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WATER USE IN THE LOWER KOOTENAY RIVER BASIN

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Inland Waters and Lands
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ENVIRONMENT CANADA
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PACIFIC AND YUKON REGION

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ABSTRACT

To provide a data base for long-term water demand forecasting and planning, water use in the Lower Kootenay River Basin is estimated for three economic sectors and five sub-basins. Information sources include existing population, agricultural and industrial data from federal, provincial and municipal agencies, private sector interviews and field work.

Annual water use in the Basin is estimated to be 27.4 million cubic metres. Agriculture accounts for 53.7 percent of this total, with domestic and commercial water use accounting for 43.9 percent. Industrial water use is 2.4 percent. Most water use occurs in the South Lake sub-basin. A major increase in water demand is not expected in the foreseeable future.

RESUME

L'utilisation d'eau du bassin inférieure de la rivière Kootenay est estimée pour trois secteurs économiques et cinq sous-bassins dans le but de fournir une banque de donnée pour la planification et la prédiction de besoin en eau à long terme. Les informations sur la population actuelle, l'agriculture et l'industrie viennent de données d'agences fédérales, provinciales et municipales, d'entrevue avec le secteur publique et de travail sur le terrain.

L'utilisation d'eau annuelle du bassin est estimée à 27.4 millions de mètres cubes. L'agriculture utilise 53.7 p. 100 de ce montant, l'utilisation domestique et commerciale 43.9 p. 100 et l'industrie 2.4 p. 100. La plupart de cette utilisation d'eau vient du sous-bassin South Lake. On n'entrevoit pas une augmentation significative de besoin en eau dans un avenir rapproché.

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I. INTRODUCTION

A. Study Objectives

The objective of this study is to estimate water use in the Lower Kootenay River Basin by economic sector and sub-basin. Sources of water use data and methods of using this data are also identifed and may serve as guidelines in future water use studies. The collection of water use information is the initial step in long-term water use forecasting and planning.

The figures in this report are estimates and intended only as baseline data for future water use investigations. For the purposes of this study, water use estimates are generally restricted to water withdrawal from surface and ground water sources. In most instances, it is not practical to account for return flows.

Instream water uses such as hydroelectric production, fisheries and wildlife require extensive research and are therefore beyond the scope of this study. However, their importance cannot be overlooked in future water resource planning and a brief discussion of instream water requirements is included.

B. Economic Sectors

Water use estimates are classified into three major economic sectors.

1. Industrial
2. Domestic and Commercial
3. Agricultural

These categories are consistent with water use data obtained for the Okanagan, Similkameen and Kettle-Granby River Basins. Instream flow requirements are considered separately.

C. Sub-Basins

Estimates of water use have been determined for the Basin and its five designated sub-basins. The association of water use data with specific geographic units of the Basin facilitates identification of competing water uses. In addition, this information could prove useful in future determinations of water quality criteria and planning objectives for specific areas in the Basin.

The five designated sub-basins are Slocan, North Lake, West Arm, South Lake and Moyie (figure 1). This breakdown was selected on the basis of watershed boundaries and common land-use patterns. In most instances sub-basin boundaries follow those of aggregated watersheds designated by the Water Management Branch of the British Columbia Ministry of Environment and Parks. Individual sub-basins were planimetered to determine their approximate areas; these figures are provided in table 1. The total area of the Lower Kootenay River Basin is approximately 1.8 million hectares.

TABLE 1. AREAS OF SUB-BASINS

Sub-Basin	Hectares
Slocan	356 000
West Arm	139 000
North Lake	725 000
South Lake	432 000
Moyie	156 000
Total Area of Lower Kootenay River Basin	1 808 000

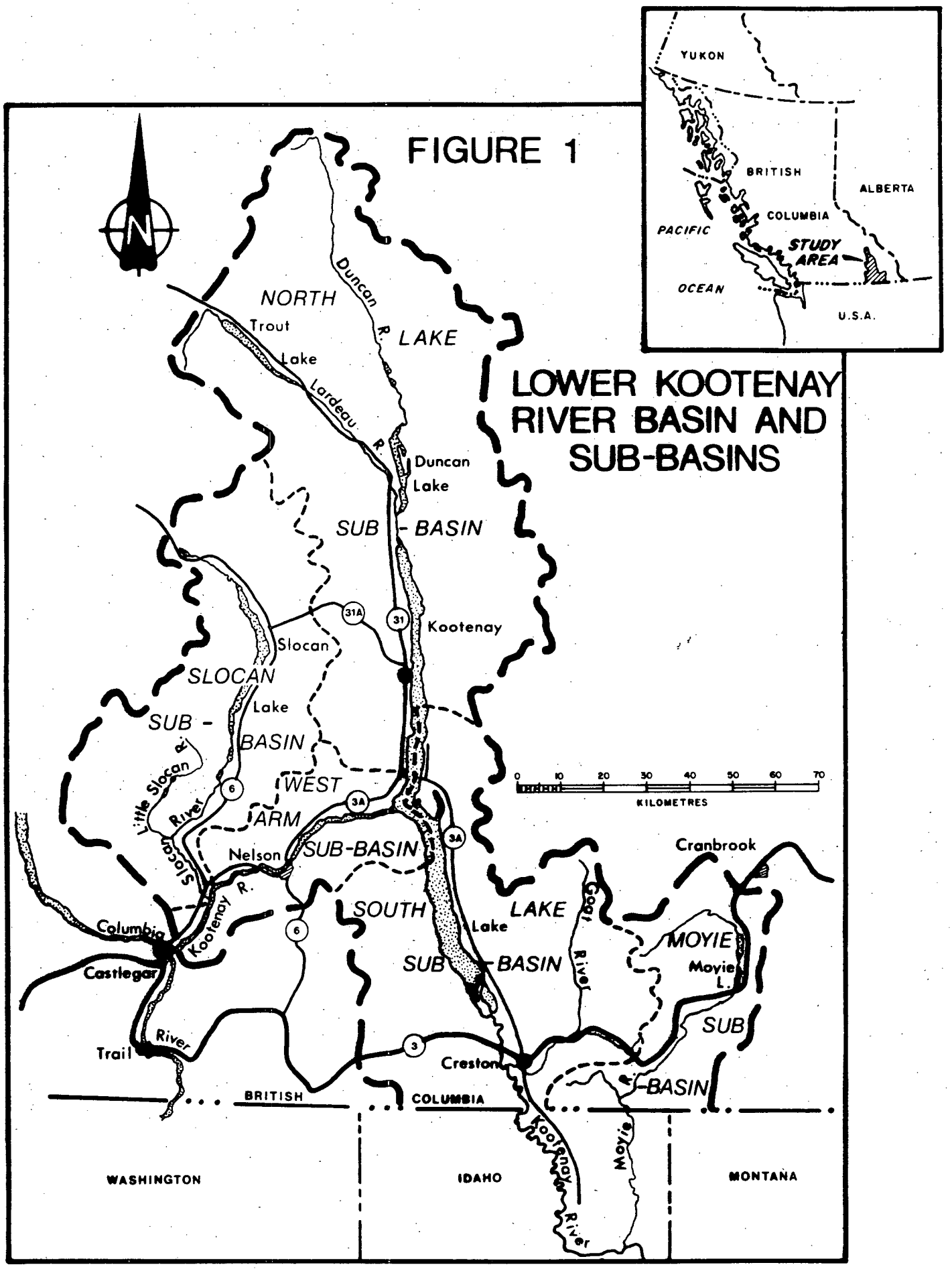
FIGURE 1
LOWER KOOTENAY RIVER BASIN AND SUB-BASINS
YUKON
BRITISH COLUMBIA
ALBERTA
PACIFIC OCEAN
STUDY AREA
U.S.A.
N
NORTH SUB-BASIN
Trout Lake
Lardeau R.
Duncan R.
LAKE SUB-BASIN
Duncan Lake
Kootenay
Slocan
SLOCAN SUB-BASIN
Lake
Little Slocan River
Slocan River
WEST ARM SUB-BASIN
Nelson
Kootenay R.
Columbia
Castlegar
Trail
River
SOUTH LAKE SUB-BASIN
Lake
Creston
Cranbrook
Goat River
MOYIE SUB-BASIN
Moyie L.
Moyie
Kootenay River
BRITISH COLUMBIA
WASHINGTON
IDAHO
MONTANA
0 10 20 30 40 50 60 70
KILOMETRES

II. INDUSTRIAL WATER USE

A. Introduction

This category includes primary resource industries such as mining and forestry as well as large-scale manufacturing, processing and other activities which are not included in the domestic and commercial category.

Industrial activity in the Basin is limited due to the small local market and long distances to major centres. Lumber-processing is an important economic activity in the Basin; however, this industry is not an important water user. Most industrial water use occurs in the food and beverage industry which is predominantly located in the Creston area, for example a single brewery in Creston accounts for approximately 63 percent of industrial water use in the Basin. Although mining traditionally played an important role in the Basin's economy and considerable exploration activity is still taking place, there is currently only one operating mine in the area. The Canadian Pacific Railway facilities in Nelson are also included in the industrial water use category.

B. Methods for Determining Industrial Water Use

To arrive at an estimate of industrial water use in the Basin, major industrial water users were identified and then quantities of water used by the individual firms determined (figure 2). Small mineral producers, defined as producing less than ten tonnes of ore annually, are not included in this inventory.

The following information sources[1] were used to determine major industries operating in the Basin.

1. Canada Employment Centre: The Employers' Directories for Nelson and Creston
2. Nelson and District Chamber of Commerce

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[1] Publication data for these sources is included in the bibliography.

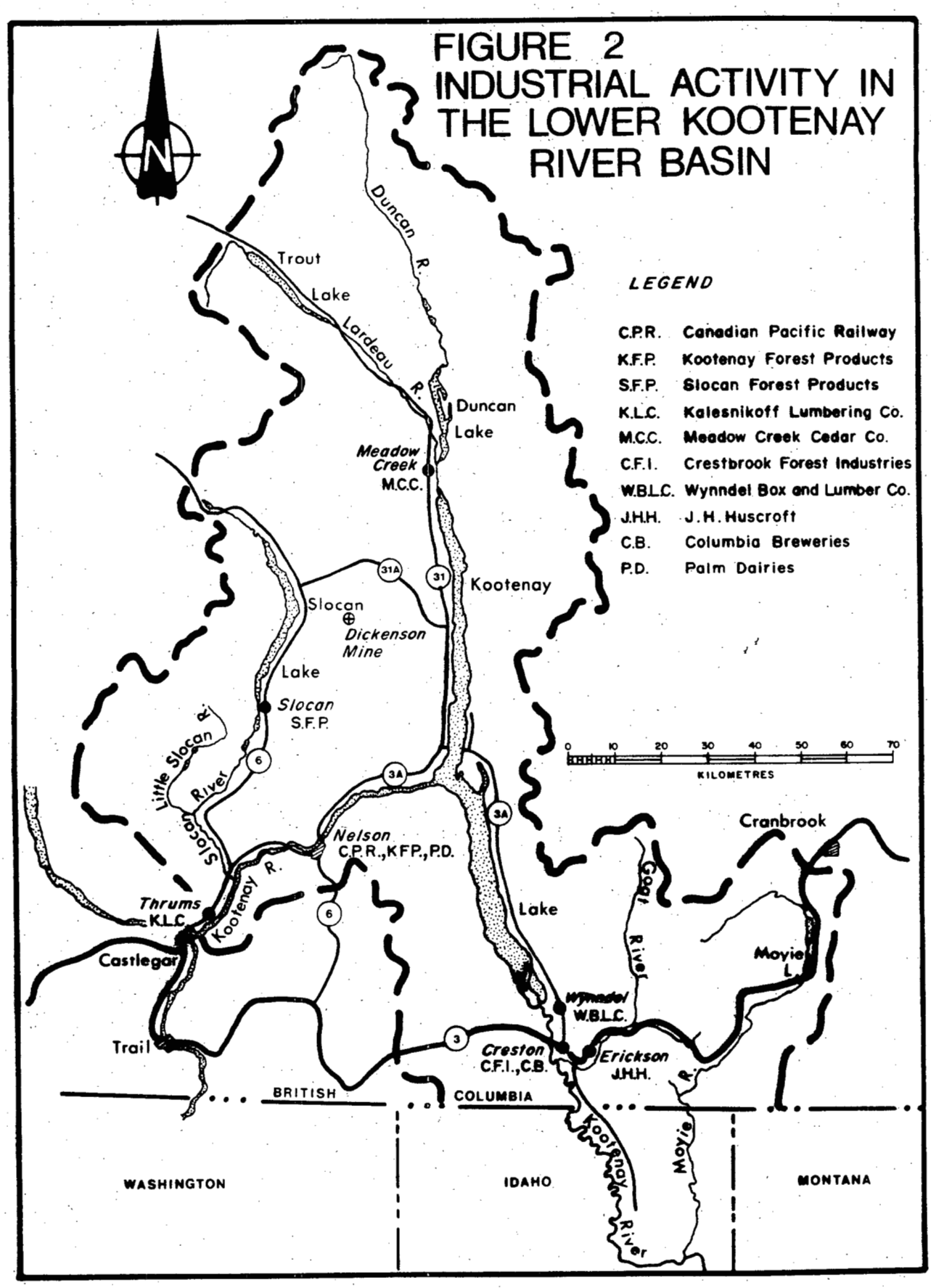
FIGURE 2
INDUSTRIAL ACTIVITY IN THE LOWER KOOTENAY RIVER BASIN
N
Duncan R.
Trout Lake
Lardeau R.
Duncan Lake
Meadow Creek M.C.C.
31A
31
Kootenay Lake
Slocan
Dickenson Mine
Slocan Lake
Slocan S.F.P.
Little Slocan R.
Slocan River
6
3A
Nelson C.P.R., K.F.P., P.D.
Kootenay R.
Thrums K.L.C.
Castlegar
Trail
Cranbrook
Goat River
Moyie L.
Wynndel W.B.L.C.
3
Creston C.F.I., C.B.
Erickson J.H.H.
BRITISH COLUMBIA
Kootenay River
Moyie R.
WASHINGTON
IDAHO
MONTANA
LEGEND
C.P.R. Canadian Pacific Railway
K.F.P. Kootenay Forest Products
S.F.P. Slocan Forest Products
K.L.C. Kalesnikoff Lumbering Co.
M.C.C. Meadow Creek Cedar Co.
C.F.I. Crestbrook Forest Industries
W.B.L.C. Wynndel Box and Lumber Co.
J.H.H. J. H. Huscroft
C.B. Columbia Breweries
P.D. Palm Dairies
0 10 20 30 40 50 60 70
KILOMETRES

3. Creston Chamber of Commerce
4. British Columbia Ministry of Environment and Parks: Water Licensing Data and Pollution Control Permits
5. British Columbia and Yukon Chamber of Mines: Location of Mining Properties Map and British Columbia Mineral Exploration Review 1985
6. British Columbia Ministry of Lands and Forests: Timber Supply Area Yield Analysis Reports
7. Regional District of Central Kootenay (RDCK)
8. Nelson and Creston Area B.C. Telephone Directories
9. Canadian Mines Handbook 1984-85
10. Madison's Canadian Lumber Directory 1985

Estimates of water use for individual firms could often be obtained by direct consultation with plant managers. The results of a national industrial water use survey carried out in 1981 by Environment Canada in conjunction with Statistics Canada provided water use data on some of the larger lumber-processing plants (Tate 1981). In some instances it was necessary to calculate a coefficient, or industry norm, from existing data and apply it to similar operations for which no data was available.

C. Mining

The only mine of significant size currently operating in the Basin is the Silvana division of Dickenson Mines which employs 39 people (Harris 1986). In 1985, 23 059 tonnes of silver/lead/zinc ore were mined and milled on site at Sandon near New Denver, British Columbia (Bried 1986).

Water is essential in the processing of ore into concentrate and the majority of water use at Dickenson is for this purpose. Of the approximately 200 cubic metres per day of water withdrawn from Tributary Creek, most is used in the milling process. A small portion is also used in underground drilling operations (ibid). The mine was in operation

five days a week for a total of 260 days last year bringing the water use total to 52 000 cubic metres per year. In addition, the mine operates a Pelton Wheel hydro-driven turbine on flows from Carpenter and Tributary Creeks. The wheel is currently used to supply power to residents of Sandon (ibid).

As of December 31, 1985 ore reserves at Dickenson were recorded at 39 009 tonnes (Dickenson, 1985, p. 12-13). Although exploration was maintained at a high level during 1985, this was a significant drop from 1984 levels. Future operation will depend to a great extent on increased ore reserves and favourable silver prices.

The Little Tim Mine, east of Slocan, was to begin operation this summer at approximately 100 tonnes per day but low silver prices have resulted in an indefinite deferral of the operation (Addie 1986).

There is considerable exploration activity occurring throughout the Basin. The possibility exists for a significant increase in mining water demands should future market conditions become more favourable.

D. Forestry

Forestry and forestry-related industry is an important sector in the economy of the Lower Kootenay River Basin. Lumber-processing operations are the major water users within the forestry sector.

There are six large mills operating in the Basin, each employing 20 or more workers. The largest of these is the Slocan Forest Products sawmill which employs approximately 225 people. Other operations include Kalesnikoff Lumbering, Meadow Creek Cedar, Wynndel Box and Lumber, Crestbrook Forest Industries and J.H. Huscroft. In addition to these larger plants, there are approximately 13 smaller mills which employ a total of 38 workers.

The Kootenay Forest Products mill in Nelson employed approximately 350 workers prior to its closure in 1983; the forest licence has recently been advertised and there is a possibility that the mill will reopen sometime next year (Bradley 1986). No decisions had been confirmed at the time of this study and it is impossible to anticipate the scale of future operations.

Although officials from each of the six larger sawmills were contacted in a telephone survey, none were able to provide accurate estimates of water use. However, the information obtained indicated that the mills in the Basin generally use water for sanitation, cooling and lubricating saws, and for watering lumber yards. Watering takes place during the summer months to keep dust to a minimum and prevent fires in the stored lumber.

As no water use figures were obtained from the telephone survey, it was necessary to consult the National Industrial Water Use Survey carried out by Statistics Canada and Environment Canada in 1981. Four sawmills in the Lower Kootenay River Basin responded to the survey and copies of their completed questionnaires were made available for this study. By combining data on water intake and number of employees for these four mills, it was possible to estimate a coefficient for per employee water use in sawmill operations. The aggregated water intake is 82 603 cubic metres per year for a total of 579 employees (Tate 1981). The per employee water use is estimated at 143 cubic metres per year.

Current employee counts for the sawmills operating in the Basin were obtained from the Nelson and Creston Employers' Directories. These figures were multiplied by the per employee water use coefficient of 143 cubic metres per day to arrive at a water use estimate for each mill. The sawmills were then grouped into the appropriate sub-basins and separate sub-basin water use totals were calculated as indicated in table 2.

TABLE 2. SAWMILLS WATER USE

Sub-basin	Sawmill (location)	Employees[1,2]	Water Intake (cubic metres/ year)[3]	Sub-basin Totals[3]
Slocan	Slocan Forest Products (Slocan)	224	32 000	
	Kalesnikoff Lumbering Co. (Thrums)	62	8 900	
	Other Small Operations	5	700	41 600
West Arm	Other Small Operations	13	1 900	1 900
North Lake	Meadow Creek Cedar Co. (Meadow Cr)	29	4 100	
	Other Small Operations	18	2 600	6 700
South Lake	Wynndel Box and Lumber (Wynndel)	118	16 900	
	Crestbrook Forest Ind. (Creston)	60	8 600	
	J.H. Huscroft (Erickson)	20	2 900	
	Other Small Operations	2	300	28 700
Moyie	Other Small Operations	0		
				78 900

[1]Canada 1986a and 1986b
[2]Richardson 1986
[3]Rounded to the nearest 100 cubic metres

E. Food and Beverage Processing

The South Lake sub-basin contains most of the food and beverage processing operations in the Basin. Columbia Breweries, a major water user, is located in Creston. This plant is currently the largest single industrial water user in the Basin with a recorded water intake of approximately 420 000 cubic metres for 1985 (McLeod 1986). Some 45 000 cubic metres of water were actually consumed in the production process (ibid). The remainder of the water is used in cooling processes and for sanitation prior to its eventual discharge.

Major food processing operations in the South Lake sub-basin include Creston Cooperative Packers, Allstate Grain Dehydraters, Triple-D Meats and Thompson Meats. Creston Valley Foods has recently been purchased by Spedifores, a company involved in the production of seed potatoes (Laing 1986). Spedifores could not be reached for comment on water use in its operations. For the remaining companies mentioned above, telephone contact with industry officials indicated that Creston Cooperative Packers and Triple-D Meats were the only potentially significant water users. Creston Cooperative Packers uses water for apple washing throughout the months of September to December. Triple-D Meats use water for washing and cleanup on the kill floor, scalding pigs and sausage-making (Douma 1986). Neither of these operations had metered water connections and no figures were available on water use. Although these plants could not be included in the industrial water use totals, they are considered noteworthy from a water use point of view.

In the West Arm sub-basin, Palm Dairies is currently processing approximately 380 000 litres of raw milk per month into milk and cream products. The plant is located in Nelson and draws its water from the city supply. Water use for the yearly period of May 1984 through April 1985 was recorded at approximately 26 900 cubic metres and increased to 48 700 cubic metres for the same period in 1986 (Bennel 1986). Most of this water is used in cleaning processes although some is also consumed in production.

F. Other Industrial Water Use

The Canadian Pacific Railway Company has a railway station, transport terminal, telecommunications building, diesel locomotive shop and car repair shop in Nelson (Bossio 1986). Although industry officials were not able to provide water use figures for current operations, a Pollution Control Permit from 1976 contains effluent data which is considered to be applicable. The assumption is made that water intake was roughly equal to outflow.

An average daily outflow of 182 cubic metres of water per day was listed on the permit for use in the boiler room as a compressor coolant, for diesel locomotive wash water and sanitation (B.C. 1976c). Under full-time operation, an upper limit of approximately 66 000 cubic metres of water per day would be used by Canadian Pacific Railway.

G. Industrial Water Use Estimates

Industrial water use in the Lower Kootenay River Basin is minor in comparison to agricultural, domestic and commercial water use. Total industrial water intake is estimated at 665 600 cubic metres per year and approximately 448 700 cubic metres of this amount (67 percent) is used in the South-Lake Sub-basin. Table 3 summarizes industrial water use by sub-basin and provides a Basin total. Sawmills and forest products have been aggregated from table 2.

TABLE 3. LOWER KOOTENAY RIVER BASIN INDUSTRIAL WATER USE

Sub-Basin	Industry	Water Intake (m^3/year)	
Slocan	Dickenson Mines	52 000	
	Sawmills/Wood Products	41 600	93 600
West Arm	Palm Dairies	48 700	
	Canadian Pacific Railway	66 000	
	Sawmills/Wood Products	1 900	116 600
North Lake	Sawmills/Wood Products	6 700	6 700
South Lake	Columbia Breweries	420 000	
	Sawmills/Wood Products	28 700	448 700
			665 600

III. DOMESTIC AND COMMERCIAL WATER USE

A. Introduction

The domestic and commercial water use category combines domestic use with commercial use such as small-scale manufacturing, processing and local service industries. This aggregation is necessary because of the difficulty in estimating commercial water use as a separate category. It is also probable that changes in commercial water use closely parallel changes in population. Furthermore, commercial activity in the Basin is generally limited to Nelson and Creston for which total water use figures were available.

Consumptive recreational water use is included as a separate sub-section of the domestic and commercial water use category. Water withdrawals for recreational purposes are not considered sufficient to warrant separate categorization but are still significant. The recreational water users that have been included in this section depend upon water supplies from streams or springs that are generally external to any community water system. For this reason it is important that they be inventoried.

B. Population

To calculate population figures, the Basin was outlined on federal electoral district maps which are subdivided into enumeration areas (EA's) (Canada 1981a and 1981b). Populations for the EA's were obtained from the 1981 Census of Canada (Canada 1982).

Two methods were employed to deal with EA's that overlap a Basin boundary. One method determined what proportion of the EA's area lies within the Basin and then assumes that the same proportion of the EA's population also lives there. A second method was simply to completely include or exclude the EA. This method was employed when the overlapping portion of the EA appeared to be uninhabitated. For example, EA 103 of

the Electoral District of Kootenay-West is completely excluded because the portion within the Basin contains no mapped roads and no dwellings appear on air photos of the area.

The same methods were employed to determine populations of the individual sub-basins. Generally, the problem of overlapping EA's was not common as few EA boundaries cross basin or even sub-basin boundaries. Table 4 provides a summary of sub-basin populations. A more detailed population breakdown appears later in table 7. The total population of the Lower Kootenay River Basin, according to the 1981 census, is 35,497.

TABLE 4. LOWER KOOTENAY RIVER BASIN AND SUB-BASIN POPULATIONS

Sub-Basin	Population
Slocan	5,091
West Arm	16,478
North Lake	2,267
South Lake	10,924
Moyie	737
TOTAL	35,497

C. Water Use Estimates

An estimate of domestic and commercial water use in the Lower Kootenay River Basin was determined after consulting a variety of sources. Water use estimates are categorized into urban and rural to differentiate between water consumption figures in commercialized areas and the frequently lower rural domestic consumption. Consumptive recreational water use figures are then added to the urban and rural water use

totals. The municipalities of Nelson and Creston as well as the villages of New Denver, Silverton, Slocan and Kaslo are included in the urban water use category (figure 3). The remainder of the population in the Basin is defined as rural.

Domestic and commercial water use figures for Nelson and Creston are available from the Environment Canada Municipal (Water) Use Database (MUD) (Canada 1986d). The MUD database contains water use data for Canadian municipalities with populations greater than 1,000. Municipalities with a population greater than 5,000, such as Nelson, were directly contacted in 1983. The data for Creston is also considered current to 1983. The information contained in the MUD database is considered to be very accurate as it includes data on both public and private water supply systems in the municipality.

The MUD database reports water use in Nelson is 8 933 cubic metres per day or 3 260 545 cubic metres per year. Of this total, industry uses approximately 114 700 cubic metres per year.[5] Domestic and commercial use for Nelson is therefore estimated to be approximately 3 145 845 cubic metres per year. For Creston, the MUD database reports a water use figure of 3 670 cubic metres per day or 1 339 550 cubic metres per year. Industry in Creston uses approximately 428 580 cubic metres per year of this total.[6] Domestic and commercial water use in Creston is therefore estimated at 910 970 cubic metres per year.

Water use in New Denver, Silverton, Slocan and Kaslo was estimated by the provincial Water Management Branch. Water system administrators from these villages supplied the Branch with data on the number of domestic and commercial connections to their local water systems. A water use

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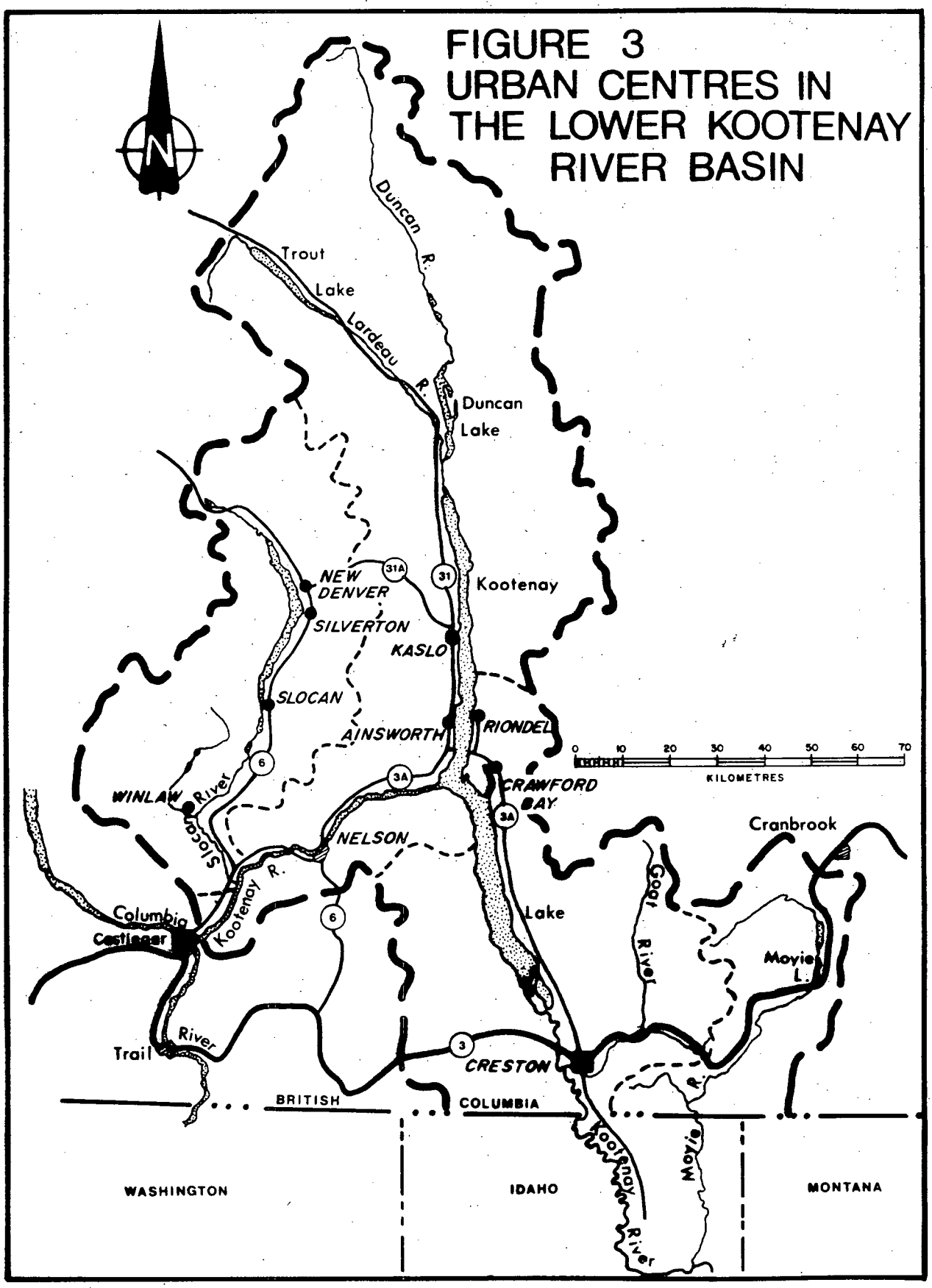
5 From Industrial Water Use Section. Canadian Pacific Railway and Palm Dairies are located in Nelson and supplied by the city water system.

6 From Industrial Water Use Section. Columbia Breweries and Crestbrook Forest Industries are located in Creston and supplied by the city water system.

FIGURE 3
URBAN CENTRES IN THE LOWER KOOTENAY RIVER BASIN



coefficient of 830 cubic metres per connection per year was then applied by the B.C. Ministry of Environment and Parks to obtain an estimate of total water use in the Kootenays (Robinson 1986).

Water use information obtained from provincial Water Management Branch is summarized in table 5 (ibid). The New Denver Water System supplies water to 27 connections outside of the municipal boundaries, but to avoid double counting in the rural category, those connections are not included here.

TABLE 5. COMMUNITY WATER USE

Town	Number of Connections	Estimated Use (m^3)[1]
New Denver	295	244 800
Silverton	125	103 700
Slocan	203	168 500
Kaslo	440	365 200
TOTAL		882,200

[1]Rounded to the nearest 100 cubic metres.

In previous water use studies (Canada 1985b and 1986c), rural domestic water use included only water used in the home. Rural lawn and garden watering was included within agricultural water use. In this study, lawn and garden watering is included in rural domestic water use estimates.

There are two reasons for this departure. First, given the methodology of this study, there are a large number of gardens which are too small and isolated to map accurately. These small gardens are common in the Slocan Valley and Creston areas. The Slocan Valley, in particular, has recently attracted a large number of people seeking alternate or more self-sufficient lifestyles. This may partially account for the many small gardens found in the area. Second, the summer during which this study was carried out had unusually high rainfalls. For this reason it

was more difficult to distinguish between irrigated and non-irrigated land. For this study it was considered more practical to apply water use coefficients which include water used for lawns and gardens.

Rural water use was estimated with the assistance of the provincial Water Management Branch in Nelson. The estimates of per connection water use coefficients provided for the Slocan and South Lake sub-basins are higher than the coefficients provided for the remainder of the rural households in the Basin for the reasons described previously.

During the four summer months, 5 688 litres per connection per day is used in the Slocan and South Lake sub-basins (Springman 1986). Elsewhere in the Basin, summer use is 4 550 litres per connection per day (ibid). For the remaining eight months of the year, rural domestic water use is estimated at 1 138 litres per connection per day throughout the Basin (ibid).

Weighted averages are calculated from these figures to obtain an annual rural water use of 969 cubic metres per year per connection in the Slocan and Creston sub-basins and 831 cubic metres per year per connection for the West Arm, North Lake and Moyie sub-basins.

Dwelling counts for individual sub-basins are from Statistics Canada data (Canada 1982). These figures are then multiplied by the water use coefficients to obtain annual rural water use totals for individual sub-basins. Rural domestic water use information is summarized in table 6. Table 7 provides a complete breakdown of urban and rural domestic and commercial water use by sub-basin.

D. Consumptive Recreational Water Use

Most of the water withdrawn for recreation activities in the Lower Kootenay River Basin is used for irrigating seven golf courses and operating the hot springs pool at Ainsworth.

TABLE 6. RURAL DOMESTIC WATER USE

Sub-basin	Rural Population	Number of Dwellings	Coefficient m^3/yr/connection	Water Use m^3/year
Slocan	3,818	1,355	969	1 313 000
West Arm	7,501	2,923	831	2 429 000
North Arm	1,256	472	831	392 200
South Lake	6,734	2,414	969	2 339 200
Moyie	737	283	831	235 200
TOTAL	20,046	7,447		6 708 600

TABLE 7. URBAN AND RURAL DOMESTIC WATER USE

Sub-Basin	Population	Water Use m^3/year[1]
Slocan		
Rural	3,818	1 313 000
New Denver	642	244 800
Silverton	280	103 700
Slocan	351	168 500
		1 830 000
West Arm		
Rural	7,501	2 429 000
Nelson	9,143	3 145 800
		5 574 800
North Lake		
Rural	1,256	392 200
Kaslo	845	365 200
		757 400
South Lake		
Rural	6,734	2 339 200
Creston	4,190	911 000
		3 250 200
Moyie		
Rural	737	235 200
TOTAL BASIN	34,497	11 647 600

[1]Rounded to nearest 100 cubic metres

Water use for irrigating golf courses fluctuates significantly with weather conditions during the warm season. The summer of 1986 was wetter than usual and therefore course superintendents were asked to provide an average yearly figure for water use. Typically, golf courses in the Basin are operated for seven months of the year and irrigated for a minimum of about 90 days during this period (Stocker and Boyer 1986).

Estimates of water use and the number of irrigated areas for each golf course were obtained from a course superintendent or greenskeeper at two of the golf courses contacted. Officials at the remaining golf courses were able to provide estimates of the area currently under irrigation.

Kokanee Springs Resort in Crawford Bay uses approximately 69 000 cubic metres per year for irrigation of 32 hectares (Stocker 1986). Valley View Golf Course located north of Winlaw requires some 32 000 cubic metres per year for irrigation of 12 hectares (Boyer 1986).

An average water application coefficient of 2 268 cubic metres per hectare per year was calculated from the figures provided and applied to those golf courses for which water use data was not available. This information is summarized in table 8.

Water use in golf courses is highest in the summer months and declines to zero for approximately four months during the winter season. Ainsworth Hot Springs is operated year-round. Total consumptive recreational water use is estimated at 395 400 cubic metres per year which is comparatively low in terms of total water use in the Basin.

E. Total Domestic and Commercial Water Use Estimates

To derive an estimate for total domestic and commercial water use by sub-basin, consumptive recreational water use figures are added to those calculated for urban and rural water use. These figures are summarized in table 9. Total domestic commercial water use in the Lower Kootenay River Basin is estimated to be 12.043 million cubic metres per year.

TABLE 8. LOWER KOOTENAY RIVER BASIN CONSUMPTIVE RECREATIONAL WATER USE

Sub-basin	Location	Facility	Irrigated Area (hectares)	Water Intake (m^3/year)[1]
Slocan	Winlaw	Valley View Golf Course	12	32 000
	New Denver	Slocan Lake Golf Course	12	27 500
West Arm	Nelson	Nelson Golf Course	12	27 500
North Lake	Kaslo	Rainbow Golf Course	8	18 400
	Ainsworth	Ainsworth Hot Springs	-	166 000
South Lake	Riondel	Riondel Golf Course	12	27 500
	Crawford Bay	Kokanee Springs Resort Golf Course	32	69 000
	Creston	Creston Golf Course	12	27 500
				395 400

[1]Rounded to the nearest 100 cubic metres.

TABLE 9. URBAN, RURAL AND CONSUMPTIVE RECREATIONAL WATER USE

Sub-basin	Domestic and Commercial[1]	Recreational[1]	Total Use[1]
Slocan	1 839 000	59 500	1 889 500
West Arm	5 574 800	27 500	5 602 300
North Lake	757 400	184 000	941 800
South Lake	3 250 200	124 000	3 374 200
Moyie	235 200	0	235 200
TOTAL (m^3)	11 647 600	395 400	12 043 000

[1]Rounded to the nearest 100 cubic metres

IV. AGRICULTURAL WATER USE

A. Introduction

Although agriculture in the Lower Kootenay River Basin is limited to some extent by topography and distance to major markets, it remains an important element in the local economy (B.C. Central Credit Union 1985).

The climate in the southern area of the Basin is particularly suited for growing a wide variety of cereal grains, forage crops, oil seeds, fruits and vegetables. Agriculture in other regions of the Basin is hindered somewhat by steep slopes and narrow valleys. Northern areas in particular support only hardier species of vegetables, cereals and forage crops. High agricultural capability land is found predominantly in the Creston area but is also scattered throughout other low-lying areas of the Basin (figure 4). Dairy farming is common in the region south of Creston.

The Creston Valley is essentially the only area in the Basin which supports agricultural production on a commercial scale. The Creston Valley flats have been reclaimed as a result of dyking projects begun in the 1930's and their rich alluvial soils support "some of the best agricultural land in British Columbia outside of the Fraser Valley" (Canada 1972). The benchlands along the Creston Valley also have rich soils which are particularly suited for growing tree fruits, berries and hay.

For the purposes of this study, the agricultural water use category is subdivided into irrigation water use and livestock water use. As a result of higher precipitation levels, favourable soil conditions and a high water table in the Creston flats, irrigation water requirements are less significant than those of previous river basins studied. In contrast to the flats, irrigation on the benchland is limited to some extent by the high costs of pumping water up from the valley below (Laing 1986).

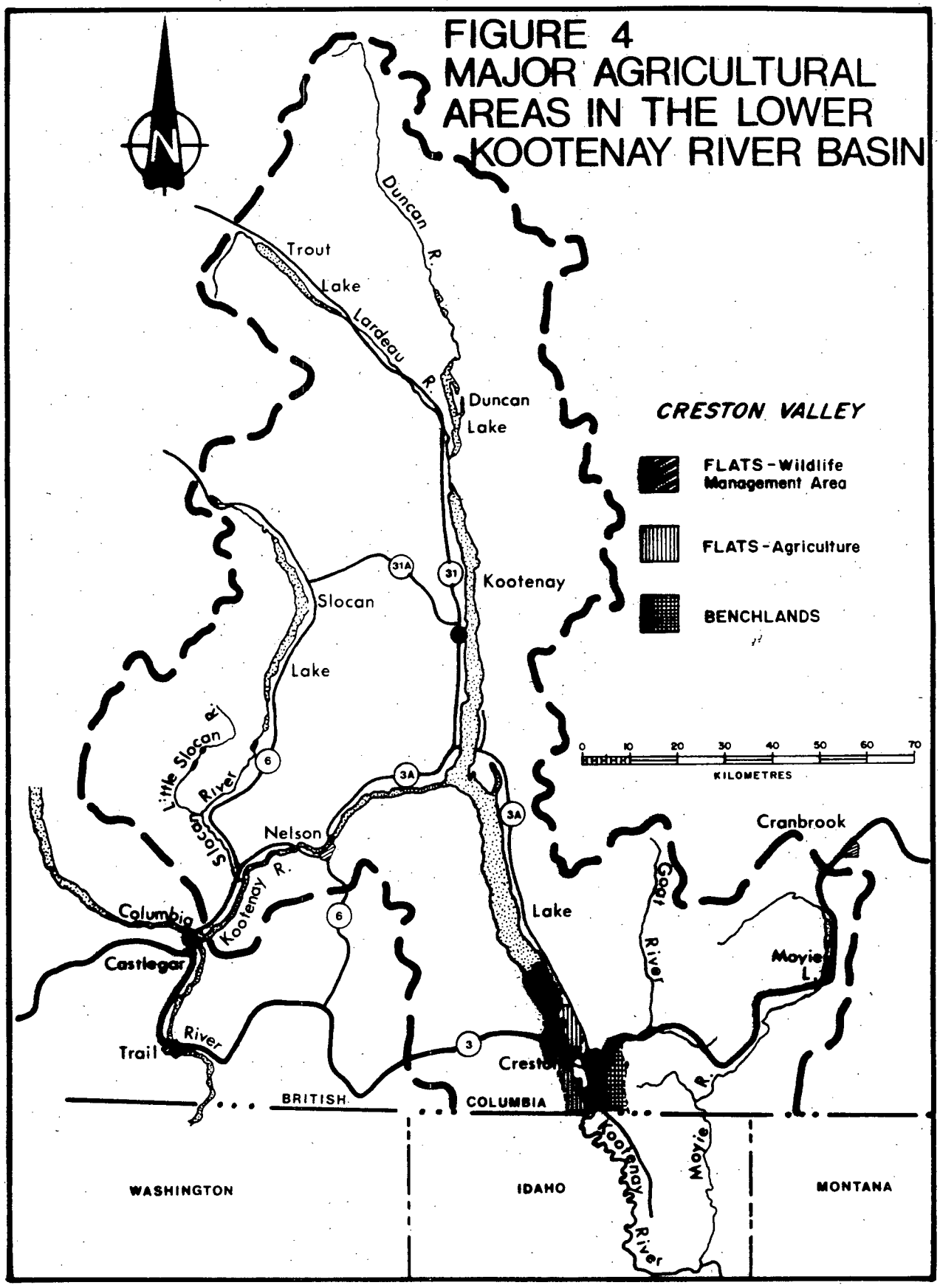


FIGURE 4
MAJOR AGRICULTURAL AREAS IN THE LOWER KOOTENAY RIVER BASIN
N
Duncan R.
Trout Lake
Lardeau R.
Duncan Lake
CRESTON VALLEY
FLATS - Wildlife Management Area
FLATS - Agriculture
BENCHLANDS
31A
31
Kootenay
Slocan
Lake
Little Slocan R.
6
3A
0 10 20 30 40 50 60 70
KILOMETRES
Slocan River
Nelson
Kootenay R.
Columbia
Castlegar
Trail
River
Cranbrook
Goat River
Lake
Moyie L.
3
Creston
BRITISH COLUMBIA
Kootenay R.
Moyie R.
WASHINGTON
IDAHO
MONTANA

B. Water Use for Irrigation

In studies carried out in the Okanagan, Similkameen and Kettle-Granby River Basins, water use for agriculture was estimated by determining the areas of irrigated crops in a basin and then multiplying these areas by appropriate water use coefficients. The area of irrigated land was determined by identifying the darker-shaded irrigated fields on 1:20 000 air photos, outlining these fields on 1:20 000 planimetric/cadastral maps, and then planimetering the mapped areas (British Columbia 1986). The results were checked in a ground level field survey.

Difficulties were encountered when attempting to use the same procedure in the Lower Kootenay River Basin. Higher than average precipitation during the warm season made it impossible to identify irrigated land from air photos. In addition, the Basin experienced an unusually wet summer in 1986 which hindered field surveys. Irrigated land was therefore not readily distinguished from non-irrigated land. For this reason, field surveys were used only to determine crop types and not to obtain an estimate of irrigated hectares.

Results from the 1981 Census of Agriculture were also available for this study (Canada 1981c). In the survey, farmers were questioned about the area of irrigated fields as well as the area of each crop type (table 10). To determine how irrigation correlated with crop type, a linear regression was run. It was found that oil seeds, grains and the category "other crops" were not correlated with irrigation. This result seemed reasonable since oil seeds and grains are seldom irrigated. Therefore, a second regression was run without including these crops. The remaining five crop types were combined into two variables which increased the degrees of freedom of the regression. One of the combined variables included the total area of orchards, berries and vegetables, while the other included the area of hay, forage and improved pasture. Total irrigated area was then regressed against these two variables. Both of the independent variables were found to be significant at the

TABLE 10. AREA OF IRRIGATED LAND BY SUB-BASIN

Sub-basin	Orchards and Vegetables (hectares)	Hay, Grains and Forage (hectares)
Slocan	16.9	137.8
West Arm	36.3	94.5
North Lake	8.6	35.7
South Lake	1 022.1	1 220.2
Moyie	0.0	15.0
TOTAL	1 083.9	1 503.2

95 percent confidence level. The joint hypothesis that the two variables together explain variation in the dependent variable was also accepted at the 95 percent confidence level. The regression indicated that 77 percent of the area cultivated in orchards, berries and vegetables and 16 percent of the area cultivated in hay and pasture is irrigated.

It is estimated from the 1986 field survey that there are a total of 1 407.8 hectares of orchards, berries and vegetables in the Basin. As well, there are 9 394.8 hectares of hay and pasture. Applying the coefficients from the regression, it is estimated that there are 1 083.9 hectares of irrigated orchards, berries and vegetables and 1 503.2 hectares of irrigated hay and pasture (Canada 1986c).

The Irrigation Design Manual, published by the B.C. Ministry of Agriculture and Food, reports that in the Creston area 0.5588 metres per year of water are required for crop irrigation (B.C. 1983). By multiplying this figure by the irrigated area in the Lower Kootenay River Basin an agricultural water use estimate of 14 456 700 cubic metres is obtained. A breakdown by sub-basin is included in table 11.

TABLE 11. WATER USE FOR IRRIGATION BY SUB-BASIN

Sub-basin	Orchards and Vegetables[1] (m^3)	Hay, Grains and Forage[1] (m^3)	Water Use[1] (m^3)
Slocan	94 400	770 000	864 400
West Arm	202 800	528 100	730 900
North Lake	48 100	199 500	247 600
South Lake	5 711 500	6 818 500	12 530 000
Moyie	0	83 800	83 800
TOTALS	6 056 800	8 399 900	14 456 700

[1]Rounded to the nearest 100 cubic metres

In comparison, it is reported in the Statistics Canada 1981 Survey of Agriculture that there are 2 207 hectares of irrigated land in the Basin. By applying the irrigation application rate to this figure, it is estimated that 12 327 100 cubic metres of water were used for irrigation in the Basin in 1981. A breakdown by sub-basin of these results is included in table 12.

Although the two estimates are not entirely independent of each other, the similarity between the two suggests that this report's water use estimates for irrigation are reasonably accurate.

TABLE 12. IRRIGATED HECTARES FROM STATISTICS CANADA

Sub-basin	Area Irrigated (hectares)	Water Use[1]
Slocan	170	950 000
West Arm	182	1 017 000
North Lake	199	1 112 000
South Lake	1 523	8 510 500
Moyie	132	737 600
TOTAL (m^3)	2 206	12 327 100

[1]Rounded to the nearest 100 cubic metres

C. Livestock Water Use

Livestock water use in the Lower Kootenay River Basin is approximated by applying per head water use coefficients to the numbers of each type of livestock found in the Basin. Livestock quantities from the 1981 Census of Agriculture were obtained from Statistics Canada. Due to the practical difficulties in obtaining more current data, this is the primary information source used in calculating livestock totals.

The livestock figures contained in the census data are grouped by agricultural regions, each region being composed of one or more enumeration areas. A separate printout received from Statistics Canada listed the enumeration areas that are grouped in each census region. These regions were then organized into the appropriate sub-basins. Where a region overlapped sub-basin boundaries, a percentage of the livestock total equal to the percentage area of the region within a particular sub-basin is added to that sub-basin total.

Some livestock quantities are not available in the census data. For instance, if there were only one or two sheep farmers operating in any particular region, the number of sheep in that region is not provided. For this reason, actual livestock totals may be somewhat higher than they appear in table 13.

The livestock water use coefficients used in this study are the same as those used by the Prairie Provinces Water Board in a water demand study carried out in the Saskatchewan Nelson Basin (Prairie Provinces Water Board 1982). These coefficients were converted to cubic metres per year per head as listed in table 14. The coefficient for milk cows and heifers is much higher than that for other types of livestock because it includes both animal intake and water for washing and flushing equipment.

TABLE 13. LIVESTOCK POPULATIONS BY SUB-BASIN

Type of Livestock	Sub-Basin					Total
	Slocan	N. Lake	West Arm	So. Lake	Moyie	
Milk cows	66	25	53	2,295	7	2,446
Beef cows	298	244	136	2,371	247	3,296
Steers	60	301	172	771	60	1,364
Pigs	38	20	73	4,458		4,589
Sheep	39			16		55
Horses	72	62	37	317	32	520
Chickens	1,457	1,132	2,343	31,562	461	36,955
Other Poultry	186	7	244	206	26	669

TABLE 14. LIVESTOCK WATER USE ESTIMATES BY SUB-BASIN

Type of Livestock	Water Use Coefficient (m^3/yr/h)	Sub-Basin					Total[1]
		Slocan (m^3)	N. Lake (m^3)	West Arm (m^3)	So. Lake (m^3)	Moyie (m^3)	
Milk Cows	56.21	3 710	1 405	2 979	129 002	393	137 500
Beef Cows	23.36	6 961	5 700	3 177	55 387	5 770	77 000
Steers	18.61	1 117	5 602	3 202	14 348	1 117	25 400
Pigs	2.19	83	44	160	9 763	0	10 000
Sheep	1.28	50	0	0	20	0	100
Horses	24.82	1 787	1 539	918	7 868	794	12 900
Chickens	0.10	146	113	234	3 156	46	3 700
Other Poultry	0.18	33	1	45	37	5	100
Total by Basin[1]		13 900	14 400	10 700	219 600	8 100	266 700

[1]Rounded to the nearest 100 cubic metres

Livestock water use coefficients are multiplied by livestock quantities to obtain the annual livestock water use by sub-basin. The data is summarized in table 14. Total livestock water use in the Basin is estimated at 266 700 cubic metres per year.

D. Total Agricultural Water Use

To arrive at an estimate of agricultural water use by sub-basin, irrigation water use is added to livestock water use. These figures are summarized in table 15. Total agricultural water use in the Lower Kootenay River Basin is estimated to be 14 723 400 cubic metres per year.

TABLE 15. WATER USE FOR IRRIGATION AND LIVESTOCK

Sub-basin	Livestock (m^3)	Irrigation (m^3)	All Agriculture (m^3)
Slocan	13 900	864 400	878 300
West Arm	14 400	730 900	745 300
North Arm	10 700	247 600	258 300
South Arm	219 600	12 530 000	12 749 600
Moyie	8 100	83 800	91 900
TOTAL	266 700	14 456 700	14 723 400

V. INSTREAM WATER USE

A. Introduction

Non-consumptive instream water demands are an important component of water use in the Lower Kootenay River Basin. Although difficult to measure, certain minimum streamflows and lake levels are essential to meet resource management objectives in the Basin. While no attempt was made to estimate desirable streamflows, a brief discussion of instream water use in the Basin is included.

Some of the major instream water requirements are for hydroelectric production, maintenance of the 6 880 hectare wildlife management area in the Creston Valley, and support of an important inland fishery and water-based tourist industry.

B. Hydroelectric Production

There are six dams and seven powerplants currently operating in the Lower Kootenay River Basin. Five of the dams and all seven of the power plants are located on a steep reach of the Kootenay River between Nelson and Castlegar (figure 5).

Corra Linn dam, located about 11 kilometres downstream from Nelson, is the first dam in a series. Corra Linn provides approximately 1.8 metres of water storage (about 9.9×10^8 cubic metres) in Kootenay Lake (B.C. 1977). The dam controls lake levels except under high flow conditions when natural channel constrictions in the West Arm restrict flows. The Upper Bonnington, Lower Bonnington, South Slocan and Brilliant dams are located downstream from the Corra Linn site; the earliest project was completed in 1897 (B.C. 1977). The pondage areas behind these dams are relatively small with levels fluctuating between 2.1 to 4.3 metres (B.C. 1977). All of the dams depend upon seasonal storage in the Corra Linn reservoir.

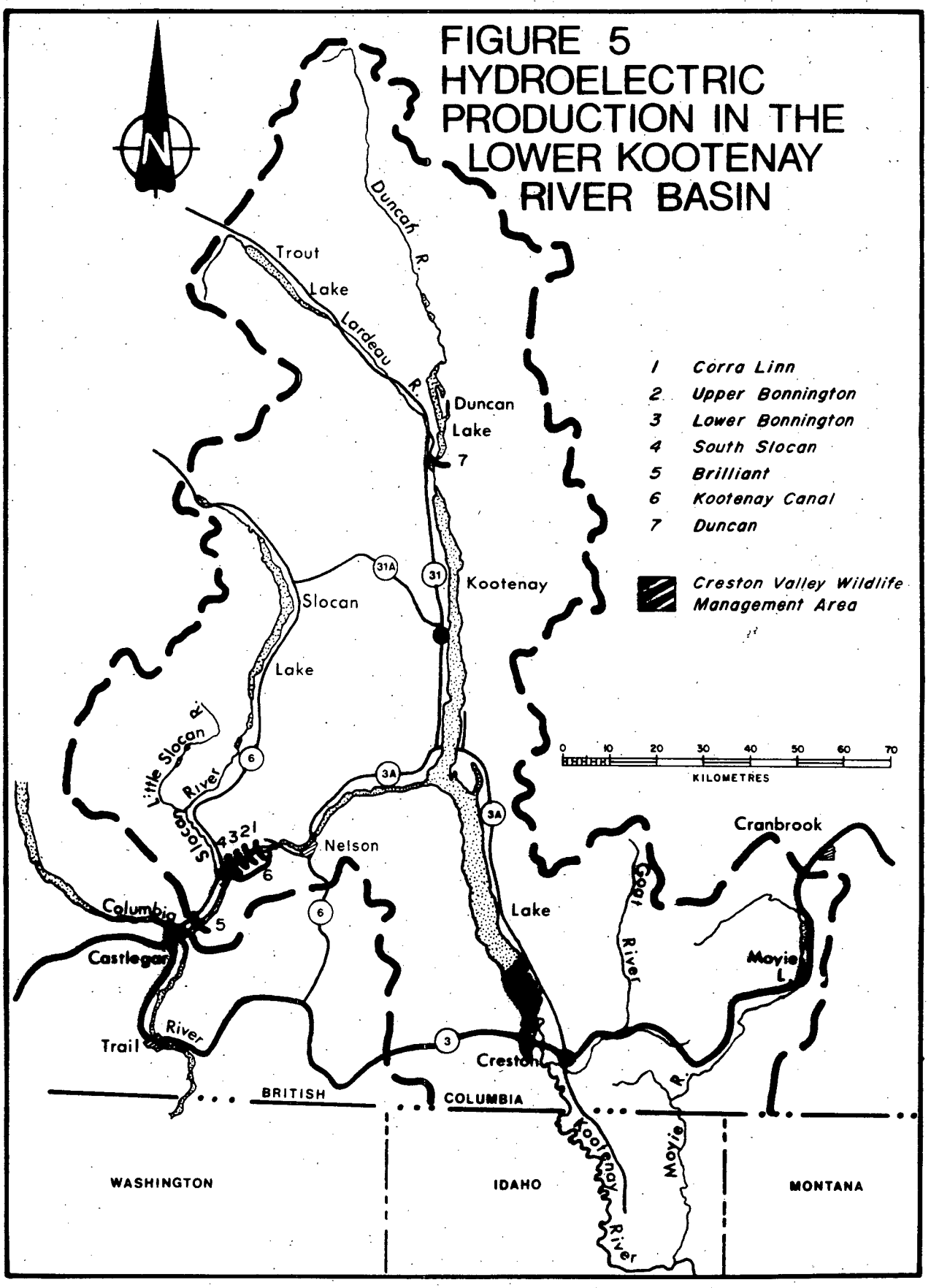


FIGURE 5
HYDROELECTRIC PRODUCTION IN THE LOWER KOOTENAY RIVER BASIN
N
Duncan R.
Trout Lake
Lardeau R.
Duncan Lake
7
Kootenay
Lake
31A
31
Slocan
Lake
Little Slocan R.
River
6
3A
Slocan
River
321
Nelson
6
Columbia
5
Castlegar
River
Trail
6
3
Lake
Creston
Cranbrook
Goat River
Moyie L.
R.
Kootenay River
Moyie
BRITISH COLUMBIA
WASHINGTON
IDAHO
MONTANA
1 Corra Linn
2 Upper Bonnington
3 Lower Bonnington
4 South Slocan
5 Brilliant
6 Kootenay Canal
7 Duncan
Creston Valley Wildlife Management Area
0 10 20 30 40 50 60 70
KILOMETRES

Corra Linn, Upper Bonnington, South Slocan and Brilliant dams were built by Cominco to provide power for the company's smelter in Trail. Lower Bonnington was constructed by West Kootenay Power and Light Company (WKPL) to produce electricity for its residential and commercial customers in the West Kootenay and Okanagan.

Cominco and its parent company, Canadian Pacific Enterprises, subsequently purchased WKPL although the subsidiary retains both ownership of the Lower Bonnington dam and its corporate identity (RDCK 1982). WKPL now leases all the Cominco plants except for the one at Brilliant. Power generated from these plants is still transmitted to the Trail smelter with surplus being available to WKPL for its own customers, sale to B.C. Hydro or export to the United States (ibid). In addition to these power plants, another facility is operated at Upper Bonnington by the City of Nelson. Table 16 provides a list of the power generating stations in the Basin together with their installed capacities.

TABLE 16. LOWER KOOTENAY RIVER BASIN POWER GENERATING STATIONS

Name of Facility	Nameplate Installed Capacity (MW)
Corra Linn	51
Upper Bonnington	59
Upper Bonnington (City of Nelson)	53
Lower Bonnington	129
South Slocan	42
Brilliant	7
Kootenay Canal	529

Despite operation of these dams on the Kootenay River, a majority of the river's potential energy remained unharnessed until the Kootenay Canal Project was completed by B.C. Hydro in 1976. The canal was designed to

make use of additional regulated flow in the river resulting from storage behind the Duncan dam north of Kootenay Lake and the Libby dam near Libby, Montana (B.C. Hydro 1978). A three-mile canal with an intake at Corra Linn dam supplies water to a 500 MW power plant just downstream from the South Slocan dam.

For most of the year, approximately 142 cubic metres per second of water travels down the Kootenay River via the Corra Linn system while the remainder (up to 708 cubic metres per second) passes through the canal (Strongman 1986). When summer discharges in the Kootenay River exceed 850 cubic metres per second the excess water travels through the Corra Linn system.

The Duncan dam, built by B.C. Hydro under the terms of the Columbia River Treaty, was designed to provide storage for flood control along the Columbia River in the United States. Creation of the Duncan Lake reservoir flooded approximately 40 square kilometres of land in B.C.; water levels in the reservoir fluctuate by as much as 28 metres during the year.

The Goat dam was built on the Goat River in 1933 by WKPL for power generation. In 1956 the dam was heavily damaged in a flood and the reservoir behind the dam is now filled with sediment. The powerhouse is no longer used and water simply spills over the dam.

C. Creston Valley Wildlife Management Area

The Creston Valley Wildlife Management Area, established in 1968, consists of approximately 6 880 hectares of land in the valley area between the south end of Kootenay Lake and the United States border. The wildlife area is an integral part of the Pacific Flyway, a main migration route for birds from their southern winter habitats to northern breeding and nesting sites.

Wetland portions of the region are reserved for aquatic wildlife, particularly waterfowl species. By controlling water levels to increase production of desirable food plants and decrease loss of nests to flooding, wildlife experts have improved the area as a breeding and stop-over area for numerous species.

Dykes were constructed along the Kootenay River to prevent water from flowing into marsh lands and compartmentalize each large marsh area. Water level control structures such as gravity gates and pumping stations are used to withdraw large quantities of water from the old channel of the Kootenay River (prior to farmland reclamation) and redistribute it amongst various compartments within the management area. Nesting habitat has been increased by construction of islands and peninsulas in shallow water and provision of drainage for some moist areas. Periodic drawdowns are necessary to chemically alter the substrate by oxidation.

An interpretive centre at the south end of the management area was threatened with closure in 1985, but has been kept open on a reduced budget with federal, provincial and private support. In some years up to 25,000 people visit the centre which is located just outside of Creston (Patterson 1986).

Although water use at the wildlife area is licensed, actual use differs significantly from licensed quantities. In addition water use is reported to fluctuate greatly with evaporation rates and available funding and therefore an accurate estimate of water use was impossible to obtain (Moore 1986).

VI. SUMMARY

A. Total Water Use Estimates

Water use for all categories is shown for each sub-basin in table 17. Agriculture accounts for most water use with 53.7 percent of the total. Domestic and commercial is almost as high with 43.9 percent of the total. Industry accounts for much less with only 2.4 percent of total water use. The South Lake sub-basin accounts for 60.4 percent of water use. Most of the agricultural water use and a large portion of domestic water use occurs in this sub-basin. The West Arm, where most domestic and commercial water use occurs, accounts for 23.7 percent of total water use. Total annual water use in the Lower Kootenay River Basin is estimated to be 27.432 million cubic metres.

B. Water Use Forecasts

Total water use is forecasted using population growth rates for the Central Kootenay Regional District obtained from the B.C. Ministry of Industry and Small Business Development (McRay 1986). Total annual water use forecasts to the year 2006 are in table 18. A major increase in water demand in the foreseeable future is not expected; water use may initially decline before slow growth is resumed.

C. Conclusions

A low-cost approach was used in this study to obtain disaggregated water use data. Existing data sources and maps of the area were used wherever possible and field travel was kept to a minimum. Expensive procedures such as air photography of the Basin were not undertaken. Despite this approach, the water use estimates are reasonably accurate. Although problems were experienced in mapping irrigated fields, another

TABLE 17. TOTAL WATER USE FOR THE LOWER KOOTENAY RIVER BASIN

Sub-basin	Industrial (m^3)	Domestic and Commercial (m^3)	Agriculture (m^3)	Total (m^3)
Slocan	93 600	1 889 500	878 300	2 861 400
West Arm	116 600	5 602 300	745 300	6 464 200
North Lake	6 700	941 800	258 300	1 206 800
South Lake	448 700	3 374 200	12 749 600	16 572 500
Moyie	0	235 200	91 900	327 100
TOTAL	665 600	12 043 000	14 723 400	27 432 000
PERCENTAGES	2.4	43.9	53.7	

TABLE 18. POPULATION GROWTH FOR THE LOWER KOOTENAY RIVER BASIN

Year	% Change[1]	Population Projection	Population Change	Forecasted Water Use (m^3)
1981 census		35,497		
1985 - 1986	-2.00	34,787	-710	27 432 000
1986 - 1987	-1.90	34,135	-661	26 910 792
1987 - 1988	-0.20	34,066	-68	26 856 970
1988 - 1989	0.70	34,305	238	27 044 969
1989 - 1990	1.10	34,682	377	27 342 464
1990 - 1991	1.40	35,168	486	27 725 258
1991 - 1992	1.40	35,660	492	28 113 412
1992 - 1993	1.40	35,159	499	28 507 000
1993 - 1994	1.40	36,666	506	28 906 098
1994 - 1995	1.40	37,179	513	29 310 783
1995 - 1996	1.40	37,700	521	29 721 134
1996 - 1997	1.20	38,152	452	30 077 788
1997 - 1998	1.10	38,572	420	30 408 643
1998 - 1999	0.90	38,919	347	30 682 321
1999 - 2000	0.80	39,230	311	30 927 780
2000 - 2001	0.70	39,505	275	31 144 274
2001 - 2002	0.70	39,781	277	31 362 284
2002 - 2003	0.60	40,020	239	31 550 458
2003 - 2004	0.60	40,260	240	31 739 761
2004 - 2005	0.60	40,502	242	31 930 199
2005 - 2006	0.70	40,785	284	32 153 710

[1]Water Consumption begins with an estimate of total annual water use which is then increased by the growth rate in the % Change column.

method of estimating water use was developed which was considered to be sufficiently accurate. Population and dwelling counts from the 1981 Census of Canada are still accurate as little growth has occurred in the Basin since then. There are few industrial establishments in the Basin and their water use was determined using existing data and a telephone survey.

There is a need for more information on average water use for all sectors of a basin's economy. Little is known and much less is readily accessible about such things as per capita water use, water use by crop type or even water use by industrial sector. Again, existing information is often either not disaggregated enough or of limited quality. Water use studies such as this one require reliable water use coefficients; if available, water use studies could be completed with much greater accuracy and speed.

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