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METHODS USED TO DETERMINE WATER USE IN THE OKANAGAN RIVER BASIN IN 1970

WORKING PAPER

PREPARED BY:

ROMEO PRINCIC

MARCH 1985

Inland Waters Directorate
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ABSTRACT

A number of studies were undertaken during the Okanagan Basin Study to estimate water use in 1970. Three general water use categories were examined; agricultural, domestic-municipal, and industrial. The results and methods used are summarized in this paper.

Agricultural use was estimated by using land-use maps and air photos to determine irrigated areas and then multiplying irregated acreage by an estimate of water duty. Indirect methods were used for domestic-municipal consumption; whereby the number of connections to municipal systems were determined and then multiplied by an annual consumption coefficient. Industrial water use was estimated from a number of existing data sources including water licence records, municipal records and pollution discharge permits.

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I. INTRODUCTION

The objective of the Okanagan Basin water demand studies was to prepare estimates of the consumptive use of water for agriculture, industry and domestic purposes as well as its non-consumptive use for recreation, fish and wildlife and transportation. Final results showed total water withdrawals in the Basin in 1970 were 230,600 acre feet.[1] Of this total, agriculture required 77 percent, domestic use accounted for 11 percent and industry 12 percent. Actual consumptive use amounted to 102,000 acre feet or 44 percent of total water withdrawal.

This paper provides a very brief overview of the methods used to determine consumptive and non-consumptive water uses and the results of the studies.

II. IRRIGATION

A. Introduction

Historically, irrigation has made the greatest consumptive demand on water resources of the Okanagan Basin. Irrigation provides a supplement to natural precipitation to enable the cultivation of fruit crops and other crops requiring large quantities of water. Since the Okanagan is hot and dry during the summer months, large amounts of water are stored to meet the increased demands for irrigation.

Irrigation in the past was done by lateral furrows or flooding the fields. Today, spray irrigation from a pressurized distribution system is widely used in the Okanagan. Trickle irrigation systems are also common.

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1 Background work for this Study was done in 1970, therefore original "imperial" units have been maintained.

B. Estimates of Cultivated Area

The first step in determining the irrigated areas of the Okanagan Basin was to estimate the amount of cultivated land. The most pertinent reference of cultivated land in the Okanagan Basin was the information compiled by the Canada Land Inventory for 1966. This information was adapted to satisfy the requirements of the study, which were to obtain estimates of the agricultural land use in the Basin. For consistency the land classification codes used by the Canada Land Inventory were retained.

The 1966 data were transferred to maps on a scale of 1:50,000 and each land use category was planimetered to estimate the acreages. The 1966 land use maps and the agricultural acreages were updated by transcribing new information from 1970 coloured air photos.

This inventory of agricultural land use represents a summary of the acreages under cultivation in 1970. This acreage does not necessarily represent the total area presently under irrigation. Table 1 shows the cultivated land in the Okanagan Drainage Basin in 1970 broken down by area and Canada Land Inventory classification.

C. Estimates of Irrigated Area

The land use maps produced from Canada Land Inventory data represent only the cultivated land in the Basin. Initial estimates of irrigated areas were obtained through interpretation of air photographs and discussions with growers and irrigation district managers in the valley. However, since planimetering produced a small amount of error (by including road allowances, buildings and farmyards), the final irrigated land area was derived by reducing the planimeter totals by 10 percent in municipalities and irrigation districts and by 5 percent in unorganized areas. The reduction in the irrigated land area for municipalities and irrigation districts was calculated by taking the average difference between planimeter area on air photos and the tax-roll areas of irrigated land.

TABLE 1

OKANAGAN RIVER BASIN

CULTIVATED LAND 1970

LOCATION	LAND CLASSIFICATIONS WITHIN WATERSHED				
	H	G	A	P	TOTAL (acres)
NORTH OKANAGAN					
Organized Area	46	-	498	-	544
Unorganized Area	943	40	16,349	3,424	20,756
Totals	989	40	16,847	3,424	21,300
OKANAGAN LAKE					
Organized Area	1,155	23,401	282	16,508	41,346
Unorganized Area	409	3,044	377	11,769	15,599
Totals	1,564	26,445	659	28,277	56,945
OKANAGAN RIVER					
North Section:					
Organized Area	-	719	-	501	1,220
Unorganized Area	44	296	-	1,204	1,544
Totals	44	1,015	-	1,705	2,764
Middle Section:					
Organized Area	36	2,684	-	12	2,732
Unorganized Area	372	770	-	2,042	3,184
Totals	408	3,454	-	2,054	5,916
South Section:					
Organized Area	-	3,268	-	127	3,395
Unorganized Area	-	1,354	-	1,168	2,522
Totals	-	4,622	-	1,295	5,917
Total for River Section	452	9,091	-	5,054	14,597
Total Organized Area	1,237	30,072	780	17,148	49,237
Total Unorganized Area	1,768	5,504	16,726	19,607	43,605
Total Cultivated Acreage	3,005	35,576	17,506	36,755	92,842

G - Orchards and Vineyards - tree fruits and grapes
H - Horticulture - vegetables, market gardens, nurseries, flowers
A - Cropland - sugar beets, potatoes, associated fallow and land in the process of being cleared for cultivation
P - Improved Pasture and Forage Crops - hay, alfalfa, etc.

Table 2 summarizes the distribution of agricultural and irrigated land by region within the Basin. Note that three-quarters of the land irrigated is in Okanagan Lake Region. Water supply for these lands is primarily drawn from the tributary streams into Okanagan Lake. Most of the remaining irrigated lands are in the southern area of the Basin and are supplied from the mainstream system.

TABLE 2

OKANAGAN RIVER BASIN:

AGRICULTURAL AND IRRIGATED LAND BY REGION (1970)

REGION	IRRIGATED LAND (1970) Acres	CULTIVATED BUT NOT IRRIGATED (1970) Acres	TOTAL CULTIVATED LAND (1970) Acres
NORTH OKANAGAN	2,000	19,300	21,300
OKANAGAN LAKE	44,070	6,700	50,770
OKANAGAN RIVER	14,000	-	14,000
TOTALS	60,070	26,000	86,070

Figure 1 shows the existing and potential irrigation areas within the Basin in 1970. Most of this potential is located in the cooler northern areas at the Basin where it is presently being used as pasture. Some potential irrigation areas exist on Indian Reserves south of Penticton. Table 3 provides a break down of irrigated land into six crops for the three separate regions in the Basin.

Figure 1

Existing and Potential Irrigation in the Okanagan Area

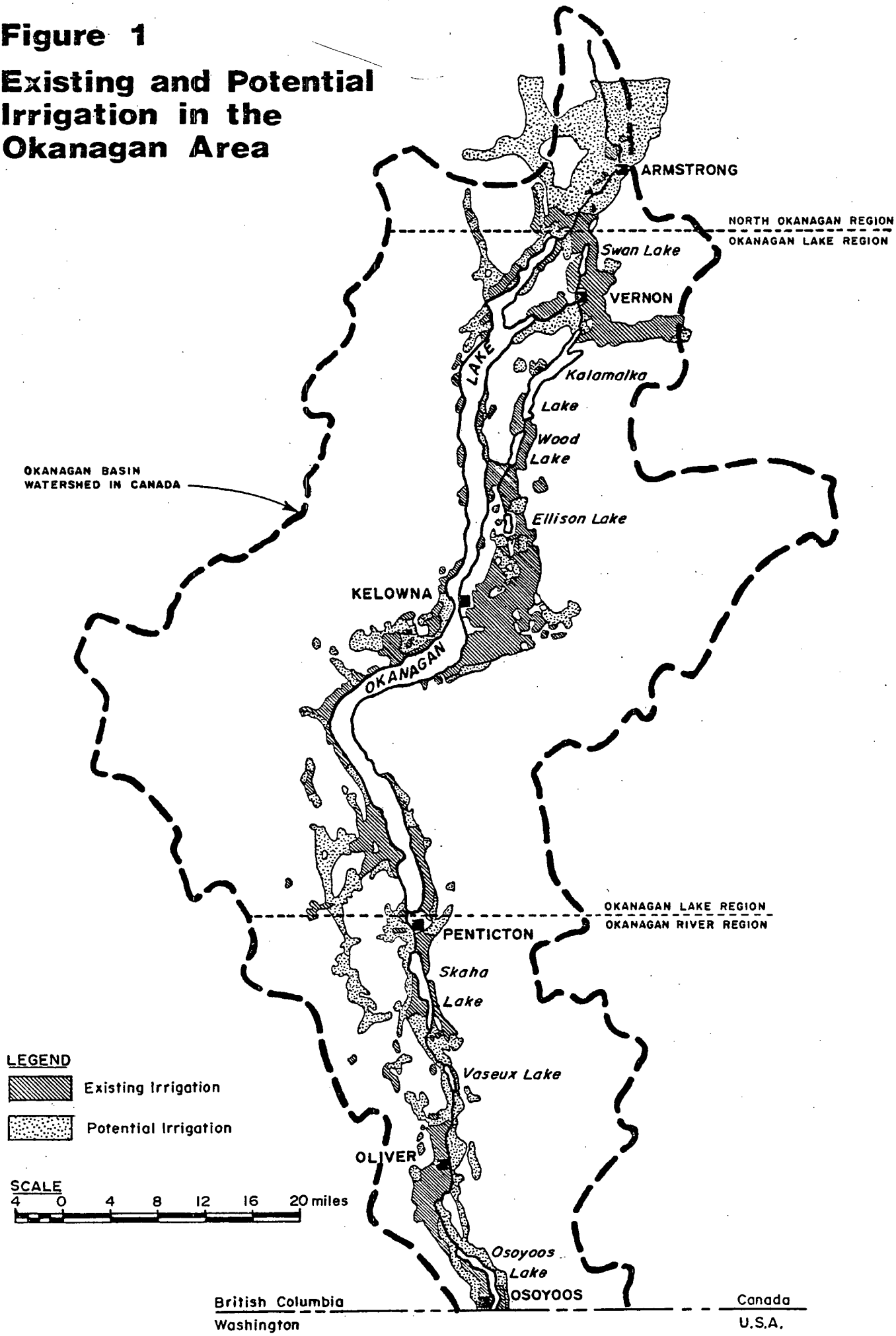

TABLE 3
OKANAGAN RIVER BASIN:
IRRIGATED CROPS BY REGION, 1970
(Acres)

REGION	TREE FRUITS	GRAPES	NURSERY CROPS	VEGETABLES	FIELD CROPS	FORAGE CROPS & PASTURE	TOTAL
NORTH OKANAGAN	-	-	80	140	340	1,440	2,000
OKANAGAN LAKE	23,100	1,500	460	650	-	18,360	44,070
OKANAGAN RIVER	8,720	800	160	420	-	3,900	14,000
BASIN TOTALS	31,820	2,300	700	1,210	340	23,700	60,070

D. Estimates of Water Required

Since few irrigation diversions are monitored to provide reliable information, the estimates of water use are the product of the number of acres of land times the water duty in feet. Water duty is defined as the amount of water per unit area. In the Okanagan it falls within the range of 1.5 feet at Glenmore, to 5.2 feet in the Southern Okanagan Lands Irrigation District. Water duties are a function of the type of soil, topography, elevation, length of growing season and the amount of summertime precipitation. Although some accurate information was available on a few districts where detailed soil surveys had been carried out, only averages could be obtained for the majority of areas.

Average farm duties were calculated for all irrigation districts and tributary basins of the Okanagan.[2] These duties were estimated by local irrigation specialists based on their knowledge of irrigation

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2 Canada-British Columbia Okanagan Basin Agreement, Preliminary Report No. 13, Water Demand Studies, December 1971, pp. 16-17.

practices and water requirements in the area. The quantity of water used for agricultural irrigation in the Okanagan was then calculated by multiplying the water duties by the amount of irrigated land in each sub-region. Table 4 shows the amount of water withdrawn and consumed by agriculture by sub-region in the Okanagan Basin.

E. Seasonal and Yearly Demand Variations

The demand for water in the growing seasons fluctuates from 20 to 30 percent from a wet year to a dry year. A strong increase in demand is also observed during the growing season. Table 5 shows the coefficients used for estimating monthly withdrawals and return flows of water for agricultural use in the Basin. When the coefficients are multiplied by annual withdrawal or return flows, the estimates of the monthly water use are determined. The withdrawal of water is greatest during the peak growing months June, July and August, with lesser demands occurring in May and September.

TABLE 4

OKANAGAN RIVER BASIN: ESTIMATED WATER USE, 1970

(Acres-feet)

LOCATION/REGION	AGRICULTURAL		
	Acres	Water Withdrawn	Water Consumed
1. Tributaries Mainstem Lakes Okanagan River and Wells	44,471	113,710	56,855
	15,599	64,030	32,015
2. Organized Areas	42,199	122,424	61,212
Unorganized Areas	17,871	55,316	27,658
3. Okanagan Lake [1]	45,714	112,800	56,400
Okanagan River	14,356	64,940	32,470
TOTALS	60,070	177,740	88,870

* Includes North Okanagan Region

TABLE 5

OKANAGAN RIVER BASIN:

COEFFICIENTS(α) FOR ESTIMATING MONTHLY WITHDRAWALS AND RETURN FLOWS FOR AGRICULTURAL USE IN ALL REGIONS

	Yearly Total	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
WITHDRAWAL	1.00	0	0	0	0	.15	.25	.25	.25	.10	0	0	0
RETURN FLOWS	1.00	.04	.04	.03	.04	.11	.14	.15	.14	.12	.09	.05	.05

Source: T.A.J. Leach, Okanagan Basin Inflow Determinations, Report No. 1714, Water Investigations Branch. B.C. Water Resources Service, Victoria, B.C., 1970.

α- These coefficients are factors which, multiplied by annual withdrawal or return flows, will provide estimates of monthly water use. Consumptive Use is calculated from the amount diverted less the return flow, month by month.

III. MUNICIPAL AND DOMESTIC WATER USE

A. Methods for Estimating Municipal and Domestic Use

Because of the lack of detailed municipal water withdrawal records, residential water use had to be estimated by indirect methods. A figure of 0.75 acre feet per connection per year was arrived at based on a number of sources including records of local municipalities and improvement districts with metered water, engineering studies prepared by the city of Kelowna and a number of studies under the Agricultural and Rural Development Act. The number of domestic connections were obtained from municipal and water district records. Domestic water withdrawals for both rural and urban areas was estimated by applying the average figure of 0.75 acre feet to the number of available connections.

To improve the accuracy of the municipal water withdrawal estimates, the municipal connections other than domestic use were divided into the following categories:

1. Commercial (hotels, motels)....2.0 acre-feet/connection
2. Commercial (other).....0.5 acre-feet/connection
3. Public Authority (schools).....5.0 acre-feet/connection
4. Public Authority (other).....1.0 acre-feet/connection
5. Municipal.....1.0 acre-feet/connection

The average withdrawal figures for the different categories of connections were based on a small sample of metered connections in the Okanagan Basin.

Table 6 shows the annual domestic water requirements by region and the number of connections in each region. The annual water requirements are broken down into annual water withdrawn and annual water consumed.

TABLE 6

OKANAGAN RIVER BASIN:

ANNUAL DOMESTIC WATER REQUIREMENTS BY REGION, 1970

REGION	NUMBER OF CONNECTIONS	ANNUAL WATER WITHDRAWAL (ACRE-FEET)	ANNUAL WATER CONSUMPTION (ACRE-FEET)
NORTH OKANAGAN	759	570	199
OKANAGAN LAKE	29,271	22,186	7,767
OKANAGAN RIVER	2,666	2,108	741
TOTALS	32,696	24,864	8,707

Source: Canada-British Columbia Water Demand Studies, Okanagan Basin Agreement, B.C. Ministry of Environment and Environment Canada, B.C., 1972.

B. Seasonal Variation in Domestic Demand

There is a three fold increase in municipal and domestic use in the summer compared to the winter months. Table 7 shows coefficients for estimating monthly withdrawal and return flows for domestic use in the Okanagan River Basin. Multiplying the coefficients by the annual withdrawal or return flow will provide estimates of monthly water use. Consumption can be determined by substracting return flows from the volume withdrawn.

TABLE 7

OKANAGAN RIVER BASIN:

COEFFICIENTS(α) FOR ESTIMATING MONTHLY WITHDRAWALS AND RETURN FLOWS

BY REGION FOR MUNICIPAL AND DOMESTIC USE

	Yearly Total	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
NORTH OKANAGAN													
Withdrawal	1.00	0.05	0.05	0.05	0.06	0.09	0.14	0.16	0.14	0.09	0.07	0.05	0.05
Return Flows	1.00	0.05	0.06	0.05	0.06	0.07	0.12	0.14	0.13	0.10	0.08	0.06	0.06
OKANAGAN LAKE													
Withdrawal	1.00	0.05	0.04	0.05	0.05	0.10	0.13	0.16	0.16	0.08	0.07	0.05	0.05
Return Flows	1.00	0.06	0.06	0.06	0.07	0.09	0.10	0.13	0.12	0.10	0.08	0.07	0.05
OKANAGAN RIVER													
Withdrawal	1.00	0.05	0.05	0.05	0.07	0.11	0.13	0.15	0.13	0.09	0.06	0.05	0.05
Return Flows	1.00	0.06	0.06	0.06	0.07	0.09	0.10	0.13	0.12	0.10	0.08	0.07	0.06

Source: Municipal Waterworks data for Vernon, Kelowna, Rutland, Penticton and Osoyoos

α These are factors which, multiplied by annual withdrawal or return flows, will provide estimates of monthly water use.

IV. INDUSTRIAL WATER USE

A. Methods for Estimating Industrial Water Use

To arrive at a reasonable estimate of industrial water use, a variety of information sources were used. These sources included:

i) an economic questionnaire distributed to some of the larger employers under a separate study;
ii) municipal records of industrial water use;
iii) provincial water rights licences; and,
iv) B.C. Pollution Control Branch discharge permits.

Where discrepancies between the sources occurred, data were obtained by personal communication with plant managers.

Table 8 provides the annual industrial water requirement by region and is divided into water withdrawn and water consumed. Note that the Okanagan lake region accounts for 90 percent of the water withdrawn and consumed.

TABLE 8

OKANAGAN RIVER BASIN:

ANNUAL INDUSTRIAL WATER REQUIREMENTS BY REGION, 1970

REGION	ANNUAL WATER WITHDRAWN			ANNUAL WATER CONSUMPTION (acre-feet)
	SURFACE (acre-feet)	GROUNDWATER (acre-feet)	TOTAL (acre-feet)	
NORTH OKANAGAN	250	250	500	75
OKANAGAN LAKE	25,090	910	26,000	4,100
OKANAGAN RIVER	1,000	500	1,500	225
TOTALS			28,000	4,400

Table 9 gives a breakdown of the Basin's industrial water use into 12 industrial sectors. Water withdrawn and water consumed is given for each industrial sector.

TABLE 9

OKANAGAN RIVER BASIN:

INDUSTRIAL WATER USE BY SECTOR, 1970

SECTOR	NUMBER OF OPERATIONS	WATER WITHDRAWN (acre feet)			PERCENT CONSUMED	WATER CONSUMED (acre feet)
		Surface	Ground	Total		
1. Meat & Dairy Products	13	250	250	500	20%	100
2. Fruit & Vegetable Canners	11	500	negligible	500	30%	150
3. Wineries, Soft Drinks & Distillers	11	6,950	50	7,000	10%	700
4. Other Food & Beverage Industries	19	50	negligible	50	40%	20
5. Sawmills & Planning Mills	76	9,500	500	10,000	10%	1,000
6. Other Wood Industries	51	5,800	200	6,000	10%	600
7. Metal Fabricating & Transport Equipment	51	90	10	100	30%	30
8. Non-Metalic Mineral Products	25	300	100	400	10%	40
9. Other Manufacturing	80	150	50	200	20%	40
10. Logging	103	50	50	100	30%	30
11. Packing Houses	20	950	400	1,400	10%	140
12. Mining	6	1,750	negligible	1,750	90%	1,550
TOTAL	466	26,340	1,660	28,000	16% (av.)	4,400

Wood industries withdraw the largest proportion of water (57 percent) but only consume 10 percent of the amount withdrawn. On the other hand, the mining sector withdraws only about six percent of the total but consumes 90 percent of what it withdraws. As a result, the amounts consumed by each sector are about equal. Together, the two sectors account for about 72 percent of the total water consumed by industry in the Basin.

B. Seasonal Variation in Industrial Demand

Industrial demand for water has only a slight seasonal fluctuation. There is a gradual increase in the demand for water in the summer, with a peak in demand occuring in September. This variation in demand occurs because of the increased activity in fruit packing and processing plants as the crops are harvested.

Table 10 shows the coefficients used to produce estimates of monthly industrial water consumption in 1970 and to predict future industrial water use. These coefficients were estimated primarily from municipal records which showed distribution of industrial water withdrawals.

TABLE 10

OKANAGAN RIVER BASIN:

COEFFICIENTS FOR ESTIMATING MONTHLY CONSUMPTIVE USE

FOR INDUSTRIAL PURPOSES

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	The Year
.07	.07	.07	.07	.08	.09	.10	.11	.12	.08	.07	.07	1.00

V. IN CHANNEL REQUIREMENTS

A. Flow Requirements

In the Okanagan Basin there are concerns about low flow requirements for salmon and high flow conditions which result in floods. Minimum flow requirements are recommended by Department of Fisheries and Oceans to maintain a suitable environment for salmon.

Table 11 shows the monthly recommended flow of the Okanagan River. Improvements to the River Channel have resulted in lower flows in some months in order to conserve water. In certain months these flows are not sufficient to meet the recommended flow for salmon.

It is also recognized that low flows are a constraint to kokanee and trout spawning in the tributary streams to the mainstem. Diversion of water for agricultural and domestic purposes has led to a decline in suitable spawning areas for these sportfish. However, little work has been carried out in developing minimum flows for optimum sportfish production and no recommended flows were set up for most tributaries.

TABLE 11

OKANAGAN RIVER BASIN:

SUMMARY OF FISHERY AND MINIMUM FLOW REQUIREMENTS, 1970

MONTH	FISHERY REQUIREMENTS				MINIMUM FLOW	
	Minimum Flow at Osoyoos Lake outlet	In Okanagan River Channel below S.O.L.I.D. Dam			Okanagan River below Penticton Dam	
		Desirable Range	Maximum (Gravel Scour)	Minimum Fishery Flow	1970 Conditions	With Improvements
	c.f.s.	c.f.s.	c.f.s.	c.f.s.	c.f.s.	c.f.s.
APRIL		175 - 10000		175	300	100
MAY					300	100
JUNE					300	100
JULY 1-15					300	100
16-31	100				300	100
AUGUST	100	300 - 450		300	300	100
SEP. 1-15		300 - 450		300	300	100
16-30	100	350 - 550		350	300	100
OCTOBER		350 - 550		350	100	100
NOVEMBER		175 - 1000	1000	175	100	100
DECEMBER		175 - 1000	1000	175	100	100
JANUARY		175 - 1000	1000	175	100	100
FEB. 1-15		175 - 1000		175	100	100
16-28		175 - 1000	1000	175	100	100
MARCH		175 - 1000		175	100	100

REFERENCES

1. Canada-British Columbia. Okanagan Basin Agreement. Main Report of the Consultative Board (1974), British Columbia Ministry of Environment and Environment Canada, Victoria, B.C.

2. Canada-British Columbia. Okanagan Basin Agreement. Value and Demand for Water in the Okanagan Basin (1974), Technical Supplement VII to the Main Report. British Columbia Ministry of Environment and Environment Canada, Victoria, B.C.

3. Canada-British Columbia. Okanagan Basin Agreement. Water Demand Studies (1972), Preliminary Report No. 13. British Columbia Ministry of Environment and Environment Canada, Victoria, B.C.

4. Hall, G.P. Irrigable Land in the Okanagan Basin, Preliminary Report No. 3, Okanagan Basin Agreement, British Columbia Ministry of Environment and Environment Canada, Victoria, B.C.

5. Leach, T.A. Okanagan Basin Inflow Determination (1970), Report No. 1714. Water Investigations Branch, B.C. Water Resources Service, Victoria, B.C.