, and problems at their fertilizer plant, regional employment is probably lower now than in 1981.

Although average incomes have historically been lower in the Basin than elsewhere in British Columbia, there is evidence that incomes have increased dramatically through the 1970s. This increase is largely attributed to growth of steady, year-round employment opportunities for highly-skilled workers in the mining industry, and to an increasing number of administrative and management positions for professionals. The average annual income was $18,955 in 1983 (British Columbia 1986b).

C. Community Services

In general, residents of the five larger communities in the Basin enjoy full amenities and all the benefits of an adequately maintained infrastructure. Services in smaller communities such as Wasa, Jaffray, Grasmere and Elko are greatly reduced in comparison to the larger centres. Some of the remoter areas of the Basin are not serviced with electricity or telephone.

Electricity is supplied by the British Columbia Hydro and Power Authority (B.C. Hydro). B.C. Hydro operates three small electrical generating facilities within the region on the Elk River, Bull River, and at Spillimacheen on the Columbia River. Electrical consumption by the large coal mining operations forms a significant proportion of regional electrical sales. Cominco obtains its power through West Kootenay Power

TABLE 6. EXPERIENCED LABOUR FORCE BY INDUSTRY

	1971		1981	
	Number	Percent	Number	Percent
Agriculture	375	2.3	475	1.8
Forestry	635	3.9	880	3.3
Fishing and Trapping	10	0.0	5	0.0
Mines, Quarries, and Oil Wells	2,260	13.9	4,530	17.1
Manufacturing	2,315	14.3	2,715	10.2
Construction	1,305	8.0	2,175	8.2
Transportation, Communication, and Utilities	1,590	9.8	1,940	7.3
Trade	2,235	13.8	3,995	15.1
Finance, Insurance, and Real Estate	480	3.0	970	3.7
Service (Commercial, Business, Personal)	3,515	21.6	7,050	26.6
Public Administration and Defence	655	4.0	1,295	4.9
Unspecified or Undefined	870	5.4	535	2.0
Total Experienced Labour Force	16,240	100.0	26,535	100.0

(British Columbia 1986b)

and Light Co. Demands over and above local generation are met by regional imports from the provincial grid.

Natural gas for residential and industrial consumption within the area is supplied by Cominco Natural Gas. B.C. Telephone Co. provides telephone service in the Basin. Services such as water, sewer, garbage collection and fire protection for the five major centres are summarized in Table 7. Most communities obtain their drinking water from nearby creeks, although some people have access to groundwater wells. The Royal Canadian Mounted Police are stationed in the five major communities. Family, county and provincial courts sit on a rotating basis in these cities, with the exception of Elkford. Cable television is available for the five centres, as well as Wasa. Cranbrook and Fernie have local radio stations that transmit throughout the Basin. Local newspapers are produced on a daily, bi-weekly and weekly basis in Cranbrook, Kimberley and Fernie.

Four School Districts lie within the boundaries of the Regional District of East Kootenay. These offer instructional facilities from kindergarten to Grade 12, with a combined total student enrolment in January 1982 of 12,389. East Kootenay Community College, founded in 1978, is the only post-secondary education facility within the Basin. Its main campus is located in Cranbrook, with satellite centres in Kimberley, Fernie, Sparwood and Elkford.

All of the communities in the Basin have access to public health clinics. Hospitals are located in all of the major centres, except for Elkford.

---

[1] Information for this section was obtained from RDEK 1983.

TABLE 7. COMMUNITY SERVICES

Service	Cranbrook	Kimberley	Fernie	Sparwood	Elkford
WATER:					
- Sources	Joseph Creek Gold Creek 2 Town Wells	Mark Creek Rock springs Town Well Cominco - St. Mary River	Fairy Creek	2 Town Wells 2 - 500,000 Gal. Reservoirs	Boivin Creek Groundwater Wells
- Distribution	Mainly Gravity	Gravity	Gravity	Pumps	Gravity & Pumps
- Capacity	50,000 Pop.	Not Currently Constrained	15,000 Pop.	7,000 Pop.	6,700 Pop.
SEWER:					
- Treatment	Secondary	Secondary	Secondary	Secondary	Secondary
- Capacity	47,000 Pop. (Land for spray irrigation only constraint)	12,000 Pop.	6,500 Pop. (Currently near capacity)	8,000 Pop.	6,700 Pop.
GARBAGE:					
Collection & Disposal	All municipalities offer their own or contracted collection service by truck, once weekly in residential areas, 1-3 times weekly or as needed in commercial areas. Each municipality operates its own sanitary land fill site under provincial licence.				

(RDEK 1983, p. 68)

D. Transportation

The Basin is served by three major highways with connections north via Highways 93 and 95 to the Trans-Canada Highway at Golden and Lake Louise, south on 93 to the Montana border at Roosville, east via Highway 3 through the Crowsnest Pass and Vermilion Pass to southern Alberta, and west on 3 to Creston and lower Kootenay Valley through Cranbrook (Figure 6). All communities of significant size within the Basin are located along one of these major routes, except for Elkford which is approximately twenty-five kilometres north of Highway 3 on the Elk Valley Highway (#43). The southern transmountain route along Highway 3 between Cranbrook and the Crowsnest Pass is the most heavily travelled highway in the Basin, particularly during the summer months.

Scheduled bus service directly links the Basin's communities with major centres in British Columbia, Alberta and the United States and is provided by Greyhound Lines of Canada and Dewdney Trail Stages. Charter service is available in Fernie from Dickens Bus Lines and Invermere from Canadian Mountain Tours and Ski Bus Service.

CP Rail offers freight service only in the Basin; coal and prairie grain are the principal shipments destined for Roberts Bank on the coast. The nearest passenger rail service is at Golden. The southern CP Rail route enters the East Kootenay district through the Crowsnest Pass and heads north along the Rocky Mountain Trench to Rogers Pass. The line also connects to the Great Northern Railway in Montana via Kingsgate. Important freight switching yards are in Cranbrook and Fort Steele.

The only major commercial airport in the region is the Cranbrook-Kimberley airport, administered by the City of Cranbrook. The airport is served by Canadian Airlines with daily jet service to the Okanagan, Kamloops, Vancouver, Calgary and Edmonton, and by AirBC with 6 days per week service to Castlegar, Vancouver, Calgary and Edmonton. The airport has a 1 830 by 45 metre runway with 24-hour air-ground communications and weather service. Commercial, passenger and freight levels in and out of the airport were estimated in 1981 at 110,000 passengers and 567 000 kilograms of freight (RDEK 1983). Charter and other aviation services are available at the airport.

Further north, a runway of similar capacity has recently been built to service the Columbia Valley-Windermere Lake area, although to date no scheduled passenger service operates from the airport.

There are a number of small airstrips located in the Basin: a civil airport is situated between Elkford and Sparwood in the Elk Valley, as well as in Fernie; a private gravel runway is found at Canal Flats; and a private grass runway services Wasa Lake.

E. Native Population

The status Indian population within the Basin is small and widely scattered on three different Indian Reserves: St. Mary's, Tobacco Plains and Cassimayooks (Figure 6). In 1986 the Basin's total Indian Reserve population was 219, less than one percent of the Basin's total population (British Columbia 1987b). There are also two uninhabited reserves in the Basin: Bummers Flat and Isidore's Ranch. Natives within the region belong to the Kootenay (or Kutenai) Indian band.

Several small, locally-managed commercial enterprises are found on the reserves. The most important among these is Christmas tree production, which is presently being expanded on the St. Mary's reserve. Some logging and small, family-operated agricultural activity occurs in Tobacco Plains (RDEK 1983).

F. Forestry

The Basin encompasses portions of two Timber Supply Areas (TSA's), Invermere and Cranbrook, one Tree Farm Licence and one Tree Farm. The

Cranbrook TSA covers over 1.4 million hectares (British Columbia 1985a), while the Invermere TSA is approximately 0.9 million hectares in size (British Columbia 1981f). In 1981, the total allowable annual cut (AAC) was over 1.1 million m^3/yr in the Cranbrook TSA and over 0.6 million m^3/yr in the Invermere TSA (RDEK 1983), representing over 50 percent of the forest area (RDEK 1983). Table 8 provides a summary of forest cover classification in both TSAs. The AAC for the Cranbrook area was decreased to 900 000 m^3 in 1983, and under current management performance is expected to continue to decline to a sustainable 780 000 m^3/yr in 70 years. Timber quality is also expected to decline in the long term (British Columbia 1985a). In the Invermere TSA, a 20 percent decrease in available harvest over 50 years is predicted if the present AAC is maintained (British Columbia 1981f).

The predominant species harvested are lodgepole pine, comprising 40.5 percent of timber supplies, spruce, constituting 25.3 percent of the timber stock, and Douglas fir, 19 percent (RDEK 1983).

The TSA forest resource base contains about 34 percent mature and almost 61 percent immature timber (Table 8). Most timber in the Basin is situated on medium and poor site areas. Land inventory maps indicating forest capability classes are available from the provincial Ministry of Environment and Parks. Coordinated Resource Management Plans, which are developed after consultation with the public and other government agencies prior to the commencement of logging, are available from the regional offices of the Ministry of Forests and Lands.

Infestations of mountain pine beetle on lodgepole pine are widespread in the Cranbrook and Invermere TSAs. Based on the net operable volume at risk in 1985, and assuming a salvage rate of 60 percent, the net volume loss is nearly 3.7 million m^3 in the Cranbrook TSA alone (British Columbia 1985a). The rate of infestation is forecasted to decline, however, due to host depletion, biological factors such as weather extremes, and current harvesting and sanitation practices (British Columbia 1984c). Spruce bark beetle infestations, root rot and mistletoe

TABLE 8. FOREST COVER CLASSIFICATION

	TSA Cranbrook (hectares)	TSA Invermere (hectares)	Total (hectares)	%
Aliented	154 219	86 204	240 423	10
Crown Non-Forest	460 504	377 829	838 333	36
Crown Productive Forest	807 118	460 714	1 267 832	54
TOTAL	1 421 841	924 747	2 346 588	100
Productive Forest:				
Mature	253 324	178 199	431 523	34
Immature	514 323	257 802	772 125	61
Not satisfactorily restocked, disturbed and stocking doubtful and residual	25 025	23 678	48 703	4
Non-Commercial Cover	14 446	1 035	15 481	1
TOTAL	807 118	460 714	1 267 832	100

(RDEK 1983, p. 27)

infestations also occur in the Basin, but, as yet, are considered minor problems.

In both TSAs, the use of herbicides is limited to trial applications, mostly in silvicultural practices. Maintenance of stands is conducted by manual cutting. The use of chemicals in pest management programs is restricted in individual applications to each tree as required. No helicopter spraying of herbicides or pesticides occurs in either the Invermere or Cranbrook TSAs.

As outlined in the 1981 Yield Analysis Reports for both regions, levels of reforestation in the Cranbrook and Invermere TSAs are insufficient to sustain present and predicted timber supply.

In 1981, the region's forest industry employed 1,100 people in sawmilling, 825 in logging (mostly employed by small local contractors), and 260 in pulp operations. Christmas tree production is also an important part of the region's forest industries, although production has declined through the 1970s due to competition from artificial trees. Combined with the manufacturing of wood products, the forest sector is the second largest employer in the Basin, following mining (BCCCU 1985).

In 1984, there were eight operating permanent sawmills in the Basin representing 3.5 percent of the total provincial production capacity (British Columbia 1986b). The largest forest companies in the Basin are Crestbrook Forest Industries Ltd. and Slocan Forest Products Ltd. (formerly Revelstoke Sawmills Ltd). There are also about forty smaller mills in the Basin. The main product is finished lumber. Crestbrook Forest Industries, in addition to its sawmills in Cranbrook and Canal Flats, operates a pulp mill at Skookumchuck which relies on surplus wood chips from other regional sawmills for its raw materials (RDEK 1983). The region's major sawmills and locations are listed in Table 9.

Following major forest fires in the vicinity of Canal Flats in 1985, the production levels at the Crestbrook Forest Industries Ltd. pulp mill in

TABLE 9. LARGEST SAWMILLS IN THE EAST KOOTENAYS (1984)

Operation	Location	8-hour shift capacity (Mfbm)
Crestbrook Forest Industries Ltd.	Elko	250
Crestbrook Forest Industries Ltd.	Cranbrook	180
Crestbrook Forest Industries Ltd.	Canal Flats	220
Slocan Forest Products Ltd.	Radium	295
Galloway Lumber Co. Ltd.	Galloway	100
Crestbrook Forest Industries Ltd. Pulp Mill	Skookumchuk	150 000 tonnes

(British Columbia 1986b)

Skookumchuck doubled to process fire-damaged timber. This added substantially to local employment. The salvage operation is expected to take two years, after which any remaining burnt timber will be unfit for lumber production (British Columbia 1986b).

The future of the forest industry in the region depends not only on the outcome of the free trade agreement but also on a secure supply of raw materials. The major regional sawmills are modifying plant production lines to accommodate small-diameter logs more efficiently in response to changes in production potential from traditional forest species and types (RDEK 1983).

G. Mining

Mining is the Basin's major economic activity. It contributes 20 percent of the provincial mining employment total and over $600 million per year to the economy (British Columbia 1986b). In 1985, there were six operating mines in the Basin directly employing nearly 4500 workers (Mining Association of British Columbia 1985). The mines are located on Figure 7; the annual estimated value of mineral production from 1976 to 1982 is given in Table 10. Between these years, regional mineral production values increased by 70 percent; this has been attributed to both increased mineral production and rising mineral and coal prices (RDEK 1983). In 1983, the industry experienced production reductions due to cutbacks in contracts with foreign consumers, resulting in substantial lay-offs within the region (Schiller and Grieve 1983). Increased mechanization at Cominco Ltd. also resulted in reduced employment. It is expected employment levels will return to pre-recession levels as market opportunities arise.

Coal is the leading mineral product followed by zinc, lead and silver. In 1982 the Basin accounted for all of the coal produced in British Columbia, 82 percent of the lead, 64 percent of the zinc and 17 percent of the silver. In 1982 the value of production in the mining sector

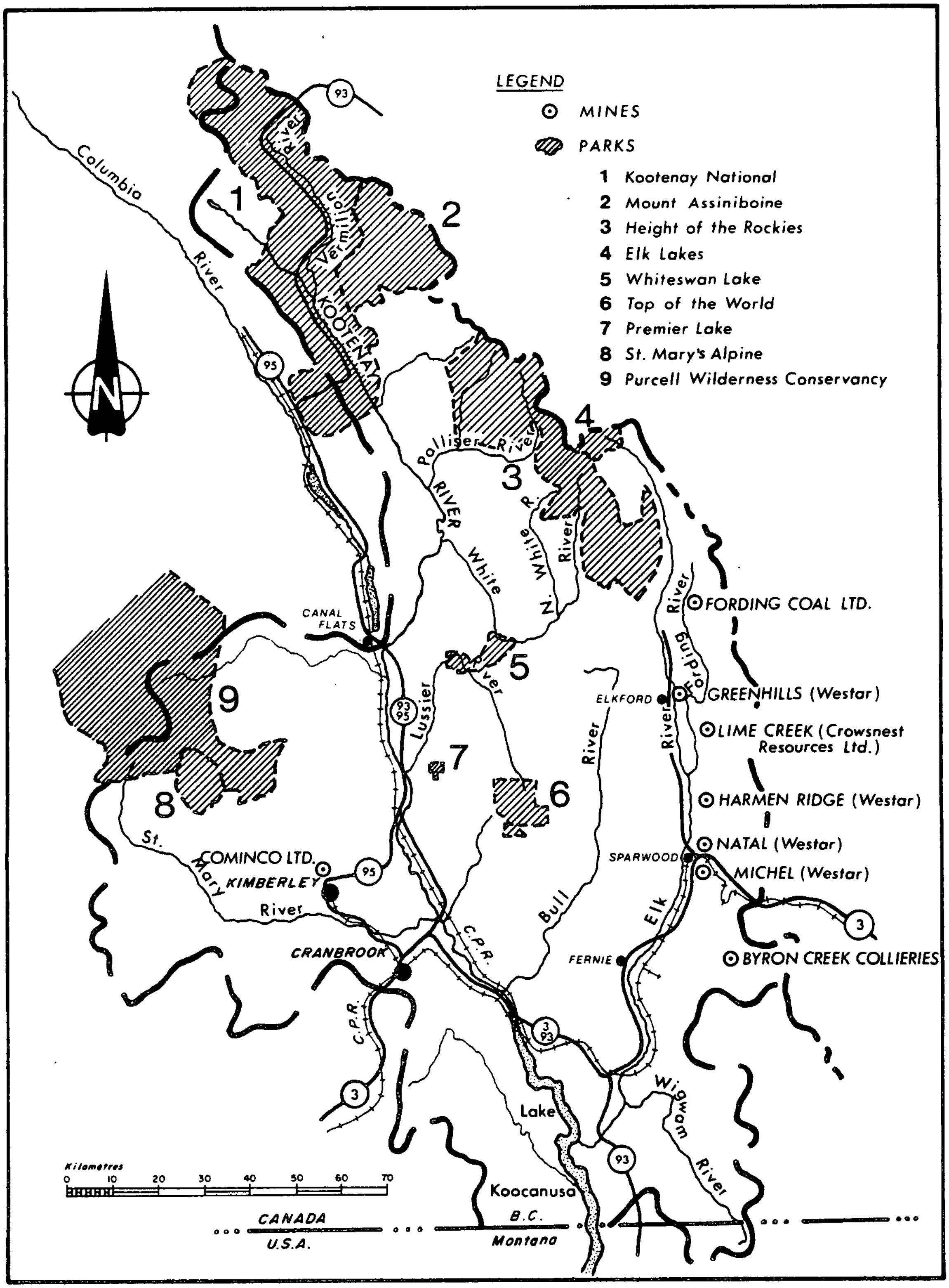


Figure 7 Mines and Parks

TABLE 10. VALUE OF MINERAL PRODUCTION ($000) 1976 - 1982

	1976	1977	1978	1979	1980	1981	1982
Gold	--	--	--	--	40	--	--
Silver	10,077	12,146	19,988	38,462	60,960	40,581	26,919
Lead	26,763	36,867	51,795	89,968	58,223	56,964	35,311
Zinc	36,264	35,298	27,510	37,781	28,017	42,573	40,778
Iron Concentrates	191	292	385	492	550	639	892
Tin	467	1,805	3,199	3,153	1,889	1,816	1,569
Coal	298,679	328,842	381,888	439,274	461,488	553,212	566,865
Industrial Minerals	5,573	3,471	4,642	7,440	10,539	11,506	10,853
Structural Materials	771	1,432	955	1,823	3,732	1,939	2,385
TOTAL	378,785	420,154	490,362	615,393	626,437	709,231	685,572

(British Columbia 1986b)

within the Basin represented nearly one-quarter of the provincial total (British Columbia 1986b). Mineral inventory maps at 1:125 000 and data are available from the B.C. Ministry of Energy, Mines and Petroleum Resources.

Coal

Coal deposits in the Basin have been mined since 1898; however, the industry expanded significantly when Japan expressed an interest in importing coxing coal. The first major shipments to Japan began in 1970 via the newly constructed port facilities at Roberts Bank near Vancouver. Other overseas markets now include Brazil, Pakistan, Romania, Denmark and Korea (RDEK 1983). Ontario Hydro also purchases thermal coal from the East Kootenays.

There are four coal producers in the Basin, but a number of other firms hold proven properties and may commence production when market conditions are favourable (British Columbia 1986b). Table 11 provides more detailed statistics on the Basin's coal producing mines.

Westar Mining, which purchased Kaiser Resources, now operates a number of mines east and northeast of Sparwood as well as the new Greenhills mine near Elkford, which began shipping thermal coal in 1982 and metallurgical coal in 1983. The Greenhills operation recently received approval-in-principle to proceed with development of a pit and dump near the southern extent of its current mine operation (British Columbia 1987d). Approximately 1,702 workers were employed by Westar in 1986, most of whom live in Sparwood, Elkford or Fernie.

The oldest and largest mine in the Elk Valley coalfield is the surface operation of Fording Coal Limited, north of Elkford. Shipment of metallurgical coal to Japan commenced in 1972; thermal coal is also marketed. In 1983 a major expansion program was undertaken on the Eagle Mountain portion of the operation, where large reserves were established (Schiller & Grieve 1983). A small thermal generating station to power the operation using run-of-mine coal is expected to be completed by

TABLE 11. PRODUCING COAL MINES

Name	Method	Capacity (M tonnes/ clean)	1986 Production (M tonnes/ clean)	Coal Type	Manpower Employed	Reserves (M tonnes)
Line Creek Mine, Crows Nest Resources Limited	Open Pit Truck & Shovel	3.0	1.7	Low/medium volatile bituminous	443	200+
Byron Creek Collieries, Esso Resources Canada Ltd.	Open Pit	1.8	0.9	Medium volatile bituminous	123	95
Fording River Mine, Fording Coal Limited	Truck/Shovel & Dragline	5.0	4.8	High & medium volatile bituminous	1,150	300
Greenhills Mine, Westar Mining Ltd.	Open Pit	2.9	1.7	Low volatile bituminous	499	162 (clean)

mid-1988, with additional power being purchased by B.C. Hydro (British Columbia 1987c). The majority of the 1,150 workers and their families reside in the village of Elkford, situated half-way between Sparwood and the mine site.

Byron Creek Collieries Ltd. operates an open pit mine on Coal Mountain, near the former town of Corbin. In 1981 the company was acquired by Esso Resources Canada Limited, a subsidiary of Imperial Oil Ltd. The company recently completed an expansion program that nearly doubled its capacity, from 1 million tonnes of clean coal to 2 million tonnes per day (British Columbia 1986b). In 1986, 123 workers were employed.

The Line Creek operation of Crows Nest Resources Ltd. is equidistant between Sparwood and Elkford. The first unit train of thermal coal left the mine site in 1982, followed by the first trainload of metallurgical coal one year later. Crows Nest Resources Ltd. is a wholly-owned subsidiary of Shell Canada Resources (Schiller and Grieve 1983), employing 443 people in 1986.

Three other major coal projects have been proposed for the area: the Elco Mining property along the upper Elk River; the Sage Creek (Cabin Creek) property owned by Rio Algom; and the Hosmer Wheeler-Westar Mining property. However, these projects are stalled indefinitely as a result of current weak coal markets. There are at present no other projects proposed for this region under the provincial Mine Development Review Process (British Columbia 1987d). Should these coal mining projects proceed, a major investment in transportation systems would be needed within the Basin, as well as between the East Kootenays and the coast if the majority of the coal was destined for overseas markets. Other improvements in regional infrastructure and associated townsites would also be required to meet the needs of workers expected to in-migrate into the region (RDEK 1983).

A coal-related project within the Basin is a B.C. Hydro proposal to generate 600 MW of electricity from thermal coal wastes. The project would be located just north of Sparwood. Refuse coals that are the by-products of the nearby metallurgical coal mining operations would be supplied to the site by conveyor belt from existing coal stockpiles and settling lagoons. The coarse refuse would be rewashed, the slurry would be centrifuged, and the beneficiated products would be stored in covered sheds (B.C. Hydro 1981). This project has been subject to some preliminary technical, economic and environmental studies, but is not currently considered as a likely development project in the next few years (RDEK 1983).

At all of the existing operations, surface drainage occurs into settling ponds, to which flocculents are added prior to water being released into nearby tributaries. Problems associated with water quality are generally considered to be minimal at the present time, and short-term in nature when they do occur (British Columbia 1987i).

Approximately 90 percent of the coal produced is mined by surface methods. The remainder is mined underground, mostly by hydraulic methods (RDEK 1983). In surface mining, the shale and sandstone overlaying the coal is removed by drilling, blasting and excavation with large shovels and trucks. The excavated rock is hauled to backfill mined areas or is banked along inactive mountain slopes. The mined areas in the Basin are being progressively rehabilitated under extensive reclamation programs (RDEK 1983). Problems associated with acid rain are not expected to develop in the future as sulphur content is relatively low, generally in the 0.4 to 0.8 percent range (British Columbia 1987c).

Metallic and Non-Metallic Minerals

Kimberley is dependent upon the operations of Cominco Ltd. which are based on the Sullivan mine, the world's largest lead/zinc ore body. Lead and zinc concentrate is shipped to the smelter at Trail. The mine also produces tin (316 tonnes in 1982 containing 119 975 kg metal) and iron concentrates. Waste rock is sold to Canadian Pacific Railways for ballast (British Columbia 1986b).

Approximately 1.7 million tonnes of ore were produced in 1986, a 22 percent reduction from 1985 due to low world market prices. As a result, lead concentrate production was lower; zinc concentrate production actually exceeded the 1985 total by three percent because of higher grades (Cominco Ltd. 1987). Production levels for 1987 will be drastically reduced as a result of a strike that lasted nearly five months.

A major capital spending program which included further mechanization to increase productivity and improve working conditions began in 1977. Since then, total employment in the mine, concentrator and administrative offices continues to decline, decreasing from 986 in 1895, to 827 in 1986 (Cominco Ltd. 1987). Initially it was believed that the Sullivan mine had sufficient reserves to remain in operation until the end of the century. However the north end of the mine is now expected to be depleted within the next three to four years and further massive reductions in employment are expected (British Columbia 1987d). Exploration for additional lead/zinc ore bodies continues throughout the Basin (B.C. and Yukon Chamber of Mines 1987).

Metallic minerals (other than lead/zinc/silver) are found throughout the Basin in numerous known small deposits. At various times, metal mines in the region have been developed to exploit deposits of gold, copper and cadmium, but almost all have been forced to shut-down as deposits were exhausted. A resurgence of placer gold mining has been noted since 1981 (RDEK 1983).

Non-metallic minerals are also of commercial significance. Sand and gravel are readily available near major centres in the southern part of the Basin. Phosphate deposits are known to exist along the Elk Valley near Fernie, but have yet to be developed commercially. Baymag owns the rights to a very large body of magnesite ore located in the Upper Mitchell River Valley near Kootenay National Park. The magnasite is crushed on-site and shipped to Exshaw, Alberta for further processing (RDEK 1983).

Production in Cominco's fertilizer operation in Kimberley was severely curtailed in 1986 as a result of the poor market conditions for phosphates. The phosphate plant which normally employs approximately 150 people operated only 230 days in 1986 and was shut down at year-end for an indefinite period. Nearly one hundred employees were laid off (Cominco Ltd. 1987). An announcement from Cominco Ltd. that the fertilizer operation will be closed permanently is expected once the strike has been settled (City of Kimberley 1987).

The 1980s has seen renewed interest in oil and gas exploration in the Basin. Exploration in the Fernie area has led to the discovery of carbon dioxide which may be piped to Albertan oilfields to enhance oil recovery (British Columbia 1986b).

H. Agriculture

Agriculture is of less significance to the Basin's economy than either forestry or mining, although it is still an essential part of the social and cultural fabric of the community. Because of the predominantly mountainous terrain, poor soils and dry climate, the industry is almost exclusively confined to cattle ranching, although assorted field crops, miscellaneous specialty crops and poultry operations may be found locally. As outlined in Table 12, nearly half of the 402 farms enumerated in 1981 were operated part-time (British Columbia 1986b).

Approximately 250 000 hectares, or 2.7 percent of the Basin's land area, are included in the B.C. Agricultural Land Reserve; 19 837 hectares are actually used for farming (British Columbia 1986a). The total value of agricultural products in 1981 was approximately $7.2 million. Average gross annual farm income reported was $20,000, compared to $39,959 provincially. The average per-farm value rose from $161,000 in 1976 to $432,000 in 1981 (British Columbia 1986b).

TABLE 12. 1981 CENSUS FARMS CLASSIFIED BY SALES AND PRODUCT TYPE

Total Number of Farms	402
Value of Products Sold in 1980	
$250,000 and over	-
$100,000 to $249,999	9
$ 50,000 to $ 99,999	30
$ 25,000 to $ 49,999	48
$ 10,000 to $ 24,999	80
$ 5,000 to $ 9,999	57
$ 2,500 to $ 4,999	59
under $2,500	119

(British Columbia Regional Index 1986b, p. 8)

Cattle production was the primary activity of 87 percent of holdings with sales greater than $50,000 in 1981 (British Columbia 1984a). Most beef cattle are shipped directly to Alberta feedlots. Hay and alfalfa are the major crops in the area. Some dairy farming occurs near Fernie and Sparwood. Hogs, sheep and poultry are raised on a part-time basis, usually with direct off-farm sales. Egg production is largely for home comsumption. Due to climatic restrictions, neither tree fruit or small fruit production occurs commercially. Hothouse vegetables and floriculture/nursery production are important locally. Honey is also an important cash crop. An estimate of farm cash receipts by product type appears in Table 13.

The total number of farms in the region has declined between 1971 and 1981, largely because of the loss of high capability soils along the Kootenay River which was flooded behind the Libby Dam. Expansion of the beef industry has been limited due, in part, to the availability of Crown range for inexpensive summer grazing. Crown range makes up almost half of the rancher's annual forage supply.

Increased beef production continues to be one of the major opportunities for agricultural expansion in the Basin; increased production levels could be attained using the current land base plus recent technological advances. However, the continuing trend towards hobby farm development and land use pressure for non-agricultural purposes has led to increased fragmentation of farmland in the Basin (British Columbia 1984a). In the summer, irrigation water demand for forage crops is high, but not generally considered a limiting factor except on high capability soils (British Columbia 1983).

Competition for habitat between ungulates and domestic livestock has deteriorated rangelands in the Basin. The situation became acute in the 1960s partially due to loss of range from the creation of Lake Koocanusa. In the 1970s two significant changes occurred: the provincial government purchased several ranches and retired their existing grazing permits in favour of wildlife use and a program of deferred rotation grazing and

TABLE 13. ESTIMATE OF 1981 FARM CASH RECEIPTS--CRANBROOK AGRICULTURAL DISTRICT

Commodity	Farm Cash Receipts ($000)	Percentage	Percentage of B.C. Output
Wheat	22.93	0.18	0.19
Oats	6.68	0.05	0.23
Barley	9.88	0.08	0.10
Potatoes	19.04	0.15	0.10
Small Fruits	7.47	0.06	0.02
Tree Fruits	33.58	0.27	0.06
Field Vegetables	6.15	0.05	0.02
Hothouse Vegetables	163.34	1.30	0.56
Floriculture/Nursery	324.70	2.58	0.63
Other Crops	77.96	0.62	0.24
Total Crops	671.74	5.34	0.24
Cattle and Calves	5,239.37	41.68	4.27
Hogs	193.15	1.54	0.37
Sheep	85.42	0.68	3.24
Poultry and Eggs	256.84	2.04	0.19
Dairy Products	4,359.58	34.68	2.01
Honey	169.66	1.35	3.33
Other Livestock and Products	394.73	3.14	1.93
Total Livestock and Products	10,698.80	85.11	1.93
Forest Products and Def. Payments	240.92	1.92	2.68
Farm Income Assurance	785.53	6.25	1.86
Dairy Supplementary Payments	174.06	1.38	2.08
Total Cash Receipts	12,571.00	100.00	1.40

(British Columbia 1984, p. 25)

Coordinated Resource Management Planning was implemented to manage the forage resource for livestock and wildlife.

Studies are currently being undertaken by representatives of the regional agricultural district to determine the effects of elk ex-closures on feed supply for cattle. Experiments on seeding range with natural grasses are also in progress (British Columbia 1987a).

A relatively recent and major addition to the agricultural economy of the area has been the City of Cranbrook Spray Irrigation Project. The project, occupying 1335 ha of Crown land, is irrigated using the effluent from Cranbrook's sewage lagoons to produce hay, alfalfa and grain (British Columbia 1984d).

I. Tourism, Recreation and Parks

Tourism and Recreation

The natural resources of the Upper Kootenay River Basin have significantly contributed to the growth of tourism and recreation. Outdoor recreation activities such as camping, fishing, hunting, swimming, windsurfing, hiking and, more recently, skiing are the major visitor attractions; these activities also play a significant role in the lives of the Basin's residents. The extent of national and provincial park facilities located within and adjacent to the Basin, as well as warm summer temperatures and variety of water sports available, have added to the growing popularity of the East Kootenays as a tourist destination.

The importance of the tourist industry to the regional economy has steadily increased. The total number of visitors to the region in 1982 was approximately 960,000, with a constant eight to ten percent annual growth since then. Total 1981 revenue generated by tourism within the area was approximately $110 million, split almost evenly from expenditures by B. C. residents and out-of-province visitors (RDEK 1983). In 1983, tourism revenue amounted to $130 million or six percent of the provincial total (BCCCU 1985). Although wage rates in the tourism and recreation industry are traditionally lower than those in other sectors, the development of tourism within the area has helped somewhat to temper the traditional "boom and bust" cycle of the regional economy.

Summer is the peak tourist season with visitors and recreational activities concentrated around and on the Basin's lakes such as Whiteswan, Premier and Wasa Lakes. Specific attractions include Fort Steele Historic Park, Cranbrook, Sam Steele Days, the Kimberley Bavarian-type Platzl and July Festival, and Radium and Fairmont Hot Springs adjacent to the Upper Kootenay River Basin. In 1986, over 77,000 people visited Fort Steele, a heritage village that depicts the culture and economy of the East Kootenays at the turn of this century (British Columbia 1987f).

Wilderness hiking, canoeing and camping opportunities are offered in the Basin's numerous national and provincial parks (see p. 57). The City of Cranbrook, which serves as a major stop-over point in the area, has benefitted from being centrally located to such surrounding destinations. The Basin has a variety of accommodation facilities, including campgrounds and year-round hotels and motels (Table 14). In addition, there is a growing number of vacation homes and condominiums in the Basin.

Winter tourism relies on skiing, with two major alpine facilities located directly within the Upper Kootenay River Basin and two other alpine facilities located just north of the Basin. North Star Resort located in Kimberley offers five lifts and has a maximum vertical descent of 701 metres; Snow Valley Resort in Fernie has five lifts with a maximum vertical descent of 640 metres (RDEK 1983). Helicopter skiing is centered in the Bugaboo Alpine Recreation Area, at the northern end of the Basin. Cross-country skiing is also an important activity in the Basin.

Ancillary tourist attractions such as water slides, trail riding and white-water rafting have developed in response to an increase in tourism

TABLE 14. TOURIST ACCOMMODATION - 1985

	Establishments	Percentage of Provincial Total	Units	Percentage of Provincial Total
Hotels	7	3.1	165	0.9
Motor Hotels	10	6.4	642	6.8
Motels	54	6.9	890	4.8
Resorts, Camps, etc.	25	5.2	880	15.8
Campgrounds/ Trailer Parks	27	4.1	1,829	5.9

(British Columbia 1986b)

within the Basin. Other recreational opportunities such as hunting and fishing help to counteract the seasonal nature of the tourism-recreation sector, with the hunting of big game animals and waterfowl being particularly important during the fall. However, in recent years developments in other sectors of the economy such as hydroelectric projects, coal mines, forestry and cattle ranching have had adverse effects on the Basin's fish and wildlife resources and associated recreational activities (British Columbia 1976a).

The formation of Lake Koocanusa has had both positive and negative effects on recreation. Over 7000 hectares of critical winter range for ungulates and wetlands for waterfowl were lost by the flooding of the Upper Kootenay River, negatively impacting on the population of several species within the area (British Columbia 1987e). Effects on sport fisheries have not yet been determined. However, camping within the immediate proximity of Lake Koocanusa, as well as boating activities, has increased. The development of further water-related activities is hampered by the cold temperatures of the lake, as well as the extreme fluctuations of water levels.

A substantial number of investments in community recreation facilities have also been made including curling rinks, skating rinks, gymnasiums, swimming pools, community parks, golf courses and community halls. The general availability of high quality outdoor recreation lessens the degree of dependence upon community-provided recreation facilities relative to more northern regions of the province or large urban centres. One consequence of the rapid growth in tourism and recreation sector activity over the past twenty years has been increased competition for recreational resources between tourists and local residents. Hunting and fishing pressures upon a declining resource base, highway congestion, purchase by non-residents of prime waterfront land and other recreational properties, and increased accommodation and food prices during the summer months have all had a negative impact on the costs of recreation for regional residents (British Columbia, 1976a).

Parks

Kootenay National Park at 140 637 hectares is the largest park in the Basin. Sixteen Class A provincial parks and one Class C park cover an additional 66 573 hectares (Figure 7). Of these, Mount Assiniboine is the largest provincial park with 39 052 hectares, followed by St. Mary's Alpine (9146 hectares), Top of the World (8719 hectares) and Elk Lakes (5625). The remaining provincial parks are considerably smaller, ranging in size from 4 to 1997 hectares (Figure 7). Purcell Wilderness Conservancy adjacent to the Basin contains a further 131 523 hectares. Several of the parks and wilderness areas are not accessible by road, while others are fully serviced. A complete list of parks, their areas, locations and use is given in Table 15.

Regional parks are located at Wycliffe (181 hectares) and Tie Lake (9 hectares) (RDEK 1983) and there is a recreation area at Elk Lakes (11 620 hectares) (British Columbia 1987f). In 1987 the Height of the Rockies, the province's first wilderness area within a provincial forest, was created. Covering 73 000 hectares, Height of the Rockies is located southwest of Kootenay National Park and Mount Assiniboine Park and east of Elk Lakes Park. The wilderness area is 66 percent alpine and features 26 peaks over 3000 metres, 50 lakes and 20 glaciers (The Kootenay Advertiser 1987).

A new provincial park along a portion of Lake Kookanusa is under consideration; the proposal calls for a system of shoreline trails to be built along the lake. Environment Canada Parks has also indicated an interest in preserving the Kootenay River in its natural state as far south as Canal Flats due to its excellent canoeing and kayaking potential; however, such an initiative would require provincial cooperation (RDEK 1983).

TABLE 15. PARKS

	Classification	Hectares	Campsites
Canal Flats	A	6	
Crow's Nest	A	49	
Elk Lakes	A	5 625	20
Elk Lakes	Recreation Area	11 620	
Elk Valley	A	81	
Elko	C	24	
Fort Steele Historic Park	A	150	
Height of the Rockies	Provincial Forest Wilderness Area	73 000	
Jimsmith Lake	A	12	29
Kikomun Creek	A	682	74
Kootenay National Park	-	140 637	
Morrissey	A	5	
Mt. Assiniboine	A	39 052	75
Mt. Fernie	A	259	38
Norbury Lake	A	97	46
Premier Lake	A	697	57
Purcell Wilderness Conservancy	Wilderness Conservancy	131 523	
St. Mary's Alpine	A	9 146	
Tie Lake Regional Park	-	9	
Top of the World	A	8 791	28
Wardner	A	4	
Wasa Lake	A	200	104
Whiteswan Lake	A	1 997	107
Wycliffe Regional Park	-	181	

A - Public Recreation Only - no industrial or commercial exploitation

C - Local Recreational Use and Management

(RDEK 1983 and B.C. 1987f).

4. SUMMARY AND CONCLUSIONS

The Upper Kootenay River rises in the Rocky Mountains and flows south for approximately 400 kilometres before crossing the international boundary into the State of Montana. The Kootenay swings west then northwest through the State of Idaho for 350 kilometres before re-entering Canada. The Lower Kootenay River flows north into Kootenay Lake and finally southwest from the lake to enter the Columbia River above Trail. The major tributaries of the Upper Kootenay River include the Vermilion, Palliser, White, Lussier, St. Mary, Bull and Elk Rivers.

The Upper Kootenay River Basin has three distinct physiographic units: the Rocky Mountains to the east, the Purcell Mountains to the west, and the Rocky Mountain Trench which runs north to south between the two. The numerous elongated ranges within the Basin are aligned approximately north-northwest to south-southeast, with watercourses flowing in similar directions within the valleys and floodplains. The climate is influenced by dry maritime polar air masses and characterized by hot summers with sporadic rain shower activity and long, cold winters. Portions of the Basin lie in zones of relatively high snowfall. Temperatures average 17.8 degrees Celsius in July and -8.9 degrees Celsius in January with a frost-free season of about 96 days.

The Upper Kootenay River drains 20 000 square kilometres and has a mean annual flow of 298 cms. Seasonal flow patterns are characterized by peak discharges in May or June from snowmelt and spring rains. Minimum flows occur during summer and early fall, often creating water deficits in smaller tributaries.

Six broad biogeoclimatic zones are found within the Basin, the most dominant of which are the Interior Douglas Fir Zone and the Subalpine Engelmann Spruce-Subalpine Fir Zone. Landforms, surficial desposits and soils of the Basin strongly reflect the influences of glaciation.

The Basin supports a variety of wildlife, with Rocky Mountain Elk the most abundant ungulate species. The Rocky Mountain Trench provides critical winter habitat since deep snow in the Rocky and Purcell Mountains excludes winter use by species other than moose or elk. Competition for range land between livestock and big game has been exacerbated by the formation of Lake Koocanusa, as well as by increased forestry and mining activities. The provincial Fish and Wildlife Branch is working with local ranchers and foresters to improve habitat management techniques. The implementation of Coordinated Resource Management Plans and Range Unit Plans in the Basin also addresses this issue. The Basin offers good sport fishing opportunities, particularly for Dolly Varden char, Yellowstone cutthroat trout and mountain whitefish. Many of the lakes are stocked from a provincial hatchery in Wardner. There are no anadromous fish in the Basin, nor is the area noted for its waterfowl capability.

Mining was the first major catalyst to economic activity in the Basin. A gold rush near Fort Steele in the mid-1860s was followed by the discovery of sizeable lead, zinc and silver ore bodies near Kimberley in 1892. It wasn't until the region became accessible by rail, however, that the export of minerals and forest products became significant.

Today, coal mining is the Basin's major economic activity. Four major companies operate five coal mines in the region; three other major coal projects have been proposed. Development may commence when world market prices improve.

Forestry also plays an important role in the Basin's economy. Eight permanent mills are currently in operation, with finished lumber being the major product. Regional sawmills are modifying plant production lines to accommodate smaller diameter logs in response to changes in traditional forest species. Over the past several years, the allowable annual cut has decreased and is expected to continue to decline in the future. A decline in timber quality has also been noted.

Agriculture is mostly limited to ranching within the Basin. Nearly half of the farms in the region are part-time operations. Other economic activities of importance within the area are tourism and recreation. Summer is the peak tourist season with activities concentrated around outdoor recreation in the Basin's national and provincial parks. Downhill and cross-country skiing are increasing in popularity.

Federal lands within the Basin include Kootenay National Park, as well as several small Indian Reserves.

Water quality in the Basin is generally considered to be good, although in the past there have been problems associated with discharge from Cominco Limited's lead-zinc mine and phosphate fertilizer operation in Kimberley, as well as problems associated with discharge from Crestbrook Forest Industry Limited's pulp mill at Skookumchuck. In the Elk River Basin, potential water quality problems are associated with mining exploration, coal mining and related operations such as coal washing and coking.

Water quality in the Basin was affected by the formation of Lake Koocanusa, a 148-kilometre reservoir created when the Upper Kootenay River was impounded by Libby Dam in the United States in the early 1970s. Biological productivity was also affected. Approximately 7287 hectares of wildlife and livestock habitat were flooded, resulting in increased competition for range land. Annual water level fluctuations of 60 to 100 metres during winter months contribute to soil erosion, as well as complicate the development of recreational facilities. The water level fluctuations were agreed to in the 1961 Columbia River Treaty between Canada and the United States. Water levels are now monitored by the 4-member international Columbia River Treaty Permanent Engineering Board. Inland Waters/Lands provides technical and administrative support to the Board.

A proposal by B.C. Hydro to divert up to two-thirds of the average annual flow of the Kootenay River into the headwaters of the Columbia River at Canal Flats received extensive scrutiny in the late 1970s. Under the

Columbia River Treaty, the diversion of up to 1.5 million acre feet of water per year became possible after September 1984, providing the flow of Kootenay River is not reduced to below the lesser of 200 cfs or the natural flow. The proposed diversion was postponed indefinitely; however, should B.C. Hydro determine the diversion of portions of the Upper Kootenay River to be feasible in the future, Environment Canada could have some involvement in the project.

There are several other resource use concerns in the Basin; most can be alleviated with effective planning and management, and most are under provincial jurisdiction. An overriding concern to the Basin's residents is their future economic survival. The Basin's economy is strongly linked to primary industries such as mining and forestry. Diversification into other sectors such as tourism and manufacturing would help to lessen dependence on these sectors.

At present, there seems to be few areas of concern or increased involvement for the federal government, particularly Inland Waters/Lands. Water quality deterioration from increased mining activity could be a problem in the future, although transboundary water quality changes from these activities would be detected through routine federal and provincial monitoring programs. Should B.C. Hydro implement a proposal to divert portions of the Upper Kootenay River into Columbia River in the future, attention from federal government agencies would be warranted at that time. Any future development on either side of the international boundary which may affect water quality or quantity on the other side would require increased federal involvement, as the Upper Kootenay is an international river. It should be noted that activities in the States of Montana and Idaho were not reviewed during this study, and represent an area worthy of further investigation.

REFERENCES

British Columbia. Agricultural Land Commission. 1986a. Annual Report Year Ended March 31, 1986. Vancouver, B.C.: Provincial Agricultural Land Commission.

British Columbia. Ministry of Agriculture and Food. 1984a. Agriculture Profile: Cranbrook District, prepared by Policy Development and Economics Division. Victoria, B.C.

British Columbia. Ministry of Agriculture and Food. July, 1987a. Pers. Comm. Psyche Brown, Cranbrook, B.C.

British Columbia. Ministry of Economic Development. Central Statistics Bureau. April 1987b. British Columbia Census Population and Occupied Private Dwellings for Census Divisions and Subdivisions. Victoria, B.C.

British Columbia. Ministry of Economic Development. 1986b. British Columbia Regional Index 1986. Victoria, B.C.

British Columbia. Ministry of Economic Development. 1976a. A Summary Report of Development Possibilities in the Kootenay Region of British Columbia, prepared by Interim Planning Agreement Staff. Victoria, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. Geological Branch. July 24, 1987c. Pers. Comm. David Grieve, District Geologist. Fernie, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. Mineral Policy and Evaluation Branch, Mineral Resources Division. July 9, 1987d. Pers. Comm. Josephine Harris, Research Officer. Victoria, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. Mineral Policy and Evaluation Branch., 1986c. Coal in British Columbia: Paper 1986-3. Victoria, B.C.

British Columbia. Ministry of Environment. Assessment and Planning Division, Air Studies Branch. 1981a. A Summary of Climatic Regimes of B.C. Victoria, B.C.

British Columbia. Ministry of Environment. Assessment and Planning Division, Air Studies Branch. 1981b. Kootenay Air and Water Quality Study Phase II - Water Quality in the Kootenay River Basin. Bulletin #20. Victoria, B.C.

British Columbia. Ministry of Environment. Assessment and Planning Division, Terrestrial Studies Branch. 1981c. Biophysical Resources of the East Kootenay Area: Outdoor Recreation. Bulletin #8. Victoria, B.C.

British Columbia. Ministry of Environment. Assessment and Planning Division, Terrestrial Studies Branch. 1981d. Biophysical Resources of the East Kootenay Area: Terrain. Bulletin #7. Victoria, B.C.

British Columbia. Ministry of Environment. Fish and Wildlife Branch. July 23, 1987e. Pers. Comm. Ray Demarchi, Regional Wildlife Biologist. Cranbrook, B.C.

British Columbia. Ministry of Environment. Parks and Outdoor Recreation Division. February 1987f. Park Data Handbook 1986. Victoria, B.C.: Queen's Printer.

British Columbia. Ministry of Environment and Parks. Parks and Outdoor Recreation Division. July 21, 1987g. Pers. Comm. Dennis Herman, Assistant District Manager. Wasa Lake, B.C.

British Columbia. Ministry of Environment and Parks. Recreational Fisheries Branch. 1987h. B.C. Sport Fishing Regulations Synopsis 1987/1988 for Non-Tidal Waters. Victoria, B.C.

British Columbia. Ministry of Environment. Surveys and Resource Mapping Branch. 1984b. Biophysical Resources of the East Kootenay Area: Vegetation, Volume 1. Technical Report #5. Kelowna, B.C.

British Columbia. Ministry of Environment. Waste Management Branch. July 23, 1987i. Pers. Comm. Mark Strosher, Industrial Waste Management Officer. Cranbrook, B.C.

British Columbia. Ministry of Environment. Inventory and Engineering Branch. 1981e. Summary of Snow Survey Measurements 1935-1980. Victoria, B.C.: Queen's Printer.

British Columbia. Ministry of Environment. Water Resources Service. 1976b. Kootenay Air and Water Quality Study Phase 1-Assessment of Information Available to the End of 1974-Water Quality in Region 4, The Lower Kootenay River Basin. Victoria, B.C.

British Columbia. Ministry of Environment. Water Resources Service. 1976c. Kootenay Air and Water Quality Study Phase 1-Assessment of Information Available to the End of 1974-Water Quality in Region 2, The Elk River Basin. Victoria, B.C.

British Columbia. Ministry of Environment. Water Resources Service. Groundwater Division. July 8, 1987j. Pers. Comm. Carol Foote, Mapping Officer. Victoria, B.C.

British Columbia. Ministry of Environment. Wildlife Branch. 1986d. Biophysical Resources of the East Kootenay Area: Wildlife. Technical Report #22. Victoria, B.C.

British Columbia. Ministry of Environment. Wildlife Branch. 1986e. B.C. Hunting Regulations Synopsis 1986-1987. Victoria, B.C.

British Columbia. Ministry of Forests. 1981f. Invermere Timber Supply Area Yield Analysis Report - October 1981-Nelson Forest Region. Nelson, B.C.

British Columbia. Ministry of Forests. 1984c. Invermere Timber Supply Area Plan 1984-2004 (unpublished report). Invermere, B.C.

British Columbia. Ministry of Forests. Planning and Inventory Branch. 1985a. Cranbrook Timber Supply Area Timber Supply Analysis Report. Cranbrook, B.C.

British Columbia. Ministry of Forests. 1985b. Cranbrook Forest Timber Supply Area Plan-Nelson Forest Region. Cranbrook, B.C.

British Columbia. Ministry of Lands, Parks and Housing. Lands and Housing Regional Operations Division. 1983. Southern Rocky Mountain Trench Sub-District Crown Land Concept Plan (unpublished report). Cranbrook, B.C.

British Columbia. Ministry of Lands, Parks and Housing. Lands and Housing Regional Operations Division. 1984d. Southern Rocky Mountain Trench Sub-District Crown Land Plan. Victoria, B.C.

British Columbia Central Credit Union. Economics Department. 1985. Socio-Economic Profiles by 1982 Census Divisions--East Kootenay Regional District #01. Vancouver, B.C.

British Columbia Hydro and Power Authority. Public Affairs Dept. 1981. Power Perspectives 1979. Vancouver, B.C.

British Columbia and Yukon Chamber of Mines. 1987. Mining Exploration and Development Review, 1986, BC/Yukon. Vancouver, B.C.

Canada. Environment Canada. Inland Waters Directorate. 1980. The Effects of Upstream Impoundments on the Limnology of Kootenay Lake, B.C., by R.J. Daley, E.C. Carmack, C.B.J. Gray, C.H. Pharo, S. Jasper and R.C. Wiegand (unpublished report). Vancouver, B.C.

Canada. Environment Canada. Lands Directorate. 1970. Canada Land Inventory: Land and Capability Analysis, East Kootenay Area. Ottawa, Ont.

Canada. Environment Canada. 1968a. Lands Directorate. Canada Land Inventory: Land Capability for Wildlife-Ungulates, East Kootenays 82G. Ottawa, Ont.

Canada. Environment Canada. 1968b. Lands Directorate. Canada Land Inventory: Land Capability for Wildlife-Waterfowl, East Kootenays 82G. Ottawa, Ont.

Canada. Environment Canada. Atmospheric Environment Service. 1982a. Canadian Climate Normals: 1951-1980 Temperature and Precipitation. Downsview, Ont.

Canada. Environment Canada. Inland Waters Directorate. Energy Developments Section. Engineering Division. Water Planning and Management Branch. March 1975. Inventory of Hydro Power Plants (Existing) in British Columbia (unpublished report). Vancouver, B.C.

Canada. Environment Canada. Inland Waters Directorate. Water Quality Branch. August 1986a. Distributional Properties of Selected Water Quality Variables in the St. Mary River (B.C.), 1975 and 1980 to 1982, by Paul H. Whitfield and B. McNaughton. Vancouver, B.C.

Canada. Environment Canada. Inland Waters and Lands. Water Quality Branch. Pers. Comm. Normand Rousseau, Water Quality Officer. August 1987a. Vancouver, B.C.

Canada. Environment Canada. Inland Waters and Lands. Water Resources Branch. Water Survey of Canada. 1985. Historical Streamflow Summary British Columbia, to 1984. Ottawa, Ont.: Ministry of Supply and Services.

Canada. Environment Canada. Inland Waters and Lands. Water Resources Branch. Water Survey of Canada. 1987b. Surface Water Data British Columbia 1986. Ottawa, Ont.: Ministry of Supply and Services.

Canada. Department of Indian Affairs and Northern Development. 1982b. Reserve Index. Vancouver, B.C. Department of Indian Affairs and Northern Development.

Canada. Employment and Immigration Commission-B.C. and Y.T. Region. June, 1986b. Employers Directory (computer printout). Vancouver, B.C.: Canada Employment and Immigration Commission.

Canada. Department of Public Works. Property Development Directorate. 1981. The Kootenays. Ottawa, Ont.: Minister of Supply and Services.

City of Kimberley. Pers. Comm. Larry Haber, Economic Development Officer. July 21, 1987. Kimberley, B.C..

The Coal Association of Canada. 1987. 1987 Review and Directory. Calgary, Alberta.

Cominco Ltd. 1987. Cominco Ltd. Annual Report 1986. Vancouver, B.C.

Farley, A.L. 1979. Atlas of British Columbia: People, Environment and Resource Use. Vancouver, B.C. The University of British Columbia Press.

Holland, Stewart S. 1976. Landforms of British Columbia: A Physiographic Outline. Bulletin 48. Victoria, B.C.: B.C. Department of Mines and Petroleum Resources.

Kelley, C.C. and P.N. Sprout. 1956. Soil Survey of the Upper Kootenay and Elk River Valleys in the East Kootenay District of British Columbia. Report #5 of the British Columbia Soil Survey. Victoria, B.C.: B.C. Department of Agriculture; Canada Department of Agriculture.

The Kootenay Advertiser. July 20, 1987. Our Precious Wilderness (Author unknown).

Krajina, V.J. 1976. Biogeoclimatic Zones of British Columbia. Vancouver, B.C.: MacMillan Bloedel.

Langin, H.D. and R. Carswell. 1974. Effects of the Libby Dam Upon Waterfowl, Fur Bearer, and Upland Game Bird Populations of the East Kootenay Area of British Columbia (unpublished report).

Mining Association of British Columbia and Price Waterhouse. 1985. Mining in British Columbia 1985. Vancouver, B.C.

Regional District of East Kootenay and Economic Development Commission. June, 1983. Regional Profile 1983. Cranbrook, B.C.

Schiller, E.A. and D. Grieve. August, 1983. "The Coalfields of Southeastern British Columbia" from Mining Magazine. Calgary, Alberta.

United States of America. U.S. Army Corps of Engineers, Seattle District. 1982. Annual Nutrient Loadings, Primary Productivity, and Trophic State of Lake Koocanusa, Montana and British Columbia, 1972-80 by Paul F. Woods, Geological Survey Professional Paper 1283. Washington, D.C.

Whitfield, Paul H. and Paul F. Woods. "Intervention Analysis of Water Quality Records" from Water Resources Bulletin. October 1984. Volume 20, No. 5, pp. 657-668.

APPENDIX 1. CLIMATIC NORMS FOR SELECTED STATIONS (CANADA 1982A)

CANAL FLATS RANGER STN
50° 9'N 115° 49'W 817 m

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE
Daily Maximum Temperature	–4.8	1.1	6.6	13.4	19.2	22.5	27.2	26.2	20.0	12.4	2.5	–2.7	12.0
Daily Minimum Temperature	–13.9	–9.1	–5.2	–0.4	4.3	7.9	10.0	9.4	5.4	0.5	–5.5	–10.4	–0.6
Daily Temperature	**–9.4**	**–3.9**	**0.7**	**6.6**	**11.7**	**15.2**	**18.6**	**17.8**	**12.6**	**6.4**	**–1.5**	**–6.6**	**5.7**
Standard Deviation, Daily Temperature	3.4	2.6	1.9	1.4	1.0	1.3	1.2	1.7	2.2	1.0	1.7	3.6	0.7
Extreme Maximum Temperature	11.7	13.3	22.0	29.4	31.1	33.9	38.0	36.7	35.0	29.0	17.2	11.7	38.0
Years of Record	17	18	17	18	17	17	19	19	18	16	13	16	
Extreme Minimum Temperature	–38.3	–31.7	–23.9	–12.2	–3.9	–0.6	1.1	0.0	–4.4	–17.2	–23.3	–41.7	–41.7
Years of Record	17	18	17	16	17	18	19	19	18	16	15	15	
Rainfall	8.2	3.6	7.3	17.0	33.7	42.2	27.1	32.7	25.2	16.2	17.3	11.5	242.0
Snowfall	44.6	27.8	11.1	3.2	0.1	0.0	0.0	0.0	0.1	4.4	13.0	36.0	140.3
Total Precipitation	**53.3**	**24.4**	**18.4**	**18.7**	**30.1**	**39.7**	**26.0**	**33.8**	**27.9**	**19.6**	**32.5**	**44.7**	**369.1**
Standard Deviation, Total Precipitation	19.4	16.4	10.7	14.4	21.4	20.8	12.6	15.2	14.7	11.6	22.0	25.3	49.4
Greatest Rainfall in 24 hours	21.8	11.2	16.5	20.6	27.9	41.1	25.7	19.3	26.9	15.2	25.1	15.0	41.1
Years of Record	18	17	16	17	18	18	18	19	17	17	15	16	
Greatest Snowfall in 24 hours	25.4	19.1	12.0	10.2	0.8	0.0	0.0	0.0	2.5	15.2	15.2	24.1	25.4
Years of Record	17	16	16	17	18	18	19	19	18	17	16	17	
Greatest Precipitation in 24 hours	25.4	19.1	17.5	26.9	27.9	41.1	25.7	19.3	26.9	16.8	25.1	24.1	41.1
Years of Record	17	16	16	16	18	18	18	19	17	17	16	17	
Days with Rain	1	2	3	6	8	10	7	9	7	5	4	2	64
Days with Snow	10	7	4	1	0	0	0	0	0	1	5	8	36
Days with Precipitation	11	9	6	7	8	10	7	9	7	6	8	11	99

FERNIE
49° 30'N 115° 3'W 1003 m

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE
Daily Maximum Temperature	–4.1	1.2	4.0	10.3	16.4	20.1	24.6	23.9	18.4	11.5	2.6	–1.9	10.6
Daily Minimum Temperature	–12.3	–9.1	–6.4	–1.5	2.7	6.2	7.9	7.4	3.7	–0.2	–4.5	–9.1	–1.3
Daily Temperature	**–8.1**	**–3.8**	**–1.2**	**4.4**	**9.5**	**13.1**	**16.3**	**15.7**	**11.1**	**5.7**	**–0.9**	**–5.6**	**4.7**
Standard Deviation, Daily Temperature	3.9	2.7	2.5	1.5	1.0	1.2	1.0	1.7	2.1	1.5	1.9	3.4	0.6
Extreme Maximum Temperature	10.6	12.2	19.4	28.9	32.8	36.1	35.6	35.0	31.7	28.0	18.3	12.5	36.1
Years of Record	63	60	61	63	62	59	62	61	61	60	58	59	
Extreme Minimum Temperature	–39.4	–40.0	–31.7	–20.0	–7.8	–2.2	0.0	–1.1	–18.3	–24.4	–32.2	–41.7	–41.7
Years of Record	62	62	62	63	62	60	64	61	60	63	59	61	
Rainfall	48.0	43.2	37.6	49.3	71.2	87.1	48.0	59.0	65.0	77.6	75.3	69.1	730.4
Snowfall	109.0	71.0	42.6	17.3	0.7	0.0	0.0	0.0	0.9	10.9	42.5	101.6	396.5
Total Precipitation	**157.0**	**114.2**	**80.2**	**66.7**	**71.9**	**87.1**	**48.0**	**59.0**	**66.0**	**88.5**	**118.3**	**170.7**	**1127.6**
Standard Deviation, Total Precipitation	76.4	62.7	30.5	31.9	34.4	32.2	31.0	46.5	38.0	56.1	72.4	63.7	200.9
Greatest Rainfall in 24 hours	63.5	81.8	37.6	47.0	41.7	52.8	48.5	44.7	64.3	105.7	70.6	106.2	106.2
Years of Record	62	62	61	61	61	61	63	66	58	58	63	63	
Greatest Snowfall in 24 hours	38.1	48.3	33.0	31.8	21.6	0.5	0.0	0.0	28.4	20.3	45.7	63.5	63.5
Years of Record	62	62	61	63	62	64	66	66	62	63	64	63	
Greatest Precipitation in 24 hours	63.5	81.8	37.6	47.0	41.7	52.8	48.5	44.7	64.3	105.7	70.6	106.2	106.2
Years of Record	61	62	62	61	61	61	63	66	58	59	64	62	
Days with Rain	4	4	6	10	13	13	9	9	10	9	7	6	100
Days with Snow	14	11	9	4	*	0	0	0	*	2	8	14	62
Days with Precipitation	17	13	13	12	13	13	9	9	10	11	13	18	151

GRASMERE
49° 6'N 115° 5'W 869 m

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE
Daily Maximum Temperature	–2.3	3.6	7.5	13.8	19.1	22.8	28.3	27.0	21.1	13.1	3.7	–0.2	13.1
Daily Minimum Temperature	–9.2	–5.3	–3.6	0.2	4.4	7.7	10.3	9.6	5.2	0.5	–3.4	–6.4	0.8
Daily Temperature	**–5.7**	**–0.9**	**2.0**	**7.0**	**11.8**	**15.3**	**19.3**	**18.3**	**13.2**	**6.8**	**0.2**	**–3.3**	**7.0**
Standard Deviation, Daily Temperature	4.3	2.0	2.5	1.9	1.2	1.9	1.6	2.1	2.4	1.8	1.7	3.6	0.6
Extreme Maximum Temperature	12.8	20.0	22.2	30.0	33.9	35.6	38.9	39.4	35.6	30.5	20.6	13.3	39.4
Years of Record	19	19	18	18	18	19	19	19	19	18	19	18	
Extreme Minimum Temperature	–36.0	–26.7	–23.9	–10.6	–6.1	–2.0	0.0	0.0	–6.7	–15.6	–25.6	–42.8	–42.8
Years of Record	19	19	19	19	19	18	19	19	19	19	18	18	
Rainfall	15.9	17.8	12.3	26.0	56.3	68.8	41.8	54.7	37.5	24.1	24.6	18.2	398.0
Snowfall	31.4	15.5	9.5	6.0	0.4	0.0	0.0	0.0	0.1	4.1	14.8	27.4	109.2
Total Precipitation	**43.3**	**29.9**	**21.3**	**29.8**	**56.7**	**68.8**	**41.8**	**54.7**	**37.4**	**28.0**	**38.4**	**43.6**	**493.7**
Standard Deviation, Total Precipitation	23.4	19.6	9.5	23.8	28.3	44.3	30.9	47.2	23.9	15.0	40.1	27.6	100.8
Greatest Rainfall in 24 hours	21.6	26.9	18.3	30.2	33.3	45.2	37.1	43.9	40.6	18.8	34.3	22.4	45.2
Years of Record	18	17	19	18	17	18	17	19	19	17	17	17	
Greatest Snowfall in 24 hours	26.7	16.5	17.6	43.2	5.1	0.0	T	0.0	3.8	17.8	15.2	27.9	43.2
Years of Record	16	17	19	18	19	19	19	19	19	18	17	17	
Greatest Precipitation in 24 hours	26.7	26.9	18.3	43.2	33.3	45.2	37.1	43.9	40.6	18.8	34.3	27.9	45.2
Years of Record	17	17	19	18	17	18	17	19	19	17	17	17	
Days with Rain	3	3	3	6	8	8	6	7	6	5	4	4	63
Days with Snow	6	3	2	1	0	0	0	0	0	1	3	6	22
Days with Precipitation	9	6	5	6	8	8	6	7	6	5	7	9	82

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE
KIMBERLEY													
49° 41'N 115° 59'W 1177 m													
Daily Maximum Temperature	-4.6	0.3	3.8	10.0	15.8	20.1	24.6	23.0	17.4	10.4	1.3	-2.6	10.0
Daily Minimum Temperature	-12.5	-8.4	-5.9	-0.8	3.6	7.6	10.2	10.0	5.1	0.2	-6.0	-9.9	-0.6
Daily Temperature	**-8.6**	**-4.0**	**-1.1**	**4.6**	**9.7**	**13.9**	**17.4**	**16.5**	**11.2**	**5.3**	**-2.3**	**-6.3**	**4.7**
Standard Deviation, Daily Temperature	3.2	1.5	2.1	1.4	1.3	1.4	1.5	2.3	3.2	1.3	1.5	2.4	0.6
Extreme Maximum Temperature	12.2	11.7	17.2	22.2	28.3	31.1	33.9	34.4	28.3	22.8	13.9	8.3	34.4
Years of Record	13	13	13	12	11	11	11	11	9	12	13	13	
Extreme Minimum Temperature	-32.2	-25.0	-23.3	-11.1	-3.3	0.0	2.2	0.6	-5.0	-15.0	-22.2	-37.2	-37.2
Years of Record	13	12	13	10	10	11	10	11	9	13	13	13	
Rainfall	8.6	8.5	12.7	22.0	43.9	61.5	29.1	41.5	26.8	37.6	16.4	10.5	317.1
Snowfall	101.5	45.7	40.8	12.6	1.0	0.0	0.0	0.0	0.5	6.7	48.4	84.6	341.8
Total Precipitation	**104.4**	**59.9**	**59.8**	**32.3**	**42.0**	**57.3**	**20.4**	**38.5**	**33.5**	**48.1**	**72.2**	**91.9**	**660.3**
Standard Deviation, Total Precipitation	35.1	19.3	21.8	20.0	17.4	40.6	16.6	21.5	25.2	29.6	41.0	41.0	79.9
Greatest Rainfall in 24 hours	20.6	9.9	20.6	17.8	42.4	41.9	21.6	50.8	20.1	45.7	23.4	14.2	50.8
Years of Record	13	12	13	11	10	11	11	12	12	13	12	13	
Greatest Snowfall in 24 hours	35.6	27.9	18.3	21.6	5.1	0.0	T	0.0	15.2	19.1	31.0	40.4	40.4
Years of Record	13	12	13	10	11	11	12	12	13	13	12	, 12	
Greatest Precipitation in 24 hours	35.6	27.9	24.1	22.9	42.4	41.9	21.6	50.8	20.1	48.8	31.0	40.4	50.8
Years of Record	13	12	13	11	10	11	11	12	12	13	12	13	
Days with Rain	2	2	3	6	9	10	7	9	7	7	4	2	68
Days with Snow	16	9	7	3	1	0	0	0	0	2	8	13	59
Days with Precipitation	17	12	11	8	9	11	7	8	8	10	12	14	127
KOOTENAY NP KTNY CRSG													
50° 52'N 116° 3'W 1170 m													
Daily Maximum Temperature	-7.0	-0.7	4.0	10.3	16.2	20.0	24.1	23.0	16.8	8.7	-0.4	-5.8	9.1
Daily Minimum Temperature	-18.1	-14.4	-10.5	-4.3	-0.7	2.9	3.9	3.0	0.2	-3.5	-10.6	-15.8	-5.7
Daily Temperature	**-12.5**	**-7.7**	**-3.2**	**3.0**	**7.8**	**11.5**	**14.0**	**13.1**	**8.6**	**2.6**	**-5.5**	**-10.8**	**1.7**
Standard Deviation, Daily Temperature	4.4	2.5	1.7	1.2	1.1	1.2	1.1	1.6	1.8	0.9	2.2	2.9	0.3
Extreme Maximum Temperature	7.2	11.1	16.7	22.2	28.9	32.2	34.4	35.0	33.3	23.0	14.4	6.7	35.0
Years of Record	10	10	12	11	12	13	14	14	11	13	13	12	
Extreme Minimum Temperature	-42.8	-36.1	-34.5	-22.2	-8.9	-5.6	-6.5	-3.9	-8.3	-20.6	-31.7	-42.8	-42.8
Years of Record	12	12	12	12	12	13	14	14	13	12	14	14	
Rainfall	2.7	2.5	2.8	12.9	49.9	63.5	38.0	42.3	38.5	27.3	10.5	1.6	292.5
Snowfall	55.9	28.5	18.4	3.9	0.7	0.0	0.0	0.0	0.9	5.1	23.0	56.8	193.2
Total Precipitation	**58.3**	**32.7**	**22.8**	**17.9**	**47.0**	**61.1**	**37.3**	**43.1**	**44.9**	**34.5**	**42.0**	**63.2**	**504.8**
Standard Deviation, Total Precipitation	25.1	26.4	16.0	17.5	40.8	30.4	20.2	30.6	20.4	19.5	24.3	36.7	38.2
Greatest Rainfall in 24 hours	5.1	6.4	9.4	16.0	77.7	28.7	39.6	23.9	18.3	25.4	14.0	11.0	77.7
Years of Record	11	14	11	12	12	14	11	15	15	13	11	11	
Greatest Snowfall in 24 hours	27.9	22.4	30.5	13.7	4.1	0.0	0.0	0.0	8.4	13.2	27.4	27.4	30.5
Years of Record	12	12	12	13	14	16	16	16	16	14	11	11	
Greatest Precipitation in 24 hours	27.9	22.4	30.5	16.0	77.7	28.7	39.6	23.9	19.6	25.4	27.4	27.4	77.7
Years of Record	12	12	12	12	12	14	11	15	15	13	11	10	
Days with Rain	1	1	1	3	10	11	10	9	9	6	3	0	64
Days with Snow	12	8	6	1	0	0	0	0	0	2	7	12	48
Days with Precipitation	12	10	7	5	10	11	10	9	9	8	10	12	113