CANADA-BRITISH COLUMBIA OKANAGAN BASIN AGREEMENT

TECHNICAL SUPPLEMENT IV



WATER QUALITY AND WASTE LOADINGS IN THE OKANAGAN BASIN



"Water is not always a passive recipient of man's wastes."

MARCH 1974

934

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'Harvesting Weed Growth at Kin Beach near Vernon'

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CANADA-BRITISH COLUMBIA OKANAGAN BASIN AGREEMENT

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TO THE

FINAL REPORT

WATER QUALITY

And Waste Loadings In The Okanagan Basin

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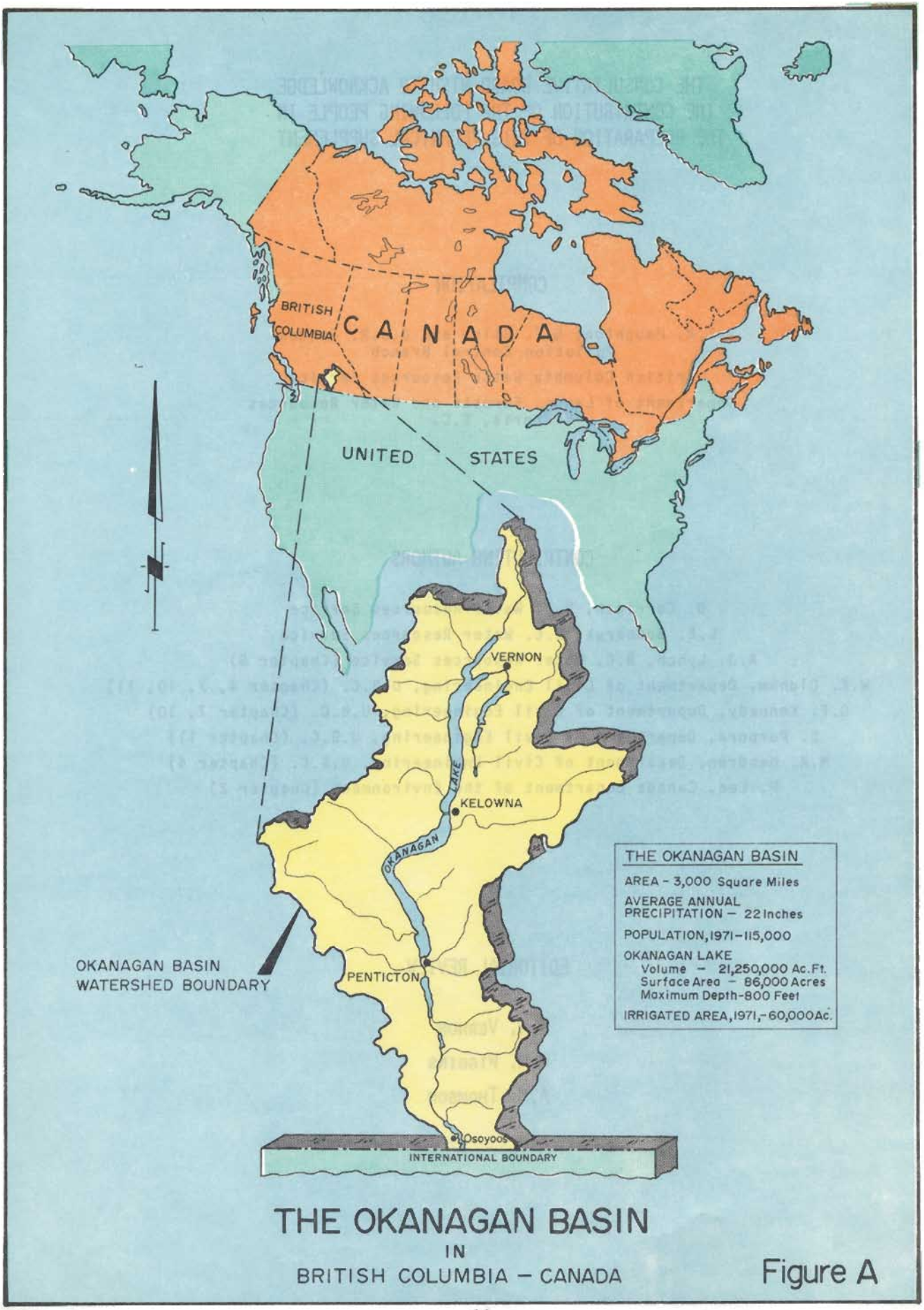
E.R. Haughton, G.E. Giles and J.J.R. Feddes
Pollution Control Branch
British Columbia Water Resources Service
Department of Lands, Forests and Water Resources
Victoria, B.C.

CONTRIBUTING AUTHORS

D. Corrigan, B.C. Water Resources Service
L.E. Bodnaruk, B.C. Water Resources Service
A.J. Lynch, B.C. Water Resources Service (Chapter 8)
W.K. Oldham, Department of Civil Engineering, U.B.C. (Chapter 4, 7, 10, 11)
G.F. Kennedy, Department of Civil Engineering, U.B.C. (Chapter 7, 10)
C. Purpora, Department of Civil Engineering, U.B.C. (Chapter 11)
M.K. Hendren, Department of Civil Engineering, U.B.C. (Chapter 4)
P. Lee, Canada Department of the Environment (Chapter 2)

EDITORIAL REVIEW

E.H. Vernon
M.M. Wiggins
A.M. Thomson



THE OKANAGAN BASIN
IN
BRITISH COLUMBIA - CANADA

Figure A

FOREWORD

This Technical Supplement describes and presents the results of all water quality studies as carried out under the Okanagan Basin Agreement. The results of associated studies on the limnology of the main valley lakes, and waste-water treatment for the control of nutrient discharges, are covered in Technical Supplements IV and VI respectively. The presentation and discussion of water quality alternatives, based on these water quality, limnology, and waste treatment studies, is confined to the main report.

The material presented in this supplement supercedes that of all earlier preliminary reports or publications prepared under the Canada-British Columbia Okanagan Basin Agreement.

A.M. Thomson,
Study Director

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PART I

BACKGROUND STUDIES

CHAPTER 1

Data Bank and Data Analysis

Computer facilities at B.C. Research Council and at the B.C. Government Data Processing Centre were used for data storage and processing for this study. All stream and outfall quality data collected during the September, 1969 to September, 1971 period was assembled by the B.C. Pollution Control Branch and forwarded to B.C. Research for storage on the water quality data bank. Weekly and monthly loadings for the various streams and outfalls were calculated by B.C. Research for the 1969-70 period.

In the fall of 1971, the processing of stream and outfall data was assumed by the Data Processing Centre of the B.C. Government. At this time, the B.C. Research files were updated with quality and quantity data collected during the sampling period from September, 1970 to October, 1971. Using the nutrient loading computer program developed by B.C. Research to match quality and quantity data, weekly and monthly loadings were computed for the 29 parameters measured at the 41 stream locations and the 19 major outfalls. The Data Processing Centre also produced summaries and statistical analyses of water quality data for the studies outlined in Section 2 - Stream Quality Study, and 3 - Outfall Discharge Study.

The weekly and monthly loading printouts consisted of some 900 pages for the 1969-70 data and some 1100 pages for the 1970-71 data. Because of the volume involved and the need to provide a simplified presentation of data for working purposes, monthly loadings (in kilograms and pounds) were summarized and totalled to provide an annual loading for each parameter measured at each of the stream and outfall locations. The monthly summary printouts consisted of some 180 pages for each year's data. In all, these printouts comprise some 2400 pages of computer output and therefore have not been included here.

The method of calculation and a description of the computer data file contents and output format for the monthly and weekly nutrient loadings are outlined in Appendices A.1, A.2, and A.3.

In many cases, it was found that data was not sufficiently complete for computer analysis. Interpolation between dates was attempted, but could not overcome all the deficiencies. Consequently nutrient loadings for phosphorus and nitrogen were calculated manually, as outlined in Section 12 of this report.

CHAPTER 2

Stream Quality Study

This chapter sets out the method used to determine the water quality of major streams within the Okanagan Basin. The sampling and analysis as outlined in this section were carried out for the purpose of estimating the annual loadings of nutrients and other constituents to the Okanagan Lake system as discussed in Chapter 12. The analytical results were also used in evaluating the water quality of tributaries and the main valley lakes (Chapter 13).

Sampling of the Okanagan River and streams tributary to the Okanagan Lakes and River began in early June, 1969 and continued until October 31, 1971. Samples were taken at 41 locations and analysed for physical, inorganic and organic constituents.

In order to carry out this program effectively the Federal Water Quality Division established a laboratory at the Kelowna Pollution Control Centre, in 1969 staffed with a chemist and a chemical technician to collect samples and conduct on-site and laboratory analyses.

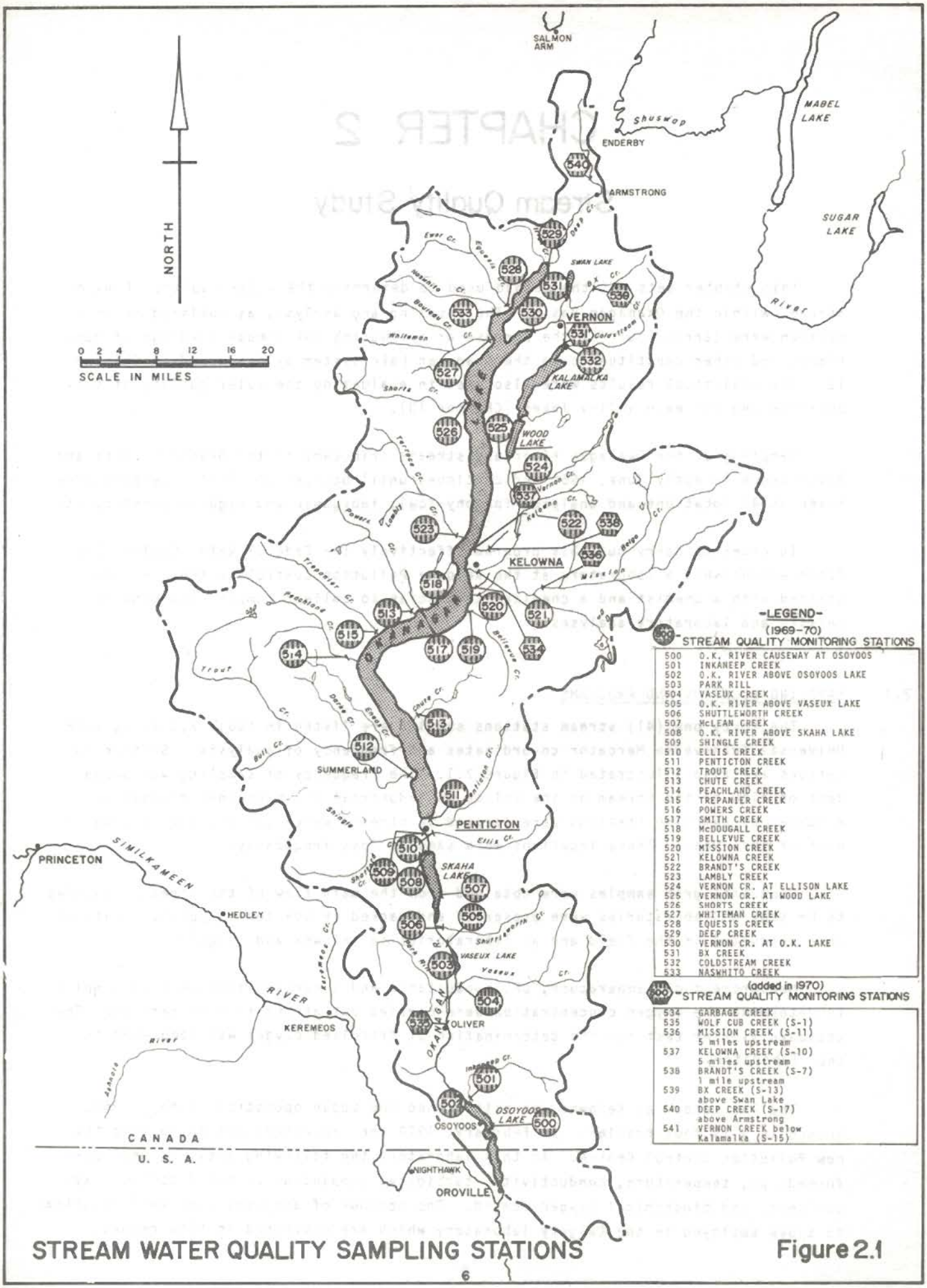
2.1 SAMPLING LOCATION AND PROGRAMS

The forty one (41) stream stations sampled are listed in Table 2.1 along with Universal Transverse Mercator co-ordinates and frequency of analysis. Station locations are also illustrated in Figure 2.1. The frequency of sampling was dependent on flow of the stream or the volume of industrial and municipal discharges. A number of sampling stations were located on streams which are dry during a major part of the year. These locations were sampled less frequently.

Composite grab samples were obtained from the main flow of the stream. Samples to be sent to laboratories were preserved and packed in ice for shipping. Analyses were conducted in the field and at laboratories in Kelowna and Calgary.

Measurement of temperature, pH, conductance and a partial treatment of samples to determine the oxygen concentration were carried out at the time of sampling. The standard Winkler test for the determination of dissolved oxygen was completed in the laboratory.

The laboratory at Kelowna was established and began operation in May, 1969, housed in a 14 foot trailer. In February, 1970 the laboratory was moved into the new Pollution Control Centre. At this laboratory the following analyses were performed: pH, temperature, conductivity, turbidity, completion of the dissolved oxygen test, and biochemical oxygen demand. The methods of analyses used were identical to those employed in the Calgary laboratory which are described in this report.



-LEGEND-

(1969-70)

STREAM QUALITY MONITORING STATIONS

500	O.K. RIVER CAUSEWAY AT OSOYOOS
501	INKANEEP CREEK
502	O.K. RIVER ABOVE OSOYOOS LAKE
503	PARK RILL
504	VASEUX CREEK
505	O.K. RIVER ABOVE VASEUX LAKE
506	SHUTTLEWORTH CREEK
507	McLEAN CREEK
508	O.K. RIVER ABOVE SKAHA LAKE
509	SHINGLE CREEK
510	ELLIS CREEK
511	PENTICTON CREEK
512	TROUT CREEK
513	CHUTE CREEK
514	PEACHLAND CREEK
515	TREPANIER CREEK
516	POWERS CREEK
517	SMITH CREEK
518	McDOUGALL CREEK
519	BELLEVUE CREEK
520	MISSION CREEK
521	KELOWNA CREEK
522	BRANDT'S CREEK
523	LAMBLY CREEK
524	VERNON CR. AT ELLISON LAKE
525	VERNON CR. AT WOOD LAKE
526	SHORTS CREEK
527	WHITEMAN CREEK
528	EQUESIS CREEK
529	DEEP CREEK
530	VERNON CR. AT O.K. LAKE
531	BX CREEK
532	COLDSTREAM CREEK
533	NASWHITO CREEK

(added in 1970)

STREAM QUALITY MONITORING STATIONS

534	GARBAGE CREEK
535	WOLF CUB CREEK (S-1)
536	MISSION CREEK (S-11) 5 miles upstream
537	KELOWNA CREEK (S-10) 5 miles upstream
538	BRANDT'S CREEK (S-7) 1 mile upstream
539	BX CREEK (S-13) above Swan Lake
540	DEEP CREEK (S-17) above Armstrong
541	VERNON CREEK below Kalamalka (S-15)

STREAM WATER QUALITY SAMPLING STATIONS

Figure 2.1

TABLE 2.1

SAMPLING LOCATIONS AND FREQUENCY

STN. NO BC 4-	STATION NAME	STATION LOCATION	U.T.M. CO-ORDINATES	1969-70 PROGRAM (MAY 1969 - JULY 1970) POLLUTION ANALYSES	1969-70 PROGRAM (MAY 1969 - JULY 1970) TOTAL ANALYSES	1970-71 PROGRAM (JULY 1970 - JULY 1/71) POLLUTION ANALYSES	1970-71 PROGRAM (JULY 1970 - JULY 1/71) TOTAL ANALYSES	1971-72 PROGRAM (JULY 1/71 - OCT.31/71) POLLUTION ANALYSES	1971-72 PROGRAM (JULY 1/71 - OCT.31/71) TOTAL ANALYSES
500	Okanagan River	Causeway at Osoyoos	IIU LE 20253330	1 per week	1 per month	2 per month	4 per year*	2 per month	4 per year
501	Inkaneep Creek	3200' above mouth	IIU LE 17403893	1 per week	1 per month	-	4 per year	-	4 per year
502	Okanagan River	1.2 miles above inlet to Osoyoos Lake	IIU LE 15004025	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
503	Park Rill Creek	At highway culvert	IIU LE 14305585	1 per week	1 per month	2 per month	4 per year	completed	
504	Vaseaux Creek	At highway bridge	IIU LE 16355762	1 per week	1 per month	2 per month	4 per year	completed	
505	Okanagan River	Dam & footbridge 2 1/2 KM above Vaseaux L.	IIU LE 13406648	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
506	Shuttleworth Cr.	at highway bridge	IIU LE 13286842	1 per week	1 per month	-	4 per year	completed	
507	McLean Creek	Exit from culvert crossing Skaha Estates road	IIU LE 14007270	1 per week	1 per month	-	4 per year	completed	
508	Okanagan River	Highway bridge at entrance to Skaha Lake	IIU LE 11828087	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
509	Shingle Creek	At C.P. Railway bridge	IIU LE 11338387	1 per week	1 per month	1 per month	4 per year	completed	
510	Ellis Creek	At mouth	IIU LE 12368376	1 per week	1 per month	2 per month	4 per year	completed	
511	Penticton Creek	175 meters south of mouth	IIU LE 12508624	1 per week	1 per month	1 per month	4 per year	1 per month	4 per year
512	Trout Creek	At Water Survey of Canada gauage at experimental farm	IIU LE 10019363	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
513	Chute Creek	at mouth	IIU LR 10420303	1 per week	1 per month	-	4 per year	completed	
514	Peachland Crk.	150 meters from mouth	IIU LF 00911340	1 per week	1 per month	2 per month	4 per year	completed	
515	Trepanier Crk.	at mouth	IIU LF 04781780	1 per week	1 per month	1 per month	4 per year	completed	
516	Powers Creek	500 meters from mouth at Water Survey of Canada gauge	IIU LF 10832110	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
517	Smith Creek (or Westbank Creek)	At mouth	IIU LF 11762209	1 per week	1 per month	2 per month	4 per year	completed	
518	McDougall Creek	Bridge crossing main road 650 meters from mouth	IIU LF 13552550	1 per week	1 per month	2 per month	4 per year	completed	
519	Bellevue Creek	Bridge on Lakeshore road 700 meters from mouth	IIU LF 20652113	1 per week	1 per month	1 per month	4 per year	completed	
520	Mission Creek	Bridge on Lakeshore Rd.	IIU LF 21182394	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
521	Kelowna Creek	Bridge on Abbot Street	IIU LF 20502840	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
522	Brandt Creek	On Guy St., Kelowna, near mouth	IIU LF 20652977	1 per week	1 per month	1 per week	4 per year	4 per month	4 per year
523	Lambly Creek	Bridge on West Side Rd.	IIU LF 19783340	1 per week	1 per month	2 per month	4 per year	completed	
524	Vernon Creek	500 meters upstream from mouth near Hiram Walker's cooling water discharge	IIU LF 29004185	1 per week	1 per month	2 per month	4 per year	2 per year	4 per year
525	Vernon Creek	South side of culvert at P. Peter's residence on main road at Water Survey of Canada's gauge	IIU LF 27814668	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
526	Shorts Creek	200' upstream from mouth	IIU LF 21235657	1 per week	1 per month	-	4 per year	completed	
527	Whiteman Creek	Bridge on west side Rd.	IIU LF 25116700	1 per week	1 per month	2 per month	4 per year	completed	

SAMPLING LOCATIONS AND FREQUENCY (CONT'D)

STN. NO. BC 4-	ION NAME	STATION LOCATION	U.T.M. CO-ORDINATES	1969-70 PROGRAM (MAY 1969 - JULY 1970) POLLUTION ANALYSES	1969-70 PROGRAM (MAY 1969 - JULY 1970) TOTAL ANALYSES	1970-71 PROGRAM (JULY 1970 - JULY 1/71) POLLUTION ANALYSES	1970-71 PROGRAM (JULY 1970 - JULY 1/71) TOTAL ANALYSES	1971-72 PROGRAM (JULY 1/71 - OCT.31/71) POLLUTION ANALYSES	1971-72 PROGRAM (JULY 1/71 - OCT.31/71) TOTAL ANALYSES
528	Equesis Creek	Bridge on west side Rd.	IIU LF 28177328	1 per week	1 per month	-	4 per year	completed	
529	Deep Creek	Road bridge on Indian Reserve off west side Rd.	IIU LF 36767954	1 per week	1 per month	1 per week	4 per year	4 per month	4 per year
530	Vernon Creek	At inlet to Okanagan L.	IIU LF 32986831	1 per week	1 per month	1 per week	4 per year	4 per month	4 per year
531	Bx Creek	Bridge at highway 97	IIU LF 39556580	1 per week	1 per month	2 per month	4 per year	2 per month	4 per year
533	Nashito Creek	Bridge on west side Rd.	IIU LF 26857250	1 per week	1 per month	-	4 per year	completed	
534	Garbage Creek	At Okanagan Lake	IIU LF 21232445	not sampled		2 per month	4 per year	completed	
535	Unknown Creek	Bridge east of Oliver	IIU LE 14685000	not sampled		2 per month	4 per year	2 per month	4 per year
536	Mission Creek	At Water Survey of Canada gauging station	IIU LF 27002743	not sampled		1 per month	4 per year	1 per month	4 per year
537	Kelowna Creek	At highway 97 bridge	IIU LF 28753292	not sampled		1 per month	4 per year	1 per month	4 per year
538	Brandt Creek	At Golfview Road	IIU LF 24253050	not sampled		2 per month	4 per year	2 per month	4 per year
539	Bx Creek	Upstream on Silver Star Road	IIU LF 42117310	not sampled		1 per month	4 per year	1 per month	4 per year
540	Deep Creek	At Young Road	IIU LF 45429208	not sampled		2 per month	4 per year	2 per month	4 per year
541	Vernon Creek	Exit from Kalamalka Lake	IIU LF 38476745	not sampled		2 per month	4 per year	2 per month	4 per year

* the 4 times per year sampling for Total Analyses took place in the following four quarters of the year:

1st Quarter - 1st - 2nd week in February.

2nd Quarter - May or June, depending on when spring run-off is peaking.

3rd Quarter - 1st - 2nd week in August.

4th Quarter - 1st - 2nd week in November (after leaf fall has occurred).

Pollution Analyses consisted of: Nitrates, Ortho-Phosphates, Total Organic and Inorganic Carbon, Total Kjeldahl nitrogen.

Total Anlyses consisted of: pH, Temperature, Alkalinity, Conductivity, Color, Turbidity, Suspended Matter, Calcium, Magnesium, Total Hardness, Sodium, Potassium, Silica, Chlorides, Iron, Manganese, Sulphates, Fluorides, Nitrates, Ortho-Phosphates, Total Phosphates, Copper, Lead, Zinc, Mercury, Total Organic and Inorganic Carbon, Total Kjeldahl Nitrogen.

Samples were prepared (when full analysis were required) for heavy metal analysis by passing a 1000 milliliter aliquot of sample through a 0.45 micron cellulose acetate filter, prewashed with nitric acid, and acidifying with 2 mls of concentrated nitric acid. Samples were forwarded to Calgary for analysis. Sampling schedules were arranged so that samples could be delivered to the Calgary laboratory within 24 hours of sampling. Samples left Kelowna at 8:00 p.m. by bus and arrived at the Calgary Terminal at 6:00 a.m. the next morning. Messenger service then delivered the samples at 8:00 a.m. to the Calgary laboratory.

The methods of analyses used in the Water Quality Laboratory at Calgary are described in tabular form (Table 2.2). The minimum detectable concentrations for each water quality parameter and their respective accuracy limits are described in Table 2.3.

TABLE 2.2
METHODS OF ANALYSES
WATER QUALITY LABORATORY AT CALGARY

NOTE: All values expressed as mg/l unless otherwise stated.

Conductivity	- Measurement made using a platinum electrode conductivity meter. Vales corrected to 25° centigrade and expressed as umho/cm. (1)*
Turbidity	- Measurement made with Hach model 2100 turbimeter. Results are expressed in Jackson turbidity units. (2)
Temperature	- Measurements made with mercury-filled thermometer (-10 to 50° centigrade range - 300 mm length). Results expressed in degrees centigrade. (1)
pH	- Electrometric method using pH meter equipped with glass and saturated calomel electrodes. Results expressed in pH units. (1)
Alkalinity (Total)	- Potentiometric titration with standard acid solution. Alkalinity expressed as $CaCo_3$. (1)
Calcium (Dissolved)	- Titration with ethylenediamine-tetraacetic acid (E.D.T.A.) and eriochrome blue as indicator. (2) (Treatment of sample for dissolved analysis follows these descriptions).
Magnesium (Dissolved)	- Calculated from the values of Total Hardness and dissolved calcium. mg = (Total Hardness) x 0.01998 - Calcium x 0.0499) x 12.16 (2)
Hardness (Total)	- Titration with E.D.T.A. using eriochrome Black T as indicator. Values expressed as $CaCo_3$. (1)
Sodium (Dissolved)	- Flame photometry by internal-standard measurement on autoanalyser. (2)
Potassium (Dissolved)	- Flame photometry by internal standard measurement on autoanalyser. (2)
Iron (Total)	- Colorimetric on autoanalyser with tripyridys-strianine. (2) (Treatment of sample for total analysis follows these descriptions).
Iron (Dissolved)	- Colorimetric on autoanalyser with tripyridyl-s-triazine. (2)
Manganese (Total)	- Atomic absorption determination by direct aspiration. (2)
Manganese (Dissolved)	- Atomic absorption determination by direct aspiration. (2)
Copper (Dissolved)	- Determination by atomic absorption after solvent extraction. (2)
Silica	- Colorimetric heteropoly blue method on autoanalyser with ammonium molybdate and aminonaphtholsulfonic acid. (2) Results expressed as SiO_2.

TABLE 2.2
METHODS OF ANALYSES

WATER QUALITY LABORATORY AT CALGARY (CONT'D)

Nitrate - Nitrogen (Dissolved)	- Colorimetric on autoanalyser Nitrate is reduced by cadmium and the resulting nitrite is determined by diazotizing with sulphanilamide and naphthylamine dihydrochloride. Thus both nitrate and nitrite are determined. (2)
Total Kjeldahl Nitrogen	- Organic nitrogen is converted to an ammonium salt by digestion with sulphuric acid. Ammonia is then distilled from an alkaline medium and absorbed in boric acid. The ammonia is determined by titration with standard acid. This test includes the organically bound nitrogen and ammonia sample. The test is performed on a shaken sample. (1)
Chloride (Dissolved)	- Colorimetric on autoanalyser with ferric ammonium sulphate and mercuric thiocyanate. (2)
Phosphate (Ortho Dissolved)	- Colorimetric on autoanalyser with ammonium molybdate and stannous chloride. (2)
Sulphate (Dissolved)	- Sample is passed through a strong cation exchange resin (Ambelite IR-120 or equivalent). Sulphate is titrated in an alcoholic solution under controlled acid conditions with a standard barium chloride solution using thorin as the indicator. (2)
Phosphate (Total)	- Colorimetric on autoanalyser with ammonium molybdate and stannous chloride after 30 minutes in an autoclave with sulfuric acid and potassium persulphate. Determination is done on a shaken sample. (2)
Fluoride (Dissolved)	- Determined with fluoride electrode and total ionic strength adjustment buffer. (2)
Total Organic Carbon	- Sample is passed through a column of quartz chips wetted with 85% H_3PO_4. Temperature is held at 150°C. A release of carbon dioxide from the inorganic carbonates is measured by infrared analyses. (2)
Lead (Dissolved)	- Determination by solvent extraction after solvent extraction.(2)
Zinc (Dissolved)	- Determination by solvent extraction after solvent extraction. (2)
Mercury (Total)	- Cold flame atomic absorption (automated). Determination done on a shaken sample. (2)
Mercury (Dissolved)	- Cold flame atomic absorption (automated). (2)
Residue (nonfilterable (105°C)	- Sample is passed through a weighed gooch crucible with a glass fibre filter. The crucible with its contents is oven dried at 103 - 105°C. The increase in weight over that of the gooch crucible and filter represents the nonfilterable residue (suspended matter). (2)
Residue (Fixed) Non-filterable	- The gooch crucible and glass fibre filter with its retained residue after completion of the test for residue non filterable (105°C) is ignited at 550°C for 1/2 hour. The increase in weight over that of the gooch crucible and filter represents residue fixed non filterable. (2)

Definition of terms used in methods:

Dissolved - (a) Heavy Metal Analysis.

The sample was filtered the same day as sampling in the Kelowna field laboratory through a 0.45 micron cellulose acetate filter. This filter was pre-washed with dilute HNO_3. 2 mls concentrated HNO_3 per liter of sample was then added at a preservative.

(b) General Dissolved Analysis (Cl, SO_4, F, etc.)

No field pretreatment. Sample was filtered through a filter in the Calgary Laboratory.

Total - For this program, total anaylsis was that analysis performed on a shaken sample.

Solvent Extraction - MIBK - APDC extraction as outlined in reference 2, page 54 - 55.

Methods of analyses for Okanagan stream sampling program, Task 131, as used in the Kelowna field laboratory in Kelowna, B.C.

pH - As described in the Calgary laboratory.

Conductance - As described in the Calgary laboratory.

Temperature - As described in the Calgary laboratory.

Turbidity - As described in the Calgary laboratory.

Dissolved Oxygen - Standard Winkler method with the azide modification. (1)

Biochemical Oxygen-Demand - 5 day incubation using the standard Winkler method with the azide modification. (1)

* Numbers in parenthesis refer to references as indicated.

TABLE 2.3

MINIMUM DETECTIONS LIMITS AND LIMITS OF ACCURACY

PARAMETER	MINIMUM DETECTION LIMIT	LIMITS OF ACCURACY (coefficient of variation)
Conductivity	0.2 umhos/cm	t 0.5% at 520 umhos/cm
Turbidity	0.1 J.T.U.	t 9.22% at 1 JTU t 3.96% at 10 JTU t 1.68% at 40 JTU t 0.45% at 100 JTU
Temperature	-	t 0.1°C in Calgary Laboratory t 0.25°C in field
pH	-	0% at pH of 8.8 0% at pH of 4.0
Alkalinity (Total)	0.5 mg/l $CaCO_3$	± 1.48% at 3.33 mg/l $CaCO_3$
Calcium (Dissolved)	0.05 mg/l Ca	± 2.9% at 13 mg/l Ca ± 0.5% at 45 mg/l Ca
Magnesium (Dissolved	as above as mg	as above
Hardness (Total)	as above as $CaCO_3$	± 0.65% at 52.0 mg/l $CaCO_3$
Sodium (Dissolved)	0.1 mg/l Na	± 0.67% at 12 mg/l Na ± 1.29% at 67 mg/l Na
Potassium	0.1 mg/l Fe	± 1.09% at 6.4 mg/l K ± 1.79% at 36 mg/l Na
Iron (Total)	0.01 mg/l Fe	± 0.7% at 50 mg/l Fe
Iron (Dissolved)	as above	as above
Manganese (Total)	0.01 mg/l Mn	+ 0.01 mg/l at detection limit; unknown at higher quantities.
Manganese (Dissolved)	0.02 mg/l Mn	as above
Copper (Dissolved)	0.001 mg/l	± 1.6% at 0.010 mg/l Cu
Silica	0.005 mg/l	± 0.7% at 0.200 mg/l SiO_2
Nitrate-Nitrogen (Dissolved	0.01 mg/l as N	± 1.6% at 0.05 mg/l N
Total Kjeldahl Nitrogen Nitrogen	0.01 mg/l N	± 4.58% at 25 mg/l N
Chloride (Dissolved)	0.1 mg/l as Cl	± 0.5% at 30 mg/l Cl

TABLE 2.3

MINIMUM DETECTIONS LIMITS AND LIMITS OF ACCURACY

(CONT'D)

Phosphate (Ortho Dissolved)	0.010 mg/l as PO_4	$\pm$ 4.65% at 0.010 mg/l PO_4 $\pm$ 3.98% at 0.025 mg/l PO_4
Sulphate (Dissolved)	0.2 mg/l as SO_4	$\pm$ 3.0% at 25 mg/l SO_4
Phosphate (Total)	0.010 mg/l as PO_4	$\pm$ 7.30% at 0.20 mg/l PO_4 $\pm$ 4.11% at 0.50 mg/l PO_4
Fluoride (Dissolved)	0.01 mg/l as F	$\pm$ 0.79% at 0.20 mg/l F $\pm$ 0.93% at 1.0 mg/l F
Total Organic Carbon	2 mg/l as C	$\pm$ 3.08% at 20 mg/l C $\pm$ 0.02% at 30 mg/l C
Total Inorganic Carbon	as above	similar to the above
Lead (Dissolved	0.001 mb/l as Pb	$\pm$ 2.2% at 0.020 mg/l Pb
Zinc (Dissolved)	0.001 mg/l as Zn	$\pm$ 1.4% at 0.010 mg/l Zn
Mercury (Total)	0.05 ug/l as Hg	$\pm$ 5.5% at 0.3 ug/l Hg $\pm$ 4.9% at 2.0 ug/l Hg $\pm$ 3.3% at 8.0 ug/l Hg
Mercury (Dissolved	as above	similar above
Residue (Non-Filterable - 105°C)	1 mg/l -	No data available
Residue (Fixed)	1 mg/l	as above
Dissolved Oxygen	0.1 mg/l as D.O.	$\pm$ 1.8% at 4.1 ug/l D.O.
B.O.D.	0.5 mg/l as oxygen (Not based on actual analyses rather a "rule of thumb")	No data available.

NOTE: Coefficient of variation is the ratio of the standard deviation to the arithmetic mean expressed as a percentage.

2.2 STREAM QUALITY DATA

A statistical summary of the analytical results for the 41 sampling stations are included in Appendix B. The data has been summarized for 1969, 1970 and 1971 in which the maximum and minimum concentrations, range and number of values have been calculated for each water quality parameter.

CHAPTER 3

Outfall Data Collection Study

This study was established to provide quantitative information on the amount of nutrients, heavy metals and other contaiminants being discharged from municipal and industrial sources into Okanagan Basin surface waters.

A documentation was made of positive discharge outfalls to lakes and tributary streams. Nineteen (19) outfalls, considered to be representative of major municipal and industrial discharges, were sampled monthly over a two-year period commencing September, 1969. In addition, thirty-six (36) other outfalls were sampled at lease twice during the period from September, 1969 to October, 1971. Figure 3.1 shows the locations of the 19 major outfall stations.

The sampling program was carried out by the Pollution Control Branch District office in Vernon. With the exception of in-situ analyses and tests not requiring extensive laboratory equipment, all samples were analysed at the Water Resources Laboratory in Vancouver. Laboratory results were submitted to the study office in Penticton and to the Pollution Control Branch in Victoria for processing.

3.1 SAMPLING LOCATIONS AND PROGRAMS

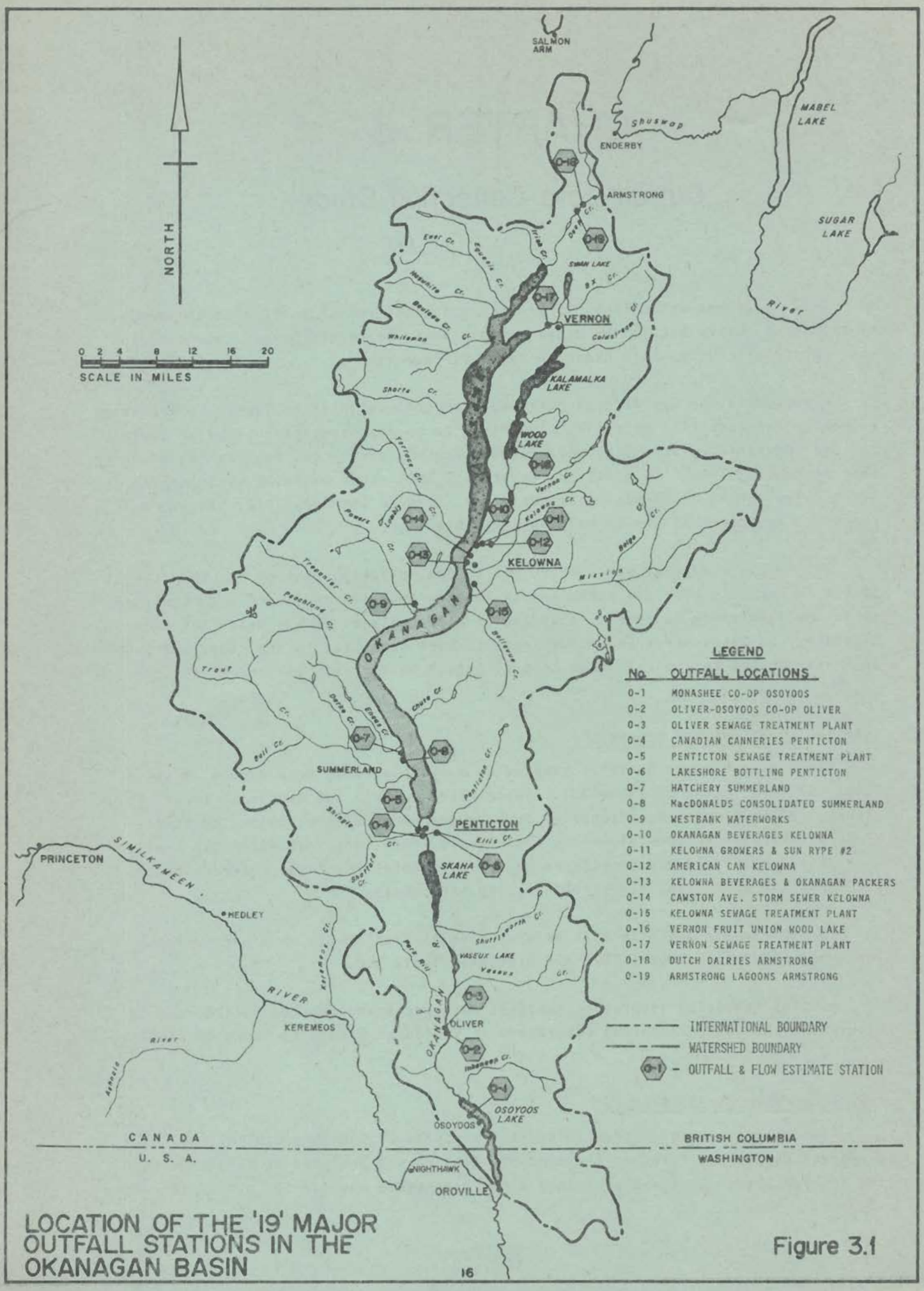
The nineteen major outfalls sampled on a monthly basis from August, 1969 to July, 1971 are listed in Table 3.1. These represent all the municipal treatment plants that have positive discharges to Okanagan Basin Waters, major industrial waste discharges in terms of volume and organic loads, and several of the small industrial establishments considered to be representative of the numerous other plants of the same type, e.g. fruit packing and canning.

The thirty-six outfalls that were sampled at least twice in a period from September, 1969 to October, 1971 are listed in Table 3.2.

Samples requiring laboratory analyses were preserved, packed in ice, and delivered to the Water Resources Laboratory in Vancouver within 24 hours of sampling.

3.2 ANALYTICAL METHODS AND RESULTS

Temperature, pH and conductivity were measured at the time of sampling. Dissolved oxygen was fixed at the time of sampling and analyzed at Vernon using the Winkler Test. Analyses of twenty other parameters was carried out at the Water



LOCATION OF THE '19' MAJOR OUTFALL STATIONS IN THE OKANAGAN BASIN

Figure 3.1

TABLE 3.1
19 OUTFALLS SAMPLED MONTHLY

NO.	NAME	LOCATION	DISCHARGE PT.	TYPE OF OPERATION	TYPE OF WASTE	TREATMENT PROVIDED
O-1	Monashee Co-Op	Osoyoos	Osoyoos L.	Fruit Packing	Cooling,wash,rinse	----
O-2	Oliver-Osoyoos Co-Op	Oliver	Okanagan R.	Fruit Packing	Cooling,wash,rinse	----
O-3	Village of Oliver	Oliver	Okanagan R.	Municipality	Domestic;industrial	Activated sludge
O-4	Canadian Canners Ltd.	Penticton	Okanagan R.	Food proc.& canning	Wash;cooling;process	----
O-5	City of Penticton	Penticton	Okanagan R.	Municipality	Domestic	Activated Sludge, Lime Precipitation
O-6	Lakeshore Bottling Co.	Penticton	Okanagan R.	Soft drink bottling	Cooling;rinse;wash	----
O-7	Fish and Wildlife Hatchery	Summerland	Okanagan L.	Hatchery	Hatchery ponds disch.	----
O-8	Cornwall Canners Ltd. (McDonalds Consolidated)	Summerland	Okanagan L.	Fruit Canning	Process;wash;rinse;cooling	----
O-9	Westbank Waterworks	Westbank	Okanagan L.	Municipality	Domestic	Lagoon
O-10	Okanagan Bev. & Calona Wines	Kelowna	Brandt's C.	Bottling;winery	Wash water & cooling, etc.	Aerated lagoon (under construction)
O-11	Kelowna Grower's Exchange & Sun-Rype No.2	Kelowna	Brandt's C.	Canning	Process;wash;rinse	" " "
O-12	American Can Company	Kelowna	Brandt's C.	Canning	Cooling Water	----
O-13	Kelowna Beverages & OK. Packers (Smith Ave. Storm Sewer)	Kelowna	Okanagan L.	Bev.-Soft drinks OK -Fruit packing	Wash; rinse Cooling	---- ----
O-14	B.C. Orchards Co-Op (Cawston Av. Storm Sewer)	Kelowna	Okanagan L.	Fruit Packing	Wash; rinse, cooling	----
O-15	City of Kelowna	Kelowna	Okanagan L.	Municipality	Domestic	Activated Sludge; Pilot Lime Precipitation.
O-16	Vernon Fruit Union	Woodsdale	Wood Lake	Fruit Packing	Wash; rinse; cooling	----
O-17	City of Vernon	Vernon	Vernon Cr.	Municipality	Domestic	Trickling Filter; Pilot Spray Irrigation.
O-18	Dutch Dairies Ltd.	Armstrong	Deep Creek	Dairy	Wash, etc.; process	----
O-19	City of Armstrong	Armstrong	Deep Creek	Municipality	Domestic	Lagoons

TABLE 3.2

SUPPLEMENTARY LIST OF 36 DISCHARGES

NO.	STATION NAME	LOCATION	DISCHARGE PT.	TYPE OF OPERATION	TYPE OF WASTE DISCHARGED	TREATMENT
1	McLean & Fitzpatrick**	Osoyoos	Osoyoos L.	Fruit Packing	Cooling water	
2	Oliver-Osoyoos Co-Op	Osoyoos	Osoyoos L.	Fruit Packing	Cooling water and def. water	
3	International Curling Club	Osoyoos	Osoyoos L.	Rink	Cooling water and def. water	
4	Haynes Co-Op	Oliver	Lagoon*	Fruit Packing	Wash water and cooling water	Lagoon
5.	Southern Co-Op (+)	Oliver	Unknown Cr.	Fruit Packing	Wash water and cooling water and brine tank overflow	
6	Sun-Rype Products (+)	Oliver	Oliver S.T.P.	Fruit Packing	Drainage and washwater and cooling water	
7	McLean & Fitzpatrick**	Oliver	Okanagan R.	Fruit Packing	Cooling and def. water (perhaps wash water)	
8	Oliver -Osoyoos (Kaleden) (Co-Op)	Kaleden	Skaha Lake	Fruit Packing	Cooling and def. water (perhaps wash water)	
9	Penticton Sawmills	Penticton	Okanagan R.	Logs Floating	Water from log float lagoon	
10	Pyramid Co-Op	Penticton	Okanagan L.	Fruit Packing	Wash water and cooling water	
11	Naramata Co-Op	Naramata	Okanagan L.	Fruit Packing	Wash water and cooling water	
12	Summerland Arena	Summerland	Prairie Cr.	Rink	Cooling Water	
13	Summerland Sweets	Summerland	Trout Cr.	Syrup Makers	Cooling Water	
14	Westbank Co-Op (+)	Westbank	Okanagan L.	Fruit Packing	Wash water and cooling water	
15	Westbank Orchards	Westbank	Westbank (Smith Cr.)	Fruit Packing	Washwater and Cooling water	
16	S.M. Simpson Ltd.	Kelowna	Okanagan L.	Sawmills and Plywood Plant	Sawdust, steam vat. and boiler blowdown...etc.	
17	Kelowna Memorial Arena	Kelowna	Doyle Ave. Storm sewer	Rink	Cooling Water	
18	Caravel Motor Inn	Kelowna	Abbott St. Storm sewer	Swimming pool	Swimming pool water and Air Cond. cooling water	
19	Provincial Building	Kelowna	Okanagan L.		Air cond. cooling water and rain water from drain.	
20	Cascade Co-Op	Kelowna	Ditch flowing into Brandt's Creek	Fruit Packing	Wash water and cooling water	

TABLE 3.2

SUPPLEMENTARY LIST OF 36 DISCHARGES (CONT'D)

NO.	STATION NAME	LOCATION	DISCHARGE POINT	TYPE OF OPERATION	TYPE OF WASTE DISCHARGED	TREATMENT
21	Valley Building Materials	Kelowna	Brandt's Creek	Ready Mix Concrete	Truck wash and batcher spillage	
22	S. DeBoer	Kelowna	(Small)Creek	Dairy Farm	Wash water from milkhouse	
23	L.M. Heemskerk	Kelowna	Scotty Creek	Dairy Farm	Washwater from milkhouse	
24	Doyle Ave. Storm Sewer	Kelowna	Okanagan L.	-	-	
25	Calona Distillers	Rutland	(Mill) Creek	Distilleries	Cooling water and perhaps wine waste spillage	
26	McLean & Fitzpatrick	Rutland	(Mill) Creek	Fruit Packing	Wash water and cooling water	
27	Kelowna Growers Exchange	Rutland	(Mill) Creek	Fruit Packing	Wash water and cooling water	
28	Winoka Co-op (+)	Okanagan Center	Okanagan L.	Fruit Packing	Wash water and cooling water	
29	Hiram Walker Sons	Winfield	Vernon Cr.	Distilleries	Cooling water	
30	Vernon Fruit Union	Oyama	Wood Lake	Fruit Packing	Cooling rusty water	
31	Tom Collins	Lavington	Coldstream Cr.	Dairy Farm	Washwater from milk parlor Washwater from milk house	
32	Coldstream Ranch	Coldstream	Coldstream Cr.	Dairy Farm	Washwater from milk house	
33	R.H. MacDonald	Vernon	B.X.Creek	Fruit Packing	Wash water and cooling water	
34	Bulmans Products Ltd.	Vernon	Girrard Cr.	Fruit Packing	Cooling Water	
35	Inland Ice & Cold Storage Ltd.	Vernon	To civic Arena, then to Girrard Cr.	Cold Storage	Cooling Water	
36	Hawkins Dairy Farm	Armstrong	Otter Lake	Dairy Farm	Washwater from milk house	

* - No positive discharge

+ - Closed

** - Now owned by Oliver-Osoyoos Co-op.

Resources Laboratory in Vancouver. The methods used for analysing samples at the laboratory and in the field, and the minimum detectable concentrations with these methods are listed in Appendix A.4.

A statistical summary of the analytical results for the 19 frequently monitored and the 36 supplemental outfalls are included in Appendices C and D respectively. This summary includes a tabulation of all physical, inorganic and organic parameters measured over the two year sampling period. Each parameter is summarized by five headings: number of values (samples), maximum concentration, minimum concentration, range and mean.

3.3 ANNUAL DISCHARGE

Annual discharges from the sampled outfalls were estimated from Pollution Control permits for the outfalls. These estimates are shown in Appendix A.5.

CHAPTER 4

Storm Sewer Discharge Study

The Okanagan Storm Sewer Discharge Study was carried out to determine the types and amounts of impurities reaching receiving waters from the storm sewers of Vernon, Kelowna and Penticton. The relative importance of this source of impurities could then be assessed to determine if corrective measures would be meaningful to the quality of water in the mainstem lakes.

4.1 LOCATION

The storm sewer system in each city is a completely separate system from the sanitary sewer system. Roof drains in the downtown areas of the cities and, in some cases, drains from service station workbays, are connected to the storm sewers.

The three cities are approximately the same size and have approximately the same climate. Annual rainfall averages 11.8 inches in Penticton, 12.4 inches in Kelowna and 13.2 inches in Vernon. Average yearly snowfall is in the range of 26" to 40" and falls in the months of November, December, January and February. Precipitation is fairly evenly distributed throughout the year with December and January having slightly higher monthly averages and March and April having slightly lower monthly averages. The intervals between precipitation events are longest in the summer and shortest in the fall and winter.

The populations and areas for the three cities are as follows (1971 data):

	POPULATION	AREA
VERNON	18,845	2,300 acres
KELOWNA (Old)	19,412	5,292 acres
PENTICTON	18,955	8,500 acres

It is important to note that due to the design of the storm drain systems, the areas contributing to stormwater are different from the actual city areas. The areas served by storm sewers in the three cities are as follows:

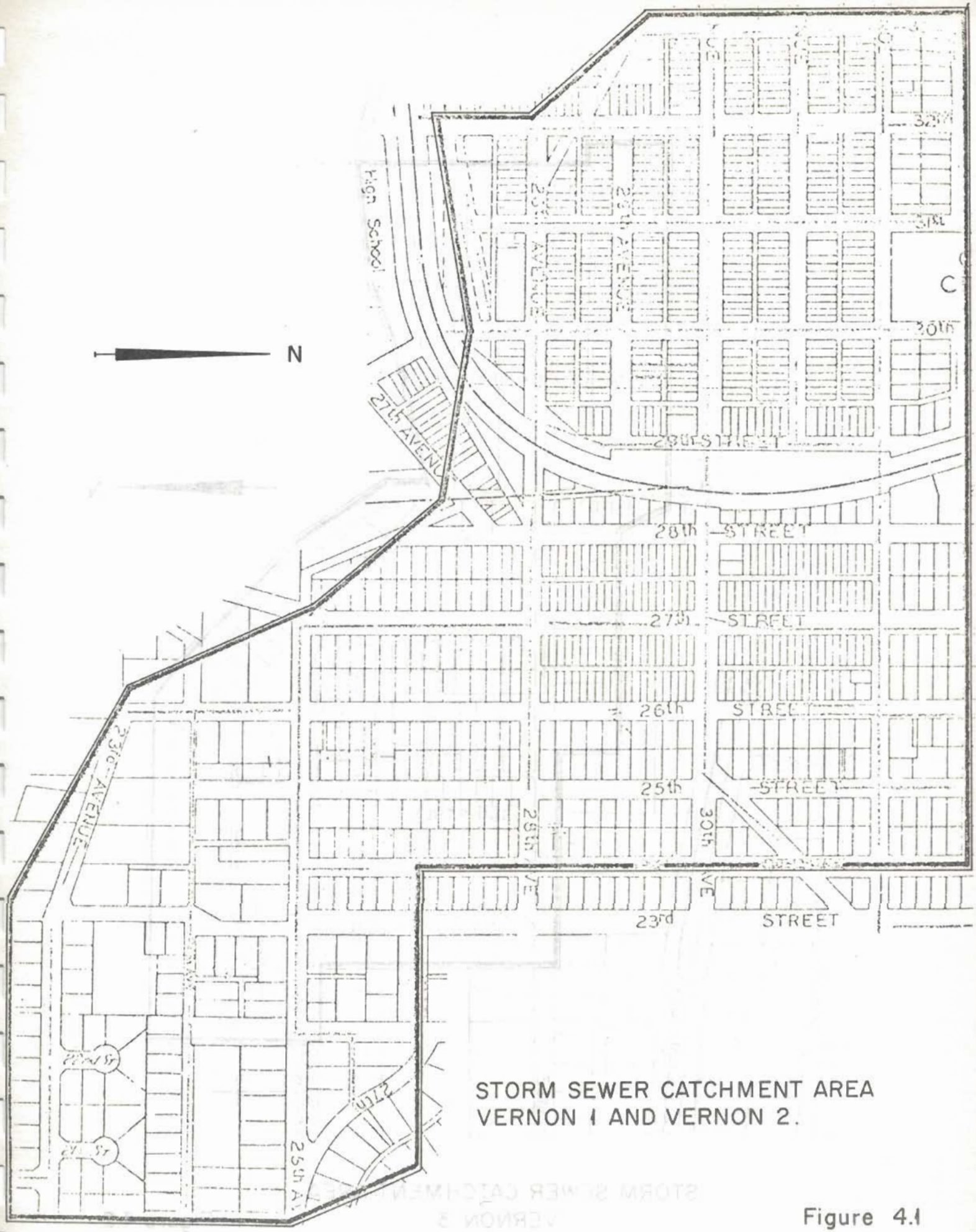
VERNON	1,100 acres
KELOWNA	655 acres
PENTICTON	1,300 acres

Three storm drains in each of the cities were sampled. The drainage areas chosen were considered to be typical of residential and commercial areas in the Okanagan. Table 4.1 provides descriptions of the areas selected. Figures 4.1 to 4.8 show the areas on street maps of the cities.

TABLE 4.1

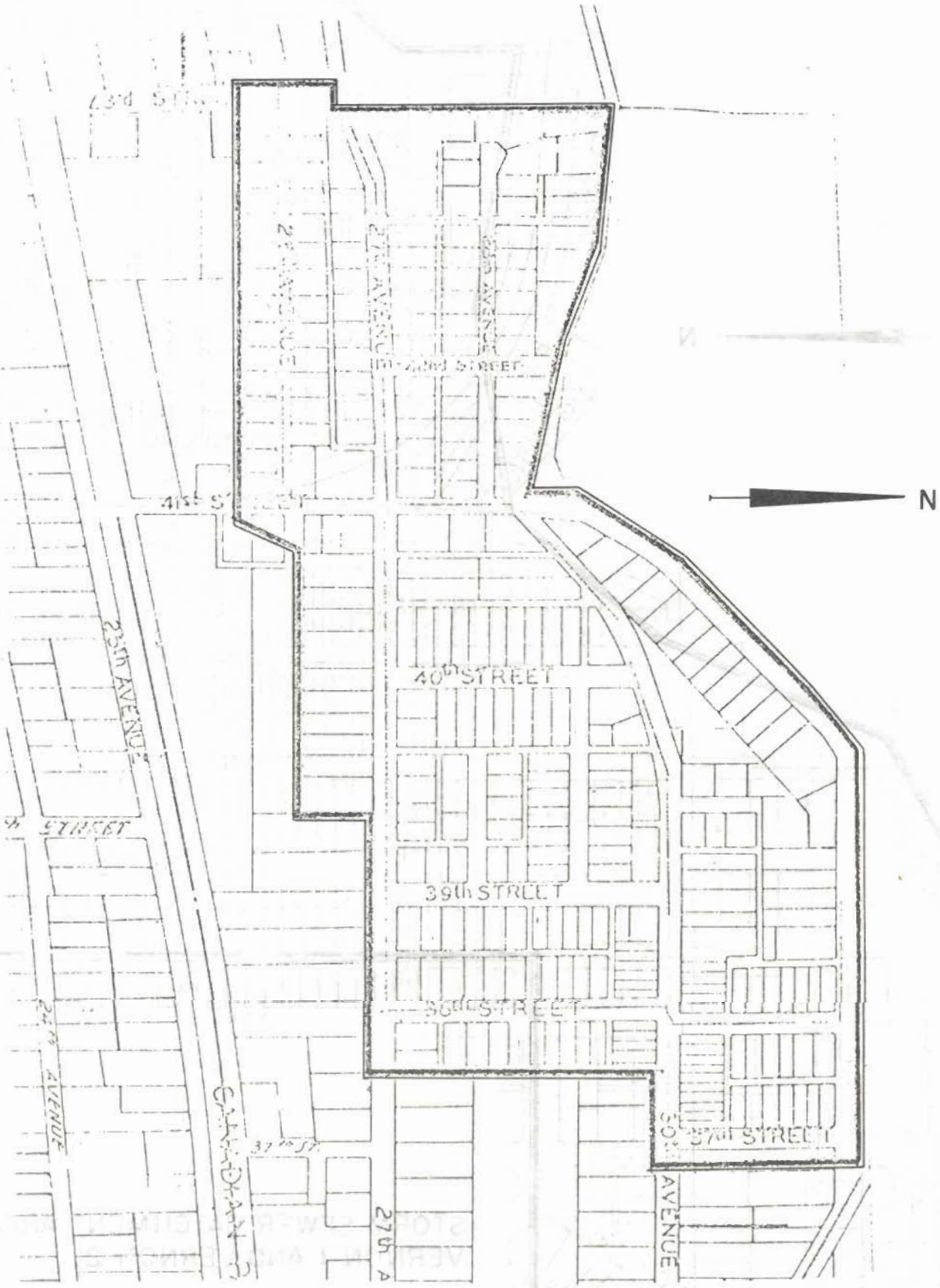
DESCRIPTION OF SAMPLED AREAS

AREA NO.	AREA IN ACRES	% IMPERV-IOUSNESS	LAND USE CLASSIFICATION	GEOGRAPHIC DESCRIPTION	ROAD DESIGN	R E M A R K S
V_1		95-100	Commercial	Mostly Flat	Curbs with pavement curb to curb	Drains downtown Vernon. Area of drainage not known because of many inter-connections with other storm sewers.
V_2		95-100	Commercial	Mostly Flat	Curbs with pavement curb to curb.	Same as above
V_3	70	21	Residential	Flat	Curbs with pavement curb to curb.	Middle class residential area.
K_1	22	15-20	Residential	Flat	No curbs	Inspection during rainstorm showed large puddles formed on gravel shoulder. Large amounts of depression storage available.
K_2	29	100	Commercial	Flat	Curbs with pavement curb to curb.	Drains large shopping center complex including Capri Hotel.
K_3	9	95-100	Commercial	Flat	Curbs with pavement curb to curb	Drains area of downtown Kelowna
P_1	6	95-100	Commercial	Flat	Curbs with pavement curb to curb	Drains area of downtown Penticton. Part of Penticton. Part of area covered by parking lot.
P_2	33	22	Residential	On a side hill	Curbs with pavement curb to curb	Drains middle class sub-division on a side hill.
P_3	70		Commercial-Residential	Flat	Curbs with pavement curb to curb	Drains main street coming into Penticton from south lined with some houses but also has service stations and other minor commercial activities. Gas stations may have washdown drains connected to sewer.



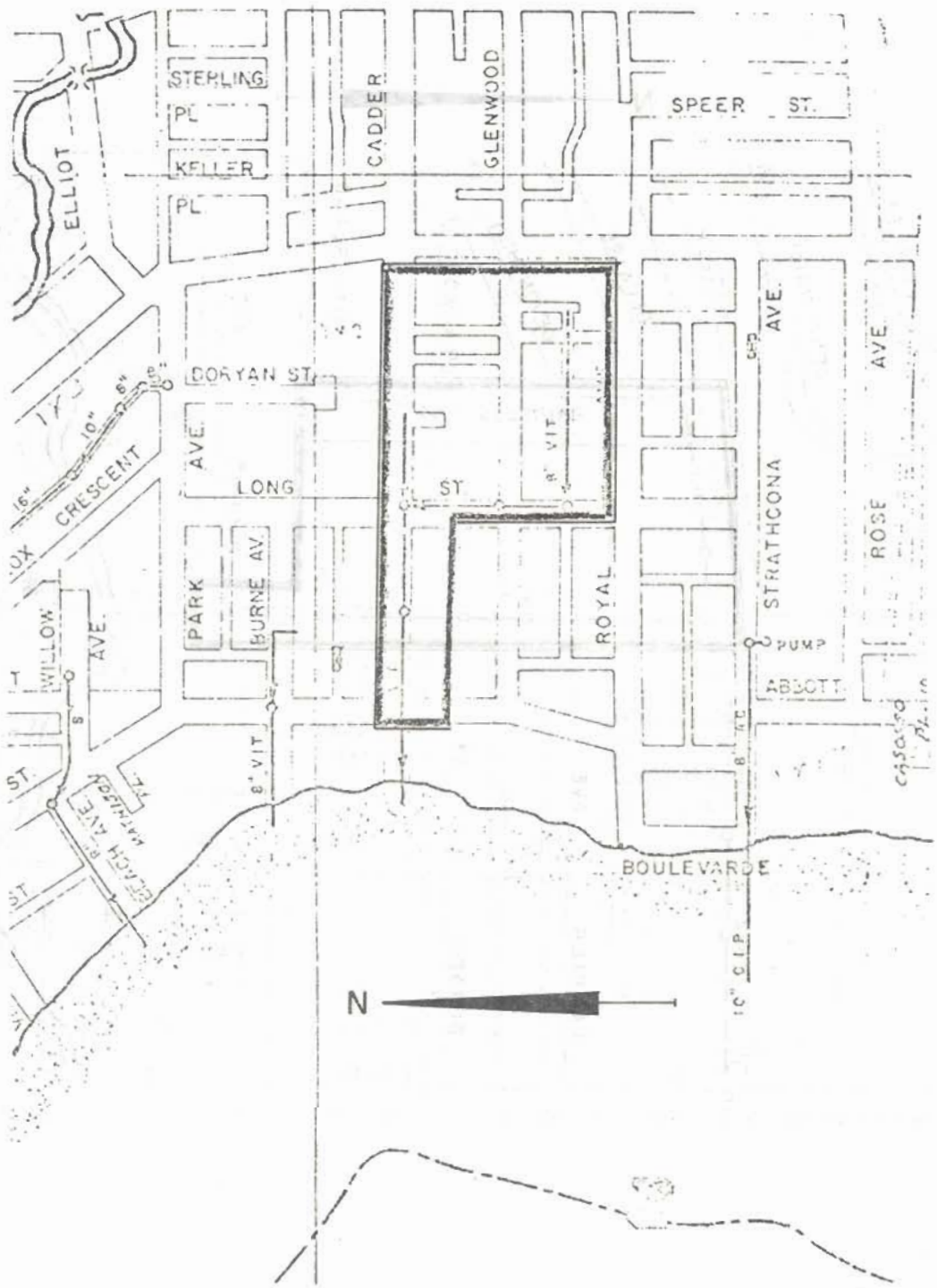
STORM SEWER CATCHMENT AREA
VERNON 1 AND VERNON 2.

Figure 4.1



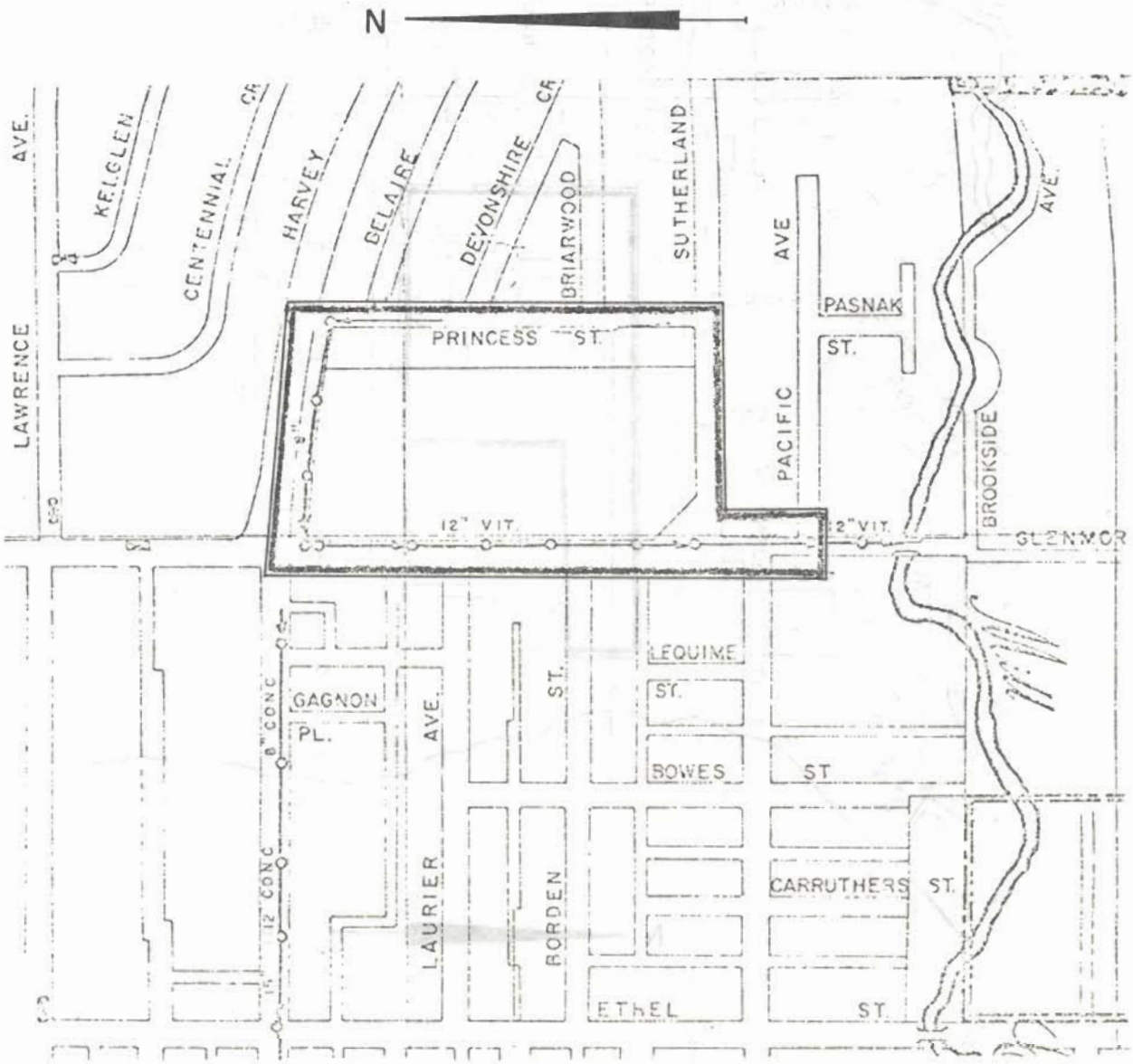
STORM SEWER CATCHMENT AREA
VERNON 3

Figure 4.2



STORM SEWER CATCHMENT AREA
KELOWNA 1

Figure 4.3



STORM SEWER CATCHMENT AREA
KELOWNA 2

Figure 4.4



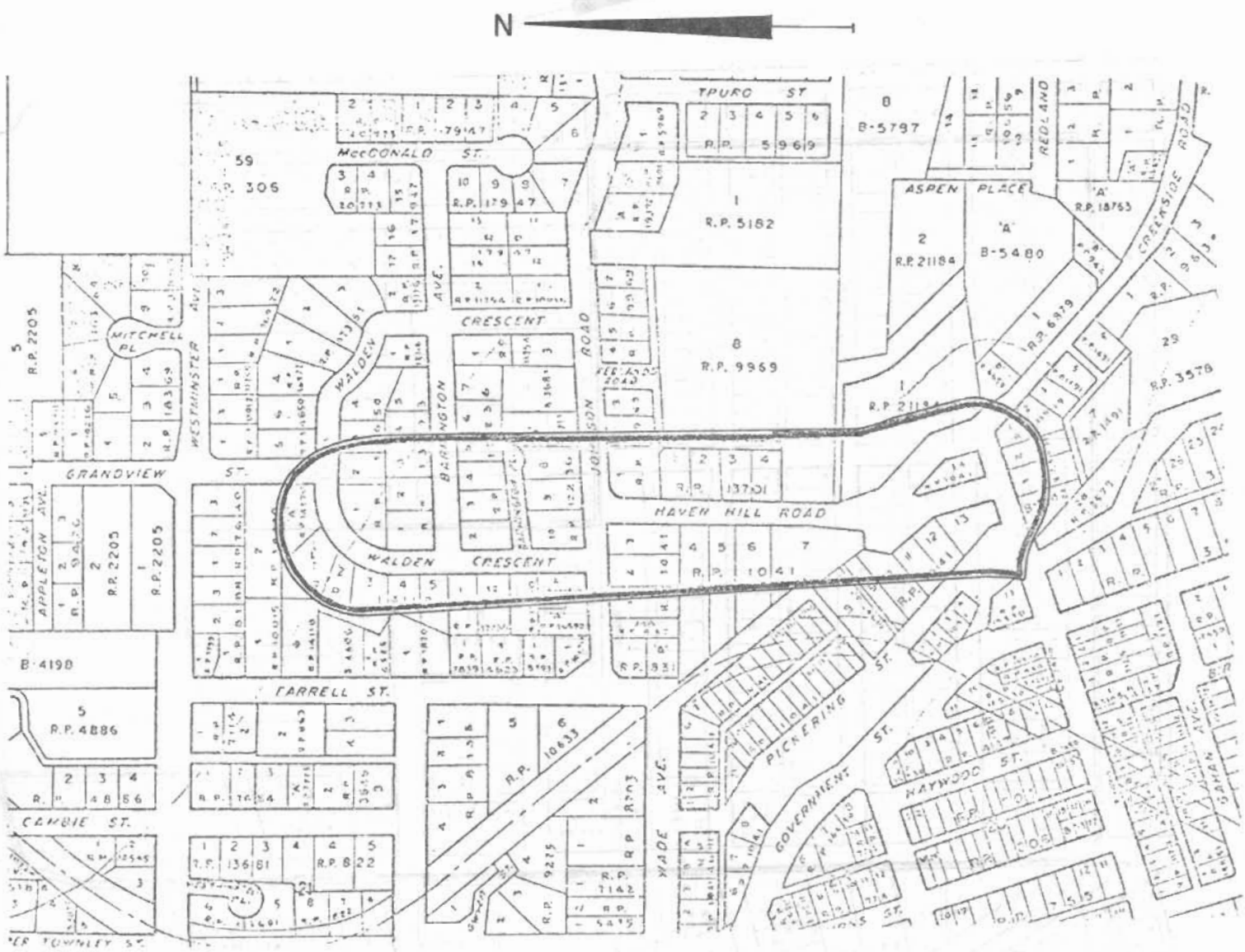
STORM SEWER CATCHMENT AREA
KELOWNA 3

Figure 4.5



STORM SEWER CATCHMENT AREA
PENTICTON

Figure 4.6



STORM SEWER CATCHMENT AREA
PENTICTON 2

Figure 4.7



STORM SEWER CATCHMENT AREA
PENTICTON 3

Figure 4.8

4.2 SAMPLING PERIOD

Sampling was conducted during the spring and summer of 1972. In addition, a limited amount of data collected during 1971 was available for comparison. Samples were taken at Vernon during one spring rain, one summer rain and three periods of daily snowmelt; at Kelowna during one spring rain, one summer rain and three periods of daily snowmelt; and at Penticton during one spring rain, one summer rain and one period of daily snowmelt.

In addition to the sampling during periods of stormwater and snowmelt flows, samples were taken of the dry weather flow and accumulated sludge in the sewers to provide a description of normal or background conditions.

Samples of daily snowmelt were collected from early morning to late afternoon to ensure that the samples taken were indicative of the entire melt. Representative samples of the full duration of the rainstorms were not always obtained, however.

The three snowmelt periods sampled in Vernon and Kelowna occurred between the 21st of February and the 7th of March. There had been some snowmelt before this time and there was still snow left on the ground after March 7th. A rough estimate based on temperature data for 1972 indicates that one-quarter of the snow had melted before the sampling period and that about one-third still remained after the sampling period. The snowmelt period sampled in Penticton was on February 29 or approximately halfway through the sampling period in Vernon and Kelowna. At this time, about 3/4 of the snow had already melted.

Runoff from snowmelt was sampled more frequently than the other events because of the potential build-up of impurities in the accumulated snow. This approach provided the most accurate estimate of annual impurity loadings for a given total expenditure of funds. Accuracy of the data obtained is discussed in more detail in Sections 4.7 and 4.8.

The estimate obtained from Vernon and Kelowna is probably more accurate than that from Penticton because three periods of snowmelt were sampled in Vernon and Kelowna, but only one was sampled in Penticton. The Penticton data, however, was still considered useable in calculating the quantity of impurities from Penticton for the following reasons:

(1) The data is in reasonable agreement with at least some of the data obtained from Vernon and Kelowna (See Section 4.7).

(2) The data is probably more indicative of the conditions in Penticton than data extrapolated from Vernon and/or Kelowna.

4.3 SAMPLING PROCEDURES

Samples were taken manually once per hour and a composite sample was prepared. The composite sample was sent to the Provincial Water Resources Service Laboratories in Vancouver for analysis. Analysis of heavy metal concentration was carried out by atomic absorption spectrophotometry. Coliform analysis, by the MPN method, was carried out by the Provincial Health Laboratory.

4.4 FACTORS AFFECTING STORMWATER QUANTITY AND QUALITY

4.4.1 Quantity

The three factors that determine the amount of stormwater discharged are the annual precipitation, the area drained by storm sewers and the coefficient of run-off (i.e., what percentage of rain falling on an area is discharged from the sewers).

The annual precipitation and the areas drained are readily available from government or municipal records or maps. The runoff coefficients, however, must be determined experimentally.

The coefficient of runoff depends on the following factors:

(1) Percentage of the surface area that is impervious to moisture.

(2) Whether or not the street is curbed.

(3) Amount of depression storage available on streets and roof tops.

(4) Intensity and duration of rain events.

(5) Geography of the drained area.

4.4.2 Quality

The concentration of impurities in stormwater will depend to a large extent upon the following six parameters.

(1) Land Use Classification - The use of the drained area is probably the most important factor in determining stormwater quality. Commercial areas have more traffic, more people and more litter than residential areas. Residential areas, on the other hand, have more vegetation which contributes more bio-degradable material to storm sewers.

(2) Fallout from Industries, Farms - Particulate matter from industries such as sawmills, dust from land cultivation, and sprays used on farms and dwellings can increase the concentrations of materials in stormwaters.

(3) Season of the Year - The season can influence stormwater quality for the following reasons:

(a) vegetation changes during the year;

(b) time lapse between precipitation events varies with the season. The longer the time lapse the more material is allowed to accumulate before it is washed into the sewers.

(4) General Cleanliness of City - The effectiveness of the street cleaning program will substantially affect the amounts of material discharged into the sewers.

(5) Infiltration and Illegal Connections

(6) Amount of Impurities in Rainwater - Studies have shown that rainwater can contain nitrates in concentrations approaching that found in the corresponding urban runoff.

4.5 HYDROLOGIC DATA

Table 4.2 gives a summary of the hydrologic data required to determine if the sampled spring rainfall events were indicative of average seasonal events. The table also shows how much of the various precipitation events were sampled and the time between start of the event and the start of sampling.

Inspection of column 1 in Table 1.7 shows that only the latter part of the Penticton spring rain was sampled. Studies done by other investigators disagree on whether or not concentrations of pollutants found in storm sewers decrease with time as the precipitation event progresses. Warnock (8) claimed that concentrations of pollutants decrease up to 90% from the beginning to the end of a rainfall event. Likewise, data contained in a report by Avco Corporation (9) indicated that concentrations decrease with time during a rainfall event. Soderlund and Lehtinen (10) claimed that concentrations do not depend on time but correlate directly with flow rate in the sewers for rainfalls up to 14 hours. Pravoshinsky and Gatillo (11) found that there is an almost linear relationship between the quantity of pollutants and the amount of rainfall, up to a total of 16 mm. This indicates that concentration remained fairly constant throughout the rainfall.

It was found that the concentration of material in the Penticton storm sewers during the spring rain was not significantly different from the concentrations found in the sewers of the other two cities. (See tables in Section 4.7). It was also found that the concentrations in Penticton were approximately the same as those found during the sampling in 1971.

In view of the preceeding, it was decided that the concentrations of material in the Penticton storm sewers probably did not change substantially in the 3 1/2 hours before sampling began. Therefore, the water quality data obtained from the Penticton spring storm was taken to be representative of the entire event.

TABLE 4.2

HYDROLOGIC DATA APPLICABLE TO SAMPLED EVENTS

EVENT	LENGTH OF EVENT (1)	LENGTH OF SAMPLING TIME (2)	TIME FROM BEGINNING OF EVENT TO BEGINNING OF SAMPLING (3)	AVERAGE INTENSITY OF RAINFALL DURING EVENT (4)	AVERAGE INTENSITY OF AVERAGE EVENT FOR THE SEASON (5)	TIME IN DAYS FROM LAST EVENT (6)	AVERAGE TIME BETWEEN EVENTS FOR PARTICULAR SEASON
VERNON Spring Rain	4 hrs.	4 hrs.	0 hrs.	0.085"/hr.	0.04"/hr.	11 days	13 days
KELOWNA Spring Rain	4 hrs.	3 hrs.	0 hrs.	0.05"/hr.	0.04"/hr.	11 days	13 days
PENTICTON Spring Rain	4 hrs.	1 hr.	3 hrs.	0.04"/hr.	0.04"/hr.	11 days	13 days

Column 3 and Column 4 compare the average intensity of rainfall during the sampled events to that associated with an average event for the season. Some researchers claim that runoff coefficient depends to a certain degree on the intensity of rainfall. It was judged, however, that the differences in intensities between sampled and average events of Table 4.2 were not great enough to have any important effects on runoff coefficient.

The lengths of the dry periods before sampled events listed in Column 5 were compared with the average lengths of dry periods for the season plotted in Column 6. The dry period before spring rain was 11 days for each of the three cities whereas the average dry period was calculated to be 13 days. The difference of only two days is as low as can be expected.

In summary, the data collected are reasonably representative of runoff conditions for the three cities.

4.6 STORM WATER QUALITY DATA

4.6.1 Nutrients

The storm water concentrations of ammonia, nitrate, nitrite, organic and total nitrogen and the concentrations of ortho and total phosphate are shown in Tables 4.3, 4.4 and 4.5. The tables show the following:

(1) The values of total nitrogen vary between 0.52 and 10.6 mg/l.

(2) The highest percentage of the total nitrogen is in the nitrate or organic forms. Together they comprise approximately 90 percent of the total.

(3) Nitrate nitrogen varies between 0.04 and 2.27 mg/l with an average value of 0.60. Nitrate values are generally higher in snowmelt than in spring rain runoff. Nitrate values are also generally higher in spring than in summer storm runoff.

(4) Kjeldahl nitrogen concentrations vary from 0.44 to 2.59 mg/l.In most cases Kjeldahl values are higher in spring rain stormwater.

(5) The organic and ammonia nitrogen concentrations measured during the summer rain in Penticton are almost an order of magnitude higher than those measured in the late winter and spring.

(6) Total phosphate concentrations range from 0.055 to 0.88 mg/l.

(7) Orthophosphate concentrations range from .003 to .270 mg/l.

The concentrations of nitrogen forms correlate well with concentrations quoted in other studies. Storm sewer sampling done in the Okanagan in 1971 showed concentrations of total nitrogen in the range of 0.6 to 2.0 mg/l in Vernon, with the predominant forms being nitrate and organic. Sampling done in Penticton showed total nitrogen in concentrations of substantially 0.0 to 2.1 mg/l. Soderlund and Lehtinen

TABLE 4.3

CONCENTRATIONS OF NUTRIENTS IN URBAN RUNOFF DUE TO SNOWMELT

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
Nitrogen									
Ammonia	0.35	0.27	0.2	0.13	-	-	0.177	0.365	-
Nitrate	2.27	1.43	0.197	0.166	0.78	-	2.06	2.24	0.11
Nitrite	0.05	0.53	0.008	0.028	0.025	-	0.4	0.026	0.025
Organic	2.12	1.6	0.24	0.715	-	-	0.87	0.57	-
Total	4.9	3.4	0.52	0.90	1.54	-	3.15	3.16	1.31
Kjeldahl	2.47	1.8	0.4	0.8	0.7	-	1.0	1.9	1.2
Phosphorus									
Total	0.24	1.3	0.088	0.821	0.700	-	.304	0.133	0.022
Ortho	0.238	0.42	0.012	0.270	0.168	-	.082	0.004	0.017

TABLE 4.4

CONCENTRATIONS OF NUTRIENTS IN URBAN RUNOFF DUE TO SPRING RAIN

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
Nitrogen									
Ammonia	0.19	0.16	0.01	0.08	0.01	0.08	0.25	0.29	0.01
Nitrate	0.96	0.48	1.5	0.05	0.43	0.19	1.34	0.06	0.10
Nitrite	0.1	0.075	0.018	0.005	0.014	0.017	0.045	0.014	0.01
Organic	2.4	3.0	1.25	2.59	0.60	0.55	1.62	0.31	1.0
Total	3.1	3.7	2.78	2.72	1.05	0.84	3.26	0.68	1.12
Kjeldahl	2.59	3.2	1.3	2.7	0.6	0.6		0.6	1.0
Phosphorus									
Total	0.374	0.170	0.174	0.426	0.158	0.398	0.75	0.063	0.260
Ortho	0.186	0.135	0.043	0.01	0.047	0.062	0.114	0.003	0.052

TABLE 4.5

CONCENTRATIONS OF NUTRIENTS IN URBAN RUNOFF DUE TO SUMMER RAIN

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
Nitrogen									
Ammonia	0.21	0.29	0.08	0.05	2.40	1.18	0.08	0.06	0.6
Nitrate	0.06	0.04	0.71	0.16	0.13	0.11	0.24	0.05	0.11
Nitrite	0.005	.005	0.017	0.025	0.015	0.009	0.18	0.01	0.015
Organic	2.26	1.05	0.90	0.48	8.0	8.0	3.0	3.0	10.0
Total	2.54	1.38	1.71	0.72	10.6	9.3	3.5	3.12	10.7
Phosphorus									
Total	0.685	0.825	0.231	0.170	0.396	0.055	0.415	0.88	0.062
Ortho	0.112	0.128	0.055	0.101	0.016	0.036	.003	0.003	0.032

Values in mg/l - indicates no tests run

(10) reported average values of total nitrogen ranging from 1.2 to 2.1 mg/l and a maximum value of total nitrogen of 4 mg/l. Avco Corporation (9) in a study at Tulsa, Oklahoma, gave results of average Kjeldahl nitrogen in the range of 0.67 to 1.46 mg/l.

The concentrations of total phosphate and orthophosphate are approximately the same as the concentrations found in the 1971 sampling program, slightly higher than those found by Soderlund and Lehtinen (10), and slightly lower than those found by Avco Corporation (9). Soderlund and Lehtinen reported total phosphate concentratiosn from 0.04 to 0.08 mg/l. Avco Corporation reported orthophosphate values from 0.67 to 1.92 mg/l. The values of ortho and total phosphate found by this study fall about midway between results of the other studies.

.6.2 Heavy Metals

The concentrations of lead, zinc, copper, arsenic, cadmium, nickel and mercury are listed in Tables 7, 8 and 9. The tables show the following:

(1) Concentrations of total unfiltered heavy metals range from 0.02 to 17.5 mg/l.

(2) Concentrations of dissolved heavy metals range from 0.01 to 14.2 mg/l.

(3) Concentrations of heavy metals in Vernon are higher than in other cities, especially during snowmelt.

(4) Metals of highest concentration are lead and zinc followed by copper. Zinc concentrations in Vernon were as high as 14 mg/l.

(5) Arsenic, cadmium, nickel and mercury are present in very small amounts. Together they comprise less than 5 percent of the total heavy metal concentrations.

There is little data in the literature with which to compare heavy metal concentrations. The 1971 sampling program showed lead and zinc concentrations from 0.007 to 0.15 mg/l or approximately 20 percent of the values found by the present study. Soderlund and Lehtinen (10) gave the following average results for heavy metals:

Pb	.002 to .1 mg/l (for different areas)
Zn	.28 mg/l
Cu	.086 mg/l

As metals concentrations were substantially higher than expected, samples of sludges settled on the bottom of the storm sewers were analyzed by atomic absorption spectrophotometry in the Pollution Control Engineering Laboratory at the University of British Columbia. The results are listed in Table 4.9. Examinations of the table shows extremely high concentrations of zinc (zinc concentration almost 20%) and substantial concentrations of copper and lead. As expected the results shown in Tables 4.6, 4.7 and 4.8 show that concentrations of nickel and cadmium are much lower than concentrations of lead, zinc or copper. Because of the high concentration

TABLE 4.6

CONCENTRATIONS OF HEAVY METALS IN URBAN RUNOFF DUE TO SNOWMELT

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
LEAD									
Total	2.45	0.45	0.093	0.063	0.09	--	0.19	0.005	1.2
Dissolved	0.081	0.019	0.009	0.039	0.03	--	0.025	0.003	0.035
ZINC									
Total	14	0.168	0.05	0.63	0.06	--	0.11	0.02	0.20
Dissolved	13.5	0.08	0.023	0.53	0.006	--	0.03	0.02	0.10
COPPER									
Total	0.33	0.06	0.047	0.04	0.035	--	0.366	0.009	0.05
Dissolved	0.05	0.017	0.011	0.033	0.025	--	0.13	0.0075	0.03
ARSENIC									
Total	0.227	0.01	0.005	0.005	0.013	--	0.005	0.005	0.006
Dissolved	--	--	--	--	--	--	--	--	--
CADMIUM									
Total	0.178	0.003	0.0002	0.0005	0.001	--	0.005	0.0001	0.0016
Dissolved	0.167	0.001	0.0001	0.0001	0.0005	--	0.002	0.0001	0.0005
NICKEL									
Total	0.025	0.17	0.01	0.01	0.01	--	0.01	0.01	0.07
Dissolved	0.02	0.17	0.01	0.01	0.01	--	0.01		0.01
MERCURY									
Total	0.3	nd	0.00018	0.00008	nd	--	nd	0.00041	nd
Dissolved	0.170	nd	0.00018	nd	nd	--	nd	0.00041	nd

TABLE 4.7

CONCENTRATIONS OF HEAVY METALS IN URBAN RUNOFF DUE TO SPRING RAIN

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
LEAD									
Total	1.5	0.015	0.6	0.5	0.16	0.275	0.40	0.005	0.5
Dissolved	0.08	0.037	0.023	0.1	0.035	0.31	0.009	0.002	0.014
ZINC									
Total	1.12	0.26	0.12	0.42	0.06	0.07	0.17	0.005	0.09
Dissolved	0.48	0.10	0.009	0.29	0.02	0.019	0.01	0.005	0.01
COPPER									
Total	0.15	0.06	0.03	0.04	0.01	0.02	0.03	0.002	0.02
Dissolved	0.03	0.01	0.01	0.02	0.007	0.01	0.009	0.002	0.004
ARSENIC									
Total	0.013	0.006	0.005	0.005	0.005	0.008	0.006	0.005	0.006
Dissolved	-	-	-	-	-	-	-	-	-
CADMIUM									
Total	0.0025	0.0015	0.0006	0.0015	0.0005	0.0007	0.0006	0.0002	0.0005
Dissolved	0.0004	0.0003	0.0002	0.0007	0.0001	0.0002	0.0001	0.0001	0.0001
NICKEL									
Total	0.05	0.05	0.01	0.01	0.01	0.02	0.05		0.02
Dissolved	0.01	0.01	0.01	0.01	0.01	0.02	0.01		0.02
MERCURY									
Total	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dissolved	nd	nd	nd	nd	nd	0.00015	nd	nd	nd

-- indicates substance not tested for.

nd indicates amount was not detectable.

Values in mg/l

TABLE 4.8

CONCENTRATIONS OF HEAVY METALS IN URBAN RUNOFF DUE TO SUMMER RAIN

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
LEAD									
Total	0.9	0.3	0.4	0.175	0.6	1.2	0.3	0.05	0.3
Dissolved	0.085	0.032	--	--	0.23	0.35	0.013	--	0.08
ZINC									
Total	1.36	0.26	0.09	0.12	0.71	1.0	0.21	0.03	0.48
Dissolved	0.66	0.11	--	--	0.68	0.78	0.04	--	0.17
COPPER									
Total	0.16	0.06	0.03	0.02	0.07	0.11	0.04	0.02	0.10
Dissolved	0.04	0.01	--	--	0.06	0.07	0.006	--	0.03
ARSENIC									
Total	0.016	0.013	0.005	0.005	0.015	0.044	0.006	0.005	--
Dissolved	--	--	--	--	--	--	--	--	--
CADMIUM									
Total	--	--	0.10	--	0.01	0.010	0.005	0.016	0.0018
Dissolved	0.008	0.0005	--	0.0001	0.004	0.0043	0.0004	--	0.001
NICKEL									
Total	0.01	0.01	0.01	0.01	0.07	0.08	0.01	0.01	0.04
Dissolved	0.01	0.01	--	--	0.03	0.04	0.01	--	0.02
MERCURY									
Total	nd	nd	nd	nd	nd	nd	nd	nd	--
Dissolved	--	--	--	--	nd	nd	--	--	--

-- indicates substance not tested for.

nd indicates amount was not detectable.

Values in mg/l

TABLE 4.9

CONCENTRATIONS OF HEAVY METALS IN STORM SEWER BOTTOM DEPOSITS

SLUDGE SAMPLE	V_1	K_3	K_1
COPPER	4,916 ppm	1,131 ppm	150 ppm
LEAD	14,516 ppm	3,105 ppm	----
ZINC	191,778 ppm	18,784 ppm	4,054 ppm
NICKEL	42 ppm	----	----
CADMIUM	63 ppm	52 ppm	----
CHROMIUM	318 ppm	26 ppm	----

TABLE 4.10

BOD, TOC AND COLIFORM COUNTS OF URBAN RUNOFF

	COMMERCIAL AREAS												RESIDENTIAL AREAS					
PARAMETER	V_1		V_2		K_2		K_3		P_1		P_3		V_3		K_1		P_2	
	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN	SNOWMELT	SPRING RAIN
TOC	287	68	40.7	72	2.67	33	6.6	65	28.5	16	----	32	7.3	50	7.7	10	31	23
BOD	<22.5	26	>23.7	27.6	6.1	10.8	10	20.1	3.3	9.0	----	24.0	8	16.8	6.1	3.0	12.3	10.5
TOTAL COLIFORM	500	>2400	63,300	>240,000	830	>2400	87,000	>240,000	542	>2400	----	>2400	>13,000		>1400	140	>1609	54,000
FECAL COLIFORM	30	900	11,000	4,900	45	920	>900	160,000	3333	>2400	----	1600	560		18	4	>1609	2,200

of heavy metals in the sludges, it was decided that the high concentrations found in the stormwater during this study were reasonable.

4.6.3 Biochemical Oxygen Demand and Total Organic Carbon

Table 1.15 shows the BOD and TOC for the snowmelt and spring storm runoffs. Note that:

(1) BOD values range from 3.3 to > 23.7 mg/l.

(2) TOC values range from 2.7 to 287 mg/l with most values between 6 and 72 mg/l.

(3) To convert TOC to theoretical oxygen demand, a factor of 2.66 is used. Theortectical oxygen demand values were approximately 3 to 25 times greater than actual BOD values. This indicates that most of the total organic carbon is not biodegradable.

The BOD and TOC values correlate well with values found both by Soderlund and Lehtinen (10) and the Avco Corporation (9). Soderlund and Lehtinen gave average BOD values ranging form 19 to 36 mg/l. Avco Corporation reported average BOD of 8 to 18 mg/l and average TOC of 20 to 48 mg/l with the ratio of non-biodegradable organics varying from 3 to 1 to about 13 to 1.

4.6.4 Coliforms

Total and fecal coliform counts are listed in Table 4.10. Total coliforms were found in concentrations as low as 500 and as high as 240,000 per 100 ml. The average value for total coliforms was 80,000 per 100 ml. and for fecal coliforms was 11,000 per 100 ml.

The corresponding values obtained by the Avco Corporation (9) are total coliform of 87,000/100 ml and fecal coliform of 470/100 ml. Avco Corporation quoted a study done in Cincinnati from July, 1963 to April, 1964 in which the average value of total coliform was 58,000/100 ml and fecal coliform was 10,900/100 ml. The concentrations of coliforms found in this study are close to the reported values for other locations.

4.6.5 Other Impurities

The concentrations of other impurities found in this study are listed in Table 4.11. Little information in literature is available to compare these results with other results.

4.7 CALCULATION OF MEAN ANNUAL LOADINGS

In order to calculate the annual amount of impurities discharged from the storm sewers, the following pattern was followed:

TABLE 4.11

CONCENTRATIONS OF OTHER IMPURITIES IN URBAN RUNOFF

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
ALK. ($CaCO_3$)	100.2	184	120.3	100.0	27.5		138	257.7	23.0
	39.5	45.5	124	46.5	22.5	29	61.5	369	28.0
	40.5	122	57	36	33.5	37.5	81.5	457	77.5
BORON	2.53	0.3	0.2	0.2	0.2		.23	.21	0.2
	0.2	0.2	0.2	0.2	0.2		0.2	0.2	0.2
	0.1	0.1	0.1	0.1	0.2	1.4	0.1	0.1	0.2
CALCIUM	38.0	41.5	37.5	28.2	7.6		54.0	95.5	5.8
	12	18.8	38.0	15.4	7.8	9.8	27.6	93.8	9.6
	16.6	37.8	18	10.2	32.5	35.0	67.5	105	42.5
CARBON (TOC)	287	40.7	2.67	6.0	28.5		7.33	7.7	31
	68	72	33	65	16	32	50	10	23
	78	62	25	17	247	274	66	92	250
CHLORIDE	169	40.8	9.4	15.0	18.4		13.8	0.3	9.5
	9.0	12.3	9.5	5.8	2.8	1.3	5.0	24.5	1.5
	6.5	11.5	4.7	2.0	7.5	12.5	8.8	22.0	4.1
COLOUR (Units)	53	23.3	5	10	35		18.3	15	40
	90	90	35	80	30	30	65	5	40
CYANIDE	.01	.01	.01	.01	.01		.01	.01	.01
	.01	.01	.01	.01	.01		.01	.01	.01
	.01	.01	.01	.01	.01	.01	.01	.01	.01
FLUORIDE	.19	.21	.223	.213	.010		.186	.35	.1
	0.1	0.1	0.17	0.11	0.1	0.1	0.1	0.29	0.1
	0.1	0.1	0.1	0.1	0.11	0.16	0.17	0.42	0.12
HARDNESS	115	219	134	102	30.0		230	382	16.6
	35	57	136	51	25	26.6	104	359	32
IRON	35	27.7	1.96	0.38	4.4	--	15.2	3.5	33
Total	21	31	7.6	4.0	4.0	6.4	24	2.9	13.6
	4.8	3.5	1.7	0.83	3.9	8.5	9.0	4.0	28.6
Dissolved	0.35	0.25	0.120	0.087	0.12	--	0.67	0.56	0.30
	0.16	0.64	0.22	0.52	0.20	0.34	0.08	0.12	0.32
	0 02	0.04	--	--	0.9	1.4	0.04	--	0.6
MAGNESIUM	5.17	17.2	8.83	6.5	1.2	--	22.3	31.1	0.4
	1.3	2.6	10.0	2.3	0.8	0.4	8.3	29.0	1.1
	0.20	0.20	0.10	0.03	0.45	0.78	45	35	10.2
MANGANESE	0.56	0.44	0.037	0.023	0.07	--	0.23	1.25	0.18
Total	0.28	0.38	0.14	0.13	0.05	0.09	0.29	1.35	0.21
	0.20	0.20	0.10	0.03	0.45	0.78	0.27	2.4	1.12
Dissolved	0.3	0.10	0.037	0.02	0.04		0.07	1.23	0.03
	0.08	0.11	0.09	0.10	0.02	0.02	0.05	1.25	0.03
	0.11	0.10	--	--	0.42	0.68	0.09	--	0.7
PHENOL	0.39	0.011	0.003	0.002	0.002	--	0.002	0.002	0.002
	0.04	0.03	0.013	--	--	--	0.015	0.002	--
	--	--	--	--	0.038	0.007	--	--	--
POTASSIUM	5.76	6.1	2.37	2.37	1.5	--	5.3	6.13	1.1
	2.8	3.1	2.5	2.0	1.5	1.3	3.2	3.5	1.3
	3.5	3.9	2.1	1.4	9.7	9.4	9.2	13.5	9.1
TOTAL SOLIDS	1050	904	240	209	126	--	595	550	200
	544	778	384	254	122	180	700	510	512
	342	472	204	90	714	854	974	770	1720
NON-FILTERABLE SOLIDS	1050	904	240	209	126	--	595	550	200
	392	582	150	83	61	123	477	64	376
	157	197	76	20	56	247	269	90	--
SILICA	8.33	11	7.6	5.5	4.2	--	8.33	32.7	1.7
	2.8	3.1	8.4	4.2	3.4	3.7	3.6	27.5	1.9
	4.9	9.1	5.1	3.4	10.8	5.6	13.2	59.1	3.8

TABLE 4.11
CONCENTRATIONS OF OTHER INPURITIES IN URBAN RUNOFF
(CONT'D.)

	COMMERCIAL AREAS						RESIDENTIAL AREAS		
	V_1	V_2	K_2	K_3	P_1	P_3	V_3	K_1	P_2
SODIUM	72. 7.7 7.3	38 5.9 15.0	13.1 17.0 9.7	27.6 12.5 4.3	19.2 4.0 12.5	-- 2.8 17.0	23.56 8.1 37.0	26.6 37.0 42.5	9.0 4.2 21
CONDUCTANCE umho's/cm	821 132	592 176	325.6 330	319.3 154	176 80	-- 83	536 275	835 292	81 95
SULPHATE	28.4 10.2 12.0	66.5 14.5 47.5	28.5 28.0 14.5	36.2 14.5 9.2	6.8 5 45	-- 5 47.5	121.6 56.6 276	55.2 56.2 12.0	5 10.8 106

Units in mg/l except where noted.

-- indicates parameter not analyzed for.

NOTE: Top figure indicates concentration of impurities in snowmelt; second figure indicates concentration of impurities in runoff from spring rainfall; third figure (where included) indicates concentrations of impurities in runoff from spring rainfall.

Summer 7

For each City:

(1) The area of commercial and residential development served by storm sewers was measured from City maps.

(2) The average annual snowfall and rainfall was obtained from meteorological records.

(3) The average annual volume of water falling on commercial and residential areas in the form of snow was calculated by multiplying the area by snowfall. It was assumed 10" snow = 1" water.

(4) The average annual volume of water falling on commercial and residential areas in the form of rain was calculated as in 3.

(5) The runoff coefficient for snowmelt was estimated for both commercial and residential areas.

(6) The runoff coefficient for rainfall on commercial and residential areas was calculated from sampling data.

(7) The average annual volume of water discharged from snowmelt on commercial areas was calculated from (3) and (5).

(8) The average annual volume of water discharged from snowmelt on residential areas was calculated from (3) and (5).

(9) The average annual volume of water discharged from rainfall on commercial areas was calculated from (4) and (6).

(10) The average annual volume of water discharged from rainfall on residential areas was calculated from (4) and (6).

(11) The volumes of water in (7) - (10) were multiplied by concentrations representative of the type of area and type of stormwater source to provide the following average annual estimates:

(a) amount of impurities from snowmelt for commercial areas;
(b) amount of impurities from rainfall for commercial areas;
(c) amount of impurities from snowmelt on residential areas;
(d) amount of impurities from rainfall on residential areas.

4.7.1 Snowmelt Runoff Coefficient

The calculation of snowmelt runoff coefficient was based entirely on the following assumptions:

(a) only snowpack on impervious surfaces would contribute to runoff;

(b) all the snowpack on impervious surfaces would eventually enter the sewers as runoff.

A much more comprehensive sampling program would be necessary in order to determine snowmelt runoff coefficient experimentally.

It was estimated from information provided by city engineers that the snow on approximately 40 percent of the commercial area in any one city is mechanically removed to a point where it can no longer enter the sewer system. The figure of 40 percent included streets, parking lots and sidewalks but did not include alleys and rooftops.

The runoff coefficient for commercial areas was therefore assumed to be the fraction of the impervious surface that was snow covered, or 1.0 - 0.4 = 0.6.

As there was no snow removal from residential areas, the residential runoff coefficient was assumed to be equal to the coefficient of imperviousness, 0.2. It is not known how accurate the assumptions are as there was no data found in the literature with which to compare these values. The assumptions can be considered only as "reasonable" estimates.

4.7.2 Rainfall Runoff Coefficient

Coefficients of runoff for rainfall events were calculated from the spring rainfall data in the following manner:

(a) depths of flow recorded hourly during sampling were graphically converted to flow rates. A roughness coefficient of 0.013 was assumed as all the pipes were concrete in good condition (Steele [12]). Graphical calculations were checked on one occasion by taking the time for one of the sewers, V-1, to fill a five litre bucket. Calculated flow was within five percent of actual flow.

(b) hourly rainfall data was obtained from the gauges of the sewage treatment plants in each of the three cities.

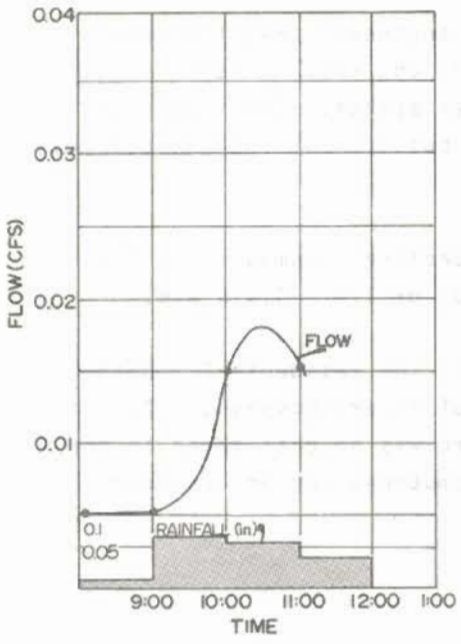
(c) graphs (Figures 4.9 (a) -(e), were plotted showing stormwater flows and hourly rainfall vs. time. Graphs for V_1 and V_2 were not plotted, because they could be misleading for reasons outlined in (d) below.

(d) hourly rainfall was multiplied by area of sampled catchment to give volume of rain that fell on the area. The areas of Vernon 1 and Vernon 2 could not be determined due to the number of interconnections in Vernon's storm sewer system. The effective catchment area could increase or decrease during the course of a storm according to the geometry of the interconnections.

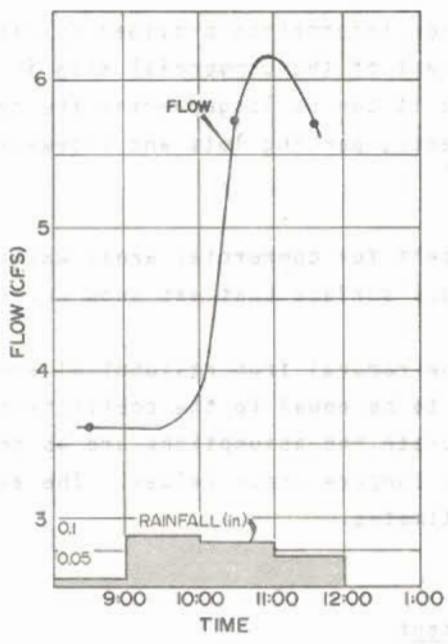
(e) area under the flow vs. time graph was measured and taken to be the total runoff caused by the event.

(f) the runoff coefficient was calculated by taking the ratio of total runoff to total volume of water falling on the catchment.

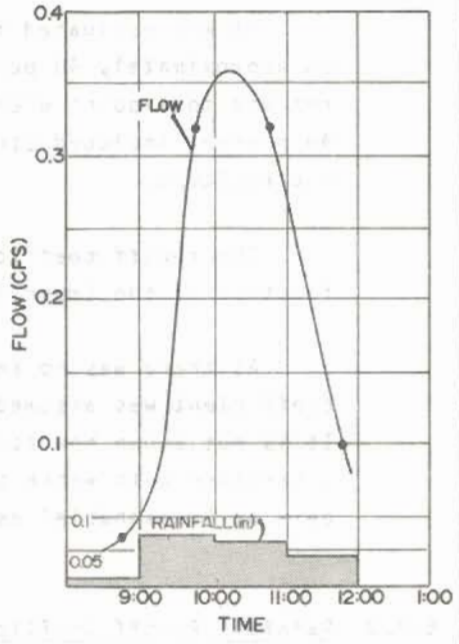
For some areas, because the entire storm was not sampled, it was difficult and sometimes not possible to calculate the runoff coefficient. The catchment data for P_1 and P_3 had to be discarded because of insufficient definition of the sewer hydrographs (Figure 4.9).



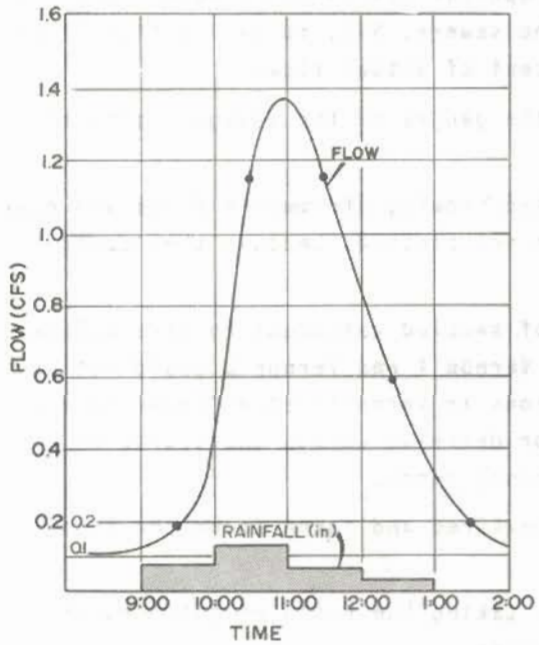
a) KELOWNA-1



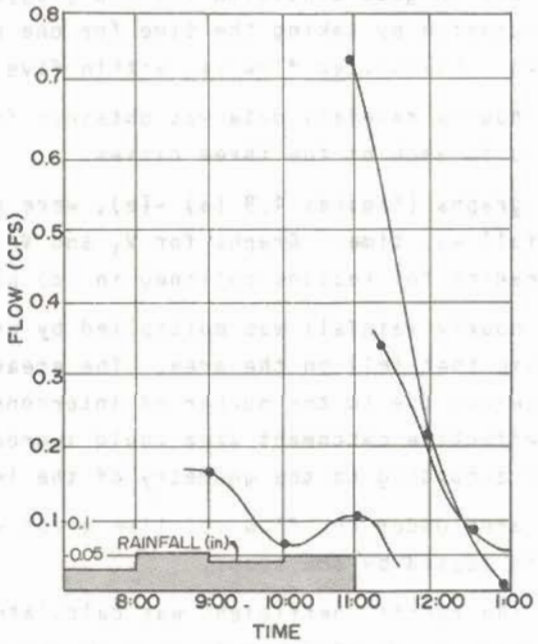
b) KELOWNA-2



c) KELOWNA-3



d) VERNON-3



e) PENTICTON-1,2,3.

RAINFALL and HYDROGRAPH
STORM SEWER DISCHARGE STUDY

Figure 4.9(a–e)

The runoff coefficients for K_1 and K_2 and P_2 were calculated in a slightly different manner from the above procedure in that:

(a) the area under the sewer hydrograph was measured for a certain time period (e.g., 10:00 a.m. to 11:00 a.m. for Kelowna 1 in Figure 4.9 (b);

(b) the rainfall causing the flow was assumed to be that falling in the same time interval at the same time of day, i.e. 10:00 a.m. to 11:00 a.m. for Kelowna 1.

This method was used because the entire rain events were not sampled and because the lag time between rainfall and runoff could not be calculated. As the rainfall intensity was fairly constant in Kelowna and Penticton, ther would be only a minimal effect on the runoff coefficient due to the time delay from the rainfall to the flow past the sampling point. Some of the flow measured in the time period may be caused from rain from the previous hour, but a similar flow caused by the period of rain considered would be lost to the succeeding hour's flow.

The results of the rainfall runoff coefficient calculations are shown in Table 4.12. The runoff coefficients for residential areas were calculated to be 0.08 and 0.125 for curbed areas and 0.005 for the non-curbed areas. The runoff coefficients for commercial areas were calculated to be 0.53 and 0.96 respectively for the two areas checked.

The values of 0.08 and 0.125 correspond to 40 and 62 percent of the water that falls on the impervious areas of the residential basin. Other studies (9) and (10) have presented values of between 25 percent to 72 percent runoff of water falling on impervious residential surfaces.

The commercial runoff coefficients correspond to 53 and 96 percent of the water falling on impervious surfaces. Other studies (9), (10) present values of 60 percent and 72 percent.

The runoff coefficient for uncurbed residential areas was very low compared with the others. This was expected because of the loss of water due to depression storage, seepage and evaporation. A site inspection showed the water forming large puddles in the gravel shoulders rather than running to the storm drains.

The values of curbed residential runoff coefficient were averaged as were commercial runoff coefficients. The results are as follows:

Rainfall runoff coefficient for curbed residential areas	- 0.1
Rainfall runoff coefficient for uncurbed residential areas	- .005
Rainfall runoff coefficient for commercial areas	- .75

(a) Volume of Runoff

The average annual volumes of water falling on commercial and residential areas of the three cities and the calculated average annual runoff from these areas are

TABLE 4.12

RAINFALL RUNOFF COEFFICIENTS FOR THE SAMPLED AREAS

	TIME USED	RAINFALL USED FOR CALC'N.	AREA	VOLUME OF RAIN	VOLUME OF RUNOFF	RUNOFF COEFFICENT	% IMPERVIOUS	RATIO OF RUNOFF TO IMPERV. AREA
V_1								
V_2								
V_3	9.00 a.m. 2.00 p.m.	.3115"	$2,880 \times_2 10^3$ ft^2	75,000$_3$ ft^3	9,400 ft^3	.125	20	.62
K_1	10.00 a.m. 11.00 a.m.	.06"	$1,320 \times_2 10^3$ ft^2	6,550$_3$ ft^3	36 ft^3	.005	15	.03
K_2	10.30 a.m. 11.30 a.m.	.06"	$1,250 \times_2 10^3$ ft^2	7,600$_3$ ft^3	7,200 ft^3	.95	100	.95
K_3	9.45 a.m. 10.45 a.m.	.065"	$425 \times_2 10^3$ ft^2	2,320$_3$ ft^3	1,100 ft^3	.53	100	.53
P_1								
P_2	9.00 a.m. 11.00 a.m.	.10"	$1,000 \times_2 10^3$ ft^2	8,330$_3$ ft^3	720 ft^3	.08	20	.40

TABLE 4.13

SEASONAL VOLUMES OF URBAN RUNOFF

REGION	AREA	ANNUAL SNOWFALL	WATER EQUIVALENT	VOLUME OF WATER FALLING ON AREA	RUNOFF COEFFICENT	ANNUAL RUNOFF DUE TO SNOWMELT	SPRING RAINFALL	SUMMER RAINFALL	AUTUMN RAINFALL	VOLUME OF WATER FALLING ON THE AREA IN THE			RUNOFF COEFFICENT	ANNUAL VOLUME OF RUNOFF DUE TO RAIN IN			TOTAL OF SPRING, SUMMER & AUTUMN
										SPRING	SUMMER	AUTUMN		SPRING	SUMMER	AUTUMN	
				(10^6 lbs)		(10^6 lbs)	(inches)	(inches)	(inches)	(10^6 lbs)				(10^6 lbs)			(10^6 lbs)
VERNON -																	
Commercial	140 ac.	40"	4"	127	0.6	76.2	3.05	3.95	3.90	96.7	125	124	0.75	72.5	93.7	93	259
Residential	1030 ac.	40"	4"	933	0.2	186.6				911	921	909	0.1	71	92	91	234
KELOWNA -																	
Commercial	155 ac.	36.4"	3.64"	128	0.6	76.8	2.34	2.90	3.36	82	102	117	0.75	61.5	76.5	87.8	223
Residential	500 ac.	36.4"	3.64"	412	0.2	82.4				265	328	378	0.005	1.4	1.6	1.9	4.9
PENTICTON -																	
Commercial	160 ac.	26.7"	2.67"	97	0.6	58.2	2.62	3.06	2.80	95	111	101	0.75	71.3	83.3	76	230
Residential	1140 ac.	26.7"	2.67"	689	0.2	138				676	790	723	0.1	68	79	72	229

shown in Table 4.13. Spring rainfall includes precipitation events from March to June, summer from June to September and autumn from September to November. The precipitation values quoted in the table are 30 year averages for the three cities.

(b) Amounts of Impurities

The mean loadings from the storm sewers were calculated on an annual basis. The annual total included contributions from snowmelt, from spring and autumn rains, and from summer rains. The contribution from autumn rains was estimated from spring data as the fall period was not sampled. It was felt that the concentrations of impurities in the autumn runoff would most closely resemble those in the spring runoff. This is because:

(1) weather conditions are similar in the autumn and spring;

(2) automobile and pedestrian traffic are similar in the autumn and spring.

(i) Nutrients - Table 4.14 shows the annual input of nutrients from urban runoff. The total nitrogen input is 5600 lb/yr of which 1270 lbs. is nitrate nitrogen. The table shows that organic nitrogen makes up most of the balance. Ammonia nitrogen and nitrite nitrogen input are relatively small.

The total phosphorus input was calculated to be 690 lbs/yr of which 120 lbs. is in the ortho form.

(ii) Heavy Metals - Table 4.15 shows the annual input of heavy metals from the urban storm sewers.

It was calculated that 2320 lbs. of heavy metals enter the lake annually. Of this amount, 980 lbs. are in the dissolved form.

Lead and zinc comprise about 90 percent of the annual input, copper comprises approximately seven percent and the combined total of arsenic, cadmium, nickel and mercury comprises about three percent.

(iii) Other Impurities - Table 4.16 presents the amounts of other impurities that enter the Okanagan watercourses from storm sewers.

4.8 GROUNDWATER AND DIRECT CONNECTIONS

An attempt was made to estimate the total quantity of impurities contributed by the storm sewers from sources other than urban runoff, i.e. from groundwater sources and direct connections. Three sewers were sampled: Vernon 1, Vernon 3, and Kelowna 2. The samplings were taken after a month of dry weather so it was assumed that the base flow was present year round. A survey indicated that there was no base flow in the Penticton storm sewers. It is not known what fraction of the storm sewers in Kelowna and Vernon were flowing continuously.

TABLE 4.14

ANNUAL DISCHARGE OF NUTRIENTS FROM SNOWMELT AND PRECIPITATION ON URBAN SURFACES

	VERNON							KELOWNA							PENTICTON							TOTAL OF VERNON KELOWNA AND PENTICTON
	COMMERCIAL			RESIDENTIAL				COMMERCIAL			RESIDENTIAL				COMMERCIAL			RESIDENTIAL				
	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	
NITROGEN																						
Ammonia	76	29	20	33	41	7.4	205	10	12	7	30	1	0.1	60	--	1.3	180	--	1.3	45	230	495
Nitrate	140	78	5.6	380	220	22	845	13	7	62	184	0.2	0.1	265	45	64	10	15	14	8	155	1270
Nitrite	22	14	0.4	74	7	16.5	130	2	0.7	1.5	2	0.7	0.02	7	1.5	2	1	3	1.3	1	10	150
Organic	140	450	212	160	260	276	1500	55	390	79	47	1	5	580	--	88	610	--	140	720	1560	3640
Total	320	565	238	590	530	320	2560	80	410	150	260	2.2	5	910	89	154	800	180	157	770	2200	5600
PHOSPHORUS																						
Total	70	36	64	57	120	38	390	63	64	20	10	0.2	1.5	160	41	23	30	3	36	4.4	137	690
Ortho	11	10	10.5	15	18	0.3	65	21	1.5	5	0.3	0.01	.005	28	10	7	1.2	2.3	7	2.3	30	120

Values in lbs/yr.
-- indicates calculation not possible due to missing values.

TABLE 4.15

ANNUAL DISCHARGE OF HEAVY METALS FROM SNOWMELT AND PRECIPITATION ON URBAN SURFACES

	VERNON							KELOWNA							PENTICTON							TOTAL OF VERNON KELOWNA AND PENTIC-TON
	COMMERCIAL			RESIDENTIAL				COMMERCIAL			RESIDENTIAL				COMMERCIAL			RESIDENTIAL				
	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	
HEAVY METAL																						
Lead - Total	110	200	84.3	35	64	27	520	5	76	35	0.4	0.01	0.08	116	5	24	46	165	70	22	332	1156
Dissolved	4	9.6	7.9	4	1.3	1.2	28	3	15	--	0.2	0.006	--	18	2	5	17	4.8	2	6	37	83
Zinc - Total	533	114	127	20	27	19	840	48	64	8	1.6	0.01	0.04	120	3	9	54	27	12	35	140	1100
Dissolved	517	48	62	6	3.2	3.7	640	41	44	--	1.6	0.006	--	87	0.3	3	52	14	1.3	12	83	810
Copper - Total	15	17	15	68	5.1	3.7	124	3	6	2.5	0.7	0.006	0.03	13	2	1.3	5	7	2.5	7	24	161
Dissolved	2.5	3.2	3.7	24	1.3	0.55	35	0.3	2.7	--	0.6	0.02	--	3.6	1	1	4	4	0.5	2	13	51.6
Arsenic - Total	9	3.2	1.5	1	1.3	0.55	17	0.4	0.7	0.05	0.4	0.007	0.008	1	0.8	0.6	1.1	0.8	0.8	--	4	22
Dissolved	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium - Total	7	1.6	--	1	0.12	0.46	3	0.04	0.2	--	0.008	0.01	0.03	0.3	0.05	0.06	0.8	0.07	0.06	0.1	1	4.03
Dissolved	6	0.3	0.7	0.4	0.01	0.04	1	0.007	0.1	0.001	0.008	0.0006	--	0.1	0.03	0.01	0.3	0.02	0.01	0.07	0.4	1.05
Nickel - Total	7	0.3	0.9	2	8.3	0.9	11	0.7	1.34	0.9	0.8	0.03	0.01	3	0.6	1.5	5.3	9.6	2.8	2.8	23	37
Dissolved	7	0.05	0.9	2	1.9	0.9	5	0.7	1.34	--	0.03	0.001	--	2	0.6	1.5	2.3	1.38	2.8	1.4	10	17
Mercury - Total	13	nd	nd	nd	nd	nd	13	0.006	nd	nd	nd	nd	nd	0.006	nd	nd	nd	nd	nd	nd	0.0	13.006
Dissolved	2.6	nd	nd	nd	nd	nd	2.6	nd	nd	nd	nd	nd	nd	0	nd	nd	nd	nd	nd	nd	2.6	5.2
TOTAL - Total	690	340	230	130	106	54	1550	58	147	47	4.1	0.06	0.2	256	12	35	112	210	90	67	525	2331
Dissolved	540	60	75	37	7	6	725	48	65	--	3.8	0.03	--	117	4.6	11.5	76	25	7	21	145	987

Values in lbs/yr.
-- indicates substantially none.

TABLE 4.16

ANNUAL DISCHARGE OF OTHER IMPURITIES FROM SNOWMELT AND PRECIPITATION ON URBAN SURFACES

	VERNON							KELOWNA							PENTICTON							
	COMMERCIAL			RESIDENTIAL				COMMERCIAL			RESIDENTIAL				COMMERCIAL			RESIDENTIAL				
IMPURITY	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	SNOWMELT	PRECIP. (Spring & Autumn)	PRECIP. (Summer)	TOTAL	TOTAL FOR VERNON KELOWNA AND PENTICTON
Alkalinity (as $CaCO_3$)	11,000	7,040	3,790	25,800	10,000	7,500	65,130	7,680	7,035	3,000	30,000	1,206	730	52,000	1,600	3,330	2,500	3,200	3,960	5,580	20,100	140,000
Boron	110	3.2	9.3	43	3	9.2	180	15	30	9	17	0.7	0.2	72	11	30	15	28	28	14	120	380
Calcium	3,000	2,560	1,555	10,100	4,480	6,210	28,000	2,100	2,350	1,580	7,900	310	170	14,000	440	1,150	2,470	800	1,300	3,000	9,100	51,000
TOC	12,500	11,500	7,300	1,400	8,300	6,070	47,000	460	9,700	2,200	580	33	150	13,000	1,650	2,400	19,000	4,300	3,200	18,000	48,500	108,000
Chloride	8,000	1,760	610	2,600	830	810	14,600	1,150	870	410	24	80	35	2,500	1,050	410	570	1,300	210	300	3,800	21,000
Cyanide	1	1.6	0.9	0.7	1.6	0.9	6.7	0.8	1.5	0.9	0.8	0.03	0.01	4	0.6	1.4	0.76	1.4	1.3	0.7	4	13
Fluoride	15	18	9	35	16	15	108	16.3	16.5	9	18	0.9	0.7	61	6	15	8.3	14	13	8.6	64	232
Iron - unf. dissolved	2,400 22	4,300 320	450 18.7	2,800 125	1,800 13	830 3.7	14,600 500	29 7	600 80	150 -	290 46	10 0.4	6.5 --	1,080 133	256 7	590 30	290 68	4,500 41	1,900 44	2,060 43	9,300 230	26,000 840
Manganese	850	54	234	4,200	1,340	4,140	10,800	500	45	439	2,600	94	56	3,700	70	115	380	55	153	730	1,500	16,000
Magnesium - Total dissolved	38 15	15 6	18.7 10.3	42 13	48 8	25 8.3	190 60	1.7 1.5	20 15	9 -	103 101	5 4	4 --	140 120	4 2	8 3	34 32	24 4	30 4	80 50	180 95	510 275
Phenol	15	2	-	0.4	2.5	-	18	0.1	-	-	9.2	0.007	--	--	0.1	--	3	0.3	--	--	--	--
Potassium	450	490	328	1,000	520	846	3,600	180	300	180	505	11.4	22	1,200	87	440	740	152	180	650	2,250	7,050
Total Solids	72,000	110,000	32,050	111,000	114,000	89,600	530,000	16,000	38,000	18,000	45,000	1,670	1,230	120,000	7,300	54,000	54,000	27,500	72,000	123,000	340,000	990,000
Filterable Solids	30,000	29,000	18,000	60,000	36,000	65,000	240,000	10,000	26,000	11,000	28,500	1,470	1,100	78,000	3,500	45,000	50,000	6,000	25,000	--	130,000	450,000
Non-Filterable Solids	42,000	81,000	14,050	51,000	78,000	24,600	290,000	6,000	12,000	7,000	15,000	200	140	40,000	2,300	9,000	4,000	27,000	32,000	--	94,000	425,000
Silica	730	490	460	1,500	380	1,215	5,000	420	630	450	2,700	94	93	4,400	240	500	820	230	260	270	2,300	12,000
Sodium	4,200	1,080	680	4,400	1,300	3,400	15,000	2,100	2,500	850	2,200	120	68	7,800	1,100	590	950	1,240	590	1,500	6,000	29,000
Sulphate	3,600	2,030	1,120	22,700	9,000	25,400	64,000	780	4,200	1,270	4,500	185	19	11,000	400	740	3,400	690	15,400	7,600	28,000	100,000

Concentrations of substances in the base flow are shown in Table 4.17. Comparison of the values in Table 4.17 with those values measured during snowmelt and spring rain shows the following:

(1) The concentration of nitrates was approximately an order of magnitude higher for V_3 and K_2 in the base flow.

(2) The concentration of organic nitrogen was an order of magnitude lower and the concentration of ammonia nitrogen generally lower in base flow.

(3) Phosphate concentrations were approximately the same for base flow and urban runoff.

(4) Concentrations of heavy metals were an order of magnitude lower for V_3 and K_2 base flow but approximately the same as urban runoff concentrations for V_1 base flow.

(5) Calcium, chloride, magnesium, potassium, silica, sodium and sulphate concentrations were two to five times higher in base flow than in urban runoff.

The preceeding observations indicate that substantial amounts of nitrates and other inorganic ions (other than heavy metals) that were reported as coming from urban runoff in fact were contributed from groundwater. Also most organic and ammonia nitrogen phosphates and heavy metals were reported correctly (except in the case of V_1) as coming from precipitation or snowmelt. The high concentration of heavy metals found only in the V_1 base flow indicates the possibility of a direct connection of an industrial or commercial facility to the Vernon 1 storm sewer.

The ratio of base flow to the average flow at which concentrations were measured during precipitation events was calculated using the flow rates measured during spring and summer rainstorms and during the dry period. The ratio was approximately 1 : 5 for the sewers sampled.

In order to compare the annual amounts of impurities due to infiltration and direct connections, it was necessary to estimate the flow due to these sources. An estimate was made on the following assumptions:

(1) No base flow in Penticton.

(2) Base flow in all storm sewers of Vernon and Kelowna.

Flows were calculated on the basis of cfs per acre of land drained. The V_3 catchment area contributed 3.2×10^{-3} cfs/acre. It was decided that a value of 2.5×10^{-3} cfs/acre would be used to estimate total base flows for Kelowna and Vernon.

Table 4.18 shows the estimated base flows for Vernon and Kelowna.

TABLE 4.17

CONCENTRATIONS OF IMPURITIES IN BASE FLOW
(mg/l)

NUTRIENTS	V_1	V_3	K_2
Nitrogen			
Ammonia	0.14	0.04	0.04
Nitrate	0.04	4.45	2.86
Nitrite	0.005	0.005	0.005
Organic	0.25	0.3	0.33
Total	0.43	4.79	3.23
Phosphorus			
Ortho	0.141	0.037	0.041
Total	0.4	0.038	0.067
HEAVY METALS			
Lead - total	0.60	0.011	0.014
dissolved	0.003	0.003	0.003
Zinc - total	1.48	0.07	0.007
dissolved	0.12	0.07	--
Copper - total	0.22	0.003	0.02
dissolved	0.05	0.003	0.02
Arsenic - total	0.043	0.005	0.005
dissolved	--	--	--
Cadmium - total	0.004	0.0002	0.0002
dissolved	0.003	0.002	0.0002
Nickel - total	0.02	0.01	0.01
dissolved	0.01	0.01	--
Mercury - total	nd	nd	nd
dissolved	nd	nd	nd
Alkalinity (Total $CaCO_3$)	178	346	211
Boron	0.3	0.2	0.2
Calcium	46	158	66
Carbon	44	6	7
Chloride	33.6	19.9	14.3
Cyanide	0.01	0.01	0.01
Fluoride	0.4	0.37	0.30
Iron - total	2.0	0.14	0.12
dissolved	0.06	0.08	0.06
Magnesium	17.4	84	17.5
Manganese	0.07	0.01	0.01
Phenol	0.137	0.002	0.002
Potassium	6.3	14.3	2.8
Total Solids	396	1292	342
Filterable Solids			
Non-Filterable Solids	58	0.8	1.7
Silica	18	22.6	16
Sodium	44.6	80.7	29.2
Sulphate	69.8	578	52.8

nd = not detectable

TABLE 4.18

ESTIMATED BASE FLOW RATES

	CFS	LBS/YR.
VERNON	2.75	5500×10^6
KELOWNA	1.65	3300×10^6

The assumptions underlying the calculation are largely unsupportable, but they will give answers within the right order of magnitude. The use of base flow values as measured in the driest season should compensate somewhat for the assumptions that all storm sewers in Vernon and Kelowna contribute base flow to watercourses.

The estimated amounts of impurity discharge due to infiltration and direct connections is shown in Table 4.19. A comparison of Table 4.19 with Tables 4.15, 4.16 and 4.17 shows the following:

(1) Nitrate contribution from infiltration is an order of magnitude higher than the contribution from urban runoff.

(2) Contribution of phosphorus is approximately the same for the two sources.

(3) Base flow in Vernon 1 contributes almost as much heavy metals as does urban runoff.

(4) Base flow contributions of calcium, chloride, magnesium, potassium, silica, sodium and sulphate are an order of magnitude higher than those from storm runoff.

The contribution of nitrates and other salts is probably due to leaching from the soil. Okanagan soil generally is rich in substances found to be in high concentration in the base flow.

The contribution of heavy metals from Vernon 1 may be due to a direct connection. It seems unlikely that heavy metals in the concentrations noticed in this study would be contributed from natural sources or from urban runoff. The low ratio of nitrate to ammonia nitrogen in Vernon 1 lends further credence to the assumption that the flows in that sewer are not primarily of groundwater origin.

4.9 CONCLUSIONS

(1) The concentration of impurities found in the Okanagan storm sewers correlated well with concentrations found in other studies.

(2) The runoff coefficients calculated from sampling data agree with those calculated in other studies.

TABLE 4.19

DISCHARGE OF IMPURITIES DUE TO BASE FLOW
(lbs/yr)

NUTRIENTS	VERNON		KELOWNA	TOTAL
	COMMERCIAL	RESIDENTIAL		
Nitrogen				
Ammonia	70	200	132	400
Nitrate	20	23,000	9,500	32,000
Nitrite		25	16	40
Organic	125	1,500	1,100	2,700
Total	215	24,000	10,600	35,000
PHOSPHORUS				
Ortho	70	185	135	390
Total	200	190	220	610
HEAVY METALS				
Lead - total	300	55	46	400
dissolved	1.5	15	10	26
Zinc - total	740	350	23	1100
dissolved	60	350	--	410
Copper - total	110	15	66	190
dissolved	25	15	66	100
Arsenic-total	21	25	16	60
dissolved	--	--	--	--
Cadmium-total	2	1	1	4
dissolved	0.2	1	1	2
Nickel	10	50	33	93
dissolved	5	50	--	55
Mercury-total	0	0	0	0
dissolved	0	0	0	0
ALKALINITY (Total $CaCO_3$)	90×10^3	1.7×10^6	700×10^3	2.5×10^6
BORON	150	1,000	660	1,800
CALCIUM	23×10^3	800×10^3	220×10^3	10^6
CARBON	22×10^3	30×10^3	23×10^3	75×10^3
CHLORIDE	17×10^3	100×10^3	48×10^3	165×10^3
CYANIDE	5	50	33	88
FLUORIDE	200	1,800	990	3,000
IRON,- unf.	1000	700	400	2,000
dissolved	30	400	200	600
MAGNESIUM	8700	420×10^3	58,000	500×10^3
MANGANESE	35	50	30	120
PHENOL	70	10	6	85
POTASSIUM	3150	72×10^3	9,200	83×10^3
TOTAL SOLIDS	200×10^3	6.5×10^6	1.1×10^6	7.6×10^6
NON-FILT. SOLIDS	20×10^3	4,000	5,600	28×10^3
SILICA	9000	110×10^3	53×10^3	170×10^3
SODIUM	22×10^3	400×10^3	96×10^3	500×10^3
SULPHATE	35×10^3	3×10^6	175×10^3	3.2×10^6

(3) Nutrient loading from surface runoff was calculated to be as follows:

Nitrogen	
Nitrate	1270 pounds per year
Total	5600 pounds per year
Phosphorus	
Total	690 pounds per year
Ortho	120 pounds per year

(4) Heavy metal input was calculated to be 2320 pounds per year, 980 pounds of which was in dissolved form. The metals in greatest abundance were lead and zinc followed by copper. Arsenic, cadmium, nickel and mercury were much less abundant.

(5) BOD of the snowmelt and spring stormwater ranges from 3 to about 30. Comparison of BOD to TOC indicated that most of the TOC was not biodegradable.

(6) Average value of coliform counts from snowmelt and spring runoff were as follows:

Total	80,000/100 ml.
Fecal	11,000/100 ml.

(7) The runoff coefficients for snowmelt and rainfall were calculated to be as follows:

Commercial Areas	
Snowmelt	0.6
Rainfall	0.75
Residential Areas	
Snowmelt	0.2
Rainfall, Vernon and Penticton	0.1
Kelowna	0.005

(8) Nutrient loading from groundwater and direct connections (baseflow) was calculated to be as follows:

Nitrogen	
Nitrate	32,000 pounds per year
Total	35,000 pounds per year
Phosphorus	
Total	610 pounds per year
Ortho	390 pounds per year

(9) Baseflow sources contribute a much greater quantity of nitrogen than storm runoff and approximately equivalent quantities of phosphorus.

(10) Analysis of the baseflow data indicates the possibility of direct connections to the Vernon storm sewer.

(11) Contributions by baseflow represent inaccuracy in estimating the loading from surface runoff, as the baseflow was not separated for the surface runoff estimates. It is estimated that this error is in the range of 20 to 40 percent.

CHAPTER 5

Dustfall and Precipitation Quality Study

Knowledge of the chemistry of atmospheric precipitation is an important preliminary to the study of controls on surface and groundwater quality. This section attempts to assess the relative importance of atmospheric sources of nitrite as nitrogen, nitrate as nitrogen, total kjelkahl nitrogen, phosphate as phosphorus and total dustfall.

5.1 LITERATURE SURVEY AND DISCUSSION

It has been amply demonstrated that much of the total load of certain chemicals in streams and lakes can be contributed by atmospheric precipitations. (17,18,20,13,15). Table 5.1 compares the flux from this study with those in otner recently studied areas in Eastern Canada and the United States.

The median soluble nitrate nitrogen flux measured during the study is comparable with levels determined at various world-wide locations (Table 5.2). Although ammonia nitrogen was not measured in the study, values from the literature have been presented to indicate the significance of ammonia as a source of nitrogen.

5.2 SAMPLING LOCATIONS AND ANALYSES

The sampling sites chosen for this study were located on land adjacent to the main valley Okanagan Lakes (Figure 5.1). Table 5.3 gives a detailed description of sampling statons. Several of the original stations were relocated and the analyses discarded when the results were considered unrepresentative and new locations were chosen to replace the originals.

Samples were taken monthly from collectors that were continuously open to the atmosphere. The collector at each station is similar to those used in the studies referenced and consisted of a 4" x 8" tubular plastic canister. The canisters were housed in aluminum frames to which were attached spikes to discourage birds from landing on the frames. The apparatus was mounted on a pole about 5' above a stable base.

Dustfall and precipitation samples were analyzed for soluble kjeldahl, nitrite, and nitrate nitrogen, soluble phosphate and total dustfall. The method of analysis for the individual parameters are given in detail in Table 5.4.

TABLE 5.1

COMPOSITION OF ATMOSPHERIC PRECIPITATION IN VARIOUS AREAS IN EASTERN CANADA AND THE UNITED STATES

LOCATION	REFERENCES	STUDY PERIOD	PRECIP. (in/yr)	FLUX (thousandths of tons per square mile per month) AMMONIUM AS N	NITRATE AS N	TOTAL NITROGEN AS N	TOTAL PHOSPHORUS AS P	ORTHO-PHOSPHORUS AS P	DISSOLVED PHOSPHORUS AS P
Carolina, U.S.	(17)	62-63	44	25	38	63	-	-	-
Virginia, U.S.		63-64	44	25	36	61	-	-	-
New Hampshire, U.S.	(20)	63-64	46	--	35	74	-	-	-
	(19)	64-65	37	39	95	147	-	-	-
	(21)	65-66	49	52	--	--	-	-	-
	(21)	65-66	53	--	--	--	-	-	-
Northeastern U.S.		-	45	49	20	69	4	-	-
Ontario, Can.	(13)	68-69	--	--	--	98	5	-	
Ontario, Can.	(15)	67	35	210	70	--	9	1	4
B.C., Can.		72	--	--	26	66	-	-	8

TABLE 5.2

NITROGEN FLUX FOR VARIOUS LOCALITIES (16)

LOCATION	YEARS OF DATA	MEAN ANNUAL RAINFALL in/year	NITROGEN FLUX - tons/sq mi-mon. $N(NH_3)$	$N(NO_3)$
Harpenden (U.K)	28	74	0.007	0.035
Garfoed (U.K.)	3	68	0.170	0.052
Flahult (Sweden)	--	83	0.087	0.035
Groningen (Netherlands)	--	70	0.120	0.037
Blemforiteni and Durban (South Africa)	2	--	0.106	0.037
Ottawa (Canada)	10	60	0.118	0.056
Ithaca (N.Y.)	11	75	0.097	0.019
Okanagan Valley (weighted mean)	1	13	--	0.026

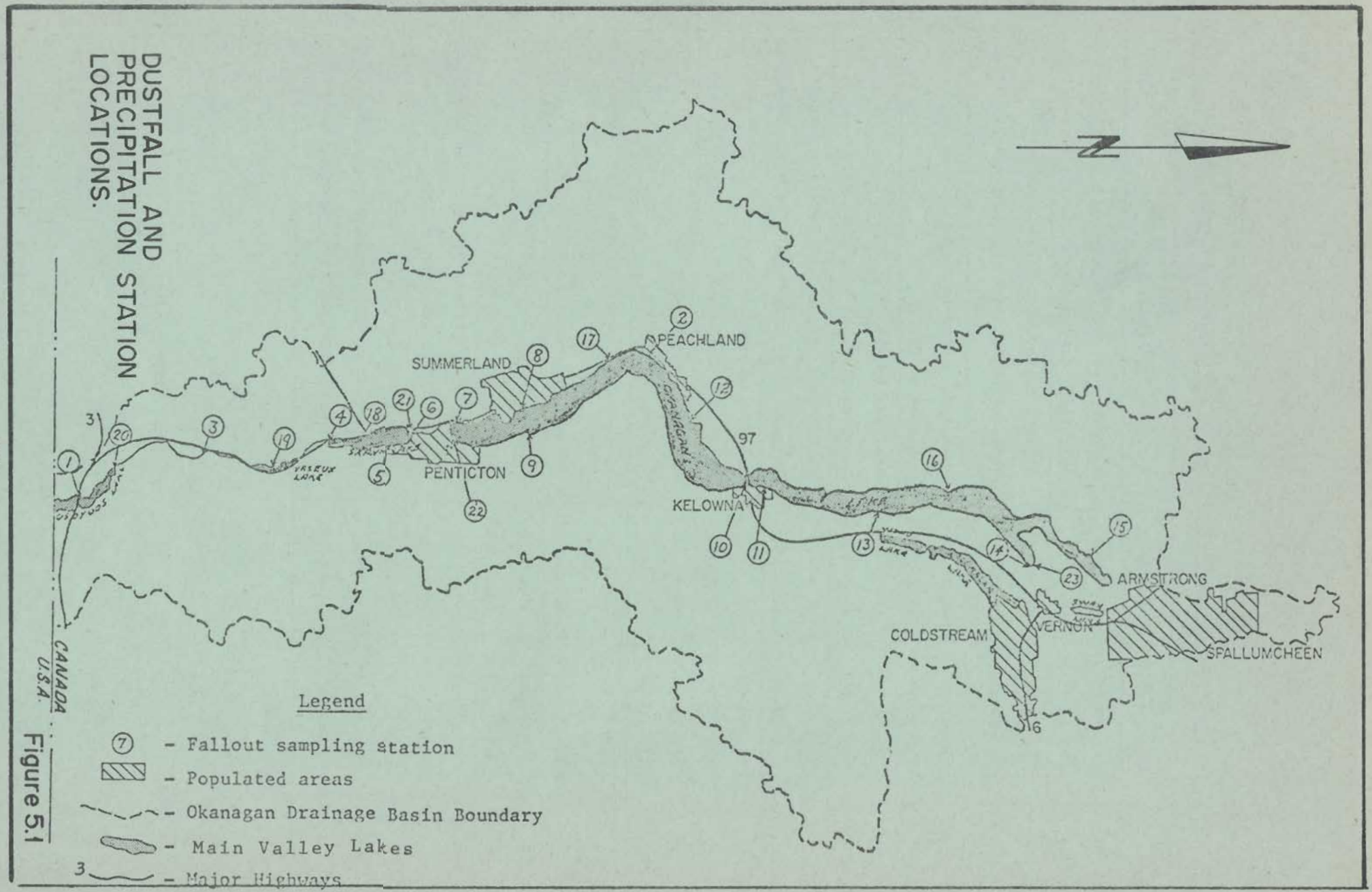

DUSTFALL AND PRECIPITATION STATION LOCATIONS.
PEACHLAND
SUMMERLAND
PENTICTON
KELOWNA
ARMSTRONG
VERNON
COLDSTREAM
SPALLUMCHEEN
97
CANADA
U.S.A.
Legend
- Fallout sampling station
- Populated areas
- Okanagan Drainage Basin Boundary
- Main Valley Lakes
- Major Highways

Figure 5.1

TABLE 5.3

DESCRIPTION OF DUSTFALL AND PRECIPITATION SAMPLING STATION LOCATIONS

STATION NO.	LONGITUDE	LATITUDE	LOCATION
OBS-1	119-27-25	49-01-40	Osoyoos, Hwy. #3, Bridge over Osoyoos Lake.
OBS-2	119-44-05	49-46-30	Peachland, Government of Canada Breakwater.
OBS-3	119-32-30	49-11-00	Oliver, Bridge over Okanagan River.
OBS-4	119-34-30	49-20-50	Okanagan Falls, Government of Canadan Breakwater.
OBS-5	119-34-00	49-24-35	East Side, Skaha Lake.
OBS-6	119-35-45	49-27-10	Replaced by OBS-21.
OBS-7	119-35-25	49-30-15	Replaced by OBS-22.
OBS-8	119-38-50	49-36-05	Summerland, Yacht Club Boat Dock.
OBS-9	119-35-50	49-35-35	Naramata, Government of Canada Breakwater.
OBS-10	119-30-15	49-52-50	Kelowna, Hwy. 97-Bridge over Okanagan Lake.
OBS-11	119-30-00	50-54-00	Kelowna, Crown Zellerbach Mill log pond.
OBS-12	119-37-15	49-48-55	Westbank, Government of Canada Breakwater.
OBS-13	119-27-00	50-02-55	Okanagan Center, CPR Pier.
OBS-14	119-20-30	50-14-33	Replaced by OBS-23.
OBS-15	119-21-45	50-19-20	W. side of N. Arm Okanagan Lake, Hoover Sawmill.
OBS-16	119-29-25	50-08-15	Fintry, Beach on Okanagan Lake.
OBS-17	119-44-20	49-42-02	Greata, Beach on Okanagan Lake.
OBS-18	119-35-38	49-24-00	Kaleden, Beach on Skaha Lake.
OBS-19	119-31-39	49-16-22	Vaseux Lake, Railway Bridge at S. end of lake.
OBS-20	119-31-20	49-04-30	Osoyoos Lake, Beach on N. end.
OBS-21	119-35-37	49-27-15	Skaha Lake, Beach on N. end.
OBS-22	119-35-25	49-30-15	Penticton, S. end, Okanagan Lake.
OBS-23	119-20-21	50-14-15	N.E. Arm, Okanagan Lake, Okanagan Landing.

TABLE 5.4

METHOD OF ANALYSES FOR OKANAGAN DUSTFALL AND PRECIPITATION SAMPLES

Total Dustfall	- Chemistry laboratory method for dustfall; which is a modified ASTM and APCA procedure.
Nitrate (N)	- Analysis performed on the soluble portion of the dustfall sample only. Nitrate is the difference between (Nitrate + Nitrite), determined by automated hydrazine sulphate reduction, and Nitrite, determined by the automated diazotization procedure.
Nitrite (N)	- Analysis performed on the soluble portion of the dustfall sample only. Automated colourimetric-diazotization method. Diazotization with sulphanilamide and N-1-napthylethylene diamine dihydrochloride.
Total Kjeldahl (N)	- Analysis performed on the soluble portion of the dustfall sample only. Organic nitrogen is converted to ammonia salt by digestion with sulphuric acid. Ammonia is then distilled from the alkaline medium and absorbed in boric acid. The ammonia is determined by Nesslerization.
Phosphate (PO_4)	- Analysis performed on the soluble portion of the dustfall sample only. Manual sulphuric acid and potassium persulphate digestion followed by automated ortho-phosphate determination with ammonia molybdate and stannous chloride.

When considering flux per unit area, departure of individual stations from the normal pattern were considered. Generally the interpretations in this report were based on a visual evaluation.

Analytical data expressed as concentrations of precipitation constituents cannot be used directly in evaluating the atmospheric contributions to surface and groundwater chemistry because of water-volume changes resulting from evapotranspiration. The results have therefore been expressed as chemical flux in tons per square mile per month.

Although the monthly wind frequency, magnitude and direction as measured at Penticton was utilized in calculating flux, the relative importance of wind direction can be considered to be minimal considering the number of stations and overall coverage of the area. The average monthly ten-year wind frequencies (in percent) are given in Table 5.5. The wind direction during sampling period was predominantly from the north which was reflected in the higher total dustfall loading in the northern section of the valley.

Knowledge of seasonal variations in the composition of dustfall and precipitation is important in understanding the annual chemical loading to surface water particularly in a large area; however, information was not available beyond the summer period. No analysis of seasonal variation has therefore been considered. Because of the shortness of the sampling period the values of chemical flux are

considered to represent expected values only; however these values are generally supported by current literature.

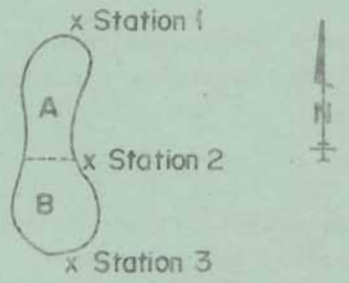
TABLE 5.5

AVERAGE MONTHLY TEN YEAR WIND FREQUENCIES (in percent)
AT PENTICTON AIRPORT

MONTH / Wind From	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
NORTH	22	30	32	40	47	47	58	56	51	31	25	18	39
SOUTH	58	48	42	28	22	18	13	13	15	34	50	63	33
REMAINING	20	22	26	32	31	35	29	31	34	35	25	19	28

5.3 METHOD OF CALCULATION OF NUTRIENT FLUX

The following method was used to determine nutrient flux on the Okanagan Lakes. For purposes of illustration, three dustfall stations designated as stations 1, 2 and 3 are assumed to exist on a lake or section of a lake and may be located as illustrated below.



The basic assumptions are: (1) for a south wind the total dustfall on area A of the lake is assumed to be $A \times X_2$ and for area B to be $B \times X_3$; (2) for north winds the total dustfall or areas A and B is assumed to be $A \times X_1$ and $B \times X_2$ respectively and; (3) for other winds the total dustfall to the lake, areas A and B is assumed to be $(A + B) \times \frac{(X_1 + X_2 + X_3)}{3}$.

Therefore the total dustfall to the lake is estimated to be:

$$N \times (A \times X_1 + B \times X_2) + S \times (A \times X_2 + B \times X_3) + R \times (A + B) \times \frac{(X_1 + X_2 + X_3)}{3}$$

where:

Xn = Dustfall at station n, in tons/sq. mi-mon
N = Frequency of north quadrant winds, in %
S = Frequency of south quadrant winds, in %

R = Frequency of other quadrant winds or (1-N-S), in %
A = Area of lake north of station 2, in sq. mi.
B = Area of the lake south of station 2, in sq. mi.

5.4 CONSIDERATION OF INDIVIDUAL SPECIES

Nitrogen containing compounds are known to be particularly susceptible to changes in concentration due to biological activity (22). Therefore there may be variation in samples from the original time of sampling. The error from this time factor for nitrite, nitrate and kjeldahl nitrogen has not been estimated and must be considered when examining the results of the study. It is often convenient to consider total soluble nitrogen as opposed to a consideration of each individual species. By so doing some of the errors introduced by interaction between the individual nitrogenous species may be eliminated. However, no apparent trend of nitrogen flux within the Okanagan Valley is obvious.

The calculated flux for phosphorus is shown in Table 5.6. The mean of the median total soluble phosphorus, 0.008 tons per square mile per month should be considered an order of magnitude figure only. The total soluble phosphorus flux measured during the study indicate that the phosphorus contribution from dustfall and precipitation is significant and should not be disregarded when considering sources of phosphorus input from all sources.

TABLE 5.6

TOTAL DUSTFALL (TD), PHOSPHATE AND NITROGEN FLUX ON THE MAINSTEM OKANAGAN LAKES FROM OCTOBER, 1971 TO SEPTEMBER, 1972

LAKE	AREA (sq mi)	PARA-METER	NO. OF VALUES	FLUX (Tons/sq mi-mon)			
				MEDIAN	MEAN	MAX.	MIN.
Wood	3.46	NO_2-M	8	0.002	0.001	0.003	0.000
		NO_3-N	8	0.012	0.029	0.129	0.001
		TKN	6	0.031	0.061	0.038	0.005
		PO_4-P	8	0.002	0.339	2.645	0.001
		TD	8	7.0	13.3	64.2	3.3
Kalamalka	9.68	NO_2-N	10	0.001	0.001	0.003	0.000
		NO_3-N	9	0.011	0.030	0.134	0.005
		TKN	5	0.028	0.025	0.038	0.005
		PO_4-P	9	0.003	0.034	0.141	0.004
		TD	9	5.9	12.1	64.2	1.9
Okanagan (North)	36.12	NO_2-N	9	0.001	0.003	0.011	0.000
		NO_3-N	9	0.027	0.041	0.105	0.011
		TKN	5	0.028	0.026	0.040	0.005
		PO_4	10	0.025	0.074	0.203	0.001
		TD	9	5.3	11.8	50.3	1.9
Okanagan (Central)	63.99	NO_2-N	11	0.002	0.002	0.005	0.000
		NO_3-N	11	0.017	0.049	0.307	0.010
		TKN	9	0.018	0.028	0.079	0.005
		PO_4	12	0.003	0.018	0.047	0.003
		TD	10	8.7	8.6	15.5	2.6
Okanagan (South)	34.10	NO_2-N	10	0.001	0.002	0.009	0.000
		NO_3-N	10	0.054	0.093	0.521	0.003
		TKN	6	0.025	0.196	1.108	0.002
		PO_4-P	12	0.011	0.106	0.492	0.000
		TD	10	7.3	10.5	29.3	1.1
Skaha	7.58	NO_2-N	10	0.001	0.002	0.004	0.000
		NO_3-N	10	0.036	0.051	0.265	0.005
		TKN	7	0.087	0.112	0.348	0.010
		PO_4-P	12	0.009	0.086	0.317	0.001
		TD	10	4.8	7.7	22.5	1.5
Vaseux	1.02	NO_2-N	9	0.001	0.002	0.007	0.000
		NO_3-N	9	0.025	0.027	0.057	0.005
		TKN	6	0.120	0.141	0.349	0.022
		PO_4-P	10	0.001	0.033	0.246	0.001
		TD	8	6.6	6.1	11.0	2.0
Osoyoos (Canadian)	5.77	NO_2-N	8	0.001	0.001	0.005	0.000
		NO_3-N	8	0.024	0.031	0.080	0.005
		TKN	6	0.019	0.073	0.329	0.005
		PO_4-P	11	0.007	0.085	0.580	0.000
		TD	5	1.7	8.7	17.5	0.2

CHAPTER 6

Agricultural Operations Requiring Animal Waste Management Practices

In recent years, animal wastes in the Okanagan Valley have been suspected of being a significant factor affecting water quality. This study is concerned with surface flow contributions of nutrients to receiving waters from various agricultural activities.

Steadily increasing livestock numbers together with increased use of automation and mechanical aids within these operations have resulted in an increase in size of confinement production systems (23). Confinement production systems can be in the form of feedlots or total confinement housing units. Feedlots are open confined areas used to raise cattle to market weight for purposes of slaughter whereas total confinement housing is used in hog, poultry and dairy operations where the enclosed facilities are environmentally controlled. In some cases, these intensive operations are established on small parcels of land which are inadequate with respect to waste assimilation. Consequently, wastes can be spread in excessive amounts thus becoming likely sources for surface and groundwater contamination.

Another type of agricultural production system to be considered is the pasture operation. These operations apply to dairy, beef, sheep and brood sows. Currently the number of animals per acre of pasture is increasing, especially in areas where land is at a premium. To the majority of livestock operators, the purchase of additional land to meet the grazing requirements of their livestock is unfeasible. As a result, the pastures can become overgrazed such that consideration is given to supplemental feeding programs or to increasing the productivity of the pasture. This is especially prevalent in the dairy industry. In the cow/calf operations, the pastures are used for grazing and as supplemental feeding areas during the winter months. During the summer months, the cattle graze the summer range areas while the winter grazed areas are used for growing hay crops. It should be noted that these winter grazing areas are irrigated during the summer for purposes of growing hay crops or for summer grazing as in dairy operations.

6.1 THE EFFECT OF ANIMAL WASTE PRACTICES ON WATER QUALITY

Water Quality may be affected through surface runoff or groundwater flow into a body of water. The quantity and the concentration of the pollution load to streams from feedlots, confinement housing and pasture operations are dependent mostly on the waste management practices. The key pollution indices used in evaluating the effect of agricultural activity on water quality are phosphorus, nitrate-nitrogen, organic matter, salinity and fecal coliforms.

6.1.1 Feedlots

Specialization has removed a major proportion of the cattle numbers from pasture and native grassland to small areas where livestock are confined on an intensive basis. This has resulted in accumulations of large volumes of wastes which are susceptible to runoff since feedlots operate under varying climatic exposures. The quantity and quality of runoff entering surface waters are dependent on temperature, rainfall quantity and intensity, topographical conditions and closeness of the feedlots to stream.

Gilbertson et al (24) reported the characteristics of runoff resulting from snowmelt and rainstorms from an unpaved feedlot (Table 6.1). Individual rainstorms produced variable amounts of runoff ranging from 0 to 72% of rainfall (24). A recent study indicated that in cases where disposal sites were poorly located or managed or where pastured animals have access to streams the amounts of pollutants (natural plus animal wastes) which reach streams is a very small proportion (less than 10%) of the potential from the animal wastes deposited in the watersheds (25).

Cattle feedlot runoff has been shown to contain large concentrations of bacteria, nitrogen and, at times, phosphorus. Some of the nitrogen is volatilized, some remains with the accumulating wastes, some is lost with runoff or seepage water, and some may be converted to nitrate or ammonia to subsequently accumulate or denitrify to gaseous nitrogen. Stewart (26) reported that a wet feedlot surface resulted in high nitrate accumulation, whereas a dry surfaced feedlot was conducive to high ammonia concentrations.

Stewart (26) reported on a study which determined the difference between the quality of water samples obtained from core holes in irrigated fields and feedlots. The largest difference existed in the concentrations of ammonium nitrogen and organic carbon, a measure of soluble organic matter. In all cases, the concentrations of the ammonium nitrogen and organic carbon of the feedlots exceeded those of the irrigated fields.

The main factors which determine the waste load on surface or groundwaters from feedlot wastes are the waste management practices. Good waste management practices include the following (27):

(1) diverting natural runoff around the feedlot facilities

(2) incorporating a retention facility to contain the runoff

(3) pumping the contained runoff for land disposal to allow for additional runoff and prevent excessive seepage from the retention facilities

(4) situating feedlots on soils which are not conducive to excessive leaching unless feedlot is hard surfaced.

(5) Surface drainage from stockpiled animal wastes must be routed to a retention lagoon.

TABLE 6.1
RANGES OF RUNOFF CONCENTRATIONS FROM UNPAVED FEEDLOTS(24)

ANALYSIS	RANGE OF CONCENTRATION	
	WINTER RUNOFF	RAINSTORM RUNOFF
pH	6.7-7.6	6.6-9.4
Conductivity (millimhos/cm)	3.0-11.5	1.0-3.4
Total Solids (%)	3.0-19.8	0.24-1.74
Volatile Solids (%)	1.4-10.7	0.12-0.73
Ash (%)	1.5-9.2	0.12-1.05
COD (mg/l)	14,100-77,800	1300-8200
P (ppm)	6.8-753	1.4-46
NH_4-N (ppm)	670-2028	26-82
NO_3-N (ppm)	0-80	0-17
Total N (ppm)	1429-5765	65-555

TABLE 6.2
MANURE PRODUCTION AND CHARACTERISTICS

	DAIRY	BEEF	HENS	PIGS	SHEEP
Animal Size, lb.	1300	900	4.5	150	75
Population equiv./animal	130	8.0	0.14	1.9	2.45
Moisture Content, %	84	84	71	67	74
Raw Manure, lb/day/1000#	88	60	59	50	37
Volume of Manure, cu.ft./day/animal	1.6	.60	.004	.25	.01
Volume of Storage req'd, cu. ft./day/animal	2.2	.9	.005	.36	.24
Total Solids, lb/day/1000 lb.	9	6	17.4	7.2	8.4
Volatile Solids, lb/day/1000 lb.	7.2	4.8	12.9	5.9	6.9
BOD_5, lb/day/1000 lb.	1.7	1.5	4.4	2.1	.7
COD lb/day/1000 lb.	10.6	8.8	15.7	6.4	8.8
Coliforms, x 10^6/lb./1000 lb.	9200	6250	35000	75000	270000
Nitrogen, lbs./day/1000 lb.	.36	.47	2.01	.55	.37
Phosphorus lb/day/1000 lb.	.099	.072	.80	.30	.11
Potassium, lb/day/1000 lb.	.146	.108	.37	.45	.24

(6) All cattle feedlots should be located outside of the 10 year flood plain of all watercourse systems. If the 10 year flood plain of the stream is unknown, all feedlots should be located at least 100 yards outside of the apparent flood plain. This distance also applied to drainage or irrigation ditches.

6.1.2 Confined Housing

In confined housing systems, the wastes are either in a solid, semi-solid or liquid form. The characteristics of the effluents from confinement housing (28) is assumed to be similar to the composition of the wastes excreted by the animals (Table 6.2). A difference in concentrations usually occurs because of dilution with wasted water. The solid wastes are usually stockpiled to be spread on the land when convenient. The liquid slurries are commonly treated in anaerobic storage lagoons or pits till such time that land disposal is convenient with respect to cropping practices. Robbins et al (29) reported their results on lagoon effluents, as summarized in Table 6.3. In these lagoon effluents, they found that ammonia nitrogen averaged 80% of the total nitrogen and the orthophosphate averaged 83% of the total phosphate. Also, the anaerobically treated wastes from 1000 swine were roughly equivalent to the raw wastes water produced by a community of 1000 people. Their data also suggested that during warm weather fecal coliform numbers increased through reproduction as the wastes were transported down the stream.

Some waste management practices for confined housing include the following:

(1) Surface drainage from stockpiled manure must be routed to a retention lagoon if the possibility of contaminating a watercourse exists.

(2) The effluent from anaerobic lagoons should receive further treatment or be disposed to land since generally the effluent is considered inadequately treated for discharge to receiving waters.

6.1.3 Runoff from Range and Pasture Operations

Erosion and nutrient loss are less from range and pasture lands than from intertilled soils. Wastes from grazing cattle are normally uniformly distributed with the liquids absorbed by the soils and the nutrients utilized by the vegetative cover. High intensity rains can result in runoff, but the wastes are sufficiently diluted by the time the runoff reaches a watercourse. In many cases, wastes from grazing animals or from application to land were found to be beneficial, as the resulting vegetative cover reduced erosion (30).

Generally, nitrates do not accumulate under native grasslands, since during most of the crop year they are utilized as they are formed. In one study, however, a substantial pollution load drained from an agricultural basin devoid of farm animals (29). This study reported an average nitrate content of 1.4 mg/l and a maximum concentration of 17 mg/l.

TABLE 6.3
QUALITY FROM ANAEROBIC SWINE WASTE LAGOONS

VARIABLE	VALUE AT GIVEN SITE		
	A	B	C
Number of animals*	30	10	9
Lagoon age, yr.	6	3	2
Lagoon capacity, cu. ft./lb. animal	8	12	18
Loading frequency	Daily	Daily	Weekly
Soil type	Tight Clay	Sandy Loam	Tight Clay
Flow, cfs.	0.027	0.002	0.002
gpd/animal	580	140	120
Study period	10/68-8/69	10/68-5/69	10/68-5/69
Number of samples	179	90	107
FC, 10^3 col/100 ml	420	1,040	170
10^3 col/day/animal	9.0	4.9	0.9
BOD_5, mg/l	390	270	610
lb/day/animal	1.81	0.28	0.71
TOC, mg/l	360	340	470
lb/day/animal	1.70	0.35	0.55
N, mg/l	245	170	290
lb/day/animal	1.15	0.18	0.33
PO_4, mg/l	140	110	115
lb/day/animal	0.69	0.12	0.13

* 1,000 lb live weight basis.

NOTE: Cu. ft. x 0.028 = cu m; gal x 3.785 = l; lb x 0.454 = kg.

A, B, C - swine waste lagoon sites.

TABLE 6.4
LAND REQUIREMENTS FOR MANURE DISPOSAL (2,3)

NUMBER OF ANIMALS PER ACRE	TYPE OF ANIMAL	ANIMAL EXCRETION		
		NITROGEN (lb/N)	PHOSPHATE (lb.P_2O_2)	POTASH (lb.K_2O)
1	Dairy cow (1200 lb.)	140*	65	175
2	Beef cows (400-1100 lb.)	140	65	175
6	Hogs (30-200 lb.)	140	79	49
120	Hens (5 lbs.)	140	112	62
180	Broilers (0-4 lb.)	140	63	54

* Land requirements for utilization of liquid manure in crop production (based on 140 lb. N/acre/year).

Pasturing can be conducive to stream contamination where cattle are permitted to use the stream as their drinking source. In such instances, animals have the opportunity of excreting directly into the stream or in the immediate vicinity of the stream where natural runoff can transport these wastes directly into the stream. The accessible areas along the streams should be fenced to minimize contamination from animals wastes and provision should be made for suitable watering tanks.

6.1.4 Land Disposal of Animals Wastes

There appears to be a general consensus among researchers that animals wastes should be returned to the land since they provide organic matter to the soil medium and nutrients for plant life. The nutrients of major importance are nitrogen and phosphorus. Proper land spreading can reduce nutrient loadings into streams by more than 99% (25). Application rates of manure are dependent on whether the land is irrigated or not and the amount of manure that can be tilled into the soil and maintain a proper seedbed. Since nitrates are more mobile than phosphates, the nitrogen content of the manure along with the amount of nitrogen removed by the crop becomes the basis criteria used in the application rates of animal wastes (31).

Based on the assumption that 140 lbs. of N can be utilized per acre in continuous cropping, Table 6.4 shows the annual excretion of nitrogen, phosphorus, and potash by the livestock and the acreage required to utilize their waste (31). It should be noted that the amounts of nutrients present in the manure at the time of application depends on management practices (31). Also, only 50% of the nitrogen in the manure is available in the first year of application. The animal wastes must be spread uniformly and not applied on drainage paths leading to watercourses.

Animals residues or excreted materials undergo numerous transformations to become available to plant life. However, the transformations of major importance in the nitrogen cycle are mineralization and immobilization, nitrification and denitrification. These processes are discussed below.

(a) Mineralization and Immobilization

In the soil, the major proportion of the nitrogen exists in an organic form. The plants can only utilize nitrogen in its mineralized form, namely ammonia and nitrate. During the mineralization process, a large amount of nitrogen is incorporated and temporarily immobilized into microbial tissue which is subsequently complexed into the soil organic fraction (32). These nitrogenous substances function as a reserve where gradual mineralization takes place and eventually becomes utilized by the plants (32). Addition of high carbohydrate residues will induce proliferation of the microflora, therefore resulting in the immobilization of the inorganic nitrogen. The rate of proliferation is also dependent on the resistance of the organic matter to be reduced (32) which is indicated by the C:N ratio A C:N ratio above a critical value of 20 to 25 results in a net immobilization of N whereas a ratio below this value leads to net mineralization (30).

(b) Nitrification

In most instances, nitrogen is used by the plant in its most oxidized form - nitrate. Nitrification which is brought about by two groups of aerobic autotrophic bacteria, involves the conversion of ammonia to nitrate. The Nitrosomas bacteria oxidize the ammonia to nitrite while the Nitrobacter species oxidizes nitrites to nitrates.

The nitrification process is very sensitive to poor aeration conditions and a low pH. In situations where excessive moisture is prevalent or the soil structure is such that the oxygen access is limited, large amounts of NH_3 may be present, since the ammonifiers are less sensitive to these extreme conditions than the nitrifiers.

In feedlots, the nitrification rate was found to be very minimal due to the high concentration of NH_3 which increased the pH. This phenomena was noted in high density feedlots where there were excessive additions of urine per unit area (35). The urea in the urine hydrolyzes immediately into NH_3 thus resulting in a high pH. No nitrates are present in the feces excreted by the animals (33).

(c) Denitrification

Under suitable conditions, nitrate levels are controlled by bacterial denitrification. The denitrification process usually occurs under anaerobic conditions where NO_3 is transformed to nitrogen gases which are subject to volatilization.

Optimum conditions for denitrification are as follows (30).

(1) Excessive moisture in the soil or in anaerobic microenvironments of well-drained soils such as small pores filled with water, the rhizosphere of plant roots and the vicinity of decomposing plants and animal residues. The critical moisture content has been found to be 60% of the water holding capacity of the soil (23).

(2) Temperature of 25°C or above.

(3) Soil pH near neutral since denitrification is sensitive to high hydrogen ion concentrations.

(4) A supply of readily decomposable organic matter is required by the denitrifying organics as an energy source.

Recently, additions of sulphur to the soil have been found to be very effective in increasing the rate of denitrification since the Thiobacillus denitrificans uses the sulfur as an energy source (34). This may be more practical than additions of exogensus carbon since there is competition for available carbon among the non-denitrifying bacteria (34).

Phosphate contamination to groundwater supplies from feedlots or wastes applied to land is insignificant. The reason being that the phosphorus, upon application, becomes insoluble within a few hours (35). Fixation of phosphorus occurs by the

formation of insoluble compounds of iron, aluminum or calcium. Surface waters can become contaminated with PO_4 through runoff. Runoff can contain phosphorus in a particulate form as a result of soil erosion or in a dissolved form resulting from excess moisture.

Phosphorus is utilized by plants as inorganic orthophosphorus which exists in a soluble form. During decomposition,the organic phosphorus usually accumulates near the surface but decreases with depth. Through microbial activity organic phosphorus is converted to inorganic phosphorus. The orthophosphorus exchanges continuously with the inorganic orthophosphorus ions held by the soil solids. If phosphorus is added to the solution, phosphorus is adsorbed by the soil minerals till such time that an equilibrium is established between the phosphorus in the soil solution and that held by the soil solids (30). In acid soils, phosphorus is fixed by aluminum and iron while in alkaline soils calcium phosphates predominate (32).

6.2 OBSERVED ANIMAL WASTE MANAGEMENT PRACTICES

Nutrient contributions of major concern in the Okanagan Valley are from agricultural operations situated directly adjacent to watercourses since these operations were considered most conducive to nutrient contributions through surface runoff. The locations of the beef feedlots, confined animal housing units and pastures along receiving waters were obtained from background information gathered for the background study on Groundwater Nutrient Input (Section 7). On the basis of the documented management guidelines and the literature review, the animal waste management practised by each operation were evaluated by means of a visual appraisal. The possible agricultural nutrient sources along each stream and lake are tabulated in Table 6.5. The number of agricultural operations along each stream are listed in Table 6.6. The following discussion evaluates the drainage basin of each stream as to possible surface inputs from agricultural sources.

TABLE 6.6

NUMBER OF AGRICULTURAL OPERATIONS ALONG EACH STREAM

WATERCOURSE	NUMBER	WATERCOURSE	NUMBER
Deep Creek	14	Skaha-Vaseaux (OK R.)	2
BX Creek	3	Vaseaux-Osoyoos (OK R.)	5
Kelowna Creek	5	Park Hill Creek	4
Coldstream Creek	6	Shatford Creek	4
Vernon Creek	3	Okanagan Lake	1
OK-Skaha (OK R.)	1	Swan Lake	1
	32		17

TABLE 6.5

AGRICULTURAL OPERATION LOCATED ALONG WATER COURSES
IN THE OKANAGAN BASIN

NAME	OPERATION	LIVESTOCK	NUMBER	ACRES	STREAM OR LAKE
McChenie	F[1]	beef	28-8[4]	70	Deep Creek
Landon	H[2]	chickens	450	20	Deep Creek
Shephard	H[3]	chickens	3,000	20	Deep Creek
Moller	P	beef	14	5	Deep Creek
Wagner	F + P	dairy	67-65	40	Deep Creek
Hoover	P	beef	100	70	Deep Creek
Gill	P	dairy	50-38	175	Deep Creek
Johnstone	P	beef	100-50	220	Deep Creek
Solomon	F	beef	187	170	Deep Creek
Wood	P	beef	40	35	Deep Creek
Pridham	F + P	dairy	32-22	155	Deep Creek
Durrer Bros.	P	dairy	52-18	10	Deep Creek
Hayes	P	beef	175-70	100	Hutley (D.C.)
Marshall	F + P	dairy	115-55	100	Deep Creek
Anderson	P	beef	600	200	BX Creek
Leduc	P	beef	100-150	600	BX Creek
Not Known	P	beef	250-30	40	BX Creek
Coldstream R.	P	beef	890-800	350	Coldstream
Not Known	P	beef	60	150	Coldstream
Collins	F + P	dairy	150-50	80	Coldstream
Lischuk	P	beef	70-22	80	Coldstream
Olhauser	H	dairy	75-21	23	Coldstream
Wade	P	beef	80-20	150	Brewer Cr. (C.C.)
Sanvers	F	sheep	200	100	Hayton Cr.
Holt	P	beef	100-40	80	Vernon Cr.
McCarthy	P	beef	30-15	60	Vernon Cr.
Winfield R.	P	beef	681-475	700	Kelowna & Ellison
Not Known	P	beef	30-20	10	Kelowna & Scotty
Hemsheak	P + F	dairy	30-21	65	Scotty (Kelowna)
Not Known	P	beef	16-15	30	Kelowna Cr.
Not Known	P	beef	130	22	Kelowna Cr.
Sather Bros.	P	beef	60	100	OK-Skaha
Kusler	F	beef	235		Shatford (Shingle)
T6 Ranch	F	beef	155		Marron (Shingle)
Messerschmidt	F	beef	65		Shatford (Shingle)
Divinell	F	beef	34		Shatford (Shingle)
Phelps	P	beef	100	150	SK-Vaseaux
Lindsay	P	beef	105	100	SK-Vaseaux
Don Ranch	F	beef	100		Rill Creek
Willow Brook	F	beef	150		Rill Creek
Johnstone	F	beef	180		Rill Creek
Johnson	F	beef	150		Rill Creek
Thompson	P	beef	105	100	Vas-Osoyoos
Oliver Poultry	H	chickens	5,000		Vas-Osoyoos
Mills	H	turkeys	30,000		Vas-Osoyoos
Peters	H	turkeys	30,000		Vas-Osoyoos
McGibbon	P	beef	200	150	Vas-Osoyoos
Lewis	P	beef	75-30	75	OK Lake (Vernon Area)
Harrop	P + F	dairy	30-10		Swan Lake (West Side)

1. Feedlots
2. Housed Livestock
3. Pasture
4. Mature-Young (defined in Section 2.5)
5. SK - Skaha Lake
6. OK - Okanagan Lake
7. Vas - Vaseaux Lake

6.2.1 Deep Creek

Dairy and beef animals comprise the majority of the farming operations along Deep Creek. This creek runs through a broad and flat valley which is extensively farmed. Most of the land along the creek between the North Arm of the Okanagan and Armstrong consisted of pastures. Generally, cattle had access to the creek between Okanagan Lake and Otter Lake while more fencing was prevalent along the creek between Armstrong and Otter Lake. The cow/calf operations generally occupy this land between the months of October to May, then are routed to summer range grazing areas. The winter pastures then become a source of hay during the summer months. One dairy herd was found to have direct access to the shallow creek. Generally, feedlots were situated a suitable distance from the stream or drainage paths leading to the creek. There were two exceptions where the stream ran through the feedlots. These were considered to be small feedlots of less than 25 animals.

Nutrient contributions could originate from the pastured lands along the creek. Since most of the cattle activity along the creek occurs during the winter months, this would indicate that the major nutrient loadings occur through the surface runoff of animal wastes during the freshet period. Also animal wastes from confined areas are disposed to these areas. Other possible contributions could result from the creek overflowing during freshet where the streambed is shallow and possibly flushing the wastes from the land immediately adjacent to the stream. The land along the creek is irrigated for the purposes of growing hay crops and dairy pastures. Through the application of water, the wastes may solubilize and consequently be transported to the stream via groundwater during the course of summer.

6.2.2 Coldstream Creek

Coldstream Creek lies in a narrow valley which is extensively used for agricultural purposes. All farming oprations along the creek consist of dairy or beef cattle. At two of the operations along the stream, cattle had direct access to the creek, one was a small feedlot and the other was a pastured dairy operation. Although there were relatively few operations along the creek, the cattle numbers were quite substantial, especially at the Coldstream Ranch. At some locations a the creek overflowed its banks thus resulting in flooding of pastured land. As in Deep Creek, this would indicate a removal of nutrients through erosion of land and deposited wastes. The high water table also would result in the removal of solubilized nutrients - nitrogen and phosphorus - from the land and the applied wastes.

6.2.3 Kelowna Creek

A large portion of this creek flows through orchards, vineyards, pastures and cropland. Of the five livestock operations along the creek, three did not meet the recommended waste management guidelines. The locations of two operations were considered too close to the creek while the third allowed direct cattle access to

the creek. These conditions would be conducive to surface runoff of nutrients. Along this creek system, it also was evident that a high water table existed in some areas. This could be conducive to nutrient transport to the streams via groundwater.

6.2.4 B.X. Creek

Relative to the other major water basins, the B.X. watershed is highly developed. A large number of animals were observed grazing in the watershed under seemingly proper management practices. All the cattle were confined by fences with water facilities installed. The contribution of nutrients through surface runoff was considered minimal although nutrients could be transported to the creek via drainage paths intercepting surface water from the adjacent pastures.

6.2.5 Vernon Creek

Surface contributions from cattle was considered minimal since the pastures were fences and situated at distances greater than one-quarter of a mile from the creek.

6.2.6 Shingle and Park Rill Creek

Shingle and Park Rill Creek systems lie west of Skaha and Vaseux Lakes respectively. The only agricultural activity along Shingle Creek is basically where the creek runs through the Indian Reserve. West of the reserve, the major agriculutural activity lies along Shatford Creek, a main tributary to Shingle Creek. Shatford and Park Rill Creeks have very low flows which seem to disappear and reappear along the course of the streams. The loadings from these creeks were considered minimal.

Generally, the pastured cattle had access to these streams and their tributaries. These watersheds are very narrow with narrow pastures bordering the streams. The feedlots along the creeks appeared to be well managed except for one exception on Park Rill Creek in which case the creek ran through a small feedlot.

6.2.7 Okanagan River

There was found to be very little livestock access to the Okanagan River since the river was either fenced or channelled. The agricultural operations along the river consisted of either pastures or confinement housing. Many cattle occupy this portion of the Okanagan Basin during the winter months. As in the other creek systems considered the major contribution of nutrients would appear to be through groundwater transport.

6.3 RECOMMENDATIONS

(1) Natural stream pollution occurring in watersheds should be distinguished from the extent of pollution caused by farm animals by further studies specifically orientated to agricultural activities.

(2) The direct discharge of animal wastes to water courses should be prohibited.

(3) Additional research should be undertaken to

(a) determine the true extent of surface nutrient loading from runoff to groundwater contamination, and

(b) determine the effect of groundwater table height on the nutrient removal from those agricultural lands devoid of animal wastes and from those with applied wastes.

(4) When stocking at a high rate, animals must be confined away from streams and drainage paths.

(5) Wastes must not be applied on grassed waterways, drainage paths or areas proximate to watercourses.

CHAPTER 7

Determination of Nutrient Loadings to Okanagan Basin Lakes by Groundwater Transport

Nutrients enter the Okanagan Basin lakes not only by effluent outfalls and tributary flows but also by groundwater flows.

Assessment of the quality of groundwater in the Okanagan Basin, and the amounts of nutrients reaching the lakes in the Basin by groundwater flows, are required to select appropriate wastewater treatment technology and to estimate maximum acceptable nutrient loadings to maintain acceptable lake quality.

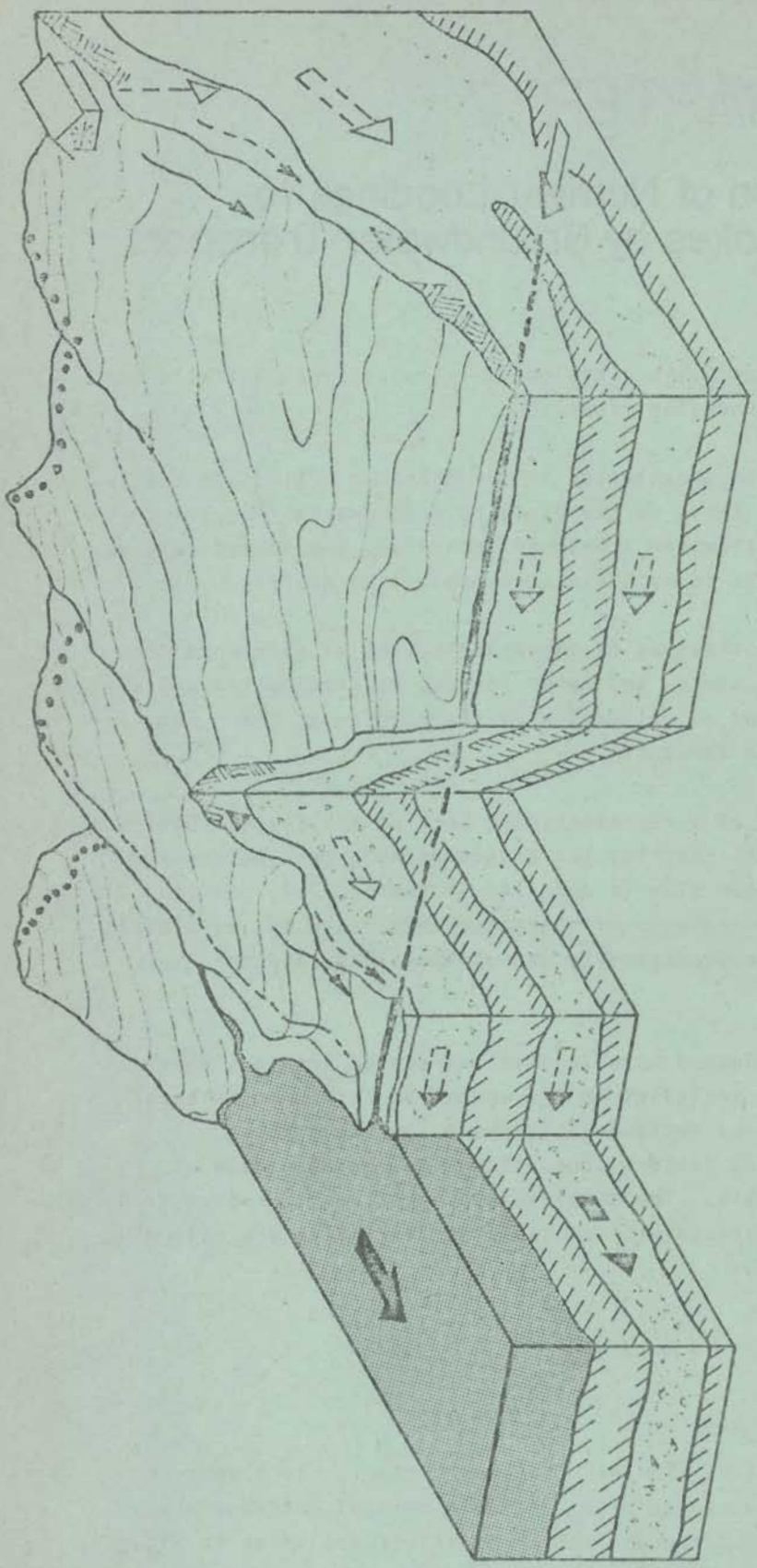
This chapter provides an estimation of the contribution of nutrients from agricultural activities, septic tanks, and other sources to groundwater and streams throughout the Okanagan Basin and an estimation of the portion of these nutrients that reaches lakes and rivers in the Basin.

Figure 7.1 shows a cutaway of a representative part of the Basin. Determination of the amounts of nutrients reaching the transporting ground waters and streams by percolation and surface flow is detailed in Section 7.1. Section 7.2 details the determination of the amounts of nutrients that reach the main basin surface and groundwater from the transporting groundwaters and streams.

Sources of nutrient contribution were located and source loadings were determined. The effect of source variables on the amount of nutrients released from the source to groundwater and surface water was mathematically modelled by multiplying the source load by factors proportional to the magnitude of the effect of each source variable. The mechanisms of nutrient transport from the sources through different soil conditions and other variables was also modelled by the use of factors.

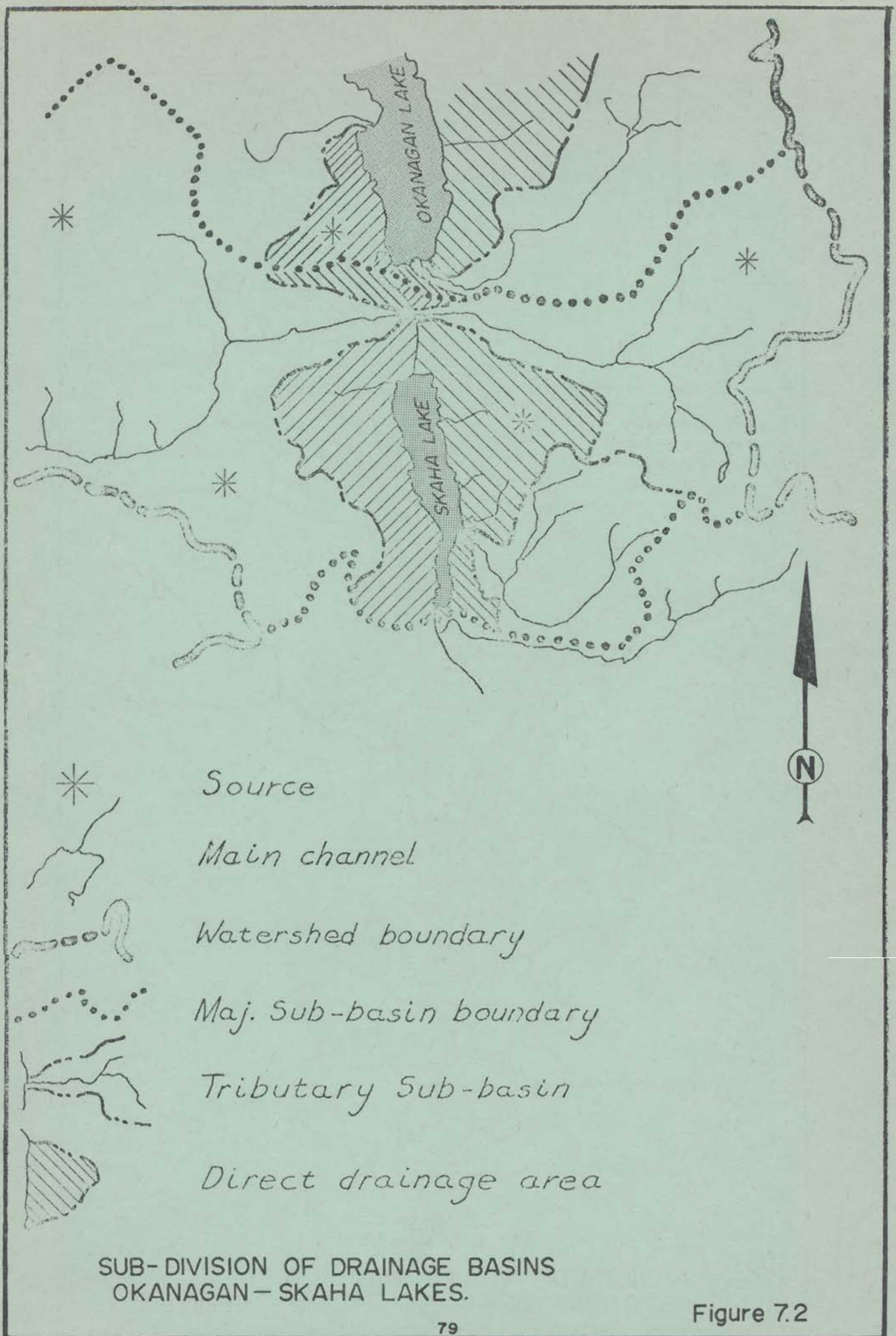
DIVISIONS OF THE BASIN

Major Okanagan Basin divisions (Vaseux, Okanagan Central, etc.) were subdivided according to tributary drainage areas and main channel drainage areas. The concept is shown in Figure 7.2 and the actual divisions are shown in Figure 7.3. There are 36 tributary basins, 44 direct drainage areas, and three unclassified areas.



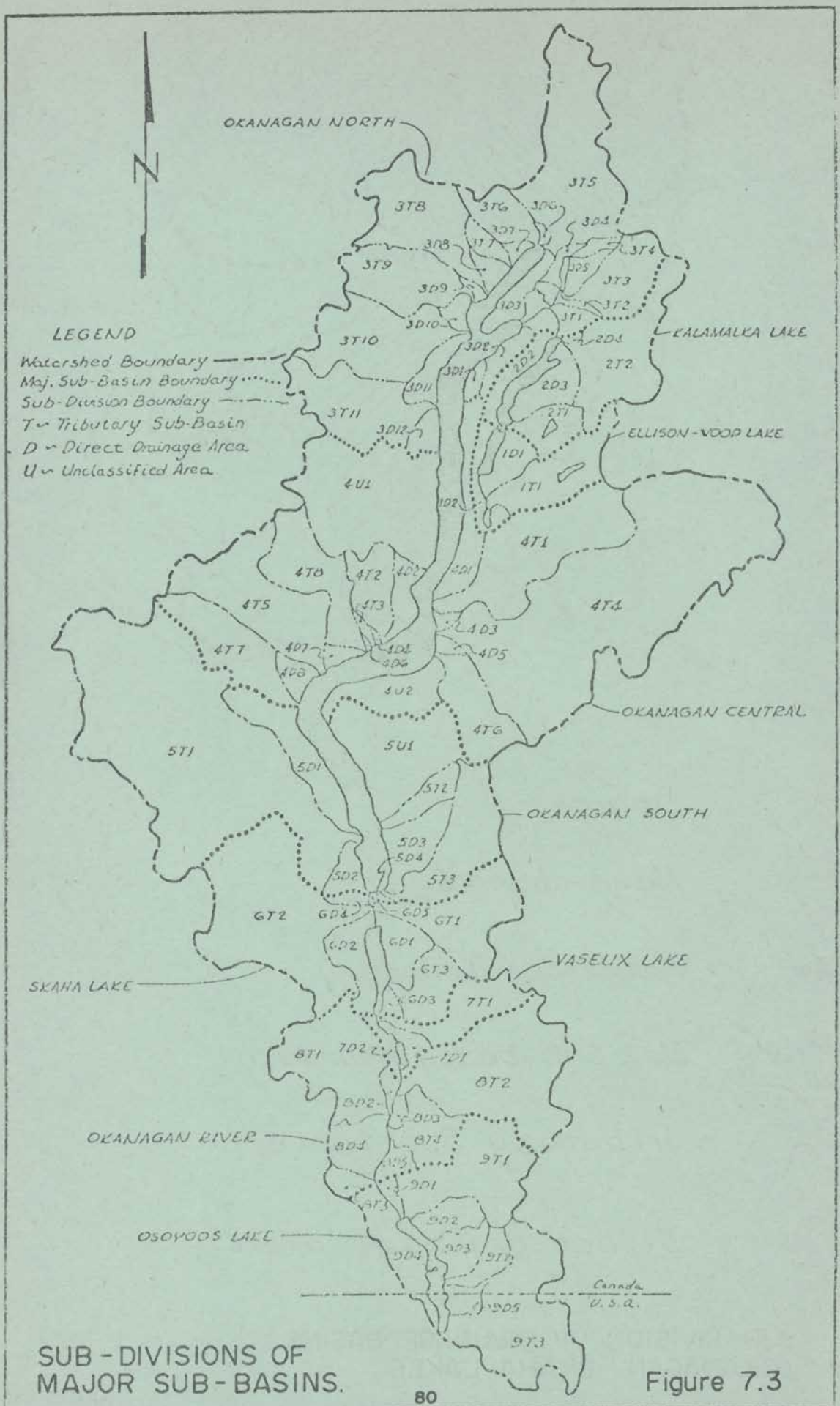
3-DIMENSIONAL REPRESENTATION OF PART OF THE BASIN-
3 PHASE METHOD.

Figure 7.1



SUB-DIVISION OF DRAINAGE BASINS
OKANAGAN – SKAHA LAKES.

Figure 7.2



SUB-DIVISIONS OF MAJOR SUB-BASINS.

Figure 7.3

7.1 DEVELOPMENT OF VERTICAL TRANSPORT MODEL

7.1.1 Source Locations

The two agricultural sources considered were irrigated and fertilized cropland, and animal grazing and confining.

Cropland locations and acreages were determined for each sub-basin area shown in Figure 7.3. These figures are given in Appendix E.1. Data on the distribution of agriculture were extracted from land use studies carried out by the Okanagan Basin Study (84). The total cultivated acreage estimated for the Okanagan Basin was 88,195 acres. There was some variation in this figure from other estimates (84) (87). The totals for the various crop types were in agreement with the proportions estimated in the earlier studies.

Animal distribution was determined by field studies. Results are presented in Appendix E.2 for each sub-basin drainage area. The contribution of nutrients to transporting groundwater from septic tanks is reported in Chapter 10. The loadings from septic tanks are combined with the results developed in this Section for the other sources and the other sources and the overall loadings examined in Section 7.2

7.1.2 Source Loadings

The amounts of nutrients applied to the documented sources were determined as follows:

(a) Irrigation Water -

Total irrigated cultivated acreage was estimated at 57,528 acres with an estimated volume of irrigation water of 163,983 acre-feet. Other studies (87) (86) estimated 66,452 and 54,831 irrigated acres respectively. (86) estimated irrigated water volume at 163,348 acre-feet. A study (85) carried out in August, 1970 suggested a total irrigated acreage of 51,700 acres with an application of 137,710 acre-feet based on recommended application rates.

In order to estimate the loading of nutrients by application of irrigation water the quality of water was determined from previous studies (84) (85) (86) (87) and from B.C.W.I.B. drawings (file #0177201-6, DWG No. 4841-3).

Data on the streams that the irrigation waters were drawn from were generally available but only for sampling points near the mouths of the streams, far downstream from the point of diversion for irrigation. These data represented composite stream quality that reflected all the upstream contributions, including return irrigation flow. To obtain a more reasonable estimate of irrigation water quality the following formula was used (2 x minimum + mean)/3; that is, a weighted average. The annual minimum and mean water quality figures for 1969, 1970 and 1971 were used.

Estimates of nutrient loading from irrigation water were based on these estimated concentrations and volumes. Water quantity, quality and calculated loadings are given in Appendix E.4 for each sub-basin. Nutrient loading to the ground was estimated at 109,000 lbs. of total nitrogen and 17,000 lbs. of total phosphorus. Only a portion of these loadings return to receiving waters thus irrigation reduces the amount of nutrients reaching receiving waters, whereas other practices such as fertilizer application increases the loading of nutrients to receiving waters.

(b) Fertilizer Distribution - Detailed information on distribution of fertilizer was not available. A field survey of fertilizer application rates was carried out, the results of which are shown in Appendix E.5. It was assumed that fertilizer was applied only to irrigated cultivated acreage. If in fact some of the fertilizer was applied to dryland areas then the nutrient contribution to groundwater would be less than herein estimated. Appendix E.5 shows a fertilizer classification breakdown; that is, the loadings due to specific types of commercial fertilizer.

Total estimated loading was 2,200,000 pounds of total nitrogen and 264,000 pounds of total phosphorus.

(c) Agricultural Animal Distribution - The results of a field survey of agricultural animal distribution is presented in Appendix E.2. The potential nutrient loading was calculated by using conversion figures shown in Appendix E.6, for each basin subidivision. The total loadings of the subdivisions were 2,600,000 lbs. of total nitrogen and 265,000 pounds of total phosphorus. These figures are very close to the corresponding fertilizer loadings. A large portion of the animal loading occurred in sub-basin VIII.

For added information Appendix E.2 gives animal population distributions for beef, dairy, poultry, hogs and miscellaneous when animal wastes are spread over irrigated cropland some nutrient loading will enter surface transporting waters through surface runoff and some will percolate to groundwater. These contributions are tabulated in Table 7.1.

TABLE 7.1

NUTRIENT CONTRIBUTION TO TRANSPORTING WATERS FROM AGRICULTURAL SOURCES*

BASIN	SUB DIV	GROUNDWATER						SURFACE STREAM		TOTAL	
		IRRIGATION WATER		FERTILIZER		ANIMALS		ANIMALS			
		Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P
I	1D1	728.8	20.5	8878.8	331.9	-	-	-	-	9607.6	352.4
	1D2	1800.0	18.7	431.7	15.4	488.9	.3	4454.0	284.4	7174.6	318.8
	TOTAL	2528.8	39.2	9310.5	347.3	488.9	.3	4454.0	284.4	16782.2	671.2
II	2T1	-	-	-	-	970.0	.8	-	-	970.0	.8
	2T2	334.5	1.9	4204.5	32.2	17442.0	12.8	2058.9	226.7	24039.9	273.6
	2D1	79.8	.2	254.6	-	-	-	-	-	334.4	.2
	2D2	133.0	.7	80.2	2.6	-	-	-	-	213.2	3.3
	2D3	-	-	-	-	288.4	-	253.0	30.2	541.4	30.2
	TOTAL	547.3	2.8	4539.3	34.8	18700.4	13.6	2311.9	256.9	26098.9	308.1
III	3T1	164.0	.2	3401.6	9.5	289.5	.3	2066.0	328.6	5921.1	338.6
	3T2	67.5	.2	525.7	1.5	-	-	367.9	44.0	961.1	45.7
	3T3	59.0	.3	2107.9	6.4	1527.9	1.3	5892.4	357.9	9587.2	365.9
	3T4	.8	-	88.1	4.4	-	-	-	-	88.9	4.4
	3T5	515.2	35.9	11701.1	962.7	3085.1	60.0	15563.1	1217.8	30864.5	2276.4
	3T8	124.8	3.8	-	-	-	-	-	-	124.8	3.8
	3D2	-	-	-	-	360.0	-	-	-	360.0	-
	3D3	8.2	-	52.9	.3	820.0	-	-	-	881.1	13
	3D4	39.5	.3	543.6	27.6	262.1	-	401.5	38.5	1246.7	66.4
	3D5	99.9	.8	8631.7	9.3	-	-	-	-	8731.6	10.1
	3D8	143.9	.8	-	-	-	-	2144.4	136.9	2288.3	137.7
	TOTAL	1222.8	42.3	27052.6	1021.7	6344.6	61.6	26435.3	2123.7	61055.3	3249.3
IV	4T1	630.3	26.0	32356.1	673.5	2357.0	14.3	545.0	35.0	35888.4	748.8
	4T2	53.7	1.5	-	-	-	-	-	-	53.7	1.5
	4T3	582.1	6.6	2068.2	5.8	-	-	-	-	2650.3	12.4
	4T4	547.0	13.3	24418.0	421.3	2785.0	26.1	754.0	102.0	28504.0	562.7
	4T5	15.1	.4	391.1	5.6	-	-	-	-	406.2	6.0
	4T6	49.7	2.4	2636.9	127.6	-	-	-	-	2686.6	130.0
	4T7	12.8	.2	17.3	-	-	-	-	-	30.1	.2
	4T8	165.6	1.1	1480.7	-	-	-	-	-	1646.3	1.1
	4D1	347.0	-	17384.8	-	947.0	-	-	-	18678.8	-
	4D2	266.0	1.1	5909.1	12.0	-	-	-	-	6175.1	13.1
	4D3	71.7	.7	2359.8	16.1	-	-	-	-	2431.6	16.8
	4D4	39.7	.5	-	-	-	-	-	-	39.7	.5
	4D5	100.1	3.1	10534.3	145.8	1147.9	22.8	-	-	11782.3	171.7
	4D6	174.0	.1	20.6	-	-	-	-	-	194.6	.1
	4D7	23.3	.4	61.0	5.0	-	-	-	-	84.3	5.4
	4D8	363.8	5.2	-	-	-	-	-	-	363.8	5.2
	4U2	87.0	4.0	1031.6	-	-	-	-	-	1118.6	4.0
	TOTAL	3528.9	66.6	100669.9	1412.7	7236.9	63.2	1299.0	137.0	112734.4	1679.5

* Nutrients might be removed from these transporting waters before they reach receiving waters; therefore these are maximum estimates of contribution to receiving waters.

TABLE 7.1 (cont'd)

NUTRIENT CONTRIBUTION TO TRANSPORTING WATERS FROM AGRICULTURAL SOURCES*

BASIN	SUB DIV	GROUNDWATER						SURFACE STREAM		TOTAL	
		IRRIGATION WATER		FERTILIZER		ANIMALS		ANIMALS			
		Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P
V	5T1	670.3	45.1	8694.1	68.3	135.0	.1	124.0	7.9	9623.4	121.4
	5T2	64.9	3.8	2573.9	7.5	-	-	-	-	2638.8	11.3
	5T3	43.9	3.8	548.6	17.0	-	-	-	-	592.5	20.8
	5D1	906.4	57.2	22498.4	333.7	401.5	3.6	-	-	23806.3	394.5
	5D2	18.9	.5	498.8	1.7	-	-	-	-	517.7	2.2
	5D3	347.5	1.7	16483.4	6.5	214.4	.2	-	-	17045.3	8.4
	5U1	45.4	.2	1734.7	.3	-	-	-	-	1780.1	.5
	TOTAL	2097.3	112.3	53031.9	435.0	750.9	3.9	124.0	7.9	56004.1	559.1
VI	6T1	8.8	.3	144.2	4.4	-	-	-	-	153.0	4.7
	6T2	502.6	8.5	-	-	17802.0	166.5	4289.0	274.0	22593.6	449.0
	6T3	147.0	3.8	-	-	2401.7	2.0	-	-	2548.7	5.8
	6D1	221.0	5.3	3881.9	18.4	-	-	-	-	4102.9	23.7
	6D2	92.3	4.9	4840.9	35.6	2297.0	.3	257.0	16.5	7487.2	57.3
	6D3	52.7	2.3	298.7	.8	2840.2	2.4	-	-	3191.6	5.5
	6D4	22.2	.1	620.1	.6	-	-	-	-	642.3	.7
	TOTAL	1046.6	25.2	9785.8	59.8	25340.9	171.2	4546.0	290.5	40719.3	546.7
VII	7T1	70.3	.6	-	-	-	-	-	-	70.3	.6
	7D1	376.5	4.6	4065.1	5.9	1671.0	1.7	-	-	6112.6	12.2
	7D2	34.3	.7	-	-	-	-	-	-	34.3	.7
	TOTAL	481.1	5.9	4065.1	5.9	1671.0	1.7	-	-	6217.2	13.5
VIII	8T1	365.5	5.6	3501.1	131.9	13451.0	25.3	-	-	17317.6	162.8
	8T2	22.3	.4	-	-	-	-	-	-	22.3	.4
	8T3	221.8	4.1	2709.8	78.3	-	-	-	-	2931.6	82.4
	8T4	40.2	3.7	228.6	-	-	-	-	-	268.9	3.7
	8D1	121.1	.8	297.7	18.1	-	-	-	-	418.8	18.9
	8D2	546.9	8.1	371.4	8.9	-	-	-	-	918.3	17.0
	8D3	557.3	7.7	7109.4	76.8	56995.0	2341.0	-	-	64661.7	2425.5
	8D4	1634.3	16.8	59838.6	671.8	-	-	-	-	61472.9	688.6
	8D5	-	-	7939.4	161.8	-	-	-	-	7939.4	161.8
	TOTAL	3509.4	47.2	81996.1	1147.6	70446.0	2366.3	-	-	155951.5	3561.1
IX	9T1	43.9	3.7	-	-	-	-	-	-	43.9	3.7
	9T2	192.9	5.3	6191.9	112.1	4053.0	61.6	-	-	10437.8	179.0
	9D1	333.9	.9	4607.8	10.3	3259.0	2.1	-	-	8200.7	13.3
	9D3	503.0	14.0	8702.7	124.1	-	-	-	-	9205.7	138.1
	9D4	1970.2	31.9	54850.9	750.1	1351.0	20.5	-	-	58172.1	802.5
	9D5	69.2	1.9	3009.7	49.2	-	-	-	-	3078.9	51.1
	TOTAL	3113.1	57.7	77363.0	1045.8	8663.0	84.2	-	-	89139.1	1187.7
TOTAL CONTRIBUTION (LBS.)											
		18075.3	399.2	367813.9	5510.6	139642.6	2766.0	39170.2	3100.4	564702.0	11776.2
		18000.0	400.0	368000.0	5500.0	140000.0	2800.0	39000.0	3100.0	565000.0	11800.0

(d) Rainfall - Two background studies (85) (86) provided the climatic data necessary to estimate the net loading due to precipitation. This information is superseded by section 5.

7.1.3 Source Variables and Multiplying Factors

To estimate the fraction of source loading penetrating the unsaturated soil medium to the groundwater, it was necessary to derive multiplying factors corresponding to the variables that affect the nutrient transfer.

(a) Source Variables

The two major source variables are:

(1) soil type; and

(2) depth of soil to groundwater or first impervious layer.

Soil types in crop root zones were grouped into three categories; fine, medium and coarse texture. It was assumed that the soil texture would remain constant or become more coarse as the water table or first impervious layer was approached. A further assumption was that nutrients and water leaching from the root zone could reach the groundwater.

Soil depths to groundwater were designed: S for shallow (less than 6 feet), I for intermediate (6 to 30 feet) and D for deep (greater than 30 feet). The Groundwater Division of the B.C. Water Resources Service provided the necessary well data cards so that water table elevations could be plotted in these three depth ranges.

Distributions of the combinations of soil type and depth to groundwater are shown in Appendix E.3.

A third source variable, climate, was also considered. The climatic data required for this study was provided by two background studies (85) (86). The influence of varying climate in the basin is reflected in the different multiplying factors for North, Central and South regions as shown on Table 7.2.

Each combination of soil types and depths was given by a different multiplying factor. When calculating the contribution loading to groundwater in each subdivision, the distribution of source variables as shown in Appendix E.3 for total cultivated acreage was applied proportionately to irrigated acreage by the ratio of irrigated to total cultivated acreage for that whole subdivision.

The following example illustrates this procedure: Subdivision 1.D.1. The total cultivated acreage equals 1,535 acres and the boundary condition breakdown was 38 acres FS, 4 FI, 117 MS, 153 MI, 81 MD, 918 CS, 160 CI, 59 CD and 5 MKS for a total of 1,535 acres. Of the 1,535 total cultivated acreage, 73.6% or 1,130 acres was

TABLE 7.2

MULTIPLYING FACTORS FOR IRRIGATED-FERTILIZED AGRICULTURAL CULTIVATED LAND

REGION		FS	FI	FD	MS	MI	MD	CS	CI	CD	MKS	REC. APP. RATE	BASIN
NORTH OKANAGAN	N*	.12	.09	.06	.150	.110	.070	.15	.13	.11	.15	1.86	VERNON & NORTH (Basin III)
	P	-	-	-	.002	.001	-	.04	.03	.02	.04		
	RF	.05	.05	.05	.070	.070	.070	.15	.15	.15	.15		
CENTRAL OKANAGAN	N	.16	.12	.08	.020	.150	.100	.20	.17	.15	.20	2.60	REMAINDER (Basin I,II,& IV-XI)
	P	-	-	-	.003	.002	.001	.05	.04	.03	.05		
	RF	.07	.07	.07	.100	.100	.100	.20	.20	.20	.20		
SOUTH OKANAGAN	N	.20	.15	.10	.250	.190	.130	.25	.21	.17	.25	3.91	OK FALLS & SOUTH (Basin VII-IX)
	P	-	-	-	.004	.003	.002	.06	.05	.04	.06		
	RF												

* N - is total Nitrogen; p - is total Phsophorus; RF - is Return Flow

☐ - multiplying factors obtained directly by lysimeter experiments, other values represent estimatations only.

irrigated. Therefore, the boundary condition breakdown for the irrigated acreage was 73.6% of the figures for total cultivated acreage, or 28 acres FS, 3 FI, --- etc.

(b) Multiplying Factors for Vertical Nutrient Transport

To determine the amounts of the nutrients applied as fertilizer or irrigation water that percolate downward to the groundwater, multiplying factors were estimated for the various combinations of the source variable. These multiplying factors are shown in Table 7.2.

The multiplying factors are intended to reflect mechanisms of vertical transport of nutrients and water through the unsaturated zone of soil media. The values of the multiplying factors vary from a minimum for fine soils in the North Okanagan to a maximum for coarse soils in the South Okanagan.

In some cases, a portion of the nutrients applied pass through to groundwater, whereas in other cases, the loading of irrigation water causes nutrients to be removed from the unsaturated zone of the soil profile. The net effect on the various soil types as determined by lysimeter studies has been examined and are outlined on Table 7.2 with heavy lines.

7.1.4 Calculation of the Release of Nutrients and Water to Transporting Waters from Agricultural Sources

(a) Nutrients

Nutrient contribution to transporting waters from agricultural sources were arrived at by multiplying the source loadings by the multiplying factors set out in Table 7.2, for the source variables. Only one source was assumed to contribute to surface streams, namely animal confinement units. These contributions were assessed on an individual farm basis. The results of these calculations are presented in Table 7.2 and a summary for the nine major sub-basins broken down into tributary and direct drainage areas is given in Table 7.3. Nutrients reaching the groundwater from irrigation water amounted to 5,700 pounds of total nitrogen and 180 pounds of total phosphorus for the tributary sub-basins and a corresponding 12,400 pounds of total nitrogen and 210 pounds of total phosphorus for direct drainage areas. This amount was less than that originally diverted from streams for the purpose of irrigation, Appendix E.4. Therefore, the practice of irrigation itself reduces nutrient contribution to receiving waters but because of irrigation larger amounts of nutrients get to transporting waters from fertilizers and animal wastes applied to irrigated acreage.

(b) Water Return Flow to Transporting Waters

Multiplying factors for calculating irrigation water return flow were presented

TABLE 7.3

SUMMARY OF AGRICULTURAL NUTRIENT LOADING CONTRIBUTION IN THE VICINITY OF SOURCE

BASIN		TO GROUNDWATER (TSB & DD)								TO STREAM (TSB) & RW (DA)		TOTAL	
		IRRIGATION WATER		FERTILIZER		ANIMALS		TOTAL		ANIMALS			
		Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P
I	TSB	-	-	-	-	-	-	-	-	-	-	-	-
	DD	2530	39	17300	627	490	-	12330	386	4455	284	24775	950
II	TSB	335	2	4205	32	18410	14	22950	48	2060	227	25010	275
	DD	215	1	335	3	290	-	840	4	255	30	1095	34
III	TSB	930	40	17825	985	4905	62	23660	1087	23890	1948	47550	3035
	DD	290	2	9230	37	1440	-	10960	39	2545	175	13505	214
IV	TSB	2060	52	63370	1234	5140	40	70570	1326	1300	137	71870	1463
	DD	1475	15	37300	179	2095	23	40870	217	-	-	40870	217
V	TSB	780	53	11815	93	135	-	12730	146	125	8	12855	154
	DD	1320	60	41215	342	615	4	43150	406	-	-	43150	406
VI	TSB	660	13	145	4	20205	169	21010	186	4920	274	25300	460
	DD	390	13	9640	55	5135	3	15165	71	255	17	15420	88
VII	TSB	70	1	-	-	-	-	70	1	-	-	70	1
	DD	410	5	4065	6	1670	2	6145	13	-	-	6145	13
VIII	TSB	650	14	6440	210	13450	25	20540	249	-	-	20540	249
	DD	2860	33	75555	937	56995	2341	135410	3311	-	-	135410	3311
IX	TSB	235	9	6190	112	4055	62	10480	183	-	-	10480	183
	DD	2875	49	71170	934	4610	23	78655	1006	-	-	78655	1006
TOTAL	TSB	5720	184	109990	2670	66300	372	182010	3226	31665	2594	213675	5820
	DD	12365	217	265810	3120	73340	2396	343525	5453	7510	506	359025	6239

in Table 7.2. Table 7.4 presents the irrigation water return flow to groundwater in the vicinity of the source. This table gives the return flow along with the summary of the application volume for each of the nine major sub-basins. The information is further broken down into direct drainage and tributary sub-basins. The total of the two is presented as well.

In the total Okanagan basin the direct drainage area application volume is 93,000 acre-feet and the return flow is 15,000 acre-feet; the tributary sub-basins application is 71,000 acre-feet and the return flow is 9,000 acre-feet; and for total of direct drainage areas and tributary sub-basins, the total application is 164,000 acre-feet and the return flow is 24,000 acre-feet. It should be stressed that the return flow to the groundwater in the vicinity of the source reflects mechanisms of vertical transport through the unsaturated soil profile.

7.1.5 Comparison of Estimated Net Nutrient Contributions and Source Loads

The overall effect of the multiplying factors for the source variables is reflected in Table 7.5, where agricultural nutrient loading contribution in the vicinity of the source is calculated as a percentage of the original source loading. These percentages are calculated for each of the nine sub-basins as well as the overall Okanagan basin total. Irrigation water and fertilizer reaching groundwater have essentially the same percentage since it was assumed that the fertilizers were applied over the same total irrigated acreage. The percentages for the total basin were 16.6% total nitrogen, 2.3% total phosphorus for irrigation water, and 16.8% total nitrogen and 2.1% total phosphorus for fertilizer. For animals the percentages were lower since some of the animal wastes were spread over dry land or non-irrigated acreage. The overall basin percentage for animal contribution to groundwater was 5.5% total nitrogen and 1.1% total phosphorus. The corresponding percentages for animals contributing to surface water was 1.5% nitrogen and 1.2% total phosphorus. It was also possible to assess each major sub-basin individually using Table 7.5. This points out possible problem areas. For example, Basin I and Basin III have above-average total nitrogen contribution to streams from animals.

A presentation of totals for the Okanagan basin will help to sum up this particular phase of the report, as presented in Table 7.6. The contribution in the vicinity of source and the percentage of total potential loadings for individual sources are presented. Contribution to groundwater is divided into direct drainage areas and tributary sub-basins. Contribution to surface water is divided into direct drainage areas to receiving waters and tributary sub-basins to streams. The total for groundwater and surface water are added for a grand total of contribution from the individual agricultural sources.

TABLE 7.4

IRRIGATION WATER RETURN FLOW TO GROUNDWATER IN THE VICINITY OF SOURCE

BASIN	DIRECT DRAINAGE AREA		TRIBUTARY SUB-BASIN		TOTAL	
	APPLICATION (acre-ft)	RETURN FLOW (acre-ft)	APPLICATION (acre-ft)	RETURN FLOW (acre-ft)	APPLICATION (acre-ft)	RETURN FLOW (acre-ft)
I	7,769	1,363	-	-	7,769	1,363
II	1,651	235	8,790	970	10,441	1,205
III	6,228	524	12,676	1,001	18,904	1,525
IV	21,147	2,600	29,641	3,147	50,788	5,747
V	15,748	1,999	9,239	1,665	24,987	3,664
VI	6,056	1,008	4,470	818	10,526	1,826
VII	2,090	435	374	61	2,464	496
VIII	15,598	3,153	3,922	919	19,520	4,072
IX	16,788	3,435	1,706	426	18,494	3,861
TOTAL	93,075	14,752	70,818	9,007	163,893	23,759

TABLE 7.5

CONTRIBUTION IN "VICINITY OF SOURCE" AS A PERCENTAGE OF POTENTIAL LOADING

BASIN	IRRIGATION WATER		FERTILIZER		ANIMALS			
	To Groundwater		To Groundwater		To Groundwater		To Surface Water	
	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P
I	17.0	3.5	18.2	3.6	.5	-	4.3	3.7
II	13.8	0.9	13.1	0.7	6.8	0.1	0.8	1.2
III	10.8	1.1	11.2	1.0	1.1	0.1	4.4	4.3
IV	15.0	1.9	15.1	2.3	3.1	0.3	0.6	0.6
V	17.0	2.6	16.6	2.7	1.0	0.1	0.2	0.1
VI	16.5	3.0	16.5	3.0	7.7	0.8	1.4	1.4
VII	20.3	3.1	20.3	3.2	9.5	0.2	-	-
VIII	19.3	3.3	20.4	3.3	8.5	1.9	-	-
IX	19.5	3.6	19.6	3.6	10.1	1.5	-	-
TOTAL	16.6	2.3	16.8	2.1	5.5	1.1	1.5	1.2

TABLE 7.6

ANALYSIS OF TOTALS FOR OKANAGAN BASIN: CONTRIBUTION (IN THE VICINITY OF SOURCE) AS A PERCENTAGE OF TOTAL POTENTIAL FOR AN INDIVIDUAL SOURCE.

DESCRIPTION	IRRIGATION WATER						FERTILIZER				ANIMALS			
	Total N		Total P		Total RF		Total N		Total P		Total N		Total P	
	C[1](lbs)	%	C(lbs)	%	C (acre-ft)	%	C(lbs)	%	C(lbs)	%	C(lbs)	%	C(lbs)	%
To Groundwater														
- G.W. in DD[2]	12,365	11.4	217	2.3	14750	9.0	257820	11.8	2840	1.1	73340	2.9	2396	.9
- G.W. in TSB	5,720	5.2	184	1.1	9010	5.5	109990	5.0	2670	1.0	66300	2.6	372	.1
TOTAL TO G.W.	18085	16.6	401	2.3	23760	14.5	367810	16.8	5510	2.1	139640	5.5	2768	1.0
To Surface Water														
- S.W. in DD											7510	0.3	506	.2
-Streams in TSB											31665	1.2	2594	1.0
TOTAL TO S.W.											39175	1.5	3100	1.2
TOTAL	18085	16.6	401	2.3	23760	14.5	367810	16.8	5510	2.1	178815	7.0	5868	2.2

[1] C signifies contribution in lbs or acre-ft; % signifies contribution as a percentage of potential loading (Irrigation water 108,900 lbs N, 17,100 lbs P, and 163,900 acre-ft; Fertilizer 2,186,400 lbs N & 264,000 lbs P; and Animals 2,562,000 lbs N & 265,650 lbs P)

[2] DD signifies direct drainage area and TSB signifies tributary sub-basin.

7.1.6 Non-agricultural Sources Due to Man's Influence

(a) Septic Tanks

Septic tanks as a nutrient source were developed in Section 7.10. The calculation of nutrient loading reaching the groundwater at the vicinity of the source is discussed in this section.

(b) "Other Sources"

The potential loadings of other sources are presented in Appendix E.7 and the estimate of loading reaching transporting waters in the vicinity of the source is given in Appendix E.8. The loadings are subjected to multiplying factors in a manner similar to agricultural and septic tank sources.

There are a number of sources of nutrient input to the basin other than those discussed. Some of these sources constitute a direct input while in other instances they make an indirect contribution. Sources that make a direct contribution include:

(1) The use of agricultural fertilizers in industrial operations. An example of this is the use of urea as a substitute for salt to breakdown ice buildup on airport runways.

(2) Household pets - there are no accurate figures available for the number of pets in the area. If it is assumed that there are 20,000 then the estimated contribution of nitrogen and phosphorus would be in the order of 20 tons and 5 tons respectively.

(3) Fertilizers used by householders and industrial operations for lawns and gardens. In total tonnage, these are probably not significant compared to the amount of fertilizer used in agriculture. They are used, however, at much higher loading rates and with higher rates of water application than normal agriculture practice. This results in a larger amount of the potential being contributed to groundwater than what occurs in normal agricultural practice.

(4) Discharge of industrial wastes to the ground. Ground disposal of industrial wastes can include large volumes and contribute nutrients to the groundwater in the vicinity of the source.

(c) Indirect Sources

(1) Exhaust emissions from the combustion of petroleum products, forest fires and industrial smoke. These emissions can return to the basin in dustfall and precipitation. Loadings from this source were calculated using data from the study (9) which determined nutrient loadings.

(2) Nitrogen fixation - the fixation of nitrogen by algae and soil bacteria can contribute to the potential nitrogen loading.

(3) Wildlife --- particularly birds. This contribution occurs when the wildlife feeds on agricultural crops and deposit their wastes in a location where nutrients can return to the receiving water through groundwater or surface flows or in cases where the wastes are deposited directly to the receiving water.

(d) Consideration of Import-Export of Feedstuffs

Data on the importation of feedstuffs into the Basin and the export of produce out of the Basin is not included in this report. This is done because the analysis used to determine the amount of nutrients reaching the receiving waters of the Basin included a consideration of this import-export balance. The analysis to determine the nutrient contribution by fertilizers included the amount of fertilizer used to produce the crop that it was applied to. Therefore, it was not necessary to collect data on the amount of agricultural products produced in the Basin. The analysis to determine the nutrient contribution by livestock was based on the amount of nutrients contained in the wastes produced by the animal. Therefore, it was not necessary to collect data on the importation of feedstuffs into the Basin or the movement of feedstuffs from one Basin location to another when considering contribution to receiving waters. If one were concerned with overall nutrient balance in basins as distinct from what gets to receiving water then a consideration of import-export would be applicable.

There is one indirect "other source" which has been omitted from the analysis and that is the effect of man's disturbance of topography, vegetation cover, etc. on the virgin flow quantities. Some or all of the net effect of this disturbance might already be accounted for by the rough general estimating but in any event this sort of other source should be looked into when carrying out a more intensive study.

7.1.7 Return Flow to Vicinity of Source

Return flow irrigation water was 14,700 acre-feet to groundwater in direct drainage areas for 9% and 9,000 acre-feet in tributary sub-basins for 5.5% and a total for Okanagan basin of 14.5%. Irrigation return flow, when further subjected to multiplying factors reflecting horizontal transport mechanisms reaching streams or receiving waters will be less than 14.5%. This is substantially lower than the normally accepted value of 50% return flow. The two figures are not directly comparable since conveyanace losses were not considered as part of the potential water loading as considered in the 50% figure.

Although return flow irrigation water was considered to be of minimal importance, it does emphasize that this technique can be used as a secondary approach for calculating nutrient contribution and that this independant method of calculating return flow gives a value greatly different from that normally accepted. The actual return flow is assumed between the calculated and the accepted value. This discrepancy emphasizes the fact that more research is required before a realistic value can be obtained.

The method used in calculating return flow is a direct method, while that of other authors has been a difference method, where evapotranspiration is directly estimated. Both evapotranspiration and return flow are difficult parameters to estimate with an accuracy less than $\pm$ 100%.

The calculated return flow values were felt to be low for the following reasons: (a) the calculations are based predominately on lysimeter studies in Penticton and (b) Penticton studies were concerned mainly with forage crops as opposed to orchard crops from which a higher return flow is expected. The return flow values cited by literature appear to be high for the following reasons: (a) the soil profile in certain parts of the Okanagan study area theoretically require 20 years to build up the soil storage capacity before any leachate reaches groundwater. Therefore, for this length of time, excess irrigation water is not being returned fully to receiving waters; (b) much of the land is sloped and water seeping out of the root zone can move downslope and be utilized by native vegetation or domestic crops through evapotranspiration or by direct evaporation from bare soil.

7.2 TOTAL NUTRIENTS FROM ALL SOURCES ULTIMATELY REACHING RECEIVING WATERS

7.2.1 Horizontal Transport of Nutrients and Water

The total nutrients reaching receiving water by groundwater is difficult to determine. In Section 7.2 estimated contributions to groundwater in the immediate vicinity of sources were derived. Between the vicinity of the source and the receiving water, the transporting groundwater may remove additional nutrients from the soil medium or it may deposit some of the nutrients that it was carrying. Some groundwater enters the root zone prior to reaching the receiving waters. Plants can remove a portion of the water and nutrients. Some groundwater reaches the surface and moves as runoff to streams, whereas other groundwater reaches the stream directly or the stream feeds groundwater prior to reaching the receiving waters. This illustrates the complexity of the transporting pathways and why it is difficult to determine horizontal nutrient transport.

(a) Flow Equations

Horizontal transport of nutrients and water can be represented by the following flow equations. These equations form the basis for the methodology used in estimating nutrient and water transport to the receiving waters. The flow equations includes the movement of nutrients and water in tributary sub-basins and direct drainage areas under both virgin conditions and man affected conditions.

For virgin conditions:

S,s streamflow and stream
O,o outflow to receiving waters and receiving water
R,r surface runoff

G,g groundwater flow
v virgin
d direct drainage area
t tributary sub-basin

then virgin streamflow $V_v = R_{v-s} + G_{v-s}$ . . . (1)

Where R_{v-s} is the virgin surface runoff to stream and G_{v-s} is the virgin groundwater flow to streams. This is the virgin flow after the effect of virgin evapotranspiration has been taken into account. Also, R_{v-s} is comprised of two parts, namely: R'_{v-s} and $G_{v-r,s}$ where R'_{v-s} is surface originating surface runoff and $G_{v-r,s}$ is groundwater which returns to surface and enters surface runoff prior to discharging into the stream. The groundwater component is linked to the direct groundwater discharge to streams or receiving waters.

Virgin outflow O_{v-t} from a tributary sub-basin is:

$$O_{v-t} = S_v + G_{v-o,t} \quad . . . (2)$$

where $G_{v-o,t}$ is the virgin groundwater discharging directly to receiving waters at outlet from tributary sub-basin. Virgin outflow from a direct drainage area O_{v-d} is:

$$O_{v-d} = R_{v-o} + G_{v-o,d} \quad . . . (3)$$

R_{v-o} is the virgin surface runoff discharging into receiving waters was in the case of R_{v-s}, R_{v-o} is made up on two parts, R'_{v-o} and $G_{v-r,d}$ where this groundwater component is combined with direct groundwater discharge $G_{v-o,d}$.

For man influenced conditions:

F,f return flow
E diversions
n net

then net streamflow $S_n = S_v - E_s + F_s$ . . . (4)

Relative to streamflow only the diversions from streams were considered when evaluating E but when evaluating return flow to streams F_s all diversions were considered. Water and nutrients diverted from one basin to another has been included in the evaluation. Return flow to streams F_s can be broken down to:

$$F_s = R_{f-s} + G_{f-s} \quad . . . (5)$$

and again R_{f-s} further broken down to R'_{f-s} plus $G_{f-r,s}$. G_{f-s} and $G_{f-r,s}$ are lumped as before. An effective net streamflow S'_n was used at times since for rough calculations it approximates the actual net S_n.

$$S'_n = S_n - F$$

$$\text{or} \quad = S_v - E_s \quad . . . (6)$$

$S'_n \simeq S_n$ when the return flow to streams is small.

If diversions from groundwater are significant then diversions should be considered when computing net groundwater flow.

$$G_n = G_v - E_g + F_g \quad \ldots (7)$$

but E_g is small in our study area and therefore was neglected.

$$\text{Net outflow } O_{n-t} = S_n + G_n$$

$$= (S_v - E_s + F_s) + G_{v-o,t} + G_{f-o,t} \quad \ldots (8)$$

Net outflow O_{n-d} from a direct drainage area is:

$$O_{n-d} = R_n + G_n$$

$$R_{v-o} + R_{f-o,d} + G_{v-o,d} + G_{f-o,d} \quad \ldots (9)$$

$R_{f-o,d}$ breaks down into $R'_{f-o,d}$ plus $G_{f-r,o}$ where again $G_{f-r,o}$ is lumped together with $G_{f-o,d}$. It should be noted that some of O_n may be return flow to lakes where water was diverted from the lake and applied to sub-basins and some of O_n may be return flow of nutrients and waters brought into basin from the outside.

The overall outflow from sub-basins to the receiving waters is O_n where:

$$O_n = O_{n-t} + O_{n-d} \quad \ldots (10)$$

The symbols used in these equations apply to water, nutrients and the combinations of both, regardless of whether they have equal multiplying factors. These parameters are noted on final result Tables 7.8 to 7.13. Note that the G's shown actually contain the component of groundwater which joins surface water prior to reaching the streams or receiving waters.

(b) Multiplying Factors

In Section 7.2 multiplying factors were used to compute the amount of water and nutrients reaching the groundwater in the vicinity of the source for the case of agricultural sources. In this section horizontal transport multiplying factors reflect the horizontal movement of material through a saturated soil medium. These multiplying factors (Table 7.7) were averaged for the Okanagan Basin.

For agricultural sources, nutrient loading reaching groundwater in the vicinity of the source were initially considered. Of this groundwater loading, 80% of N, and 50% of P in the return flow quantity reaches the receiving water. Fifty percent of the nitrogen and phosphorus are assumed to enter the stream while 50% remain with the groundwater; that is, 0.4 N, 0.4RF and 0.25 P goes to making up part of F_s (all of G_{f-rs} and part of G_{f-s}) while 0.4 N, 0.4 RF and 0.25 P remains with groundwater. As the groundwater moves down the tributary floor towards the outlet to the receiving waters 80% of N, RF and 50% of P are assumed to reach the outlet as streamflow and groundwater. The losses were accounted by soil storage and evapotranspiration. The amount of phosphorus and nitrogen therefore in the groundwater

reaching the outlet was equivalent to 0.32N, 0.32 RF and 0.13 P. Fifty percent of the nutrients and water joined streamflow making up the balance of G_{f-s} and the remaining amount enters receiving waters as groundwater flow ($G_{f-o,t}$); namely, 0.16 N, 0.16 RF and 0.07 P. The total amount which returned to the streams (G_{f-s}) therefore, is equal to 0.56N, 0.56 RF and 0.32 P. The multiplying factor for septic tank flows were calculated in a similar manner and a summary of these results are presented in Table 7.7.

TABLE 7.7

MULTIPLYING FACTORS REFLECTING THE EFFECT OF MECHANISMS ENCOUNTERED DURING HORIZONTAL TRANSPORT OF GROUNDWATER

	AGRICULTURAL		SEPTIC TANK			
	D.D.	T.S.B.	D.D.		T.S.B.	
NUTRIENTS			500'	500'	500'	500'
- reaches Receiving water via groundwater						
Total N	0.8	0.16	1.0	0.7	0.2	0.14
Total P	0.5	0.07	1.0	0.3	0.13	0.04
- reaches tributary stream						
Total N		0.56			0.7	0.49
Total P		0.32			0.63	0.19
RETURN FLOW						
- reaches groundwater in vicinity of source Return flow			0.9	0.9	0.9	0.9
- reaches receiving water via groundwater Return Flow	0.8	0.16	1.0	0.7	0.2	0.14
- reaches tributary stream		0.56			0.7	0.49

7.2.2 Total Contribution of Nutrients and Water to Receiving Waters, with Emphasis on Groundwater Flow

Four methods were used in determining reasonable estimates of nutrient contribution to receiving waters by groundwater, based on type of data available. The methodology and results will be outlined separately. Since the first method was considered most reliable the other methods served as checks in while or in part. Figure 7.4 illustrates the assumed net pathways of water and nutrients from source to receiving waters.

(a) Method 1 - Groundwater nutrient contributions to receiving waters

Method 1 involved subjecting the nutrient loading at the vicinity of the source

TABLE 7.8

METHOD 1 GROUNDWATER NUTRIENT CONTRIBUTION TO RECEIVING WATERS

BASIN		GROUNDWATER NUTRIENT CONTRIBUTION BY SOURCE REACHING RECEIVING WATERS								Natural G.W. (lbs)	
		AGRICULTURAL. (lbs)		SEPTIC TANKS (lbs)		OTHER SOURCES (lbs)		TOTAL SOURCES (lbs)			
		Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P
I	T	-	-	-	-	770	2	770	2	1880	30
	D	9865	193	4370	782	1675	256	15910	1231	765	12
	Σ	9865	193	4370	782	2445	258	16680	1233	2645	42
II	T	3670	3	610	76	185	1	4465	80	1500	24
	D	670	2	1995	360	320	2	2985	364	555	10
	Σ	4340	5	2605	436	505	3	7450	444	2155	34
III	T	3785	76	1590	153	290	4	5665	233	13695	404
	D	8770	20	3030	607	1160	20	12960	647	1705	50
	Σ	12555	96	4620	760	1450	24	18625	880	15400	454
IV	T	11290	93	2490	214	1830	23	15610	330	46305	1016
	D	32695	109	11690	2121	4330	51	48715	2281	7775	171
	Σ	43985	202	14180	2335	6160	74	64325	2611	54080	1187
V	T	2035	10	800	98	1520	26	4355	134	20975	341
	D	34520	203	14510	2159	9135	161	58165	2523	6180	107
	Σ	36555	213	14310	2257	10655	187	62520	2657	27155	448
VI	T	3360	13	180	20	130	2	3670	35	7755	127
	D	12130	36	6815	1236	4390	67	23335	1339	2340	38
	Σ	15490	49	6995	1256	4520	69	27005	1374	10095	165
VII	T	10	-	235	27	40	-	285	27	2730	48
	D	4915	7	530	124	555	5	6000	136	1640	29
	Σ	4925	7	765	151	595	5	6285	163	4370	77
VIII	T	3285	17	380	45	185	3	3850	65	2540	49
	D	108330	1656	7960	1373	2315	60	118605	3089	720	14
	Σ	111615	1673	8340	1418	2500	63	122455	3154	3260	63
IX	T	1675	13	45	6	150	3	1870	22	990	74
	D	62925	503	21920	4153	2270	67	87115	4723	1840	137
	Σ	64600	516	21965	4159	2420	70	88985	4745	2830	211
TOTAL	T	29110	225	6330	639	5100	64	40540	928	98370	2113
	D	274820	2729	72820	12915	26150	689	373790	16333	23620	568
	Σ	303930	2954	79150	13554	31250	753	414330	17261	121990	2681
	T							$G_{f-o,t}$		$G_{v-o,t}$	
	D							$G_{f-o,d}$		$G_{v-o,d}$	
	Σ							G_{f-o}		G_{v-o}	

Σ - means summation of

TABLE 7.9

METHOD 2 GROUNDWATER NUTRIENT CONTRIBUTION TO RECEIVING WATERS

BASIN		GROUNDWATER QUANTITY BY SOURCE REACHING RECEIVING WATERS						QUALITY FINAL CONC. (PPM)		NUTRIENT LOADING (lbs)	
		AGRIC. (acre-ft)	SEPTIC (acre-ft)	OTHER (acre-ft)	TOTAL SOURCE (acre-ft)	NATURAL G.W. (acre-ft)	TOTAL G.W. (acre-ft)	Total N	Total P	Total N	Total P
I	T	-	-	39	39	272	311				
	D	1090	150	-	1240	110	1350				
	Σ	1090	150	39	1279	382	1661	3.439	0.054	15535	244
II	T	155	19	-	174	360	534				
	D	188	62	-	250	158	408				
	Σ	343	81	-	424	518	942	2.070	0.032	5305	82
III	T	160	49	-	209	2654	2863				
	D	419	91	-	510	330	840				
	Σ	579	140	-	719	2984	3703	2.567	0.076	25885	765
IV	T	503	94	25	622	5596	6218				
	D	2080	496	-	2576	940	3516				
	Σ	2583	590	25	3198	6536	9734	4.116	0.090	108975	2383
V	T	266	11	-	277	2110	2387				
	D	1600	332	-	1932	662	2594				
	Σ	1866	343	-	2209	2772	4981	4.945	0.081	66995	1097
VI	T	131	3	-	134	780	914				
	D	806	110	-	916	236	1152				
	Σ	937	113	-	1050	1016	2066	4.945	0.081	27790	455
VII	T	10	5	-	15	134	149				
	D	348	16	-	364	81	445				
	Σ	358	21	-	379	215	594	10.138	0.179	16380	289
VIII	T	147	5	-	152	748	900				
	D	2523	100	-	2623	212	2835				
	Σ	2670	105	-	2775	960	3735	1.689	0.032	17160	325
IX	T	68	-	-	68	133	201				
	D	2748	192	-	2940	247	2187				
	Σ	2816	192	-	3008	380	3388	3.704	0.276	34135	2543
TOTAL	T	1440	186	64	1690	12787	14477				
	D	11802	1549	-	13351	2976	16327				
	Σ	13242	1735	64	15041	15763	30804			318130	8183
	T				$G_{f-o,t}$	$G_{v-o,t}$	$G_{n-o,t}$			$G_{n-o,t}$	
	D				$G_{f-o,d}$	$G_{v-o,d}$	$G_{n-o,d}$			$G_{n-o,d}$	
	Σ				G_{f-o}	G_{v-o}	G_{n-o}			G_{n-o}	

Σ - means summation of

TABLE 7.10

METHOD 3 CALCULATED NUTRIENT LOADING OF STREAMS BY SOURCES

BASIN		NUTRIENT CONTRIBUTION RETURN FLOW TO STREAMS (TSB)									
		AGRICULTURAL (lbs)		SEPTIC TANKS (lbs)		OTHER SOURCES (lbs)		TOTAL SOURCES (lbs)		NATURAL STREAMFLOW (lbs)	
		Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P	Total N	Total P
I	1	-	-	-	-	10220	310	10220	310		
	2	-	-	-	-	2685	240	2685	240		
	Σ	-	-	-	-	12905	550	12905	550	18395	816
II	1	2060	227	-	-	35	46	2095	273		
	2	12850	15	2125	366	645	4	15620	385		
	Σ	14910	242	2125	266	680	50	17715	658	38325	1664
III	1	23890	1948	-	-	102005	47076	125895	49024		
	2	13250	348	5560	734	1010	17	19820	1099		
	Σ	37140	2296	5560	734	103015	47093	145715	50123	157820	51011
IV	1	1300	137	-	-	2515	515	3815	652		
	2	39520	424	8710	1023	6405	105	54635	1552		
	Σ	40820	561	8710	1023	8920	620	58450	2204	187885	19466
V	1	125	6	-	-	15	3	140	11		
	2	7130	47	2805	475	5315	120	15250	642		
	Σ	7255	55	2805	475	5330	123	15390	653	75190	10912
VI	1	4290	274	-	-	-	-	4290	274		
	2	11765	60	635	97	455	10	12855	167		
	Σ	16055	344	635	97	455	10	17145	441	19295	1735
VII	1	-	-	-	-	-	-	-	-		
	2	40	-	820	132	135	1	995	133		
	Σ	40	-	820	132	135	1	995	133	5665	453
VIII	1	-	-	-	-	-	-	-	-		
	2	11500	80	1330	216	640	15	13470	311		
	Σ	11500	80	1330	216	640	15	13470	311	15350	1093
IX	1	-	-	-	-	-	-	-	-		
	2	5870	59	160	29	520	14	6550	102		
	Σ	5870	59	160	29	520	14	6550	102	2090	652
TOTAL	1	31665	2594	-	-	114790	47950	146455	50544		
	2	101925	1033	22145	3072	17810	526	141880	4631		
	Σ	133590	3627	22145	3072	132600	48476	288355	55175	520005	87775

ROW # 1 is surface return flow

2 is groundwater return flow

Σ - means summation of

TABLE 7.11

METHOD 3' GROUNDWATER NUTRIENT CONTRIBUTION TO STREAMS [1] (TSB)

BASIN	RETURN FLOW (TSB)				FINAL CONCENTRATIONS		NATURAL GROUND-WATER acre-ft 4% VSR [2]	FINAL CONC.- VIRGIN = CONC. DUE TO SOURCES	
	AGRIC. acre-ft	SEPTIC acre-ft	OTHER acre-ft	TOTAL acre-ft	TOTAL N	TOTAL P		TOTAL N	TOTAL P
I	-	-	136	136	3.439	0.054	544	0.897	0.0141
II	543	67	-	610	2.070	0.032	720	0.540	0.0084
III	561	170	-	731	2.567	0.076	5308	0.6698	0.0198
IV	1762	328	89	2179	4.116	0.090	11192	1.0738	0.0236
V	983	39	-	1022	4.945	0.081	4220	1.2900	0.0210
VI	458	10	-	468	4.945	0.081	1560	1.2900	0.0210
VII	33	16	-	49	10.138	0.179	268	2.6448	0.0468
VIII	514	16	-	530	1.689	0.032	1496	0.4407	0.0084
IX	239	1	-	240	3.704	0.276	266	0.9663	0.0720
TOTAL	5093	647	225	5965			25574		

[1] For total source volume x concentration and natural g.w. volume x concentration, see Table IV-8.

[2] VSR signifies virgin surface runoff

TABLE 7.12

CONTRIBUTION FROM MAN'S SOURCES TO RECEIVING WATERS VIA GROUNDWATER (TSB & DD)

METHOD 2 vs 1 (Comparison of Methods)

BASIN		METHOD # 2 QUANTITY X M.F.X. CONCENTRATION						METHOD#1 "NUTRIENT X M.F."	
		SOURCES quantity x final conc.		+ NATURAL G.W. quantity x Δ conc.		= TOTAL NUTRIENT LOADING DUE TO MANS SOURCES		TOTAL NUTRIENT LOADING DUE TO MANS SOURCES	
		TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P
I	T	365	6	665	10	1030	16	770	2
	D	11600	182	265	4	11865	186	15910	1231
II	T	980	15	530	7	1510	22	4465	80
	D	1410	22	235	4	1645	26	2985	364
III	T	1460	43	4835	145	6295	188	5665	233
	D	3560	105	600	18	4160	123	12960	647
IV	T	6965	152	16345	354	23310	506	15610	330
	D	28840	631	2750	59	31590	690	48715	2281
V	T	3725	61	7405	124	11130	185	4355	134
	D	25985	426	2725	39	28710	465	58165	2523
VI	T	1800	30	2735	42	4320	72	2670	35
	D	12320	202	835	14	13155	216	23335	1339
VII	T	415	7	965	17	1380	24	285	27
	D	10035	177	595	10	10630	187	6000	136
VIII	T	700	13	895	16	1595	29	3850	65
	D	12050	228	255	4	12305	232	118605	3089
IX	T	685	51	350	26	1035	77	1870	22
	D	29620	2207	650	48	30270	2255	87115	4723
TOTAL	T	17095	378	34725	741	51605	1119	40540	928
	D	135420	4180	8910	200	144330	4380	373790	16333
	Σ	152515	4558	43635	941	195935	5499	414330	17261

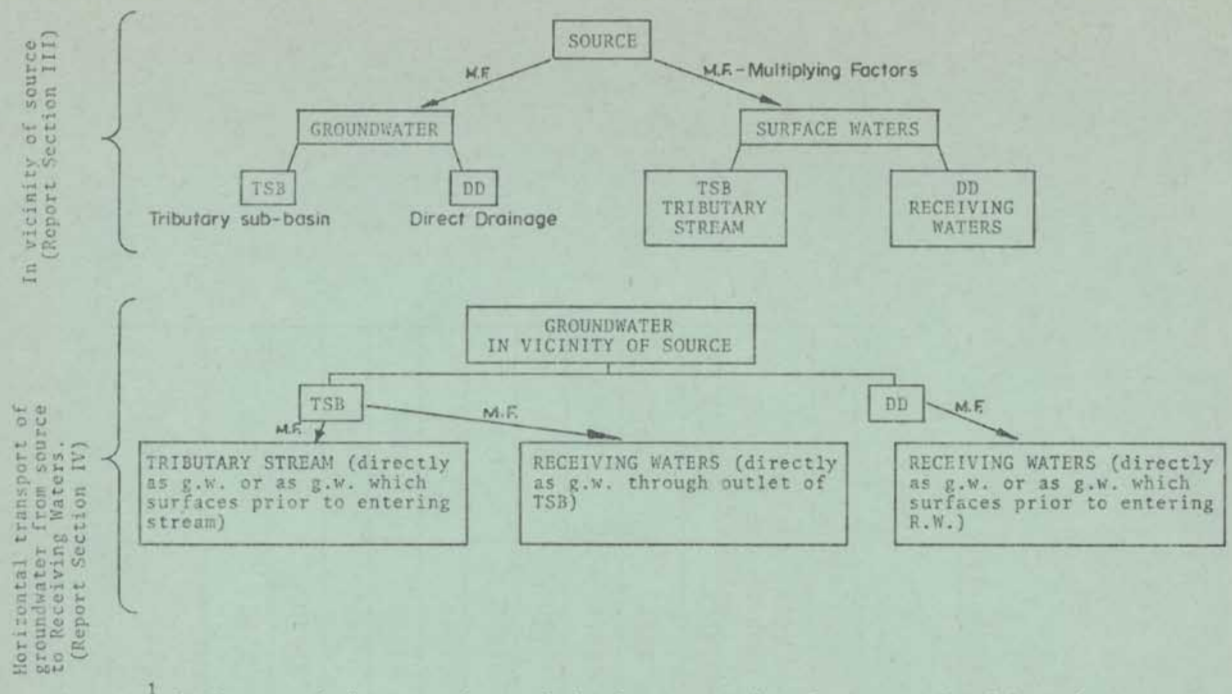
Σ-means summation of

TABLE 7.13

CONTRIBUTION FROM MAN'S SOURCES TO STREAMS VIA GROUNDWATER (TSB)

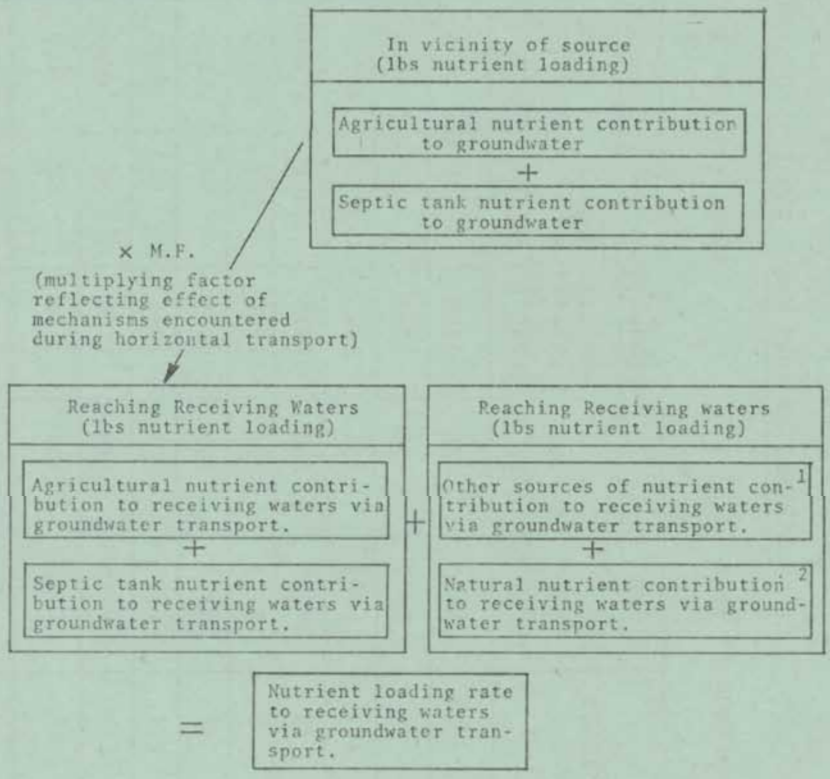
METHOD 3' vs 3 (Comparison of Methods)

BASIN	METHOD #3' "QUANTITY X M.F. X CONCENTRATION"						METHOD #3 "NUTRIENT X M.F."	
	SOURCE quantity x final conc.		+ NATURAL G.W. quantity x conc.		=TOTAL NUTRIENT LOADING DUE TO MANS SOURCES		TOTAL NUTRIENT LOADING DUE TO MANS SOURCES	
	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P
I	1270	20	1325	20	2595	40	2685	240
II	3435	53	1060	14	4495	67	15620	385
III	5105	151	9675	290	14780	441	19820	1099
IV	24395	533	32695	708	57090	1241	54635	1552
V	13745	225	14805	248	28550	473	15250	642
VI	6295	103	5035	84	11330	187	12855	167
VII	1350	24	1930	34	3280	58	995	133
VIII	2435	46	1790	32	4225	78	13470	311
IX	2420	180	700	52	3120	232	6550	102
TOTAL	60450	1335	69015	1482	129465	2817	141880	4631



[1] It is assumed that groundwater feeds the streams (as the net result of interchange between groundwater and surface streams.)

PATHWAYS OF WATER & NUTRIENTS FROM SOURCE TO RECEIVING WATERS. Figure 7.4



(METHOD I)

1. Based on rough guess work
2. Based on rough estimate of natural groundwater quantity x average groundwater quality.

INDIVIDUAL SOURCE CONTRIBUTIONS OF NUTRIENTS VIA GROUNDWATER TO RECEIVING WATERS. Figure 7.5

directly to the multiplying factors reflecting mechanisms of horizontal transport. The methodology is illustrated in Figure 7.5 while Table 7.8 presents the contributions from all components of groundwater; namely agricultural, septic tanks, other sources, and natural groundwater. The natural groundwater component was obtained by estimating natural groundwater quantity (2% of virgin surface runoff Appendix E.9) and multiplying the quantity by the virgin groundwater concentration (Appendix E.10).

Reference was made to Tables 7.3 and 10.12 for the nutrient loadings to groundwater in the vicinity of the source for agricultural sources and septic tanks respectively. For the nutrient loadings of other sources reference was made to Appendix E.8. The loadings in Appendix E.8 were determined by using vertical multiplying factors and proportionate ratios from the agriculture and septic tank analysis. Method 1 gives a total groundwater nutrient contribution equal to 536,000 pounds of total nitrogen and 20,000 pounds of total phosphorus.

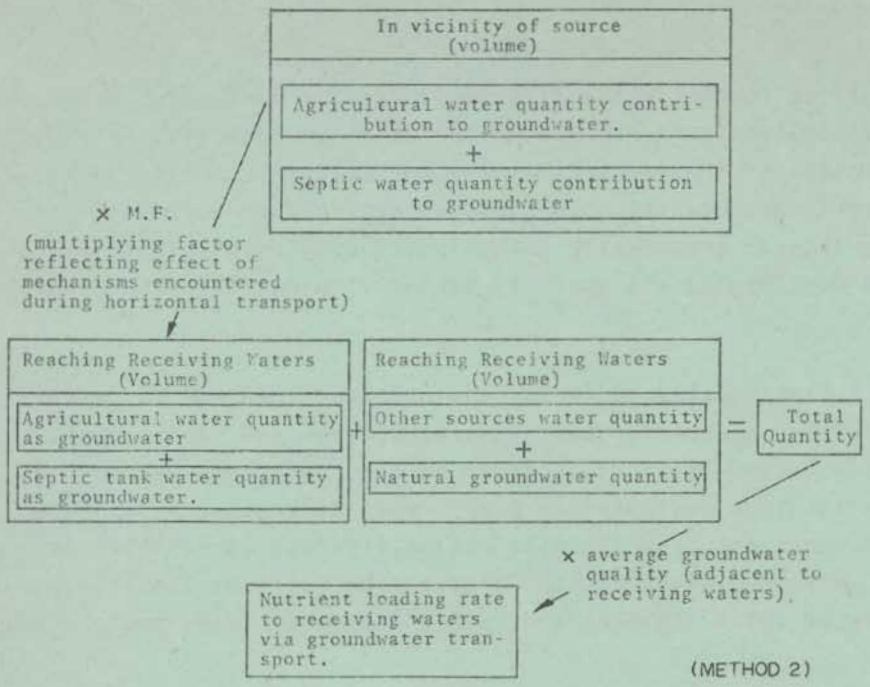
b) Method 2 - Groundwater nutrient contribution to receiving waters

Method 2 involves subjecting water quality return flow in the vicinity of the source to multiplying factors reflecting mechanisms of horizontal transport after which the quantities are multiplied by the final groundwater concentrations. The total loading due to man's influenced sources is equal to (i) the sum of agricultural quantity, septic tank quantity,and "other sources" quantity, multiplied by final groundwater concentration; plus (ii) natural groundwater quantity multiplied by the difference in groundwater concentration (final minus virgin quality). The total groundwater nutrient contribution to receiving waters is the sum of: (i) the above man's influenced sources plus (ii) natural groundwater quantity multiplied by the virgin groundwater quality. This is equivalent to the quantities due to agriculture, septic tanks and other sources being added to natural groundwater quantity and this total sum subjected to the final groundwater quantity. Table 7.9 gives the results for this method and is illustrated by means of a flow chart in Figure 7.6.

By Method 2, the total groundwater nutrient contribution equals 318,000 pounds to total nitrogen and 8,000 pounds to total phosphorus. These figures are lower than those of Method 1 by approximately one order of magnitude.

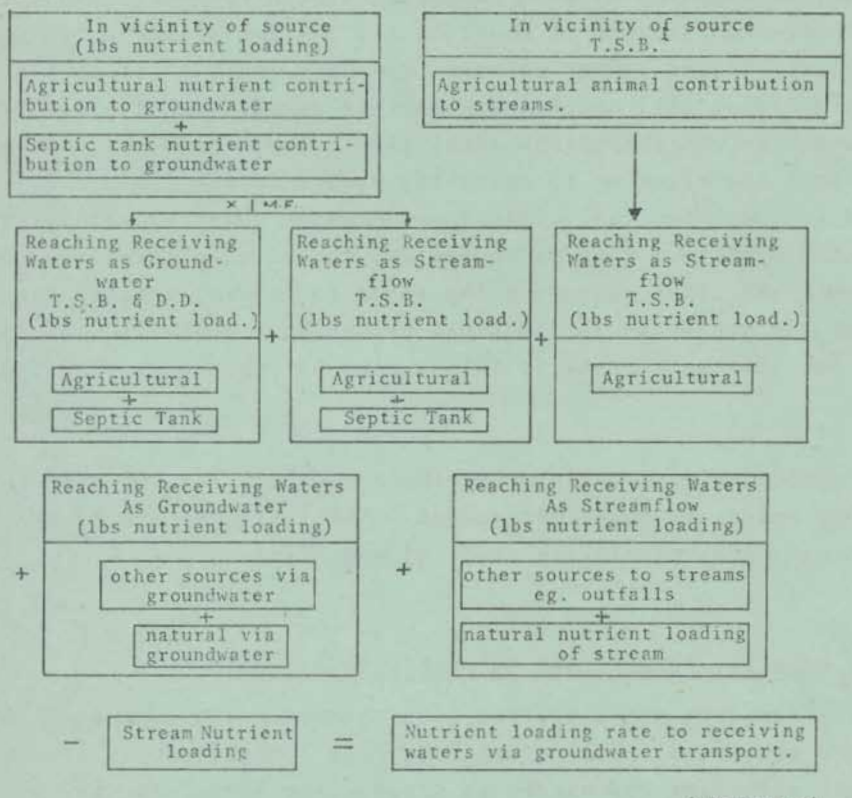
c) Method 2 - Groundwater quantity return flow to receiving waters

In Method 2, the return flow from man's sources plus the natural groundwater inflow to receiving waters were estimated. The return flow from agriculture is 13,200 acre-feet of which 1,400 acre-feet discharges as groundwater from tributary subbasins while 11,800 acre-feet discharges as groundwater (both $G_{f-o,d}$) and $G_{f-r,d}$) from direct drainage areas. The corresponding values for septic tanks are a total of 1,700 acre-feet, 200 acre-feet from TSB and 1,500 acre-feet from DD.



GROUNDWATER QUANTITY x GROUNDWATER QUALITY.

Figure 7.6



[1] T.S.B. = Tributary Sub-Basins; D.D. = Direct Drainage

TOTAL LOADING CONTRIBUTION TO BOTH STREAMS AND GROUNDWATER-STREAM LOADING CONTRIBUTION.

Figure 7.7

(d) Method 3 - Nutrient contribution to tributary streams

Method 3 was a check rather than an independent method. Consideration was given to an overall balance between stream flow and groundwater flow discharging to receiving waters. The objective of this method was to estimate total discharge of nutrients to receiving waters and then to estimate the groundwater portion by the subtraction of the stream flow discharge loading. This quantity was consequently compared with the groundwater contribution of Method 1.

The portion of Method 3 dealing with groundwater nutrient contribution to tributary streams is analogous to the procedure of Method 1; that is, nutrient loadings in the vicinity of the source were directly subjected to multiplying factors reflecting mechanisms of horizontal transport. The total contribution from man's sources was equal to the sum of agriculture, septic tanks and "other sources". The natural groundwater component is incorporated into streamflow by definition. If it is necessary to separate out this component then it could be done by the virgin groundwater quality. Method 3 has calculated both surface and groundwater nutrient flow as illustrated in Figure 7.7.

Table 7.10 contains the results of calculated nutrient loading to streams by the sources considered. The sum of man's sources by Method 3 (both surface and groundwater) is 288,000 pounds of total nitrogen and 55,000 pounds of total phosphorus while the natural or virgin streamflow carried 520,000 pounds of total nitrogen and 88,000 pounds of total phosphorus.

The data of Table 7.10 is divided into surface and groundwater return flow of nutrients. The groundwater component yields 142,000 pounds of total nitrogen and 4,600 pounds of total phosphorus; of which 102,000 pounds of total nitrogen and 1,000 pounds of total phosphorus comes from agriculture. The surface nutrient return flow from agriculture is 32,000 pounds of total nitrogen and 2,600 pounds of total phosphorus. These latter values are also listed in Table 7.3 where the corresponding surface runoff values for direct drainage areas are presented; that is, 7,500 pounds of total nitrogen and 500 pounds of total phosphorus. Other sources contribute highly to the surface flow feed to streams, 115,000 pounds of total nitrogen and 48,000 pounds of total phosphorus.

(e) Method 4 - Groundwater nutrient contribution to tributary streams

The Method 4 calculates the groundwater nutrient contribution to streams from man made sources in a manner analogous to Method 2. Here the quantity in the vicinity of the source was subject to multiplying factors reflecting mechanisms of horizontal transport, rather than the nutrient loading directly. The total groundwater loading due to man was the sum of quantities from agriculture, septic tanks and other sources multiplied by final groundwater concentration; plus the natural groundwater quantity multiplied by the difference in groundwater concentration. (final concentration minus virgin concentration).

The results for this method are presented in Table 7.11. The total groundwater nutrient loading is 129,000 pounds to total nitrogen and 2,800 pounds of total phosphorus which is approximately the same as the results from Method 3; namely 142,000 pounds total nitrogen and 4,600 pounds of total phosphorus.

(f) Method 4 - Water quantity return flow to tributary streams

Method 4 deals with water quantity from the various sources. The quantity reaching the stream as a result of man's influenced sources constitute return flow while the virgin or base quantity due to natural groundwater flow was simply natural groundwater flow and makes up part of natural or virgin streamflow.

The results are presented in Table 7.11 where the total return flow from agriculture is 5,100 acre-feet, from septic tank 650 acre-feet, and from "other sources" 200 acre-feet for a total man's influenced sources return flow of 6,000 acre-feet. The estimated natural groundwater flow is 25,600 acre-feet.

7.2.3 Comparison of the Two Basic Methods; Nutrients x M.F. and Quantity x M.F. x Quality

There are two analogous sets of data to compare. These are the contribution from man's sources via groundwater to: (i) receiving waters (Method #1 vs #3) and (ii) streams (Method #3 vs #4). It is worth stressing at this point that the only concern is with the contribution attributable to man's influenced sources since the virgin groundwater was treated in the same manner in each set of methods. Comparison tables have been presented, namely Table 7.12 (Method #2 vs #1) and Table 7.13 (Method #4 vs #3).

In both cases the method using quantity gives lower results than the method using nutrient loadings directly. This immediately suggests various alternatives:

(1) the return flow from man's sources is too low (i.e.: multiplying factors too low or potential loading too low) or

(2) the final groundwater concentration is too low, or

(3) the virgin groundwater quantity is too low, or

(4) the virgin groundwater concentration is too high, or

(5) the nutrient loadings of Methods 1 and 3 are too high (i.e.: multiplying factors too high or potential loading too high). Individual sub-basins vary either side of the overall averages, and the one sub-basin which deviates greatly explains the reason for differences in the total basin figures.

Certain weaknesses in the analysis are apparent. Firstly, the quality information is very sketchy. One isolated area shows up in Table 7.12 where consideration was given to the direct drainage areas of sub-basin VIII. Here, Method #2 gives

a total nutrient loading of 12,300 lbs. of total nitrogen and 230 lbs. of total Phosphorus as compared to Method #1 giving 119,000 lbs. of total Nitrogen and 3,100 lbs. of total Phosphorus. There is a large nutrient loading due to animals and fertilizer and therefore suspect that the limited well water quality data available for this area does not reflect the actual nutrient loading. If in fact the groundwater quantity estimates did reflect the true loading, then most of the nutrients must be reaching receiving waters by surface runoff which was not accounted for in the groundwater estimate even though $G_{f-r,o}$ was lumped with $G_{f-o,d}$ where $G_{f-r,o}$ is groundwater which surfaced prior to entering receiving waters. Therefore, much of the loading likely remains in groundwater and the quality data was simply deficient for this area.

Another possibility is that the water quantity for "other sources" was significantly underestimated. Sprinkling of domestic and industrial lawns were neglected while fertilizer applications for same were included.

Table 7.12 illustrates that for tributary sub-basins Method #2 actually gives larger nutrient contribution loading than does Method #1; that is, Method #2 gives 52,00 lbs. of total Nitrogen and 1,100 lbs. of total Phosphorus compared to Method #1 giving 41,000 lbs. of total Nitrogen and 900 lbs. of total Phosphorus.

In the direct drainage areas the results of Method #2 were significantly less than that of Method #1. Table 7.13 deals strictly with tributary sub-basins and the results are quite comparable; Method #3 giving 142,000 lbs. of total Nitrogen and 4,600 lbs. of total Phosphorus compared to Method #3 with 129,000 lbs. of total Nitrogen and 2,800 lbs. of total Phosphorus. The loadings calculated for each method were averaged for each tributary sub-basin and the loadings for direct drainage sub-basins were based on weighted averages.

7.2.4 Overall Balance of Nutrient Inflow to Receiving Waters

The object of Method #3 is to compare calculated and estimated measured loading of streams. If there is no significant difference between these two values then groundwater loading to receiving waters as calculated earlier fits into the overall balance. If, however, a significant positive difference is found, then the estimate of nutrients reaching streams would be low. Correspondingly, the estimate of groundwater contribution from tributary sub-basins to receiving waters would be high assuming other parameters were correct. Significant negative values would reflect an opposite situation.

The results as shown in Table 7.14 indicated no significant difference between measured and calculated stream loading. To assign final and virgin quality values the average mean measured values for the years 1969, 1970 and 1971 were used for the final concentration and 1/2 (mean + minimum) values for virgin concentrations (Appendix E.10).

TABLE 7.14

ESTIMATE OF TOTAL GROUNDWATER GETTING TO RECEIVING WATER

BASIN		METHOD #1 NUTRIENT LOADING (lbs)		METHOD #2 NUTRIENT LOADING (lbs)		METHOD #3 STREAMFLOW LOADING[2] (lbs)		- CALCULATED LOADING TO STREAMS (lbs)		= DIFFERENCE[1]	
		TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P
I	T	2650	32								
	D	16675	1243								
		19325	1275	15535	244	24740	1223	31300	1366	-6560	-143
II	T	5965	104								
	D	3640	374								
		9605	478	5305	82	58385	2596	56040	2322	2345	274
III	T	19360	637								
	D	14665	697								
		34025	1334	25855	765	267440	90834	303535	101134	-36095	-10300
IV	T	61915	1346								
	D	56490	2452								
		118405	3798	108975	2383	309125	32627	246335	21670	62790	10957
V	T	25330	475								
	D	64345	2630								
		89675	3105	66995	1097	94190	21607	90580	11565	3610	10042
VI	T	11425	162								
	D	25675	1377								
		37100	1539	27790	455	33460	5114	36440	2176	-2980	2938
VII	T	3015	75								
		7640	165								
		10655	240	16380	289	9330	734	6660	586	2670	148
VIII	T	6390	114								
	D	119325	3103								
		125715	3217	17160	325	23150	3399	28820	1404	-5670	1995
IX	T	2860	96								
	D	88955	4860								
		91815	4956	34135	2543	3475	1108	8630	754	-5155	354
TOTAL	T	138910	3041								
	D	397410	16901								
		536320	19942	318130	8183	823295	159242	808340	142977	+14955	16265

[1] Method #3 (eg #3) serves as a check on Method #1 (eg/or #2)

[2] Using average concentration of Task 131

The use of 1/2 (mean + minimum) for virgin streamflow quality is consistent with the earlier use of 1/3 (mean + 2 minimum) values for irrigation water quality, as irrigation water is diverted upstream while the virgin streamflow is calculated at mouth since the virgin groundwater inflow to streams comprise part of virgin streamflow.

For the total basin, calculated streamflow loading equals 808,000 lbs. of total nitrogen and 143,000 lbs. of total phosphorus while the corresponding values for measured streamflow are 823,000 lbs. total Nitrogen and 159,000 lbs. total phosphorus. As stated earlier there is no significant difference between these values but the minor difference may be explained by the ommission of storm sewers outfall data.

The results in Table 7.14 show that sub-basin IX has a negative difference for total Nitrogen and sub-basins IV, V, VI and VIII have positive differences for total Phosphorus. Table 7.14 also shows total nutrient loading to receiving waters via groundwater flow. As Method #1 and Method #2 reflect only on man's influenced sources and not on the virgin groundwater contribution component of the total groundwater contribution. The virgin groundwater component is identical for both methods.

7.2.5 Overall Water Quantity Balance

An important factor in the calculations of Section 7.3 is the realistic estimation of virgin surface runoff. Based on work done by study groups and the British Columbia Water Investigations Branch, estimates of virgin surface runoff were obtained. Virgin and net surface runoff data from various sources and extrapolations based on available data and ratios of surface area are presented in Appendix E.11. An average net runoff (virgin less diversions) was calculated. A new adjusted virgin surface runoff was possible by adding diversions to this final averaged net streamflow. The complete net streamflow does not include net return flow to the streams. The overall balance of quantity is presented in Table 7.15.

The data on Table 7.15 is divided into two regions of the Okanagan Basin. Sub-basins I to V include all discharges to the Okanagan Lake. The second region, sub-basins VI to IX includes all of the Okanagan basin below (south) Okanagan Lake. The table illustrates the breakdown inflow to receiving waters and outflow of receiving waters for comparative purposes. More information is available for the first than the second region i.e. inflow and outflow from Okanagan Lake.

The inflow to Okanagan Lake from tributary streams S_n is 437,400 acre-feet. The surface runoff to receiving waters from direct drainage areas is equal to 27,000 acre-feet giving us a total surface inflow to Okanagan Lake of 464,400 acre-feet. Groundwater flowing into Okanagan Lake from the tributary sub-basins is equal to 12,300 acre-feet and the corresponding figure for groundwater reaching

TABLE 7.15

OVERALL WATER QUANTITY BALANCE[1]

DESCRIPTION	SUB-BASIN I -V K acre-ft	SUB-BASIN VI - IX K acre-ft	TOTAL BASIN K acre-ft
Inflow to Receiving Waters			
A: Surface Water			
(1) Streams to R.W.(TSB)			
$S_{v\ adj}$	540.1	86.5	626.6
$-E_s$	117.1	10.3	127.4
$+G_{f-s,t}$	4.7	1.3	6.0
$+R_{f-s,t}$	9.7	-	9.7
$+S_n$	437.4	77.5	514.9
(2) Surface runoff to RW(DD)			
$R_{v-o,d}$	27.0	9.7	36.7
$-E_r$	-	-	-
$+R_{f-o,d}$	?[1]	?	?
$+R_n$	27.0	87.2	551.6
(3) Total surface water to R.W.			
$S_n + R_n$	464.4	87.2	551.6
B: Groundwater			
(1) G.W. to R.W. (TSB)			
$G_{v-o,t}$	11.0	1.8	12.8
$-E_{g,t}$	-	.3	.3
$+G_{f-o,t}$	1.3	.4	1.7
$=G_{n,t}$	12.3	1.9	14.2
(2) G.W. to R.W. (DD)			
$G_{v-o,d}$	2.2	.8	3.0
$-E_{g,d}$	1.6	.1	1.7
$+G_{f-o,d}$	6.5	6.8	13.3
$+G_{n,d}$	7.1	7.5	14.6
(3) Total Groundwater to R.W. $G_{n,t} + G_{n,d}$	19.4	9.4	28.8
C: Total Inflow to R.W. $(S_n+R_n)+(G_{n,t}+G_{n,d})$	483.8	96.6	580.4
Outflow of Receiving Waters			
Inflow[2]	483.8	96.6	580.4
$-E_l$ (irrigation only)	4.6	41.1	45.7
+lake surface ppt.	83.7	(5.9)[3]	89.6
-lake surface evap.	266.9	(30.2)	297.1
=outflow	296.0	31.2	327.2

[1] A major ommission exists here, i.e. outfalls discharging directly to receiving waters.

[2] for VI - IX inflow is due only to outflow from TSB's and DD's, it does not include outflow from the upstream segment of receiving waters.

[3] Estimate - R.W. surface area ratio approximately 7.8%, ppt. assumed 80% of north and evap. assumed 130% of north.

receiving waters from the direct drainage areas is 7,100 acre-feet giving us a total groundwater inflow to Okanagan Lake of 19,400 acre-feet; thus, the total inflow to Okanagan Lake is equal to surface plus groundwater for a total of 483,800 acre-feet. Considering the outflow from Okanagan Lake, the surface and groundwater inflow equals 483,800 acre-feet. An estimate of diversions from Okanagan Lake through irrigation is 4,600 acre-feet, neglecting other withdrawals. The addition to the lakes due to precipitation is estimated at 83,700 acre-feet and the lake surface evaporation is estimated at 266,900 acre-feet, giving us a new outflow equal to 296,000 acre-feet. It is worth noting at this point that the precipitation and evaporation estimates as well as the bulk of virgin surface water inflow to Okanagan Lake is based on data provided from the water quantity model (9).

The corresponding values are shown on Table 7.15 for the sub-basins VI-IX inclusive. Also shown in this table is the summation of all the sub-basins in the Okanagan Basin. The table divides the various inflow points down into the smaller components such as diversion, groundwater return flow, and surface water return flow. The figures presented for these components are used in the analysis of the nutrient loadings where quantity times concentration was considered.

A major ommission in Table 7.15 is the surface return flow aters. The majority of these outfalls are located in direct drainage areas. This data is available in the study reports concerned with nutrient loading (Section 3). The second ommission mentioned previously is the return flow from storm sewers which outlet to both streams and receiving waters.

7.2.6 Final Nutrient and Return Flow Contribution to Receiving Water and Streams

The nutrient contributions to receiving waters calculated in Method 1 and the nutrient contributions to streams calculated in Method 3 were considered as final estimates. This decision was based on the fact that a large discrepancy occurred in the sources considered in between Method 1 and Method 2 such that an average was not justifiable. The return flow quantities were based on the estimate in Method 2.

Table 7.16 presents the surface water contributions to receiving water via the tributary sub-basin and the direct drainage area. The values presented for the tributary sub-basins represent the stream loading which consists of man influenced sources plus natural stream flow. The direct drainage area contribution as presented was the contribution from Agricultural animals in confinement. The single largest component which was omitted from the totals in Table 7.16 was the surface water return flow from outfalls discharging directly to receiving waters.

The total streamflow loading to receiving waters is 808,360 lbs. of total nitrogen and 142,950 lbs. of total phosphorus. The partial loading for direct

drainage areas due to agricultural animals is 7,500 lbs. of total nitrogen and 500 lbs. of total phosphorus.

TABLE 7.16

- FINAL ESTIMATE -

SURFACE WATER CONTRIBUTION TO RECEIVING WATER[3]

BASIN	TRIBUTARY SUB-BASIN[1]		DIRECT DRAINAGE AREA[2]	
	TOTAL N	TOTAL P	TOTAL N	TOTAL P
I	31,300	1,366	4,455	284
II	56,040	2,322	255	30
III	303,535	101,134	2,545	175
IV	246,335	21,670	-	-
V	90,580	11,565	-	-
VI	36,440	2,176	255	17
VII	6,660	586	-	-
VIII	28,820	1,404	-	-
IX	8,630	754	-	-
TOTAL	808,360	142,950	7,510	506

[1]The values listed here are stream loadings (the breakdown for this is given in Table 7.10)

[2]the values listed here represent contribution from Agricultural Animals only.

[3]Surface water return flow (outfalls) directly to receiving waters is not included.

Table 7.17 shows that the total nutrient contribution to receiving waters via groundwater flow is 536,320 lbs. of total nitrogen and 19,942 lbs. of total phosphorus. Of this amount, 303,930 lbs. of total nitrogen and 2,954 lbs. of total phosphorus are attributable to Agriculture; 79,150 lbs. of total nitrogen and 13,554 lbs. of total phosphorus to Septic tanks;

TABLE 7.17

SUMMARY OF GROUNDWATER AND SURFACE WATER NUTRIENT CONTRIBUTION TO TRIBUTARY STREAMS (TSB) AND RECEIVING WATERS (TSB + DD)

	TRIBUTARY STREAMS[1]		RECEIVING WATERS[2]	
	N	P	N	P
Agriculture	133,590	3,627	303,930	2,954
Septic Tanks	22,145	3,072	79,150	13,554
Other Sources	132,600	48,476	31,250	753
Total Sources	288,355	55,175	414,330	17,261
Natural Streamflow	520,005	87,775		
Natural Groundwater			121,990	2,681
TOTAL	808,360	142,950	536,320	19,942

[1]Groundwater and Surface Water to Streams - Method 3

[2]Groundwater Flow to receiving waters from tributary sub-basins and direct drainage basins - Method 1

Also, Table 7.17 shows that the total nutrient contribution to the streams was 808,360 lbs. of total nitrogen and 3,630 lbs. of total phosphorus was attributable to Agriculture; 132,600 lbs. of total nitrogen and 48,000 lbs. of total phosphorus was attributable to natural streamflow. Septic tanks were found to contribute 22,145 lbs. of total nitrogen and 3,072 lbs. of total phosphorus.

7.2.7 Contribution versus Potential

The analysis of contribution versus potential is restricted to Okanagan Basin totals. Table 7.18 presents the results of such an analysis. The contribution reaching receiving waters and its percentage of the total original potential for individual sources are presented. The contribution was further broken down to a groundwater and a surface water component which were considered for each tributary sub-basins and direct drainage areas.

The total contribution to the receiving waters excluding outfalls from both groundwater and surface water flow amounted to 1,365,860 lbs. of total nitrogen and 172,000 lbs. of total phosphorus is attributable to Agriculture; 101,300 lbs. of total nitrogen and 16,600 lbs. of total phosphorus to Septic tanks; 163,800 lbs. of total nitrogen and 49,000 lbs. of total phosphorus to other sources; and 656,000 lbs. of total nitrogen and 99,500 lbs. of total phosphorus is attributable to natural or virgin flow.

The natural stream flow component was separated into surface runoff and groundwater portions. The natural groundwater flow to streams which is included in the virgin stream flow is a fixed quantity therefore any adjustment to the natural stream loading was done by altering the virgin surface runoff. Since the final stream loading was calculated, the surface virgin runoff was the result from subtracting man influenced sources and natural groundwater return flow from the final stream loading.

Also, Table 7.7 shows that the total nutrient contribution to the streams was *808,360 lbs. of total nitrogen and 142,950 lbs. of total phosphorus. Of this amount* 133,590 lbs. of total nitrogen and 3,630 lbs. of total phosphorus was attributable to Agriculture; 132,600 lbs. of total nitrogen and 48,000 lbs. of total phosphorus to "other sources"; and 520,000 lbs. of total nitrogen and 87,780 lbs. of total phosphorus was attributable to natural streamflow. Septic tanks were found to contribute 22,145 lbs. of total nitrogen and 3,072 lbs. of total phosphorus.

Of this total contribution it can be seen that for total nitrogen 32.6% is attributable to agriculture, 7.4% to septic tanks, 12.0% to other sources and 48.0% to natural flow. For total phosphorus the corresponding breakdown is 4.1% to agriculture, 9.7% to septic tanks, 28.6% to other sources, and 57.6% to natural flow.

TABLE 7.18

ANALYSIS OF TOTALS FOR OKANAGAN BASIN: CONTRIBUTION (TO RECEIVING WATERS) AS A PERCENTAGE OF TOTAL POTENTIAL FOR AN INDIVIDUAL SOURCE

Description	AGRICULTURE						SEPTIC					
	Total N		Total P		Total RF		Total N		Total P		Total RF	
	C[1] (lbs)	%	C (lbs)	%	C ac-ft	%	C (lbs)	%	C (lbs)	%	C ac-ft	%
To Receiving Water via G.W.												
-G.W. in DD	274,820	5.7	2,729	.5	11802	7.2	72,820	16.2	12,915	9.5	1,549	45.8
-G.W. in TSB	29,110	.6	225	0.0	1440	0.9	6,330	1.4	639	.5	186	5.5
TOTAL VIA G.W.	303,930	6.3	2,954	0.5	13242	8.1	79,150	17.6	13,554	10.0		
To R.W. via Surface Water												
-from DD	7,510	0.2	506	0.1								
-from TSB												
- S.W. comp.	31,655	0.6	2,594	0.5								
- G.W. comp.	101,925	2.11	1,033	0.2	5093	3.1	22,145	4.9	3,072	2.2	647	19.1
(TSB)	133,580	2.7	3,627	0.7	5093	3.1	22,145	4.9	3,072	2.2	647	19.1
TOTAL VIA S.W.	141,090	2.9	4,133	0.8	5093	3.1	22,145	4.9	3,072	2.2	647	19.1
GRAND TOTAL	445,020	9.2	7,097	1.3	18335	11.2	101,295	22.5	16,626	12.2	2,382	70.4

C[1] signifies the contribution in pounds per year;

% - signifies contribution as a percentage of the potential loadings (Agriculture - 4,857,300 lbs. N, 546,750 lbs P and 163,900 ac-ft;

- Septic Tank: 450,460 lbs N, 136,480 lbs P and 3,384 ac-ft;
- Others: 495,910 lbs N, 138,120 lbs P and 10,187 ac-ft.)

Description	OTHERS						NATURAL			TOTAL[1]		
	Total N		Total P		Total RF		Total N	Total P	Volume	Total N	Total P	Volume
	C (lbs)	%	C (lbs)	%	C ac-ft	%	C (lbs)	C (lbs)	C ac-ft	C (lbs)	C (lbs)	C ac-ft
To Receiving Water via G.W. Method 2												
-G.W. in DD	26,150	5.3	689	.5	-	-	23,620	568	2,976	397,410	16,901	16,327
-G.W. in TSB	5,100	1.0	64	.05	64	0.6	98,370	2,113	12,787	138,910	3,041	14,477
TOTAL VIA G.W.	31,250	6.3	753	0.6	64	0.6	121,990	2,681	15,763	536,320	19,942	30,804
To R.W. via Surface Water Method 3												
-from DD										7,510	506	
-from TSB												
- S.W. Comp.	114,790	23.1	47,950	34.7	9,745	95.6	336,995	92,596	473,626	483,410	143,140	483,371
- G.W. Comp.	17,810	3.6	526	0.4	225	2.2	196,740	4,242	25,574	338,620	8,873	31,539
(TSB)	132,600	26.7	48,476	35.1	9,970	97.8	533,695	96,838	499,200	822,030	152,013	514,910
TOTAL VIA S.W.	132,600	26.7	48,476	35.1	9,970	97.8	533,695	96,838	499,200	829,540	152,519	514,910
GRAND TOTAL	163,850	33.0	49,229	35.7	10,034	98.4	655,685	99,519	514,963	1,365,860	172,461	545,714

[1] Total does not include outfalls discharging directly to receiving waters.

The total water flow to receiving water is 546,000 acre-feet of which 515,000 acre-feet is natural flow and the remaining 31,000 acre-feet is return flow from man's sources. Of the return flow, 18,300 acre-feet was attributable to agriculture, 2,400 acre-feet to septic tanks and 10,000 acre-feet to other sources.

Of this total water flow, 5.7% is return flow from the man influenced sources to both receiving waters and streams while 94.3% is natural stream flow. Of the surface inflow to the receiving waters, 31,500 acre-feet (6.1% of streamflow) makes up the groundwater component to streams while 483,400 acre-feet (93.9%) makes up the surface runoff component.

The potential loadings of the various sources used in computing percentages of contribution versus potential are: Agriculture - 4,900,000 lbs. of total nitrogen; 546,800 lbs. of total phosphorus; and 164,000 acre-feet; septic tank 450,000 lbs. of total nitrogen, 136,000 lbs. of total phosphorus and 3,400 acre-feet; and "other sources" 497,000 lbs. of total nitrogen, 138,000 lbs. of total phosphorus and 10,200 acre-feet (Appendices E.3 to E.7).

7.3 CONCLUSIONS

The major emphasis of this chapter which estimated the nutrient contribution to receiving waters was placed on calculating the contribution of nutrients to transporting waters, both surface and sub-surface, in the vicinity of the source. This information is developed in Section 7.2. To arrive at this contribution, the methodology and procedure outlined in Section 7.1 were followed. The major influencing boundary conditions were directly accounted for while those with sparse data were handled in an indirect method.

The three key inputs, which enables the final calculation for contribution in the vicinity of the source were: (i) the direct calculation of potential loadings of the various agricultural sources (ii) dividing the affected cultivated acreage on a basis of various combinations of influencing boundary conditions and (iii) the construction of a multiplying factor table. Using these results it was then possible to apply the multiplying factors, for the various combinations of boundary conditions, to the potential loadings and thereby arrive at the final estimation of contribution in the vicinity of the source as set out in Tables 7.1 and 7.3.

Table 7.6 shows how the final contribution to the transporting waters in the vicinity of the source compares with the original potential loadings for the various components of the agricultural sources.

The contribution results depend on the reliability of the multiplying factors (Table 7.2). If this table could be improved then a more accurate set of results would be obtained. The results of Section 7.2 (vicinity of source) are more accurate than those of Section 7.3 (receiving waters).

The secondary emphasis was to group information on contribution from all sources and to arrive at "ball park" estimates of total nutrient loading reaching receiving waters via groundwater flow. Contribution to transporting waters in the vicinity of the source was determined for "other sources" and corresponding values for agriculture were extracted from Section 7.2 and the values for septic tanks were extracted from Section 10. These loadings were then subjected to multiplying factors reflecting the mechanisms of horizontal transport through saturated soil systems. Surface water contributions were not subjected to multiplying factors reflecting the mechanisms of horizontal transport through saturated soil systems as they were transferred directly from vicinity of source to receiving waters.

Several methods were undertaken to estimate loadings. The first method involved applying multiplying factors directly to nutrient loadings while the second method applied multiplying factors to water quantity which in turn were multiplied by the water quality concentrations. The third method was an attempt to relate the groundwater components to an overall surface groundwater flow balance. The results from these three methods were in agreement indicating an order of magnitude accuracy. However, the estimates are likely low for certain individual sub-basins while high for others. Where these situations occur the discrepancy can approach two or three hundred percent. While carrying out Method 3 it was necessary to break down the various sources contributing to the streamflow. This information is valuable and its accuracy is similar to other estimates in Section 7.3. The final estimates of nutrient contributions are presented in Tables 7.16 and 7.17 which are a summary of Tables 7.8, 7.9 and 7.10.

Table 7.18 is a useful summary table. Here the contributions to the total Okanagan basin are presented along with their corresponding percentage of original potential loading. This table presents the results for both surface and groundwater contributions to receiving waters. Groundwater contributed 39.2% of the total nitrogen to receiving waters while the surface waters contributed the remaining 60.8%. Groundwater contributed 11.5% of the total phosphorus to the receiving waters while surface waters accounted for the remaining 88.5%. Groundwater contributed 5.6% of the water quantity inflow to the receiving waters while surface waters accounted for the remaining 94.4%.

The results depend on the reliability of (i) the accuracy of the estimation of the contribution to transporting waters in the vicinity of the source, and (ii) the multiplying factors (Table 7.7) which reflect the mechanisms of horizontal transport through saturated soil are less accurate than the multiplying factors reflecting vertical transport through unsaturated soil. Surface water components are assumed to be accurate since they depend on the ability to account for the majority of the surface loadings.

The overall effect of man's influence on the virgin state is to add 551,000 lbs. of total nitrogen, 50,300 lbs. of total phosphorus and remove at least 146,000

acre-feet of water per year. Man adds total nitrogen and total phosphorus in amounts approximating the order of magnitude of virgin state contribution.

7.4 RECOMMENDATIONS

Two basic directions of work could take place. The first would be an attempt to improve on input values and thereby improve the output estimates following the general overall Okanagan basin procedures as used in present study. Under this first route the general methodology could be refined to some extent. The second direction would be to enter into more intensive procedures in order to evaluate more accurately the output from special potential problem areas.

Various items to consider under the first route would include:

(i) Improve on the multiplying factor tables which reflect mechanisms of vertical transport of material through unsaturated soil media. Carry on further cropland and septic tank lysimeter studies in order to better represent the predominate combinations of boundary conditions.

(ii) Re-calculate cultivated acreage in the southern region of the Okanagan Basin.

(iii) Consider nutrients and water quality loadings which were previously omitted.

(iv) Improve on the multiplying factor table which reflects mechanisms of horizontal transport of material through saturated soil media. This would involve a much more intensive evaluation of boundary conditions relative to horizontal transport and should include field site investigation of the subsurface conditions.

(v) Seek other direct or indirect methods of gauging the contribution rates; for example, limnology studies.

(vi) Consider in more detail the roughly interpreted boundary conditions such as climate.

If the inputs are improved then it would be possible to further refine the analysis, such as take into account the effect of time, seasonal contribution and loading rates.

Various items to consider under the second route would include:

(i) Intensify the methodology used in the present general study. This involves the development of more complex sub-surface systems modelling.

(ii) Carry out lysimeter pilot studies.

(iii) Install and carry out field experiments for the major source systems.

(iv) Carry out general study.

CHAPTER 8

Bacteriological Study

Recreational accivities involving the use of bathing areas in the Okanagan is an important industry. It is estimated that the population of the Okanagan doubles in July and August primarily as a result of tourism. Local residents are concerned about the water quality of the bathing areas in the Okanagan, both for their own enjoyment and as attraction to tourists.

The Health Branch, Province of British Columbia, has published recommended water quality standards (40). The standards stipulate that bathing, swimming and recreational areas in clear water lakes and upper areas of streams should have median less than 240 organisms per 100 milliliters for total coliforms and that this value should not be exceeded in more than 20% of the samples. The coliform organisms indicate the sanitary quality of water by determining the disease-producing potential of the water. Differentiation of fecal from non-fecal coliforms inhabit the intestines of warm-blooded animals and non-fecal sources originate from plants, soils and insects (42).

Recently, the Health Branch has adopted, for primary contact recreational waters, a fecal coliform standard of a log mean of 200 organisms per 100 mls; with not more than 10% of the total samples during any 30 day period to exceed 400 organisms per 100 mls (41). This standard is based on a minimum of not less than 5 samples for any 30 day period of the recreational season. This standard was previously recommended by the U.S. Federal Water Pollution Control Administration (42). This study was undertaken in April, 1972 to investigate typical bathing areas in the Okanagan for the following reasons:

(1) Insufficient data was available to determine the bacteriological quality of the major bathing areas.

(2) The existing standards at that time did not specify the number of samples required to calculate a meaningful coliform count to "open" a bathing area or to "close" a bathing area.

(3) Concern of local residents and businesses regarding the water quality of the bathing areas.

The objectives of the Bacteriological Study were as follows:

(1) to determine the coliform levels in three major bathing areas of the Okanagan.

(2) to determine the minimum number of samples required to calculate a meaningful coliform count for a given bathing area.

(3) to determine the coliform count of the major outfalls and streams in the Okanagan Basin.

8.1 STUDY DESIGN

Three beaches were chosen to represent the overall swimming areas in the Okanagan Valley. They were:

(a) Skaha Beach at Penticton (north end of Skaha Lake).

(b) Okanagan Beach at Penticton (south end of Okanagan Lake).

(c) Kin Beach at Vernon (north end of Okanagan Lake).

The beaches were broken down into a grid pattern with sixty different sampling sites at three different distances from shore. These points encompassed the whole swimming points usually marked by buoys.

The first two samplings in June were to determine the method, depth and number of samples to be run during subsequent samplings. Initially sixty samples at each of three beaches were taken at three different depths: surface, one-foot and mid-depth. The one-foot and mid-depth samples were taken using a modification of a dye sampler developed by the Canada Centre for Inland Waters in Burlington, Ontario.

The sampling locations at each beach are shown in Figure 8.1, (a), (b) and (c).

In September, it was decided to concentrate on one beach at one depth in order to obtain a larger number of samples per beach. Skaha Beach at Penticton was chosen for its size and because of the influence of the Penticton Sewage Treatment Plant entering the beach area. One hundred and eighty coliform samples were taken over a three day sampling period (sixty samples per day).

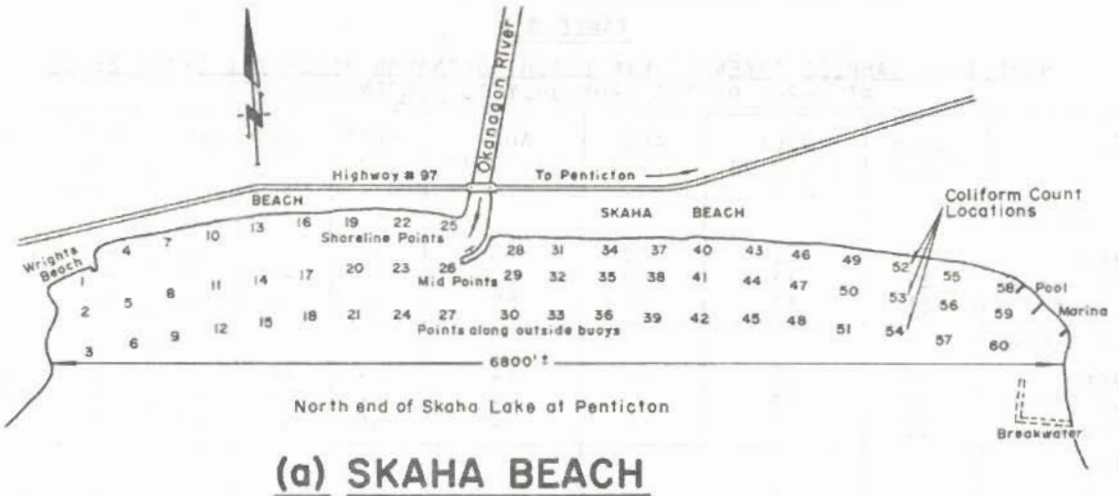
The bacteriological samples were shipped overnight in a cooler to the Vancouver Laboratory of the Division of Laboratories, Health Branch, Province of British Columbia. Analyses were performed using the multiple-tube fermentation technique as outlined in Standard Methods for the Examination of Water and Wastewater (1).

Moore's gauze swabs were secured at various locations in Skaha Beach in an attempt to isolate pathogenic organisms (43).

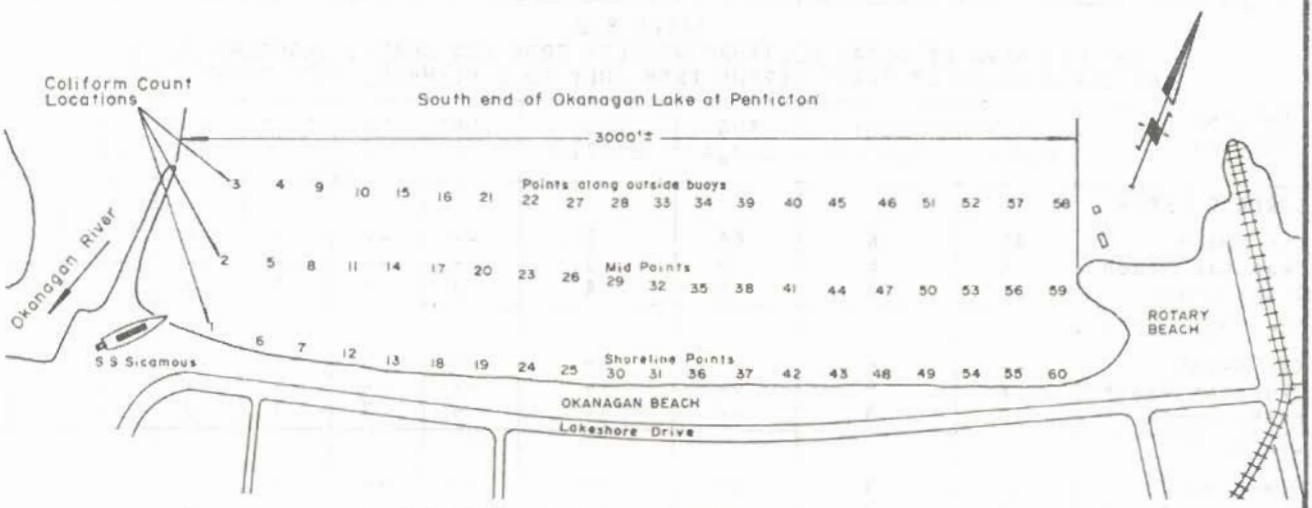
Stream locations used in the Stream Quality Study (Section 2) and the outfall locations used in the Outfall Quality Discharge study (Section 3) were also sampled for bacteriological parameters on a monthly schedule between October 1970 and October 1971.

8.2 DISCUSSION OF RESULTS

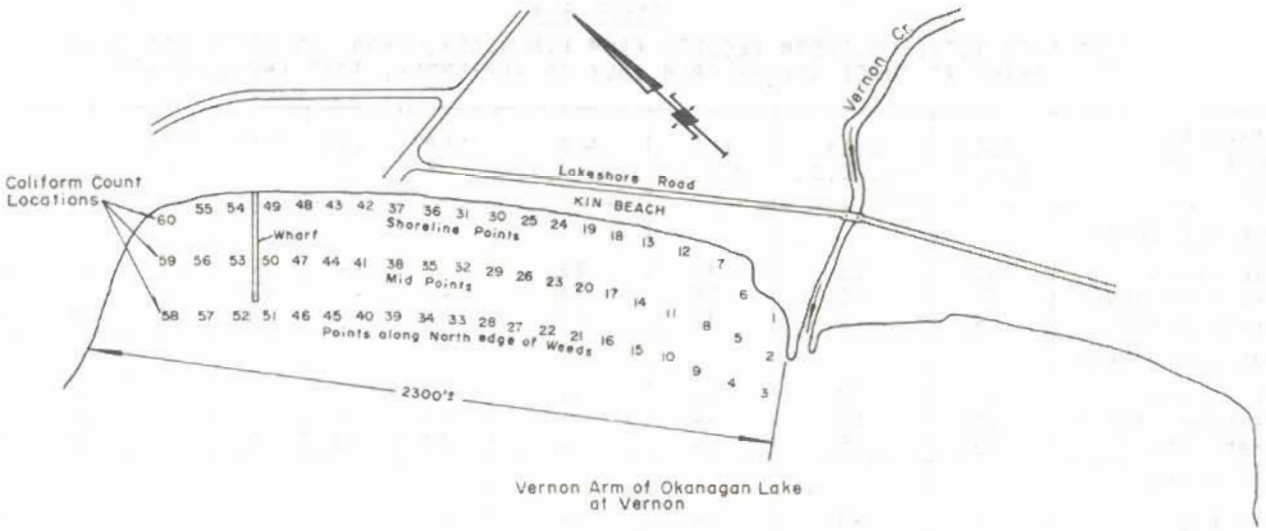
The date and number of samples taken at the surface, one-foot and mid-depth at each beach are given in Table 8.1.



(a) SKAHA BEACH



(b) OKANAGAN BEACH



(c) KIN BEACH

COLIFORM COUNT LOCATIONS - 3 OKANAGAN BEACHES

Figure 8.1

TABLE 8.1

NUMBER OF SAMPLES TAKEN AT KIN BEACH, OKANAGAN BEACH AND SKAHA BEACH AT THREE DEPTHS FROM JULY TO SEPTEMBER, 1971

SAMPLING LOCATION & DEPTH	JULY 5,6,7	JULY 19,20,21	AUG 2,3,4	AUG 16,17,18	SEPT 7	SEPT 8	SEPT 9	SEPT 20	SEPT 21	SEPT 22
SURFACE DEPTH										
Kin Beach	20	27	20	60	--	--	--	--	--	--
Okanagan Beach	27	13	60	29	--	--	--	--	--	--
Skaha Beach	21	13	59	60	30	30	30	30	30	30
ONE FOOT DEPTH										
Kin Beach	--	27	--	--	--	--	--	--	--	--
Okanagan Beach	25	13	--	--	--	--	--	--	--	--
Skaha Beach	22	13	--	--	30	30	30	30	30	30
MID DEPTH										
Kin Beach	--	5	--	--	--	--	--	--	--	--
Okanagan Beach	7	4	--	--	--	--	--	--	--	--
Skaha Beach	11	4	--	--	--	--	--	--	--	--

TABLE 8.2

THE LOG MEAN OF FECAL COLIFORM RESULTS FROM KIN BEACH, OKANAGAN BEACH AND SKAHA BEACH AT THREE DEPTHS FROM JULY TO SEPTEMBER, 1971 (MPN/100ml)

SAMPLING LOCATION & DEPTH	JULY 5,6,7	JULY 19,20,21	AUG 2,3,4	AUG 16,1718	SEPT 7	SEPT 8	SEPT 9	SEPT 20	SEPT 21	SEPT 22
SURFACE DEPTH										
Kin Beach	45	6	64	5	--	--	--	--	--	--
Okanagan Beach	8	6	5	3	--	--	--	--	--	--
Skaha Beach	5	3	6	4	3	3	3	3	3	*3
ONE FOOT DEPTH										
Kin Beach	--	6	--	--	--	--	--	--	--	--
Okanagan Beach	7	9	--	--	--	--	--	--	--	--
Skaha Beach	5	3	--	--	4	3	3	3	3	3
MID DEPTH										
Kin Beach	--	8	--	--	--	--	--	--	--	--
Okanagan Beach	7	3	--	--	--	--	--	--	--	--
Skaha Beach	5	3	--	--	--	--	--	--	--	--

TABLE 8.3

THE MEDIAN OF TOTAL COLIFORM RESULTS FROM KIN BEACH, OKANAGAN BEACH AND SKAHA BEACH AT THREE DEPTHS FROM JULY TO SEPTEMBER, 1971 (MPN/100 ml)

SAMPLING LOCATION & DEPTH	JULY 5,6,7	JULY 19,20,21	AUG 2,3,4	AUG 16,17,18	SEPT 7	SEPT 8	SEPT 9	SEPT 20	SEPT 21	SEPT 22
SURFACE DEPTH										
Kin Beach	780	23	240	23	--	--	--	--	--	--
Okanagan Beach	43	43	18	4	--	--	--	--	--	--
Skaha Beach	4	9	39	23	23	23	9	4	12	*4
ONE FOOT DEPTH										
Kin Beach	--	23	--	--	--	--	--	--	--	--
Okanagan Beach	23	43	--	--	--	--	--	--	--	--
Skaha Beach	33	15	--	--	23	23	9	4	8	15
MID DEPTH										
Kin Beach	--	43	--	--	--	--	--	--	--	--
Okanagan Beach	23	4	--	--	--	--	--	--	--	--
Skaha Beach	23	23	--	--	--	--	--	--	--	--

* Algae noted in four samples.

Table 8.2 shows the log mean fecal coliform results and Table 8.3 shows the median coliform results for each beach at each sampling location.

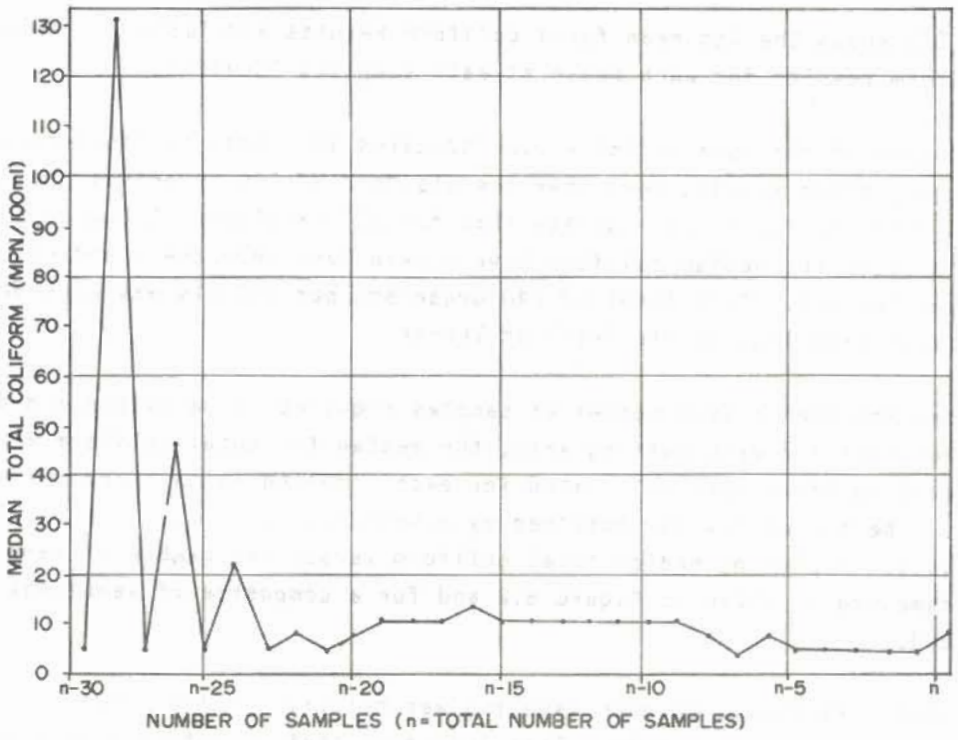
Examination of the data in Table 8.2 indicates low fecal coliform results. All samplings yielded results less than the standard of 200 organisms per 100 mls. The results shown in Table 8.3 indicate that for all samplings at Okanagan Beach and at Skaha Beach the median coliform levels were less than the standard of 240 organisms per 100 mls. This level of 240 organisms per 100 mls was exceeded in two out of four samplings at Kin Beach at Vernon.

To determine the minimum number of samples required to calculate a meaningful coliform count for each bathing area, the median for total coliform and log mean for fecal coliform were calculated for each sampling using n and n-x number of samples. The number n-x was obtained by discarding 1, 2, 3, ... x results on a random basis. A plot of median total coliform versus n-x number of samples for a typical sampling is shown in Figure 8.2 and for a composite of samplings is shown in Figure 8.3.

In general the curves on each sampling was relatively flat between n and n-15 and erratic between n-15 and n-30. This indicates that to obtain a representative coliform count greater than ten samples should be collected at each beach, over the entire area, for each sampling. To obtain a monthly median coliform level in a given beach a number of samplings are required. Insufficient data was obtained in this study to evaluate all the factors contributing to changes in coliform levels of bathing areas. It is recommended that in future studies,factors such as bathing population, waste water, discharges, and meteorological factors be fully evaluated.

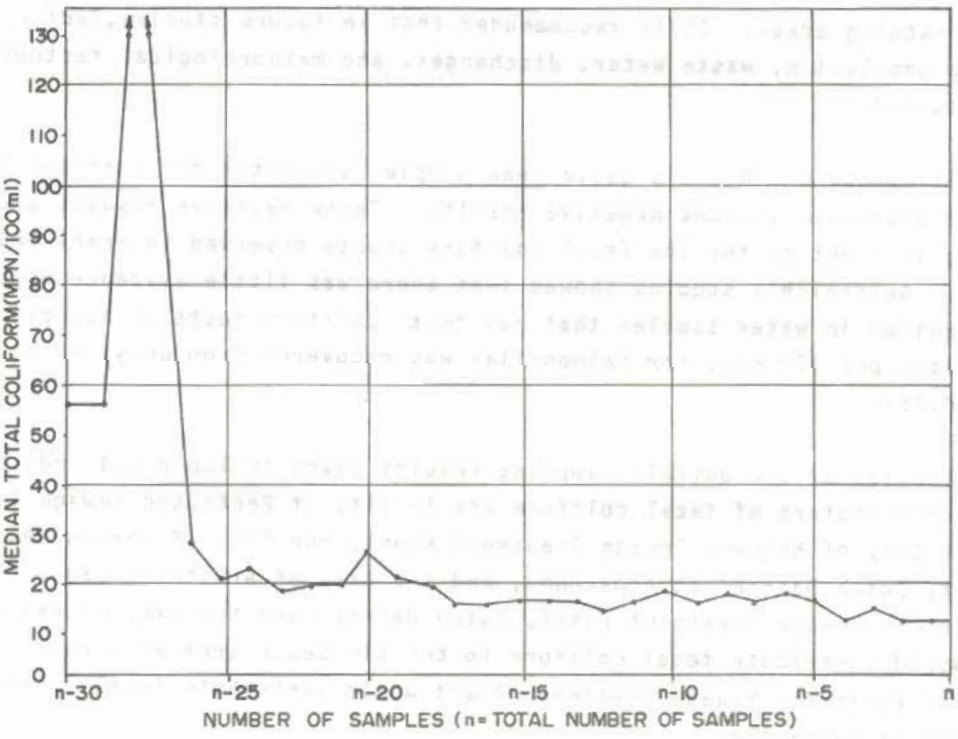
In all cases, the Moore's gauze swab samples submitted for examination of pathogenic organisms yielded negative results. These negative results are not surprising in light of the low fecal coliform counts observed in Skaha Beach at Penticton. Geldreich's studies showed that there was little evidence of pathogenic organisms in water samples that had fecal coliform tests of approximately 200 organisms per 100 mls; for Salmonellae was recovered from only 28% of the samples tested (44,45).

Examination of the outfall sampling results given in Table 8.4 indicates that the main contributors of fecal coliform are in City of Penticton Sewage Treatment Plant, The City of Kelowna Sewage Treatment Plant, the City of Vernon Sewage Treatment Plant, Dutch Dairies at Armstrong, and the City of Armstrong Lagoons. The City of Vernon Sewage Treatment Plant, Dutch Dairies and the City of Armstrong Lagoons would contribute fecal coliform to the Kin Beach area at Vernon while the City of Penticton Sewage Treatment Plant would contribute fecal coliforms to Skaha Beach at Penticton.



TOTAL COLIFORMS AT SURFACE DEPTH OF SKAHA LAKE.

Figure 8.2



COMPOSITE GRAPH OF TOTAL COLIFORM AT SURFACE DEPTH IN SKAHA LAKE.

Figure 8.3

TABLE 8.4

COLIFORM RESULTS - OUTFALL SAMPLING LOCATIONS

STATION		COLIFORM - TOTAL		COLIFORM - FECAL	
NUMBER	LOCATION	NUMBER OF SAMPLES	MEDIAN MPN/100ml*	NUMBER OF SAMPLES	LOG MEAN MPN/100ml*
0-03	Village of Oliver S.T.P.	18	2,000	6	110
0-04	Canadian Canners, Penticton	1	2,400,000	-	-
0-05	City of Penticton S.T.P.	20	2,750	9	949
0-09	Westbank Lagoon	7	54,200	2	110
0-10	Calona Wines & O.K. Beverages, Kelowna	1	2,000	-	-
0-15	City of Kelowna S.T.P.	18	89,050	6	423,983
0-17	City of Vernon S.T.P.	25	2,000	7	431
0-18	Dutch Dairies, Armstrong	20	160,900	2	978,500
0-19	City of Armstrong Lagoon	21	160,900	4	16,375

* Most probably number

TABLE 8.5

COLIFORM RESULTS - STREAM AND LAKE SAMPLE LOCATIONS

STATION		COLIFORM - TOTAL		COLIFORM - FECAL	
NUMBER	LOCATION	NUMBER OF SAMPLES	MEDIAN MPN/100ml*	NUMBER OF SAMPLES	LOG MEAN MPN/100ml*
500	Osoyoos Lake	20	11	20	3.3
501	Inkaneep Creek	3	1,263	3	115.9
502	Okanagan River at Road 22	21	348	21	13.1
504	Vaseaux Creek	7	70	7	4.7
505	Okanagan River at Okanagan Falls	20	40	21	3.5
506	Shuttleworth Creek	3	918	3	64.9
507	McLeans Creek	3	924	3	108
508	Okanagan River at Skaha Lake	29	109	29	8.7
509	Shingle Creek	7	221	7	45.7
510	Ellis Creek	15	542	15	7.8
511	Penticton Creek	14	516	14	26.3
512	Trout Creek	18	854	18	19.4

TABLE 8.5

COLIFORM RESULTS - STREAM AND LAKE SAMPLE LOCATIONS (CONT'D.)

STATION		COLIFORM - TOTAL		COLIFORM - FECAL	
NUMBER	LOCATION	NUMBER OF SAMPLES	MEDIAN MPN/100ml*	NUMBER OF SAMPLES	LOG MEAN MPN/100ml*
513	Chute Creek	3	130	3	6.9
514	Peachland Creek	15	348	15	6.1
515	Trepanier Creek	8	185	8	8.9
516	Powers Creek	21	490	21	14.3
517	Smith Creek	15	5,420	15	232
518	McDougall Creek	15	542	15	6.3
519	Bellevue Creek	8	240	15	6.1
520	Mission Creek at mouth	30	500	20	88
521	Kelowna Creek at mouth	29	5,420	21	1,122
522	Brandt's Creek	47	169,000	43	980
523	Lambly Creek	14	86	14	3.7
524	Vernon Cr. at Hiram Walker's	19	109	19	7.8
525	Vernon Creek at Woods Lake	20	2,260	20	102
526	Shorts Creek	3	918	3	13
527	Whiteman's Creek	15	79	15	8.1
528	Equesis Creek	3	939	3	123
529	Deep Cr. at mouth	41	1,300	42	119
530	Vernon Cr. at mouth	53	5,420	49	438
531	BX Creek at HWY 97	30	7,900	22	1,887
532	Coldstream Creek	42	1,410	40	377
533	Naswhito Creek	3	348	3	14.3
534	Garbage Creek	13	1,609	13	55.4
535	Unknown Creek	20	3,480	20	33.6
536	Mission Cr. at Guage	11	109	11	9.1
537	Kelowna Cr. at HWY.97	11	800	11	238
538	Brandt's Creek	31	14,100	23	386
539	BX Creek at East Vernon Road	9	109	9	12.6
540	Deep Creek	29	1,300	19	165
541	Vernon Creek at B.C. Hydro	28	1,609	19	129

Table 8.5 gives coliform results obtained from the stream and lakeshore locations associated with the Stream Quality Study (Section 2). The main streams contributing fecal coliform organisms are Inkaneep Creek, Smith Creek, Kelowna Creek, Brandts Creek, Equesis Creek, Deep Creek, Vernon Creek, BX Creek. The Vernon Creek would have an effect on fecal coliform levels in Kin Beach at Vernon and the Okanagan River would affect the Skaha Beach at Penticton.

Results of the initial sampling indicated that the coliform levels tended to be higher for surface samples as compared to mid-depth or one-foot samples. In the shallower areas of the beach there was no significant difference between the mid-depth, one-foot and surface samples. For this reason and for the fact that the eyes, ears, nose, and throat of a swimmer are in contact with the surface water more frequently than water at a depth of one foot or mid-depth, it was decided to collect the remaining samples in this study at surface depth.

8.3 CONCLUSIONS

An economically important industry in the Okanagan area is recreation involving the use of bathing areas. In recent years considerable public concern has been expressed regarding the water quality of the bathing areas in the Okanagan. Although water quality standards have been established, these standards did not specify the number of samples required to calculate a meaningful coliform count, or the technical procedures for "closing" or "opening" bathing areas. The objectives of this study were to determine:

(1) The coliform levels in three major bathing areas.

(2) The minimum number of samples required to calculate a coliform count.

(3) The coliform count of the major outfalls and streams.

Three beaches were divided into a grid sampling pattern and sampled twice per month. The samples were shipped to the Health Branch Laboratory in Vancouver. The results indicated that:

(1) For all samplings of Kin Beach at Vernon, Okanagan Beach at Penticton, and Skaha Beach at Penticton the log mean for fecal coliform was less than the Health Branch standard of 200 organisms per 100 mls.

(2) For all samplings of Okanagan Beach and Skaha Beach the median for total coliform was less than the Health Branch standard of 240 organisms per 100 mls.

(3) The level of 240 organisms per 100 mls for the median of total coliform was exceeded in two out of four samplings at Kin Beach.

(4) To obtain a reliable coliform count for the three beaches, more than ten random samples encompassing the entire beach area are required for each sampling.

CHAPTER 9

Pesticide Use Study

Private and governmental agencies were canvassed to obtain qualitative and quantitative information (past and present) on pesticide use in the Okanagan basin. The purpose of this chapter is to furnish information for use in evaluating stream and lake ecology.

The survey and documentation of pesticide use was carried out by Mr. C.L. Neilson, Provincial Entomologist, British Columbia Department of Agriculture; while the information on changing patterns in the use of Insecticides was completed by Dr. J.L. Mason and Dr. H.F.Madsen of the Canada Department of Agriculture, Reasearch Station, Summerland, B.C.

9.1 RECOMMENDED PESTICIDE USE IN THE OKANAGAN WATER BASIN

The recommended insecticides, fungicides and herbicides and the recommended rates for 1960 - 1970 inclusive are listed in Appendix F.1 (Tree Fruits), and Appendix F.2 (Vegetables and Field Crops). This information was taken from the British Columbia Department of Agriculture spray calendars and production guides. Other pesticides are also used for pets, livestock, public health problems and by home gardners.

Estimating the actual acreage treated on the basis of these recommendations was not possible. Despite the fact that approximate acreage figures were available for each crop, there was often a choice of two or more pesticides which could be used to control a single pest. In addition, the number of applications and rate of application of a particular pesticide needed to control a given pest could vary from area to area and indeed from farm to farm, depending on the degree of the initial infestation and its decline or buildup during the season. Such insect population fluctuations are dependent on many biological and meteorological factors, consequently assessed and reassessed and controls applied to suit the appropriate individual situation.

9.2 ESTIMATED PESTICIDE SALES IN THE OKANAGAN BASIN

There is no method of obtaining accurately the total amount of pesticides used within an area of the province such as the Okanagan basin under present circumstances. While all pesticides sold in Canada must have Canadian registration, and Statistics Canada report total Canadian Pesticide Sales, there is no requirement in respect to listing such sales by smaller areas. Most pesticides that are sold

in British Columbia are manufactured or formulated outside of the Province and many outside of Canada. They are then sold in Canada through a series of dealers, wholesaler and retailers. In addition, pesticides may be imported into Canada by an individual for his own use, even though they do not have Canadian registry. While all stores in B.C. which sell pesticides at the retail level are now required (effective 1966) to be licensed and keep certain records, they are not required to keep records of total pesticide sales.

The pesticide sales shown in Appendix F.3 are based mainly on the actual records of one of the two main suppliers in the Okanagan. The second main supplier had not kept records which were suitable for analysis. Final figures were obtained by adding a calculated figure for the sales of the second buyer, based on relative sales, and an estimate of sales from other sources. Other approaches were explored in an attempt to arrive at the more accurate figures but they were not successful. It is important to recognize that the figures are rough estimates only - they must not be considered definitive.

9.3 CHANGING PATTERNS IN THE USE OF INSECTICIDES

Insects that damage fruit in orchards are currently kept down through a concept called integrated control or pest management. This method of control attempts to balance biological and chemical methods so that adverse effects against natural enemies of pests is minimal. Chemical sprays are applied only when it is evident that economic damage will occur to the crop. Pesticides that have a low toxicity to beneficial insects are used whenever possible. If more toxic pesticides must be applied, they are used at low rates which minimizes adverse effects to predators or parasites. It is often possible to use these more toxic pesticides at times of the year when beneficial insects and mites are not present or are hiding in protective resting sites.

We have now entered a new phase of insect control which still depends upon pesticides, but uses them intelligently. Before pest managment programs are successfully established on all crops, a great deal of information needs to be gathered on economic levels of pest infestation, the ecology of pests and their natural enemies, the effect of new pesticides on destructive and beneficial insects and environmental effects following pesticide use. Entomologists are actively pursuing these studies in addition to investigating methods of control which may eliminate pesticides completely.

These changes in pest control to make maximum use of natural controls combined with minimum use of insecticides represent a major change in direction from the earlier practices. Prior to the early 1940's, growers and orchardists were dependent upon inorganic compounds such as lead arsenate, cryolite and sulfur which required frequent sprays and still fell short of obtaining adequate control.

When DDT appeared upon the scene, control practices changed drastically. DDT and related chlorinated hydrocarbon compounds such as aldrin, dieldrin and heptachlor provided high initial kill and long residual action against a wide spectrum of insect pests. In the early days of the chlorinated hydrocarbons there were predictions that some insect pests would be eradicated by these chemicals. This did not happen. Instead, a number of insects developed resistance and control problem often became more complicated. For example, a number of minor pests, notably mites, became major pests because the chlorinated hydrocarbons destroyed parasites and predators which had held these pests under control.

The most serious problem associated with DDT and related compounds was their persistence in the environment and the accumulation in the food chain. Animals at the top of the food chain showed high levels of DDT in their body fat, and there was increasing evidence that their reproductive potential was adversely affected. Rachel Carson in her book, Silent Spring, condemned the use of DDT and other chlorinated hydrocarbons and created a public furore which has not abated.

Shortly after the introduction of DDT, another group of chemicals appeared on the scene known as organophosphorus compounds. Parathion is perhaps the best known insecticide of this group. These chemicals were less persistent, did not accumulate in the environment, but were extremely hazardous to handle. Their initial toxicity to humans and animals was very high and a whole set of regulations were formulated to insure that proper safety precautions were followed. These compounds, although very effective against pests, created a number of problems. Several major insect pests developed resistance to the organophosphorus compounds and pest species often resurged to populations higher than the original. Many of the compounds were toxic to beneficial insects and this created further pest increases.

It had become evident to many entomologists that pesticides were not the final answer to insect control and studies were initiated to find means of control other than chemical. Biological control, control by insect diseases, insect sterilization and release, genetic manipulation, growth hormones and sex attractants were some of the avenues explored. Research entomologists devoted considerable time to these non-chemical methods while continuing to search for spray chemicals less hazardous to the environment.

9.4 CHANGES IN PESTICIDE SALES

Some highlights of the pesticide sales in the Okanagan Basin area as reported in Appendix F.1 are outlined here. DDT 50W sales have declined from a 10-year peak of 836,000 pounds in 1965 to 27,700 pounds in 1970. Malathion E8 sales declined from 6,400 gallons in 1969 to 40 gallons in 1970. Malathion 25 WP declined from 23,850 pounds in 1961 to 0 pounds in 1969 and 1970. Parathion 15% sales declined from 27,100 pounds in 1961 to 3,750 pounds in 1970. Sevin 50W sales declined

from 77,175 pounds in 1962 to 15,200 pounds in 1970. There have been no sales of Aldrin since 1965.

Some new materials have appeared in the last 10 years. Casoron 49 sales started in 1968. Cygon sales started in 1964-65. Dormant Oil sales started in 1966 and reached 124,300 gallons in 1970. Ethion 25W sales started in 1962. Gramoxone sales started in 1964 and reached 3,375 gallons by 1970. Imidan 50W sales started in 1967 and peaked at 15,960 pounds in 1968. Morocide 50W sales started in 1963, peaked at 16,450 pounds in 1967 then declined to 500 pounds in 1970. Omite 30W sales started in 1969. Rogor 40 sales started in 1965. Tedion 25WP sales started at 84,400 pounds in 1966 but declined to 300 pounds by 1970.

CHAPTER 10

Influence of Septic Tank Effluent on Receiving Water Nutrient Gain from Groundwater

In order to suggest methods by which the input of major nutrients to the receiving waters of the Okanagan Valley can be controlled, it is first necessary to know how much nutrients are originating from various sources which are capable of being controlled. Septic tank effluent as dispersed via tile fields certainly contains sufficient quantities of nutrients (when considered collectively throughout the study area) to potentially be a major contributor of nutrients. The project discussed in this chapter was implemented to accomplish two main purposes. firstly, to determine the total amounts of major nutrients which are contained in the septic tank effluents of the Valley; and secondly, to estimate how much of these loadings actually reach the receiving waters via groundwater.

The determination of total amounts of major nutrients present in septic tank effluents required that a septic tank count of the entire valley be carried out. This survey was carried out by getting as much information as possible from maps in the various District and Municipal offices, with a considerable amount of field counting being required to fill in the blanks and check the validity of the available maps. The nutrient content of septic tank effluent was estimated by analyzing the effluent of a "representative" septic tank, and by calculating the per capita nutrient contents of the raw sewage entering the Vernon and Penticton sewage treatment plants.

Estimating the amount of applied nutrients that finally get into the surface waters of the valley involves the considerations of many parameters, the most important of these probably being: depth of unsaturated soil above the water table; soil characteristics; and proximity of tile fields to surface waters. Adequate understanding of the vertical movement of nutrients through unsaturated soils and the horizontal movement through saturated soils had to be obtained so that the effects of the above-mentioned parameters could be reasonably estimated. Furthermore, mapping of the Okanagan Valley drainage basin relative to major soil types, and depth to groundwater, had to be undertaken in order for the final calculations to be carried out. This latter information was actually gathered in Section 7.

10.1 ENUMERATION OF SEPTIC TANKS

The amount of septic tank effluent being applied to the ground in the Okanagan Valley drainage basin has been approximated by obtaining a count of residential. commercial, and tourist-oriented establishments that dispose of liquid effluent in this manner. A substantial portion of this data was available from land use maps in Municipal and Regional offices throughout the Valley. There was, however, a considerable amount of direct field counting of residences required to ensure that

reliable data was available for all the potentially important areas of the Valley. The only regions not investigated were the hinterlands of the basin where concentrations of septic tanks are low, and the distances to groundwater or surface water are large. It was decided that the potential input of nutrients from these regions is so small that the work involved in collecting the data was unwarranted.

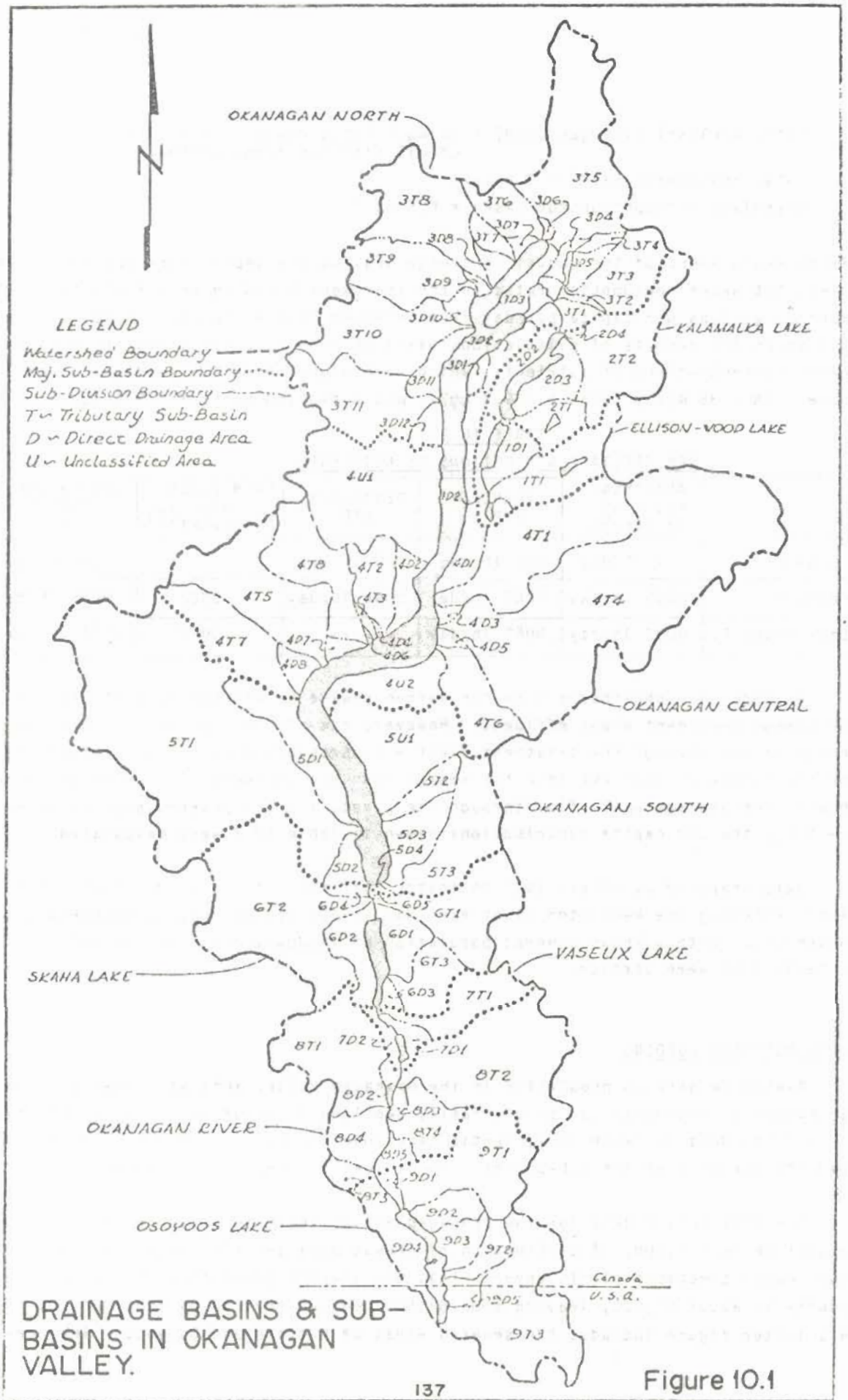
Data obtained from the existing land use maps and from the field enumeration was transposed onto transparent overlays of the Valley. These overlays were primarily at a scale of 1" = 1000 feet, with a few being at a scale of 1" = 1320 feet. Boundaries of the various drainage sub-basins were plotted on the overlays, as well as the positions of lakes, rivers and streams of the Okanagan basin. The overlays were designed to be used in conjunction with base maps of the Valley which show water table elevations and soil types. Simultaneous examinations of the maps will allow estimates to be made of the percentages of applied nutrients that reach the receiving waters.

Table 10.2 shows a summary of the number of "equivalent single family units" that are serviced by septic tanks in each of the sub-basins, with the locations of the sub-basins being indicated on Figure 10.1. An "equivalent single family unit" can be defined as that concentration of activity that produces the same nutrient loading to the soil as an average single family residence. A ten-unit apartment building would therefore be considered to be 10 equivalent single family units, whereas a ten-unit motel or a ten-unit campsite would be somewhat less in effect. Some of these conversion factors have been somewhat arbitrarily assigned, but the effect on the study conclusions of any possible error in the conversion factors is considered minimal.

10.2 NUTRIENT LOADINGS PER UNIT

When dealing with the nutrient content of domestic sewage, it is essential that information for local conditions be obtained. Published data for other parts of North America are not acceptable, primarily because the different laws respecting additives in detergents can have a marked effect on nutrient content in sewage. The nitrogen and phosphorus content of Okanagan sewage was calculated in three ways: from analysis of septic tank effluent originating from a family-type apartment near Vernon; from long-term analyses available on effluent from the Vernon sewage treatment plant, and from available analyses of raw sewage at the Penticton sewage treatment plant.

The apartment building chosen has eleven units with a total of 28 residents during the period of this study. Since each suite has its own laundry facilities, and since garbage grinders are not being used, it is considered to be representative of average dwelling units in the Okanagan Valley. The results of some thirty analyses of the septic tank effluent during 1972 gave rise to the following average concentrations:



DRAINAGE BASINS & SUB-BASINS IN OKANAGAN VALLEY.

Figure 10.1

Total Kjeldahl Nitrogen (asN) = 32 mg/l (this was well over 99% of all nitrogen forms present)

Total Phosphorus (asP) = 7.8 mg/l

Dissolved orthophosphorus (asP) = 6.8 mg/l

Direct measurement of the amount of sewage leaving the septic tank was not undertaken, but water consumption rates in the apartment building were found to be 37 Imperial gallons per capita per day from December 1971 to February 1972. Table 10.1 shows the results of calculations based on this flow rate, and the winter season concentrations of nutrients, which were higher than the averages given above (TKN = 38 mg/l; Total P = 9.2 mg/l; and Dissolved ortho P = 8.1 mg/l).

TABLE 10.1

PER CAPITA CONTRIBUTIONS OF NUTRIENTS

	APARTMENT BUILDING 37 Igpcpd	VERNON STP	PENTICTON STP	FROM ZANONI AND RUTKOWSKI (2)	DESIGN VALUE USED IN STUDY
Total N	.014 lb/day	.021 lb/day	.027 lb/day	.0202	.020 lb/day
Total P	.0035 lb/day	.0061 lb/day	.0062 lb/day	.0082	.0055 lb/day
Diss.Ortho P.	.0030 lb/day	.0052 lb/day	-----	.0040	.0042 lb/day

Nitrogen and phosphorus data for Vernon sewage is limited to that present in the sewage treatment plant effluent. However, the slight loss in nutrients as the sewage passes through the treatment plant will probably more or less compensate for the nutrients that get into the sewage from non-residential sources in Vernon. Knowing the average daily flow through the plant, and the sewered population in the City, the per capita contributions shown in Table 10.1 were calculated.

Data prepared by others (90) indicates that the total average amount of nutrients entering the Penticton plant each day is 420 lb. of total phosphorus (as phosphate). With a known sewered population of 16,000,the per capita values shown in Table 10.2 were derived.

10.3 TOTAL NUTRIENT LOADING

Available data on population in the Okanagan Valley indicates that the average number of residents per single family dwelling is about 3.5. Using this factor and the data in Table 10.1, septic tank counts were converted into nutrient loadings for each of the sub-basins. These loadings are summarized in Table 10.2.

The 1971 census data for the Okanagan Valley indicates that the total basin population is 113,500. A combination of census data and flow data from the various sewage treatment plants reveals that the sewered population of the valley amounts to about 51,000, leaving some 62,500 people serviced by septic tanks. This latter figure includes the sewered areas of Rutland and Osoyoos. They are

TABLE 10.2

SUMMARY OF NUTRIENT LOADINGS FROM SEPTIC TANKS

Sub-basin Number (See Fig.I)	Equiv. Single Fam. Unit (SFU)		Population		TKN lb./yr.		Total P lb./yr.		Diss. Ortho P lb./yr.		Nitrate N lb./yr.	
	500' from water	500' from water	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'
1D1	88	199	308	697	2,050	4,610	620	1,400	470	1,070		
1D2	453	390	1,586	1,366	10,550	9,050	3,190	2,740	2,430	2,100		
1T1	0	2	0	7	0	50	0	10	0	10		
					12,600	13,710	3,810	4,150	2,900	3,180	negligible	
2D2	102	112	357	392	2,370	2,600	720	790	550	600		
2D3	51	99	179	347	1,190	2,300	360	700	280	530		
2D4	68	33	238	115	1,580	760	480	230	370	180		
2T1	78	24	273	84	1,810	560	550	170	420	130		
2T2	295	314	1,033	1,099	6,840	7,380	2,070	2,210	1,580	1,690		
					13,790	13,600	4,180	4,100	3,200	2,120	negligible	
3D2	250	46	875	161	5,800	1,070	1,760	330	1,340	250		
3D3	113	11	396	39	2,630	260	800	80	610	60		
3D4	15	22	53	77	350	510	110	160	80	120		
3D5	18	120	63	420	420	2,790	130	840	100	640		
3D6	0	3	0	11	0	70	0	20	0	20		
3D7	0	59	0	207	0	1,390	0	420	0	320		
3T1	231	530	809	1,855	5,470	12,280	1,620	3,720	1,240	2,840		
3T2	51	207	179	725	1,190	4,810	360	1,460	280	1,110		
3T3	130	335	455	1,173	3,020	7,770	920	2,360	700	1,800		
3T4	0	42	0	147	0	980	0	300	0	230		
3T5	40	442	140	1,547	930	10,270	280	3,100	210	2,370		
3T6	0	12	0	42	0	280	0	90	0	70		
					19,810	42,480	5,980	12,880	4,560	9,830	negligible	
4D1	201	30	704	105	4,680	700	1,420	210	1,080	160		
4D2	257	430	899	1,505	5,960	9,990	1,810	3,020	1,380	2,300		
4D3	499	286	1,747	1,351	11,600	8,960	3,510	2,710	2,680	2,070		
4D4	227	42	795	147	5,270	980	1,600	300	1,220	230		
4D5	285	289	998	1,012	6,600	6,700	2,000	2,030	1,530	1,550		
4D6	26	58	91	203	600	1,340	180	410	140	310		
4D7	61	148	214	518	1,420	3,430	430	1,040	330	790		
4D8	414	49	1,449	172	9,600	1,140	2,910	350	2,220	2,670		
4T1	108	2,423	378	8,481	2,510	56,100	760	17,000	580	12,980		
4T2	10	15	35	53	230	350	70	110	50	80		
4T3	6	138	21	483	140	3,200	40	970	30	740		
4T4	260	501	910	1,754	6,030	11,560	1,830	3,620	1,400	2,760		
4T5	61	0	214	0	1,410	0	430	0	330	0		
4T6	215	78	753	273	4,990	1,810	1,520	550	1,160	420		
4T8	25	121	88	424	580	2,810	180	860	140	660		
4U2	128	91	448	319	2,970	2,110	900	640	690	490		
					64,590	111,180	19,590	33,820	14,960	28,210	negligible	
5D1	421	1,646	1,474	5,761	9,770	38,200	2,970	11,550	1,880	8,820		
5D2	72	63	252	221	1,670	1,460	510	440	390	340		
5D3	105	197	368	689	2,440	4,560	740	1,290	560	980		
5T1	29	269	102	942	680	6,240	210	1,900	160	1,450		
5T4	87	27	304	95	2,020	630	610	190	470	150		
5T5	25	5	88	18	580	120	180	40	140	30		
5U1	169	22	592	77	3,920	520	1,090	160	830	130		
					21,080	51,730	6,310	15,570	4,430	11,890	negligible	
6D1	43	180	151	630	1,000	4,180	300	1,270	230	920		
6D2	150	182	525	637	3,480	4,210	1,060	1,280	810	980		
6D3	151	151	529	529	3,500	3,500	1,070	1,070	820	820		
6T1	29	76	102	266	680	1,760	210	540	160	410		
6T3	8	0	28	0	190	0	60	0	50	0		
					8,850	13,650	2,700	4,160	2,070	3,130	negligible	
7D1	54	11	189	39	1,250	260	380	80	290	60		
7D2	1	3	4	11	30	70	10	20	10	20		
7T1	67	115	235	403	1,560	2,670	470	810	360	620		
					2,840	3,090	860	910	660	700	negligible	
8D2	31	37	109	130	720	860	220	260	170	200		
8D3	115	64	403	224	2,690	1,480	810	450	620	340		
8D4	113	439	396	1,537	2,620	10,180	800	3,090	610	2,360		
8T1	46	28	161	98	1,070	650	320	200	240	150		
8T2	13	76	46	266	300	1,760	90	540	70	410		
8T3	7	10	25	35	170	230	50	70	40	50		
8T4	1	1	4	4	30	30	10	10	10	10		
					7,600	15,190	2,300	4,620	1,760	3,520	negligible	
9D1	28	30	98	105	650	700	200	210	150	160		
9D3	146	155	512	543	3,390	3,600	1,030	1,100	790	840		
9D4	436	689	1,526	2,413	10,100	16,000	3,060	4,840	2,340	3,690		
9T1	1	1	4	4	30	30	10	10	10	10		
9T2	6	5	21	18	140	120	40	40	30	30		
					14,310	20,450	4,340	6,200	3,320	4,730	negligible	

included under septic tank areas, however, because ground disposal of effluent is practised in both cases, and hence should be taken into account as potential contributors to nutrients in groundwater.

The total equivalent septic tank population shown in Table 10.2 amounts to some 68,000. This compared very favourably with the census figure of 62,500, especially when it is realized that the count of 68,000 people includes the equivalent average annual tourist population that contributes to septic tank discharges.

10.4 EFFECT OF SOIL TYPE ON NUTRIENT MOVEMENT THROUGH UNSATURATED SOIL

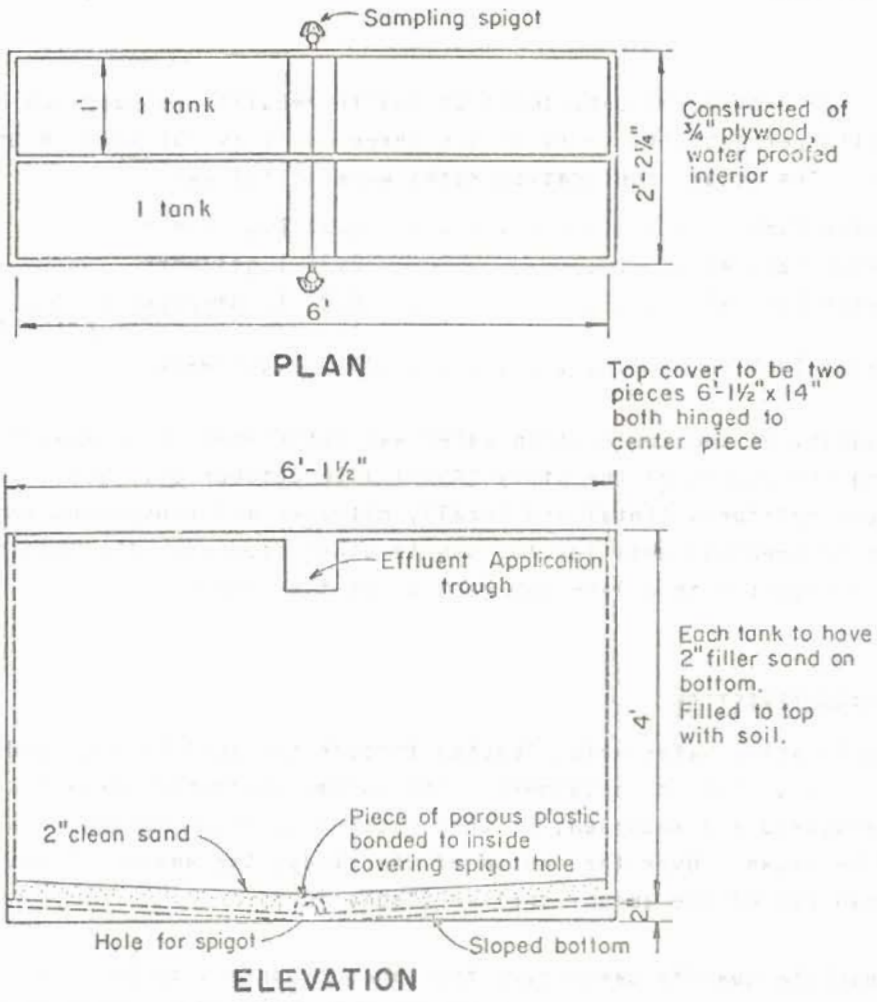
In order to estimate the amount of nutrients which move vertically through the unsaturated soil column from the point of application of the septic tank effluent to the groundwater table, some pilot scale experimentation was necessary. With the help of the District Office of the Soils Division of the Provincial Department of AGriculture, three soils typical of conditions in areas of the Valley where septic tanks are common were chosen for testing.

With the cooperation of the City of Vernon, an addition to the storage building at the Vernon sewage treatment plant was constructed to house the lysimeter units. These units were constructed to simulate four one-foot lengths of septic tank tile fields (see Figure 10.2). Each of the four boxes so constructed were water proofed with coal-tar epoxy approved for use in potable water systems. In addition to the entire assembly being inside a building, hinged covers were attached to each lysimeter tank, thus reducing the evaporation losses as much as possible, and hence approximating natural conditions in a tile field. The sloping bottoms were lined with two to three inches of clean uniformly graded sand (0.15 mm. average diameter), so that water which percolated down through the soil could flow to the collection spigot without significant disruption of the stream lines in the soil itself. It would thus simulate an extensive tile field in which the flow is downward toward a free groundwater surface. One of the lysimeter tanks was constructed with leachate collection trays and spigots at three elevations, to enable the rate of movement of impurity "fronts" to be determined.

The soils selected to be placed in the lysimeter tanks were a loamy sand from Pine Grove Estates in Kelowna, a silty loam from the Coldstream Creek area, and a relatively clean sand from lower Summerland. The loamy sand was placed in tanks #1 and #2 (with number 2 having collection trays and spigots at three levels), the silty loam was placed in tank #3, and the sand in tank #4. Descriptions of the sites from which the soils were obtained are included in Figure 10.2.

10.5 APPLICATION WATER

Septic tank effluent from Kalavista Terrace apartments was applied to the four lysimeter tanks on a daily basis. The daily application rate was that rec-



CHARACTERISTICS OF SOILS USED IN SEPTIC TANK TILE FIELD SIMULATION STUDY

LOAMY SAND - from Pine Grove Estates near Kelowna

HORIZON	DESCRIPTION
Ap 0-10"	- loamy sand, cultivated horizon
C_1 10-18"	- loamy sand containing occasional pieces of fravel
	- somewhat compact
C_2 18-26"	- coarse, loose sand
Cgj_1 26"-40".	- sandy loam and loamy sand
	- moderate, medium subangular block structure
	- weakly mottled indicating that the watertable sometimes rises into this horizon.
Cgj_2 40"-52"+	- loose fine sand and fine loamy sand
	- weakly mottled

The materials from 26" downward are reasonably similar textured and should be suitable for your lysimeter work.

SILTY LOAM - from flats next to Coldstream Creek

HORIZON	DESCRIPTION
Ah 0-6"	- loamy sand or sand, probably younger than the remainder of the soil profile and desposited by more recent flooding.
IIAh 6-12"	- weakly calcareous

SEPTIC TANK LYSIMETER DESIGN Figure 10.2

ommended in the Provincial Department of Health regulations, and was determined by the in-situ permeability tests on the three soils as outlined in those same regulations. The actual application rates were as follows:

Lysimeter Tank #1 . . . . . 2.75 I.gal/week
Lysimeter Tank #2 . . . . . 2.75 I.gal/week
Lysimeter Tank #3 . . . . . 2.2 I. gal/week (1.1 I.gal/week prior to June 6)
Lysimeter Tank #4 . . . . . .16.3 I.gal/week

The quality of the application water was determined on approximately a weekly basis during the course of the study (April 1 to October 31, 1972). Parameters measured were coliforms (total and fecal), nitrogen and phosphorus content, plus some ten other chemical entities for use in other studies. The results of these analyses are reported in a late sub-section of this report.

10.6 LEACHATE CHARACTERISTICS

All application water which leached through the soil to the sand layer was collected in hard plastic containers. The volume collected between application times was measured and recorded, so that water loss from leakage, evaporation, etc. would be known. Over the course of the study, the amount of lost water was no more than 20% of the amount applied (Table 10.3).

The leachate quality parameters that are of concern to this study are coliform bacteria (as an indicator of bacterial contamination), nitrogen forms, and phosphorus forms. Generally, the other impurities in household septic tank effluents are a function of the water supply source, and not of the use to which the water has been put before release to the septic tanks.

Coliform analyses (both total and fecal) were performed on the septic tank effluent and on the lysimeter tank leachates at relatively constant intervals during the period of study. The number of analyses performed ranged from a low of 21 for the lower sampling spigot of lysimeter tank #2, to a high of 50 for the septic tank effluent (application liquid). All coliform analyses were performed by the Provincial Laboratory of the Public Health in Vancouver, and procedures used were that laboratory's standard multiple tube fermentation technique.

The application liquid was found to have an average total coliform count of something greater than 2,400,000 bacteria per 100 ml., while the average fecal coliform count was in excess of 1,000,000 bacteria per 100 ml. No more difinitive numbers are possible because of the high percentage of tests in which all tubes incubated were found to be positive in gas production.

TABLE 10.3

QUANTITIES OF APPLICATION & LEACHATE LIQUID

LYSIMETER NO.	PERIOD OF APPLICATION	MONTH OF REWARD	AMOUNT OF APPLICATION WATER (Imp.Gal)	LEACHATE COLLECTED (Imp.Gal.)
1	April 5, 1972 to Oct. 26, 1972	April 1972	8.4	5.3
		May 1972	11.5	9.2
		June 1972	12.1	11.5
		July 1972	11.0	11.0
		Aug. 1972	12.1	10.7
		Sept. 1972	11.5	9.8
		Oct. 1972	9.3	9.2
			75.9	66.7
2	May 1, 1972 to Oct. 26, 1972	May 1972	12.1	3.5
		June 1972	12.1	10.9
		July 1972	11.0	11.2
		Aug. 1972	12.1	11.7
		Sept. 1972	11.5	9.2
		Oct. 1972	9.3	8.0
			68.1	54.5
3	May 1, 1972 to Oct. 20, 1972	May 1972	4.8	4.7
		June 1972	9.0	5.7
		July 1972	8.8	7.4
		Aug. 1972	9.7	7.3
		Sept. 1972	9.2	7.2
		Oct. 1972	7.5	6.1
			49.0	38.4
4	May 1, 1972 to Oct. 26, 1972	May 1972	64.3	54.8
		June 1972	73.5	70.8
		July 1972	66.9	66.5
		Aug. 1972	73.5	67.3
		Sept. 1972	70.2	65.7
		Oct. 1972	56.9	57.6
			405.3	382.7

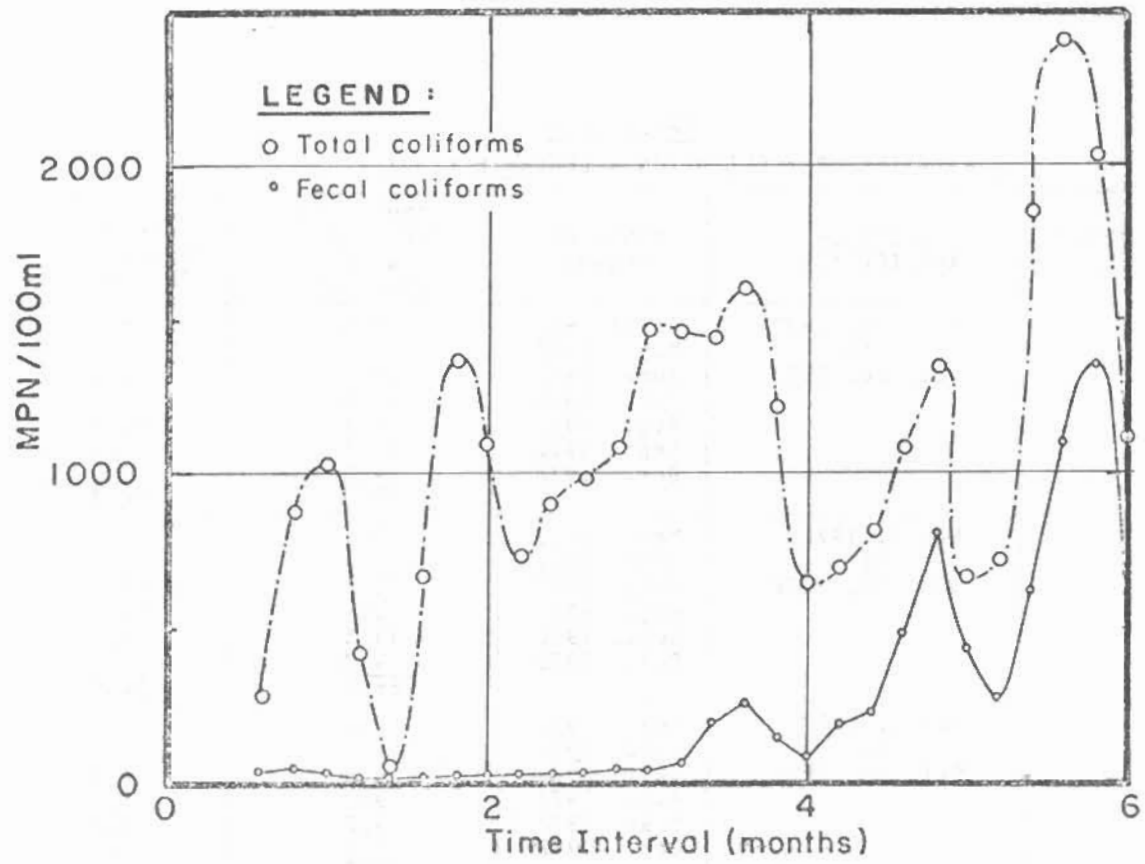
Efficiencies of the three selected soil types in removing coliform organisms can be seen by referring to Figures 10.3 - 10.7. Because of the rather wild day to day fluctuations in coliform concentrations of the individual samples, it was decided to calculate "moving averages (92) for plotting on the figures listed above. The use of this technique smooths out the many sudden fluctuations, and allows the more important long term trends to be easily observed. Three things are readily apparent from the plotted graphs:

(i) the removal efficiences of both total and fecal coliforms is in excess of 99.7% for all three soil types;

(ii) the finer textured soil in lysimeter #3 is consistently better than the coarser soils in its ability to remove coliforms;

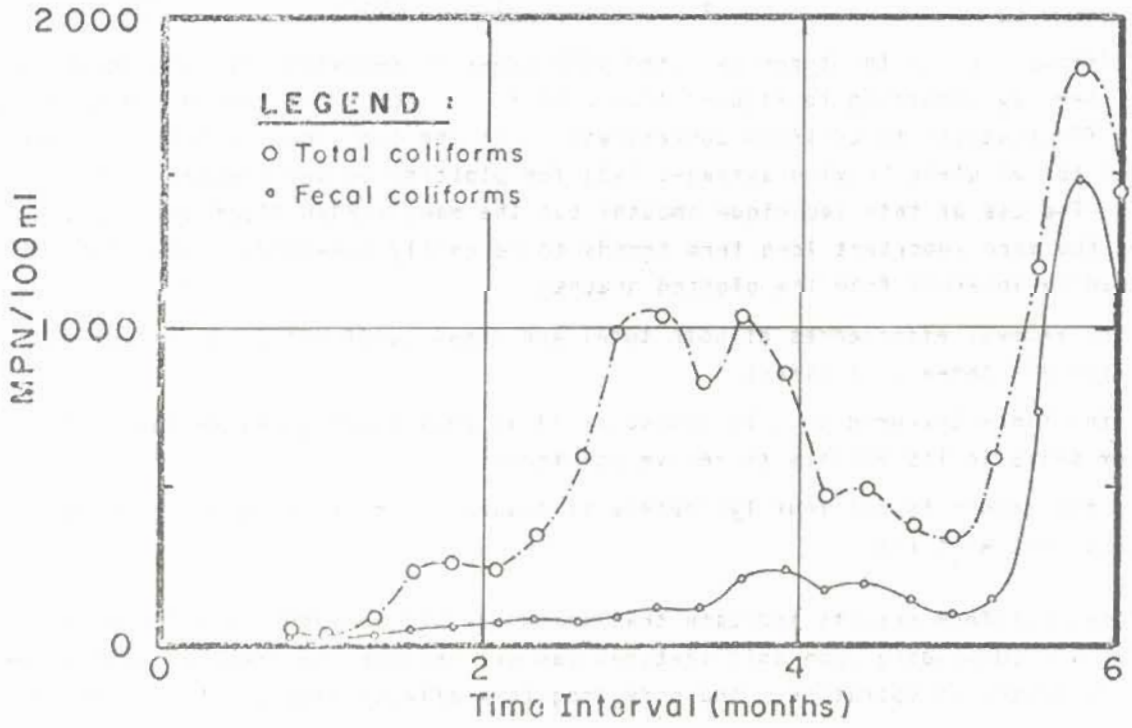
(iii) the trends in all four lysimeters is toward an increase in leachate coliforms content with time.

The fecal coliform results indicate that somewhere between 300 and 3000 organisms per 100 ml. (depending upon soil texture) can get through four feet of soil after some six months of operation. The more long-term effects have not been studied



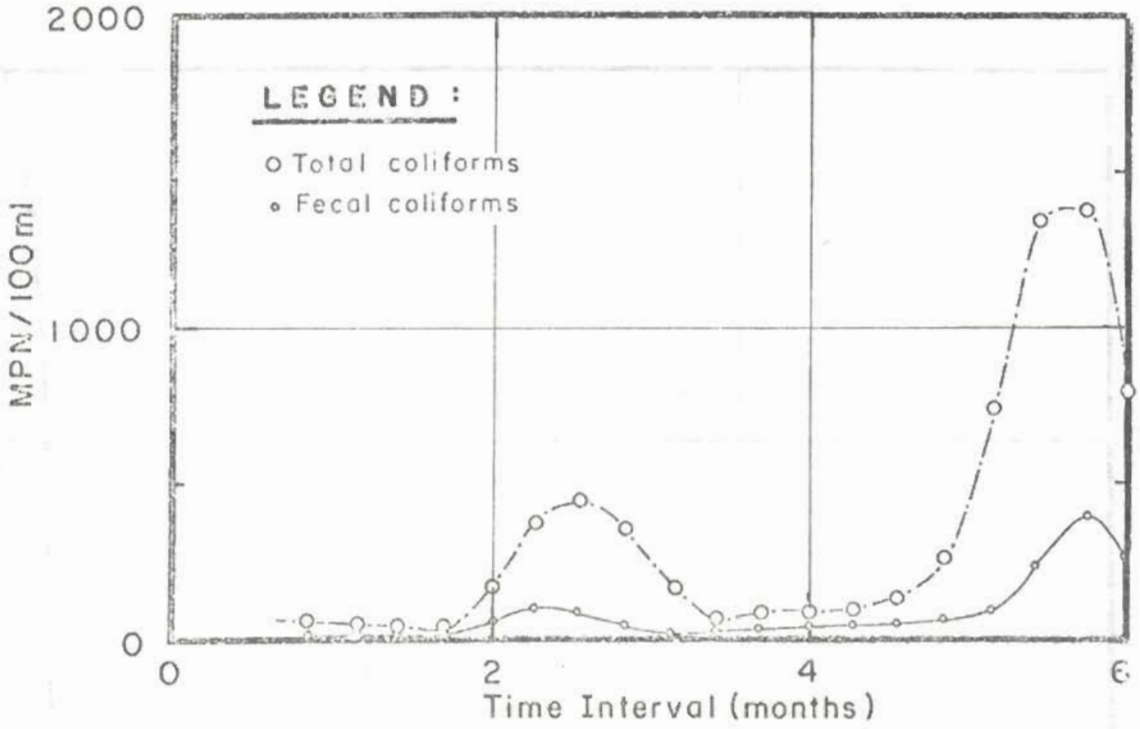
COLIFORM CONCENTRATIONS IN LEACHATE FROM LYSIMETER #1

Figure 10.3



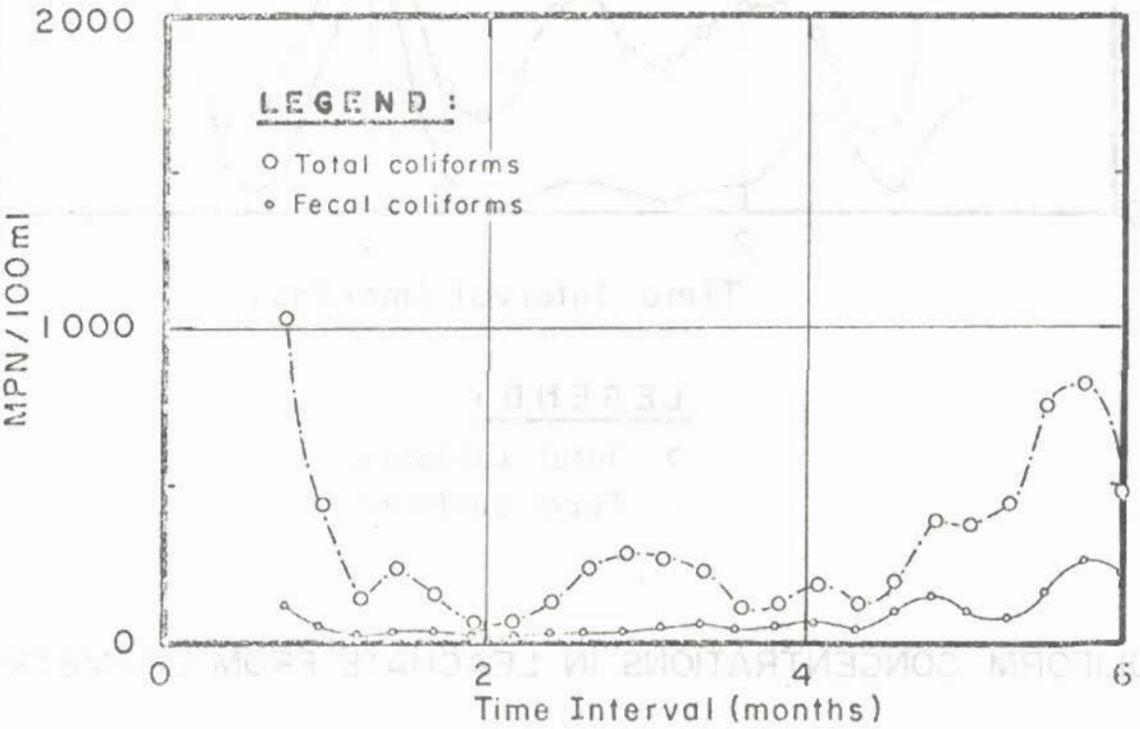
COLIFORM CONCENTRATIONS IN INTERMEDIATE LEACHATE FROM LYSIMETER#2

Figure 10.4



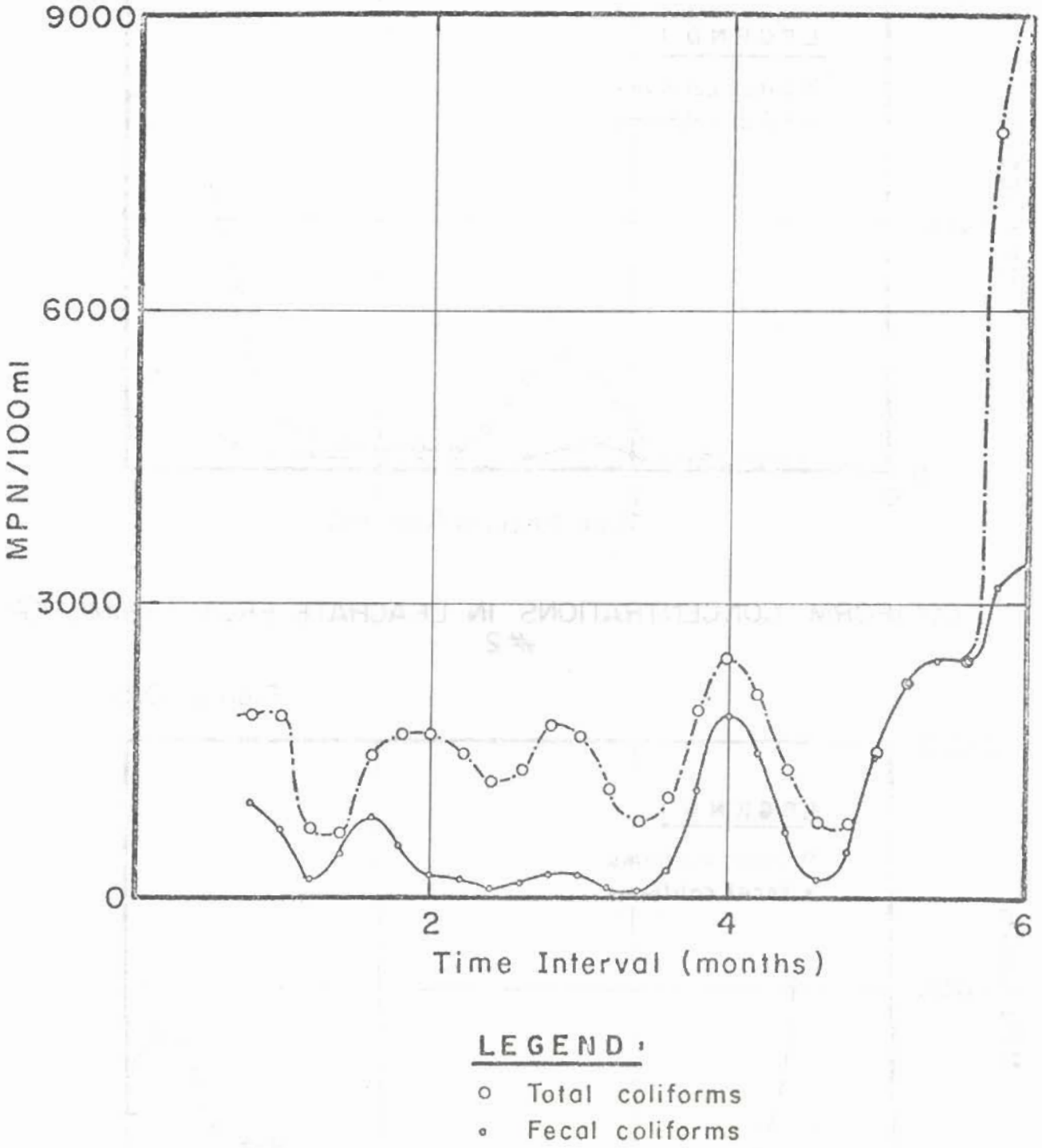
COLIFORM CONCENTRATIONS IN LEACHATE FROM LYSIMETER #2

Figure 10.5



COLIFORM CONCENTRATIONS IN LEACHATE FROM LYSIMETER #3

Figure 10.6



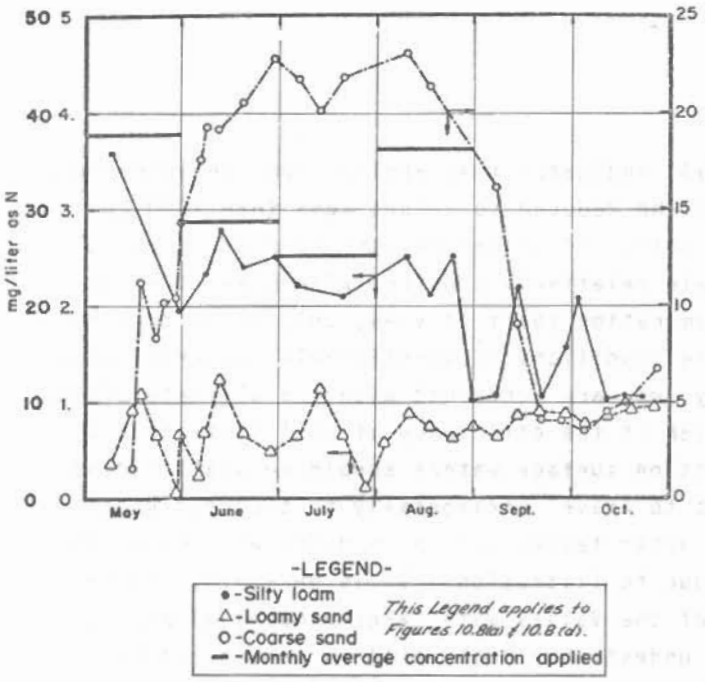
COLIFORM CONCENTRATIONS IN LEACHATE FROM LYSIMETER#4

Figure 10.7

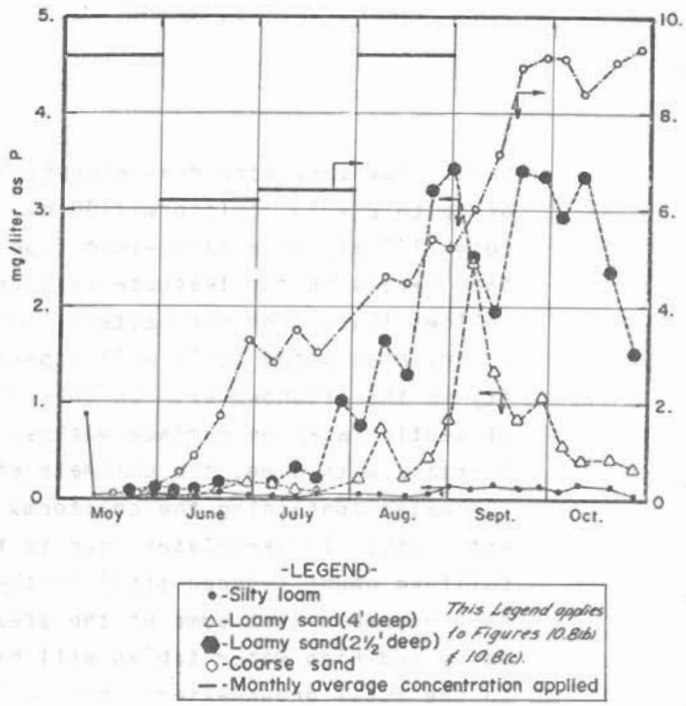
here. However, work done elsewhere (93) indicates that application concentrations of up to 2 x 10^8 coliforms/100 ml. will be reduced to values less than 1000 coliforms/100 ml. in a sandy-loam type of soil. If it can be assumed that fecal coliform levels in the leachate would remain relatively constant with time, then it follows that, from the bacterial contamination point of view, only areas that have a very high water table will experience conditions of questionable bacterial quality in the groundwater. In this study, we are concerned with the ultimate effect of septic tanks on surface waters. Even if the efficiency of soil filtration does decrease with time, the ultimate effect on surface waters should be small indeed. The water containing the coliforms has to travel horizontally to the receiving water after it percolates down to the water table, and in so doing will have its coliform count reduced still further due to filtration. It is possible, and in fact probable that some of the areas of the Valley with large numbers of septic tanks and high water tables will have undesirably high coliform concentrations in the local groundwater. More will be known about this as the results from the Provincial Kalamalka-Wood Lake Basin Study are compiled.

Nutrient analyses on the septic tank effluent and on the lysimeter leachates were limited to the following: ammonia nitrogen; nitrate nitrogen; nitrite nitrogen, organic nitrogen, dissolved ortho-phosphate; and total phosphorus. As expected, the nitrogen in the septic tank effluent was limited almost entirely to ammonia and organic forms. When the average values of the forty-five samples were calculated, it was found that less than 1/2% of the nitrogen was in the nitrate and nitrite forms. Phosphorus analyses showed that dissolved ortho phosphate accounted for about 90% of the total phosphorus present in the septic tank effluent. It was apparent from the data that there was a temporal fluctuation in concentrations of all nutrient forms, and hence monthly averages were calculated, and are shown on Figures 10.8 (a), (b), (c), (d). Speculation as to why this fluctuation is occurring is difficult, but it is interesting to note that, with the exception of the trivial nitrate levels, the nutrient concentrations drop off during the two main summer months.

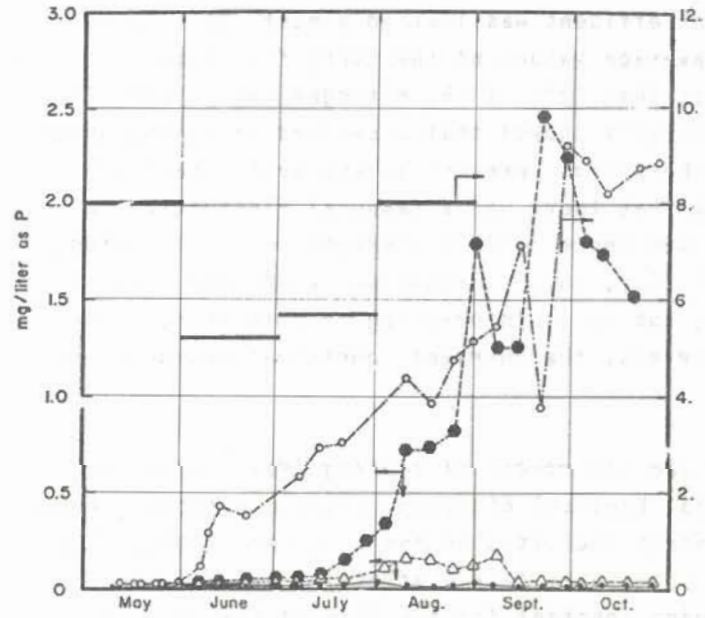
Leachate analyses performed over the six months of testing (May 1 to October 30, 1972) showed concentrations of total Kjeldahl nitrogen, nitrate nitrogen, total phosphorus, and dissolved ortho phosphorus indicated on the attached graphs. The TKN data indicates that the two finer soils were fairly effective in removing TKN, with these removal efficiencies remaining constant for the life of the project. The reason for the silt being less effective than the loamy sand (93% vs. 98% removal) is obscure, but it may be attributable to a nitrification-denitrification process in the loamy sand that could not be set up in the silty loam due to the presence of only a very small aerobic zone at the surface. The sand exhibited odd TKN characteristics when considered in isolation, but when nitrate data is observed simultaneously, the reasons for TKN trend becomes obvious: (1) TKN concentration rises very quickly, as the sand has very little capacity to adsorb it; (2) as nitrifying bacteria establish themselves in the easily maintained aerobic zone of



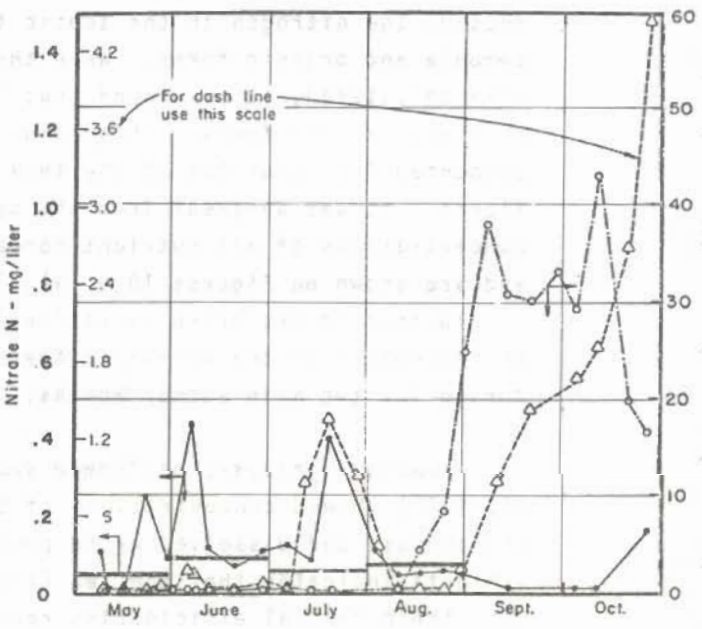
(a)TKN CONCENTRATIONS IN LEACHATE FROM LYSIMETERS.



(b)TOTAL PHOSPHORUS CONCENTRATIONS IN LEACHATE FROM LYSIMETERS.



(c)DISSOLVED ORTHO-P CONCENTRATIONS IN LEACHATE FROM LYSIMETERS.



(d) NITRATE - NITROGEN CONCENTRATIONS IN LEACHATE FROM LYSIMETERS.

Figure 10.8 (a-d)

the sand, the TKN concentration falls off at the same time as the resulting NO_3 level rises. By the time four months have elapsed, the NO_3 levels have reached almost 90% of the application loads of TKN.

Nitrate concentrations in the leachate from the loamy sand were beginning to rise toward the end of the six months, indicating that nitrification was proceeding without a totally compensating dentrification process at greater depth. In the silty-loam, no appreciable NO_3 was observable at any time, indicating that either all TKN was being adsorbed as TKN, or if any nitrification was occurring, it was being completely denitrified again as the water moved through the deeper soil.

Total phosphorus and dissolved orthophosphorus concentrations in the leachate were more easily explainable, with total breakthrough of both occurring in the four foot depth of sand during the test period. In the loamy sand, breakthrough of both total and ortho P at the 2 1/2 foot depth began to occur after three months (35% breakthrough after five months), while no breakthrough was apparent after five months at the four foot depth. The leachate from the silt loam had no appreciable concentration of phosphorus in it after the five months of testing.

10.7 AMOUNTS OF NUTRIENTS REACHING GROUNDWATER

To estimate the amounts of the various nutrient forms that actually travel from the loading sites to the groundwater table, it is necessary to consider the types of soil involved at the loading sites, and the depths of unsaturated soil above groundwater. Both of these factors may substantially affect the fraction of nutrient loading that reaches the groundwater. A matrix can then be established that shows the superimposed effects of these two parameters.

10.8 EFFECT OF SOIL TYPE

As a result of the tile field simulation studies at Vernon, it was possible to estimate the concentrations of nutrients leaching through some 4 feet of the three tested soil types. Some ideas of the rate of movement of the nutrient fronts through the soil was also obtainable, although no definite rates in terms of feet per year could be established. The results summarized in Figures 10.8 (a) and (b) were used to estimate multiplying factors to convert septic tank loadings into leachate quantities for 4 feet of soil depth. These factors are shown in Table 10.4.

The nitrate nitrogen factors shown in Table 10.4 must be used in conjunction with TKN loadings. The data from the tests indicated that no nitrate nitrogen was present in the septic tank effluent, and hence the nitrate levels found in the leachate must be due to nitrification that has occurred in the soil.

TABLE 10.4

FRACTION OF NUTRIENT LOADINGS APPEARING IN LEACHATE FROM SOIL COLUMNS

NUTRIENT	SILTY LOAM (COLDSTREAM)	LOAMY SAND (KELOWNA)	SAND (SUMMERLAND)
Total Kjeldahl Nitrogen	0.05	0.03	0.15
Nitrate Nitrogen*	0.01	0.06	0.85
Total Phosphorus	0.02	0.4	1
Dissolved Ortho-Phosphorus	0.02	0.4	1

* multiplying factors for nitrate nitrogen are to be applied to TKN loadings.

At present time, there is no conclusive explanation of why the loamy sand allowed less TKN to pass through than the silty loam did, but a possible reason might be that the loamy sand allowed considerably more nitrification to occur, with a subsequent denitrification occurring in the lower levels of the soil. The silty loam, on the other hand, could conceivably contain such a small aerobic zone that little nitrification occurred, but some TKN was still able to pass through.

All of the factors shown in Table 10.4 are based on the more or less steady-state conditions that were evident after six months of testing. The question of how long each of the soils would continue to adsorb the nutrients is difficult to answer. It is obvious that the Summerland sand was exhausted of its adsorptive capacity within 3 or 4 months, while the Kelowna loamy-sand was showing a partial breakthrough of phosphorus after about four months at a depth of 2 1/2 feet (Figures 10.8 (c) and (d)). The factors that were derived for Table 10.4 are intended to be indicative of conditions that might prevail in a septic tank tile field area that has been in existence at least two years. The factors may be considerably higher where loadings have been applied for periods well in excess of two years.

To make use of soil categorization maps that had already been prepared for the agricultural inputs aspects of Section 7, it was necessary to change the factors shown in Table 10.4 to conform with the soil types used on the categorization maps. These three soil types were loosely termed fine, medium, and coarse. According to detailed soils maps, none of the three soils that had been chosen for the septic tank field experiment were indicative of the fine soils of the Okanagan Basin. Both the loamy-sand and the sand fell in the coarse category, while the silty-loam is classified as medium. An estimate therefore had to be made for loading fractions reaching groundwater for fine soils, and this is shown in Table 10.5.

TABLE 10.5

MULTIPLYING FACTORS FOR DEFINED SOIL TYPES
(fraction reaching groundwater)

SOIL TYPE / DEPTH TO GROUNDWATER	F	M	C
	Total Phosphorus		
0'-6' (S)	.01	.03	1.0
6'-30' (I)	.005	.015	0.7
30' + (D)	.002	.007	0.3
	Dissolved Orthophosphorus		
0'-6' (S)	.01	.03	1.0
6'-30' (I)	.005	.015	0.7
30' + (D)	.002	.007	0.3
	Total Kjeldahl Nitrogen		
0'-6' (S)	.02	.04	.15
6'-30' (I)	.01	.02	.10
30' + (D)	.005	.008	.07
	Nitrate Nitrogen(xTKN loading)		
0'-6' (S)	.01	.05	.85
6'-30' (I)	.01	.03	.7
30' + (D)	.01	.01	.5

10.9 EFFECT OF SOIL DEPTH

For purposes of this study, the areas of the Okanagan Basin that contain septic tanks were categorized according to depth of soil to groundwater. This was accomplished by overlaying transparencies showing septic tank areas onto base maps showing existing wells. The Groundwater Division of the Provincial Water Resources Service then supplied the necessary well data cards so that water table elevations could be plotted in three depth ranges; shallow (0'-6'); intermediate (6'-30'); and deep (30'). These three categories were deemed sufficient to adequately estimate the total input of nutrients to groundwater. For the shallow depth areas, the field experiments provide factors for estimating fractions of loading reaching groundwater. The intermediate depth factors are still estimable from the field experiments, and although the factors for the deep category may be substantially in error, there is only a very sm ll percentage of the septic tanks in the basin that are located in such areas.

Table 10.5 is a summary of factors for converting source nutrient loadings to groundwater contributions for the three chosen soil depth categories. It should be noted that, as was the case in Table 10.4 the nitrate nitrogen factors are to be used in conjunction with the TKN loadings.

10.10 GROUNDWATER CONTRIBUTIONS

Map transparencies of the Okanagan Basin have been prepared which show septic tank numbers and densities within each of the drainage sub-basins shown on Figure 10.1. When these transparencies, plus the transparencies which show soil types, are superimposed over the base maps that indicate depths to groundwater, it is possible to determine quite closely the number of septic tanks in each combination of soil type and depth to groundwater. Table 10.6 summarizes the information so obtained. The term single family unit (SFU) was used so that all establishments using septic tanks for disposal of sewage could be considered in the same terms. Conversion estimates for motels, for instance, were made on the basis of the number of rental units contained, and the percentage of time occupied.

To determine the nutrient contributions of septic tanks to groundwater, the loadings shown in Table 10.2 were multiplied by the fractions of SFU's in each category of soil type and depth to groundwater shown in Table 10.6 and that result was subsequently multiplied by the appropriate multiplying factor in Table 10.5. The results of these calculations are summarized in Tables 10.7, 10.8, 10.9 and 10.10.

It is interesting to note that by far the majority of the septic tanks are located in the coarse or intermediate soil areas, and in the shallow or medium depth to groundwater areas. The choosing of coarse soils for developments that utilize septic tanks for sewage disposal has historically been recommended to avoid potential public health problems. However, Table 10.5 shows that such soils are much less desirable than the fine soils when the problem of nutrient transport is considered. Because most of the development is located in the main valley near water bodies, the depth to groundwater is not great, and hence a greater percentage of nutrient loadings reach that groundwater than would be the case in higher areas of the basin.

In summary, the estimates of additions of nutrients to groundwater from septic tanks over the entire basins are as follows:

Total Kjeldahl Nitrogen	20,600 lb/yr.
Nitrate Nitrogen	108,000 lb/yr.
Total Phosphorus	31,800 lb/yr.
Dissolved Orthophosphorus	24,500 lb/yr.

10.11 AMOUNTS OF NUTRIENTS REACHING SURFACE WATERS VIA GROUNDWATER

The estimations of nutrient transport via groundwater to the surface waters of the Okanagan Basin can be considered approximate at best. To provide relatively accurate estimates would require the establishment of well-fields in areas of high septic tank density so that the increase in nutrient content of the groundwater can be measured as it passes under the septic tank area.

TABLE 10.6

EQUIVALENT SINGLE FAMILY UNITS (S.F.U.'S) RELATED TO SOIL TYPES AND DEPTH TO GROUND WATER

Soil Type	Depth to Groundwater
F=Fine M=Medium C=Coarse	S=Shallow (0-6') I=Intermediate (6'-30') D=Deep (30')

Sub-Basin	No. of Equiv. S.F.U.'s	No. of Equiv. SFU's in each combination of Soil Type and depth to Ground Water								
		CS	CI	CD	MS	MI	MD	FS	FI	FD
3T5	482	59	94	12	8	117	9	6	156	21
3T6	12				7			5		
3D6	3					3				
3D3	124					36			88	
3D4	37				2			34	1	
3D7	59		28			6			25	
3T4	42	8							28	6
3D5	138	37	10		10	18		15	40	8
3T3	465	24	27	20	45	265	30	30	21	3
3T1	761	2	30		51	313	10		208	147
3T2	258					110	40		108	
3D2	296	130	34	106		11		5	5	5
Basin 3	2,677	260	223	138	123	879	89	95	680	190
2D4	101					101				
2T2	609	15	20		30	298	2		244	
2D3	150					67			83	
2D2	214		205			9				
2T1	102		30			10	14		48	
Basin 2	1,176	15	255	0	30	485	16	0	375	0
1D1	287				87	14		70	116	
1D2	843		233		103	120	10	109	229	39
1T1	2					2				
Basin 1	1,132	0	233	0	190	136	10	179	345	39
4D1	231		30						201	
4T1	2,531		8		174	2,152		50	144	3
4D3	885		167			4			714	
4T4	761	30	176			484		35	36	
4T3	144		10			20		20	94	
4D6	84							17	67	
4T8	146					112		5	29	
4D7	209				7	196		3	3	
4T5	61					61				
4D8	463					463				
4D4	269				75	75		63	56	
4T2	25				15	10				
4D2	687				250	249		94	94	
4U2	219		36		62	62		29	30	
4D5	574		449			75				
4T6	293	10	226	57						
Basin 4	7,582	40	1,152	57	583	3,963	0	316	1,468	3
5D1	2,067		808			1,257			2	
5T1	298		197			101				
5D2	135					135				
5D3	302		97			205				
5U1	191					191				
5T4	114		10			104				
5T5	30		30							
Basin 5	3,137	0	1,142	0	0	1,993	0	0	2	0
6T3	8					8				
6D3	302					302				
6D1	223		54			169				
6D2	332		320			12				
6T1	105		105							
Basin 6	970	0	479	0	0	491	0	0	0	0
7D2	4		4							
7D1	65		41	1	16	7				
7T1	182	27	16		60	32	47			
Basin 7	251	27	61	1	76	39	47	0	0	0
8D4	552	5	322	10	57	153			5	
8D2	68		2		2	64				
8T4	2		2							
8T2	89		89							
8D3	179	49	114		6	10				
8T1	74		24		17	31	2			
8T3	17		11						6	
Basin 8	981	54	564	10	82	258	2	0	11	0
9D1	58	2	42				3		11	
9D4	1,125	160	760	148	10	46			1	
9T2	11	5	4	2						
9D3	301	72	229							
9T1	2		2							
Basin 9	1,497	239	1,037	150	10	46	3	0	12	0

TABLE 10.7

AMOUNT OF TKN REACHING GROUNDWATER

SUB-BASIN	TKN LOADING (lb/yr)	AMOUNT OF TKN REACHING GROUNDWATER FOR EACH COMBINATION OF SOIL TYPE AND DEPTH TO GROUNDWATER (loading) x (fraction of SUF's in each category (Table 1.65) x mult. factor (Table 1.64)									
		CS	CI	CD	MS	MI	MD	FS	FI	FD	TOTAL
1	26,310	0	541	0	177	63	2	83	80	5	951
2	27,390	52	594	0	28	226	3	0	87	0	990
3	62,290	907	519	225	114	409	17	44	158	22	2,415
4	175,770	139	2,671	92	541	1,837	0	147	340	0	5,767
5	72,810	0	2,650	0	0	925	0	0	0	0	3,575
6	22,500	0	1,111	0	0	228	0	0	0	0	1,339
7	5,840	94	142	2	71	18	9	0	0	0	336
8	22,790	188	1,310	16	76	120	0	0	3	0	1,713
9	34,760	832	2,408	244	9	21	1	0	3	0	3,518
										=	20,604

TABLE 10.8

AMOUNT OF NITRATE N REACHING GROUNDWATER

SUB-BASIN	TKN LOADING (lb/yr)	AMOUNT OF NITRATE REACHING GROUNDWATER FOR EACH COMBINATION OF SOIL TYPE AND DEPTH TO GROUNDWATER (loading) x (fraction of SUF's in each category (Table 1.65) x mult. factor (Table 1.64)									
		CS	CI	CD	MS	MI	MD	FS	FI	FD	TOTAL
1	26,310	0	3,787	0	221	95	3	42	80	10	4,238
2	*27,390*	*295*	*4,156*	*0*	*35*	*339*	*4*	*0*	*97*	*0*	*4,918*
3	62,290	5,140	3,633	1,607	143	614	21	22	158	44	11,382
4	175,770	788	18,697	657	676	2,756	0	74	340	0	23,988
5	72,810	0	18,550	0	0	1,388	0	0	0	0	19,938
6	22,500	0	7,777	0	0	342	0	0	0	0	8,119
7	5,840	533	994	14	89	27	11	0	0	0	1,668
8	22,790	1,065	9,170	114	95	180	0	0	3	0	10,627
9	34,760	4,715	16,856	1,743	11	32	1	0	3	0	23,361
										=	108,239

TABLE 10.9

AMOUNT OF TOTAL P REACHING GROUNDWATER

SUB-BASIN	TOTAL P LOADING lb/yr	AMOUNT OF TOTAL P REACHING GROUNDWATER FOR EACH COMBINATION OF SOIL TYPE AND DEPTH TO GROUNDWATER (loading) x (fraction of S.E.U. in each cat. (Table 1.65) x mult. factor (Table 1.64)									
		CA	CI	CD	MS	MI	MD	FS	FI	FD	TOTAL
1	7,960	0	1,147	0	40	14	0	13	12	1	1,227
2	8,280	106	1,257	0	6	51	1	0	13	0	1,434
3	18,860	1,831	1,100	292	26	93	4	7	24	3	3,380
4	53,410	282	5,681	120	123	419	0	22	52	0	6,699
5	21,880	0	5,576	0	0	209	0	0	0	0	5,785
6	6,860	0	2,371	0	0	52	0	0	0	0	2,423
7	1,770	190	301	2	16	4	2	0	0	0	515
8	6,920	381	2,785	21	17	27	0	0	0	0	3,231
9	10,540	1,683	5,111	317	2	5	0	0	0	0	7,118
										=	31,812

TABLE 10.10

AMOUNT OF DISSOLVED ORTHO P REACHING GROUNDWATER

SUB-BASIN	TOTAL ORTHO P LOADING lb/yr	AMOUNT OF DISSOLVED ORTHO P REACHING GROUNDWATER FOR EACH COMBINATION SOIL TYPE AND DEPTH TO GROUNDWATER (loading) x (S.F.U. fraction in each cat. (Table 1.65) x (mult. factor (Table 1.64)									
		CS	CI	CD	MS	MI	MD	FS	FI	FD	TOTAL
1	6,080	0	876	0	31	11	0	10	9	0	937
2	6,330	81	961	0	5	39	1	0	10	0	1,097
3	14,390	1,398	839	223	20	71	3	5	18	2	2,579
4	43,170	228	4,591	97	100	338	0	18	42	0	5,414
5	16,320	0	4,159	0	0	156	0	0	0	0	4,315
6	5,200	0	1,797	0	0	39	0	0	0	0	1,836
7	1,360	146	231	2	12	3	2	0	0	0	396
8	5,280	291	2,125	16	13	21	0	0	0	0	2,466
9	8,050	1,285	3,903	242	2	4	0	0	0	0	5,436
										=	24,476

Analysis of the data in Table 10.2 permits the major sub-basin loadings to be categorized according to whether they are applied on land that drains directly to the mainstem lakes and rivers or on land that drains to tributary streams, and also according to whether they are applied to land less than or more than 500 feet from surface water courses. These calculations are summarized in Table 10.11.

TABLE 10.11

FRACTIONS OF NUTRIENT LOADINGS APPLIED TO AREAS THAT DRAIN DIRECTLY TO MAINSTEM LAKES AND RIVERS

SUB-BASIN (see Fig. I)	% OF LOADING APPLIED TO DIRECT DRAINAGE AREAS		% OF LOADING APPLIED TO TRIBUTARY DRAINAGE AREAS	
	500' FROM SURFACE WATER	500' FROM SURFACE WATER	500' FROM SURFACE WATER	500' FROM SURFACE WATER
1	48	52	0	0
2	19	21	32	28
3	15	10	17	58
4	26	19	11	44
5	19	61	10	10
6	35	53	4	8
7	22	6	27	45
8	26	55	7	12
9	41	58	0.5	0.5

By combining the data from Table 10.11 with that from Tables 10.7 to 10.10 the amounts of nutrients reaching groundwater in each of the categories of Table 10.11 can be calculated. A summary of these calculations is contained in Table 10.12.

In order to determine the amounts of nutrients actually reaching the receiving waters via groundwater flow and stream flow, three assumptions have been made:

(i) 100% of all nutrients that reach groundwater within 500 feet of a surface water will reach the valley floor in tributary sub-basins or the receiving water plant in the direct drainage areas.

(ii) 30% of TKN, total phosphorus and orthophosphorus and 70% of nitrate N that reach groundwater further than 500 feet from a surface water will reach the valley floor in the tributary and basin or the receiving water plane in the direct drainage areas.

(iii) 80% of the NO_3N under the valley floor reaches the valley outlet plane while 50% of the other nutrients under the valley floor reach the valley outlet plane.

TABLE 10.12

NUTRIENT CONTRIBUTIONS TO GROUNDWATER IN AREAS THAT DRAIN DIRECTLY TO MAINSTEM LAKES AND RIVERS

SUB-BASIN	TKN (lb/yr)				NITRATE N (lb/yr)				TOTAL P (lb/yr)				DISS. ORTHO P (lb/yr)			
	DIRECT DRAINAGE AREA		TRIBUTARY DRAINAGE AREA		DDA		TDA		DDA		TDA		DDA		TDA	
	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'	500'
1	455	495	0	0	2030	2200	0	0	590	640	0	0	450	485	0	0
2	190	210	310	280	935	1030	1570	1375	270	300	460	400	205	230	350	305
3	360	240	410	1400	1705	1140	1935	6600	505	340	575	1960	385	260	440	1490
4	1500	1095	635	2540	6235	4555	2640	10550	1740	1270	735	2945	1325	965	560	2245
5	680	2180	360	360	3790	12160	2000	2000	1100	3530	580	580	840	2690	440	440
6	470	710	55	110	2840	4300	325	650	850	1285	95	195	645	980	70	150
7	75	20	90	150	370	100	450	750	115	30	140	230	90	25	105	175
8	445	940	120	205	2765	5845	745	1275	840	1775	225	390	640	1350	170	295
9	1440	2035	20	20	9575	13540	115	115	2915	4125	35	35	2220	3140	25	25

The percentages given in the above assumptions cannot be specifically defended. However, the 100%, 80% and 70% figures are probably not substantially in error due to the short distance involved in assumption (i) and the chemical inactivity of nitrate indicated by 70 and 80 percent which could be altered through denitrification. The 30 and 50 percent figures are only crude estimates and may in fact range from 0% to something in excess of 50% for different sections of the basin, depending upon what percentage of the groundwater actually reaches a surface water course and upon the adsorptive capacity of the saturated soil.

The data presented in Table 10.12 was converted to loadings to the receiving waters and to streams for direct and tributary drainage areas (Table 10.14). Figures 10.9 , 10 10, 10.11 and 10.12 illustrate the methodology used in estimating the nutrient loadings to the streams or to the receiving waters. The multiplying factors used for horizontal flow in the tributary and direct drainage areas are presented in Table 10.13.

The nutrient loadings to receiving water via groundwater and streamflow are tabulated in Table 10.14. The amounts of nutrients shown under the Loading "Direct Drainage Area" in Table 10.14 reach the mainstem lakes or rivers directly. The amounts shown under "Tributary Drainage Area" reach their final destination via groundwater and surface streams.

10.12 CONCLUSIONS

Septic tank and related ground discharge of sewage can contribute to nutrient loadings in the surface waters of the Okanagan Basin. Transport of these nutrients involves downward movement through unsaturated soils to the water table, and then horizontal movement with the groundwater to a surface water course. In order to estimate the influence of this nutrient source on the basin, it was necessary to do three things:

(a) determine the number and relative density of septic tanks throughout the basin;

(b) assess the parameters that affect the vertical movement of nutrients through unsaturated soil. The two most important parameters were considered to be soil type and depth to water table;

(c) determine the proximity of septic tanks to surface waters, and estimate the nutrient loadings that actually reach the mainstem lakes and the tributary streams, respectively.

The enumeration of septic tanks was accomplished by a combination of utilizing land use maps prepared by the various regional governments and direct field counting of residences.

The travel of nutrients through unsaturated soil was investigated with the help of a pilot-scale experiment in which simulated tile-field disposal of septic

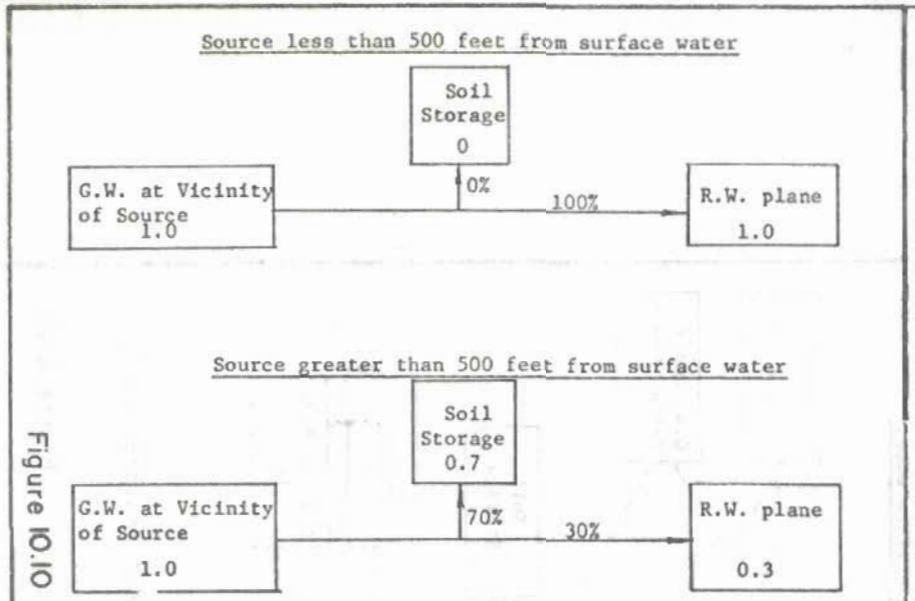


Figure 10.10

HORIZONTAL FLOW MULTIPLYING FACTORS FOR DIRECT DRAINAGE AREAS
(Total Kjeldahl, Total Phosphorus and Orthophosphorus)

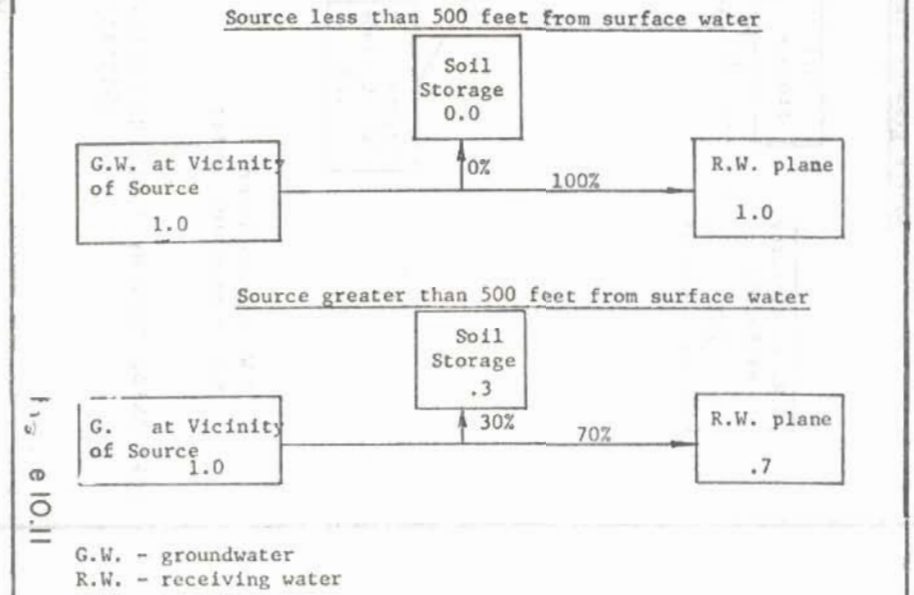
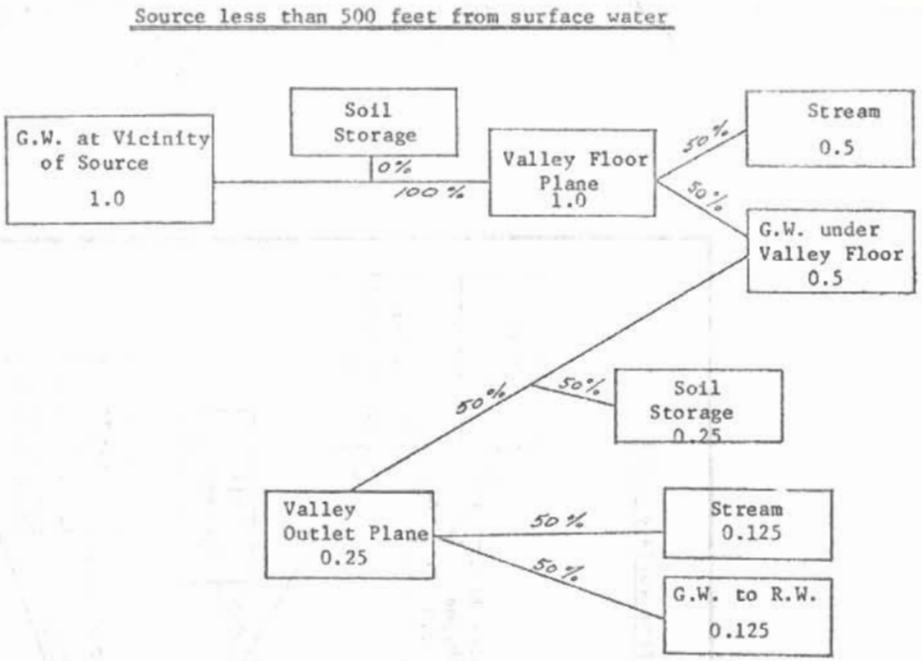


Figure 10.11

HORIZONTAL FLOW MULTIPLYING FACTORS FOR DIRECT DRAINAGE AREAS
(Nitrate N)



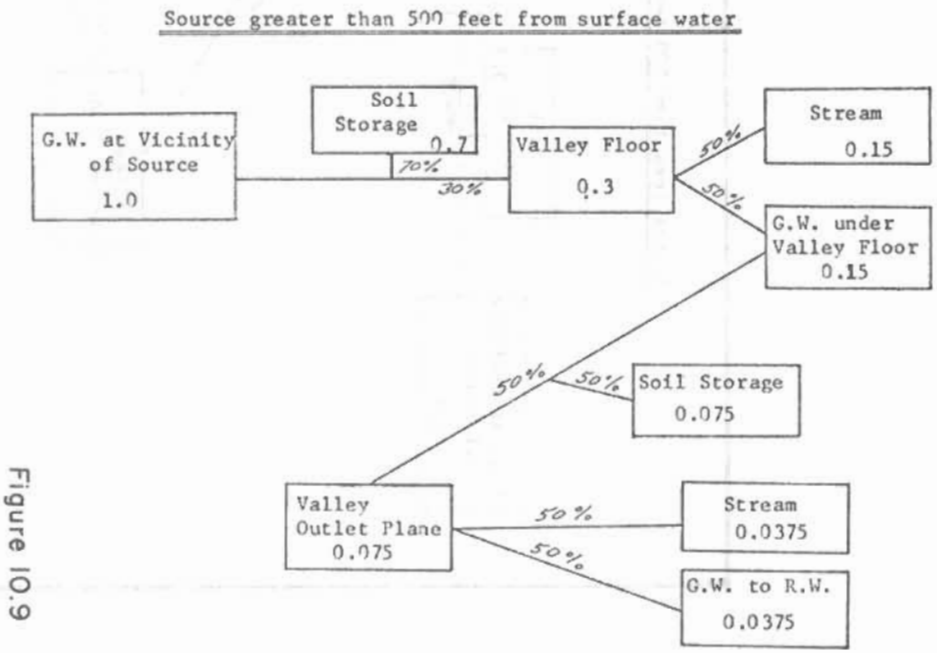
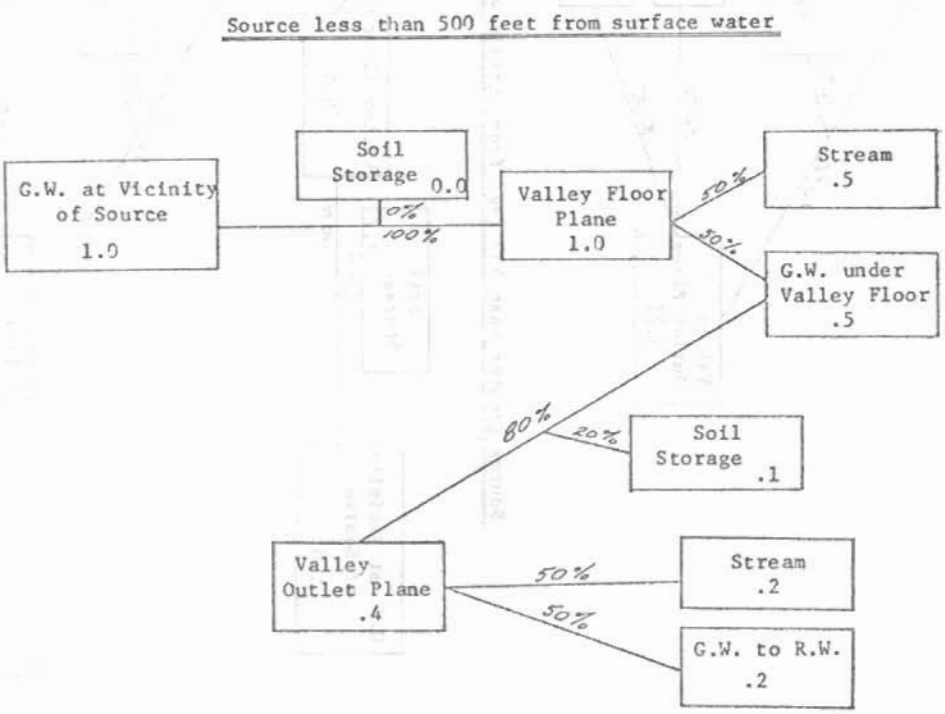
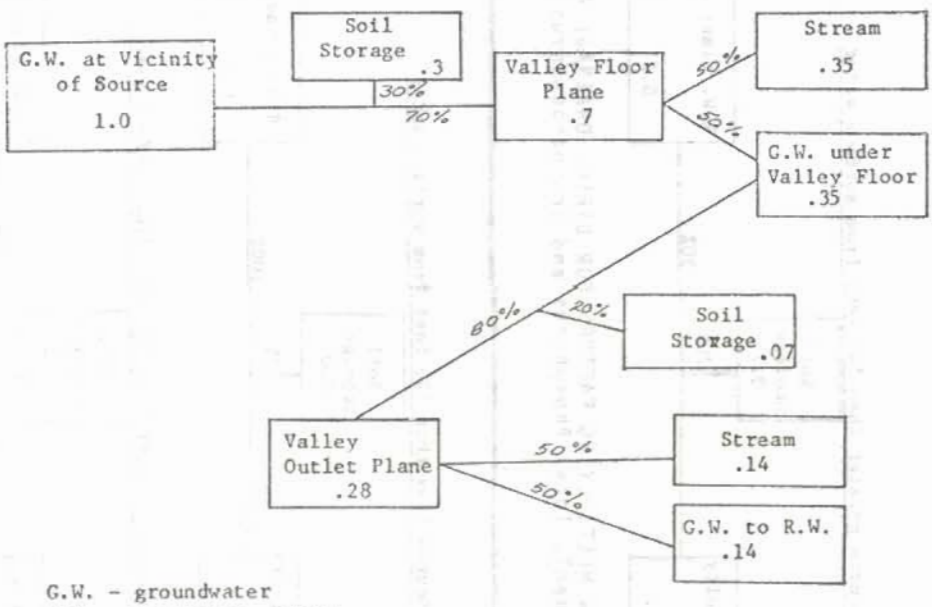


Figure 10.9

HORIZONTAL FLOW MULTIPLYING FACTORS FOR TRIBUTARY DRAINAGE AREAS
(Total Kjeldahl Nitrogen, Total Phosphorus and Orthophosphorus)





G.W. - groundwater
R.W. - receiving water

HORIZONTAL FLOW MULTIPLYING FACTORS FOR TRIBUTARY DRAINAGE AREAS
(Nitrate N)

Figure 10 12

TABLE 10.13

MULTIPLYING FACTORS REFLECTING THE EFFECT OF MECHANISMS ENCOUNTERED DURING HORIZONTAL TRANSPORT OF GROUNDWATER CARRYING SEPTIC TANK NUTRIENTS

NUTRIENTS	TKN, TOTAL P, DISS. ORTHO P				NITRATE N			
DRAINAGE AREA	TDA		DDA		TDA		DDA	
DISTANCE FROM SURFACE WATER	500	500	500	500	500	500	500	500
Valley Wall Storage	0.000	0.700	+	+	0.000	0.300	+	+
Valley Floor Soil Storage	0.250	0.075	+	+	0.100	0.070	+	+
Soil Storage (DDA)	+	+	0.000	0.700	+	+	0.000	0.300
Stream Pick-up	0.625	0.188	+	+	0.200	0.490	+	+
Groundwater to Receiving Water	0.125	0.038	1.000	0.300	0.700	0.140	1.000	0.700
TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE 10.14

NUTRIENT LOADINGS REACHING SURFACE WATERS IN THE MAJOR SUB-BASINS OF THE OKANAGAN

	TKN (lb/yr)				NITRATE N (lb/yr)				TOTAL P (lb/yr)				DISS. ORTHO P (lb/yr)			
	GROUNDWATER			STREAM	GROUNDWATER			STREAM	GROUNDWATER			STREAM	GROUNDWATER			STREAM
	DDA	TDA	TOTAL	TDA	DDA	TDA	TOTAL	TDA	DDA	TDA	TOTAL	TDA	DDA	TDA	TOTAL	TDA
1	603	0	603	0	3570	0	3570	0	782	0	782	0	595	0	595	0
2	253	51	304	248	1656	506	2162	1772	360	75	435	365	274	57	331	278
3	432	109	541	524	2503	1311	3814	4588	607	153	760	734	463	116	579	560
4	1828	184	2012	882	9423	2005	11428	7017	2121	213	2334	1022	1614	162	1777	779
5	1334	61	1395	295	12302	680	12982	2380	2159	98	2257	475	1647	74	1221	360
6	683	11	694	55	5850	156	6006	546	1235	20	1255	96	939	15	954	72
7	81	17	98	85	440	195	635	682	124	27	151	131	97	20	118	99
8	727	23	750	114	6856	327	7184	1146	1372	44	1417	215	1045	33	1078	163
9	2050	3	2053	16	19053	39	19092	136	4152	5	4158	28	3162	4	3166	20
8 + 9	2777	26	2803	130	25909	366	26276	1282	5524	49	5575	243	4207	37	4244	183
TOTAL	7991	459	8450	2219	61653	5219	66873	18267	12912	635	13549	3066	9836	481	10319	2331

tank effluent was carried out over a six-month period of time. Three parallel units were used, each one containing a soil from an area of the valley which has a large number of septic tanks.

To aid the estimation of nutrient transport within the groundwater zone, all septic tank enumeration was split into categories of: less than 500 feet distant from surface waters in sub-basins that drain directly to mainstem lakes and rivers; less than 500 feet distance from surface waters in sub-basins than drain to tributary streams; and greater than 500 feet distant from surface waters in direct drainage sub-basins and tributary sub-basins, respectively.

As a result of the studies carried out on septic tanks in the Okanagan Valley, teh following general conclusions have been reached:

(1) Nutrient loadings from septic tanks in the whole Okanagan Basin amounted to 497,000 lb/yr. of Total Kjeldahl Nitrogen, 137,000 lbs/yr. of Total Phosphorus, and 104,000 lb/yr. of Dissolved Orthophosphorus.

(2) The mounts of nutrients travelling through the unsaturated soil and thus reaching the groundwater were calculated to be 20,000 lb/yr. of Total Kjeldahl Nitrogen, 108,000 lb/yr. of Nitrate (from denitrification of TKN), 31,800 lb/yr. of Total Phosphorus, and 24,500 lb/yr. of Dissolved Orthophosphorus.

(3) The amounts of nutrients that are estimated to be transported by the groundwater to surface waters are as follows:

	to mainstem lakes	to tributary streams
TKN	8,500 lb/yr	2,220 lb/yr.
Nitrate N	66,879 lb/yr.	18,270 lb/yr.
Total P	13,550 lb/yr	3,070 lb/yr.
Dissolved Orthophosphorus	10,320 lb/yr	2,330 lb/yr.

Of the amounts of nutrients that are shown to finally reach surface waters, the fractions that enter the mainstem lakes or rivers directly are estimated to be 70% of all four nutrient forms considered.

By far the least accurate part of the study was the estimations of the amounts of septic tank nutrients transported by the groundwater to lakes or streams. If the management alternatives for the basis are found to be sensitive to the calculated septic tank figures, then more work should be undertaken before any final decisions are made.

10.13 RECOMMENDATIONS

There is a significant number of assumptions inherent in the calculations of the quantities listed above, as discussed in previous sections of the report. This is especially true of calculations required to arrive at the figure given in conclusion number 3 above. However, it is known that the boundaries of those values lie

between 0 lb/yr. and the number shown in conclusion 2 above. If it is found that the amounts of nutrients reaching the lake system are critical to the solution of the water quality problems in the Okanagan, then it is recommended that more work be done so that the figures quoted in Table 10.13 can be adequately verified. This work should involve the following:

(1) Continuation of the septic tank leaching studies at Vernon to ascertain better average concentration of nutrients in the leachate waters after percolation through different soils;

(2) A more detailed approach to the effects of soil type on the transport of nutrients from the source to the groundwater;

(3) A few field experiments using well-points to allow actual samples of groundwater to be gathered upstream and downstream of septic tank areas in the Okanagan Valley.

Furthermore, if it appears that septic tank leachate may be responsible for localized surface water quality problems, it is recommended that well-points be installed in these locations before any corrective actions are taken. By so doing, the impact of the corrective action can be realistically monitored, and the results used to plan corrective actions in other problem areas.

CHAPTER 11

Nutrient Contributions from Refuse Disposal Sites

The purpose of this investigation was to characterize the potential of the refuse disposal site in Vernon as a source of groundwater contamination and to estimate the nutrient input to groundwater from this source. The study was also intended to provide information that would be useful in assessing the pollution potential of the other refuse disposal sites in the Okanagan Basin area.

The study was carried out in two parts:

(1) An investigation of groundwater quality in the vicinity of the Vernon disposal site; and

(2) A laboratory scale landfill leaching experiment conducted at the Vernon Sewage Treatment Plant.

The disposal site is cradled in a sidehill gulley about one-half mile northwest of the City of Vernon. It has been operated as a burning dump on and off for 75 years until just recently, when dumping was discontinued. The dump area is small, about 4 1/2 acres, while the depth is estimated to be 30'.

Natural drainage of the area is westerly, off moderately steep and predominantly barren hillsides. Two surface drainage courses lead to the top of the dump. They enter the dump site on either side of a large out-cropping of bedrock. Below the dump is a strip of land extending northward, and paralleling the Old Kamloops Road, which is largely covered with orchards and croplands (Figure 11.1).

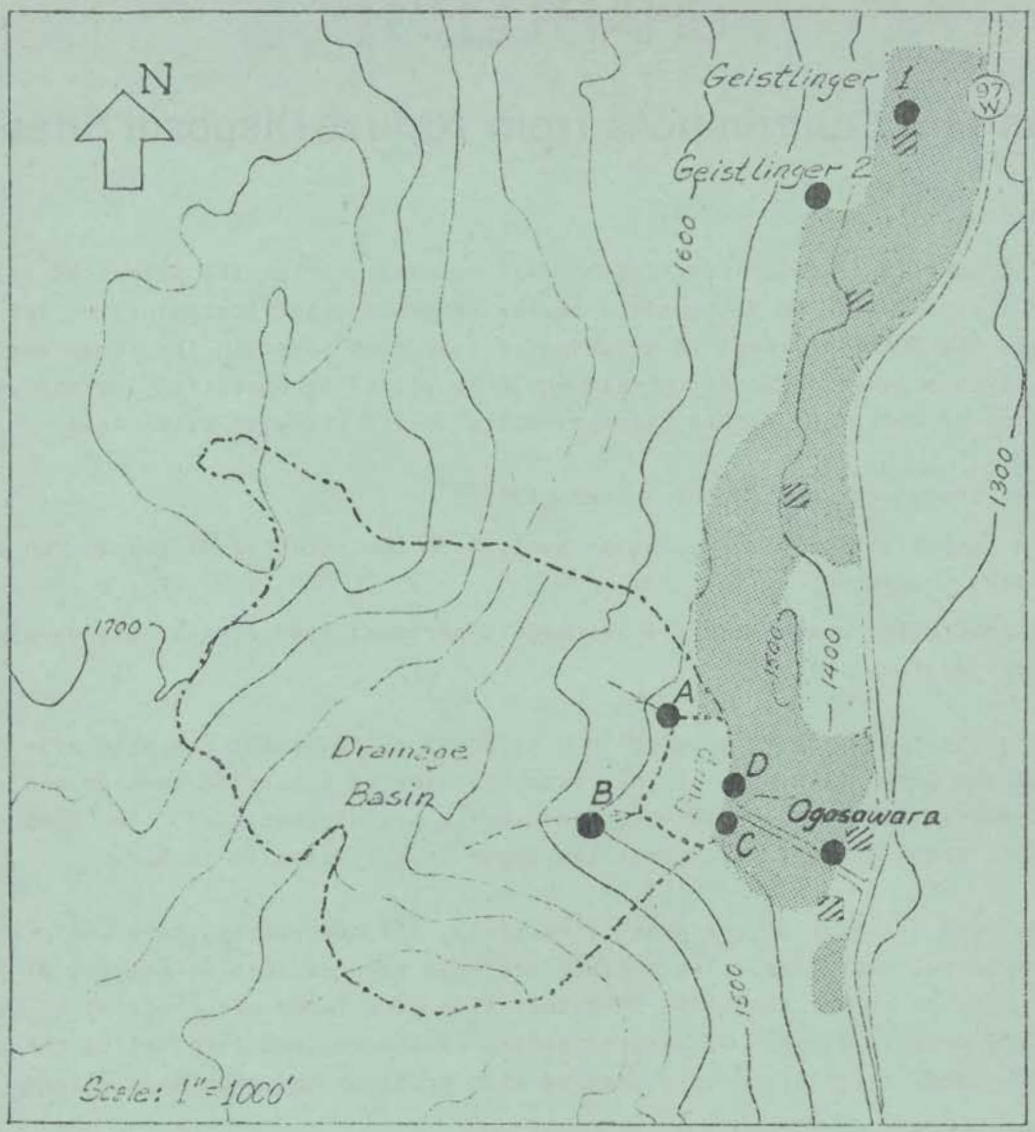
The average yearly precipitation in the Vernon area is 15", with snowfall accounting for about 1/3 of this total.

11.1 GROUNDWATER MONITORING PROGRAM

Two existing domestic wells in the area were monitored for groundwater quality on a regular basis. Following is a description of the two wells:

(1) Ogasawara Well - located 600' downslope of the dumping site. A dug well 12' deep with a 3' diameter concrete casing and with galvanized piping; covered. This well is no longer used. Surface elevation: 1370' above sea level.

(2) Geistlinger 2 - located 3500' north of the above well in a drainage course on a moderately steep hillside. A dug well 18' deep with a 3' diameter concrete casing and with galvanized piping; covered. This well is no longer used. Surface elevation: 1450'.



Geistlinger 1 – Wellpoint, 68 feet deep, Domestic Use.
Geistlinger 2 – Dug Well, 18 feet deep, No Longer Used
Ogasawara – Dug Well, 12 feet deep, No Longer Used
Wellpoint A — 6 feet deep
Wellpoint B — 8 feet deep
Wellpoint C — 11 feet deep
Wellpoint D — 11 feet deep

Orchard and Feed Crop Areas

GROUNDWATER MONITORING SITES AT VERNON. Figure 11.1

Because of the location of the Ogasawara well directly downslope from the disposal site it was thought that the water in this well would be likely to reflect any quality situations due to contamination of the groundwater by the disposal site; the water in the Geistlinger 2 well would indicate quality situations due to natural phenomena. Sampling from a third well, Geistlinger 1, was discontinued shortly after the program commenced as it was considered too deep at 68' to reflect the quality situations of a shallow well.

In addition to the monitoring of these two wells, two wellpoints immediately above the dump and two directly below were placed late in the summer of 1971 in the hope that when groundwater levels rose in the spring samples from above and below the dump would be available for comparison.

The wellpoints were the self-jetting type and came with a 30" slotted plastic screen. Each wellpoint and connected piping (1-1/2" galvanized steel) was flushed into the ground with water supplied by a flush truck until downward progress ceased. Sand was packed around the screen and a surface seal of clay was provided around the pipe casing to insure that surface water would not enter the wellpoint directly. Following is a description of the four wellpoints:

Wellpoint A - - Located in one of the two drainage courses above the dump. 6' deep; may be resting on bedrock. Surface elevation: 1496'.

Wellpoint B - - Located in the other drainage course above the dump. 8' deep. Surface elevation: 1524'.

Wellpoint C - - Located at the toe of the dump. 11' deep. Surface elevation 1391'.

Wellpoint D - - Located below the dump. 11' deep. Surface elevation 1417'.

Locations of all the groundwater monitoring sites are shown in Figure 11.1.

Monitoring of the existing wells commenced in July 1971 and, except for increased sampling frequency during the first month and again during the spring, was continued on a once-a-month sampling schedule to the end of the study period, October 1972. Sampling of the wellpoints was to be once a week when there was water to sample. All samples were shipped to the Provincial Water Resources Service Chemistry Laboratory in Vancouver and there analyzed for twenty water quality parameters.

11.2 COLUMN LEACHING EXPERIMENT

Leaching columns were set up at the Vernon Sewage Treatment Plant in order to ascertain quality and quantity characteristics of water percolating through

refuse material. Experimental conditions were such that some of the results from this study could be meaningfully related to the groundwater monitoring program. It should be noted that in a laboratory experiment of this nature it is impossible to duplicate in situ field conditions. The experimental results therefore can only serve to indicate situations likely to occur in the field and not positiviely identify them.

Clear acrylic tubing 8" in diameter was selected as the column material. There was some concern that this column size might be too small to allow for representative compaction of the fill material and therefore representative percolation. It was felt though, that the constructional, operational, and cost advantages of smaller columns, plus the fact that the fill material in all but one column was of a fine granular nature (This material had been readily compacted in a 3" diameter column prior to the design of this experiment) was criteria enough to disregard this concern.

Prior to adding the fill material a 5" layer of 2 mm silica sand was placed in the bottom of each column to prevent organic solids from reaching and perhaps clogging the exit port.

Following are descriptions of the experimental conditions for the eight columns: (see Figure 11.2 for photographs showing the column set-up).

COLUMN I

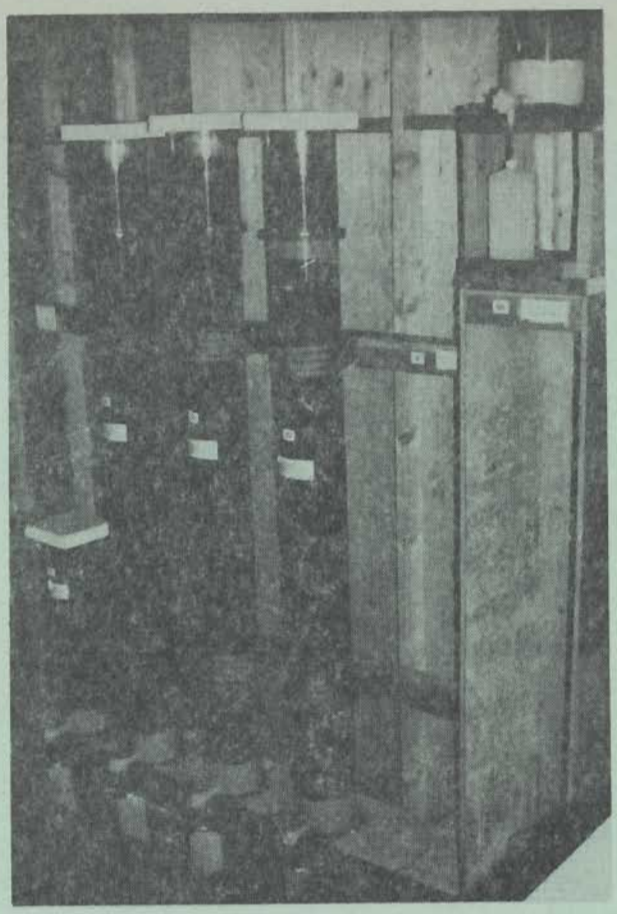
Column height -- 30"
Fill material -- from the Vernon refuse disposal site.
Fill weight -- 45 lbs. as placed.
Fill height -- 20"
Covered with a styrofoam lid.
Distilled water applied each week equal to the actual precipitation of the week prior.

COLUMN II

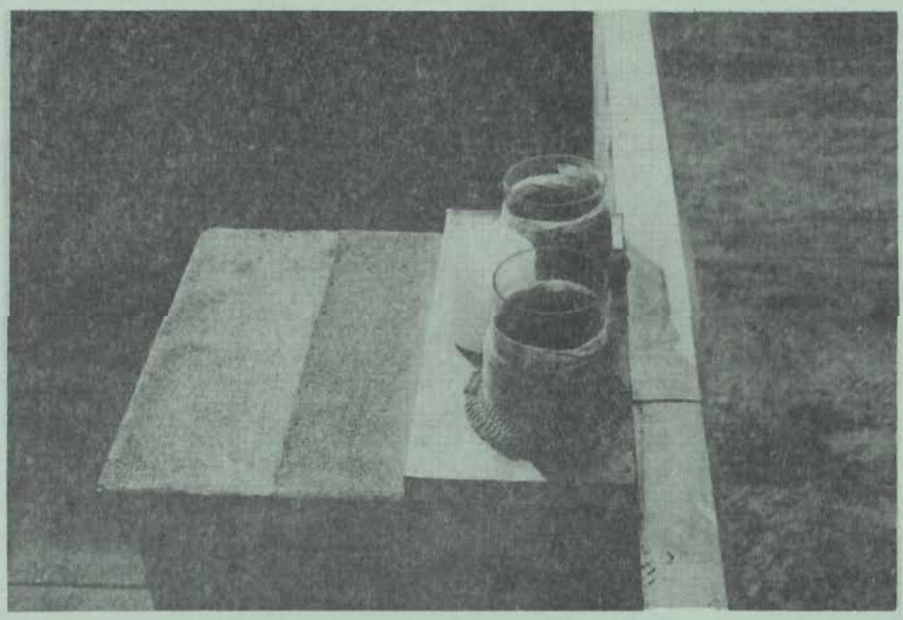
Column height -- 86"
Fill material -- same as Column I
Fill weight -- 170 lbs.
Fill height -- 74"
Covered.
Application rate -- Same as for Column I.

COLUMN III

Conditions same as for Column II except that distilled water is applied at a rate of 1.5" per week.



Columns I, II, III, & IV



Columns V & VI Exposed to Atmosphere

LEACHING COLUMNS AT VERNON Figure II.2

COLUMN IV

Column height -- 86"
Fill material -- Fresh refuse.
Fill weight -- 45 lbs. as placed.
Fill height -- 66" and an 8" surface cover of soil.
Covered
Application rate -- Same as for Column III.

COLUMN V

Conditions same as for Column I except that the top of this column is exposed to the atmosphere and receives natural precipitation.

COLUMN VI

Conditions same as for Column II except that the top of this column is exposed to the atmosphere.

COLUMN VII

Conditions same as for Column III.

COLUMN VIII

Conditions same as for Column III except that the application is the leachate from Column VII.

The fill material from the Vernon refuse disposal site was a composite, excavated from three locations considered of a granular and fairly homogeneous mixture of ash and decomposed refuse; it did not contain any fresh refuse. The depth from which this material was gathered ranged from surface to 6' deep. Before placement in the columns it was sieved through screening material with 1" openings. The rocks and large pieces of metal were discarded, while tins and bottles were broken up and added to the composite.

The fresh refuse placed in Column IV was composited according to the following list as described in a study by Salvato (88).

Approximate Composition of Residential Solid Wastes

Component	Percent by Weight
Food Wastes	15
Garden Wastes	5
Paper Products	50
Plastics, Rubber	3
Rags	2
Glass, Ceramics	8
Metal	8
Wood	2
Rocks, Dirt, Miscellaneous	7

The column leaching experiments were designed to provide the following information:

(1) The role that evaporation plays in reducing the amount of water available for percolation. This is arrived at by comparison of the results from Columns I and II with those of Columns V and VI. The two short columns were included to insure that at least some data would be collected in the event that precipitation was not great enough to produce leaching from Column II.

(2) The difference in leachate quality and quantity of a column filled with Vernon dump material and one filled with fresh refuse. Columns III and IV.

(3) The effect that the depth of refuse has on the leachate quality. Columns III and VIII. (Note that Columns VII and VIII together act effectively as a single column with a 12' depth of fill).

Water was applied to the columns on a once-a-week basis starting in January and finishing in September 1972. Each week the leachate was collected and refrigerated until there was sufficient volume (2.5 liters) for a complete analysis.

11.3 GROUNDWATER MONITORING PROGRAM

During the 1971-72 winter, 95" of snow fell on the Vernon area. This was twice the annual average of 48" (average for the past 13 years). An early snow-cover prevented the ground from freezing. This had the effect of allowing a greater than normal proportion of the spring melt to infiltrate the ground rather than to run off the surface. This was evident at the disposal site as there was very little surface runoff in the area during the spring thaw.

The results of monitoring the two existing domestic wells and the four well-points are summarized in Figures 11.3, 11.4, 11.5 and 11.6 and Table 11.1.

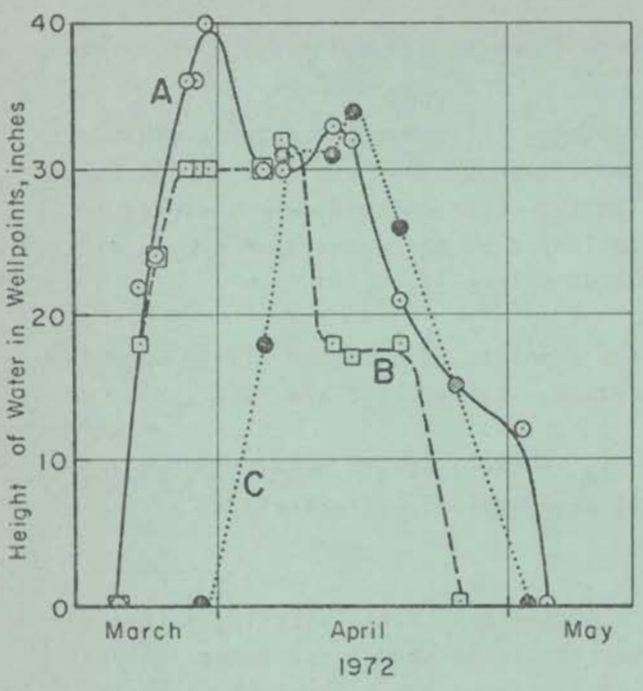
Figure 11.3 portrays the groundwater level variations during the period of study. Inspection of Figure 11.3 shows the following:

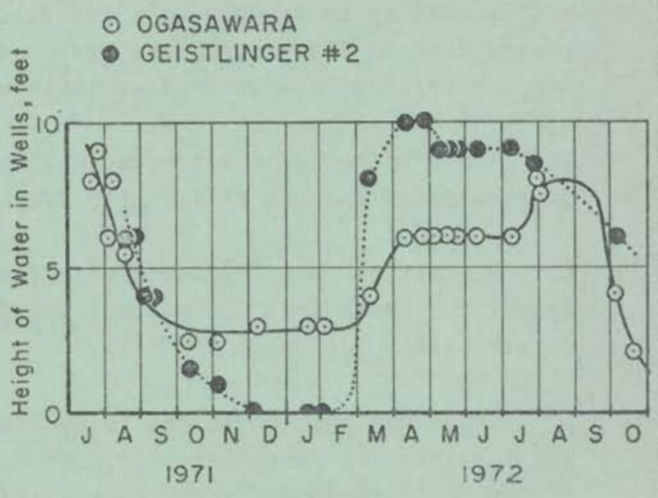
(1) that there was groundwater in Wellpoint A for 43 days (March 22 to May 4); in Wellpoint B for 34 days (March 22 to April 26); in Wellpoint C for 32 days (April 1 to May 2). There was never any water in Wellpoint D.

(2) that there was water in the Ogasawara well all year. Water levels rose in the spring and again in the summer (due to irrigation of the upslope orchards) and dropped in the fall.

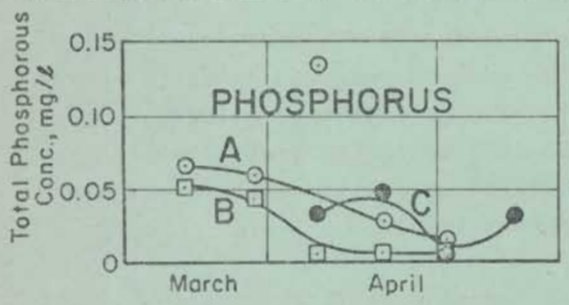
(3) that the Geistlinger 2 well was dry from December through February.

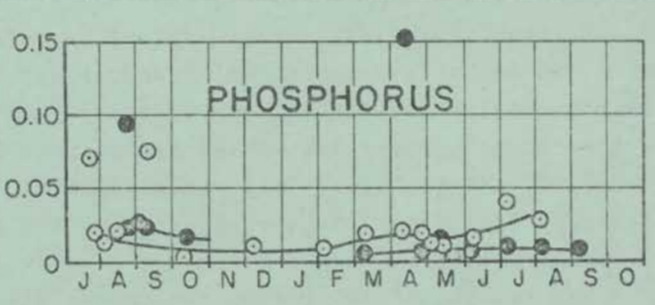
The average concentrations of the chemical parameters are given in Table 11.1. These averages were calculated using the results of all the samples. Note the following:

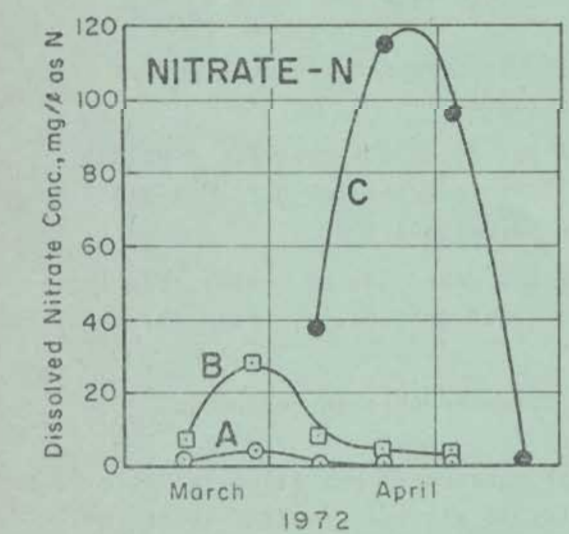


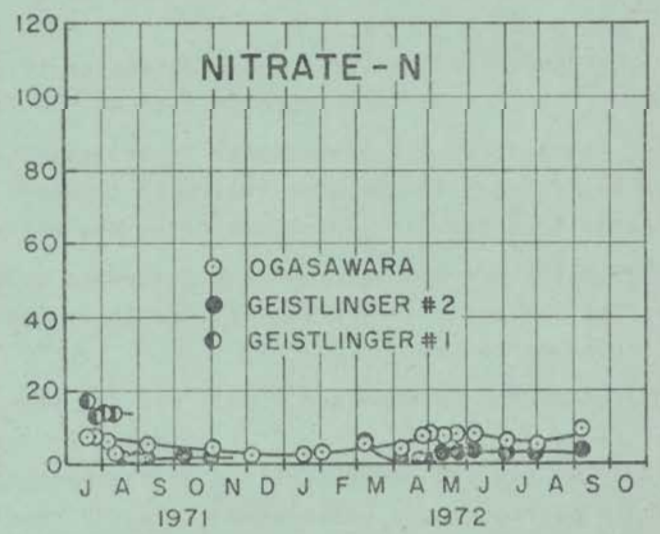


GROUNDWATER QUANTITY - VERNON AREA. Figure II.3

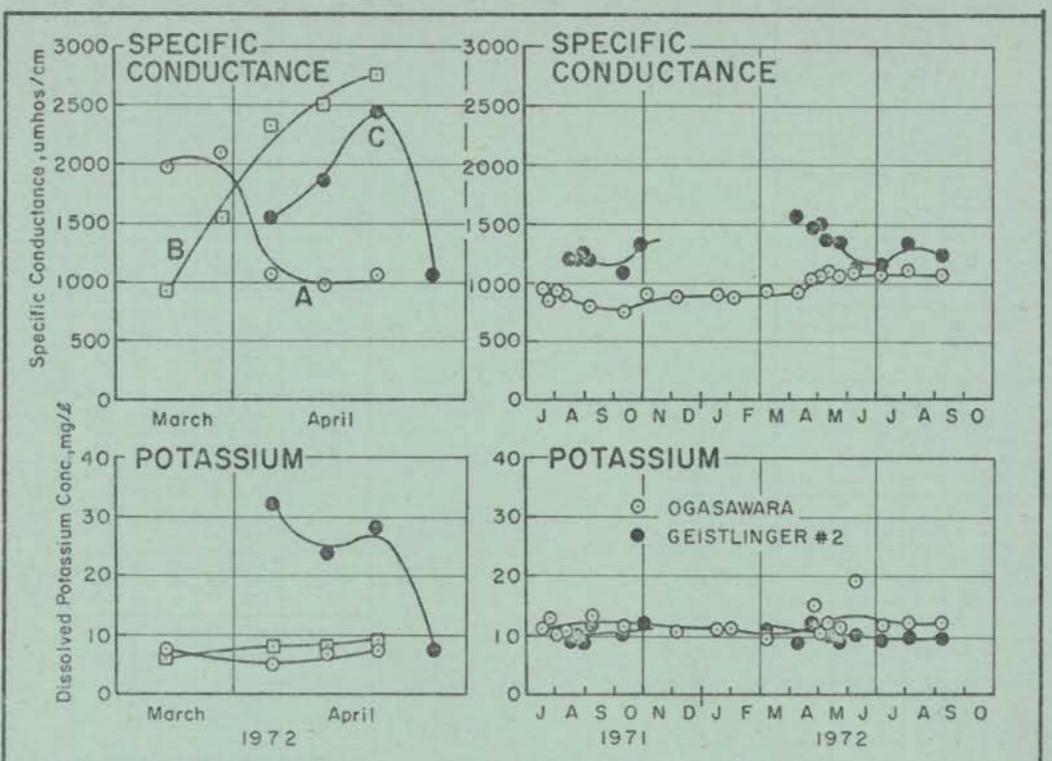






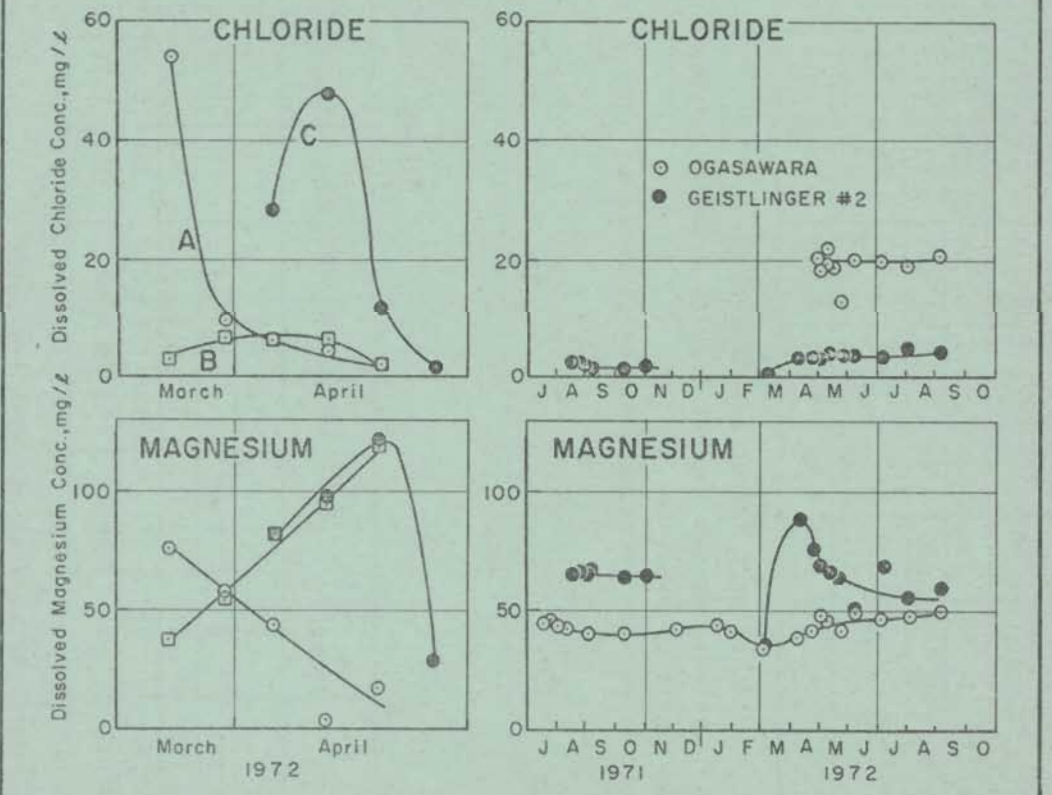


GROUNDWATER QUALITY - VERNON AREA. Figure II.4



GROUNDWATER QUALITY - VERNON AREA

Figure 11.5



GROUNDWATER QUALITY - VERNON AREA

Figure 11.6

TABLE 11.1

GROUNDWATER QUALITY

AVERAGE CONCENTRATION OF CONSTITUENTS [1]

	pH	TKN	NO_3-N	NO_2-N	TOTAL P	Na	K	Ca	Mg	B	TOTAL ALK.	SPEC. [3] COND.	SO_4	Cl	Cu [4]	Zn	Pb	Fe
OGASAWARA [2]	7.7	0.30	5.6	0.009	0.024	32.2	11.7	110	44.5	0.3	320	950	206	18.9	0.01	0.07	0.003	0.08
GEISTLINGER #2 [2]	8.0	0.48	2.3	0.005	0.031	37.5	10.0	154	65.0	0.3	228	1,250	490	2.7	0.01	0.37	0.003	0.04
WELLPOINT A	8.3	0.63	1.2	0.005	0.061	49.0	6.8	173	40.0	0.3	218	1,440	485	15.2	0.01	0.01	0.005	0.10
WELLPOINT B	8.1	0.94	10.8	0.005	0.030	56.0	7.8	310	38.5	0.3	286	2,000	975	4.8	0.01	0.01	0.006	0.43
WELLPOINT C	8.1	0.06	63.0	0.021	0.029	29.0	22.9	194	82.0	0.5	214	1,720	447	22.2	0.01	0.01	0.003	0.13

1. Units of mg/l except as noted below
2. Averages do not include results from the October 5 and the October 15 sampling
3. Units of umhos/cm
4. Dissolved concentrations for all metals

TABLE 11.2

COLUMN LEACHATE QUALITY

AVERAGE CONCENTRATION OF CONSTITUENTS [1]

	NO. OF [2] SAMPLES	LITERS [3]	TOC	pH	TKN	NO_3-N	NO_2-N	TOTAL [4] PO_4	Na	K	Ca	Mg	B	TOTAL ALK.	SPEC. [5] COND.	SO_4	Cl	Cu [6]	Zn	Pb	Fe
COLUMN I	2	6.1	14	8.7	2.0	92	0.99	0.05	1550	1140	537	385	10.2	320	14000	4230	2270	0.06	0.49	0.009	0.02
COLUMN II	1	3.6	9	8.4	0.6	170	1.86	0.03	2110	1390	750	465	13.2	316	14300	3210	3490	0.05	0.10	0.005	0.02
COLUMN III	8	23.3	15	8.5	1.6	106	1.07	0.27	1600	1340	519	460	14.1	572	12900	4060	1940	0.05	0.79	0.006	0.07
COLUMN IV	7	21.5	10400	6.8	712	332	6.30	18.0	1060	1470	3300	540	5.4	5320	18200	2220	1250	0.21	104	4.23	251
COLUMN VIII	5	14.1	19	8.5	3.2	530	1.49	0.23	2550	1780	740	630	14.7	610	19600	4250	4800	0.06	0.64	0.007	0.05

1. Units of mg/l except as noted below
2. Does not include sampes of Sept. 11, Sept 18, & Oct 19
3. Leachate quantity included in the calculation of the average concentrations
4. As P
5. Units of umhos/cm
6. Dissolved concentrations for all metals

(1) that nitrate was the dominant form of nitrogen. Average concentrations varied from a low of 1.2 mg/l in Wellpoint A to a high of 63.0 mb/l in Wellpoint C.

(2) that the average concentrations of Total Phosphorus ranged from 0.024 mg/l in the Ogasawara well to 0.061 mg/l in Wellpoint A.

Figures 11.4, 11.5 and 11.6 show how the concentrations of the chemical parameters varied with time during the study period. Graphs of pH, TKN, NO_2-N, B, and the metals were not considered to add enough information relevant to this report to warrant inclusion. Graphs of Ca, Na SO_4, and Total Alk, were also not included; in each of these cases the shape of the curves for wellpoints A, B, and C were similar to those displayed for Specific Conductance. These figures show the following:

(1) that for the water in the Ogasawara well, concentrations of the various quality parameters remained fairly constant throughout the monitoring period. Slight seasonal variations are evident though for nitrate and specific conductance.

(2) that the quality of the last sample taken from Wellpoint C corresponds very closely to that occurring year round in the Ogasawara well. This statement holds true for Total P. NO_3-N, K, Mg, Spec. Cond., Na, and Ca. There are three exceptions; Cl and Total Alk. which are significantly higher in the Ogasawara well, and SO_4 which is significantly higher in Wellpoint C. (see Table 11.3) for data on Ca, Na, SO_4, and Total Alk.

TABLE 11.3

CHEMICAL COMPOSITION OF MATERIAL FROM VERNON REFUSE DUMP

Vernon Dump Material used in the Leaching Study.

Chemical composition as analyzed at the provincial Soil Service Testing Laboratory in Kelowna:

Moisutre	1.32%
pH	7.5
Organic Matter	3.21%
Nitrogen	0.126%
C/N ratio	14.78
SO_4	0.2305%
Cu	0.0823%
Zn	0.2989%
Boron	0.0209%
Total Phosphorus	0.3804%
Calcium	1.045%
Mg	0.0587%
Na	0.1095%
K	0.2060%
Cation Exchange Capacity	10.27 meq/100 gr.

and, as analyzed at the Pollution Control Laboratory, University of British Columbia:

Cl	0.0920%

(3) that the nitrate N concentration in Wellpoint C reached a maximum of about 120 mb/l near the middle of the period that water was present in this wellpoint and a minimum of 2 mg/l toward the end.

11.4 COLUMN LEACHING EXPERIMENT

The results of the column leaching experiment are summarized in Figures 11.7, 11.8 and 11.9 and Table 11.2.

Figures 11.7 and 11.8 show the experimental conditions for each column and graphically present the hydraulic data (i.e., the amount of water applied to each column and amount of leachate collected from each column for each weekly period). Inspection of Figure 11.7 and 11.8 shows the following:

(1) that leaching from Column I began after the application of 3.5" of water; from Column II after 6"; from Column III after 16"; from Column IV after 16"; from Column VII after 16"; and from Column VIII after 9.5".

(2) that no leachate was collected from Columns V and VI over the period of the study. During this time these columns received a total application of 15" of water.

Table 11.2 lists the average concentrations of the quality parameters for each of the column leachates. This table shows the following:

(1) that the average concentration of organic carbon is high (10,400 mg/l) in the leachate from the fresh refuse and low (15 mg/l) in the leachate from the Vernon dump material.

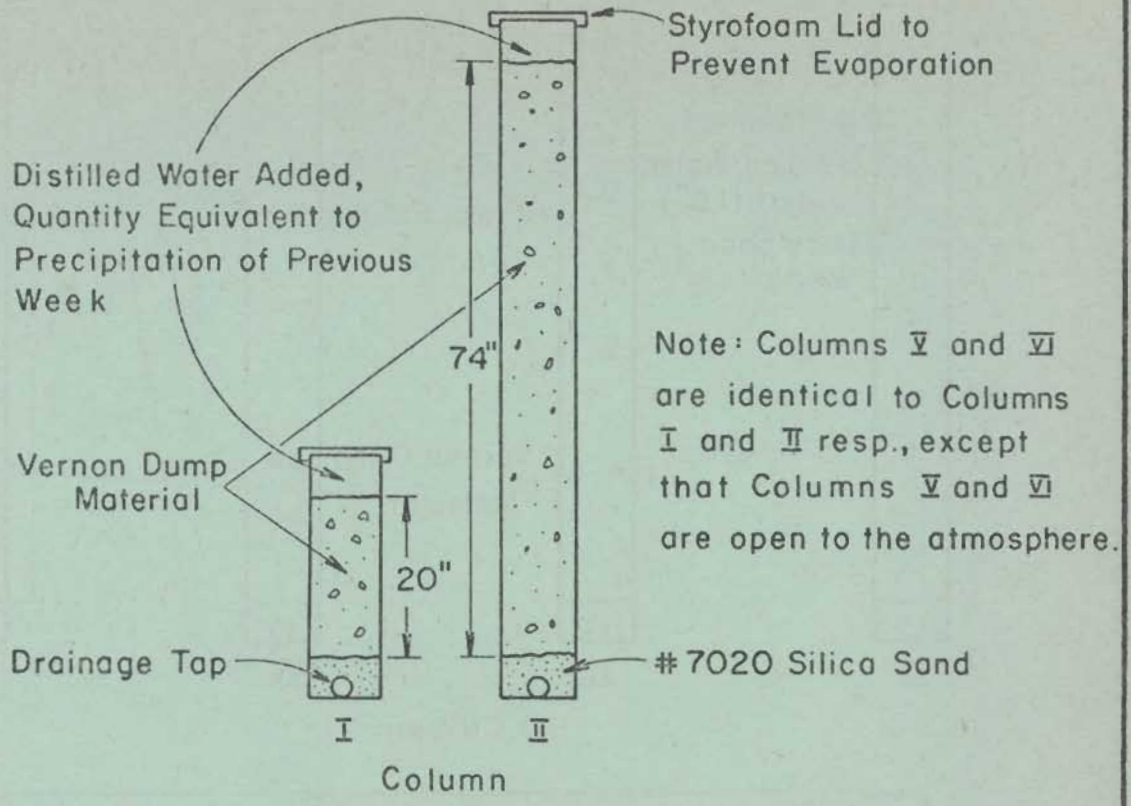
(2) that nitrate is the dominant form of nitrogen in the leachate from the Vernon dump material, while both TKN and nitrate are in significant quantity in the leachate from the fresh refuse.

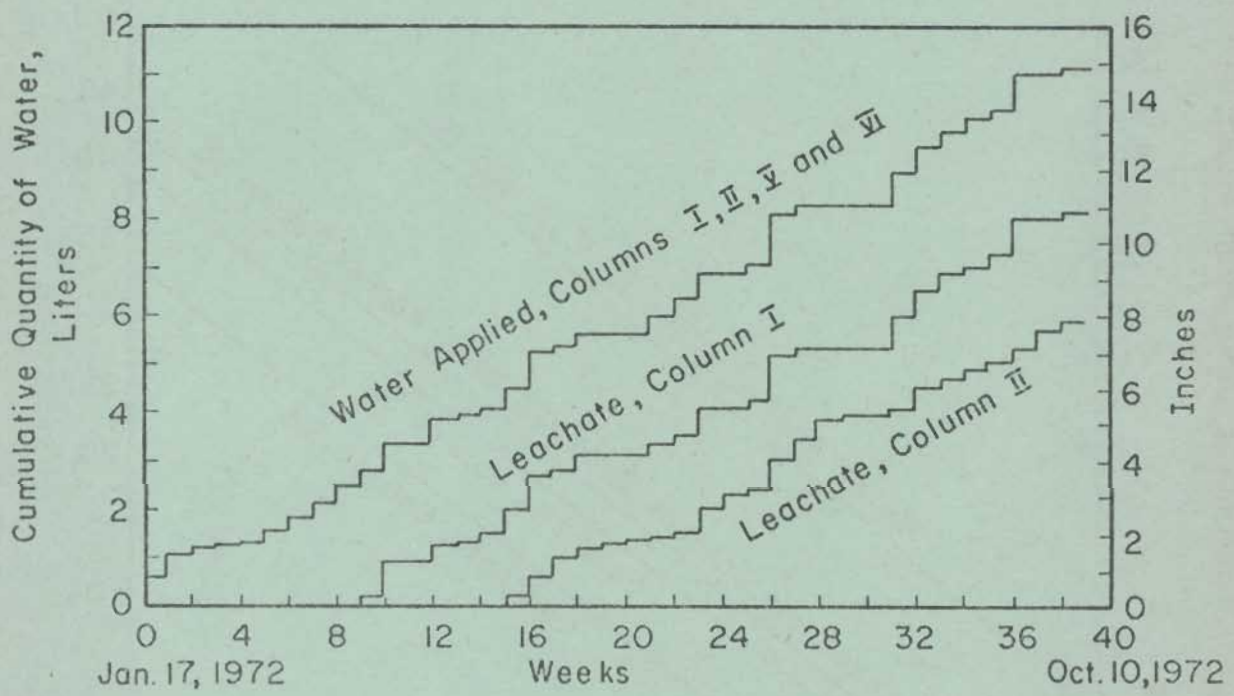
(3) that the average concentration of total phosphorus is 70 times greater in the leachate from the fresh refuse than it is in the leachate from the Vernon dump material.

(4) that metals were leached in much greater quantity from the fresh refuse than from the Vernon dump material.

A similar simulated landfill leaching study was reported by Qasim (89). In this study fresh refuse was compacted to a depth of 77" inside a 3' diameter column and water applied at a rate of 3" once every two weeks. Below is a comparison of the average concentrations of similar leachate parameters as reported in the Qasim study and as reported in this study.

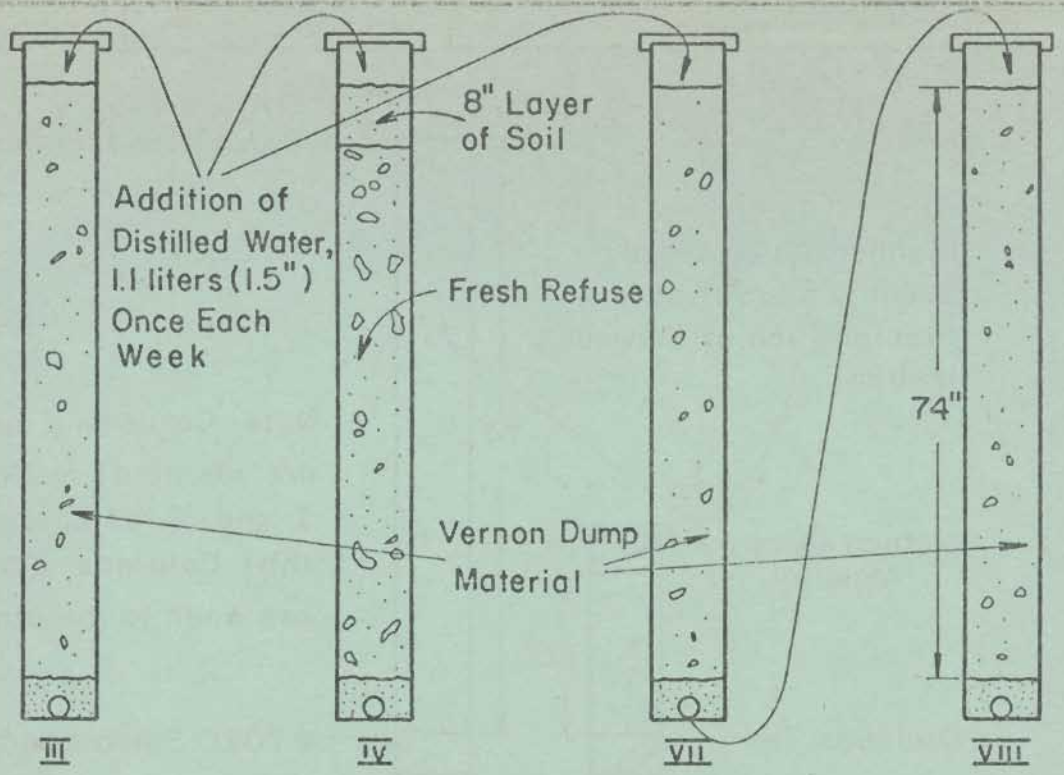
QUALITY PARAMETER	AVERAGE CONCENTRATION IN LEACHATE QASIM STUDY	COLUMN IV
Total Leachate Quantity	32 inches	21.5 inches
Ca	2080 mg/l	3300 mg/l
Total Alk, as $CaCO_3$	13800 "	5320 "
Mg	280 "	540 "
Cl	1200 "	1250 "
Total PO_4 as P	10 "	18 "
TKN	1090 "	712 "
K	1800 "	1470 "
SO_4	660 "	2220 "
Na	940 "	1060 "

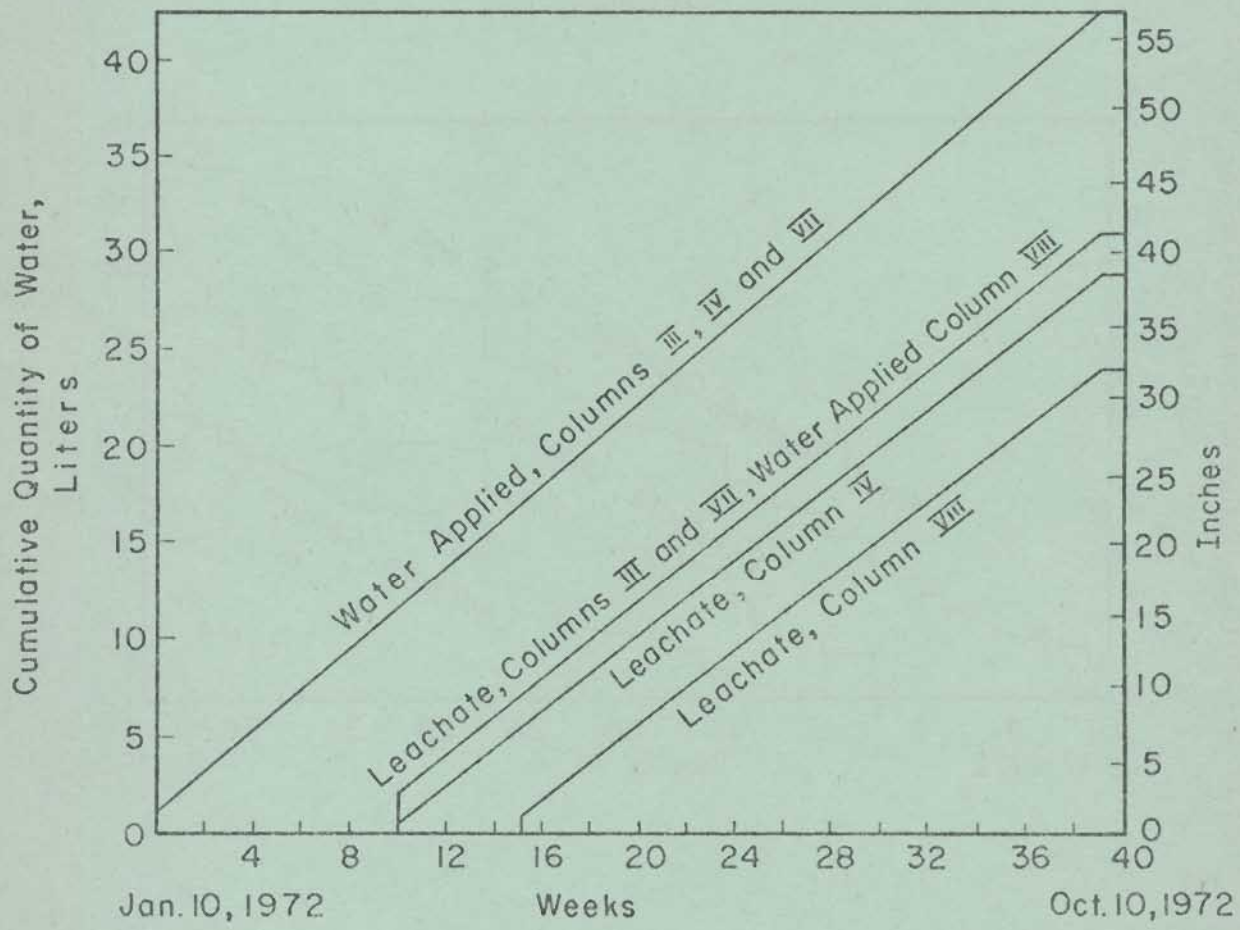




COLUMN LEACHING EXPERIMENT

Figure II.7





COLUMN LEACHING EXPERIMENT Figure II.8

COLUMN LEACHING QUALITY

Figure 11.9

The graphs in Figure 11.9 show how the concentrations of Total PO_4, NO_3-N, Cl,and Specific Conductance varied with cumulative leachate quantity as collected from Columns III, IV, and VIII. Note the following:

-- that the leachate quality form Column VIII, when compared to that of Column III, exhibits nearly the same or just slightly higher initial concentrations for the various parameters, but that these initial concentrations are extended over a greater quantity of leachate in the case of the deeper column. An exception is the nitrate concentration in the leachate from Column III. (See Table 11.3 for supporting data for other quality parameters).

11.5 DISCUSSION OF RESULTS

(1) the quality of water in the Ogasawara well did not appear to be detrimentally contaminated by the Vernon refuse disposal site during the period of study. The overall quality compared favorably with that of the water in the Geistlinger 2 well. Seasonal variations were slight and when apparent (as for NO_3-N and Specific Conductance) were no more pronounced in the Ogasawara well than in the Gesitlinger 2 well. The increased level of nitrate which occurred in the Ogasawara well during the spring months was most likely caused by contamination from the disposal site (explained in further detail below), natural sources, and by nitrate being leached from the fertilizer applied to the upslope orchards.

(2) During the spring, contamination of groundwater by the disposal site did occur. This contamination was most likely caused by intrusion of groundwater into an unleached portion of the dump rather than by surface water percolating through the fill to groundwater. These statements are based on the following observations:

(a) That nitrate and chloride, both readily leached from the dump material, were present in significantly higher concentrations in Wellpoint C below the dump than in Wellpoints A and B above the dump. The concentration of potassium was also higher below the dump.

(b) That the groundwater level evident during the spring was abnormally high.

(c) That it is doubtful that surface water percolates into the fill to any great depth. This was certainly the indication given by Column V where precipitation did not percolate through 20" of the Vernon dump material. Also, the composite material evacuated from the dump site and used in the column leaching studies contained high quantities of nitrate and chloride which would not have been present if leaching had occurred in situ.

(3) It was felt that because of the relatively high concentrations of nitrate evident below the dump in Wellpoint C that an attempt should be made to estimate

the total nitrogen input to groundwater from the dump source. Following is a step-by-step summary of this calculation:

(a) The area having surface drainage to the dump site was determined from aerial photographs. This area is shown on Figure 11.1. The area was calculated to be:

4.9×10^6 ft^2 (112 acres)

(b) It was assumed that 70% of the snow which fell on this drainage area became groundwater flowing to the dump site in the spring. The 30% accounts for water which was retained in the soil and for water loss due to evaporation. In the calculation of the total amount of groundwater produced 10" of snow was taken to be equivalent to 1" of water. Total volume of groundwater:

2.7×10^6 ft^3 (2.0×10^7 U.S. gal.)

(c) The assumption was made that the bottom of Wellpoint A rested on bedrock. It could be said then, that the time that water was present in this wellpoint was equivalent to the time-span that groundwater from the above source had an influence on groundwater levels in the area. When this time-span is applied to Wellpoint C it results in an extension of the curve as shown in Figure 10.11.

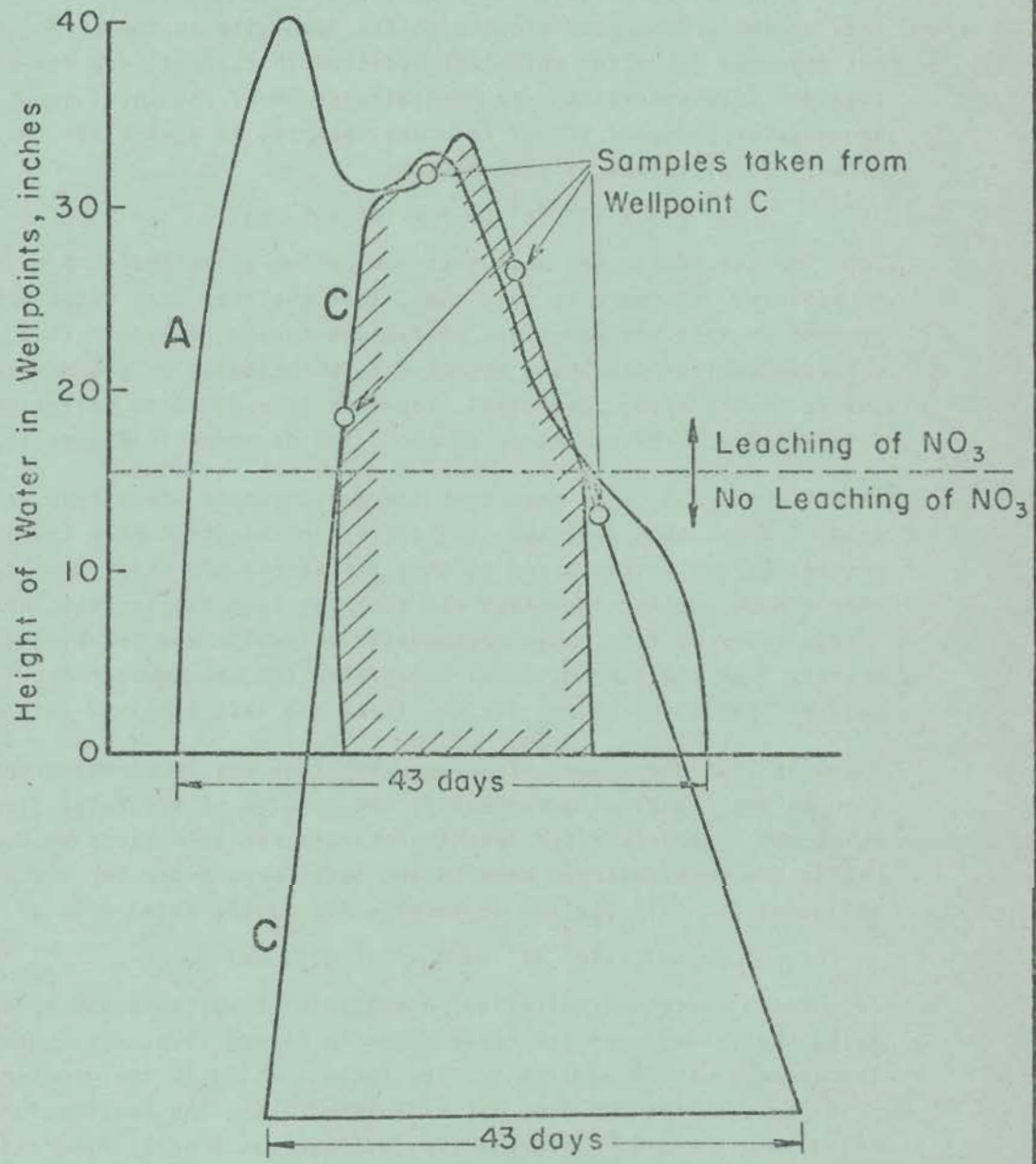
From Figure 11.4 it is seen that the first sample taken from Wellpoint C shows some increase in nitrate concentration over that present in Wellpoints A and B; that the second and third samples show a much greater increase; and that the last sample shows none. It was assumed, then, that groundwater intrusion and leaching of nitrate from the dump material began when the groundwater level was between that which it was for the first and last samples. (Figure 11.10)

Assuming that the volume of groundwater flow was in direct proportion to the height of groundwater, the portion of the total flow which was responsible for leaching nitrate was calculated by comparing the cross-hatched area to the total area under the curve for Wellpoint C. This portion represents 40% of the total flow or:

1.1×10^6 ft^3 (8.0×10^6 U.S. Gal.)

(d) The nitrate concentration in Wellpoint C was computed by averaging the values over the curve shown in Figure 11.4. The resulting average was 79 mg/l as N. The concentration in the groundwater prior to entering the dump was calculated using the results for Wellpoints A and B. The resulting average was 6 mg/l. Therefore, the increase in nitrate concentrate due to leaching of the dump material was:

73 mg/l



CALCULATION OF NITROGEN INPUT Figure 11.10

(e) the total nitrate input to groundwater was calculated by multiplying the result of (c) by the result of (d)

Total N = 4900 lbs.

It should be emphasized that this estimate is crude and only serves to place a very approximate magnitude on the nutrient addition to groundwater which occurred during the study period.

11.6 CONCLUSIONS AND RECOMMENDATIONS

11.6.1 Conclusions

(1) Contamination of groundwater by the Vernon refuse disposal site occurred in the spring of the study period when groundwater levels were at their highest. This contamination was most likely caused by intrusion of groundwater into a portion of the bottom of the dump rather than by surface water percolating through the fill to groundwater. The nutrient input from this occurrence was calculated to be:

Nitrogen:	
Nitrate	4900 lbs.
Total	4900 lbs.
Phosphorus	nil

(2) The quality of water in an existing domestic well located 600' downslope of the dump site was minimally affected by this contamination. The overall quality of water in this well compared favorably with that of a similar well not close to the dump.

(3) Water percolating through fresh refuse had higher concentrations or organic carbon, total nitrogen, total phosphate, and dissolved heavy metals than did water percolating through an equal depth of decomposed refuse material.

(4) The tests indicated that no leaching of pollutants from garbage dumps occurs because of the percolation of rain water through the dump material.

(5) Garbage dumps and sanitary landfills in the Okanagan Basin are all subject to the same or less precipitation than the Vernon dump. The spring groundwater leaching problem at Vernon is considered to have been greater in 1972 than in most years because of the large winter snowfall and the lack of ground frost. It is considered, therefore, that the potential input of pollutants from garbage dumps to groundwater, and hence to surface receiving waters, is negligible, and need not be given further consideration.

11.6.2 Recommendations

To ensure that no localized groundwater pollution occurs in the vicinity of sanitary landfills, the main precaution necessary is to prevent the water table from ever rising sufficiently to enter the refuse material.

PART II

WATER QUALITY EVALUATIONS

CHAPTER 12

Estimation of the Annual Input of Nutrients to the Main Valley Lakes

12.1 OBSERVED ANNUAL NUTRIENT LOADINGS

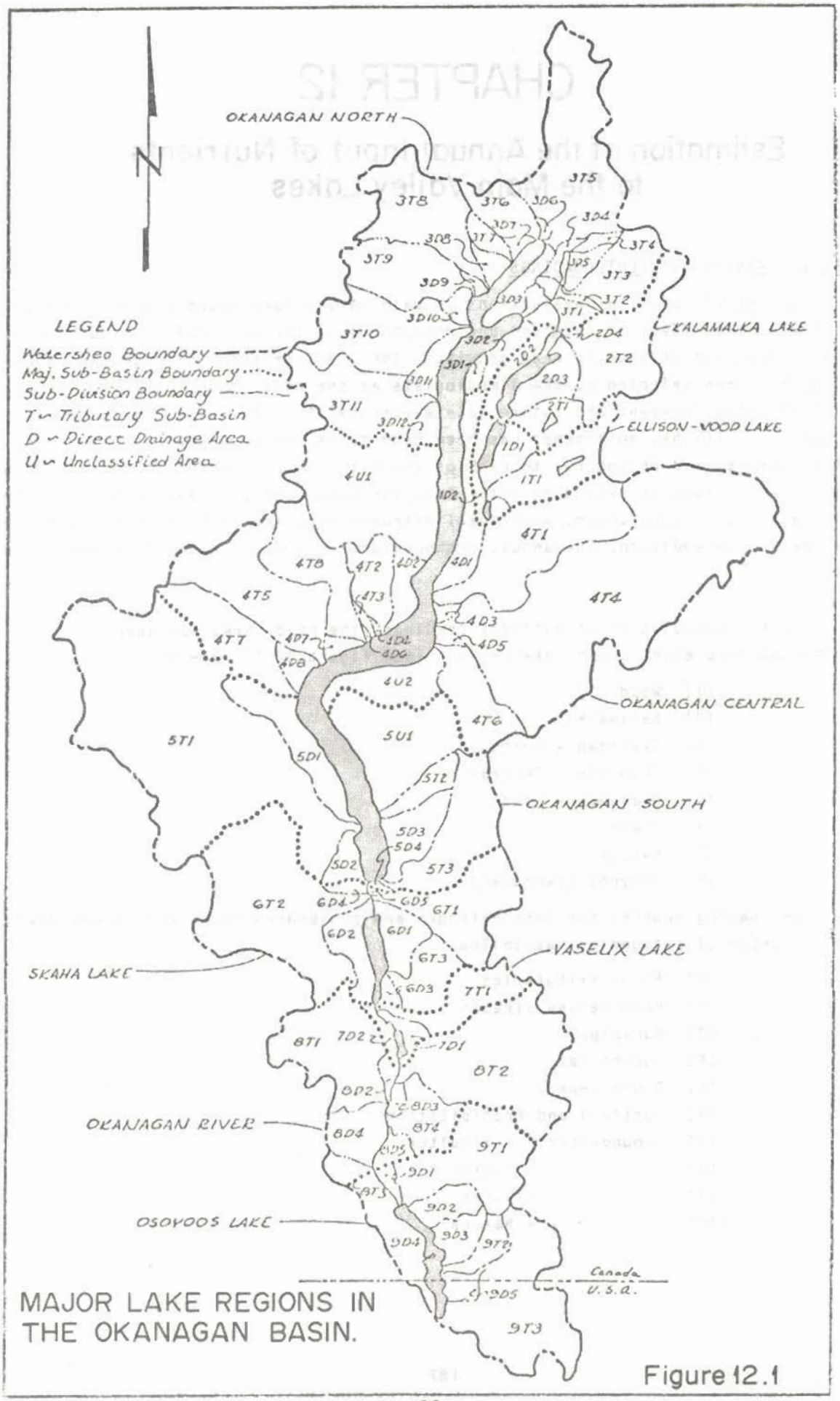
Current limnological evaluations of main valley lake water quality have been focused on the effect of nitrogen and phosphorus on the presence or occurrence of algal blooms and/or aquatic weed growths. The input of total nitrogen and phosphorus has been selected by the limnologists as the most important criteria upon which to assess present and future lake water quality. To assist in these limnological evaluations, an attempt has been made to estimate the current input of total nitrogen and phosphorus to each of the main valley lakes from known sources based on measurements made during the two-year study period. All loadings reported herein are in tons/annum, with total nitrogen reported as N and total phosphorus as P. In addition, the annual orthophosphorus input to each lake was estimated.

For the calculation of nutrient loadings, the study area has been subdivided into eight major lake regions (see Figure 12.1) namely:

(1) Wood
(2) Kalamalka
(3) Okanagan - North
(4) Okanagan - Central
(5) Okanagan - South
(6) Skaha
(7) Vaseux
(8) Osoyoos (Canadian)

The loading sources for both nitrogen and phosphorus have been broken down into a number of categories, as follows:

(1) Minor tributaries
(2) Main Valley streams
(3) Municipal
(4) Industrial
(5) Storm sewers
(6) Dustfall and Precipitation
(7) Groundwater - Agriculture
(8) - Septic tank
(9) - Other
(10) - Natural



MAJOR LAKE REGIONS IN THE OKANAGAN BASIN.

Figure 12.1

12.1.1 Tributary Streams

The stream sampling program in Chapter 2 included only those streams considered to be representative of the major streams tributary to the main valley lakes. A comparison of the number of streams sampled to the total number of tributaries (Table 12.1) indicates that the measured streams represent only a small portion of the total number of streams in each drainage basin. However, the streams monitored represent the larger drainage basins (Table 12.2).

TABLE 12.1

NUMBER OF TRIBUTARY STREAMS, TOTAL AND MEASURED

MAIN VALLEY LAKE	TOTAL NUMBER OF TRIBUTARY STREAMS	NUMBER OF MONITORED STREAMS	
		1969-1970	1970-1971
Wood	5	1	1
Kalamalka	5	1	1
Okanagan	47	20	21
Skaha	8	2	2
Vaseux	3	2	2
Osoyoos	7	2	2

TABLE 12.2

MONITORED AND TOTAL AREAS OF STREAM DRAINAGE BASINS

LAKE	TOTAL DRAINAGE AREA OF STREAMS SAMPLED WITHIN REGION (Mi^2)	TOTAL DRAINAGE AREA OF REGION (Mi^2)	MONITORED TOTAL (percent)
Wood	40.	78.	51
Kalamalka	79.	139.	57
Okanagan N	654.	747.	86
Okanagan C	796.	904.	88
Okanagan S	393	530	74
Skaha	204.	280.	73
Vaseux	35.	54.	65
Osoyoos	75.	144.	52

To provide an estimate of the total input of nitrogen, phosphorus and orthophosphorus into each of the main valley lakes from all streams, an estimate of the input from unmeasured streams was required. To do this, the following pro-rating procedure was used:

Let Ar = the remaining drainage area for a given lake

Am = the total drainage area of all measured representative tributary streams for a given lake (representative tributary streams are those not influenced by outfalls or those connecting the main valley lakes).

Nm = the total annual input of nitrogen from the measured tributary stream, in tons

Om = the total annual input of phosphorus from the measured tributary streams, in tons.

Then the remaining input of nitrogen (Nr), phosphorus (Pr), and orthophosphorus (Or) into each main valley lake from tributary streams was given as:

$$Nr = Nm \frac{(Ar)}{(Am)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$Pr = Pm \frac{(Ar)}{(Am)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

and $$Or = Om \frac{(Ar)}{(Am)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Those streams which were influenced by positive outfalls (Vernon, Deep, Brandt's and Westbank Creeks), or those which connected the main valley lakes (Vernon Creek and Okanagan River), were not considered representative of drainage basin tributary streams and were thus omitted from this pro-rating procedure.

There are several methods available to provide this required estimate (percentage projections, weighting factors, statistical analysis, etc.), however, the method used herein is considered to be reliable in providing the order of magnitude figures required.

Depending on the amount of rainfall and subsequent runoff, the N and P loading rates for a given stream can vary from month to month or from year to year. This became evident when the annual N and P loading rates for various streams measured in the 1969-70 and 1970-71 sampling periods were compared. In some cases, the differences in annual input were found to vary up to 300% between the two sampling years. In order that a reasonable estimate of the present annual input of N and P stream loadings to the main valley lakes could be made, all quality (N and P) and quantity (Flow) data gathered for each measured stream was totalled and then averaged for the two year sampling period. The averaged flow and N and P concentrations were then used to compute the annual input of N and P from the stream in question.

The computed stream loadings, as well as the estimate of the total annual input of N and P to each of the main valley lakes from tributary streams, are summarized in Tables 12.5 to 12.8 inclusively. In these tables mean concentration and loadings of orthophosphorus are in terms of phosphorus found in the ortho form, not in terms of formula weight PO_4.

A review of the estimated annual loadings of the major tributary streams indicates that those streams with larger drainage areas generally contribute higher amounts of nutrients. The eight streams, Mission, Trout, Shorts, Lambly, Deep, Kelowna, Whiteman and Coldstream contributed over 60% of the total input of nitrogen and phosphorus to the main valley lakes between 1969-71. Those creeks in sparsely developed areas - Shorts, Whiteman, Naswhito, ect., contributed significant amounts of total phosphorus, but less than 20% of this was in the soluble orthophosphorus form.

Estimates of the portion of loadings to streams that occur from agricultural and septic tank sources are shown in Tables 12.3 and 12.4. These loadings are primarily from surface runoff or groundwater which enters the tributary streams and has been measured as a part of the total stream loading.

TABLE 12.3

ESTIMATED LOADING OF PHOSPHORUS TO STREAMS
FROM NATURAL, AGRICULTURAL AND SEPTIC TANK SOURCES (TONS)

STREAMS TRIBUTARY TO	NATURAL	AGRICULTURAL SOURCES	SEPTIC TANK SOURCES	TOTAL
Wood Lake	0.20*	Not estimated	Not estimated	0.20
Kalamalka Lake	1.54	0.01	0.25	1.80
Okanagan Lake	30.25	1.41	2.28	33.94
Skaha Lake	1.82	0.17	0.11	2.10
Vaseux Lake	0.00	-	0.13	0.13
Osoyoos Lake	0.35	0.03	0.02	0.40
TOTALS	34.16	1.62	2.79	38.57
PERCENT	88.6	4.2	7.2	100%

* Includes diffuse loadings from agricultural and septic tank sources.

TABLE 12.4

ESTIMATED LOADING OF NITROGEN TO STREAMS
FROM NATURAL, AGRICULTURAL AND SEPTIC TANK SOURCES (TONS)

STREAMS TRIBUTARY TO	NATURAL	AGRICULTURAL SOURCES	SPETIC TANK SOURCES	TOTAL
Wood Lake	5.00*	Not estimated	Not estimated	5.00
Kalamalka Lake	27.88	7.45	4.17	39.50
Okanagan Lake	172.10	42.61	33.40	248.10
Skaha Lake	1.81	8.02	1.26	11.10
Vaseux Lake	3.17	0.02	1.61	4.80
Osoyoos Lake	0.05	0.50	0.31	1.00
TOTALS	210.01	58.61	40.75	309.37
PERCENT	68.0	18.9	13.1	100%

* Includes diffuse loadings from agricultural and septic tank sources.

TABLE 12.5

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, ORTHOPHOSPHORUS AND TOTAL PHOSPHORUS FROM STREAMS INTO WOOD AND KALAMALKA LAKES

TRIBUTARY	SAMPLING STATION NUMBER	HYDROMETRIC STATION NUMBER	DRAINAGE AREA Mi^2	MEAN ANNUAL INFLOW KAcFt.	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING TONS/YEAR		
					TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.	TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.
Wood Lake Drainage Basin										
Vernon Cr. (to Wood Lake)	BC4-525	8NM-009	40.0	2.3	1.605	0.070	0.026	5.0	0.2	0.08
Remaining Drainage Area			38.1					5.0	0.2	0.08
Total for Drainage Basin			78.1					10.0	0.4	0.16
Kalamalka Drainage Basin										
Coldstream Creek	BC4-532	8NM-154	79.3	10.0	1.648	0.071	0.026	22.4	1.0	0.35
Remaining Drainage Area			60.4					17.1	0.8	0.28
Total for Drainage Basin			139.7					39.5	1.8	0.63

TABLE 12.6

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, ORTHOPHOSPHORUS AND TOTAL PHOSPHORUS FROM STREAMS INTO REGIONS OF OKANAGAN LAKE

TRIBUTARY	SAMPLING STATION NUMBER	HYDROMETRIC STATION NUMBER	DRAINAGE AREA Mi^2	MEAN ANNUAL INFLOW KAcFt.	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING TONS/YEAR		
					TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.	TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.
NORTH REGION										
Short Cr.	BC4-526	8NM-151	72.0	24.0	0.244	0.082	0.012	8.0	2.7	0.39
Whiteman Cr.	BC4-527	8NM-180	76.0	18.5	0.289	0.054	0.029	7.3	1.4	0.73
Equesis Cr.	BC4-528	8NM-161	77.0	12.7	0.332	0.054	0.021	5.7	0.9	0.36
Nashwito Cr.	BC4-533		31.7	1.3	0.182	0.064	0.064	0.3	0.4	0.11
Deep Cr. (a)	BC4-529	8NM-153	99.0	9.3	1.505	0.351	0.207	19.0	4.4	2.56
Deep Cr. (b)								14.8	2.3	0.85
Total Measured Tributary Streams (e)			256.2					21.3	8.4	1.59
Remaining Drainage Areas								7.8	2.0	0.38
Vernon Cr. (c)	BC4-530	8NM-160	297.3	20.7	2.074	0.660	0.535	58.4	18.6	15.0
Vernon Cr. (d)								20.2	0.8	0.15
Total - Drainage Basin (f)								43.9	9.7	2.82
CENTRAL REGION										
Peachland Cr.	BC4-514	8NM-159	58.9	7.2	0.775	0.041	0.015	7.6	0.4	0.15
Trepanier Cr.	BC4-515	8NM-155	99.6	23.0	0.160	0.015	0.006	5.0	0.5	0.19
Powers Cr.	BC4-516	8NM-157	55.8	14.3	0.879	0.040	0.022	17.1	0.8	0.43
Smith Cr. (a)	BC4-517		4.3	1.1	1.533	0.373	0.254	2.3	0.6	0.38
Smith Cr. (b)								0.6	0.0	0.00
McDougall Cr.	BC4-518		18.6	1.1	0.343	0.092	0.071	0.5	0.1	0.11
Bellvue Cr.	BC4-519	8NM-156	34.0	5.9	0.861	0.047	0.021	6.9	0.4	0.17
Mission Cr.	BC4-520	8NM-116	336.1	116.7	0.467	0.050	0.013	74.1	7.9	2.53
Kelowna Cr.	BC4-521	8NM-53	85.9	8.4	1.202	0.116	0.058	13.7	1.3	0.66
Lambly Cr.	BC4-523	8NM-003	103.3	28.7	0.419	0.044	0.017	16.4	1.7	0.66
Total Measured Streams (c)			796.5					141.9	13.1	4.90
Remainder			108.3					19.3	1.8	0.67
Total -Drainage Basin			904.8					161.2	14.9	5.57
SOUTH REGION										
Penticton Cr.	BC4-511	8NM-118	69.5	16.7	0.462	0.37	0.005	10.5	0.8	0.13
Trout Cr.	BC4-512	8NM-158	289.4	30.5	0.508	0.147	0.006	21.1	6.1	2.49
Chute Cr.	BC4-513		34.1	0.5	0.355	0.014	0.005	0.2	0.0	0.00
Total Measured Streams			393.0					31.8	6.9	2.62
Remainder			137.9					11.2	2.4	0.92
Total Drainage Area			530.9					43.0	9.3	3.54

NORTH REGION

(a) Includes effluent from the Armstrong Sewage Treatment Plant.
(b) Excludes effluent from the Armstrong Sewage Treatment Plant.
(c) Includes effluent from the Vernon Sewage Treatment Plant.
(d) Excludes effluent from the Vernon Sewage Treatment Plant.
(e) Includes Drainage Area and Loadings from Shorts, Whiteman, Equesis, & Nashwito Creeks.
(f) Excluding Vernon Creek

CENTRAL REGION

(a) Includes input from Westbank Sewage Lagoons.
(b) Excludes Input from Westbank Sewage Lagoons.
(c) Excludes Smith Creek

TABLE 12.7

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, ORTHOPHOSPHORUS AND TOTAL PHOSPHORUS FROM STREAMS INTO SKAHA LAKE

TRIBUTARY	SAMPLING STATION NUMBER	HYDROMETRIC STATION NUMBER	DRAINAGE AREA Mi^2	MEAN ANNUAL INFLOW KAcFt.	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING TONS/YEAR		
					TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.	TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.
Okanagan River										
(Okanagan L. Outlet)	-	8NM-050	-	270.6	-	-	-	-	-	-
(Inflow to Skaha L.) (a)	BC4-508			289.1	0.394	0.054	0.026	154.9	21.2	10.20
(Inflow to Skaha L.) (b)								98.8	6.8	(-)
Skaha Lake Drainage Basin										
Shingle Cr.	BC4-509	8NM-150	117.1	8.8	0.253	0.027	0.005	3.0	0.3	0.06
Ellis Cr.	BC4-510	8NM-135	64.6	8.0	0.460	0.108	0.028	5.0	1.2	0.30
McLean Cr.	BC4-507		23.0	0.2	0.366	0.035	0.019	0.1	0.0	0.00
Measured Trib. Total			204.7					8.1	1.5	0.36
Remaining Drainage Area			75.8					3.0	0.6	0.13
TOTAL - (c)			280.5					11.1	2.1	0.49

(a) Includes input from Okanagan Lake, Shingle, Ellis Creeks, remaining tributary drainage area, and the Penticton Sewage Treatment Plant.
(b) Excludes input from the Penticton Sewage Treatment Plant.
(c) Includes Shingle Creek and Ellis Creek.
(-) Orthophosphorus uptake rate is high therefore a larger error is inherent in these calculations.

TABLE 12.8

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, ORTHOPHOSPHORUS AND TOTAL PHOSPHORUS FROM STREAMS INTO VASEUX AND OSOYOOS LAKES

	SAMPLING STATION NUMBER	HYDROMETRIC STATION NUMBER	DRAINAGE AREA Mi^2	MEAN ANNUAL KAcFt.	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING TONS/YEAR		
					TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.	TOTAL NIT.	TOTAL PHOS.	ORTHO PHOS.
Okanagan River										
At Okanagan Falls		8NM-002		287.8						
Upstream of Vaseux Lake	BC4-505	-		301.2	0.328	0.023	0.007	134.4	9.4	2.88
Upstream of Osoyoos L. (a)	BC4-502	8NM-85	-	320.2	0.365	0.030	0.006	158.9	13.1	2.61
Upstream of Osoyoos L. (b)								154.8	11.1	0.78
Vaseux Lake Drainage Basin										
Shuttleworth Cr.	BC4-506	8NM-149	35.0	3.4	0.671	0.030	0.006	3.1	0.1	0.03
Remaining Drainage Area			18.7					1.7	0.1	0.02
Total								4.8	0.2	0.05
Osoyoos Lake Drainage Basin										
Inkaneep Cr.	BC9-501		75.3	1.4	0.259	0.081	0.032	0.5	0.2	0.06
Remaining Drainage Areas			68.5					0.5	0.2	0.05
Total								1.0	0.4	0.11

(a) Includes Village of Oliver Sewage Treatment Plant Discharge.
(b) Excludes Village of Oliver Sewage Treatment Plant Discharge.

12.1.2 Main Valley Streams

Estimates were made of the input of nutrients from the main valley stream. In most cases, these were given directly by measurements of stream flows and nutrient concentrations (e.g. Vernon Creek at the inlet to Okanagan Lake, Okanagan River at inlets to Skaha Lake, Vaseux Lake, and Osoyoos Lake).

Internal fluxes in Okanagan Lake, however, presented a special case. Nutrient fluxes from the northern portion of Okanagan Lake to the central region, and from the central region to the south were estimated from (1) a water budget to estimate the annual flow of water and (2) mean measured nutrient concentrations. This analysis is summarized in Table 12.9. In the water budget, tributary inflow

TABLE 12.9

1969-1971 AVERAGE NUTRIENT OUTFLOWS FROM ONE REGION OF OKANAGAN LAKE TO THE NEXT

	NORTH	CENTRAL	SOUTH
Tributary inflow (ac.ft.)	99,000	234,500	64,400
Consumptive use (ac.ft.)	0	7,600	1,000
Net evaporation (ac.ft.)	27,200	48,200	25,600
Storage increase (ac.ft.)	4,700	8,400	4,500
Mainstem inflow (ac.ft.)	-	67,100	237,400
Net outflow (ac.ft.)	67,100	237,400	270,600
Concentration			
Total N (ppm)	0.297	0.205	0.247
Total P	0.037	0.020	0.0144
Ortho P (median)	0.01	0.01	0.01
Inflow to Next Region			
Total N (Tons)	27.1	66.1	90.8
Total P (Tons)	3.4	6.4	5.3
Ortho P (Tons)	0.9	3.18	3.63

is the measured mean annual tributary inflow for the two year period, corrected for unmeasured tributary area as outlined in Section 12.1 above. Consumptive uses were estimated in preliminary reports to Technical Supplement I. The net storage increase for the whole of the lake was given by the change in water level in the lake from the beginning to the end of the two year period. Net evaporation was then estimated as the difference between the net inflow to the lake and the measured outflow. This quantity and the net change in storage were allocated to each region according to lake surface area.

TABLE 12.10

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, TOTAL PHOSPHORUS AND ORTHOPHOSPHORUS INTO OKANAGAN BASIN SURFACE WATERS FROM MUNICIPAL DISCHARGES

MUNICIPALITY	POINT OF DISCHARGE	MEAN ANNUAL DISCHARGE (10^6 Imp. Gal.)	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING / tons/year		
			TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as P)	TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as))
Armstrong	Deep Creek	54.8	18.97	7.57	6.25	5.20	2.07	1.71
Vernon	Vernon Creek	445.0(a)	17.15	7.99	6.66	38.16	17.77	14.85
Kelowna	Okanagan Lake	577.0	20.01	7.08	5.99	57.77	20.42	17.30
Westbank	Smith Creek	18.2	19.01	9.03	8.00	1.73	0.82	0.73
Penticton	Okanagan River	463.0	24.21	6.24	5.00	56.09	14.45(b)	11.52
Oliver	Okanagan River	60.8	13.32	6.68	6.05	4.05	2.03	1.83

(a) Net Discharge to Vernon Creek (allowing for diversion of approximately 50% of discharge for six months to pilot spray irrigation scheme).

(b) Phosphorus removal facilities not in operation.

TABLE 12.11

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, TOTAL PHOSPHORUS AND ORTHPHOSPHORUS INTO OSOYOOS LAKE (CANADIAN) FROM INDUSTRIAL DISCHARGES

INDUSTRIAL SOURCE	SAMPLING STATION NUMBER	MEAN ANNUAL DISCHARGE (x 10^6 Imp. Gal.)	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING - tons/year		
			TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (As P)	ORTHO-PHOSPHORUS (as P)	TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as P)
McLean & Fitzpatrick*	1	31.5	14.74	0.021	0.014	2.32	0.01	0.000
Oliver-Osoyoos Co-Op	2	99.7	5.32	0.975	0.056	2.65	0.04	0.028
International Curling Club	3	7.8	4.96	0.120	0.120	0.19	0.01	0.004
Monashee Co-Op	0-1	5.1	1.824	1.479	0.882	0.05	0.04	0.022
					Estimated Annual Input	5.21	0.09	0.054

* Now owned by Oliver-Osoyoos Co-Op.

Nutrient concentrations for the northern region were based on a limited number of observations (generally 3 or 4). The phosphorus concentration for the central region was based on one measurement near Kelowna. Phosphorus and nitrogen concentrations for the southern region were based on estimated nutrient outflow from the lake and measured Okanagan River streamflow, as many more samples were taken from Okanagan River than from the lake.

Several sources of error exist in these estimates of loadings. The concentration data, for example, may be significantly in error as it is based on few observations. In addition, the water budget may have error, although these possible errors are not thought to be significant. It should be noted that the calculated fluxes are internal transfers and, hence, should not be included if Okanagan Lake is considered as a unit.

12.1.3 Municipal Discharges

At this time there are six municipalities within the Okanagan Basin which discharge treated effluents into surface waters. All municipalities provide some degree of conventional treatment to their municipal wastes prior to discharge. The City of Penticton provides tertiary treatment by chemical precipitation after secondary treatment to achieve up to 80% overall phosphorus removal.

Based on two years of data (Section 3) the mean nitrogen, phosphorus, and orthophosphorus concentrations in the effluent and the mean annual discharge were determined for each of the six municipalities. These data were then combined to provide an estimate of the annual inputs from municipal discharges, into the receiving waters. The mean concentrations, as well as the annual loadings, are summarized in Table 12.10. Orthophosphorus loadings, which represent the soluble portion of total phosphates, have been included to show the high percentage of phosphorus that is in the soluble form following secondary (biological) treatment as compared to the low percentage that is in the soluble form in tributary stream discharges.

During the summer and fall of 1971, the City of Vernon spray irrigated approximately one half of its treated discharge. This aspect was accounted for when determining the mean annual discharge into Vernon Creek.

In 1971 the City of Penticton completed a chemical tertiary treatment unit for the removal of phosphorus, but this unit was not in operation during the monitoring period and the effect of this facility is not reflected in the values shown. The amount of phosphorus removed consistently by this tertiary unit in 1972-73 has been estimated at 50 to 60%.

TABLE 12.12

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND ORTHOPHOSPHORUS INTO THE CENTRAL REGION OF OKANAGAN LAKE FROM INDUSTRIAL DISCHARGES

INDUSTRIAL SOURCE	SAMPLING STATION NUMBER	MEAN ANNUAL DISCHARGE ($\times 10^6$ Imp. Gal.)	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING - tons/year		
			TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as P)	TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as P)
Okanagan Beverages and Calona Wines*	0-10	4.91	1.477	1.863	0.540	0.04	0.05	0.013
Kelowna Growers Exchange and Sun-Rype No. 2*	0-11	39.7	2.463	0.688	0.167	0.49	0.14	0.033
American Can Company*	0-12	0.6	0.499	0.041	0.005	0.01	0.01	0.001
Cascade Co-Op*	20	5.0	1.94	0.267	0.182	0.05	0.01	0.005
S.M. Simpson Ltd.	16	15.5	0.760	1.90	0.012	0.06	0.15	0.001
Kelowna Memorial Arena	17	2.6	0.090	0.027	-	0.01	0.01	0.000
B.C. Orchards Co-Op	0-14	52.4	0.684	0.272	0.139	0.18	0.07	0.039
Kelowna Beverages and OK Packers	0-13	122.4	1.336	0.125	0.052	0.82	0.08	0.032
						1.66	0.52	0.124

* Discharges to Brandt's Creek

TABLE 12.13

ESTIMATED ANNUAL INPUT OF TOTAL NITROGEN, TOTAL PHOSPHORUS AND ORTHOPHOSPHORUS INTO SKAHA LAKE AND THE SOUTH REGION OF OKANAGAN LAKE FROM INDUSTRIAL DISCHARGES

INDUSTRIAL SOURCE (South region of Okanagan Lake)	SAMPLING STATION NUMBER	MEAN ANNUAL DISCHARGE ($\times 10^6$ Imp. Gal.)	MEAN CONCENTRATION mg/l			ESTIMATED ANNUAL LOADING - tons/year		
			TOTAL NITROGEN (As N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as P)	TOTAL NITROGEN (as N)	TOTAL PHOSPHORUS (as P)	ORTHO-PHOSPHORUS (as P)
Pyramid Co-Op	10	5.5	0.028	0.122	0.028	0.01	0.01	0.001
Naramata Co-Op	11	1.4	0.604	0.903	0.417	0.01	0.01	0.003
Fish and Wildlife Hatchery[1]	0-7	340.2	4.248	0.111	0.039	7.23	0.19	0.067
Cornwall Canners Ltd.	0-8	32.3	2.032	0.699	0.381	0.33	0.11	0.061
(Skaha Lake) Oliver-Osoyoos Co-Op (Kaledan)	8	28.8	1.0	0.5	-	0.144	0.072	-
					Estimated Annual Input	7,724	0.392	0.132

*[1] The Fish and Wildlife Hatchery at Summerland obtaines its water from Shaughnessey Spring. This water supply is contaminated by nitrates having a mean total nitrogen concentration of 4 milligrams per liter. This contamination is reflected in the annual effluent loadings from the Hatchery (Ref. Technical Supplement VI.).

12.1.4 Industrial Outfalls

Thirteen major industrial outfalls (waste effluent discharged to surface waters) were monitored on a monthly basis between August, 1969 and July, 1971. These outfalls included all the major industrial waste discharges in terms of volume and organic loads, and several of the small industrial establishments considered to be representative of numerous other plants of the same category. In addition, 36 minor outfalls were sampled at least twice during the monitoring period. Data collected on those industries with positive discharges to surface waters were used to estimate the annual nutrient loadings from each industrial source. Those industries which discharge their waste effluent into ground disposal systems are considered as groundwater sources. As in the case of streams and municipal outfalls mean concentrations and mean discharges were used to estimate annual loadings for industrial outfalls. (Tables 12.11 to 12.13).

The total contribution of nutrients from industrial outfalls represents less than one percent of the total annual input of phosphorus and nitrogen from all other sources and except for local problems which they may cause, are not currently of prime importance in the control of phosphorus and nitrogen to surface waters.

12.1.5 Dustfall and Precipitation

The monthly areal input of nitrogen and phosphorus due to dustfall and precipitation on the main valley Okanagan Lakes was outlined in Section 5. The median area distribution of total soluble nitrogen and total soluble phosphate in tons/square mile/month was combined with the surface area of each respective lake to provide an estimate of the annual input of nitrogen and phosphorus (as P) from dustfall and precipitation. This information is summarized in Table 12.14. Orthophosphorus loadings were estimated by assuming that all of the total phosphorus was in the ortho form.

TABLE 12.14

ESTIMATED ANNUAL INPUT OF TOTAL SOLUBLE NITROGEN AND PHOSPHORUS INTO THE MAIN VALLEY OKANAGAN LAKES FROM DUSTFALL AND PRECIPITATION

MAINSTEM LAKE	LAKE SURFACE AREA SQ. MI.	MEDIAN AREAL DISTRIBUTION TONS/SQ. MI/MON		ESTIMATED ANNUAL LOADING TONS/YEAR	
		TOTAL PO_4 [1]	TOTAL N NITROGEN	TOTAL SOLUBLE P PHOSPHORUS (as P)	TOTAL N NITROGEN
Wood	3.46	0.005	0.045	0.07	1.9
Kalamalka	9.68	0.008	0.040	0.30	4.6
Okanagan-North	36.12	0.075	0.056	2.95	24.3
-Central	63.99	0.010	0.037	2.48	28.4
-South	34.10	0.033	0.080	4.37	32.7
Skaha	7.58	0.028	0.124	0.83	11.3
Vaseux	1.02	0.004	0.146	0.02	1.8
Osoyoos (Canadian)	5.77	0.022	0.044	0.49	3.0

[1] Expressed as weight of PO_4, not elemental P.

Section 5 suggests that the nitrogen and phosphorus data as reported, represents the maximum contribution to the main valley Okanagan Lakes from dustfall and precipitation. As the nitrogen and phosphorus found in dustfall and precipitation is essentially in soluble form, the concentrations as reported are taken to represent total nitrogen and total phosphorus.

12.1.6 Storm Sewer Discharges

A study to determine the amount of nutrients and other impurities discharging into the surface waters of the Basin from the storm sewers of the cities of Vernon, Kelowna and Penticton, was carried out through the spring and summer of 1972. The storm sewer system in each city is completely separate from the sewage collection system and these three represent the only ones in the Basin in 1971. The annual loadings from this source were determined by combining the concentrations of nutrients found in samples of storm sewer water from both snowmelt and rainfall, with the volume of storm water discharged by each city. The volume of storm water was based on annual precipitation, drainage area, and an estimate of the percentage of rainfall actually discharged through the storm sewers.

The annual loadings of nitrogen, phosphorus, and orthophosphorus from storm sewers to each main valley lake were estimated in Section 4 and are included in Tables 12.15, 12.16 and 12.17 respectively.

12.1.7 Groundwater Sources

Groundwater sources encompass all nutrients transported to the surface water system by groundwater flows. These nutrient sources include agriculture, septic tanks, and other unidentified sources including those which occur naturally through the dissolving of various elements by moving water. These groundwater sources in general represent the greatest unknown of all nutrient sources due primarily to the difficulty in measuring groundwater flows. Part of the water that falls as precipitation on the watershed percolates through the soil to the groundwater table and eventually finds its way to the surface waters of tributary streams and the main valley Lakes. In the Okanagan Basin this is augmented by groundwater return flows from irrigation. Studies of the latter indicate that up to 50% of the water applied for irrigation purposes eventually returns to the lake system, and is considered to make up the largest portion of the total groundwater flow in irrigated areas. The transport of this water through the ground is very slow however, and its ultimate destination very difficult to determine. Part of the return flow from irrigation water applied during April to November, for example, may not return to the surface water system for 6 to 12 months. Therefore, while estimates of the concentrations of nutrients in the groundwater can be determined fairly accurately, the groundwater flow and resulting loadings are much more difficult to assess.

TABLE 12.15

ESTIMATED INPUT (IN TONS) OF TOTAL NITROGEN TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES, 1969 - 1971

Sources \ Drainage Basin	Wood 1	Kalamalka 2	OKANAGAN LAKE North 3	OKANAGAN LAKE Central 4	OKANAGAN LAKE South 5	Skaha 6	Vaseux 7	Okanagan River 8	Osoyoos (Canadian) 9
Tributary Streams, Total[1]	5.00	39.50[3]	43.90	161.20	43.00	11.10[8]	4.80	-	1.00
Tributary Streams, Natural[2]	5.00	27.88[3]	14.54	123.69[4]	33.87[4]	1.81[9]	3.17	-	0.05[7]
Main Valley Streams	5.00	-	20.20	27.10[4]	66.10[4]	90.80[10]	134.40	-	158.90
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal	-	-	43.36	59.50	-	56.09	-	-	4.05
Industrial	0.05	-	-	1.64	7.56	0.14	-	-	5.21
Storm Sewers	-	-	1.28	0.46	0.37	0.74	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture[12]	-	7.45	18.57	20.41	3.63	8.03[11]	0.02	5.75	0.50[7]
Septic Tanks[5]	-	4.17	10.80	17.10	5.50	1.26[11]	1.61	2.60	0.31
Septic Tanks[6]	-	1.06	2.78	4.35	1.40	0.32	0.41	0.66	0.08
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture[13]	4.93	2.17	6.28	21.99	18.26	7.74	2.46	55.81	32.30
Septic Tanks[5]	8.58	5.11	9.08	27.80	28.10	13.78	1.49	16.38	43.20
Septic Tanks[6]	2.18	1.30	2.31	7.09	7.15	3.50	0.38	4.17	10.98
Other[13]	1.22	0.25	0.72	3.08	5.32	2.26	0.30	1.25	1.21
Natural[13]	1.32	1.07	7.70	27.04	13.78	5.04	2.18	1.63	1.41
TOTAL	28.00	52.70	156.87	358.21	214.99	199.00	147.73	83.42	250.59

▒▒ - Loading not included in the total.

NOTES:

1. Includes contribution from agriculture and septic tank sources within the tributary stream basins.
2. Excludes diffuse contribution from agriculture and septic tank sources within the tributary stream basins.
3. Includes main valley stream loading.
4. These figures represent internal fluxes within the lake and are considered as a first order approximation. If the Okanagan Lake is considered as one unit these internal fluxes are removed.
5. This septic tank contribution is considered to be the maximum loading which can be expected. This figure is based upon the per capita contribution of phosphorus and nitrogen in septic tank effluent; but does not consider systems which are operating inefficiently as a result of improper maintenance or a poorly designed tile disposal system. Generally these figures represent systems where water use is not the limiting factor. These figures are derived from Wood-Kalamalka septic tank nutrient contributions given in Table 2.2.3 in Technical Supplement #1.
6. These figures are based on laboratory experimental data as given in Table 10.14 of Chapter 10 interpreted in the groundwater report included in this Supplement. These loadings are not included in the overall total loading.
7. The agriculture nitrogen contribution in the Osoyoos drainage basin has been adjusted as a result of an apparent discrepancy in the groundwater data.
8. Includes loading from Shingle Creek, Ellis Creek, McClean Creek plus remaining creeks flowing into Skaha Lake.
9. As in footnote 8, but excluding input from agriculture and septic tanks which contribute to tributary stream loading.
10. Excluding loading from the sewage treatment plant, Shingle and Ellis Creeks.
11. Includes septic tank and agriculture on Shingle and Ellis Creeks as well as remaining creeks.
12. These loadings are derived from Table 7.10 of Chapter 7.
13. These loadings are derived from Table 7.8 of Chapter 7.

TABLE 12.16

ESTIMATED ANNUAL INPUT (IN TONS) OF TOTAL PHOSPHORUS AS P TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES, 1969 - 1971

Sources \ Drainage Basin	Wood 1	Kalamalka 2	OKANAGAN LAKE North 3	OKANAGAN LAKE Central 4	OKANAGAN LAKE South 5	Skaha 6	Vaseux 7	Okanagan River 8	Osoyoos (Canadian) 9
Tributary Streams, Total[1]	0.20	1.80[3]	9.74	14.90	9.30	2.10[8]	0.13	-	0.40
Tributary Streams, Natural[2]	0.20	1.54[3]	7.84	13.62[4]	8.79[4]	1.82[9]	0.00	-	0.35
Main Valley Streams	0.20	-	0.80	3.40[4]	6.40[4]	5.30[10]	9.40	-	11.07
Dustfall and Precipitation	0.07	0.30	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal	-	-	19.84	21.24	-	14.45	-	-	2.03
Industrial	0.01	-	-	0.50	0.30	0.07	-	-	0.10
Storm Sewers	-	-	0.19	0.09	0.02	0.05	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture[12]	-	0.01	1.15	0.23	0.03	0.17[11]	-	0.04	0.03
Septic Tanks[5]	-	0.25	0.75	1.05	0.48	0.11[11]	0.13	0.23	0.02
Septic Tanks[6]	-	0.12	0.36	0.51	0.23	0.05	0.06	0.11	0.01
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture[12]	0.20	0.01	0.05	0.10	0.11	0.02	0.01	0.83	0.26
Septic Tanks[5]	0.83	0.47	0.78	2.42	2.33	1.30	0.14	1.46	4.28
Septic Tanks[6]	0.39	0.22	0.38	1.17	1.13	0.63	0.07	0.71	2.08
Other[13]	0.13	0.00	0.00	0.03	0.09	0.03	0.01	0.03	0.03
Natural[13]	0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL	1.66	2.59	34.57	45.75	23.14	24.23	9.78	2.62	18.78

TABLE 12.17

ESTIMATED ANNUAL INPUT (IN TONS) OF TOTAL ORTHOPHOSPHORUS AS P TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES, 1969 - 1971

Sources \ Drainage Basin	Wood 1	Kalamalka 2	OKANAGAN LAKE North 3	OKANAGAN LAKE Central 4	OKANAGAN LAKE South 5	Skaha 6	Vaseux 7	Okanagan River 8	Osoyoos (Canadian) 9
Tributary Streams, Total[1]	0.08	0.63[3]	2.82	5.57	3.54	0.13[8]	0.05	-	0.11
Tributary Streams, Natural[2]	-	0.37[3]	0.92	4.29[4]	3.01[4]	0.00[9]	0.00	-	0.06
Main Valley Streams	0.08	-	0.15	0.90[4]	13.18[4]	0.00[10]	2.88	-	0.78
Dustfall and Precipitation	0.07	0.30	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal	-	-	16.56	18.03	-	11.52	-	-	1.83
Industrial	0.00	-	-	0.12	0.03	0.00	-	-	0.05
Storm Sewers	-	-	0.03	0.01	0.01	0.01	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture[12]	-	0.01	1.15	0.23	0.03	0.17[11]	-	0.04	0.03
Septic Tanks[5]	-	0.25	0.75	1.05	0.48	0.11[11]	0.13	0.23	0.02
Septic Tanks[6]	-	0.19	0.36	0.51	0.23	0.05	0.06	0.11	0.01
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture[12]	0.20	0.01	0.05	0.10	0.11	0.02	0.01	0.83	0.26
Septic Tanks[5]	0.83	0.47	0.78	2.42	2.33	1.30	0.14	1.46	4.28
Septic Tanks[6]	0.39	0.22	0.38	1.17	1.13	0.63	0.07	0.71	2.08
Other[13]	0.13	0.01	0.01	0.03	0.09	0.03	0.01	0.03	0.03
Natural[13]	0.02	0.01	0.22	0.59	0.22	0.08	0.04	1.75	0.10
TOTAL	1.41	1.43	23.57	30.25	23.96	14.07	3.23	4.34	7.93

▭ — Loading not included in total.
See Table 12.15 for notes.

Four studies were undertaken in an attempt to provide order of magnitude figures on the amounts of nutrients entering the main valley lakes via groundwater. These included a theoretical study of all potential source loadings, augmented by pilot studies on septic tanks, landfills, and spray irrigation-lysimeter tests. The study on source loadings involved the documentation of all nutrients that might ultimately reach receiving waters in the ground. These included such sources as irrigation water, fertilizers, agricultural animals, wildlife, dustfall, and decaying organic matter. A large percentage of these groundwater loadings return to the tributary streams themselves and therefore have been measured as part of the stream loadings. The remaining groundwater enters the main valley lakes directly. The pilot studies on septic tanks, landfills, and spray irrigation-lysimeter tests were carried out in conjunction with the waste treatment pilot studies and will be discussed in more detail in the waste treatment section. Briefly, they provide information on the transport of water and nutrients through various soil types under controlled conditions.

The estimated annual input of nitrogen and phosphorus from natural groundwater, septic tank, agricultural and other sources were outlined in Section 7. These loadings are included in Tables 12.15 and 12.16. Although reported as total phosphorus, generally groundwater phosphorus is in the ortho form (81). Therefore, the orthophosphorus loadings were assumed equal to total phosphorus (Table 12.17).

The overall accuracy of these results is considered to be correct to within one order of magnitude, but greater variations may occur within the basin as a whole. Further, since phosphporus has been considered as the key element in controlling lake enrichment, this degree of error will not have the same importance on the overall results as it would had nitrogen been indicated as the controlling element.

12.1.8 Relative Distribution of Nitrogen and Phosphorus

To provide a better understanding of the significance of each known source in relation to the total known input,the percentage contributions of total nitrogen and phosphorus from each source to the main valley lakes are summarized in Tables 12.18 and 12.19 respectively. These percentages were calculated from the loadings summarized in Tables 12.15 and 12.16.

These results indicate that groundwater contributes approximately 20% of the total nitrogen and 10% of the total phosphorus entering the main valley lakes. Nitrogen is a transient element which is readily transported by water through the soil, while phosphorus becomes bonded with the soil particles and is transported only when conditions of excess phosphorus occur.

(a) Accuracy of Results

Based on the information available, the nutrient loadings represent an estimate of the current input of nutrients and other measured parameters to the major

TABLE 12.18

ANNUAL INPUT (IN PERCENT) OF TOTAL NITROGEN TO THE MAIN VALLEY OKANAGAN LAKES FROM KNOWN SOURCES, 1969 - 1971

Sources \ Drainage Basin	Wood 1	Kalamalka 2	OKANAGAN LAKE North 3	OKANAGAN LAKE Central 4	OKANAGAN LAKE South 5	Skaha 6	Vaseux 7	Okanagan River 8	Osoyoos (Canadian) 9
Tributary Streams, Natural	17.9	52.9	9.3	34.5	15.8	0.9	2.1	-	0.0
Main Valley Streams	17.9	-	12.9	7.6	30.7	45.6	91.0	-	63.4
Dustfall and Precipitation	6.8	8.7	12.5	7.9	15.2	5.7	1.2	-	1.2
POINT SOURCES									
Municipal Input	-	-	27.6	16.6	-	28.2	-	-	1.6
Industrial	0.2	-	-	0.5	3.5	0.1	-	-	2.1
Storm Sewers	-	-	0.8	0.1	0.2	0.4	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	14.1	11.8	5.7	1.7	4.03	0.0	6.9	0.2
Septic Tanks	-	7.9	6.9	4.8	2.6	0.6	1.1	3.1	0.1
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	17.6	4.1	4.0	6.1	8.5	3.9	1.7	66.9	12.9
Septic Tanks	30.6	9.7	5.8	7.8	13.1	6.9	1.0	19.6	17.2
Other	4.4	0.5	0.5	0.9	2.5	1.1	0.2	1.5	0.5
Natural	2.5	1.6	4.6	7.2	5.7	2.2	0.9	0.1	0.4
TOTAL	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0

TABLE 12.19

ANNUAL INPUT (IN PERCENT) OF TOTAL PHOSPHORUS TO THE MAIN VALLEY OKANAGAN LAKES FROM KNOWN SOURCES, 1969 - 1971

Source \ Drainage Basin	Wood 1	Kalamalka 2	OKANAGAN LAKE North 3	OKANAGAN LAKE Central 4	OKANAGAN LAKE South 5	Skaha 6	Vaseux 7	Okanagan River 8	Osoyoos (Canadian) 9
Tributary Streams, Natural	12.1	59.5	22.7	29.9	38.0	7.6	0.0	-	1.9
Main Valley Streams	12.1	-	2.4	7.5	27.7	21.9	96.9	-	59.1
Dustfall and Precipitation	4.3	11.6	8.6	5.5	18.9	3.5	0.2	-	2.6
POINT SOURCES									
Municipal Input	-	-	57.4	46.6	-	59.7	-	-	11.0
Industrial	0.6	-	-	1.1	1.3	0.3	-	-	0.5
Storm Sewers	-	-	0.5	0.1	0.0	0.2	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	0.4	3.3	0.5	0.2	0.7	-	1.6	0.1
Septic Tanks	-	9.7	2.1	2.2	2.0	0.4	1.3	8.8	0.1
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	12.0	0.4	0.1	0.2	0.5	0.0	0.1	31.7	1.3
Septic Tanks	50.0	18.1	2.2	5.2	10.1	5.3	1.4	55.7	22.8
Other	7.8	0.0	0.0	0.0	0.4	0.1	0.1	1.1	0.1
Natural	1.1	0.3	0.6	1.2	0.9	0.3	0.4	1.1	0.5
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Okanagan Basin Lakes. The following aspects should be realized when using the loadings reported herein:

(i) Information and supporting data on dustfall and precipitation, storm sewer discharges and groundwater was considered to be the minimum amount required to provide an indication as to the magnitude of nitrogen and phosphorus loadings emanating from these sources. However, the data collected agreed with published data.

(ii) The amount of water quality data gathered on outfalls and streams was considered to be extensive enough to provide an accurate assessment of existing quality.

(iii) The error in the outfall and stream loading computations will be directly proportional to the error in the flow measurement values. The quantity (flow) data collected on metered positive discharges and streams with continuous stage recorders could be in error as much as 10%. Many of the streams were measured manually and at infrequent intervals (time of sampling), which could result in flow measurements being in error as much as 50%. This percentage error would also apply to most of the positive discharges, as these flows were not continuously metered and were estimated at the time of sampling (once/month).

(iv) Due to the wide variations in the total annual inflow for any given stream from year to year, it is very difficult to establish any accurate mean annual loadings. In this report, the mean annual loading of nitrogen and phosphorus from streams was based on the average of only two years' (1969 to 1971) quality and quantity data. It is interesting to note that for some streams, the N and P loadings for the 1969-1970 period were exceeded by as much as 300% by the N and P loadings for the 1970-1971 period. This extreme variation was attributed to the higher surface runoff experienced in the Okanagan Valley in the spring of 1971.

(v) The phosphorus loadings reported for the City of Penticton municipal discharge (14.5 tons/annum) do not reflect the use of the chemical precipitation facilities which were being constructed during the time of sampling. This facility has since been completed, and it is estimated that the current loading of phosphorus in this discharge has been reduced to 5.4 tons/annum (assuming 80% overall P removal).

(b) Significance of Known Sources

Based on the total annual input of nitrogen to the main valley lakes, as determined in this report, the following trends are apparent:

(i) The major contributors of total nitrogen to all main valley lakes are tributary streams.

(ii) The City of Vernon municipal discharge accounted for 26 and 52 percent of the total input of nitrogen and phosphorus respectively into the north region of Okanagan Lake during 1969 to 1971.

(iii) The City of Kelowna municipal discharge accounted for 17 and 45 percent of the total input of nitrogen and phosphorus respectively into the central region of Okanagan Lake.

(iv) The City of Penticton municipal discharge (during the 1969-1971 sampling period) accounted for 28 and 60 percent of the total input of nitrogen and phosphorus respectively into Skaha Lake. With implementation of the phosphorus removal facilities, this discharge would now account for 47% of the total phosphorus input to Skaha Lake.

(v) The amount of nitrogen and phosphorus discharged from industrial and storm sewer sources is negligible when compared to the total input from all known sources. The major industrial source is the Fish and Wildlife Hatchery effluent at Summerland, which accounts for 3.5 percent of the total nitrogen input to the south region of Okanagan Lake of which the majority of the nitrogen contribution is input from Shaugnessy Spring, the source of water for the hatchery.

(vi) The contribution of total nitrogen and phosphorus from dustfall and precipitation accounted for approximately 10 percent of the total input of each element of Wood, Kalamalka, and Okanagan Lakes. This percentage decreases to approximately 5 percent for Skaha Lake and to 1 percent for Osoyoos Lake.

(vii) Septic tanks and streams are the major sources of phosphorus to Wood Lake, each accounting for 49 and 18 percent respectively of the total input.

(viii) Agriculture is a significant source of nitrogen to Wood, Okanagan and Osoyoos Lakes.

(ix) Septic tanks accounted for approximately 28, 12, 23 percent respectively, of the total input of phosphorus to Kalamalka, south region of Okanagan, and Osoyoos Lakes.

(x) Septic tanks represent 56 percent of the input of phosphorus to the Okanagan River between Vaseux and Osoyoos Lakes.

In considering Okanagan Lake as one lake, the following trends are noted:

(1) Streams accounted for 41 and 31 percent of the total input of nitrogen and phosphorus respectively.

(2) Municipal discharges accounted for 14 and 41 percent of the total input of nitrogen and phosphorus respectively.

(3) Dustfall and precipitation accounted for 9 and 8 percent of the total input of nitrogen and phosphorus respectively.

(4) Agriculture accounted for 7 percent of the total input of nitrogen.

12.2 VARIATION OF ANNUAL NUTRIENT LOADINGS

As noted previously, nutrient contributions by tributary streams was observed to vary greatly from one year to the next. Since the 1969 to 1971 study period represented a period of lower than average runoff, an evaluation was required of the factors involved in the variation of nutrient loadings by the various sources and the effect of a wet year in order to indicate a possible range of fluctuation to be expected. Emphasis was placed on the contribution by tributary streams, as data for this covered a wide range of runoff conditions.

Most of the major tributaries were sampled for water quality by Federal and Provincial agencies during 1969, 1970 and 1971 as outlined above. In addition, the British Columbia Pollution Control Branch has continued monitoring of several of the tributaries on a less frequent basis after the conclusion of the study program. In total, these data represent a range of runoff conditions from dry to average to wet year.

For the purposes of this study, eight creeks were chosen for examination. These creeks are the eight examined in water quantity studies in Technical Supplements I and II, and for which estimates of the extent of runoff fluctuation exist. These streams account for some 60% of the total inflow, and therefore most of the tributary nutrient load, to Okanagan Lake. These streams are:

1. Mission Creek
2. Trout Creek
3. Vernon Creek
4. Penticton Creek
5. Powers Creek
6. Equesis Creek
7. Peachland Creek
8. Kelowna Creek

As the sampling frequency varied greatly from 1970 to 1971 to 1972, the method of calculating the annual loadings was somewhat different from the methods of Section 12.1. As a first step in the analysis, individual daily stream nutrient concentrations were converted to loadings. A statistical correlation analysis on this data failed to reveal a general correlation between daily loading and daily streamflow for all eight tributaries, although a strong correlation was indicated for several streams.

The daily data was then averaged over time in order to reduce the apparent effects of minor events and to reflect long term effects. The period of time chosen

was four months, with each sampled year divided according to the three phases in the hydrologic regime, namely the freshet period (April 1 to August 1), the summer-fall period (August 1 to November 1), and the winter period (November 1 to April 1). A longer time base was not considered desirable in order to account for the various sampling frequencies. Loading data were averaged for each of the periods, and, where discrepancies existed between the total mean runoff and the mean runoff on sampling dates, were adjusted by this factor.

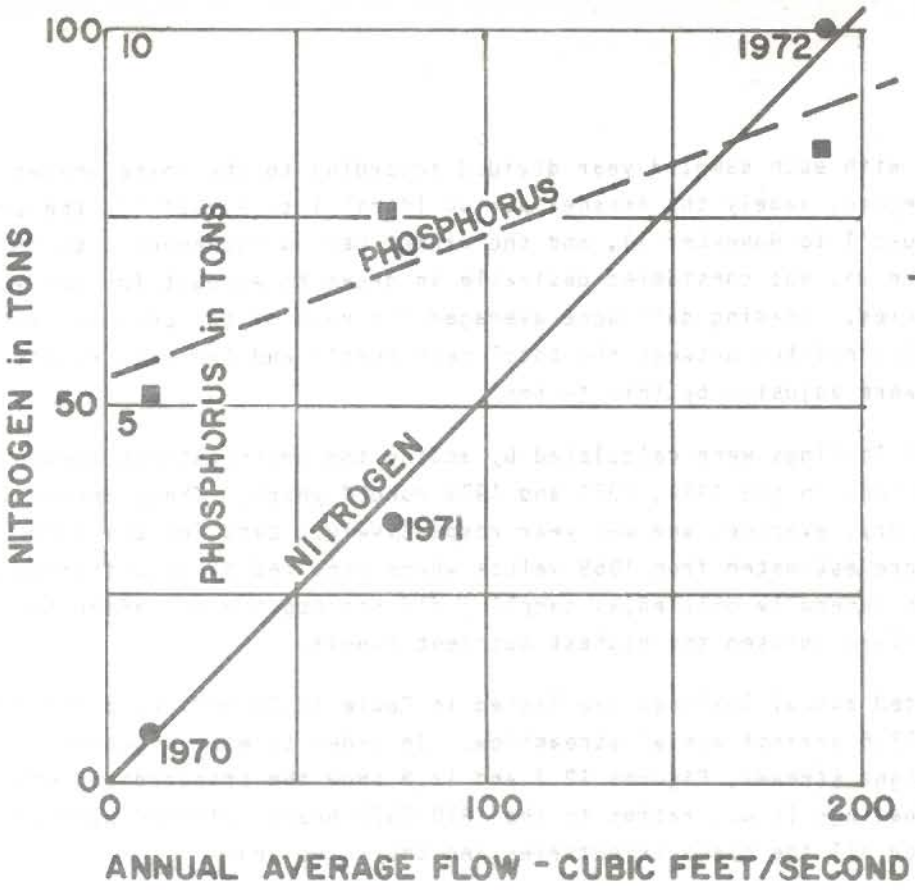
Total annual loadings were calculated by adding the contributions during each of the runoff periods in the 1970, 1971 and 1972 runoff years. These annual loadings represent a dry, average, and wet year respectively. Data for the summer and winter of 1972 were estimated from 1969 values where required by insufficient data. The 1969 year was generally omitted,as sampling did not begin until after the spring runoff and, therefore, missed the highest nutrient runoff.

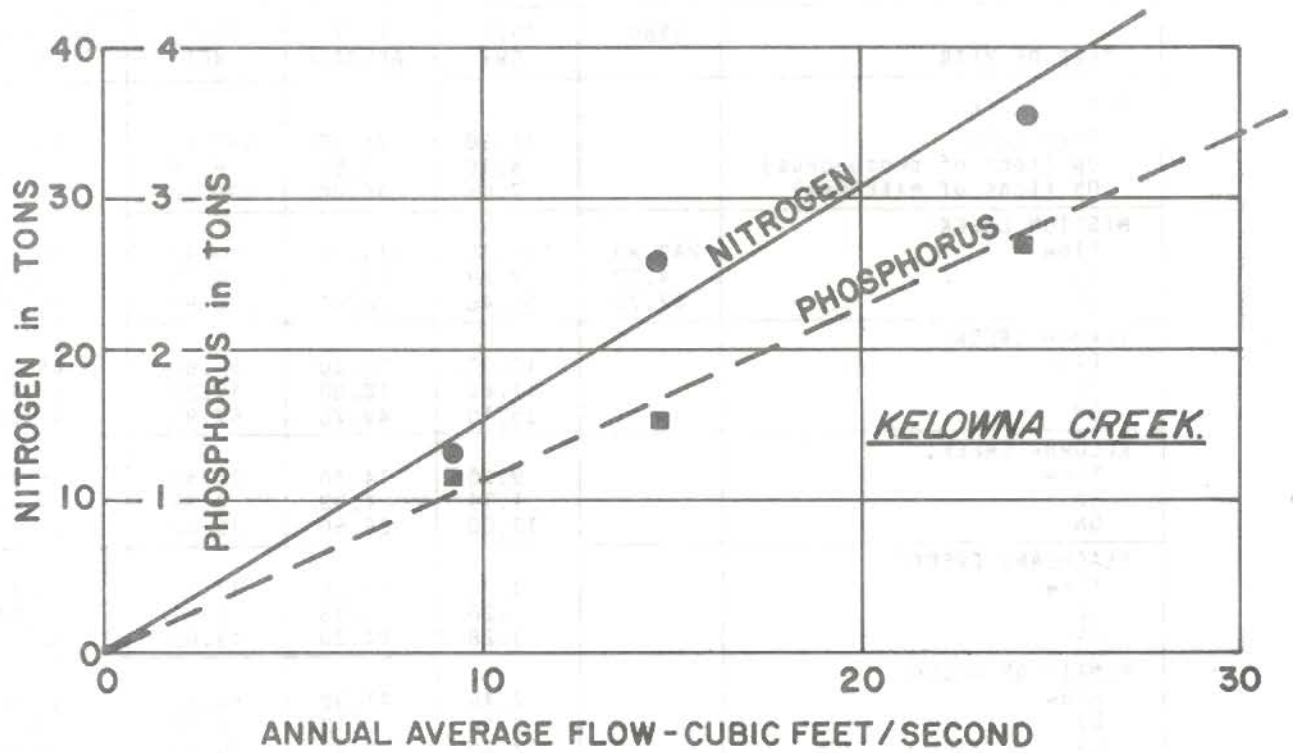
The calculated annual loadings are listed in Table 12.20 and are plotted in Figures 12.2 to 12.6 against annual streamflow. In order to make a general statement about all eight streams, Figures 12.7 and 12.8 show the standardized nitrogen and phosphorus loadings (i.e., ratios to the 1970-1972 means) plotted against standardized flows for all the eight tributaries and the three years.

TABLE 12.20

ANNUAL STREAM FLOWS AND NUTRIENT RUNOFFS - (HYDROLOGIC YEARS)

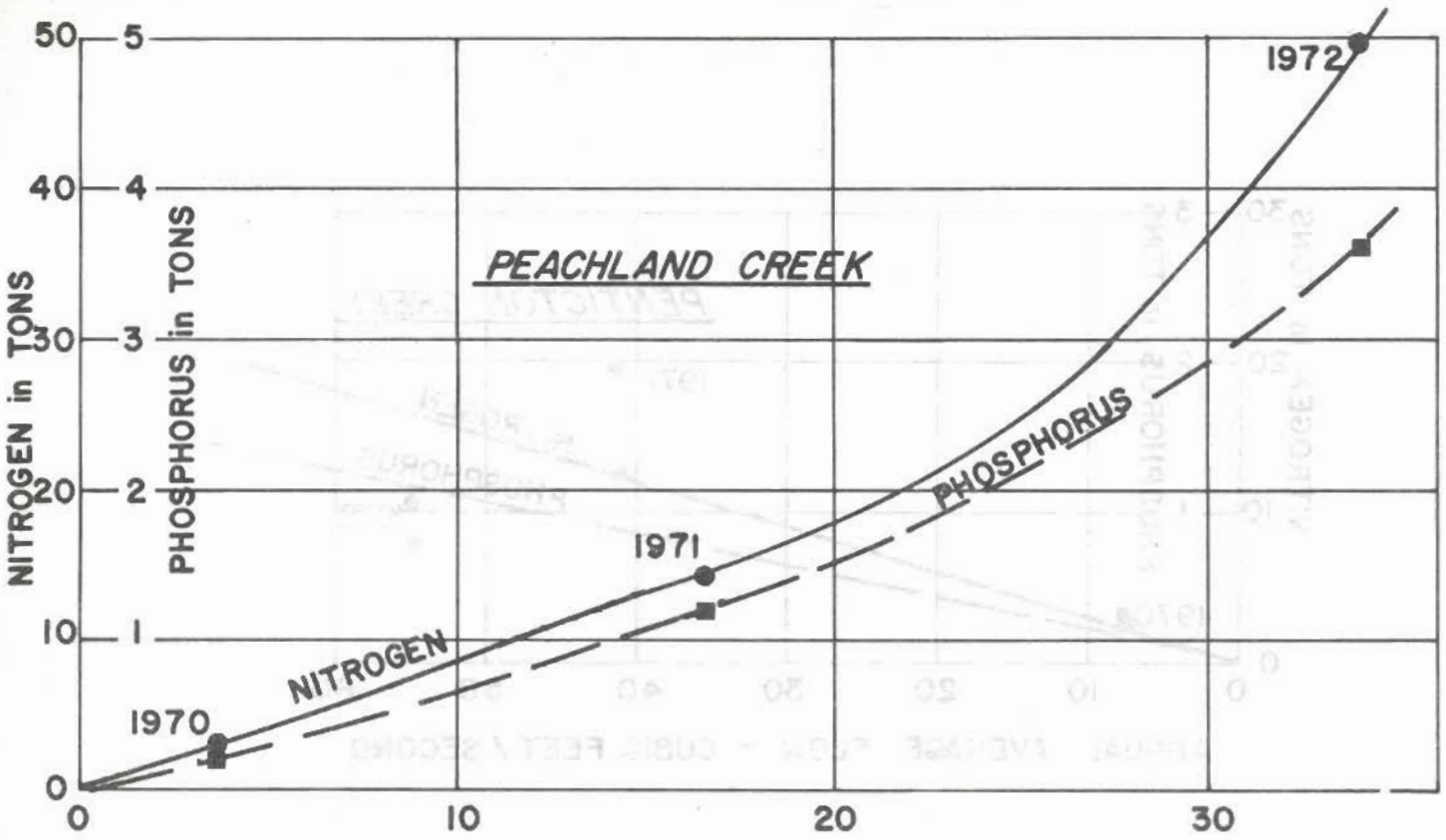
TYPE OF YEAR	1969	1970 DRY	1971 AVERAGE	1972 WET	1970-1972 MEAN
TROUT CREEK:					
Flow (cfs)		11.30	75.50	190.60	92.50
Qp (tons of phosphorus)		5.10	7.58	8.44	7.04
QN (tons of nitrogen)		7.09	35.00	100.20	47.40
MISSION CREEK:					
Flow	249.80	101.10	215.50	328.40	215.00
Qp	4.70	7.80	64.80	10.70	27.80
QN	82.70	30.40	76.60	118.60	75.20
VERNON CREEK:					
Flow		16.30	39.30	81.80	45.80
Qp		11.60	12.80	17.20	13.90
QN		35.10	49.70	57.90	47.60
KELOWNA CREEK:					
Flow		9.20	14.50	24.40	16.00
Qp		1.14	1.53	2.74	1.80
QN		13.00	26.50	35.10	24.90
PEACHLAND CREEK:					
Flow		3.70	16.60	33.90	18.10
Qp		.20	1.18	3.61	1.66
QN		3.28	14.30	49.60	22.40
PENTICTON CREEK:					
Flow		7.46	41.30	54.70	34.50
Qp		0.30	0.127	0.77	0.78
QN		2.80	19.40	10.60	10.90
EQUESIS CREEK:					
Flow		11.50	26.60	38.80	25.60
Qp		0.57	24.30	4.76	9.90
QN		3.76	143.80	13.10	53.60
POWERS CREEK:					
Flow		10.20	30.10	47.60	29.30
Qp		0.45	1.25	1.40	1.03
QN		6.70	15.70	23.60	15.33

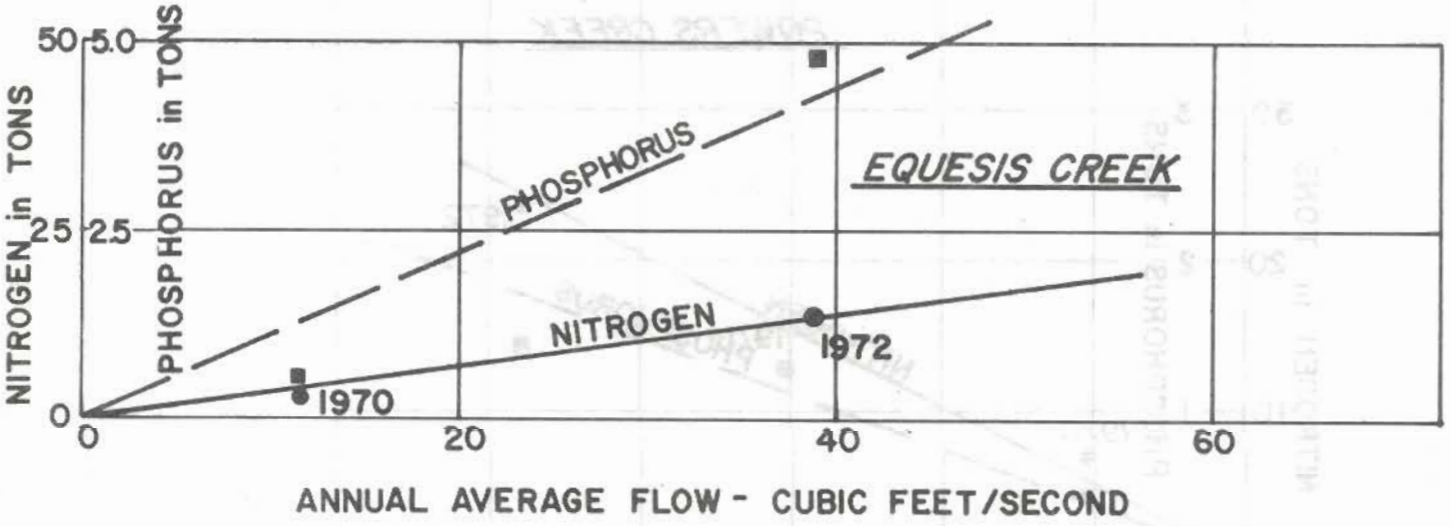




ANNUAL NUTRIENT INPUT vs MEAN FLOW
FOR TROUT AND KELOWNA CREEKS.

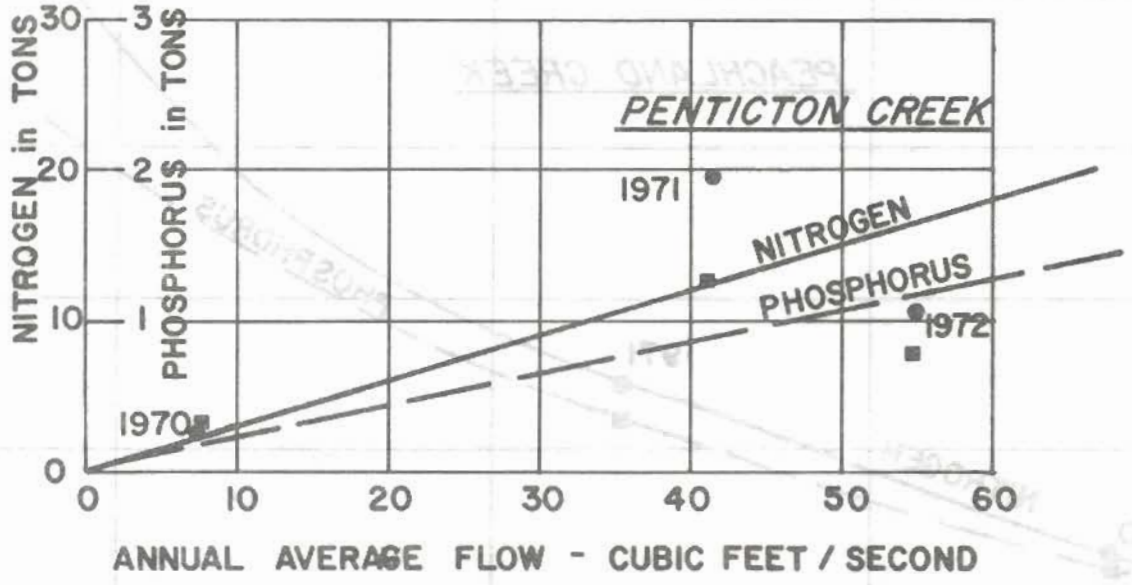
Figure 12.2

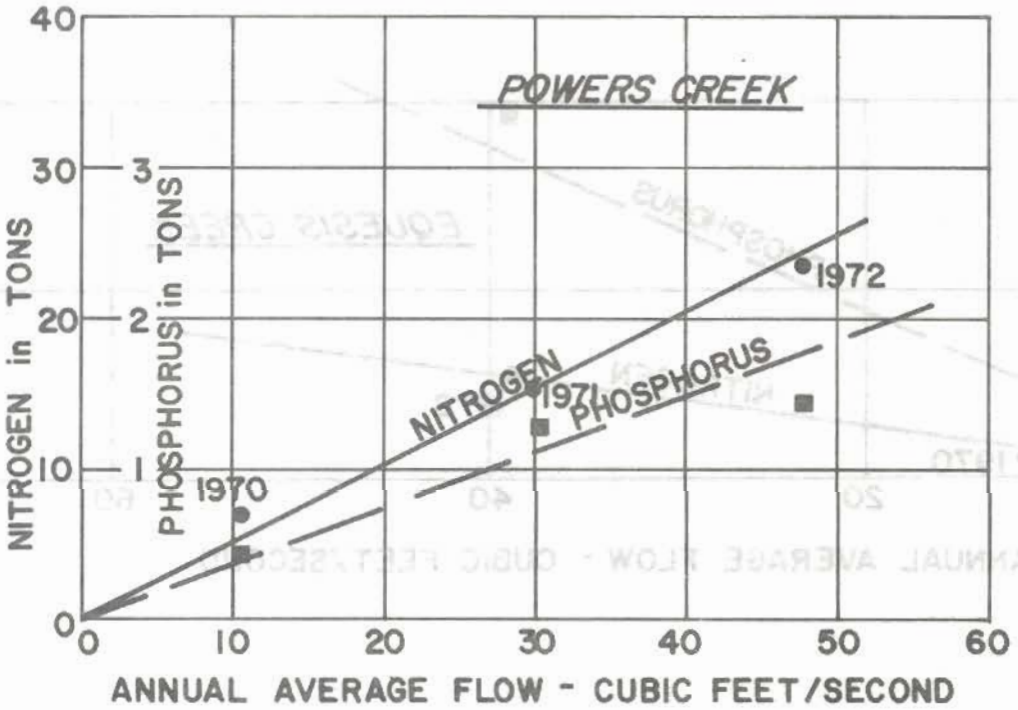




ANNUAL NUTRIENT INPUT vs MEAN FLOW
FOR PEACHLAND AND EQUESIS CREEKS.

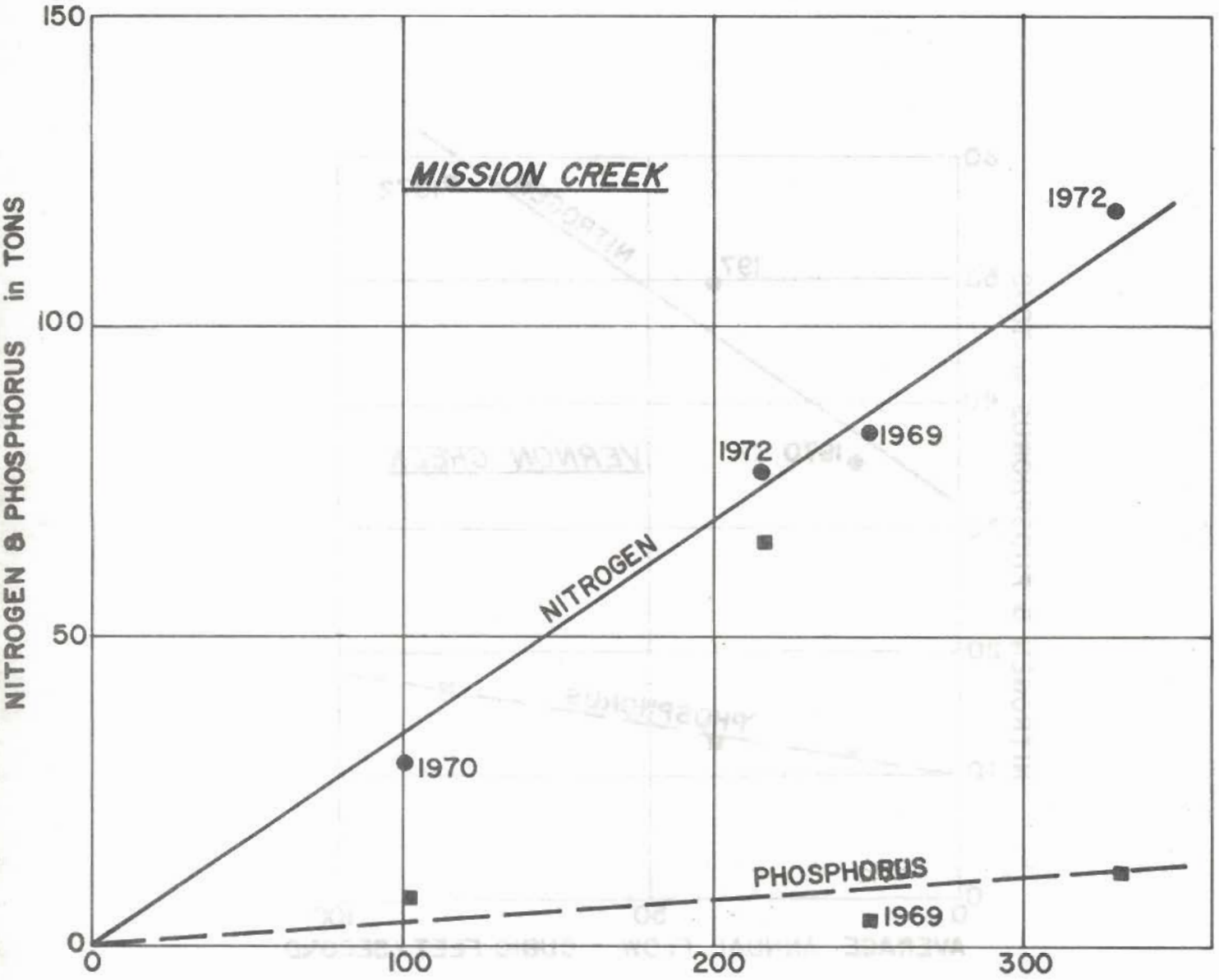
Figure 12.3





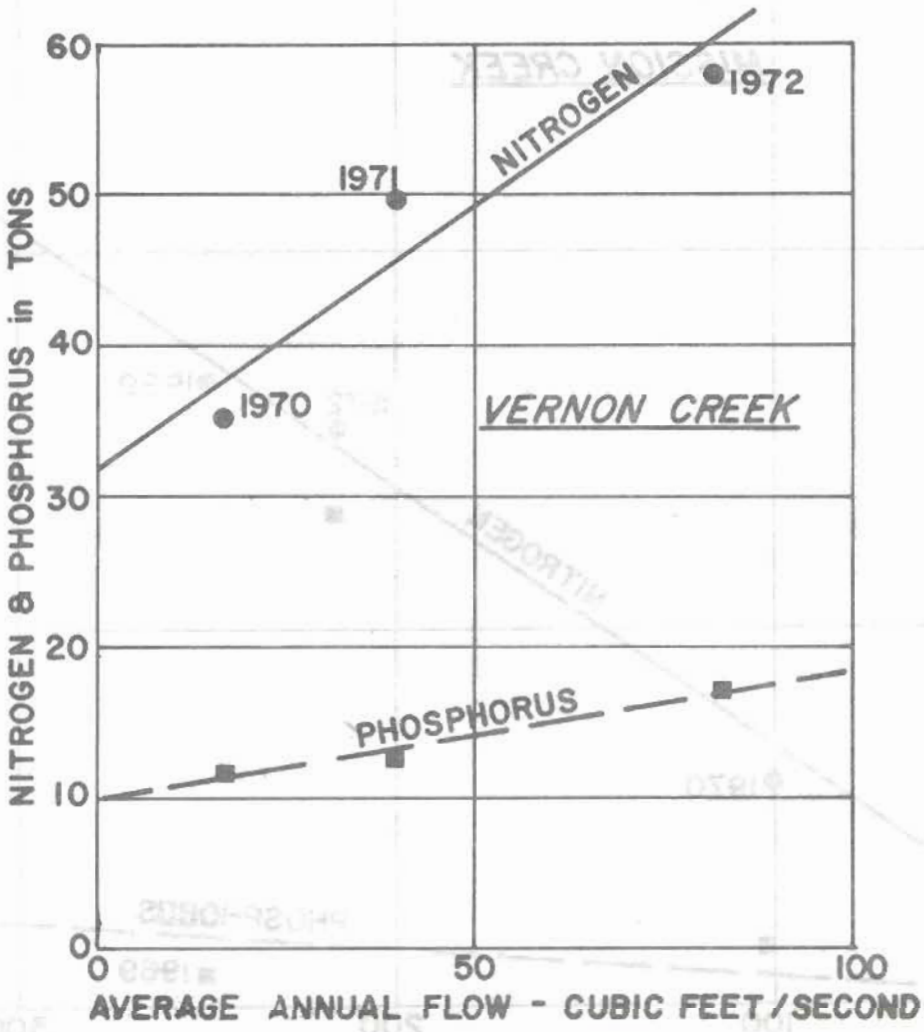
ANNUAL NUTRIENT INPUT vs MEAN FLOW
FOR PENTICTON AND POWERS CREEKS.

Figure 12.4



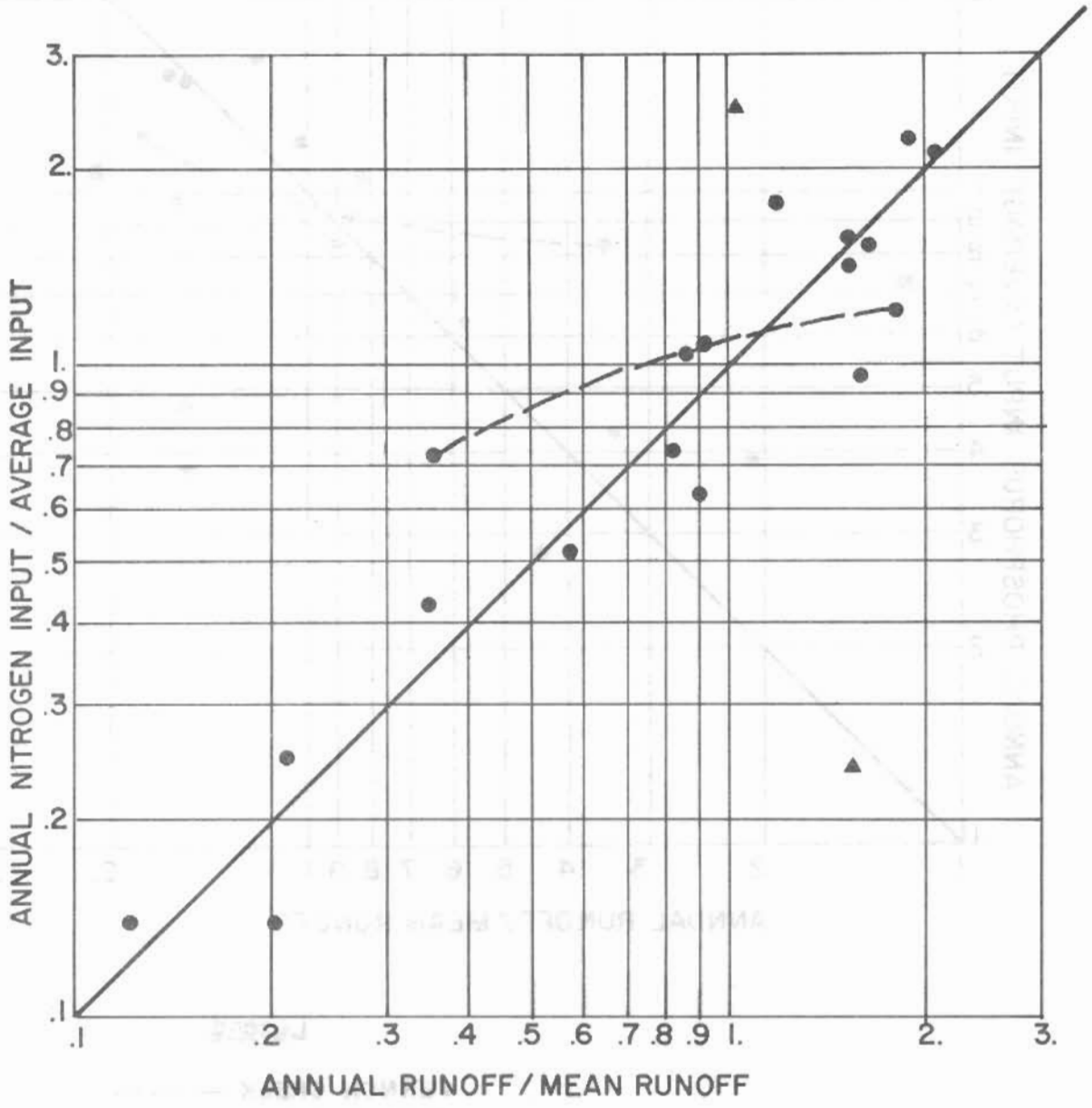
ANNUAL NUTRIENT INPUT vs MEAN FLOW
FOR MISSION CREEK

Figure 12.5



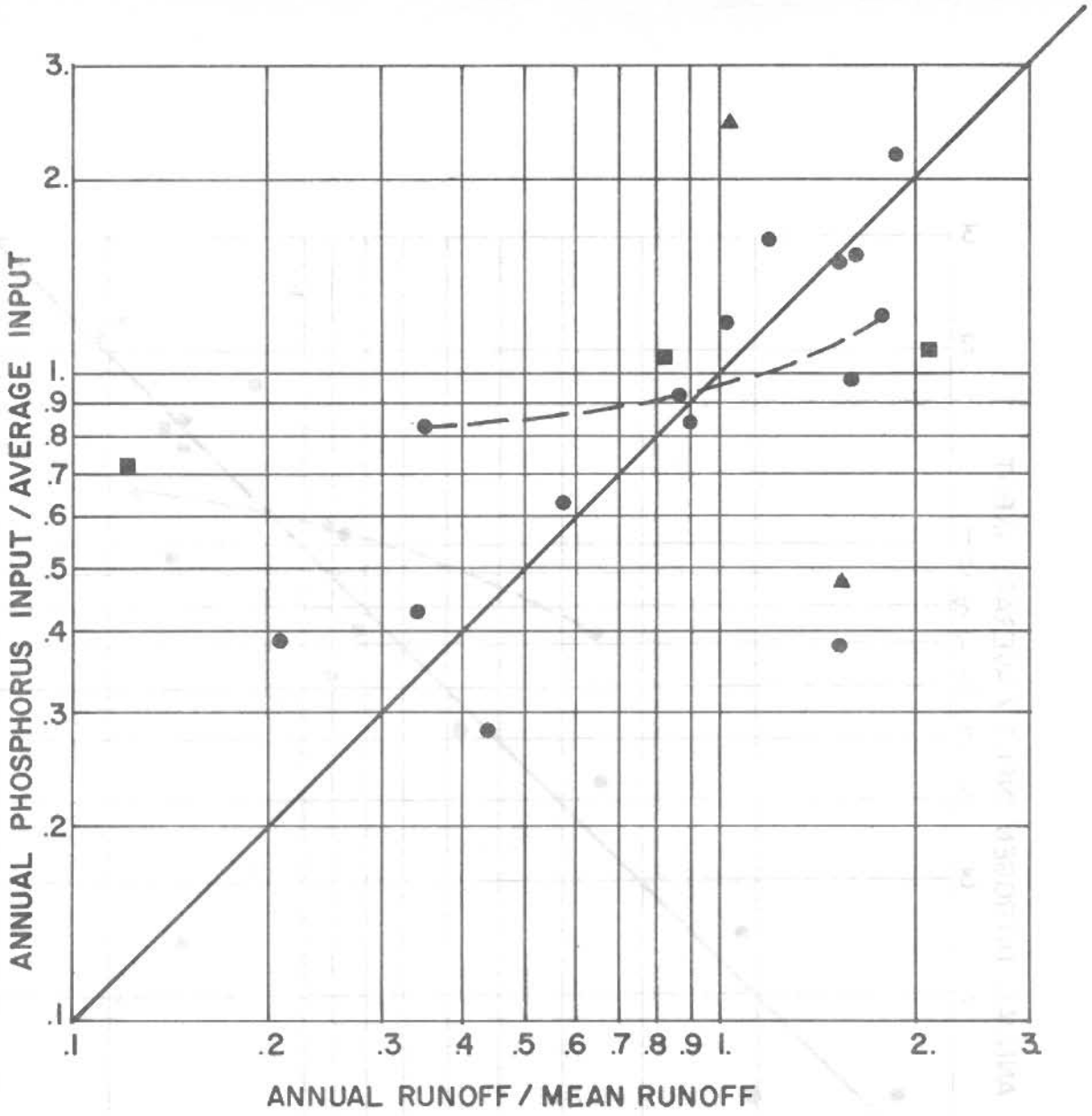
ANNUAL NUTRIENT INPUT vs MEAN FLOW
FOR VERNON CREEK

Figure 12.6



STANDARDIZED NITROGEN LOADING CURVE

Figure 12.7



STANDARDIZED PHOSPHORUS LOADING CURVE

Figure 12.8

12.2.1 Variation of Parameters

This section indicates the major factors involved in the variation of the nutrient concentrations and loadings.

(a) Daily Fluctuation

Individual sample concentrations varied over a wide range, as indicated in Section 2. In several cases, peak flows corresponded to maximum concentrations. Other peak flows on other creeks, however, yielded concentrations near to or less than the average. The extreme variation between individual samples, therefore, became difficult to explain as many factors are apparently involved.

Conversion of individual concentrations to loadings did not improve the analysis of individual samples, as flows and therefore loadings varied over an even greater range, and the apparently random fluctuation became even more severe.

(b) Seasonal Fluctuation

The reduction of concentrations to seasonal averages did reveal more significant variations. Total nitrogen generally varied in a more consistant and predictable manner than total phosphorus. Some observed trends are as follows:

(i) Concentrations varied from season to season and from year to year. Concentrations generally rose during the 1970 (dry year) period and fell during the higher runoff 1972 year.

(ii) Antecedent conditions appear to be the most important for concentration, as indicated by the general trend of rising concentrations during the dry period, Also, concentrations rose each year from freshet to summer to winter. This is especially obvious for total nitrogen.

(iii) Runoff variation was reflected by a decrease in nitrogen concentration from winter to freshet in every year. Phosphorus concentrations were more stable, but often displayed the same decrease. Superimposed on the effect of runoff is the effect of preceeding conditions, and these are often difficult to separate.

(iv) Nitrogen concentrations were almost the same for each freshet period on any creek.

(v) Loadings averaged over each four-month period displayed a strong correlation with streamflow.

(c) Annual Loadings

While a host of temporal variations is evident in the variation of single sample loadings, annual tributary loadings are more closely related to streamflow. This is due mainly to the freshet season, as this period generally contributes the

greatest runoff of nutrients to the mainstem lakes. Since average concentrations during the freshet are almost the same for one year to the next (especially for nitrogen), annual stream loadings are directly proportional to annual stream runoff. This is shown quite clearly in Figures 12.2 to 12.6. Figures 12.7 and 12.8 suggest that the relationship can be expressed by:

$$Q = \frac{Q_f \bar{Q}}{\bar{Q}_f}$$

where Q = nutrient input to the lake in any year,
$\bar{Q}$ = mean annual nutrient input,
Q_f = stream flow during the year;
and $\bar{Q}_f$ = mean annual stream flow.

(d) Remarks

It should be noted that the calculation of ratios to the mean (Figures 12.7 and 12.8) tends to increase scatter, as all three points (for the three years) are affected on any one creek when one year's estimate is in error; consequently the fitted line is thought to be a reasonable representation of the relationship. In addition, estimates of nutrient runoff were based on limited data during several periods (notably the whole of 1972). This is especially true for Equesis Creek, as the data is influenced strongly by one recorded high concentration during a period of limited sampling. Consequently, the accuracy of the Equesis Creek data is questionable.

The effect of increased runoff is often difficult to separate from that of antecedent conditions, as each study year followed a year of lower runoff. Variation in loading also reflects other factors such as the rate of melt in the spring, the relative contribution of groundwater and surface runoff, and local conditions along the stream. In applying the model, the effect of antecedent conditions should be noted: for example, several wet years in succession would yield successively lower loadings.

Vernon Creek presents a special case with an initial high loading at low runoff conditions. The nutrient loading of this creek includes the contribution by domestic wastewater from the city of Vernon. This quantity was not subtracted from the loading data as done in Section 12.1.

12.2.2 Tributary Loadings: Mean and Range

Stream inflows to the mainstem lakes can vary greatly from one year to the next. Table 12.21 shows annual runoffs for the eight creeks for a typical dry, average, and wet year as estimated in Technical Supplement III, and shows the great variation in flow and therefore nutrient inflow. Stream runoffs can be expected to vary from approximately one-half to 2.5 times the mean runoff of the

TABLE 12.21

RANGE OF ANNUAL RUNOFFS TO THE MAIN VALLEY LAKES (ACRE-FEET) AT THE 1970 STAGE OF DEVELOPMENT

	DRY YEAR	AVERAGE YEAR	WET YEAR	1969-1971 MEAN
Trout Creek	11,700	41,200	108,600	30,500
Mission Creek	66,000	107,300	202,000	116,700
Vernon Creek	11,100	28,960	80,900	20,700
Kelowna Creek	2,090	7,320	23,200	8,400
Peachland Creek	6,880	12,200	24,300	7,200
Penticton Creek	11,200	23,700	47,060	16,700
Equesis Creek	9,210	16,800	33,000	12,700
Powers Creek	2,900	8,530	20,500	14,300
Total for 8 creeks	121,000	246,000	539,600	227,200
Ratio to 1969-1971 estimate	0.54	1.08	2.38	1.00

1969-1971 period from a dry year to a wet year. Tables 12.22 and 12.23 show the expected range of variation from a dry to wet year, with a mean variation similar to that of stream runoffs. The long-term average nutrient inputs differ by 7 to 12 percent from the 1969-1971 estimates, indicating that the estimates of tributary inputs of Section 12.2 represent average conditions fairly well.

12.2.3 Other Variations

Several of the other contributions of nutrients to the main valley lakes are subject to variation from a dry year to a wet year. Groundwater contributions for example, will be greater in a wet year, with a higher contribution from septic tanks and agricultural sources. These fluctuations will not be as great as for surface sources, as subsurface runoff does not vary as greatly as surface flows. Hence these effects are not significant.

The contribution by storm sewers will also vary with precipitation. This quantity is considered to be a minor contribution to the total input, such that its variation may be neglected. The contribution by dustfall and precipitation also varies with increased precipitation. The actual extent of this variation in the nutrient concentrations in precipitation are not well defined.

The other major sources, municipal and industrial, may be considered constant for a dry or wet year, although some effect may be evidenced by factors such as water rationing and changes in industrial output. The inputs as measured during the study period may therefore be considered as reasonable estimates of these quantities.

TABLE 12.22

RANGE OF ANNUAL NITROGEN INPUTS TO THE MAIN VALLEY LAKES (TONS) AT THE 1970 STAGE OF DEVELOPMENT

	DRY YEAR	AVERAGE YEAR	WET YEAR	1969-71 MEAN
Trout Creek	8.1	28.5	75.1	21.1
Mission Creek	41.9	68.1	128.3	74.1
Vernon Creek*	10.3	28.3	78.9	20.2
Kelowna Creek	3.4	11.9	37.8	13.7
Peachland Creek	7.3	12.9	25.7	7.6
Penticton Creek	7.0	14.9	29.6	10.5
Equesis Creek	4.1	7.5	14.8	5.7
Powers Creek	3.5	10.2	24.5	17.1
Total for 8 creeks	86.1	182.4	414.7	170.0
Ratio to 1969-1971 estimate	0.51	1.07	2.44	1.00

* - Does not include effluent from the Vernon Sewage Treatment Plant.

TABLE 12.23

RANGE OF ANNUAL PHOSPHORUS INPUTS TO THE MAIN VALLEY LAKES (TONS) DURING THE PERIOD 1969-71

	DRY YEAR	AVERAGE YEAR	WET YEAR	1969-71 MEAN
Trout Creek	2.3	8.2	21.7	6.1
Mission Creek	4.5	7.3	13.7	7.9
Vernon Creek*	0.4	1.1	3.1	0.8
Kelowna Creek	0.3	1.1	3.6	1.3
Peachland Creek	0.4	0.7	1.4	0.4
Penticton Creek	0.5	1.1	2.3	0.8
Equesis Creek	0.7	1.2	2.3	0.9
Powers Creek	0.2	0.5	1.1	0.8
Total for 8 creeks	9.3	21.2	49.2	19.0
Ratio to 1969-1971 estimate	0.50	1.12	2.59	1.00

* - Does not include effluent from the Vernon Sewage Treatment Plant.

TABLE 12.24

NITROGEN RETENTION BY THE OKANAGAN BASIN LAKES

LAKE	TOTAL INPUT (TONS)	OUTPUT (TONS)	CHANGE IN STORAGE (ACRE-FEET)	WATER OUTFLOW (ACRE-FEET)	OUTPUT WITH NO STORAGE (TONS)	RETENTION (TONS)	RETENTION (%)
Wood-Kalamalka	80.70	3.4	-1260	10,200	3.0	77.7	94%
North Okanagan	156.87	27.1	+4700	67,100	29.0	127.9	82%
Central Okanagan	358.21	66.1	+8400	237,400	68.4	298.9	83%
South Okanagan	214.99	90.8	+4500	270,600	92.3	122.7	57%
Skaha	199.00	134.4	+50	287,800	134.4	64.6	32%
Vaseux	147.73	102.6	negligible	---	102.6	45.1	31%
Osoyoos	250.59	146.0	-610	319,750	146.0	104.6	41%
Okanagan Lake as a unit	636.87	90.8	+17600	270,600	96.7	540.2	85%

TABLE 12.25

PHOSPHORUS RETENTION BY THE OKANAGAN BASIN LAKES

LAKE	TOTAL INPUT (TONS)	OUTPUT (TONS)	CHANGE IN STORAGE (ACRE-FEET)	WATER OUTFLOW (ACRE-FEET)	OUTPUT WITH NO STORAGE (TONS)	RETENTION (TONS)	RETENTION (%)
Wood-Kalamalka	4.25	0.48	-1260	10,200	0.42	3.8	90%
North Okanagan	34.57	3.40	+4700	67,100	3.64	30.9	89%
Central Okanagan	45.75	6.40	+8400	237,400	6.63	39.1	86%
South Okanagan	23.14	5.30	+4500	270,600	5.39	17.8	77%
Skaha	24.23	9.40	+50	287,800	9.40	14.8	61%
Vaseux	9.78	9.70	negligible	---	--	--	0%
Osoyoos	18.78	7.60	-610	319,750	7.58	11.2	59%
Okanagan Lake as a unit	93.60	5.30	+17,600	270,600	5.64	88.0	94%

12.3 THE EFFECT OF LAKES ON THE NUTRIENT BUDGET

The tables presented in Section 12.1 (Tables 12.15, 12.16, and 12.17) show the relationship of the main valley lakes to the overall nutrient budget. Generally, lakes are important in detaining influent water for an extended period of time by mixing with the lake water or in the form of density currents, in either case to varying degrees nutrients are retained by aquatic growth and in sediments. Nutrient contributions to downstream areas are therefore reduced. This section examined the magnitude of nutrient retention by lakes in the system.

12.3.1 Nutrient Retention by Lakes

Calculation of the retention of nitrogen and phosphorus by lakes in the Okanagan system will be outlined below. Tables 12.24 and 12.25 summarize the calculations. These tables show that lakes represent an important factor in the nutrient budget as these lakes retain a high percentage, depending on residence time, of the total nutrient input.

(a) Total Input

Total nutrient input to each lake is the sum of the contributions by each source as tabulated in Tables 12.15 and 12.16 of Section 12.1. The input to the whole Okanagan Lake is given by the sum of inputs to the three regions of the lake, excluding the internal fluxes from the northern region to the central region, and from the central portion to the south. Wood and Kalamalka Lakes are considered as a unit as no direct measurements were made of the input from Wood Lake to Kalamalka Lake.

(b) Output

For the Wood-Kalamalka basin nutrient outputs were derived knowing the average concentration of total nitrogen and total phosphorus in Kalmalaka Lake near the outlet, and the flow out of Kalamalka for the period including the last six months of 1969, all of 1970 and the first six months of 1971. Concentration data were collected by the Federal government and flow data was provided by the B.C. Water Investigations Branch.

Kalamalka Lake total P = 0.027 mg/l
total N = 0.188 mg/l

Outlet flows from Kalamalka Lake = 13.3 KAcFt.

Outlet flows of total P = 0.48 Tons/yr.
total N = 3.41 Tons/yr.

Outputs from Okanagan Lake were estimated from the input to Skaha Lake by subtracting the contributions by Shingle and Ellis Creek (Table 12.7). Outputs from one region of the lake to the next are estimated in Table 12.9 of Section 12.1

Outputs from Vaseux Lake are estimated from the measured inputs to Osoyoos Lake of 158.9 tons per year of nitrogen and 13.1 tons of phosphorus (Table 12.8). Inputs to Okanagan River between Vaseux Lake and Skaha Lake are estimated in Table 12.26 and were subtracted to yield the Vaseux output.

Outputs from Skaha Lake are given by Okanagan River sampling upstream of Vaseux Lake (Table 12.8). Similarly, outputs from the Canadian portion of Osoyoos Lake were given by sampling of the Okanagan River at the causeway at Osoyoos. The relevant data for Osoyoos Lake is outlined below:

concentration	- nitrogen	0.336 mg/l
	- phosphorus	0.0175 mg/l
discharge		219,750 acre-feet
loadings	- nitrogen	146 tons/yr
	- phosphorus	7.6 tons/yr.

(c) Change in Storage

The calculated nutrient outputs were corrected for storage in the lake system to develop estimates of nutrient outputs with constant lake levels. Average storage changes per year for the study period were estimated from lake surface areas and changes in water levels (Table 12.27). In this table, a negative storage change corresponds to a net release from storage.

The nutrient outputs, with constant lake levels, were then estimated as:

$$\text{Output} = \frac{\text{Outflow + Storage change}}{\text{Outflow}} \times \text{measured output}$$

(d) Retention

Nutrient retention was estimated as the difference between total input and nutrient output to each lake corrected for storage. Nutrient retention was also calculated as a percentage of total input.

(e) Discussion

Nutrient retention in a lake reduces the nutrient input to downstream lakes. Observed nitrogen retentions are generally greater than 30% of the gross input. Osoyoos, Vaseux, and Skaha Lakes, with short water renewal times, have the lowest retention at 30%, 31% and 28% respectively. Okanagan Lake and the Wood-Kalamalka system, with longer renewal times, retain more of the input nitrogen at 83% and 81%. Phosphorus retentions are in all cases greater than the corresponding nitrogen retentions, with values ranging from 53% for Osoyoos Lake to 94% for Okanagan Lake. Negative values for Vaseux Lake probably result from errors in estimating the input of phosphorus from agricultural and septic tank sources by groundwater

TABLE 12.26

NUTRIENT OUTPUT FROM VASEUX LAKE

SOURCE	SAMPLING SITE #	DISCHARGE PER YEAR (MILLION I. GAL.)	CONCENTRATIONS-mg/l		LOADINGS - TONS/YEAR	
			NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
Oliver-Osoyoos Co-Op	0-2	0.06	0.331	3.55	0.0*	0.0
Village of Oliver	0-3	60.8	13.32	6.68	4.05	2.03
Park Rill	503				0.0	0.0
Vaseux Creek	504	4944 ac.ft.	0.187	0.014	1.26	0.094
Wolfcub Creek	535	135 ac.ft.	2.40	0.094	0.44	0.0
Haynes Co-Op	4	2.5	9.66	0.675	0.1	0.0
McLean & Fitz-Patrick**	7	2.5	2.05	0.027	0.03	0.0
Groundwater from agricultural sources					50.4	1.26
Total inputs between Vaseux L. and Osoyoos L.					56.28	3.40
Input to Osoyoos L.					158.9	13.1
Output from Vaseux L.					102.6	9.70

* Denotes negligible quantities

** Now owned by Oliver-Osoyoos Co-Op.

TABLE 12.27

STORAGE CHANGES IN THE OKANAGAN LAKES (1969-1971)

	LAKE SURFACE AREA (acres)	GAUGE READING (FT)		STORAGE CHANGES (ACRE-FEET)	
		AUGUST 1 1969	JULY 31 1971	2 years	per year
Wood Lake	2,300	--	1.56	-2520	-1260
Kalamalka Lake	6,400	1.77	1.48		
Okanagan Lake					
- North	23,100				+4700
- Central	40,900				+8400
- South	21,800				+4500
Skaha Lake	4,970	8.19	8.21	+100	+50
Vaseux Lake	680	--	--	--	negligible
Osoyoos (Canadian)	3,960	11.23	10.90	-1220	-610
Okanagan Lake	85,800	6.48	6.89	+35200	+17600

between the Vaseux Lake outlet and the nearest downstream sampling point just upstream of Osoyoos Lake. Therefore, no reasonable estimate of phosphorus retention by Vaseux Lake could be made.

It should be noted that the retention calculations were based on data collected during the 1969 to 1971 study period and therefore do not necessarily represent stable conditions. The retention figures do not indicate the ultimate fate of the nutrients, be it in increase aquatic growth, increase in lake nutrient concentrations, or deposition as sediment. If,however, the 1969 to 1971 measurements do represent long term stable conditions, the calculated retentions would be a reasonable estimate of the rate of nutrient deposition in sediments.

12.3.2 Nutrient Contributions to Downstream Lakes

In spite of the extensive removal of nutrients by lakes in the system, input from upstream lakes remains one of the major contributions to the nutrient input to any lake. This is especially true of Skaha, Vaseux, and Osoyoos Lakes, where the direct tributary runoff is vary much smaller than the inflow from Okanagan River. Table 12.28 illustrates the relative percentage of the total nutrient input to each lake which can be attributed to outputs from the next upstream lake.

TABLE 12.28

NUTRIENT CONTRIBUTIONS FROM UPSTREAM LAKES AS A PERCENT OF TOTAL INPUT

	NITROGEN	PHOSPHORUS
Kalamalka Lake	--*	--*
Okanagan Lake - North	8	2
- Central	8	8
- South	33	28
Skaha Lake	47	22
Vaseux Lake	91	98
Osoyoos Lake (Canadian)	48	50

* No adequate estimate was available of the input from Wood Lake

12.4 PROJECTED FUTURE LOADINGS

This section outlines the estimation of future loadings of total nitrogen and phosphorus to the main valley lakes for the years 1980, 2000 and 2020. The estimates of present loadings to the main valley lakes (Section 12.1) and the economic growth projections outlined in Technical Supplement X provide a basis for the projected loadings of nitrogen and phosphorus. The projections represent a range of population and development patterns as well as several degrees of waste treatment. Projected loadings to each region are summarized in Tables of Section 12.4.3.

12.4.1 Uncontrollable Sources

Several sources of nitrogen and phosphorus were assumed to yield the same loadings in the future as under present conditions, as the variation of the inputs from these sources is difficult to estimate. In most cases, the variation of these sources is thought to be relatively insignificant. These sources are as follows:

(1) groundwater (natural) - this is a constant source for any location.

(2) dustfall and precipitation - it is not known to what extent the forestry industry, for example, contributes to dustfall loadings within the study area. The literature indicates that the variation of dustfall loading for the Okanagan will not increase significantly considering the expected socio-economic growth.

(3) tributary streams - it is not known exactly to what extent land-use activities add to natural background levels in the surface waters. Consequently the degree of possible control has not been determined. Furthermore, the amount of water which will be diverted from the streams is not known. Therefore, although the concentrations of nutrients in the streams may increase, the loading has been assumed not to. The effect of land use on water quality and the degree of control by land management will be discussed further in Section 5.

(4) main valley streams - the nutrient output from a major lake subjected to a change in nutrient input has not been well quantified. Consequently, these sources have been assumed to be constant. It is felt that this variation will not be significant except possibly for Vaseux Lake and Osoyoos Lake, where the contribution from upstream lakes represents a major portion of the overall nutrient budgets. An attempt has been made to quantify the effect of the lake system on increased municipal inputs from Penticton and the input to Vaseux and Osoyoos Lakes. This will be discussed as a controllable source (carryover).

12.4.2 Controllable Sources

(a) Municipal

Projections of the municipal loadings of phosphorus to 2020 are based on a per capita loading of phosphorus influent (before treatment) of 0.008 pounds per capita per day (82) and projected populations. These phosphorus loads before treatment are presented in Table 12.29 for Projection I (Continuation Present Growth Rate) Projection II (High Economic Growth Rate), and Projection III (Low Economic Growth Rate). These influent loadings values were then reduced by 30, 80 and 90 percent removal rates to estimate future loadings from municipal sources (Table 12.30). The projections at present removal rates were derived directly from present effluent loadings and the population factors.

Municipal per capita nitrogen loading rates were estimated to remain the same as at present. The nitrogen loading projections are therefore based directly on the output of the existing plants and the population factors of Table 12.29. These nitrogen projections are included in Table 12.30.

TABLE 12.29

TOTAL PHOSPHORUS INFLUENT (IN TONS), POPULATION, AND POPULATION FACTORS

MUNICIPALITY	PRESENT EFFLUENT	PRESENT TREATMENT	PROJECTION I							
			1971 POP.	TOTAL P	1980 POP.	TOTAL P	2000 POP.	TOTAL P	2020 POP.	TOTAL P
Armstrong	P 2.07 N 5.20	Aerated lagoon to Deep Creek	1,631	2.45	2,100	3.15	3,100	4.66	4,200	6.31
Vernon	P 17.77 N 38.16	Trickling Filter to Vernon Creek	18,845	19.90	25,200	26.61	38,000	40.13	52,400	55.33
Kelowna	P 20.42 N 57.77	Activated Sludge to Okanagan Lake, 30% Removal of P	19,412	29.10	26,100	39.13	38,900	58.31	53,200	79.75
Westbank	P 0.82 N 1.73	Lagoon to Smith Creek, 9% Removal of P	1,620	0.90	2,800	4.12	5,500	8.09	9,900	14.57
Penticton	P 14.45 N 56.09	Activated Sludge & Lime Prec. to Okanagan R., 47% Removal of P	18,955	27.20	24,400	35.01	35,800	51.37	48,100	69.02
Oliver	P 2.03 N 4.05	Activated Sludge to Okanagan R., 15% Removal of P	1,598	2.40	1,700	2.55	2,000	3.00	2,200	3.30

MUNICIPALITY	PROJECTION II				PROJECTION III			
	2000 POP.	TOTAL P	2020 POP.	TOTAL P	2000 POP.	TOTAL P	2020 POP.	TOTAL P
Armstrong	3,400	5.11	4,600	6.91	2,800	4.21	3,100	4.66
Vernon	41,200	43.51	57,600	60.82	34,300	36.22	38,800	40.97
Kelowna	42,100	63.11	57,400	86.05	35,200	52.77	38,700	58.01
Westbank	6,00	8.83	10,800	15.89	5,000	7.36	7,300	10.74
Penticton	38,800	55.68	52,900	75.91	32,400	46.49	35,700	51.23
Oliver	2,200	3.30	2,400	3.60	1,800	2.70	1,800	2.70

TABLE 12.30

PROJECTED TOTAL PHOSPHORUS LOADING FROM MUNICIPAL SOURCES

1969-71	ARMSTRONG	VERNON	KELOWNA	WESTBANK	PENTICTON	OLIVER
Influent P	2.45	19.90	29.10	0.90	27.20	2.40
Effluent P	2.07	17.77	20.42	0.82	14.45	2.03
Percent Removal (3)	16.00	11.00	30.00	9.00	47.00	15.00
Effluent N (4)	5.20	38.16	57.77	1.73	56.09	4.05
PROJECTION I 1980						
Influent P	3.15	26.61	39.13	4.12	35.01	2.55
Effluent P at Present % Removal	2.65	23.68	27.39	3.75	18.56	2.17
30% Removal	2.21	18.63	27.39	2.88	24.51	1.79
80% Removal	0.63	5.32	7.83	0.82	7.00	0.51
90% Removal	0.32	2.66	3.91	0.41	3.50	0.26
Effluent N	6.70	51.03	77.67	2.93	72.20	4.31
2000						
Influent P	4.66	40.13	58.31	8.09	51.37	3.00
Effluent P at Present % Removal	3.91	35.71	40.82	7.36	27.23	2.55
30% Removal	3.26	28.09	40.82	5.66	35.96	2.10
80% Removal	0.93	8.03	11.66	1.62	10.27	0.60
90% Removal	0.47	4.01	5.83	0.81	5.14	0.30
Effluent N	9.88	76.95	115.77	5.76	105.94	5.07
2020						
Influent P	6.31	55.33	79.75	14.57	69.02	3.30
Effluent P at Present % Removal	5.30	49.25	55.83	13.26	36.58	2.81
30% Removal	4.42	38.73	55.83	10.20	48.32	2.31
80% Removal	1.26	11.07	15.95	2.91	13.80	0.66
90% Removal	0.63	5.53	7.98	1.46	6.90	0.33
Effluent N	13.39	106.11	158.32	10.36	142.33	5.58
PROJECTION II 2000						
Influent P	5.11	43.51	63.11	8.83	55.68	3.30
Effluent P at Present % Removal	4.29	38.72	44.18	8.03	29.51	2.81
30% Removal	3.58	30.45	44.18	6.18	38.97	2.31
80% Removal	1.02	8.70	12.62	1.77	11.14	0.66
90% Removal	0.51	4.35	6.31	0.88	5.57	0.33
Effluent N	10.84	83.43	125.29	6.28	114.81	5.58
2020						
Influent P	6.91	60.82	86.05	15.89	75.91	3.60
Effluent P at Present % Removal	5.80	54.13	60.23	14.46	40.23	3.06
30% Removal	4.84	42.58	60.23	11.12	53.14	2.52
80% Removal	1.38	12.16	17.21	3.18	15.18	0.72
90% Removal	0.69	6.08	8.60	1.59	7.59	0.36
Effluent N	14.67	116.64	170.82	11.30	156.54	6.08
PROJECTION III 2000						
Influent P	4.21	36.22	52.77	7.36	46.49	2.70
Effluent P at Present % Removal	3.53	32.24	36.94	6.69	24.64	2.30
30% Removal	2.94	25.35	36.94	5.14	32.55	1.89
80% Removal	0.84	7.24	10.55	1.47	9.30	0.54
90% Removal	0.42	3.62	5.28	0.74	4.65	0.27
Effluent N	8.93	69.46	104.75	5.23	95.88	4.56
2020						
Influent P	4.66	40.97	58.01	10.74	51.23	2.70
Effluent P at Present % Removal	3.91	36.47	40.61	9.77	27.15	2.30
30% Removal	3.26	28.68	40.61	7.52	35.68	1.89
80% Removal	0.93	8.19	11.60	21.48	10.25	0.54
90% Removal	0.47	4.10	5.80	1.07	5.12	0.27
Effluent N	9.88	78.57	115.17	7.64	105.64	4.56

(b) Carryover

The assumption that the Okanagan River nutrient loadings are not constant for the Okanagan River below Penticton is not valid unless a mechanism is incorporated into the nutrient loading projections to account for the variation of assimilative capacity of the river between Okanagan and Osoyoos Lakes for the variation in STP input. This mechanism is designated as "carryover."

The carryover has been calculated based on the following assumptions:

(1) Depletion of phosphorus occurs with time below the major source.

(2) The variables streamflow, time and distance are interchangeable.

(3) Under present conditions the river has assimilated total phosphorus and nitrogen to a minimal level. Any loading higher than present (1969-71) conditions is represented by a parallel curve (see Figures 12.9 and 12.10).

(4) Any loading less than present (1969-71) is estimated by interpolation between the measured loading and present background level curve.

(5) The natural state loading is based on flow increase only and does not represent the actual increase in nutrient loading.

(6) The input from Okanagan Lake is relatively constant.

The following equations are used to calculate carryover:

Carryover = STP Input - (1969-71) STP Input
when STP Input $>$ (1969-71) STP Input

or

Carryover = a variable estimated by interpolation between the measured loading curve and the present background level when STP Input $<$ (1969-71) Input.

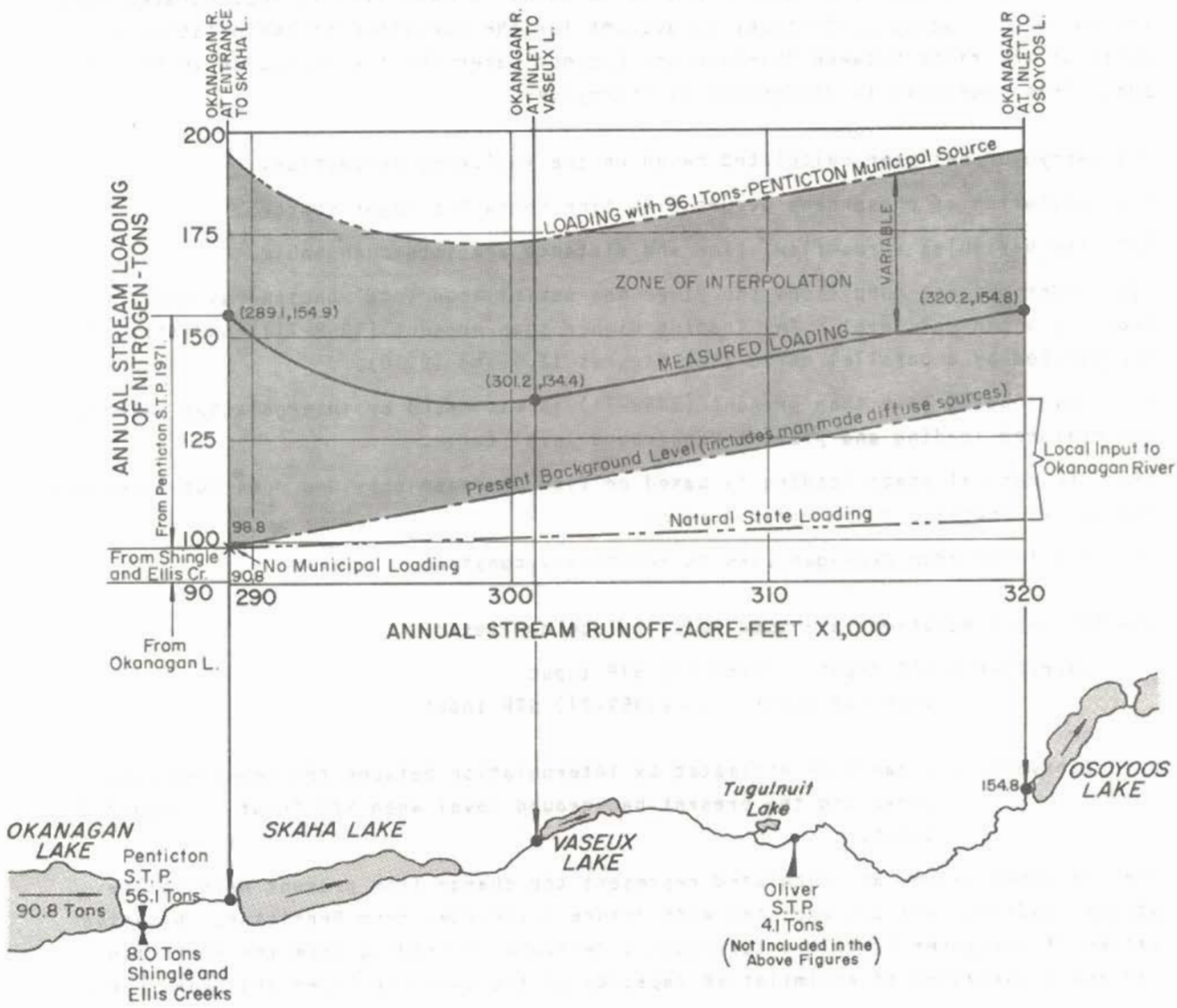
The carryover values as calculated represent the change from present main valley stream loadings that are expected with future discharges from Penticton. Negative values of carryover therefore represent a decrease in loading from the Penticton STP and a variation of assimilative capacity of the Okanagan River and Skaha Lake.

It is recognized that these models represented by Figures 12.9 and 12.10 do not incorporate all the variation occurring and that significant error can occur. It is felt, however, that the models do present fairly reasonable first estimates.

(c) Industrial

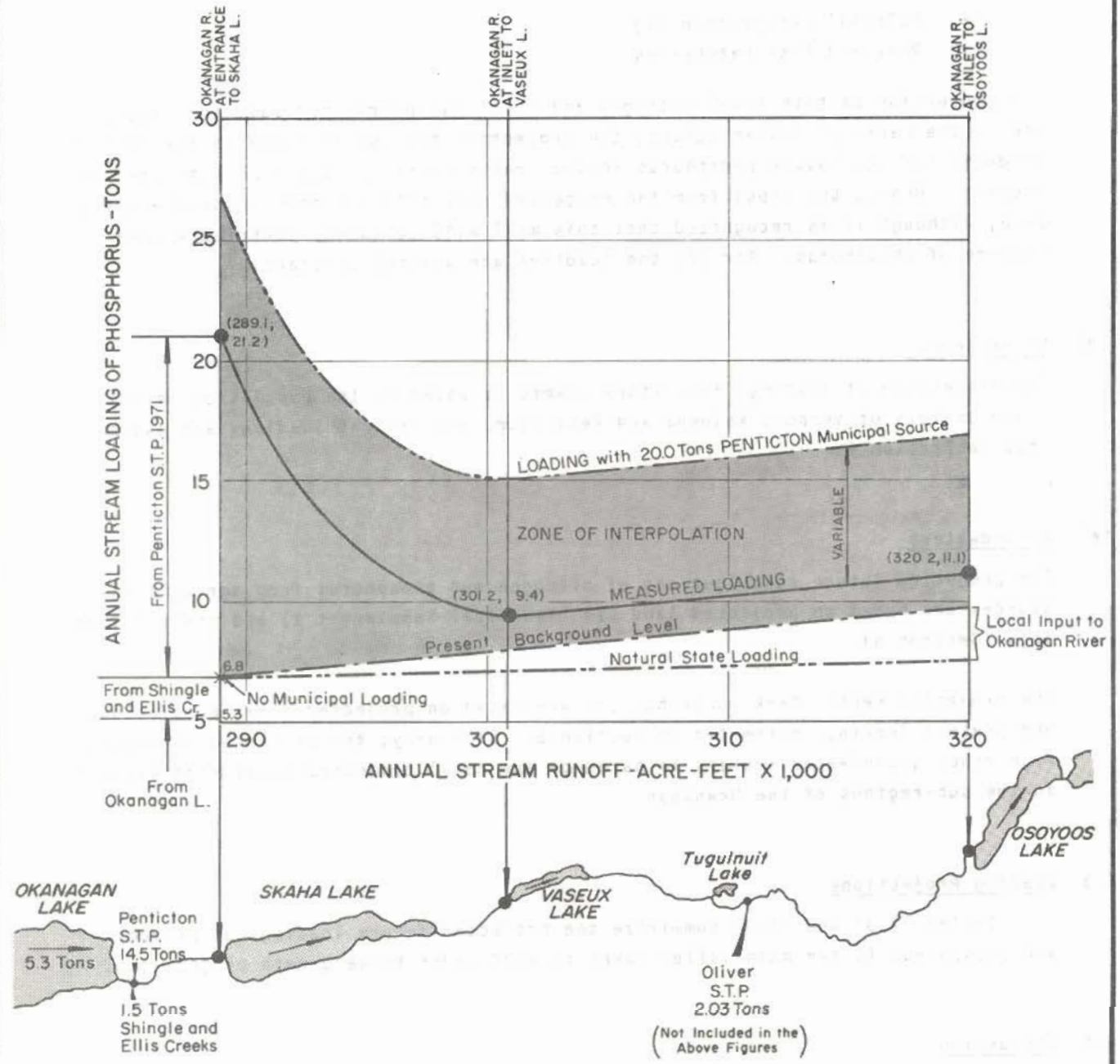
The loadings from industry were projected on the basis of dollar value and pounds or tons of product. In the calculation of industrial loadings, the industries in each of the regions have been broken down into the following categories:

(a) Fruit and Vegetable Canners
(b) Wineries, Distillers and Soft Drinks
(c) Sawmills and Plywood Mills



NITROGEN CARRYOVER IN THE OKANAGAN RIVER SYSTEM

Figure 12.9



PHOSPHORUS CARRYOVER IN THE OKANAGAN RIVER SYSTEM

Figure 12.10

(d) Fruit Packers
(e) Pulpmill (Projection II)
(f) Rink and Fish Hatcheries

The projection of both total nitrogen and total phosphorus for (a), (b), and (c) are on the basis of dollar values; the projection for (d) is based on the tons of product; for (e) future phosphorus removal rates possible cannot be estimated at present. Hence, the input from the projected pulp mill has been assumed equal to zero, although it is recognized that this mill will certainly contribute some measure of phosphorus. For (f) the loadings are assumed constant.

(d) Storm Sewers

The projection of loadings from storm sewers is based on the population of the major centers of Vernon, Kelowna and Penticton, and present loadings are estimated in Section 4.

(e) Groundwaters

The projected future contributions of nitrogen and phosphorus from agricultural sources are based on projected land use (Technical Supplement X) and present loadings (Section 6).

The projected septic tank contributions are based on projected rural populations and present loadings estimated in Section 6. Similarly, the projected increases from other groundwater sources is based on the total projected population expansion in the sub-regions of the Okanagan.

12.4.3 Loading Projections

Tables 12.31 and 12.32 summarize the projected future loadings of nitrogen and phosphorus to the main valley lakes to 2020 under three growth projections.

12.4.4 Discussion

Several shortcomings relative to providing projections with our limited knowledge have been noted above. These shortcomings have resulted in the use of several assumptions which provide a first order approximation of loadings for the future.

In the absence of industrial intake water quality data, it is impossible to determine exactly how an industrial process alters intake water quality, and hence to determine the industry's loading levels. In most cases, however, the original nutrient content is insignificant relative to the change in concentration. An exception, however, is the Summerland Fish Hatchery where a significant proportion of the nitrates in the hatchery effluent is derived from their water supply.

TABLE 12.31

ESTIMATED ANNUAL INPUT (IN TONS) OF TOTAL NITROGEN TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES

1980, PROJECTION I, PRESENT GROWTH RATE

Source \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.53	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									7.60
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	57.03	80.60	-	72.20	-	-	4.31
Municipal Carryover	-	-	-	-	-	-	16.11		16.11
Industrial	0.08	-	-	2.66	7.90	0.26	-		9.54
Storm Sewers	-	-	1.63	0.63	0.48	0.95	-		-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	7.00	25.15	16.32	3.85	9.28	0.02	5.94	0.52
Septic Tanks	-	6.49	14.52	28.02	7.09	1.70	2.41	3.36	0.40
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	4.58	2.04	8.50	17.58	19.35	7.98	2.54	57.50	33.30
Septic Tanks	15.92	7.96	12.22	45.54	36.33	18.60	2.24	20.99	55.24
Other	2.75	0.38	0.93	4.74	6.88	4.10	0.46	1.60	1.55
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
TOTAL	36.55	57.42	186.71	402.32	228.11	224.03	165.33	91.02	292.38

2000, PROJECTION I, PRESENT GROWTH RATE

Source \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.33	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									11.59
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	86.93	121.53	-	105.94	-	-	5.07
Municipal Carryover	-	-	-	-	-	-	49.85	-	49.85
Industrial	0.06	-	-	3.29	8.55	0.31	-	-	11.39
Storm Sewers	-	-	2.19	0.90	0.65	1.30	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	5.46	28.83	9.84	2.68	7.57	0.02	5.42	0.47
Septic Tanks	-	10.56	20.62	47.72	9.79	2.43	4.02	4.54	0.54
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	3.64	1.59	9.76	10.60	13.50	7.30	2.32	52.60	30.45
Septic Tanks	30.96	12.96	17.40	77.56	50.17	26.61	3.73	28.62	75.32
Other	4.40	0.64	1.29	7.56	9.50	4.02	0.76	2.20	2.13
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
TOTAL	52.28	64.76	233.55	485.23	241.09	264.44	202.25	95.01	350.62

TABLE 12.31 (cont'd)

ESTIMATED ANNUAL INPUT (IN TONS) OF TOTAL NITROGEN TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES

2020, PROJECTION I, PRESENT GROWTH RATE

Sources \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.53	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									29.50
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	119.50	168.68	-	142.33	-	-	5.58
Municipal Carryover	-	-	-	-	-	-	86.24	-	86.24
Industrial	0.03	-	-	3.82	9.20	0.31	-	-	-
Storm Sewers	-	-	3.12	1.33	0.94	1.88	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	4.34	4.89	6.14	1.82	7.75	0.02	5.55	0.48
Septic Tanks	-	18.13	31.37	84.90	14.25	3.65	6.93	6.64	0.79
GROUND WATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	2.88	1.26	16.50	6.60	9.15	7.48	2.38	53.90	31.20
Septic Tanks	63.17	22.25	26.41	137.96	72.98	39.88	6.42	42.00	110.53
Other	9.00	1.10	1.60	2.70	13.94	5.80	1.30	3.20	3.10
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
TOTAL	88.30	80.63	270.12	618.36	268.53	318.04	244.84	112.92	431.23

2000, PROJECTION II, HIGH GROWTH RATE

Sources \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.53	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									13.51
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	94.27	131.57	-	114.86	-	-	5.58
Municipal Carryover							58.72		58.72
Industrial	0.59	-	-	3.11	8.55	0.30	-	-	10.99
Storm Sewers	-	-	2.39	0.98	0.72	1.48	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	5.22	36.40	8.88	2.46	7.50	0.02	5.38	0.47
Septic Tanks	-	11.48	22.48	51.95	10.81	2.68	4.37	4.87	0.58
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	3.47	1.52	12.40	9.55	12.40	7.24	2.30	52.20	30.20
Septic Tanks	33.74	14.09	18.92	84.43	55.39	29.27	4.05	30.53	80.34
Other	4.80	0.69	1.42	8.21	10.50	4.42	0.82	2.32	2.24
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
TOTAL	55.82	66.54	255.01	504.91	247.08	276.71	211.83	96.93	366.44

TABLE 12.31 (cont'd)

ESTIMATED ANNUAL INPUT (IN TONS) OF TOTAL NITROGEN TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES

2020, PROJECTION II, HIGH GROWTH RATE

Drainage Basin / Sources	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.53	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									31.71
Dustfall and Precipitation	1.90	4.60	24.30	28.40	23.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	131.31	182.12	-	156.54	-	-	6.08
Municipal Carryover	-	-	-	-	-	-	100.45	-	100.45
Industrial	0.24	-	-	3.41	9.21	0.30	-	-	11.09
Storm Sewers	-	-	3.43	1.47	1.04	2.09	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	3.88	48.80	3.94	1.51	7.64	0.02	5.48	0.48
Septic Tanks	-	19.93	34.28	93.71	15.85	4.01	7.58	6.97	0.83
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	2.59	1.13	16.49	4.24	7.60	7.36	2.34	53.20	30.80
Septic Tanks	69.62	24.46	28.85	152.29	81.23	43.88	7.03	43.91	115.56
Other	9.90	1.19	2.08	14.05	15.40	6.42	1.42	3.34	3.24
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
Total	95.57	84.14	332.49	661.46	278.09	337.20	260.39	114.53	464.05

2000, PROJECTION III, LOW GROWTH RATE

Drainage Basin / Sources	Wood	Kalamalka	Okanagan Lake			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.53	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									11.02
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	78.39	109.98	-	95.88	-	-	4.56
Municipal Carryover	-	-	-	-	-	-	39.79	-	39.79
Industrial	0.08	-	-	3.98	8.55	0.31	-	-	11.48
Storm Sewers	-	-	2.11	0.88	0.63	1.25	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	6.45	36.75	15.00	3.55	7.56	0.02	5.43	0.47
Septic Tanks	-	10.09	19.87	46.54	9.43	2.31	3.86	4.54	0.54
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	4.27	1.88	12.40	16.12	17.90	7.30	2.32	52.80	30.50
Septic Tanks	30.37	12.39	16.70	75.63	48.27	25.27	3.58	28.62	75.32
Other	4.27	0.62	1.24	7.40	9.16	3.84	0.72	1.42	1.37
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
TOTAL	52.21	64.98	234.19	481.80	243.74	252.68	191.84	94.44	338.86

TABLE 12.31 (cont'd)

ESTIMATED ANNUAL INPUT (IN TONS) OF TOTAL NITROGEN TO THE MAIN VALLEY OKANAGAN LAKES AND STREAMS FROM KNOWN SOURCES

2020, PROJECTION III, LOW GROWTH RATE

Sources \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	5.00	27.88	14.53	123.69	33.87	1.81	3.17	-	0.50
Main Valley Streams	5.00	-	20.20	27.10	66.10	90.80	134.40	-	158.90
Input from Okanagan River									18.36
Dustfall and Precipitation	1.90	4.60	24.30	28.40	32.70	11.30	1.80	-	3.00
POINT SOURCES									
Municipal Input	-	-	88.45	122.8	-	105.64	-	-	4.56
Municipal Carryover	-	-	-	-	-	-	49.55	-	49.55
Industrial	0.07	-	-	5.18	9.19	0.35	-	-	12.64
Storm Sewers	-	-	2.29	1.00	0.70	1.39	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	6.02	48.80	12.40	2.85	8.14	0.02	5.84	0.50
Septic Tanks	-	13.23	22.89	63.47	10.70	2.68	5.17	4.87	0.58
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	3.96	1.75	16.50	13.30	14.15	7.85	2.49	56.60	32.80
Septic Tanks	47.24	16.24	19.27	103.15	53.92	29.27	4.79	30.53	80.34
Other	6.72	0.79	1.38	9.54	10.22	4.28	0.96	2.31	2.24
Natural	1.32	1.07	7.70	27.04	13.58	5.04	2.18	1.63	1.41
TOTAL	71.21	71.58	266.31	537.00	247.98	268.56	204.53	101.78	365.38

TABLE 12.32

ESTIMATED INPUT (IN TONS) OF TOTAL PHOSPHORUS TO THE MAIN VALLEY OKANAGAN LAKES FROM KNOWN SOURCES

1980, PROJECTION I, PRESENT GROWTH RATE

Source \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams	0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River	-	-	-	-	-	-	-	-	0.74
Dustfall and Precipitation	0.07	0.80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal Input, Present Rate	-	-	26.33	31.14	-	18.56	MC 4.11	-	M. M.C. 2.17 4.11
and 30	-	-	20.84	30.27	-	24.51	10.06	-	1.79 10.07
Municipal Carryover 80	-	-	5.95	8.65	-	7.00	-0.77	-	0.51 -0.77
90	-	-	2.98	4.32	-	3.50	-1.14	-	0.26 -1.14
Industrial	0.01	-	-	0.95	0.41	0.13	-	-	0.15
Storm Sewers	-	-	0.24	0.12	0.03	0.06	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	0.01	1.53	0.18	0.03	0.17	-	0.04	0.03
Septic Tanks	-	0.38	1.02	1.72	0.62	0.15	0.19	0.30	0.03
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	0.18	0.01	0.07	0.08	0.10	0.02	0.01	0.86	0.27
Septic Tanks	1.54	0.73	1.05	1.92	3.01	1.74	0.21	2.09	6.12
Other	0.24	0.00	0.00	0.04	0.11	0.06	-	0.04	0.04
Natural	0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE	2.46	3.48	42.05	56.24	24.09	28.92	13.98	3.36	25.67
30			36.56	35.37		34.87	19.93		31.24
80			21.67	33.75		17.36	9.10		19.13
90			18.70	29.42		13.86	8.73		18.51

2000, PROJECTION I, PRESENT GROWTH RATE

Sources \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams	0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River									1.46
Dustfall and Precipitation	0.07	0.80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal Input, Present Rate	-	-	39.62	48.18	-	27.23	M.C. 12.78	-	M. M.C. 2.55 12.78
and 30	-	-	31.35	46.48	-	35.96	21.51	-	2.10 21.51
Municipal Carryover 80	-	-	8.96	13.28	-	10.27	-0.51	-	0.60 -0.51
90	-	-	4.48	6.64	-	5.14	-1.00	-	0.30 -1.00
Industrial	0.01	-	-	1.17	0.63	0.16	-	-	0.18
Storm Sewers	-	-	0.32	0.18	0.04	0.09	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	0.01	2.30	0.11	0.02	0.17	-	0.04	0.03
Septic Tanks	-	0.63	1.44	2.94	0.86	0.22	0.33	0.30	0.03
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	0.15	0.01	0.10	0.05	0.07	0.02	0.01	0.80	0.25
Septic Tanks	2.98	1.20	1.48	3.27	4.18	2.52	0.35	2.87	8.38
Other	0.46	-	-	0.07	0.15	0.06	-	0.04	0.04
Natural	0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE	4.09	4.20	57.07	76.06	25.73	38.50	24.05	4.08	37.71
30			48.80	74.36		47.23	32.78		45.99
80			26.41	41.16		21.54	10.76		22.47
90			21.93	34.52		16.41	10.27		21.68

TABLE 12.32 (cont'd)

ESTIMATED INPUT (IN TONS) OF TOTAL PHOSPHORUS TO THE MAIN VALLEY OKANAGAN LAKES FROM KNOWN SOURCES

2020, PROJECTION I, PRESENT GROWTH RATE

Sources \ Drainage Basin		Wood	Kalamalka	OKANAGAN LAKE North	OKANAGAN LAKE Central	OKANAGAN LAKE South	Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
		1	2	3	4	5	6	7	8	9
Tributary Streams, Natural		0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams		0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River		-	-	-	-	-	-	-	-	3.03
Dustfall and Precipitation		0.07	0.80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES										
Municipal Input, Present Rate		-	-	54.55	69.09	-	36.58	M.C. 22.13	-	M. M.C. 2.81 22.13
and	30	-	-	43.15	66.03	-	48.32	33.87	-	2.31 33.87
Municipal Carryover	80	-	-	12.33	18.86	-	13.80	-0.07	-	0.66 -0.07
	90	-	-	6.16	9.44	-	6.90	-0.78	-	0.33 -0.78
Industrial		-	-	-	1.67	0.85	0.16	-	-	0.19
Storm Sewers		-	-	0.46	0.27	0.05	0.13	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES										
Agriculture		-	0.01	3.07	0.07	0.01	0.17	-	0.04	0.03
Septic Tanks		-	1.09	2.19	5.23	1.24	0.33	0.55	0.51	0.05
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS										
Agriculture		0.11	0.01	0.13	0.03	0.05	0.02	0.01	0.80	0.25
Septic Tanks		6.10	2.05	2.25	5.82	6.07	3.77	0.59	4.20	12.28
Other		0.95	-	-	0.12	0.22	0.09	-	0.07	0.07
Natural		0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE		7.65	5.51	74.46	102.39	28.27	49.28	42.57	5.65	52.85
	30			63.06	99.33		61.06	54.31		64.09
	80			32.24	52.16		26.05	20.37		28.50
	90			26.07	42.74		19.06	19.63		27.46

2000, PROJECTION II, HIGH GROWTH RATE

Sources \ Drainage Basin		Wood	Kalamalka	OKANAGAN LAKE North	OKANAGAN LAKE Central	OKANAGAN LAKE South	Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
		1	2	3	4	5	6	7	8	9
Tributary Streams, Natural		0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams		0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River		-	-	-	-	-	-	-	-	1.73
Dustfall and Precipitation		0.07	0 80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES										
Municipal Input, Present Rate		-	-	43.01	52.21	-	29.51	M.C. 15.06	-	M. M.C. 2.81 15.06
and	30	-	-	34.03	50.36	-	38.97	24.52	-	2.31 24.52
Municipal Carryover	80	-	-	9.72	14.39	-	11.14	-0.40	-	0.66 -0.04
	90	-	-	4.86	7.19	-	5.59	-0.95	-	0.33 -0.95
Industrial		0.01	-	-	1.42	0.63	0.15	-	-	0.18
Storm Sewers		-	-	0.36	0.19	0.04	0.10	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES										
Agriculture		-	0.01	2.30	0.10	0.02	0.17	-	0.04	0.03
Septic Tanks		-	0.68	1.56	3.19	0.94	0.24	0.36	0.41	0.04
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS										
Agriculture		0.13	0.01	0.10	0.04	0.06	0.02	0.01	0.76	0.24
Septic Tanks		3.28	1.28	1.60	3.55	4.58	2.76	0.38	3.05	8.93
Other		0.50	-	-	0.07	0.18	0.06	-	0.06	0.06
Natural		0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE		4.41	4.33	60.74	80.86	26.23	41.04	25.27	4.35	41.09
	30			51.76	79.01		50.50	34.74		50.05
	80			27.45	43.04		22.67	10.17		23.84
	90			22.59	35.84		17.10	9.26		22.60

TABLE 12.32 (cont'd)

ESTIMATED INPUT (IN TONS) OF TOTAL PHOSPHORUS TO THE MAIN VALLEY OKANAGAN LAKES FROM KNOWN SOURCES

2020, PROJECTION II, HIGH GROWTH RATE

Drainage Basin / SOURCES	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams	0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River	-	-	-	-	-	-	-	-	3.22
Dustfall and Precipitation	0.07	0.80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal Input, Present Rate	-	-	59.93	74.69	-	40.23	M.C. 25.78	-	M. M.C. 3.06 25.78
and 30	-	-	47.42	71.35	-	53.14	38.69	-	2.52 38.69
Municipal Carryover 80	-	-	13.54	20.39	-	15.18	0.73	-	0.72 0.73
90	-	-	6.77	10.19	-	7.	-0.70	-	0.36 0.70
Industrial	0.01	-	-	1.68	0.85	0.15	-	-	0.18
Storm Sewers	-	-	0.51	0.29	0.06	0.14	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	0.01	3.07	0.05	0.01	0.17	-	0.04	0.03
Septic Tanks	-	1.20	2.37	5.76	1.39	0.36	0.62	0.51	0.05
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	0.11	0.01	0.13	0.02	0.04	0.02	0.01	0.80	0.25
Septic Tanks	6.72	2.27	2.43	6.42	6.75	4.14	0.65	4.39	12.83
Other	1.05	-	-	0.13	0.27	0.09	-	0.07	0.07
Natural	0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE	8.38	5.84	80.25	109.13	29.15	53.33	36.52	5.84	57.48
30			67.74	105.79		66.24	49.43		69.85
80			33.86	54.83		28.28	11.47		30.09
90			27.09	44.63		20.69	10.04		28.30

2000, PROJECTION III, LOW GROWTH RATE

Drainage Basin / Sources	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams	0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River	-	-	-	-	-	-	-	-	1.44
Dustfall and Precipitation	0.07	0.80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal Input Present Rate	-	-	35.77	43.63	-	24.64	M.C. 9.95	-	M. M.C. 2.30 9.95
and 30	-	-	28.29	42.08	-	32.55	18.10	-	1.89 18.10
Municipal Carryover 80	-	-	8.08	12.02	-	9.30	-0.55	-	0.54 0.55
90	-	-	4.04	6.02	-	4.65	-1.02	-	0.27 -1.02
Industrial	0.01	-	-	1.47	0.63	0.16	-	-	0.19
Storm Sewers	-	-	0.31	0.17	0.03	0.08	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	0.01	2.30	0.17	0.03	0.17	-	0.04	0.03
Septic Tanks	-	0.61	1.35	2.85	0.83	0.21	0.32	0.30	0.03
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	0.18	0.01	0.10	0.07	0.09	0.02	0.01	0.80	0.25
Septic Tanks	2.95	1.15	1.42	3.18	4.02	2.39	0.35	2.85	8.38
Other	0.46	-	-	0.07	0.16	0.06	-	0.04	0.04
Natural	0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE	4.09	4.13	53.06	71.70	25.27	35.76	20.09	4.06	34.62
30			45.58	70.15		43.67	28.24		42.36
80			25.37	40.09		20.42	9.59		22.36
90			21.33	34.09		15.77	9.12		21.62

TABLE 12.32 (cont'd)

ESTIMATED INPUT (IN TONS) OF TOTAL PHOSPHORUS TO THE MAIN VALLEY OKANAGAN LAKES FROM KNOWN SOURCES

2020, PROJECTION III, LOW GROWTH RATE

Sources \ Drainage Basin	Wood	Kalamalka	OKANAGAN LAKE			Skaha	Vaseux	Okanagan River	Osoyoos (Canadian)
			North	Central	South				
	1	2	3	4	5	6	7	8	9
Tributary Streams, Natural	0.20	1.54	7.84	13.62	8.79	1.82	0.00	-	0.35
Main Valley Streams	0.20	-	0.80	3.40	6.40	5.30	9.40	-	11.07
Input from Okanagan River	-	-	-	-	-	-	-	-	1.82
Dustfall and Precipitation	0.07	0.80	2.95	2.48	4.37	0.83	0.02	-	0.49
POINT SOURCES									
Municipal Input, Present Rate	-	-	40.38	50.38	-	27.15	M.C. 12.70	-	M. 2.30 M.C. 12.70
and 30	-	-	31.94	48.13	-	35.86	21.41	-	1.89 21.41
Municipal Carryover 80	-	-	9.12	13.75	-	10.25	-0.44	-	0.54 -0.44
90	-	-	4.57	6.87	-	5.12	-0.97	-	0.27 -0.97
Industrial	0.01	-	-	1.86	0.84	0.17	-	-	0.21
Storm Sewers	-	-	0.34	0.20	0.04	0.09	-	-	-
STREAM LOADING FROM DIFFUSE SOURCES									
Agriculture	-	0.01	3.07	0.14	0.02	0.17	-	0.04	0.03
Septic Tanks	-	0.79	1.59	3.91	0.91	0.24	0.42	0.41	0.04
GROUNDWATER TO MAIN VALLEY RECEIVING WATERS									
Agriculture	0.15	0.01	0.13	0.06	0.07	0.02	0.01	0.83	0.26
Septic Tanks	4.56	1.50	1.63	4.35	4.46	2.76	0.45	3.07	8.97
Other	0.72	-	-	0.09	0.18	0.06	-	0.06	0.06
Natural	0.02	0.01	0.22	0.59	0.22	0.08	0.04	0.03	0.10
TOTAL PRESENT RATE	5.93	4.66	58.95	81.08	26.30	38.69	23.04	4.44	38.40
30			50.51	78.83		47.40	31.75		46.70
80			27.69	44.45		21.79	9.90		23.50
90			23.14	37.57		16.66	9.37		22.70

For the purposes of these projections it has been assumed that there would be no increased treatment of industrial effluents. Realistically, this assumption is unlikely in view of present developments and possible Provincial requirements. For example, an industrial waste treatment plant is being built at Kelowna. This plant, while reducing the organic load to the lake, will increase the phosphorus load by some 550 pounds per year. Similarly Dutch Dairies Ltd., in Armstrong, will be serviced with an activated sludge plant by 1973. Presently 5.5 million gallons of milk wastes are discharged annually to Deep Creek, which flows into the north arm of Okanagan Lake.

CHAPTER 13

Stream and Lake Water Quality

13.1 WATER QUALITY OF OKANAGAN STREAMS

The objective of this section is to evaluate water quality of the major Okanagan tributaries based on commonly accepted water quality criteria. Data collected under Section 2 "Stream Quality Study" is the major source of water quality data. Criteria has been examined from various sources noted in the bibliography. Surface water quality of main valley lakes and several headwater lakes has been presented but the analysis is brief.

The discussion of water quality is generally limited to domestic water supply and aquatic life criteria as these criteria satisfy requirements of most beneficial uses.

13.1.1 Monitoring Stations for Stream Quality

A series of sampling stations were established in the Okanagan Basin prior to May 1969. These stations were located at the mouths of streams flowing into the Okanagan main valley rivers and lakes. On Kelowna Creek, Brandt's Creek, Deep Creek and B.X. Creek water quality monitoring stations were located upstream of the mouth. Water quality stations were also located on streams flowing into Ellison, Wood and Kalamalka Lakes. The locations of these stations are illustrated in Figure 2.1 and tabulated in Table 2.1 of Section 2.

13.1.2 Collection and Analysis of Water Quality Samples

Agencies responsible for the analysis and collection of samples were the Environmental Protection Service (EPS) laboratories in Calgary and New Westminster or the Water Resources Laboratory in Vancouver. The choice of laboratory depended upon the type of analyses requested. The Stream Quality Study discussed in Section 2, gives a breakdown of the method of analysis and collection of chemical and physical parameters. "Standard Methods" were utilized for analysis of samples not described in detail in the above report.

13.1.3 Chemical Composition of River Water

A number of factors affect the quality of river water. Variation of quality may not necessarily mean that man made wastes have contaminated a river system.

Generally, natural waters acquire their chemical characteristic by dissolution and by chemical reactions with solids, liquids and gases with which they have come into contact during the various parts of the hydrological cycle.

River water is extremely variable in chemical composition. To begin with, there may be a considerable variation in the chemistry of the rainwater that is falling on a river basin, as indicated by section 5, "The Report on Dustfall and Precipitation Study".

The most important diffuse factors introducing temporal variability into river water chemistry, however, seems to be the relative contributions of groundwater and surface runoff.

In general, the contribution of groundwater to a river tends to be relatively stable, but the contribution of surface runoff tends to be variable. When rainfall on the basin has been light or absent for some protracted period of time, the nourishment of the stream is almost entirely by groundwater.

When rainfall is heavy, and particularly when it is concentrated in short periods of time, the nourishment of the swollen stream may be almost entirely by runoff, as can be observed in the detailed plots of physical parameters illustrated in Appendix G. This graphical data are presented to serve as a visual appraisal of the stream water quality. Due to the differing conditions and sampling frequency between stations, no further analysis was done on the plotted concentrations.

Groundwater, by its long standing contact with rocks and mineral soil, is usually much more concentrated than surface runoff, the more so because it is usually in contact with the mineral material of the soil under conditions of oxygen and carbon dioxide tension that are particularly favourable to the solution of many mineral components.

Generally, it is impossible to appreciate the full extent of the dependence of river chemistry on water quality and loadings from the comparison of monthly means and yearly means. Monthly means and yearly means of discharge completely mask the more violent contribution from runoff. Furthermore, water quality and quantity data unfortunately is not generally available on a daily basis.

In addition to these temporal variations in the chemistry of rivers, there are also spatial variations. Generally, the content of dissolved matter of river water tends to increase from source to mouth. A further complication is introduced when large amounts of chemically different waters are introduced into a river in some other way; for example, by a large spring or sewage outflow and there may not be complete mixing for a long distance downstream.

The scope of this report limits the discussion of water quality to the analysis of mean and extreme values. Detailed discussion of land use effects are given in Section 5, "A Study to Determine the Effects of Land Use on Water Quality in Tributaries of the Okanagan Basin."

13.1.4 Stream Water Quality Criteria

One troublesome problem encountered when considering water quality is the meaning of criteria. A general definition is:

> Criteria - A scientific requirement on which a decision or judgement may be based concerning the suitability of water quality to support a designated use.

A severe shortcoming in determining these scientific requirements related to water quality studies is the lack of adequate knowledge concerning many of the quality characteristics upon which criteria should be based.

Further complicating factors in setting water quality criteria are the variations in natural conditions affecting water quality, such as climate, geography and geology of a specific location. The purpose of this report is not to present criteria which are considered inflexible. The criteria presented are meant as guidelines only, to be used in conjunction with a thorough knowledge of local conditions. The water quality criteria presented can be considered as a first step in judging the quality of the water.

The use of water for drinking is generally considered to be the most essential use of water; however, other beneficial uses may have water quality requirements which are more stringent than those for drinking water. In many industrial processes water that is suitable for domestic supplies requires further treatment; softened water from municipal systems is often detrimental for irrigation; and aquatic life in streams and lakes may be destroyed or inhibited by concentrations of copper or zinc that are permissible in domestic water.

When considering water quality criteria for domestic use two conditions of the water must be considered:

(a) its quality at the source of supply, and
(b) its quality at the point of use

References dealing with water quality criteria for fish and other organisms are not only innumerable but also tend to be non-standardized. Furthermore, a wide discrepancy in criteria arises from variation in the species of fish or organism, the temperature, the season, the dissolved oxygen content synergistic substance, the mineral content of water and the time of exposure.

The significance of specific physical and chemical water quality parameters is discussed below. Maximum allowable water quality criteria commonly accepted is

presented in Table 13.1. The list of references given is not complete by any means however, an attempt has been made to select typical and representative values from the literature.

The water quality parameter descriptions below are excerpts from Water Quality Criteria, McKee and Wolf, (1); and Water Quality Criteria, FWPCA (42). Only selected parameters which exceed acceptable water quality criteria are discussed. Table 13.2 presents a list of 15 tributaries in the Okanagan Valley. These tributaries either are major streams or are located in basins with extensive use of land. The table indicates the streams exceeding the recommended criteria. A summary of the stream water quality is presented in Appendices B and H for 1969-1971 data respectively.

(a) Alkalinity:

Like acidity, alkalinity is not a specific polluting substance, but rather a combined effect of several substances and conditions. It is a measure of the ability of a solution to neutralize hydrogen ions and is expressed in terms of an equivalent amount of calcium carbonate. Alkalinity is caused by the presence of carbonates, bicarbonates, hydroxides and to a lesser extent borates, silicates, phosphates and organic substances.

The alkalinity of tributary streams in the Okanagan Valley is generally acceptable for most uses.

(b) Colour:

Colour results from the presence in water of certain metallic and organic constituents. Notably, colour usually results from iron or manganese combined with organic matter, from humus and peat.

Colour larger than 10 (colour units on cobalt-latinim scale) usually passes unnoticed and therefore less than 10 is desirable for drinking water. Colour larger than 50 tends to block out sunlight and interferes with propagation of fish food organisms. Most Okanagan Basin streams generally exhibited colour readings between 10 and 25, although in 1971 and 1972 a majority were greater than 25. None of these 1971 values, however, were larger than 50. The highest recorded average colour reading was 55 for Inkaneep Creek in 1972.

(c) Hardness:

Any substance that will form an insoluble curd with soap causes hardness; but since iron, manganese, copper, barium, lead, zinc and other trace elements are seldom present in appreciable concentrations in natural waters, hardness is attributable principally to calcium and magnesium ions.

TABLE 13.1

GENERALLY ACCEPTED ALLOWABLE CRITERIA FOR AQUATIC LIFE AND DRINKING WATER STANDARDS

WATER QUALITY PARAMETER	REFERENCE NUMBER	WATER QUALITY CRITERIA/CONCENTRATIONS RECOMMENDED AS MAXIMUM ALLOWABLE VALUES
Alkalinity	59	30-500 mg/l as $CaCO_3$ permissible criteria for raw drinking water sources.
	46	100-120 ideal to support aquatic life.
Colour	57	15 units acceptable for drinking water
Turbidity	57	5 J.T.U. not to exceed for drinking water.
	59	5 J.T.U. acceptable for drinking water.
	42	10 J.T.U. not to exceed for aquatic life
Calcium	57	200 mg/l an excessive limit in drinking water.
	65	800 mg/l lethal concentration for Stickleback.
Chlorine	66	20.0 mg/l permissible limit for drinking water.
	57	250 mg/l should not exceed for drinking water.
Copper	57,58,59	1.0 mg/l acceptable for drinking.
	59	0.01 mg/l objective for drinking.
	41,47,55	0.02 mg/l threshold concentration for freshwater fish and aquatic life.
	60	0.03 mg/l incipient lethal level for Rainbow Trout.
	47	0.1 mg/l maximum permissible for salmon streams.
Fluorides	22,66	1.5 mg/l recommended limit for drinking water.
	46,42	1.5 mg/l should not exceed for freshwater life.
	46	1.5 mg/l reduced hatching of fish eggs.
	46	2.3-7.3 mg/l harmful to trout.
Iron	57,58,59	0.3 mg/l dissolved permissible for drinking water.
	46	0.8 mg/l lethal threshold to some fish.
	47	0.6 mg/l toxic to fish.
	46	rapid kill of Rainbow Trout.
Hydrogen Ion (pH)	42	6.0-8.5 permissible for drinking water.
	46	6.5-8.2 best for overall aquatic productivity in fresh water.
Lead	57,59	0.05 mg/l maximum permissible for drinking.
	46	0.1 mg/l deleterious to fresh water fish life.
	55	0.01 mg/l suggested for fishing waters.
Magnesium	66	150,g/l excessive limit for drinking water but no maximum allowable concentration.
		1000 mg/l magnesium salts tolerated by some freshwater fish.
Manganese	57,59	0.05 mg/l acceptable for drinking water.
	46,47	1.0 mg/l suggested maximum for fish & aquatic life.
Nitrogen (NO_3 + NO_2)	42,59	10.0 mg/l acceptable for drinking water.
Oxygen		5.0 mg/l to maintain native fish populations
		4-5 mg/l may be maintained for short periods during any 24 hour period.
Total Phosphorus	46	0.1 mg/l phosphorus difficulties with coagulation.
	59	0.2 mg/l phosphates as PO_4 for acceptable drinking water.
	42	0.2 mg/l as P same potable waters exceed without algal problems in U.S.
		0.5 mg/l as P not to exceed where flowing streams enter lakes and reservoirs for aquatic life.
		0.1 mg/l as P not to exceed in flowing streams for aquatic life.
Sulphate	66	400 mg/l excessive limit but no maximum allowable limit for drinking water supplies.
Zinc	57,58,59	5.0 mg/l acceptable for drinking water.
	46	0.1 mg/l reported as lethal to fresh water trout and eggs.
	55	0.1 mg/l suggested for salmonid fishes.
	47	1.1 mg/l destroyed benthic fauna.

TABLE 13.2

SELECTED TRIBUTARIES IN THE OKANAGAN WHICH EXCEED GENERALLY ACCEPTED MAXIMUM ALLOWABLE DRINKING WATER (●) AND AQUATIC LIFE (○) CRITERIA

	YEAR	INKANEEP CREEK	VASEUX CREEK	ELLIS CREEK	PENTICTON CREEK	TROUT CREEK	PEACHLAND CREEK	POWERS CREEK	MISSION CREEK	KELOWNA CREEK	BRANDT'S CREEK	LAMBLY CREEK	SHORTS CREEK	EQUESIS CREEK	DEEP CREEK	VERNON CREEK
		501	504	510	511	512	514	516	520	521	522	523	526	528	529	530
Alkalinity	69										●					
	70											●				
	71															
	72															
Colour	69	●	●	●	●	●		●	●	●	●	●			●	
	70	●	●	●	●	●		●							●	
	71	●	●	●	●	●		●	●	●	●	●	●	●	●	
	72	●	●	●	●	●		●	●	●	●		●	●	●	
Total Hardness	69										●				●	
	70										●				●	
	71										●				●	
	72										●				●	
Turbidity	69	●		●		●	●			●	●				●	●
	70	●		●	●		●	●	●	●	●				●	●
	71	●		●		●	●			●	●		●	●	●	●
	72	○		●		○	○	●	●	○	○		●	●	●	●
Dissolved Iron	69			●	●						●					
	70				●											
	71															
	72	●	●	●												
Oxygen	69										○					
	70															
	71															
	72															
Dissolved Manganese	69			●							●				●	
	70			●						●	●				●	●
	71															
	72														○	
Total Phosphorus	69	○								○	○				○	○
	70			○		○					○				○	○
	71	○				○			○	○	○				○	○
	72	○		○		○			○		○			○	○	○

Where carbonates or bicarbonates are present in concentrations equivalent to or greater than the calcium and magnesium, the scale that will form upon evaporation or heating will consist primarily of calcium carbonate and magnesium hydroxide. Such hardness is termed "carbonate" and can be removed with acid.

Where alkalinity is low, the more soluble sulphates and chlorides may form scales that cannot be readily dissolved by acid, and such hardness is called "non-carbonate".

Generally, hardness over 100 mg/l becomes increasingly inconvenient, for it results in a waste of soap and incrustation of utensils. However, the major detrimental effect of hardness is economic. In good water the total hardness is usually below 250 mg/l (42).

Waters in the Okanagan Valley can be considered as moderately hard water. Hardness tends to be excessive in only a few tributaries which appears to result from domestic and industrial waste sources.

(d) Turbidity:

The turbidity of water is attributable to suspended and colloidal matter, the effect of which is to disturb clearness and diminish the penetration of light. Turbidity is caused by micro-organisms or organic detritus; silica or other minimal substances including zinc, iron, and manganese compounds; clay or salt; or sawdust, fibers or other materaials, either as a result of addition of domestic sewage or wastes from various industries, such as mining, logging, pulp and paper manufacturing and others. Potable waters should have a turbidity of less than 1 J.T.U. although 5 J.T.U.'s is the acceptable limit. For aquatic life, the critical time with regards to turbidity should not exceed 10 J.T.U.'s for optimum aquatic productivity, and in any case, should be less than 25 J.T.U.'s.

Referring to the summary of data, it can be seen that from 1969 to 1972, the number of streams showing turbidities greater than 5 J.T.U. nearly doubled. Of these streams, 3 were greater than 25 J.T.U. in 1971. Trout Creek was persistently greater than 25 J.T.U., although the highest average turbidity during the three year period was 56 J.T.U., for Equesis Creek in 1971.

(e) Iron:

In addition to corrosion products, natural waters may be polluted by iron-bearing industrial wastes such as those from pickling operations and by the leaching of soluble iron salts from soil and rocks, e.g.: acid mine-drainage and iron bearing groundwater.

Although many of the ferric and ferrous salts such as the chlorides are highly soluble in water, the ferrous ions are readily oxidized in natural waters to the ferric condition and form insolubly hydroxises. These precipitates tend to agglomerate flocculate and settle or be absorbed on surfaces; hence, the concentration of iron in well aerated waters is seldom high.

Generally, drinking water standards are not based upon physiological considerations, for iron in trace amounts is essential for nutrition. The daily nutritional requirement is 1 to 2 mg and most diets contain 7 to 35 mg per day. Consequently, drinking waters containing iron in unpalatable and unesthetic concentrations, say 1.0 mg/l would have little effect on the total daily intake. Instead of physiological reasons, therefore, the limit is based on esthetic and taste considerations.

Generally 50% of the waters that support good fish fauna in Canada and the United States have a concentration of 0.3 mg/l or less which is considered as a permissible level.

Iron concentrations are generally not excessive in the Okanagan tributaries except in populated areas such as Kelowna and Penticton. In 1970, all but Penticton, Ellis and Brandt's Creek were acceptable. The highest recorded average of dissolved iron content was 0.441 mg/l for Penticton Creek in 1970. In 1972, Inkaneep, Vaseux and Ellis Creeks exceeded the permissible limit.

(f) Dissolved Oxygen:

A deficiency of oxygen in natural water is of some concern to the santiary engineer and limnologist. Inadequate dissolved oxygen in surface waters may contribute to an unfavourable environment for fish and other aquatic life and the absence of dissolved oxygen may give rise to odoriferous products of anaerobic decomposition. Generally, in domestic water supplies oxygen is not considered harmful. In aquatic life, 4-5 mg/l generally is recommended. However, in spawning areas in particular, it has been recommended that dissolved oxygen values be no less than 7-8 mg/l.

The effect of dissolved oxygen on aquatic life has been documented in numerous reports; however, no attempt will be made to summarize these references. The Aquatic Life Advisory Committee of ORSANCO has recommended that the minimum permissible oxygen concentration for well rounded fish populations should not be less than 5 mg/l at least 16 hours of any 24 hour period.

The majority of stream in the Okanagan Valley have adequate oxygen concentration with the exception of Brandt's Creek, which contained an average concentration of 3.3, 4.4 and 6.6 mg/l in 1969, 1970 and 1971 respectively. The oxygen concentration of streams within the Okanagan Basin can be expected to be excellent except under conditions of extreme contamination.

(g) Manganese:

The metal or its salts are used extensively in steel alloys, for dry-cell batteries, in glass and ceramics, in the manufacture of paints and varnishes, in inks and dyes, in matches and fireworks, and in agriculture to enrich manganese deficient soils. The chlorides, nitrates and sulphates are highly soluble in water but for oxides, carbonates and hydroxides are only sparingly soluble. For this reason, manganic or manganous ions are seldom present in natural surface waters in concentrations above 1.0 mg/l.

Manganese is undesirable in domestic water supplies because it causes unpleasant tastes, deposits on food during cooking, stains and discolours laundry and plumbing fixtures, and fosters the growth of some micro-organisms in reservoirs, filters and distribution systems.

Based on the literature survey 1.0 mg/l manganese concentration will not be deleterious to fish. In 1969 and 1970, most Okanagan Basin streams were within drinking water criteria for manganese and none exceeded the threshold value for aquatic life. In 1971, most streams were still below the drinking water criteria, although only one stream was below a desirable level. The manganese levels in Deep and Brandt's Creek were 0.157 and 0.200 mg/l respectively for 1972.

(h) Phosphorus:

This element does not occur free in nature but is found in the form of phosphorus in minerals and soils. Phosphorus is a key nutrient in animal and plant life and is extremely important in processes involving the transfer of energy in all living cells. The major problems associated with phosphorus in drinking waters and supplies is:

(a) to avoid problems associated with algae and other aquatic plants, and
(b) to avoid coagulation problems due particularly to complex phosphates

Some potable surface water supplies now exceed 0.2 mg/l phosphorus without experiencing notable problems due to aquatic growth. Generally, 0.05 mg/l would probably restrict noxious aquatic plant growth in flowing waters and some standing waters.

At concentrations of complex phosphates of 0.1 mg/l difficulties with coagulation are experienced.

For aquatic life the allowable total phosphorus depends upon a variety of factors; allowable amounts will vary but in general a desirable guideline for rivers is 0.1 mg/l. A number of streams in the Okanagan exceed this criteria.

The data summary of averages indicates that for 1969, 1970 and 1971 a third or more of the selected 15 streams could not meet the recommended aquatic life criteria.

It must be remembered that stream sampling was conducted at each stream mouth, and therefore these concentrations in most cases reflect the result of many activities and contaminant contributions such as municipal and industrial impacts. Soil erosion can also result in high phosphorus loads. Both situations occur in the Okanagan Valley. Trout Creek has high concentrations of phosphorus from natural conditions while phosphorus loads from Brandt's Creek and Vernon Creek result from municipal discharges.

13.1.5 Fecal Coliform

Fecal coliform has been examined for the majority of streams in the Okanagan during 1969, 1970 and 1971. Table 13.3 is a summary of the fecal coliform log mean

TABLE 13.3

FECAL COLIFORM AT THE MOUTHS OF SELECTED STREAMS 1970-71

STREAM	STATION NO.	NO. SAMPLES	LOG MEAN AVERAGE (coliform/100 ml)
Inkaneep Cr.	501	4	93
Vaseux Cr.	504	3	4
Ellis Cr.	510	17	7
Shingle Cr.	509	7	7
Penticton Cr.	511	15	23
Trout Cr.	512	19	19
Chute Cr.	513	3	7
Peachland Cr.	514	15	6
Powers Cr.	516	21	14
Mission Cr.	520	21	57
Kelowna Cr.	521	20	1095*
Brandt's Cr.	522	38	1230*
Lambly Cr.	523	14	4
Equesis Cr.	528	5	24
Deep Cr.	529	44	119
B.X. Cr.	531	20	1329*

* Exceeds desirable criteria for public water supplies.

for 15 selected major streams. Generally, fecal coliform organisms may be considered as indicators of recent fecal contamination. The reliability of this analysis is discussed in greater detail in Section 6 (Bacteriological Study). The permissible criteria for surface waters utilized for public water supplies is in the range of 2000/100 ml; the desirable criteria is less than 200/100 ml. These limits assume of course that standard techniques are available for water treatment. The water at the mouths of 13 creeks meet the desirable criteria and the water of the remaining 3 creeks fall within the permissible criteria.

13.1.6 Individual Stream Examination

The individual stream analysis is composed of a cursory examination of the physiography of the basin, and a discussion of extreme deviation of water quality from the background level and acceptable water quality standards recommended for drinking water and aquatic life.

(a) Inkaneep Creek

Inkaneep Creek watershed (Figure 13.1) is predominantly an undisturbed forested watershed which drains into the northern end of Osoyoos Lake, approximately three-quarters of a mile downstream from the point of discharge of the Okanagan River into the lake.

The headwaters of this tributary originate in a swampy or marshy highland area at an elevation of approximately 4,200 feet above mean sea level. Inkaneep Creek is fed by several minor tributaries including Coteay Creek- Gregoire Creek, Baldy Creek and McCuddy Creek, each flowing to the southwest. The main trunk of Inkaneep Creek runs through a typical canyon area emerging some four miles upstream of the mouth. Below the canyon area flows over an outwash terrace and delta area. The terrace and outwash area form part of the Indian Reserve.

East of the Indian Reserve, above elevation 1,450 feet, the watershed is divided into undeveloped surveyed sub-lots. A limited amount of grazing is practised within these areas.

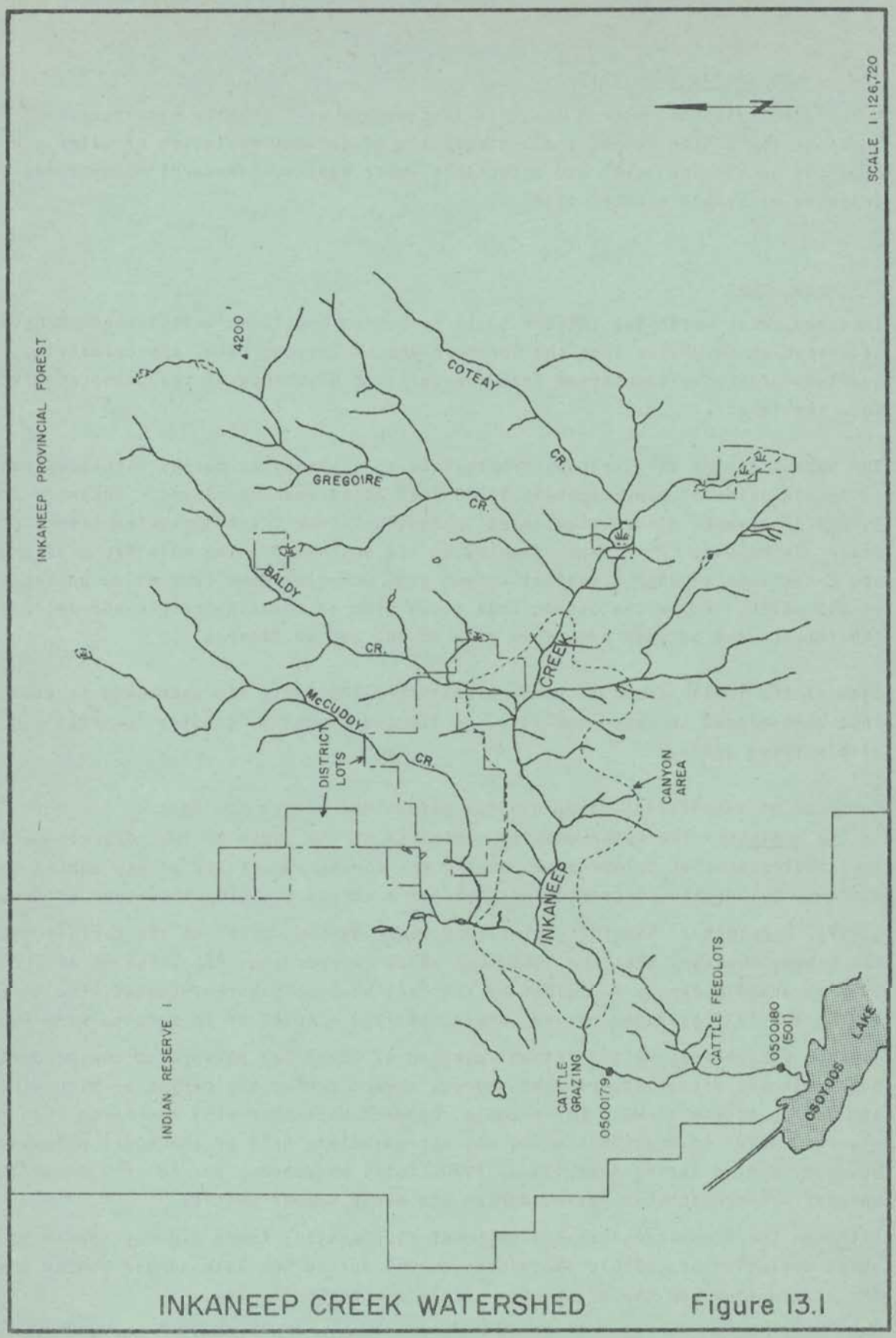
Comments on significant water quality parameters are as follows:

(i) Colour: The water quality monitored at the mouth of the Inkaneep watershed indicates that colour peaks during the spring runoff and is low during the winter. Colour is not considered high for a stream draining this type of area.

(ii) Turbidity: Turbidity similarly peaks during runoff in the spring. It was noted, however, that the 1969 mean value exceeds the 1971 value of 39.2. Such an anomaly can be explained by the fact that only three samples were collected during the 1971 averaged period, where for 1969 a total of 28 results were averaged.

(iii) Phosphorus: A significant portion of the total phosphorus measured at the mouth was dissolved orthophosphorus, except during the period of high winter and spring stream flows. For example, between September 1969 and March 1970 the observed value of orthophosphorus was approximately half of the total phosphorus. However, during spring peak flows, 1970, total phosphorus peaked at 0.25 mg/l whereas orthophosphorus peaked during the early summer months.

Although there was considerable seasonal fluctuation, there did not appear to be great depletion of soluble phosphorus except during the late summer months when the stream flow and the groundwater table was generally low.



INKANEEP CREEK WATERSHED Figure 13.1

(iv) Nitrogen: Mean total nitrogen values fluctuated between values of 0.25 mg/l and 0.32 mg/l with peak readings being observed during spring runoff. Other peak periods occurred during the fall months as well as after an early snowfall and thaw. High concentrations of nitrate nitrogen occurred at the beginning of the winter and spring thaws. Kjeldahl levels increased during the period of thaw following the nitrate peaks. Interestingly, the increased flows that served to bring in nitrogen may also scour algae from the rocks and stream beds. A rapid decrease in kjeldahl nitrogen followed closely behind the peaks. The majority of total N was total Kjeldahl nitrogen which, in fact, is more likely organic nitrogen as opposed to ammonia nitrogen. Concentrations of nitrate N are quite low except during the summer of 1971 at which time all the N (0.48 mg/l) was in the nitrate form.

(v) Hardness: Hardness at Inkaneep Creek varied from an average value of 64.3 mg/l in 1971 to 94.2 in 1969.

(vi) Metals: Metal concentrations were small and averaged, for the three years, no more than 0.009 mg/l for lead, 0.003 mg/l for copper and zinc, and 0.05 mg/l for mercury. Iron concentrations ranged from a mean of 0.10 mg/l to 0.13 mg/l manganese concentrations averaged from 0.015 mg/l to 0.022 mg/l.

(b) Vaseux Creek

Vaseux Creek is an undisturbed forested watershed which drains into the Okanagan River approximately one-half mile south of the S.O.L.I.D. diversion. Most of the stream is contained within a canyon area, and generally flows in an east to west direction, whereas the tributaries generally flow in a north to south, or a south to north direction. Major tributary streams are McIntyre Creek which discharges into Vaseux Creek from the south, and a large unnamed creek at an elevation of 3600 feet. The headwaters of this watershed originate in swampy or marshy lands.

In view of the watershed physiography, all but the lower section of the stream is inaccessible. The last few miles of the watercourse, i.e.: the stretch from elevation 1300 feet, does flow through a somewhat developed area (Figure 13.2). A small portion of the basin is under cultivation in the lower reaches of the basin as illustrated in Figure 13.2.

Comments on significant water quality parameters are as follows:

(i) Colour: The water quality monitored at the mouth indicates that the colour peaks during the spring runoff and is low during the winter. Colour, although it did not exceed the level recommended for aquatic life, was high relative to drinking water criteria during the spring runoff. Colour exceeded drinking water criteria during the years 1969, 1970 and 1971.

(ii) Turbidity: The turbidity of the creek relative to the years 1969, 1970 and 1971 was within suggested drinking water criteria. The quality of the water relative to turbidity can, therefore, be considered excellent.

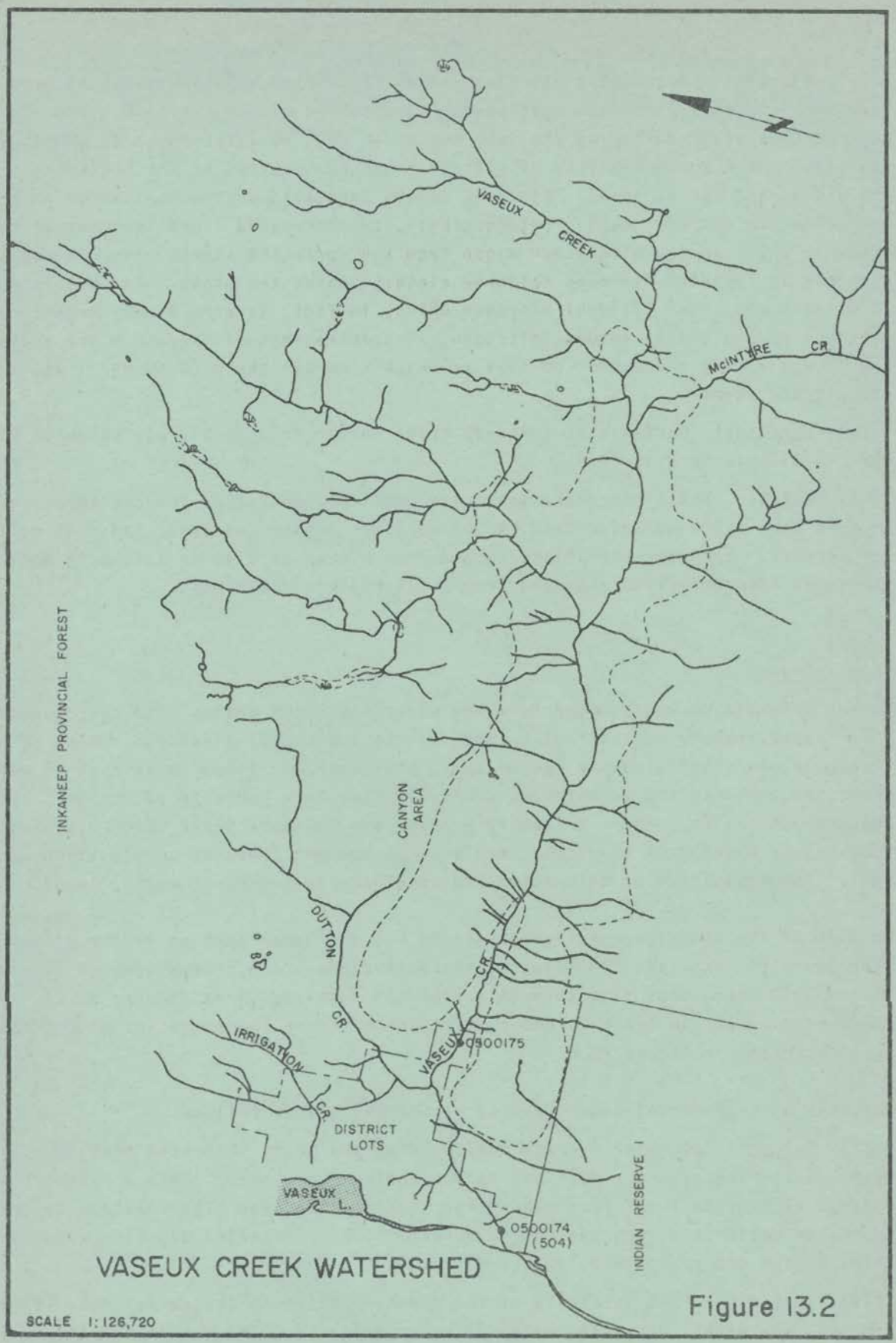

VASEUX CREEK
McINTYRE CR
INKANEEP PROVINCIAL FOREST
CANYON AREA
DUTTON CR.
IRRIGATION CR.
VASEUX CR.
0500175
DISTRICT LOTS
VASEUX L.
0500174 (504)
INDIAN RESERVE I
VASEUX CREEK WATERSHED
SCALE 1:126,720

Figure 13.2

(iii) Alkalinity: The alkalinity of Vaseux Creek water was among the lowest in the Okanagan Valley. Consistently for the years 1969, 1970 and 1971, the values remained low and the water was considered suitable for drinking with respect to alkalinity.

(iv) Manganese: The level of soluble manganese in this river basin was exceptionally low for 1969, 1970 and 1971, and falls well within the recommended level for drinking water, although other streams in the Okanagan exceeded the recommended level of 0.05 mg/l.

(c) Ellis Creek

Ellis Creek (Figure 13.3) is predominantly an undisturbed forested watershed; however, the lower reaches of Ellis Creek are highly urbanized and the mouth is located within the City of Penticton. Ellis Creek discharges into the Okanagan River approximately a mile and a half above Skaha Lake.

The headwaters of this tributary originate in a marshy highland area at an elevation of approximately 4600 feet above mean sea level. Ellis Creek is fed by several minor tributaries including South Ellis Creek, the main branch to the south; North Ellis Creek and Morris Creek, both minor tributaries flowing to the south and north respectively. The main trunk of Ellis Creek runs through a typical canyon area emerging approximately a mile from the mouth. Below the canyon area the stream flows through a residential area, situated on an outwash terrace and delta area.

Directly east of Penticton, the lower reaches of the Ellis Creek watershed has been divided into developed, surveyed lots. Within the developed area, outside of Penticton's limits, the surveyed area consists of orchards, vineyard, and unimproved pastures and rangeland.

The specific amount of timber cut within the watershed has not been compiled; however the cutting has been relatively minor.

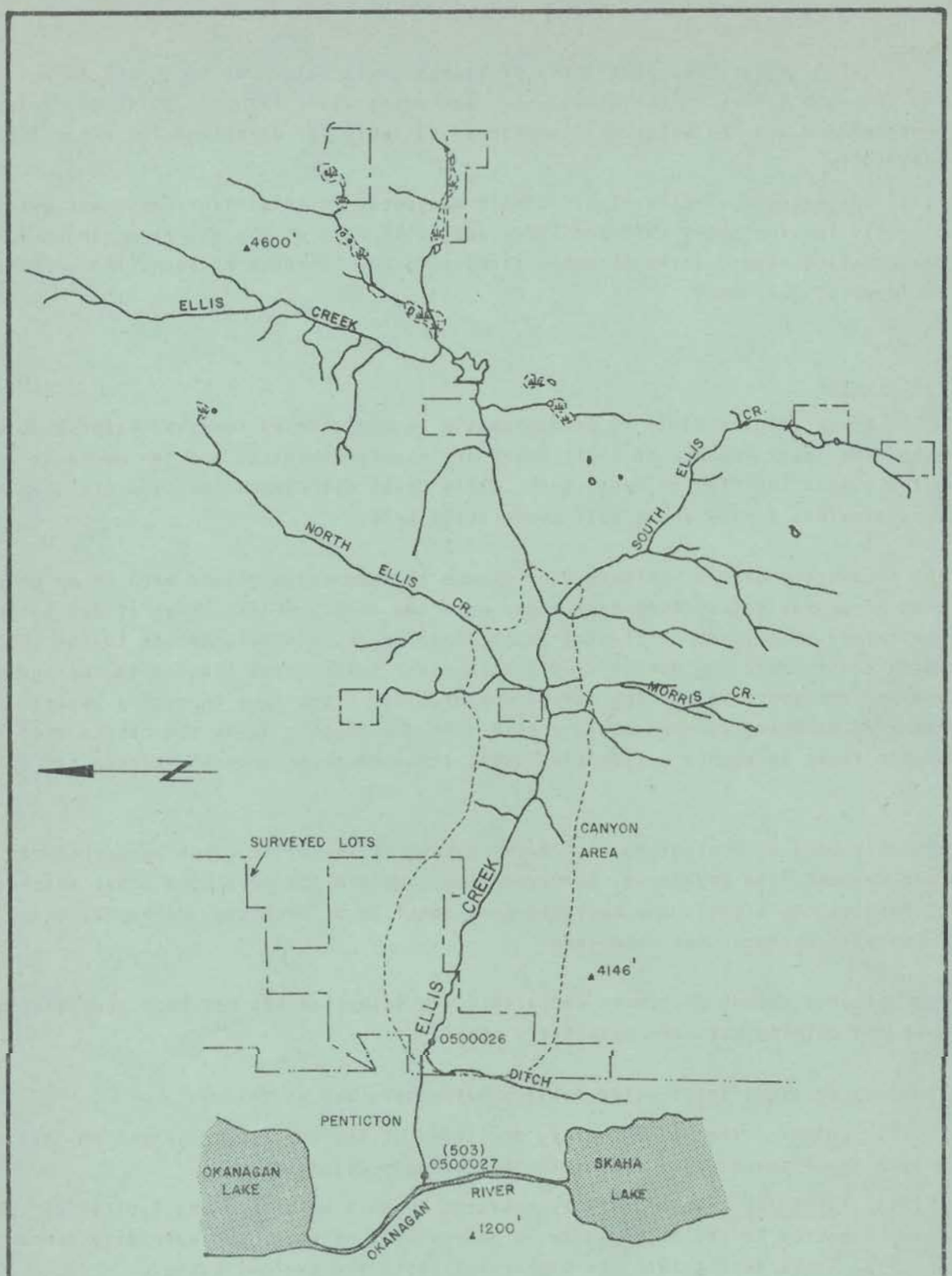
Comments on significant water quality parameters are as follows:

(i) Colour: The water quality monitored at the mouth was typical of that found within the fifteen major creeks in the Okanagan watershed.

(ii) Turbidity: The turbidity measured in this watershed was typical of the level expected in the Okanagan Basin generally. However, the turbidity measured in Ellis Creek during 1970 was high relative to the overall basin.

(iii) Manganese: The level of manganese concentration in Ellis Creek exceeded the recommended drinking water criteria during 1969, 1970 and 1971. Only three other major tributaries in the basin had as high concentrations.

(iv) Iron: Ellis Creek contained the highest concentration of iron within the Okanagan Basin with the exception of Penticton Creek. The recommended drinking



ELLIS CREEK WATERSHED

SCALE 1:126,720

Figure 13.3

water criteria concentration of iron was exceeded during 1969 to 1970. The level of iron measured in the river decreased for the 1971 period.

(v) Phosphorus: Although the recommended total soluble phosphate criteria was only exceeded during 1970, the concentration of phosphate was high. The urbanized lower section of the stream has resulted in this above average level of concentration.

(d) Penticton Creek

Penticton Creek drains a watershed which is predominantly wooded; however, some logging has been conducted in the northern sections in the headwaters of the creek. The lower reaches of Penticton Creek pass through residential areas and drain into the southern end of Okanagan Lake. (Figure 13.4)

The headwaters of this tributary originate in a highland area at an elevation of approximately 5,250 feet above mean sea level. The headwaters contain a number of small lakes. The largest of these lakes acts as a reservoir for the City of Penticton's water.

Penticton Creek is fed by several minor tributaries. Dennis Creek, Reed Creek, Harris Creek, and Stewart Creek flow from the east. Corporation Creek flows from the northwest and joins the main trunk in the headwater area. The main trunk flows from the north through a canyon area and then exists onto a broad flood plain approximately six miles from the mouth.

The headwaters of this particular basin have been logged.

Comments on significant water quality parameters are as follows:

(i) Colour: The colour of the water monitored for Penticton Creek was the highest of the fifteen major creeks in the Okanagan Basin.

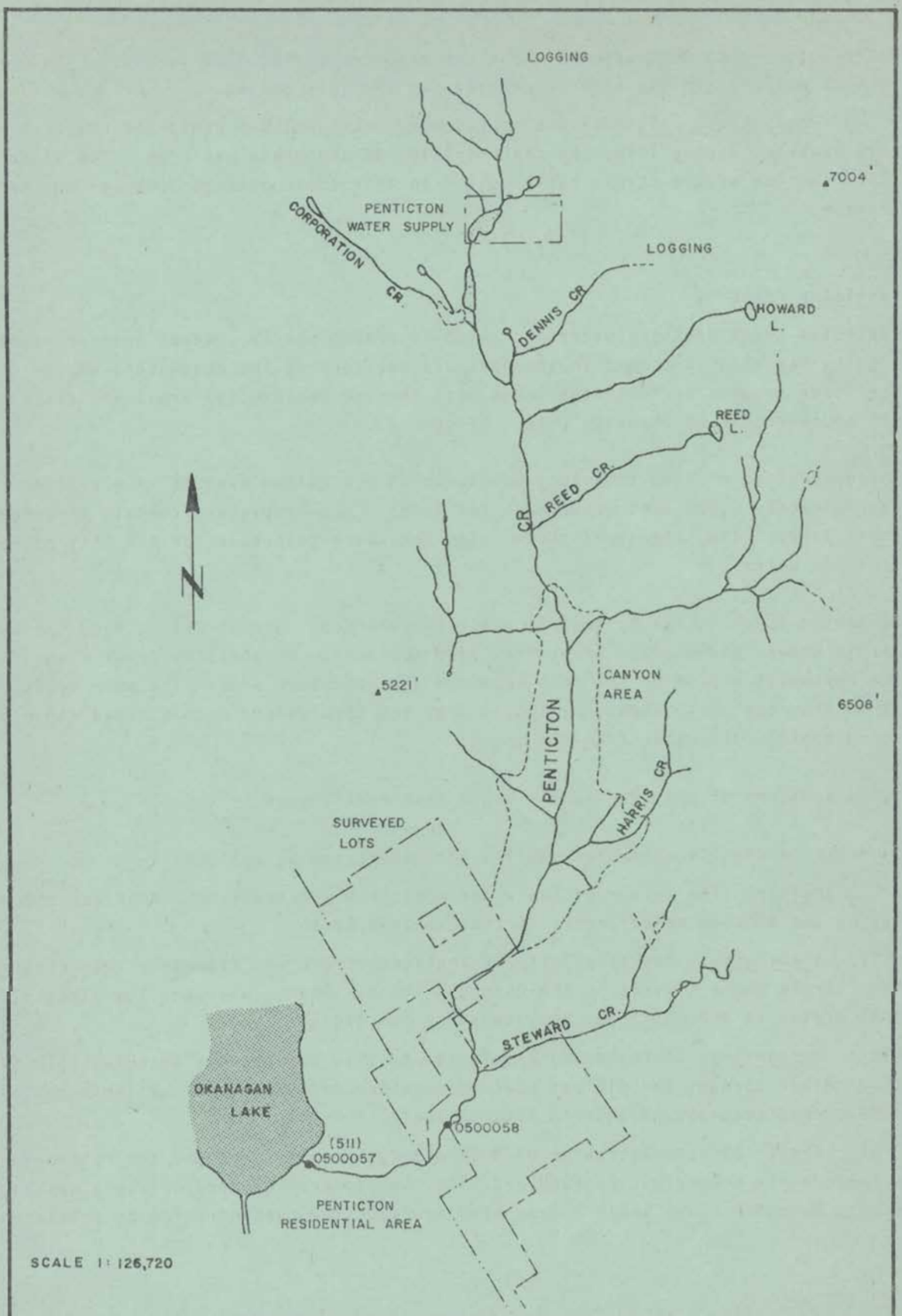
(ii) Alkalinity: The alkalinity of Penticton Creek was extremely low relative to the fifteen major streams in the Okanagan Basin. On the average, the alkalinity of this stream at the mouth was the lowest in the basin.

(iii) Manganese: Concentrations detected in this stream were exceeded only by three other streams and did not meet recommended drinking water criteria and in 1969 exceed recommended aquatic life criteria.

(iv) Iron: The concentration of this metal generally exceeded the recommended water quality criteria. In 1969 and 1970, the general desired criteria was exceeded. No other river basin had as high overall iron concentration as Penticton Crk.

(e) Trout Creek

Trout Creek is one of the fifteen major tributaries to the Okanagan Basin. The water basin itself is composed of a number of sub-basins drained by minor tributaries.



PENTICTON CREEK WATERSHED Figure 13.4

These minor tributaries generally flow in a northeast and southwest direction with the exception of Darke Creek, the largest tributary in the basin, which flows in a southeast direction parallel to the main trunk. The main trunk of Trout Creek flows through a steep valley which discontinues and is replaced by a hilly area forming the Summerland District Municipality. (Figure 13.5).

The mouth of Trout Creek is located on the west bank of the Okanagan Lake near the southern end.

The waterbasin is well wooded and only the southern section of the basin is developed. The development takes the form of unimproved pasture, orchards and vineyards as well as a residential area.

A "perpetual" slide area is located approximately three miles upstream of the mouth. This area is known to affect the water quality to some degree.

Comments on significant water quality parameters are as follows:

(i) Turbidity: The average turbidity during 1969, 1970 and 1971 was the highest in the basin exceeding both the recommended drinking and aquatic life standards. No other stream in 1969 and 1970 had as high magnitudes of turbidity as did Trout Creek. However, in 1971 three creeks in the Okanagan Basin exceeded the value of 23.0 J.T.U. measured in Trout Creek.

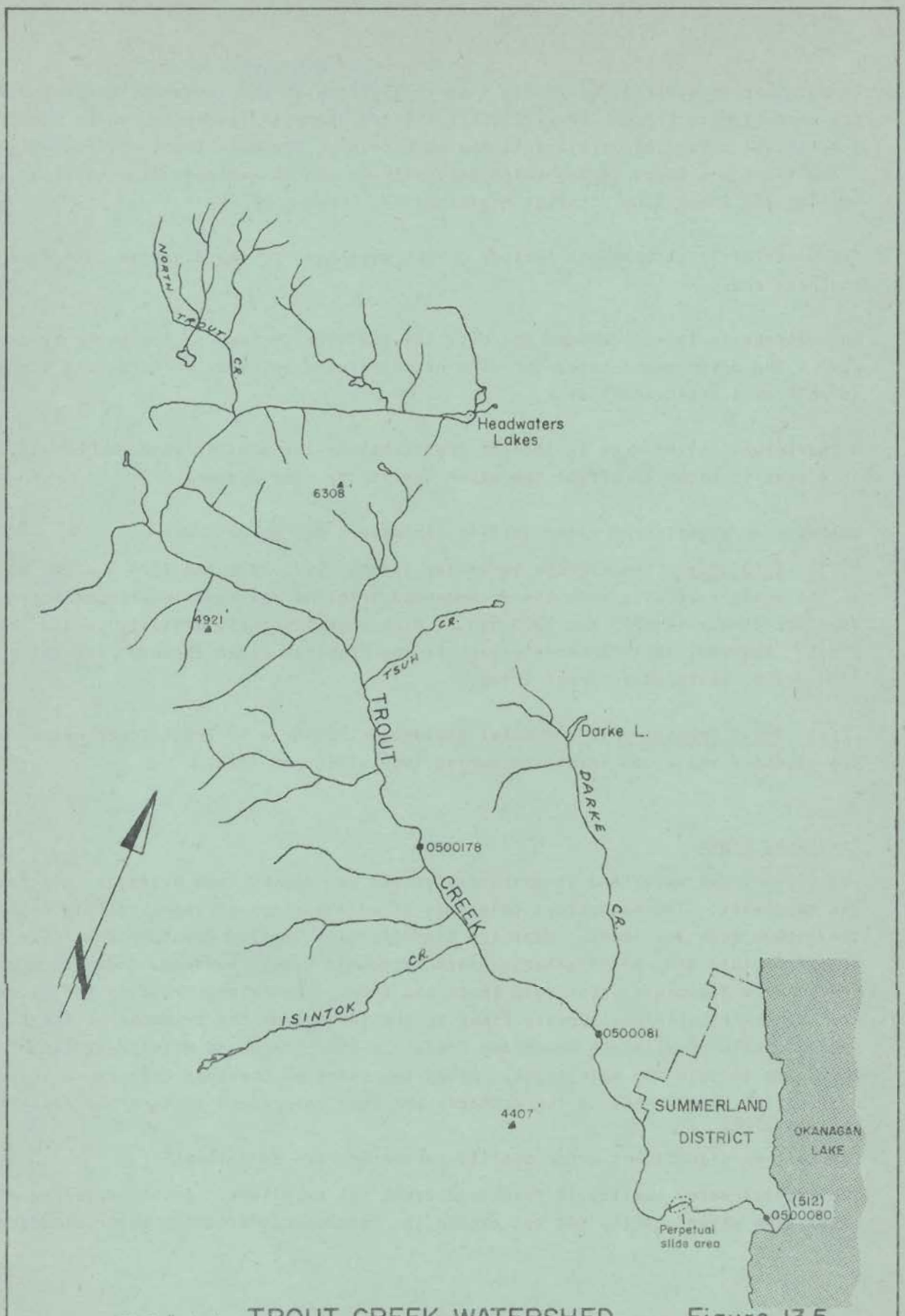
(ii) Total Phosphorus: The total phosphorus measured in Trout Creek was above the expected value and increased during 1969, 1970 and 1971.

(f) Peachland Creek

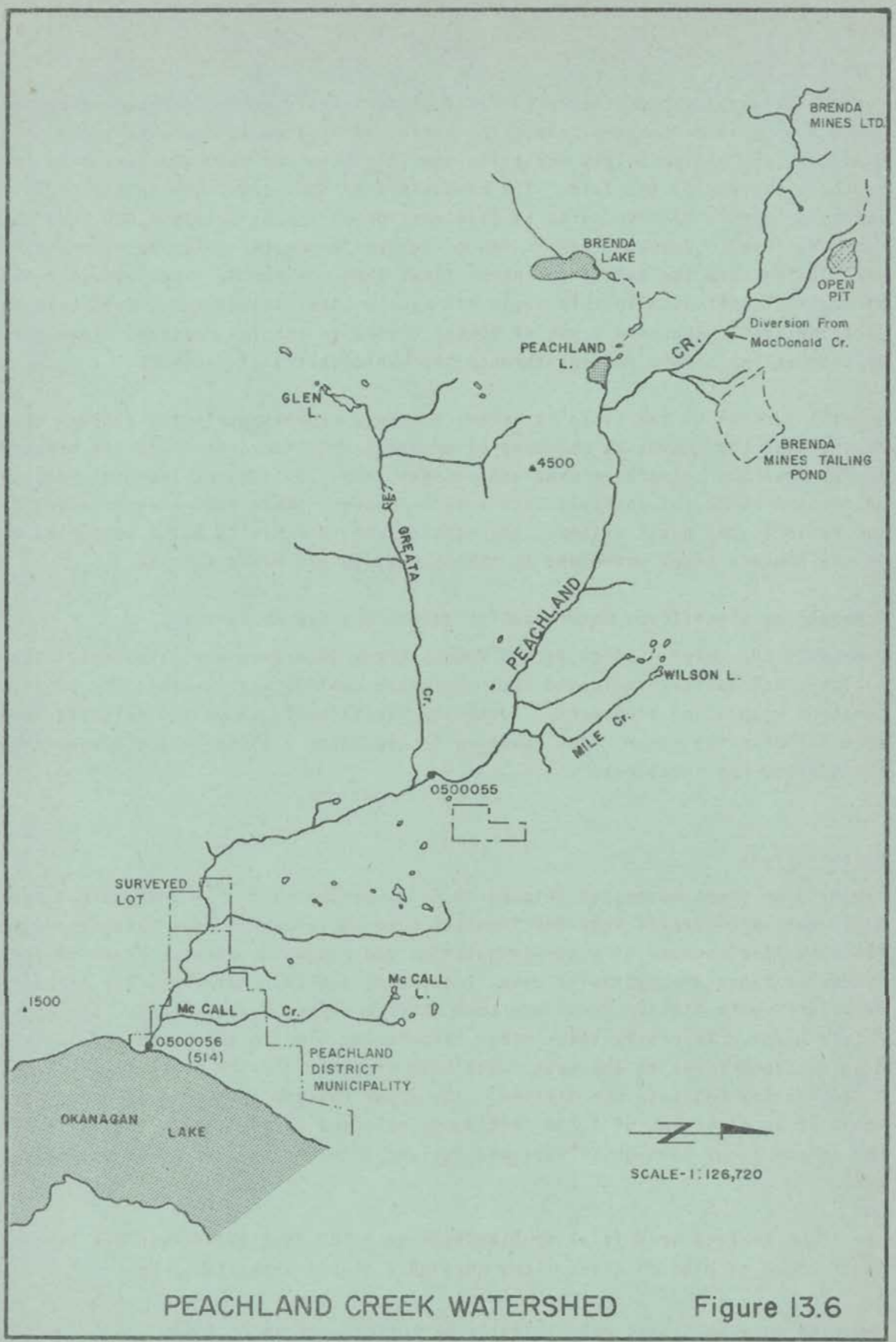
Peachland Creek watershed is primarily wooded and drains into Okanagan Lake from the northwest. The headwaters originate at an elevation of approximately 4,500 feet above mean sea level. Near the headwaters is located Brenda Mines. The tailings from this mine are discharged into MacDonald Creek; however, there is a diversion from MacDonald Creek into Peachland Creek. Peachland Creek is fed by several minor tributaries. Greata Creek is the largest of the tributaries and flows approximately parallel to Peachland Creek. McCall Creek and Mile Creek flow from the north to join the main trunk. Along the shore of Okanagan Lake there is some residential development, a few orchards and some unimproved pasture and rangeland. (Figure 13.6)

Comments on significant water quality parameters are as follows:

The overall water quality in Peachland Creek was excellent. In the majority of cases, the water quality did not exceed the recommended drinking water standards.



TROUT CREEK WATERSHED Figure 13.5



PEACHLAND CREEK WATERSHED Figure 13.6

(g) Powers Creek

Powers Creek watershed (Figure 13.7) is predominantly an undisturbed watershed which drains into Okanagan Lake. The basin was located on the west shore of the Okanagan Lake approximately one-third the length on the Okanagan Lake from the southern extreme of the lake. The headwaters of this tributary originate in a swampy or marshy highland area at an elevation of approximately 4,800 feet above mean sea level. Powers Creek is fed by several headwater lakes by minor tributaries flowing into the main trunk which flows from the north. The headwater lakes of major significance in this basin are Lambly Lake, Islaht Lake, West Lake and Jackpine Lake. The main trunk of Powers Creek, in the low reaches, flows through a steep valley before passing through the municipality of Westbank.

A small portion of the basin is urban; however, approximately six percent of the basin, near the mouth, is composed of orchards and vineyards while six percent is in improved and unimproved crop and pasture land. Outside of the municipality of Westbank a number of surveyed lots exist; however, these lots do not extend into the basin to any great extent. The most extensive activity being conducted within the Power's Creek watershed is cattle grazing and mixed farming.

Comments on significant water quality parameters are as follows:

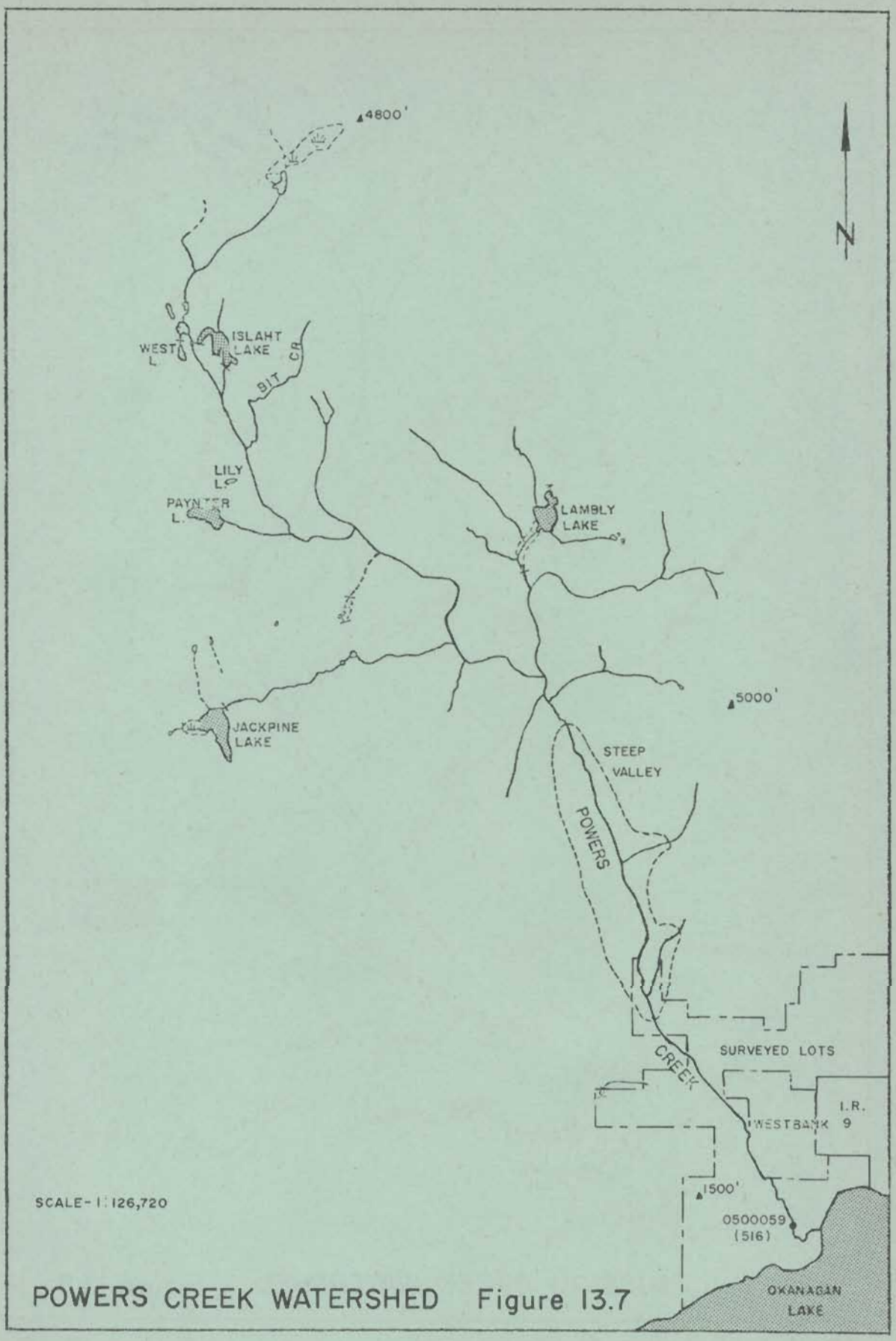
Generally the water quality in the Powers Creek watershed was excellent. The major pollution parameters indicated that the water quality was suitable for public consumption with minor treatment. Turbidity was slightly above the criteria acceptable for drinking water. But relative to the water quality in the Okanagan Basin, the quality was excellent.

(h) Mission Creek

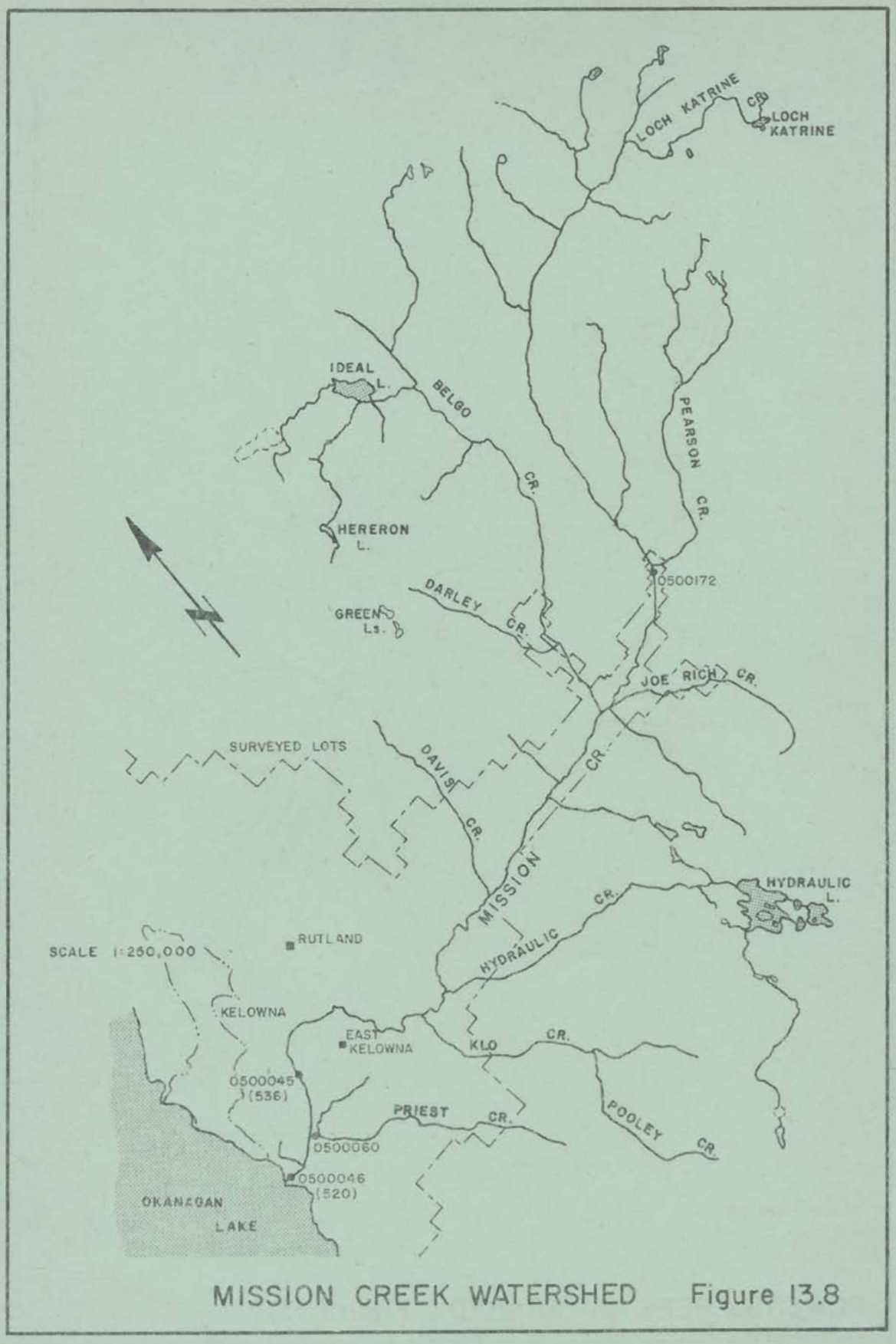
The Mission Creek watershed (Figure 13.8) is predominantly an undisturbed forested watershed which drains into the Okanagan Lake at Kelowna. This extensive river is fed by a large number of minor tributaries and headwater lakes. Three of the major headwater lakes are Hydraulic Lake, Ideal Lake and Loch Katrine. The tributaries associated with Mission Creek are Loch Katrine Creek, Pearson Creek, Klo Creek and Priest Creek. Generally these minor tributaries flow to the south and north while Mission Creek flows to the west. The main trunk of Mission Creek flows through a deep valley cut into the plateau. The upper reaches originate in upper marshlands at an elevation of 5,200 feet above mean sea level. Below the valley area, the stream flows through Kelowna and Rutland situated on part of an extensive delta area.

The lower terrace area is at an elevation of 1,500 feet above mean sea level. The lower reach of Mission Creek flows through a highly urbanized area.

Comments on significant water quality parameters are as follows:



POWERS CREEK WATERSHED Figure 13.7



MISSION CREEK WATERSHED Figure 13.8

(i) Alkalinity: Above average values of alkalinity have been recorded for 1969 and 1970. Alkalinity decreased in 1971 to 100 mg/l as $CaCO_3$.

(ii) Total Phosphorus: The phosphorus value was also high as could be expected from the highly urbanized area.

Generally, however, the water quality in the Mission Creek watershed was above average in respect to the water quality within the Okanagan Basin.

(i) Kelowna Creek

A large portion of Kelowna Creek is urban, orchards, vineyards, pasture and cropland. This particular creek, as a result of its highly urbanized watershed, has been chosen for further indepth study. Kelowna Creek is a relatively minor tributary to the Okanagan mainstream system; however, the creek flows through a heavily populated region near the mouth. (Figure 13.9)

The headwaters of this tributary originate in a swampy or marshy highland area at an elevation of approximately 4,500 feet above mean sea level. The major headwater lakes feeding Kelowna Creek are Postill Lake, South Lake, Hereron Lake, Green Lake and James Lake. The minor tributaries flowing into Kelowna Creek are Bulman Creek, Conroy Creek, and Scotty Creek.

The major portion of Kelowna Creek flows through Kelowna with the extreme reaches in forested area. The central sections of Kelowna Creek flow through steep valleys although not as steep as the valleys cut by more southerly tributaries within the Okanagan Basin. This river basin has been chosen for further indepth studies and land use effects on water quality will be discussed in greater detail in this study.

Comments on significant water quality parameters are as follows:

(i) Colour: The high level of this particular parameter exceeded the level generally found within the basin. Although drinking water criteria were exceeded, generally the suggested aquatic life standard is not exceeded.

(ii) Total Alkalinity: Only two other streams within the Okanagan Valley consistently exceed the alkalinity found in this stream.

(iii) Total Phosphorus: The effect of the high urban population within the Okanagan Valley was reflected in the high phosphorus levels measured in Kelowna Creek.

The water quality found within the Kelowna Basin has deteriorated as a result of urbanization and is generally of poorer quality than found in the majority of creeks in the Okanagan.

(j) Brandt's Creek

Brandt's Creek, a minor drainage basin in the Okanagan Valley, drains into the northern section of Okanagan Lake. The source of Brandt's Creek is Robert's Lake

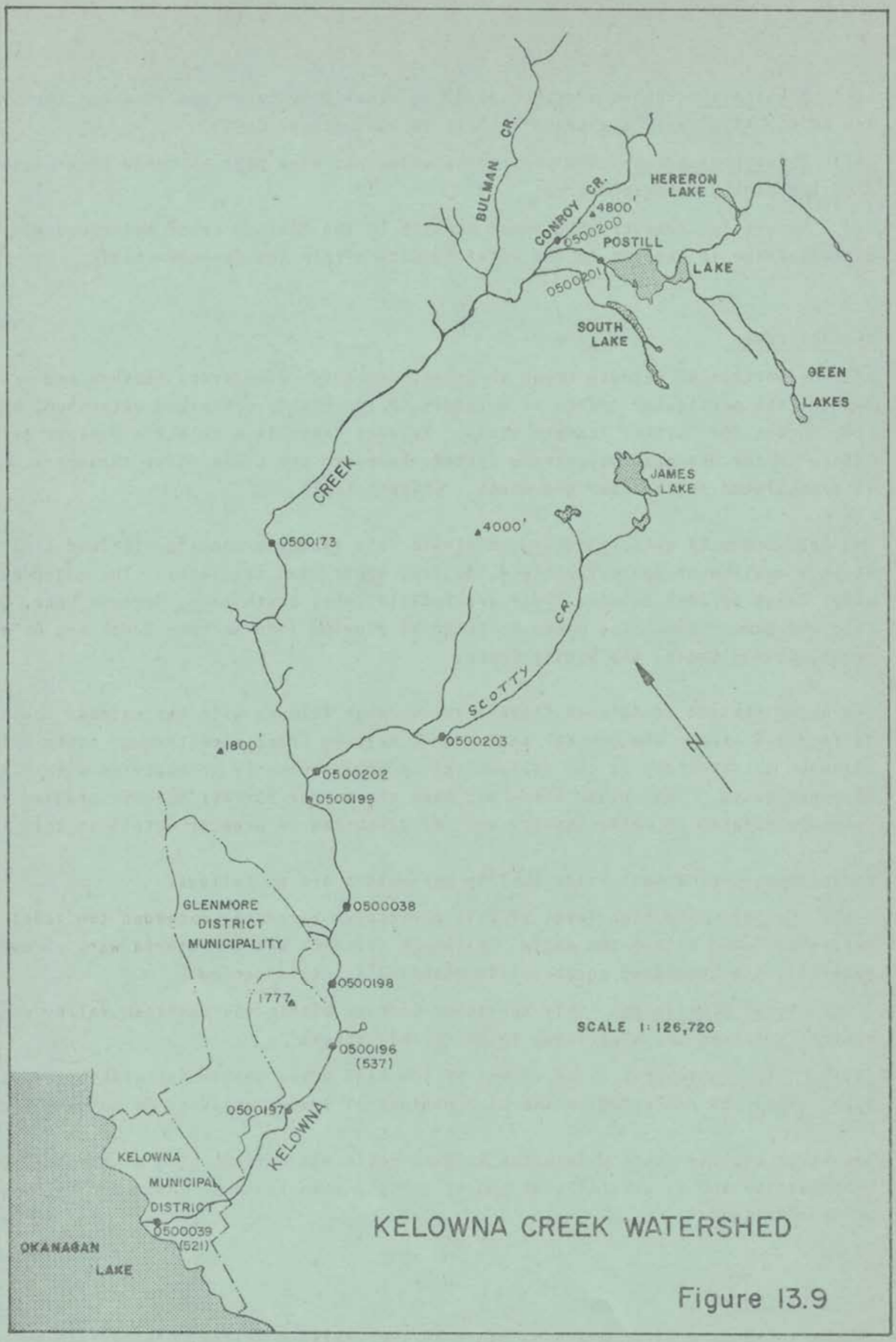

BULMAN CR.
CONROY CR.
HERERON LAKE
4800'
0500200
POSTILL
LAKE
0500201
SOUTH LAKE
GEEN LAKES
JAMES LAKE
CREEK
4000'
0500173
SCOTTY CR.
0500203
1800'
0500202
0500199
GLENMORE DISTRICT MUNICIPALITY
0500038
0500198
1777'
SCALE 1:126,720
0500196
(537)
0500197
KELOWNA
KELOWNA MUNICIPAL DISTRICT
0500039
(521)
OKANAGAN LAKE
KELOWNA CREEK WATERSHED

Figure 13.9

just outside the limits of the municipality of Kelowna. The major portion of the drainage area is pasture and cropland. The change in elevation of Brandt's Creek to the mouth is approximately three hundred feet. The drainage area of Brandt's Creek is the smallest of the fifteen creeks examined. (Figure 13.10).

Comments on the significant water quality parameters are as follows:

(i) Turbidity: The high value of turbidity of Brandt's Creek was expected for such a highly urbanized area.

(ii) Alkalinity: This parameter was also relatively high compared to the water quality monitored at the majority of creeks sampled in the Okanagan Valley.

(iii) Manganese: The manganese concentration in this creek was the highest measured in the major fifteen creeks in the Okanagan.

(iv) Iron: Only two of the major fifteen creeks monitored have concentrations of iron higher than that monitored in Brandt's Creek.

(v) Total Phosphorus: Only one other creek in the overall water basin had as high concentrations of phosphorus.

The water quality in Brandt's Creek was consistently of low quality. The high level of agriculture residential and industrial use of land has resulted in the deterioration of water quality.

(k) Lambly Creek

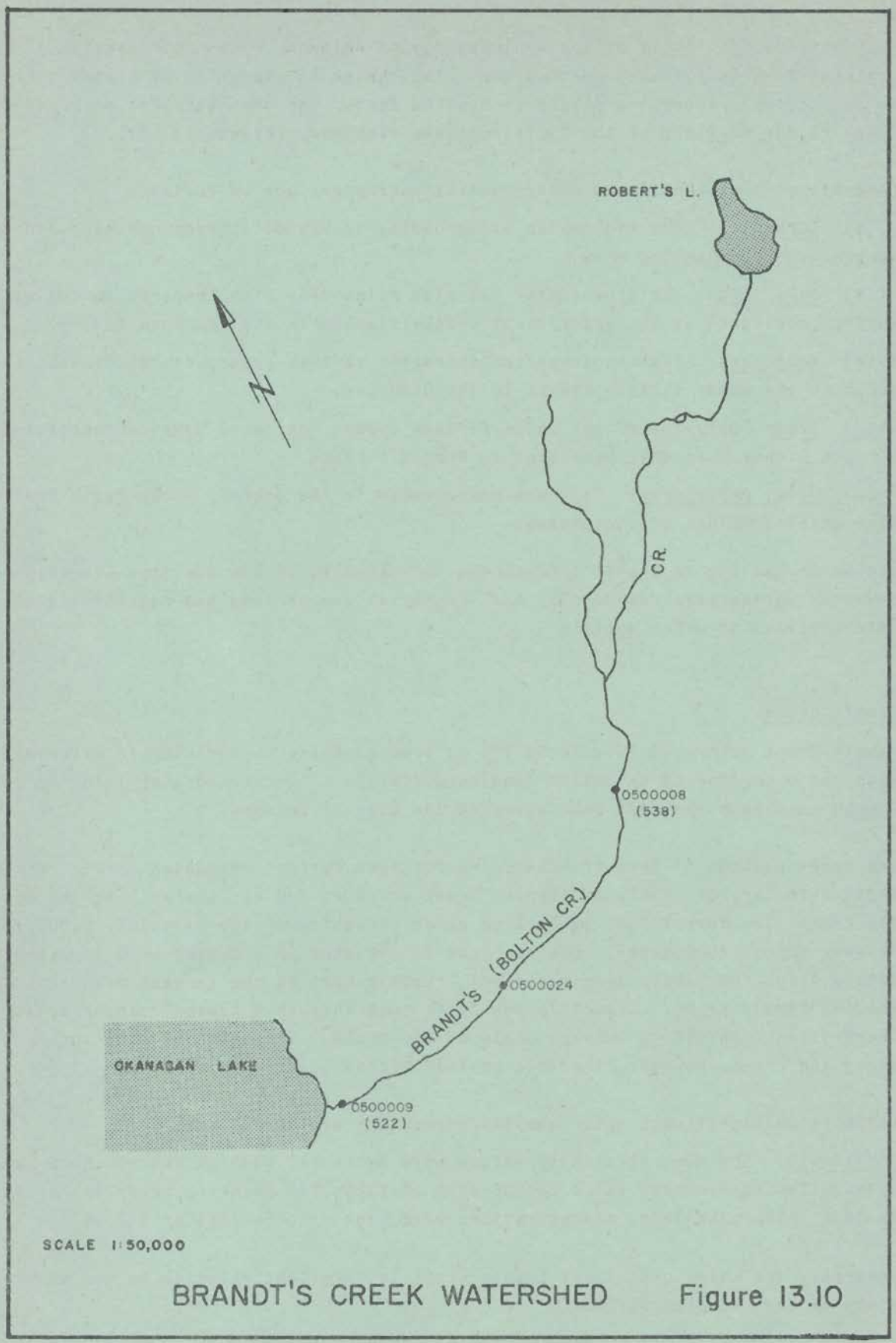
Lambly Creek watershed (Figure 13.11) is predominantly an undisturbed watershed, with the exception of extensive logging activity. The basin drains into the Okanagan Lake from the west bank opposite the City of Kelowna.

The upper reaches of this tributary are fed from several headwater lakes. A majority tributary of Lambly is Terrace Creek which is fed by Esperan Lake and Duo Via Lake. The former lake is located at an elevation of approximately 5,000 feet in very rugged topography. Duo Via Lake is situated in a marshy area at approximately 4,500 feet above mean sea level. Lambly Lake is the largest headwater lake feeding Lambly Creek. Generally the creek runs through a typical canyon area. There is no significant outwash plain at the mouth. There are several surveyed lots along the creek, however, there is no significant population.

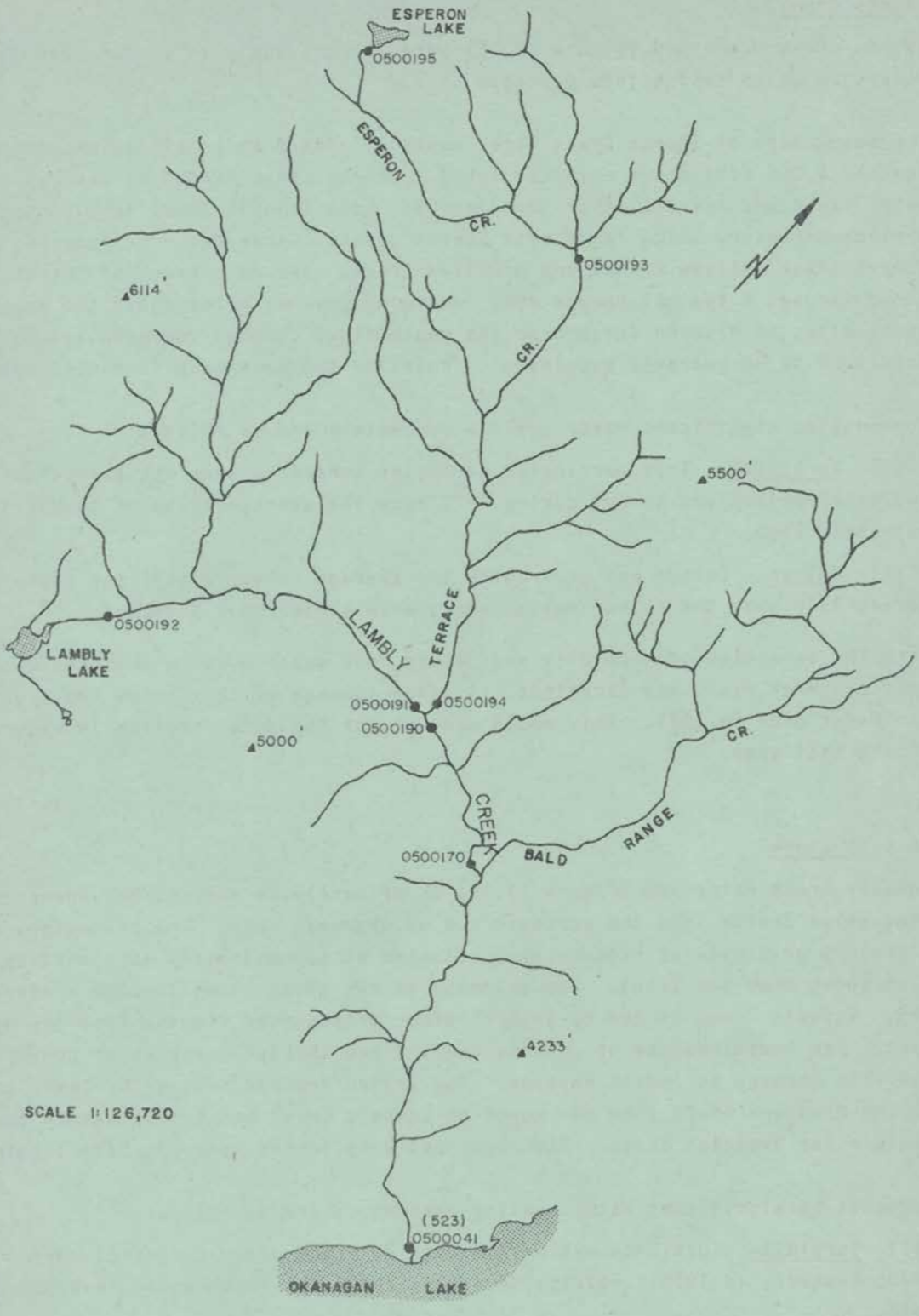
Comments on significant water quality parameters are as follows:

Alkalinity: The mean alkalinity values were extremely high at the mouth of Lambly Creek. The recommended value of 500 mb/l as $CaCO_3$ for drinking water was exceeded in 1970. The alkalinity concentrations were high also in 1971 at 418 mg/l.

Generally the water quality of Lambly Creek is excellent relative to the water quality of the Okanagan Streams.



BRANDT'S CREEK WATERSHED Figure 13.10



LAMBLY CREEK WATERSHED Figure 13.11

(l) Shorts Creek

Shorts Creek watershed (Figure 13.12) were predominantly an undisturbed forested watershed which drains into Okanagan Lake.

The headwaters of Shorts Creek water basin originate at an elevation of approximately 5,000 feet above mean sea level. Shorts Creek is fed by several headwater lakes and several minor tributaries. Loch Drinkie flows into Dunwater Creek, a minor tributary which intersects Shorts Creek. Other minor tributaries are Stuart Creek, Wilson Creek, and McMullen Creek. The main trunk of Shorts Creek flows through a typical canyon area emerging several miles above the mouth. Several miles of Mission Creek near the mouth flows through surveyed lots. These lots tend to be sparsely populated. Generally the watershed is undisturbed.

Comments on significant water quality parameters are as follows:

(i) Turbidity: This particular parameter generally does not exceed the drinking water objectives except during 1970 when the average value of turbidity was extremely high.

(ii) Colour: Colour was well below the average colour within the basin except during 1970 when the colour measurements were higher than expected.

With the exception of turbidity and colour, the water quality measured within the Mission Creek Basin was excellent. A large acreage of the Shorts Creek water basin was burnt over in 1971. This would account for the deterioration in water quality during that year.

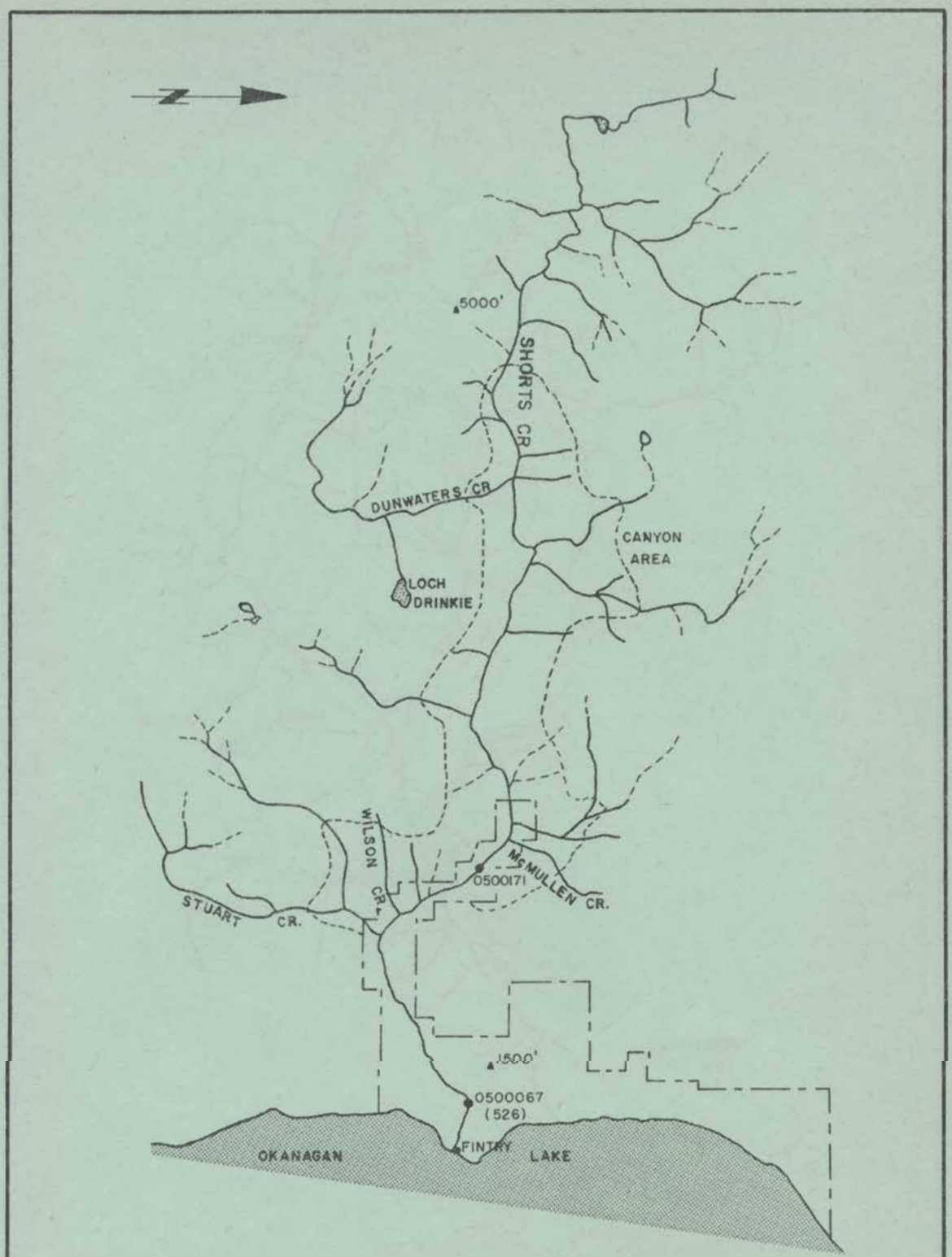
(m) Equesis Creek

Equesis Creek watershed (Figure 13.13) is primarily an undisturbed forested watershed which drains into the northern end of Okanagan Lake. The headwaters of this tributary originate at Pinaus Lake, situated at approximately an elevation of 3,200 feet above mean sea level. The majority of the river flows through a steep valley. Equesis Creek is fed by several minor tributaries flowing from the east and west. The lower reaches of Equesis Creek flows through a series of surveyed lots and then through an Indian Reserve. The Indian Reserve covers the lower section of the drainage basin from the mouth of Equesis Creek and approximately four miles up into the drainage basin. The major activity in the area has been logging.

Comments on significant water quality parameters are as follows:

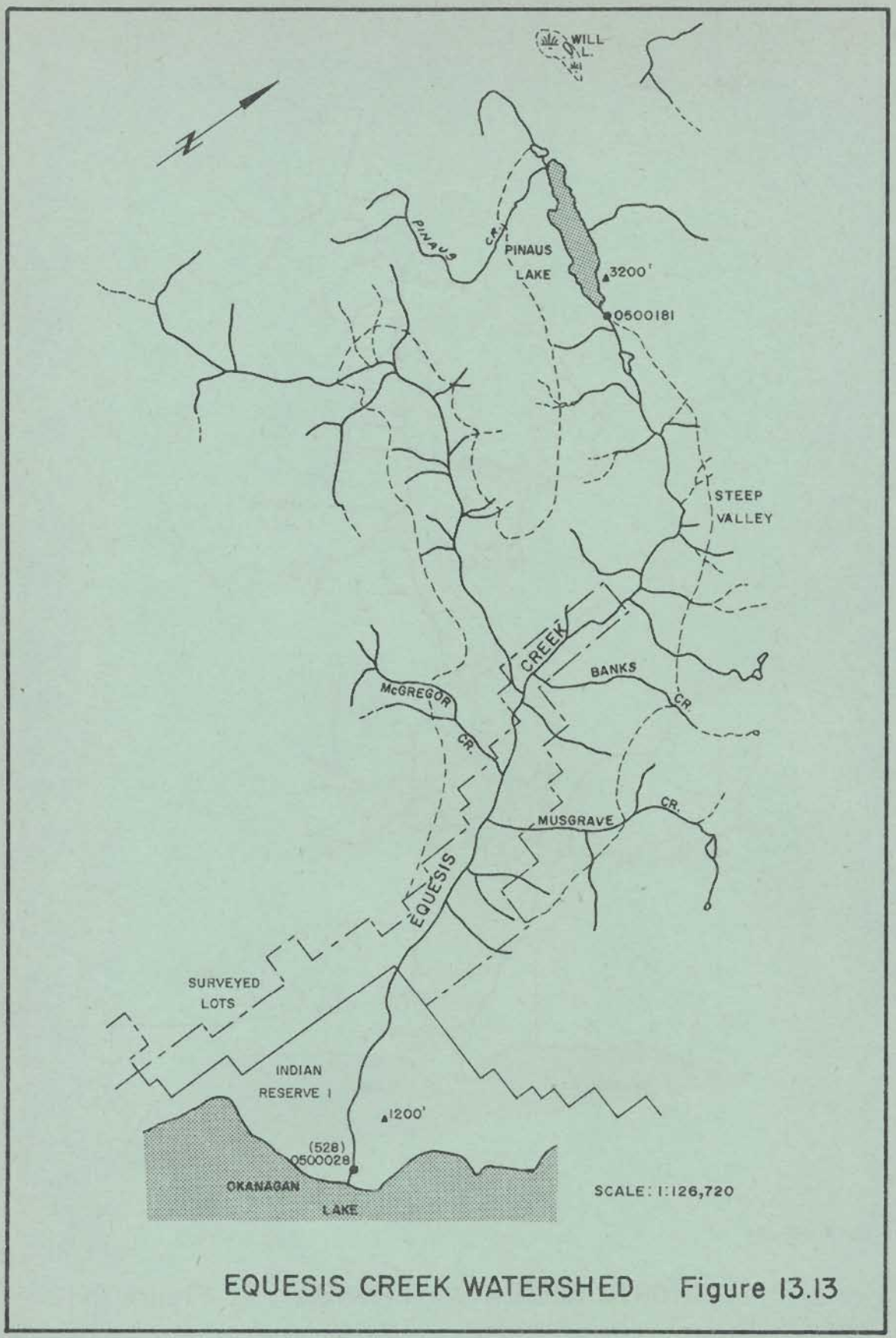
(i) Turbidity: Turbidity was well within drinking water standards during 1969 and 1970; however, in 1970 turbidity increased above the recommended level for aquatic life.

(ii) Alkalinity: Alkalinity levels were high relative to alkalinity measured in the overall study.



SCALE 1:126,720

SHORTS CREEK WATERSHED Figure 13.12



EQUESIS CREEK WATERSHED Figure 13.13

The water quality within the Equesis Creek water basin was relatively of good quality. The quality of water was generally what would be expected considering the limited land use within the basin.

(n) Deep Creek

Deep Creek watershed (Figure 13.14) is not typical of the majority of water basins within the Okanagan Valley. The valley through which Deep Creek runs is broad and flat. The valley is extensively farmed, being either crop or pasture land. Deep Creek itself discharges into the northerly end of Okanagan Lake. The minor tributaries which feed Deep Creek are located in the lower reaches of the creek. The minor tributaries - Meighan Creek, Maid Creek and Hutley Creek, flow from the east. Deep Creek flows through Armstrong, the Spallumcheen District Municipality and an Indian Reserve. Over fifty percent of the basin is croplands and pastures. The agricultural activities and the urban population can be expected to strongly influence the water quality of Deep Creek.

Comments on significant water quality parameters are as follows:

(i) Colour: The colour of the water quality of Deep Creek was higher than the average colour within the basin. In 1969, 1970 and 1971 the recommended criteria for drinking water quality were exceeded.

(ii) Alkalinity: Alkalinity at the mouth was generally higher than expected within the Okanagan Valley. Only two other creeks had as high an alkalinity.

(iii) Manganese: Manganese concentrations were consistently high during 1969, 1970 and 1971. Only Brandt's Creek had as high concentrations within the Okanagan Valley of the major fifteen creeks examined.

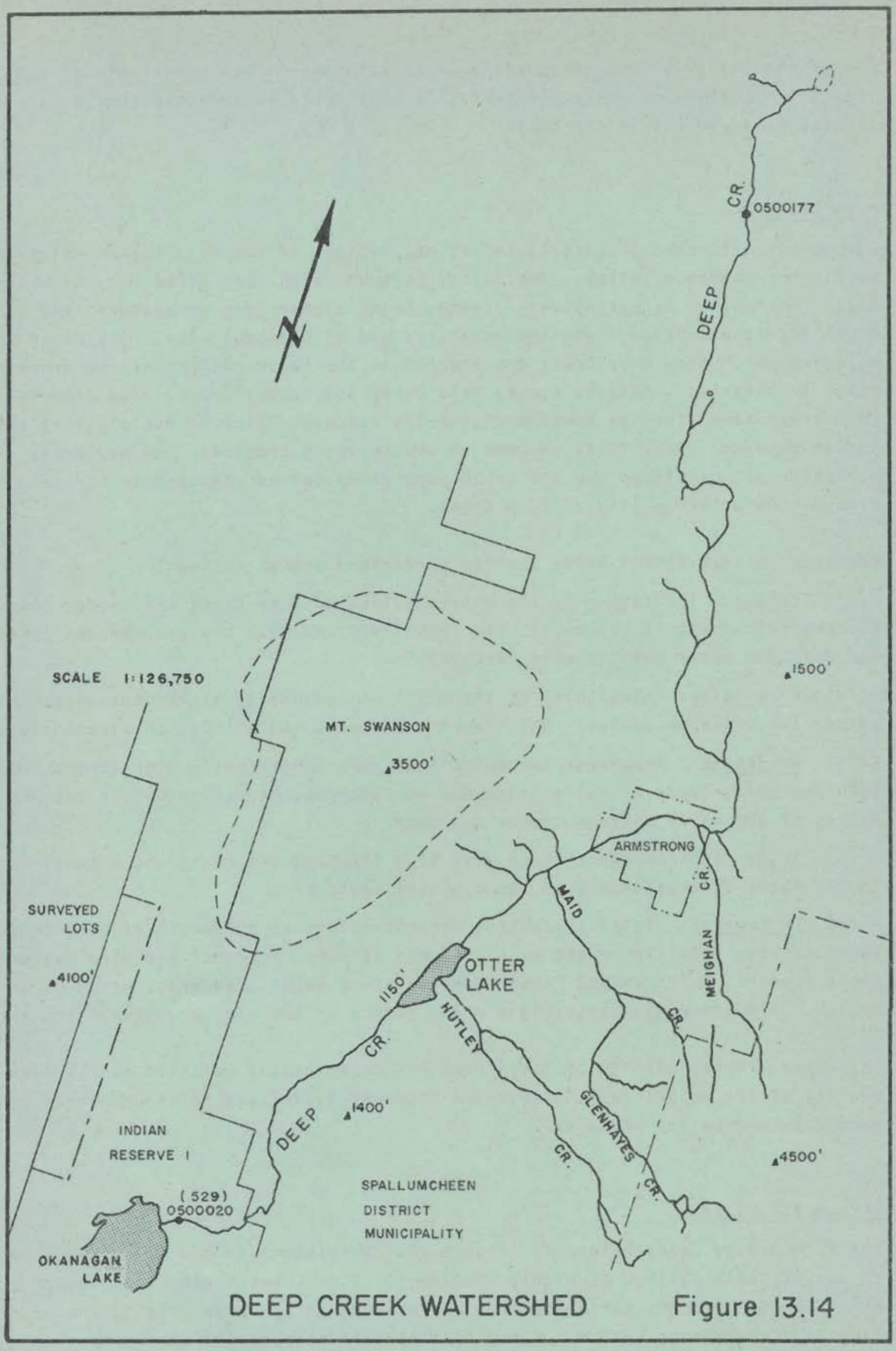
(iv) Iron: Iron concentrations were high although not among the highest relative to the major fifteen creeks in the drainage basin.

(v) Phosphorus: Total phosphorus concentrations at the mouth of Deep Creek were above average relative to the major fifteen streams, however, the high concentrations present, which exceed recommended drinking water standards, were not unexpected. Armstrong was certainly a major source of the high phosphorus concentration.

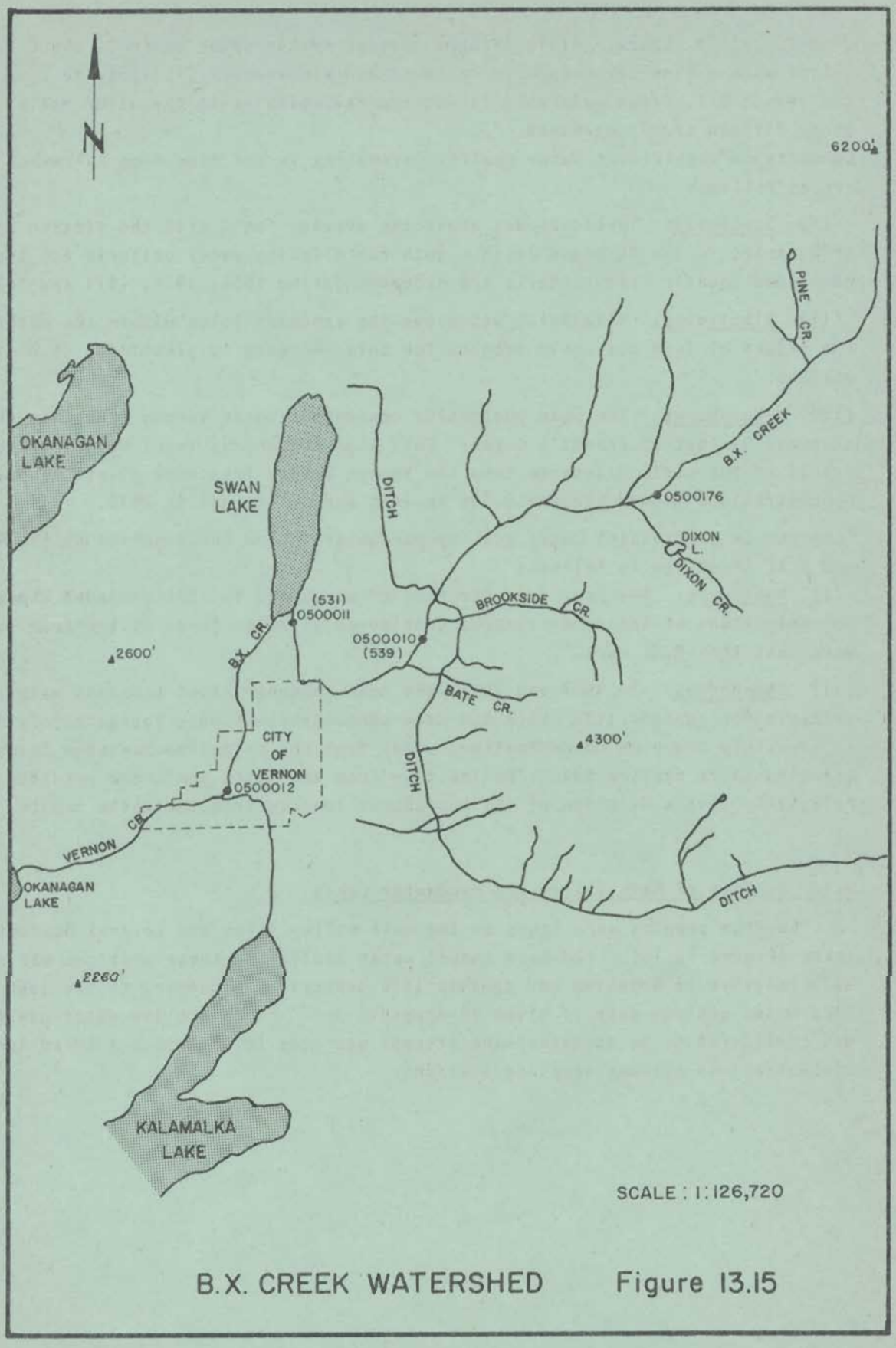
The general water quality of Deep Creek has deteriorated relative to the overall quality of the major creeks within the Okanagan Basin, and relative to the recommended water quality criteria.

(o) Vernon-B.X. Creek

The Vernon-B.X. Creek watershed (Figure 13.15) relative to the major water basins in the Okanagan Valley, is highly developed. B.X. Creek drains into Vernon Creek which drains into the northeast area of Okanagan Lake. Swan Lake is the major lake in the drainage system. A few of the minor tributaries of any significance are Pine Creek, Dixon Creek, Brookside Creek and Bate Creek. Several ditches also



DEEP CREEK WATERSHED Figure 13.14



B.X. CREEK WATERSHED Figure 13.15

drain into B.X. Creek. A significant portion of the water basin is under cultivation with a high percentage in orchards and vineyards. Similarly to Deep Creek, the Vernon-B.X. Creek watershed is not typical relative to the water basins of the major fifteen creeks examined.

Comments on significant water quality parameters in the flow from Kalamalka Lake are as follows:

(i) Turbidity: Turbidity was above the average found with the fifteen major tributaries in the Okanagan Basin. Both the drinking water criteria and the recommended aquatic life criteria are exceeded during 1969, 1970, 1971 and 1972.

(ii) Alkalinity; Alkalinity was above the expected value within the water basin. The effect of land use could account for this increase in alkalinity (i.e. irrigation).

(iii) Phosphorus: The mean phosphorus concentration in Vernon Creek was only exceeded by that of Brandt's Creek. This high phosphorus level was expected as a result of the waste discharge from the Vernon sewage treatment plant. The mean concentrations ranged between 0.356 in 1972 and 0.712 mg/l in 1970.

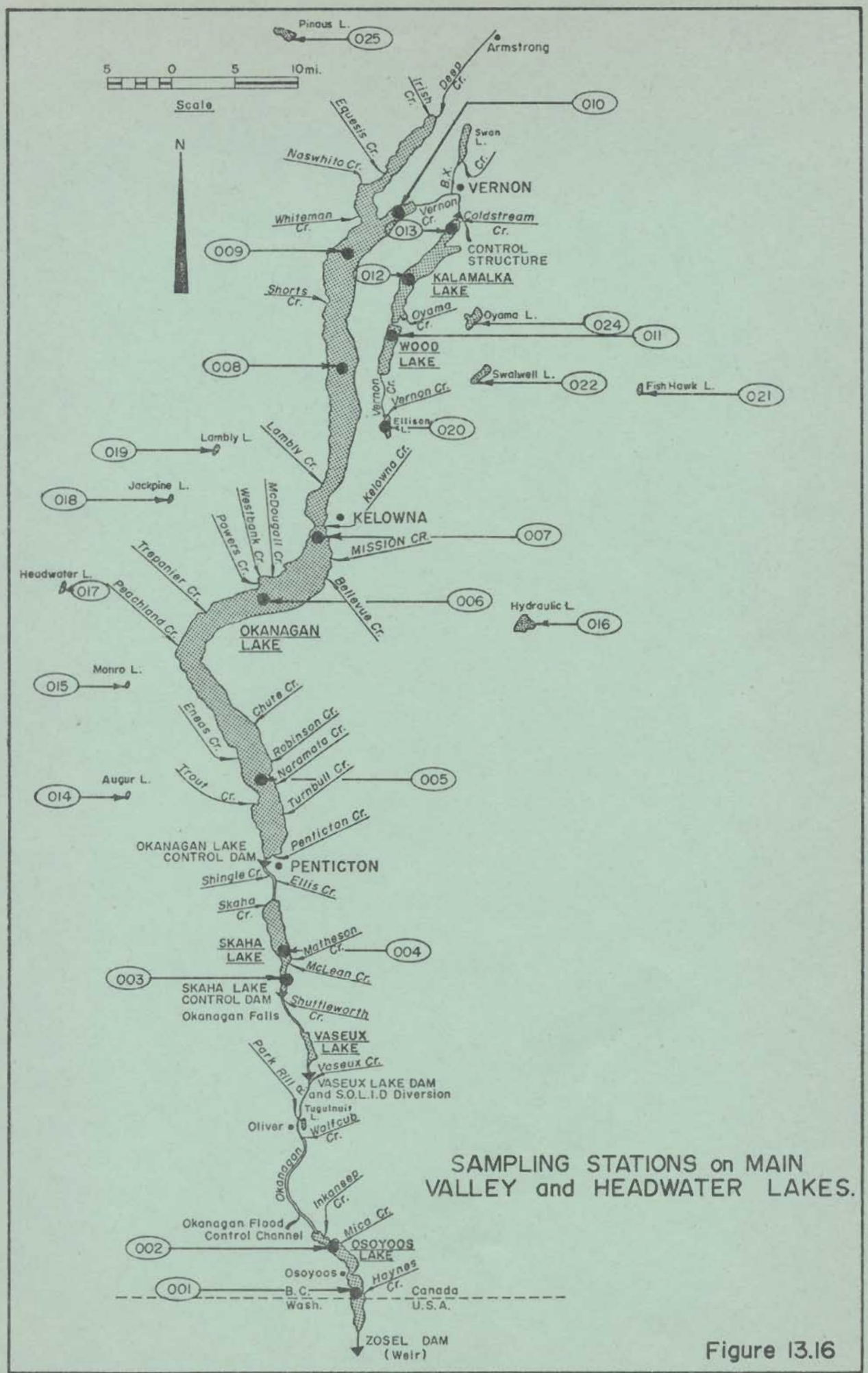
Comments on significant water quality parameters below the junction of the ditch and B.X. Creek are as follows:

(i) Manganese: The mean concentration of manganese in 1971 exceeded those mean concentrations of the other streams considered although three of the four samples were less than 0.01 mg/l.

(ii) Phosphorus: In 1971 and 1972, the mean concentrations exceeded water quality criteria for aquatic life since the mean concentrations were approximately 0.1 mg/l. Possibly the high concentrations comes from the extensive drainage ditch discharging above station 539. The low flow from the ditch and creek resulted in relatively little dilution of the phosphorus loading from the waste inputs.

13.2 Water Quality of Main Valley and Headwater Lakes

Surface samples were taken on the main valley lakes and several headwater lakes (Figure 13.16). The mean annual water quality at these stations was acceptable relative to drinking and aquatic life criteria. A summary of the lake surface water quality data is given in Appendix I. Since the water quality was considered to be acceptable no attempt was made to establish a trend in the concentrations between sampling stations.



SAMPLING STATIONS on MAIN VALLEY and HEADWATER LAKES.

Figure 13.16

CHAPTER 14

The Effect of Land Use on Water Quality in the Tributaries

14.1 LITERATURE REVIEW

14.1.1 The Effect of Forest-Related Land Use on Water Quality

The effects of forests on water quality of streams are a function of the type of soil and related soil mechanisms. The soil is a large contributor of elements to runoff; how that soil is controlled is a function of vegetative cover.

(a) Undisturbed Forests

In forested areas of steep or rolling topography, a large part of the runoff flow is through the permeable soil layers near the surface, not on the surface itself.

The most chemically-active components of a forest soil are the clay and organic colloids. Soil colloids exchange ions in solution for those adsorbed on a solid. Clays have high exchange capacities compared with most other minerals, because of their large surface area per unit volume and because of their negative electrical charge.

Carbon dioxide, produced mainly in the metabolism of micro-organisms and plant roots in the soil, results in the formation of hydrogen ions and bicarbonate ions in the soil water. Cations adsorbed on soil colloids are selectively exchanged for the hydrogen ions from the soil water and made available for mass transfer and leaching to streams. Because the metabolic production of carbon dioxide in the soil is the rate-limiting step, only water remaining for some time in the soil is likely to be effective in leaching mineral ions.

Various studies indicate that in forested areas nutrient concentrations are lower at times of high flow than at low flow (68, 69) reflecting the lower retention time. Another study, however, reported nutrient concentrations which were constant even though the stream flow varied considerably from high runoff to drought periods (20).

Thin films of water moving through unsaturated soil make a major contribution to base flows of streams during dry periods. These active films are in close contact with soil particles for long periods and hence may contribute nutrients.

Streams from forested areas generally have lower nutrient concentrations than from other land use areas, although often near the concentrations reported in eutrophic lakes. Some average values reported for concentrations in forest streams of nitrates are 0.1 to 0.2 mg/l, total kjeldahl nitrogen 0.07 to 0.08 mg/l, total nit-

rogen 0.2 to 0.3 mg/l, soluble phosphorus 4 to 9 ppb, and total phosphorus 0.02 to 0.1 ppm (70). Total discharge was reported as 0.3 to 0.8 lbs/acre/year of total phosphorus and 1.3 to 3.0 lbs/acre/year of total nitrogen.

(i) Nitrogen

The relative mobility of nitrogen in soils is related to the high solubility of the forms in which it is available to plants (ammonium and nitrate ions) and to the weak charge on the nitrate ion (the predominant form in oxidizing conditions). The positively charged NH_4 + ion is susceptible to retention by cation exchange, and is somewhat less mobile in soils. On the other hand, the oxidized and negatively charged NO_3- ion lacks strong affinity for other soil constituents, and is rapidly transported by moving water unless arrested by soil organisms.

In an undisturbed forest ecosystem there is a seasonal cycle of concentration of nitrate in stream water. High concentrations are associated with the winter period from November to April, while low concentrations persist from April through November.

The decline in May and low concentration through summer correlate with heavy nutrient demands by the vegetation and increased heterotrophic activity associated with warming of the soil.

Associated with high levels of nitrate ion in the soil solution is a corresponding concentration of cations and ready leaching. A decrease in the concentration of sulphate ion may be apparent as well.

(ii) Phosphorus

The mechanism of phosphorus fixation in soil includes the following process:

(1) adsorption;
(2) replacement reactions which may involve changes in mineral crystalline structure;
(3) precipitation reactions through which the soluble phosphates react with iron, aluminum or calcium to form insoluble compounds;
(4) uptake by soil-inhabiting organisms.

Phosphorus is often combined inorganically with iron and aluminum in acid soils, and with calcium in alkaline soils. Phosphorus is typically low in drainage from forest ecosystems. Dissolved phosphorus may be removed by aquatic plants and animals to such an extent that it is undetectable in inorganic solution at a downstream point (68).

(b) Forest Disturbances

Forest harvesting, fires, natural land movements, road construction, canal construction, and applications of chemicals can all have profound effects on water quality in streams.

Clear-cutting of forest areas causes accelerated nutrient loss to streams. Cutting can have great effects on runoff by increasing intensity of spring melt and storm runoff, thereby yielding heavier flows through the summer. The loss of deep root systems permits lower retention of soil moisture over the drier months, resulting in augmentation of summer flows.

Nitrate increases after forest cutting as a result of nitrification in the cutover ecosystem. As nitrate increases, so do the cations, Ca^{++}, Mg^{++}, Na^{++}, K^{+}. After a period of a month in the summer the concentration of nitrate returns to the level for undisturbed forest. Cation concentration remains high. Re-growth of vegetation is usually sufficient to prevent drastic losses of nutrients after logging.

Normal logging methods which greatly disturb soils cause increases in stream turbidity nutrient concentrations and sediment loads. Disturbance of stream banks and subsequent land slides caused by road construction expose soil to erosion and leaching. Drainage from forest roads should be diffused into forest soil rather than drained into surface channels and streams, otherwise the streams will be subjected to heavy turbidity and effects of erosion and leaching.

14.1.2 The Effect of Agricultural Land Use on Water Quality

Agricultural land use can be divided into several types of activity, namely:

(1) feedlots
(2) confined animal housing units
(3) pastured grassland
(4) use of fertilizers and manures
(5) irrigated and non-irrigated cropland
(6) orchards

These activities can influence the water quality of receiving waters through surface runoff or groundwater flow. The primary water quality parameters which indicate a contribution of pollutants from agricultural activities are considered to be phosphorus, nitrate-nitrogen, organic matter, salinity and fecal coliforms. Several of the above land uses, namely feedlots, confined housing, and pastures have been previously discussed (Section 6).

(a) Use of Fertilizers and Manures

In fertilizer and manure applications, nitrate nitrogen poses a potential threat to groundwater and surface water quality. According to Stewart (26), nitrate

nitrogen is no threat unless poor management practices such as excess applications or applications at the wrong time of the year have been incurred. Although phosphates are insoluble, they can present a problem through erosion of top soil.

Agricultural wastes should be incorporated into the soil soon after application. Manure application on frozen ground can produce high nutrient losses in the runoff. Up to 20% of the nitrogen, 12% of the phosphorus and 14% of the potassium in manure applied on frozen ground was reported lost under conditions favouring maximum early spring runoff (6).

(b) Irrigated and Non-irrigated Cropland

Cultivated land can either be irrigated or non-irrigated, depending on the rainfall and temperature during the growing season. Under non-irrigated conditions, water moves through the soil to depths below the rooting zone only during the winter and early spring months, when evapotranspiration is low (26). Allison, cited by Stewart (26), emphasized that minimal amounts of nitrates leach from medium textured soils during the growing season unless annual rainfall is above 50 in. Surface runoff during periods of high precipitation, however, removes soil particles, organic matter, and adsorbed phosphorus.

For irrigated lands, water quality may change as a result of a temperature increase and an increase in total salinity. The plants consume the water, resulting in an increased concentration of the dissolved solids. Also, irrigation leaches natural salts or nutrient materials from the soil and returns them to surface waters as return flow. Irrigation waters usually contain from 25 to 8000 ppm dissolved salts (29). Law et al (71) reported that salinity of receiving streams increased 5 to 10.8 times due to the effect of irrigation in western America.

The impact of irrigation on nutrient removal from soils is difficult to assess due to the lack of data. It can be a potential threat, especially in areas where substantial leaching water is required to control the buildup of dissolved salts within the plant zone. Nitrogen in the form of nitrates is relatively mobile in the soil, whereas phosphorus fertilizer is much less mobile. Erosion of sediment through runoff can result in insoluble or soluble phosphorus being transported to surface waters along with nitrogen in which case surface water runoff will likely contain more nutrients than subsurface flow, while subsurface water will likely have higher salinity concentrations. Two studies, however, reported average values of 0.9 to 3.9 lbs/acre/year of total phosphorus and 2.5 to 24 lbs/acre/year of total nitrogen from surface drainage, compared to 2.5 to 1 lbs/acre/year of phosphorus and 38 to 166 lbs/acre/year of nitrogen from sub-surface drainage (70, 72). Nitrogen to phosphorus ratios are about 6 and 15 for surface and subsurface drainage respectively. For surface drains, nitrate concentrations ranged from 0.4 to 2 mg/l, kjeldahl N from 0.1 to 0.3 mg/l, and total phosphorus from 0.2 to 0.4 ppm. Equivalent figures for sub-surface drainage were 1.8 to 4.4 mg/l, 0.1 to 0.3 mg/l, and 0.1 to 0.3 ppm (70).

Because of their solubility, nitrates are transported readily to surface and underground bodies of water. In irrigated fields, 25 to 30 lbs. of nitrate per acre moved to the groundwater table annually in studies cited by Willrich (30). Other research indicated that only minimal amounts of nitrate entered the groundwater.

(c) Orchard Runoff

The pollution load derived from orchards is basically in the form of nitrogen, phosphorus and salinity. Orchards in arid regions which are heavily irrigated commonly have a leaching fraction of 0.35, minimizing accummulation within the soil. Studies by Pratt et al (73) reported nitrate nitrogen concentrations of 21 mg/l in the drainage water from a citrus fruit grove with a typical leaching fraction of 0.36 to 0.40 and a nitrogen application rate of 150 lb/acre/year.

A review of literature shows that generally the fruit-growing industry has adjusted its fertilizer rate to approximately the plant requirements. Studies by Nelson (74) indicated that 40 to 80 percent of the fertilizer nitrogen applied usually is recovered by the crop, and 10 to 20 percent may convert to nitrogen gas and nitrogen oxides. Therefore, depending on the rate of percolation, the remaining nitrogen may accumulate below the root zone or move into the groundwater. Conditions most conducive to nitrate losses through runoff and erosion include excessive application rates on sloping lands subject to intensive rainfall, and excessive rainfall immediately following surface application.

In the Okanagan region, the British Columbia Department of Agriculture (75) recommends that fertilizers be applied in the late fall on fruit tree orchards. This is done in order to evenly distribute the fruit growers' workload and to avoid tractability problems in the early spring. Since the growing season has terminated before the fertilizer is applied and fall rains are frequent, it would seem that more nitrogen can be lost through leaching during this period, especially since Okanagan soils are quite sandy.

14.1.3 The Effect of Urban Land Use on Water Quality

Urban development results in a reduction of water quality in streams flowing through the area. This effect is evidenced firstly in a redistribution of water use in the area, then by an increase in pollution load of effluent and runoff waters, and ultimately in a reduction in water quality of the streams. These effects are dependent on the physical size and population of the urban area, the extent of its industrial development, population density, and the various hydrologic factors of the stream flow.

The major effect of urbanization on water quality is the introduction of an increased amount of waste, much of which is disposed of by water means. Thus the waste water from the area depends, in quantity on the population and the extent of

industrial development, and in quality on the intensity of water use, climate factors, and the amount of industrial contribution. Sewage from such an area is high in BOD, suspended solids, turbidity, and nutrients, and contains a great number of coliform bacteria. Output from this type of landuse are 0.24 lbs. of BOD and 200 billion coliform per capita per day (76).

In addition to the domestic and industrial wastes, land runoff represents a pollution load to the stream. Urbanization results in a greater percentage of impervious area and therefore an increase in the amount of surface runoff. This water has high sediment load and turbidity. It has a high grease and oil content from automobile use and parking in the area. Nutrient content is also greater than in the natural state, with high concentration of nitrites, nitrates, and orthophosphates. Sulfate content is higher, chiefly as a result of the higher sulfate content of urban air. Chloride content is also higher in areas where salt is used for melting ice in the winter. Antecedent rainfall conditions appear to be most important; highest nutrient concentrations are found after extended periods of low precipitation. Other factors are street sweeping and flushing, and the presence of deciduous vegetation. Concentrations also depend on highway use. One study reported highest total nitrogen values from major highways, highest soluble phosphorus values from arterial streets, and highest total phosphorus from residential streets (70). Average values were total kjeldahl nitrogen 0.1 to 0.2 mg/l, nitrates 0.53 mg/l, soluble phosphorus 0.076 ppm, and total phosphorus 0.2 ppm. Another study reported mean values of 21 ppm for BOD, 150 ppm for suspended solids, 19 ppm for oil and grease, 1.3 ppm for nitrates, 0.16 ppm for nitrites, and 1.2 ppm for orthophosphates (8).

The actual influence of urban waste on the quality of the receiving stream depends on the degree of treatment, the design of the sewage system, and the rate of flow and quality of the receiving waters.

The degree of treatment is an important factor. The BOD and suspended solids contents are reduced to varying degrees, depending on the type of treatment facilities employed. Also, the coliform content depends on whether the waste water is chlorinated. Nutrient content is not reduced to a significant extent by traditional treatment methods and requires secondary or tertiary treatment.

The design of the collection system also affects the effluent quality. Combined systems carry both waste water and storm runoff. The characteristics of this waste are therefore variable and depend on the degree of dilution by the storm runoff and the quality of this water. Problems result from periods of heavy rainfall, as few combined systems are designed to accommodate the amount of water involved, most of which is then discharged directly to the stream. Thus, even where treatment plants exist, with a combined system a significant portion of the waste is discharged in the raw, untreated form. In a separate system, the sanitary sewer carries the waste water from domestic and industrial sources, and is quite constant

in its characteristics. Again, its effects on water quality in the receiving stream are modified by the treatment received. The storm runoff is carried in a separate system, and is variable in both quantity and quality. Quantity is determined by the amount of precipitation, ground slope, and imperviousness. Quality is influenced by quantity or runoff and antecedent conditions. This water is rarely treated, and presents a pollution load not unlike that of treated domestic sewage.

In addition to the factors mentioned above, the flow rate in the receiving stream affects the water quality by the extent of dilution.

A further effect of urbanization is an increase in water temperature, with both the storm runoff and waste water contributions warmer than in the natural state. Thus, the dissolved oxygen content is reduced, while demands for oxygen are increased by increasing chemical and biological activity (77).

Groundwater quality is also affected as the impervious area is increased. This reduces the amount of groundwater flow and thereby makes it more susceptible to contamination. This is especially true where urbanized areas are not served by domestic sewage systems and rely on land disposal (septic tank systems).

It should be noted that two distinct phases exist in the water quality of a stream flowing through an urban area; namely, the low flow periods and periods of high rainfall and runoff. The low flow period is generally the critical period with respect to downstream stream quality, as dilution is minimized. Ultimate water quality of downstream lakes, however, is a function of the cumulative loadings of both these phases.

14.1.4 The Effect of Lakes on Water Quality

Eutrophication takes place when nutrients accumulate in a lake with the resulting nuisance blooms of algae. The concentration necessary to produce nuisance water growths depends on the concentrations of other substances (e.g.: turbidity), water temperature, light penetration, and the rate at which nutrients can be supplied when growth commences. Reported threshold values are 50 to 200 ppb of nitrates and 10 ppb of phosphorus, although these may drop with higher levels of the other nutrient (70). Nutrient concentrations in the lake are often less than in the source water. In one study, 55 percent of the phosphorus was lost through sedimentation, deposition of algae, and fish taken from the lake (70). Nutrient levels may drop to zero in heavy algal blooms, and will quickly rise again with the death of the algae and consequent regeneration of nutrients.

14.1.5 The Effect of Reservoirs on Water Quality

Reservoirs can seriously affect downstream water quality in that they simulate

a lake with increased biological productivity. This results from the extensive areas of shallow water which generally accompany reservoirs and headwater lakes, with photosynthesis and decomposition hastened in shallow water. Biological productivity is further enhanced when areas of vegetation are inundated by rising water levels. Also, intensive agricultural use of the watershed can result in high nutrient loadings to the reservoir, thus increasing the problem. Downstream water quality, however, is often improved as a result of the uptake of nutrients in the reservoir.

While the above is true of water supply reservoirs, with relatively stable water levels, flood control reservoirs produce varying effects on downstream water quality. Here, the reservoir is emptied as quickly as possible. As a result, winter water levels are low and the small amount of water remaining can be readily altered by even moderate inflows. Fluctuating water levels in time of high water prevent the development of stabilized conditions in shallow zones. Also the increased turbidity in times of high inflow tends to reduce algal blooms. In one study a reservoir was shown to improve downstream water quality and reduce organisms, nutrients, and BOD (78).

Leaching is also an important factor in the water quality in a reservoir. In one study, concentrations of nutrients and metals were reduced when soils (except leaf litter) were submerged with water having high concentrations of these parameters (79). The reverse was true for water of low concentration.

14.1.6 The Effect of Runoff Rates on Water Quality

High precipitation rates can have varying effects on water quality through the mechanisms of dilution of nutrients and surface flushing of soil and organic particles. Several researchers have reported an increase in concentration with increased runoff (72, 80) in areas used for agriculture and urban development. Other studies (20, 68, 69) indicated decreased or constant concentrations with higher runoff in forested regions. The organic load is increased most in areas of meadowland and cattle grazing, whereas the inorganic parameters are increased most by increased runoff in areas of cultivation (80).

The concentration in the stream itself may be reduced by the intake by stream life of some of the more readily assimilable forms of nutrients. This is shown by one study which found that during low runoff conditions, when most of the stream flow was composed of irrigation runoff, the nutrient levels were considerably lower than for irrigation return flows (70). Typical nitrogen/phosphorus ratios ranged from 3.7 to 5.3. The nitrogen/phosphorus ratio dropped in this case, indicating a greater uptake of nitrogen by aquatic life.

14.2 THE EFFECT OF LAND USE IN THE OKANAGAN

The original purpose of this study was to provide an estimate of future water quality in the tributaries of the Okanagan Basin. This was achieved by determining the effects of present land use activities on water quality and making predictions of future water quality. This objective could not be met due to the insensitivity of the data and hence the inability to derive relationships between land use and water quality.

This report does provide an investigation of present water quality in Kelowna and Lambly Creeks, representative of tributaries in the Okanagan Basin. Recommendations are made regarding improvement of present water quality and minimization of the effects of future development on water quality.

14.2.1 Description of Experimental Design

An intensive survey was carried out to determine physical and chemical characteristics of water in two creeks, at several sampling stations and on several dates.

Flows at these stations on the sampling dates were determined from hydrometric measurements at the sampling stations or by interpolation using a hydrologic model.

Mass flux for each chemical parameter at each station on each date was calculated from the concentration and flow data.

14.2.2 Description of Experimental Analysis

The differences in loadings between stations for each parameter and date were calculated, and variations due to the different sizes of drainage areas were eliminated by dividing the differences in loadings by the acreage of the area draining into that part of the creek. These quotients were labelled "drainage-area co-efficients".

An analysis of Variance, using the randomized block design, was applied to the data in order to determine the existence, if any, of significant differences among stations and dates for each parameter. Also, the Duncan's New Multiple Range Test was used to ascertain whether any pattern of significant differences existed among stations.

14.2.3 Lambly and Kelowna Creeks

After a preliminary survey of several creeks in the Okanagan Basin, Kelowna and Lambly Creeks were selected for intensive study. The main criteria for selection were the land use activities in the tributary drainage basins, the number of existing hydrometric stations, the availability of hydrometric data, prior

monitoring of water quality, and accessibility.

The watersheds of the two creeks chosen for the intensive water quality study are situated directly across Okanagan Lake from each other. Lambly Creek, emptying into the lake from the west, drains an area of 95 square miles. This watershed is the more rugged of the two, with the creek flowing in a fairly straight, well defined channel in a narrow and steep valley throughout most of its length, except in the headwaters of Terrace Creek. This region is somewhat flatter, with lakes and marsh more prevalent. In contrast to this uninhabited watershed is that of Kelowna Creek which drains an area of 86 square miles upstream of the City of Kelowna. The watershed is characterized by relatively flat agricultural and in the lower reaches, with a narrow meandering channel. It then rises steeply at its mid-point to the upper headwaters. This section is realtively flat, with an abundance of lakes, most of which are regulated for irrigation purposes. Other than storage of water for irrigation, this area is almost unaffected by man's activities.

Kelowna Creek was selected for monitoring the following land use activities:

(1) Range grazing in the upper reaches

(2) Irrigation for orchards in the lower reaches

(3) Industry between the town of Rutland and the City of Kelowna

(4) Domestic discharge to ground below Rutland

Lambly Creek was monitored for the following:

(1) Logging in the headwaters of Terrace Creek

(2) Background or control site of null activity in the remainder of the watershed.

14.2.4 Selection of Water Quality Stations

Locations of water quality sampling stations are shown on Figure 14.1 and 14.2. Station locations were selected on the basis of land use differentiation, accessibility, prior location of hydrometric stations, locations or irrigation diversions, tributary creek configuration, and locations of point-source discharges, landslides or other influences on water quality.

Exact locations of water quality sampling stations are given in Table 14.1.

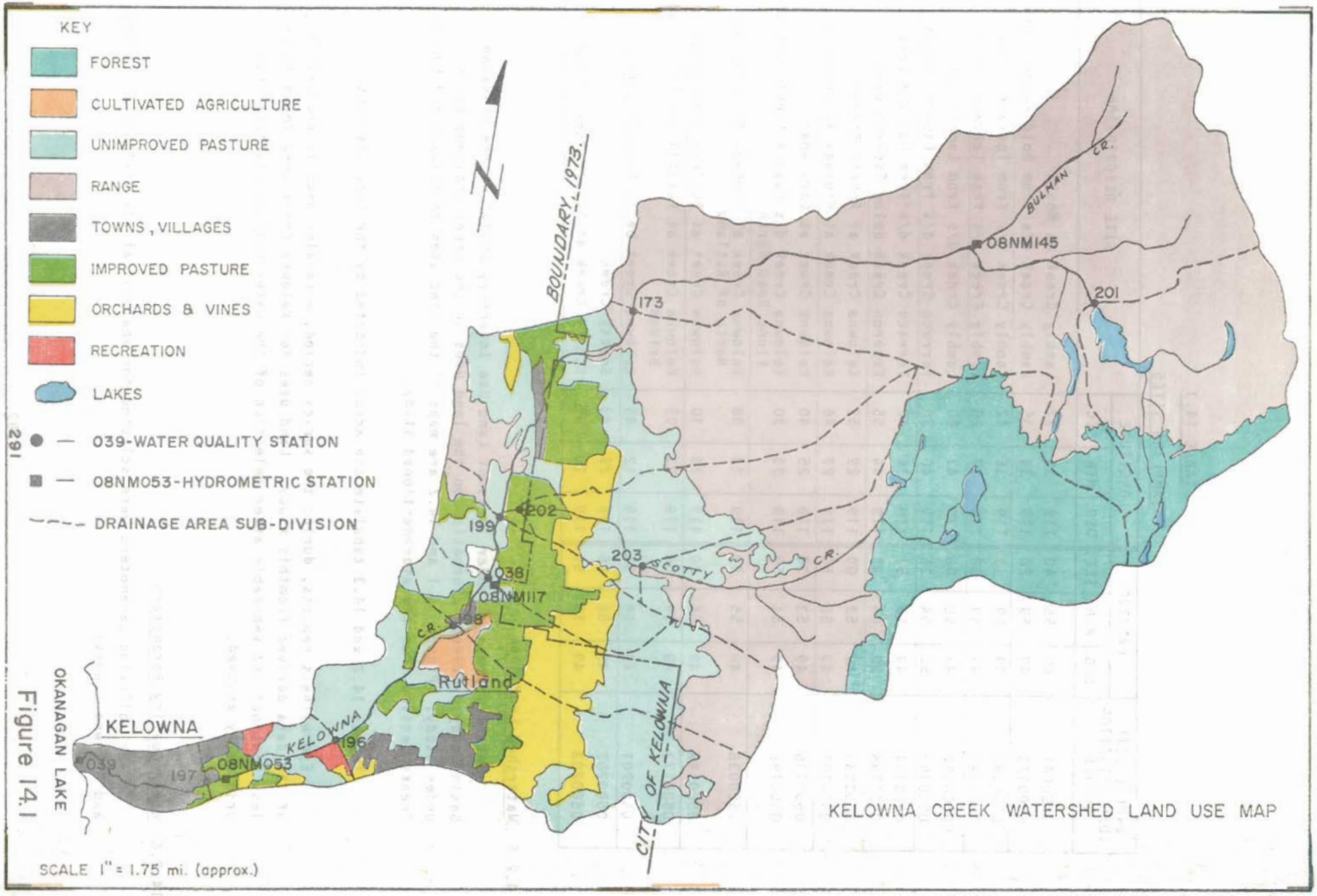

KEY
FOREST
CULTIVATED AGRICULTURE
UNIMPROVED PASTURE
RANGE
TOWNS, VILLAGES
IMPROVED PASTURE
ORCHARDS & VINES
RECREATION
LAKES
039-WATER QUALITY STATION
08NM053-HYDROMETRIC STATION
DRAINAGE AREA SUB-DIVISION
BOUNDARY, 1973.
BULMAN CR.
08NM145
201
173
202
199
203
SCOTTY CR.
038
08NM117
CR.
Rutland
KELOWNA
KELOWNA
196
039
197
08NM053
OKANAGAN LAKE
CITY OF KELOWNA
291
SCALE 1" = 1.75 mi. (approx.)
KELOWNA CREEK WATERSHED LAND USE MAP

Figure 14.1

TABLE 14.1

SAMPLING SITES

SAMPLE SITE IDENTIFICATION NUMBER	LATITUDE			LONGITUDE			SITE DESCRIPTION
	DEG.	MIN.	SEC.	DEG.	MIN.	SEC.	
0500041	49	55	40	119	30	37	Lambly Creek at Mouth
0500170	49	59	20	119	34	35	Lambly Creek u/s from Bold Range Creek
0500190	49	59	11	119	36	42	Lambly Creek d/s from Terrace Creek
0500191	49	59	38	119	37	20	Lambly Creek u/s from Terrace Creek
0500192	49	58	08	119	41	20	Lambly Creek d/s from Lambly Lake
0500193	50	04	35	119	40	20	Terrace Creek d/s from Esperon Creek
0500194	49	59	51	119	36	42	Terrace Creek d/s from Duo Via Lake
0500195	50	04	45	119	44	55	Esperon Creek below Esperon Lake
0500039	49	53	00	119	29	52	Kelowna Creek at Abbott Street
0500197	49	52	50	119	27	46	Kelowna Creek at Highway 97 crossing
0500196	49	53	30	119	25	40	Kelowna Creek at Cary Road
0500198	49	54	50	119	23	30	Kelowna Creek d/s Quadra Steel just off Finns Road North
0500038	49	55	32	119	23	08	Kelowna Creek at Highway 97 crossing-North of Rutland
0500199	49	56	20	119	23	10	Kelowna Creek at Bullman Road Bridge
0500173	49	59	00	119	21	05	Kelowna Creek at Postill and Lake Road Bridge
0500201	49	59	35	119	12	45	Kelowna Creek below Postill Lake
0500202	49	56	26	119	22	43	Scotty Creek
0500203	49	55	50	119	20	35	Scotty Creek at Scotty Road Bridge

14.2.5 Watershed Land Use

Material prepared under "Present Land Use Inventory Study" of the Okanagan Basin Study provided information on the land uses in the creek drainage basin under study. Figure 14.1 and 14.2 are maps of the land uses in Kelowna and Lambly Creeks derived from the aforementioned study.

Tables 14.2 and 14.3 tabulate the areas indicated by the land use maps.

Eye witness reports, during the survey period, were also used in evaluation of the data derived fromthis study. Land uses for Kelowna Creek were found to be less distinct and separable after selection of the water quality stations than originally assumed.

14.2.6 Water Quality Parameters

The following parameters were selected for analysis at all stations on Lambly and Kelowna Creeks:

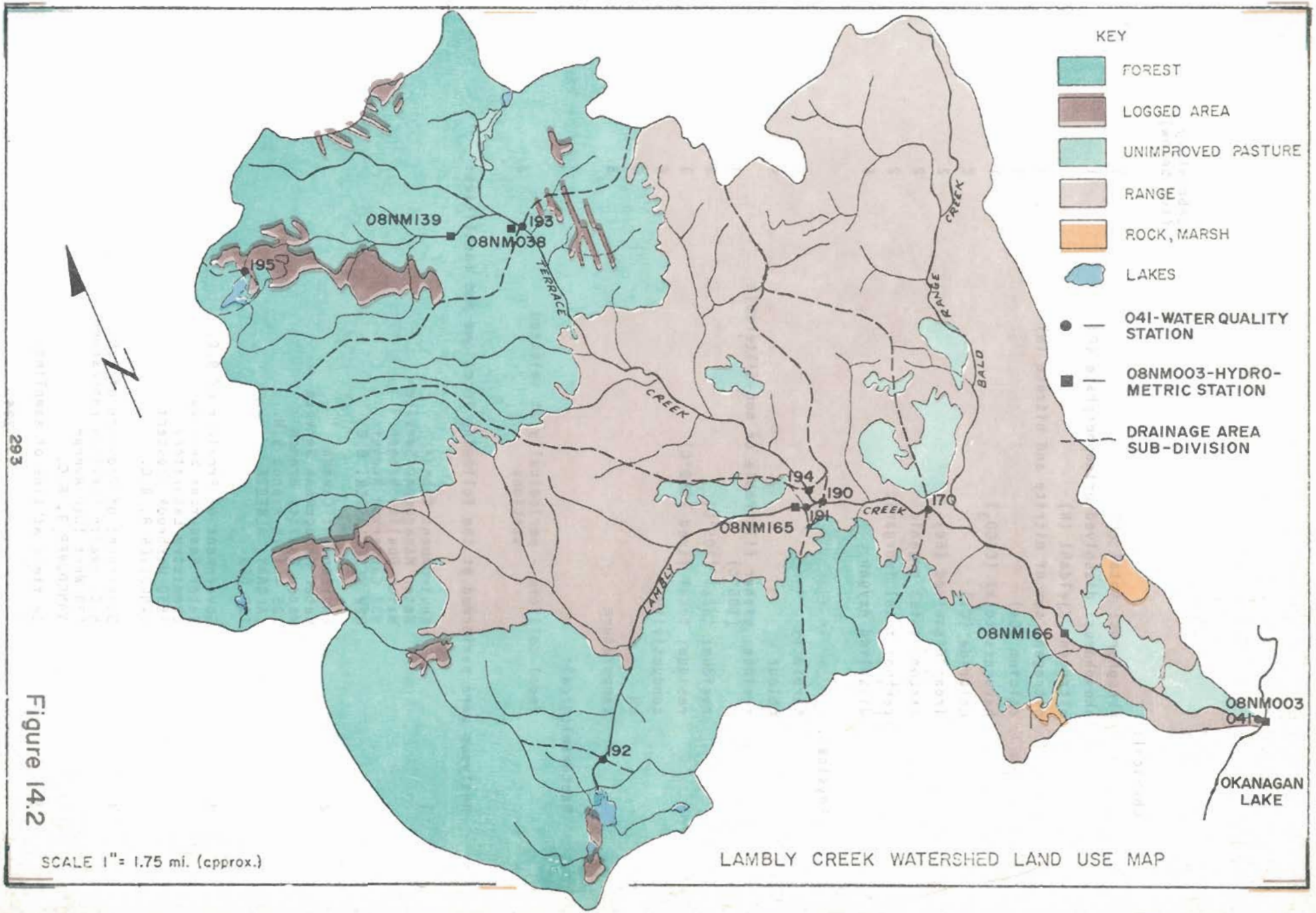

KEY
FOREST
LOGGED AREA
UNIMPROVED PASTURE
RANGE
ROCK, MARSH
LAKES
041-WATER QUALITY STATION
08NM003-HYDRO-METRIC STATION
DRAINAGE AREA SUB-DIVISION
08NM139
193
08NM038
195
TERRACE
CREEK
RANGE
CREEK
BALD
194
190
191
170
CREEK
08NM165
LAMBLY
08NM166
08NM003
041
192
OKANAGAN LAKE
SCALE 1" = 1.75 mi. (approx.)
LAMBLY CREEK WATERSHED LAND USE MAP

Figure 14.2

		Laboratory (see below)
Chemical:		
	phosphorus: total (P)	1
	phosphorus: dissolved orthophosphate (P)	1
	nitrogen: Kjeldahl (N)	
	nitrogen: sum of nitrite and nitrate (N)	1
	calcium (Ca)	1
	hardness total ($CaCO_3$)	1
	chloride (Cl)	2
	iron: dissolved (Fe)	2
	carbon: total organic	2
	carbon: total inorganic	2
	dissolved oxygen	5
Physical:		
	turbidity	2
	colour	2
	residue: either filterable or non-filterable (105°C)	3
	residue: total (105°C)	3
	residue: total fixed (550°C)	3
	conductivity	5
	pH	5
	temperature	5
Bacteriological:		
	fecal coliform - periodically at selected stations	4

Analyses were performed at the following locations and facilities:

1 Environment Canada
Water Management Service
Water Quality Branch
632 Carnarvon Street
NEW WESTMINSTER, B.C.

2 Environment Canada
Water Management Service
Water Quality Branch
725 - 11th Avenue S.W.
CALGARY, ALBERTA
T2R 0E3

3 Government of Province of B.C.
Water Resources Service
Chemistry Laboratory
3650 Wesbrook Crescent
VANCOUVER 8, B.C.

4 Government of Province of B.C.
B.C. Health Services Laboratory
828 West 10th Avenue
VANCOUVER 9, B.C.

5 In field at time of sampling.

TABLE 14.2

LAND USE IN KELOWNA CREEK WATERSHED (ACRES)

LAND USE TYPE \ DRAINAGE AREA	039 to 197	197 to 196	196 to 198	198 to 038	038 to 199	199 to 202,173	202 to 203	ABOVE 203	173 to 201	ABOVE 201	TOTAL	COMPO-SITE ABOVE 038	COMPO-SITE 038 to 197
Range			790	800		4100	1250	3200	14,500	3700	28,340	26,750	1,590
Unimproved Pasture		355	4340	1230	625	1440	940	600			9,530	3,605	5,925
Forest								5000	600	1300	6,900	6,900	
Improved Pasture	35	200	1380	500	830	1080	155				4,180	2,065	2,080
Orchards & Vines		150	1580	570	435	360	155				3,250	950	2,300
Towns & Villages	795	55	790	110		120					1,870	120	955
Cultivated Agriculture			390	110							500		500
Recreation		150									150		150
TOTALS	830	910	9270	3320	1890	7100	2500	8800	15,100	5000	54,720	40,390	13,500

(Derived from maps provided by T.S. VII)

TABLE 14.3

LAND USE IN LAMBLY CREEK WATERSHED

LAND USE TYPE \ DRAINAGE AREA	041 to 170	170 to 190	191 to 192	194 to 193	193 to 195	TOTALS
Range	12,600	2,660	5,975	6,510		27,865
Forest	1,420	1,435	9,385	4,920	8,000	25,660
Unimproved Pasture	1,600	205	170	100	85	2,160
Logged Area			170	320	735	605
Rock, Marsh	180					180
TOTALS	15,800	4,300	15,700	11,850	8,820	56,470

All samples were refrigerated and shipped on ice to the laboratories indicated.

14.2.7 Sampling Period and Dates

Samples were collected from Lambly Creek every second Tuesday and from Kelowna Creek every second Wednesday. Sampling commenced in the Lambly Creek watershed on July 5, 1972, and in the Kelowna Creek watershed on July 6, 1972.

All laboratory analyses were performed with currently-accepted materials and methods. Further information may be obtained from the laboratories indicated.

14.3 WATER QUALITY IN KELOWNA AND LAMBLY CREEKS

Results of all chemical and bacteriological analyses conducted on the water samples collected from Kelowna and Lambly Creeks during the period April to October of 1972 have been tabulated (83). For each sampling station, parameter, and date, the mean, median,maximum and minimum concentrations were calculated (Appendix J.1). The water quality parameters were selected to determine the effects of differing land use activities along the two creeks. The following discussion will attempt to associate the changes in water quality with the respective activities.

14.3.1 Water Quality Parameters

(a) Conductivity

Conductivity is a measure of ion concentration. For irrigation purposes, water is considered acceptable if the conductivity is between 250 and 750 umhos (46). To support a diverse fauna, conductivity should be between 150 and 500 umhos. The waters of Lambly Creek met both the irrigation and fish production requirements. The waters of Kelowna Creek were suitable for irrigation purposes, but would only support a suitable fauna fish upstream of Station 038. This may be attributed to a return flow or irrigation waters or to subsurface flow into Kelowna and Scotty Creek upstream of Station 038.

(b) Hardness

Calcium and magnesium ions are primarily responsible for hardness in water. For most purposes, total hardness below 250 ppm is required (46). Hardness in water can be caused by soil contact (sub-surface flow) or industrial water discharge. In addition, application to land of industrial wastes containing a high carbonic acid content, such as beverage wastes, will tend to solubilize Ca++ and Mg++ in soil complexes. Between Stations 202, and 203, and between Stations 173 and 193, hardness increased considerably. This can be attributed to subsurface creek flow

occurring between these monitoring sites. The permissible limit for hardness was exceeded only at Station 196 (259 ppm - median value).

(c) Fecal Coliforms

Fecal coliforms are known to inhabit the intestines of warm-blooded animals and humans. The raw water fecal coliform standards, taken from the Canadian Drinking Water Standards and Objectives (59), are as follows:

"Objective: at least 95% of the samples in any consecutive 30 day period should have a fecal coliform density of less than 10 per 100 ml." Non-zero fecal coliform counts indicate direct contact of livestock to the creeks or direct discharge of sewage. High fecal coliform counts can also be attributed to water spillage from stock tanks or to cattle urination near water courses.

No conclusive evidence is available to locate the sources of fecal contamination recorded in this study due to the small number of samples analyzed. In Kelowna Creek basin, the amount of fecal coliform data gathered was limited but indicated very high fecal coliform counts (<2400). Fecal contamination occurred along the shores of Scotty Creek and between the confluence of Scotty and Kelowna Creeks and Station 196. Based on coliform die-off rates, and assuming that a small percentage of livestock excreta actually reaches the stream, it would seem that a large number of cattle are responsible for the fecal contamination of Kelowna Creek.

In Lambly Creek, there was considerable fecal contamination in July and August at Stations 170 and 041 (<10/100 mls). Very few samples were analyzed for fecal contamination, so that no relationship could be established between land use activity and fecal coliform.

(d) Solids

The settleable, suspended and dissolved solids concentrations in the lower reaches of Kelowna Creek were approximately twice that of the lower reaches in Lambly Creek. The highest median solids concentration occurred at Station 196 on Kelowna Creek where concentrations for settleable, suspended and dissolved solids were 270,110 and 20 ppm, respectively.

No standards have been cited for settleable solids. The permissible limit of solids concentration in raw water supplies is dependent on the toxic effects of the solids (46). The permissible limit for suspended solids is between 25 and 80 mg/l (46), hence Kelowna Creek is unsuitable for raw water supply at this point. The concentration of dissolved solids was well within the permissible limit of 500 mg/l for public water supplies.

(e) Nitrogen

No permissible limits have been cited for kjeldahl nitrogen (includes ammonia and organic nitrogen). Organic nitrogen is not pathologically significant but it is an indication of pollution (36). British Columbia Health Branch drinking water standard (40) for nitrate plus nitrite is less than 10 mg/l as N. Algal blooms have been observed in bodies of water where total nitrogen exceeded 0.6 mg/l or nitrate + nitrite nitrogen exceeded 0.3 mg/l (46).

The results indicated that below Station 038 in Kelowna Creek, the total kjeldahl nitrogen concentrations exceeded twice that of Lambly Creek. The highest median concentration in Lambly Creek was 0.37 mg/l. On Kelowna Creek irrigation increased concentration, especially on Scotty Creek. Below Station 198 considerable amounts of nitrate plus nitrite nitrogen were added. This may be due to influx of groundwater from the Rutland residential area.

(f) Phosphorus

Total phosphorus concentrations higher than 0.05 mg/l have been known to stimulate algal blooms (42). In Lambly Creek, concentrations were well below this value. In Kelowna Creek this limit was exceeded in Scotty Creek and downstream from the confluence of Kelowna and Scotty Creeks. The orthophosphate concentration in this part of the stream was high. This indicated that orthophosphate may originate from irrigation return flow or groundwater charged with orthophosphorus from sources such as septic tanks and animal confinement units.

(g) Calcium

Calcium in natural waters occurs through leaching of soil and other natural sources. For drinking water, 75 mg/l is considered as a permissible limit (46). The calcium concentrations in Kelowna and Lambly Creeks are both within this limit. Kelowna Creek receives a large calcium loading in the vicinity of its confluence with Scotty Creek. Subsurface flow occurring between Stations 173 and 199 and also between 202 and 203 seem to be the main causes of high calcium concentrations.

(h) Total Inorganic and Organic Carbon

Both organic and inorganic forms of carbon were analyzed. The total organic carbon (TOC) concentrations in Lambly Creek were comparable to those of Kelowna Creek. The median concentrations ranged from 7 to 15 mg/l. At the two locations where Kelowna Creek flowed below the surface, the TOC concentrations were reduced by a factor of two. The TOC concentrations were the greatest at the head of each creek, probably due to the input of leaves and other detritus.

Total inorganic carbon (TIC) concentrations increased by a factor of two at the two locations where Kelowna Creek flowed below the surface.

The TIC concentration in the lower part of Kelowna Creek was approximately twice that of the lower part of Lambly Creek. In Lambly Creek, the highest median concentration was 18 mg/l, while the highest median concentration in Kelowna Creek was 40 mg/l.

(i) Chlorides

For public supplies, water is classified as acceptable if the chloride concentration is less than 125 mg/l (46). The maximum concentration for Lambly Creek water supply was 0.8 mg/l and the maximum concentration along Kelowna Creek as 10.8 mg/l, well below this maximum. A moderate increase in chloride concentration occurred in Scotty Creek and between Stations 196 and 197 of Kelowna Creek. These increases in chloride concentration coincide with irrigation activity along Scotty Creek and with the location of the Rutland sewage treatment plant, which discharges chlorinated effluent to the ground.

(j) Dissolved Oxygen

The permissible tolerance of fish is 5 mg/l dissolved oxygen (46) for 16 hours of the day. The lowest concentrations occurred at the storage facilities at the headwaters of both creeks. For Lambly Creek and the upper part of Kelowna Creek, dissolved oxygen increased with downstream movement. The lower part of Kelowna Creek is less turbulent, resulting in a decrease in the dissolved oxygen. This decrease may be attributable to the intensive land use and biological uptake in that portion of the stream. The median values for both creeks ranged from 6.3 to 8.7 mg/l.

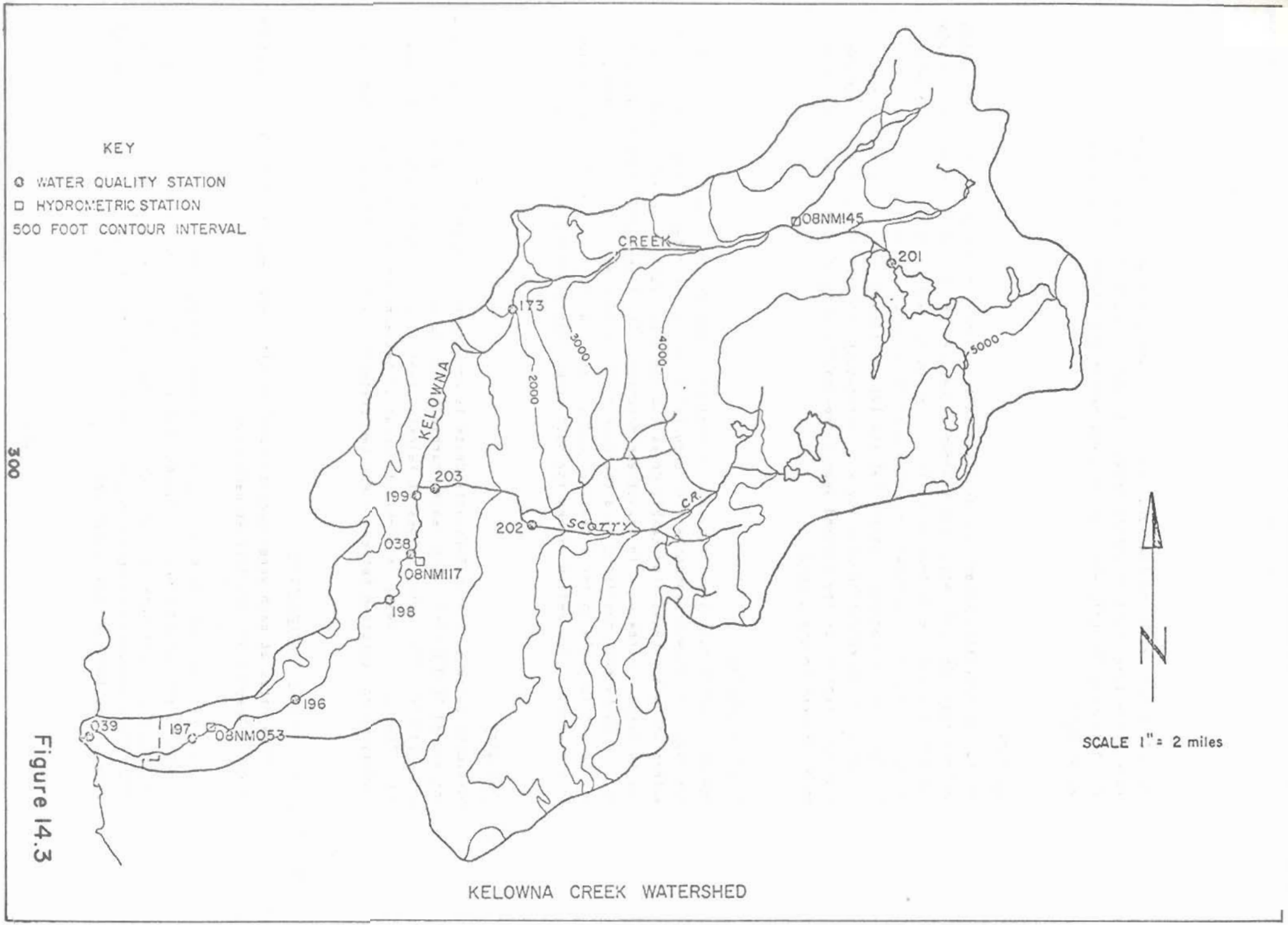
(k) Turbidity

Turbidity below 5 Jackson Turbidity Units is considered acceptable. Turbidity should not exceed 10 JTU (46). The median turbidity was below 1 mg/l in Lambly Creek for all stations. The median values at Kelowna Creek stations ranged between 11.0 and 5.6. The major increase in turbidity occurred between stations 038 and 199. A drainage ditch existing between these two stations could be a contributing factor.

14.3.2 Water Quantity Determination

Flow rates at each water quality sampling site were required for the calculation of total loading or mass flux at each site.

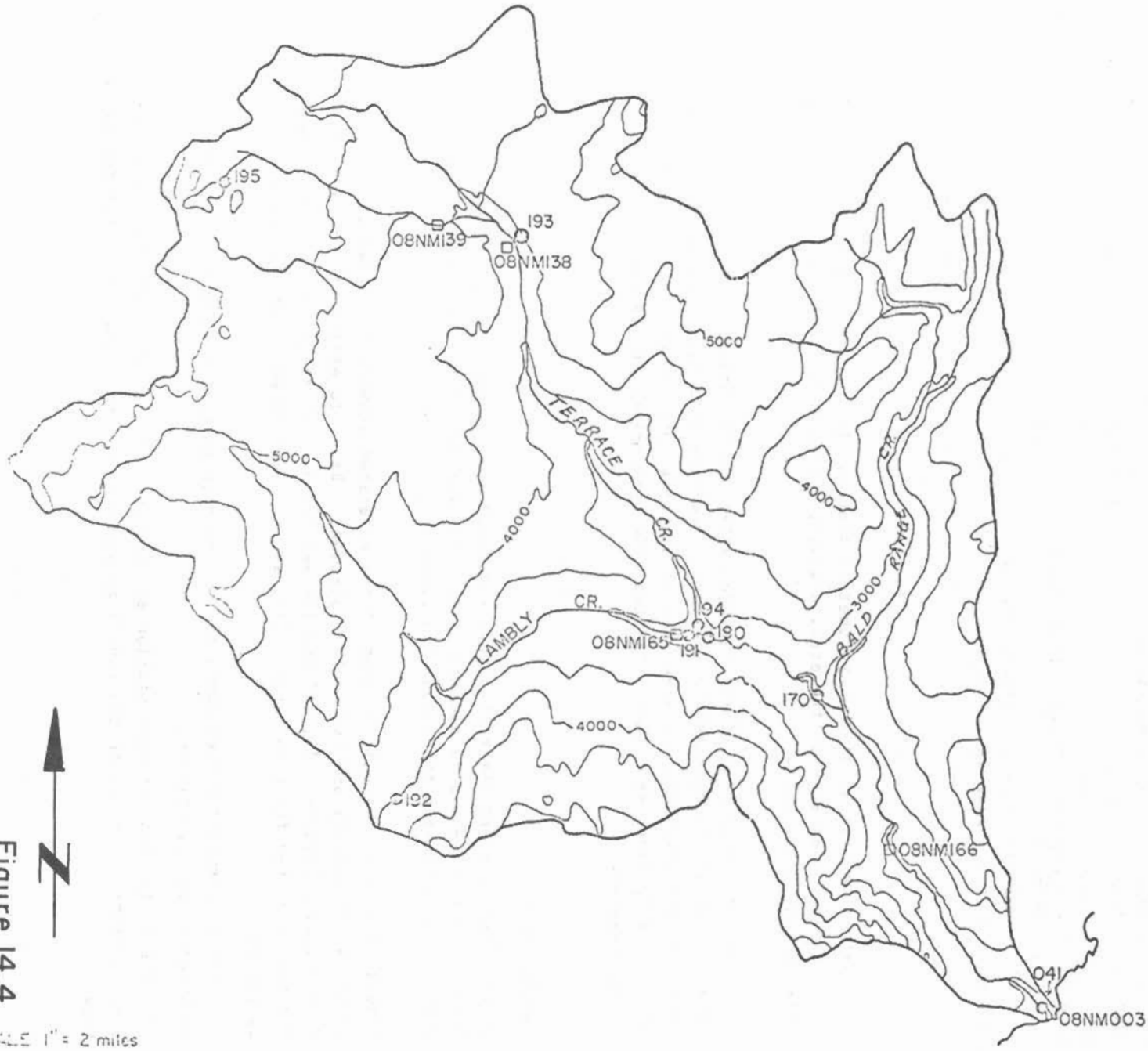
As shown in Table 14.4, only a small number of hydrometric stations were located on Kelowna and Lambly Creeks. Figures 14.3 and 14.4 show the locations of these stations and of the water quality sampling sites. This diagram also indicates that direct flow measurements were not available for several streams (for example, Scotty Creek in the Kelowna Creek watershed).



300

Figure 14.3

KELOWNA CREEK WATERSHED



LAMBLY CREEK WATERSHED

Figure 14.4

TABLE 14.4

HYDROMETRIC STATIONS OPERATING IN 1972

STATION NUMBER	DESCRIPTION	LATITUDE	LONGITUDE	DRAINAGE AREA (ACRES)
08NM 003	Lambly Creek near the mouth	49°55'40"	119°30'38"	59,900
08NM 167	Lambly Creek diversion to Rose Valley Lake (outside Lambly Creek watershed)	49°54'38"	119°33'18"	
08NM 166	Lambly Creek below Bald Range Creek	49°57'30"	119°33'24"	57,700
08NM 165	Lambly Creek above Terrace Creek	49°59'39"	119°36'52"	18,700
08NM 138	Terrace Creek	50°04'15"	119°40'00"	9,150
08NM 139	Esperon Creek	50°04'24"	119°41'16"	3,930
08NM 053	Kelowna Creek lower station near Kelowna	49°53'12"	119°27'18"	54,500
08NM 117	Kelowna Creek at Rutland Station	49°55'38"	119°23'03"	40,400
08NM 145	Bulman Creek at the mouth	50°00'18"	119°15'06"	3,800

Data from several of the hydrometric stations for September and October of 1972 were not available in the early analysis. Flow figures were revised as new data were made available.

Daily flows at most of the ungauged water quality stations were interpolated from records at the hydrometric stations. Drainage area-runoff curves were developed for each watershed and were used to estimate total runoff at the required sites. Daily flows were then estimated from hydrographs at the existing hydrometric stations.

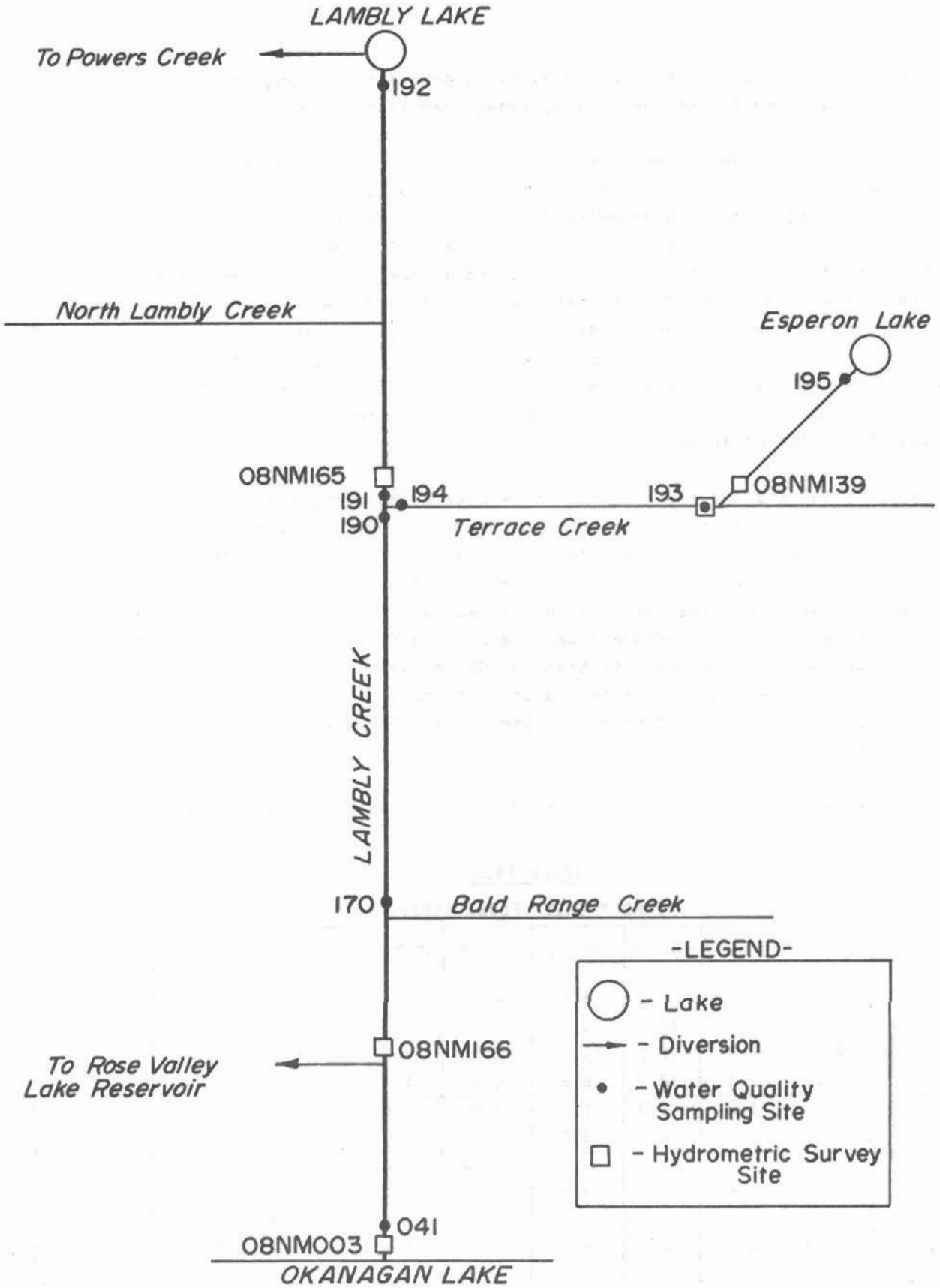
(a) Lambly Creek

Lambly Creek yielded the most accurate estimates of stream flows, as this watershed is in an essentially natural state. Furthermore, the five gauging stations were well distributed throughout the watershed.

Figure 14.5 is a schematic diagram of the watershed showing the relative locations of the water quality and hydrometric stations. Basic to estimation of flow at Water Quality Stations 170, 190 and 194 was the derivation of area-runoff curves for the watershed for each month. This analysis was based on the following assumptions:

(1) the area-runoff curves could be interpolated to estimate monthly run-offs at each water quality station.

(2) the daily flows at each station are proportional to the total monthly runoff, i.e., a station with twice the runoff as another station would have twice the daily flow.



SCHEMATIC OF LAMBLY CREEK WATERSHED.

Figure 14.5

(3) The Terrace Creek area-runoff curves could be extended along the Lambly Creek curves to account for the change in topography near Station 193.

Figure 14.6 shows the August hydrographs at the four upstream gauging stations. This Figure shows the similarity of the stream flow patterns and indicates that the daily discharges at the hydrometric stations are very nearly proportional. Thus, the second assumption is confirmed. Figure 14.7 shows the area-runoff curve for themonth of August. This curve was entered at the appropriate drainage areas to estimate the August runoffs for Stations 170, 190 and 194. Interpolating between hydrographs then yielded the daily flow estimates at these sites. An important check on the calculations was provided at the junction of Terrace and Lambly Creeks, as the estimated flow at Station 190 very nearly equalled the sum of the two upstream flows in all cases. This confirms the validity of the approach and the assumptions listed above.

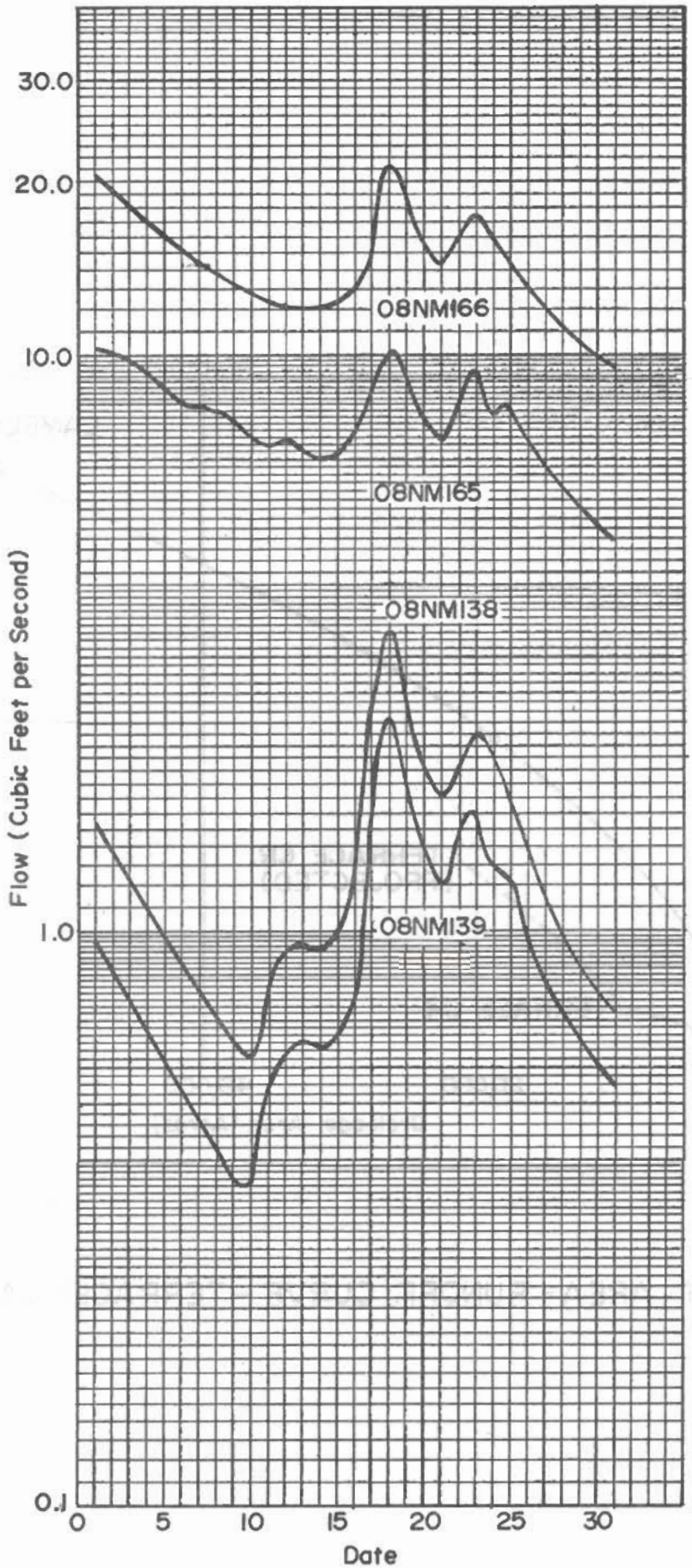
Stations 041, 191 and 193 are situated at or near hydrometric stations and, therefore, have direct stream flow measurements. At Water Quality Station 195, the area-runoff curves were used to estimate total natural runoff, and the average flow was estimated at approximately 1.5 cubic feet per second. Thus, hydrometric data for Esperon Creek (downstream of Station 195) was accepted, as this is the nearest gauging station and had an average flow of approximately 1.6 cubic feet per second during the period of the study. At Station 192, no water was discharged to Lambly Creek from Lambly Lake during the period of this study. Hence, a nominal flow was assumed to allow for seepage through the Lambly Lake Dam and for limited local inflow below the dam.

Table 14.5 shows the recorded and estimated stream flows at the water quality stations.

TABLE 14.5

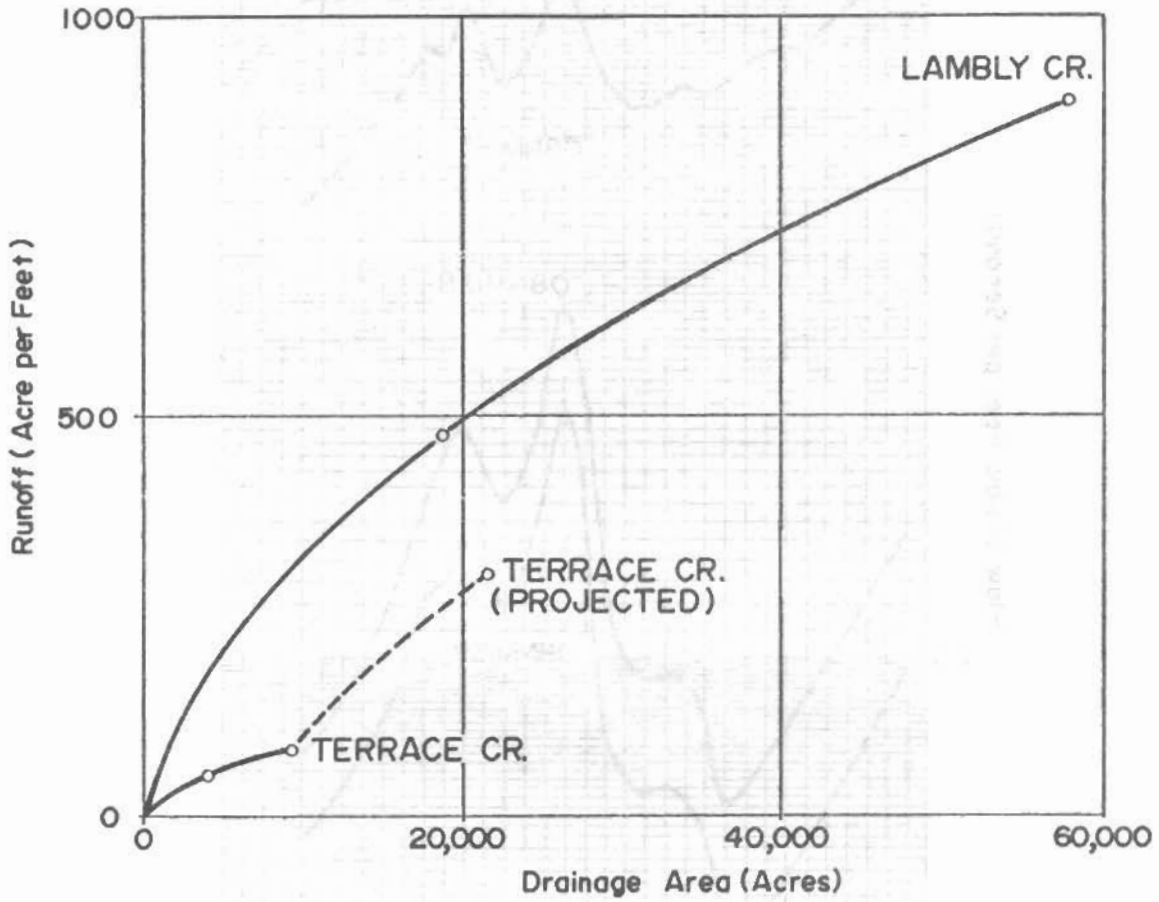
LAMBLY CREEK FLOWS (CFS)

	JULY 5	JULY 18	AUG. 1	AUG. 15	AUG. 29	SEPT. 12	SEPT. 26	OCT. 11	AVG. OF ESTIMATES
0500041	55.3	37.2	13.0	3.6	4.5	5.1	8.7	8.5	17.0
0500170	48.1	38.7	17.2	10.9	8.9	8.1	10.6	7.4	18.7
0500190	44.6	35.9	16.2	10.4	8.3	7.5	9.8	6.9	17.5
0500191	27.1	22.1	10.2	6.8	5.8	4.5	5.7	3.9	10.8
0500192	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
0500194	19.0	16.0	6.0	3.7	3.1	3.0	4.1	3.0	7.2
0500193	8.0	7.4	1.6	0.95	0.88	0.64	0.7	0.74	2.6
0500195	5.1	4.2	1.0	0.8	0.7	0.4	0.4	0.62	1.7
Diversion to Rose Valley Lake	3.2	6.9	6.2	7.9	4.0	4.5	4.5	1.1	4.8



AUGUST HYDROGRAPHS at 4 UPSTREAM STATIONS - LAMBLY CREEK

Figure 14.6



AUGUST AREA - RUNOFF CURVE - TERRACE - LAMBLY CREEKS.

Figure 14.7

Also shown are the diversions out of the watershed to Rose Valley Lake.

(b) Kelowna Creek

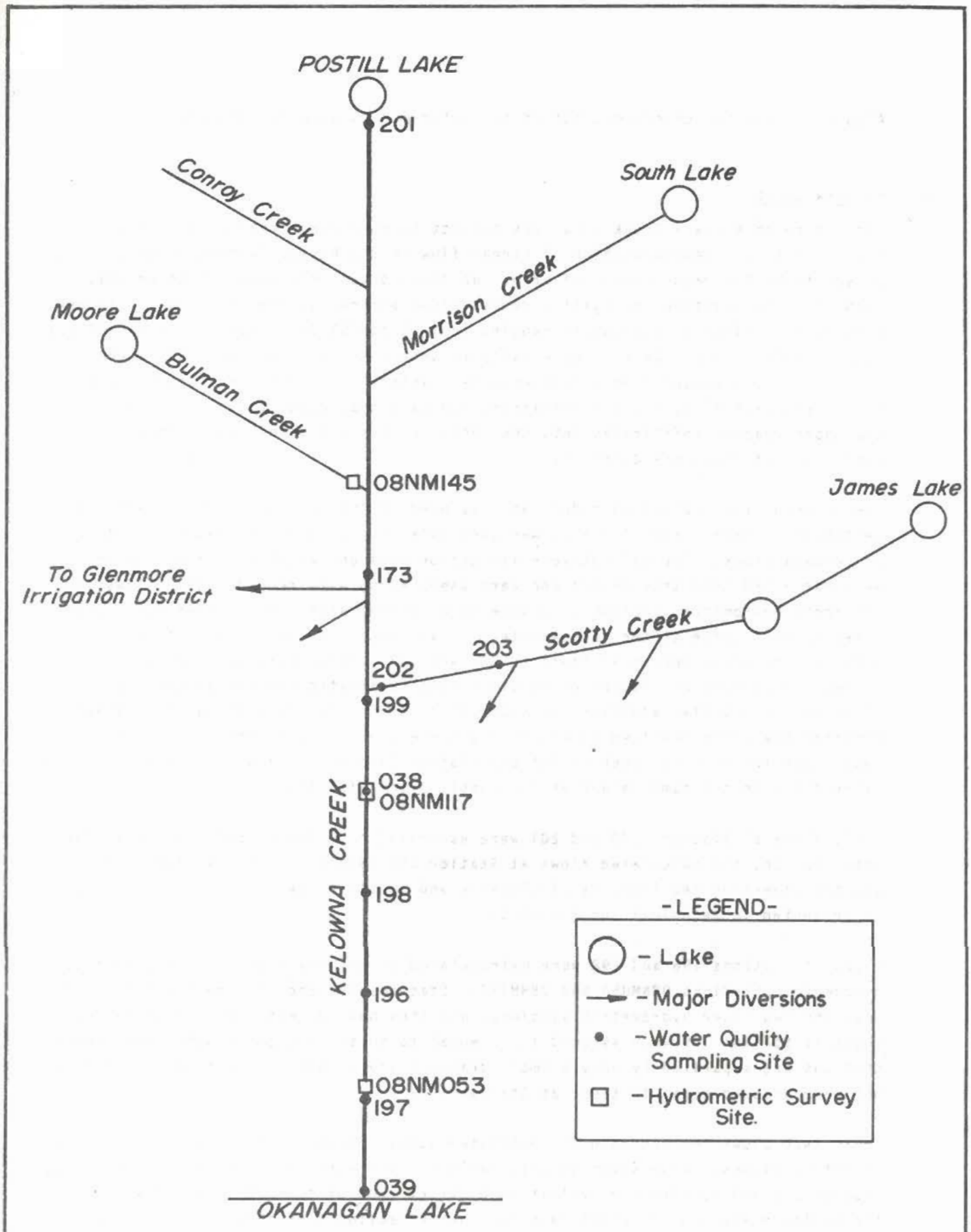
Estimation of Kelowna Creek flows was subject to more error than Lambly Creek. Figure 14.8 is a representation of stream flow in the basin. Irrigation diversions proved to be the major source of error, as these diversions were not accurately measured. In addition, irrigation return flows are not accurately known, with estimates by various investigators ranging from 0% to 50%(Technical Supplement (T.S.) I, XI and Section 7.) This is especially important in the lower reaches, where there is strong evidence of a considerable quantity of groundwater contribution to the stream. Also, field observations indicate that much of the stream flow in the upper reaches infiltrates into the ground on its way downstream. This makes estimation of flow more difficult.

The Kelowna Creek watershed model, as developed in the British Columbia Water Investigations Branch report T.S.I, was used extensively in estimating stream flows on Kelowna Creek. Typical wet-year irrigation uses and discharges from storage were extracted from this report and were used, along with recorded 1972 flows at the three hydrometric stations, to develop a natural state 1972 area-runoff curve. Entering this curve at the appropriate drainage areas yielded total natural runoffs for the study period at Stations 202 and 203. These natural flows were corrected for storage and diversion to yield total estimated runoffs at these two stations. Successive addition and subtraction of irrigation uses in this manner minimize the error involved in estimating these uses. The runoff figures and hydrograph for Kelowna Creek at Rutland station (Figure 14.9) were used to estimate daily flows in the same manner as for Lambly Creek (T.S.I).

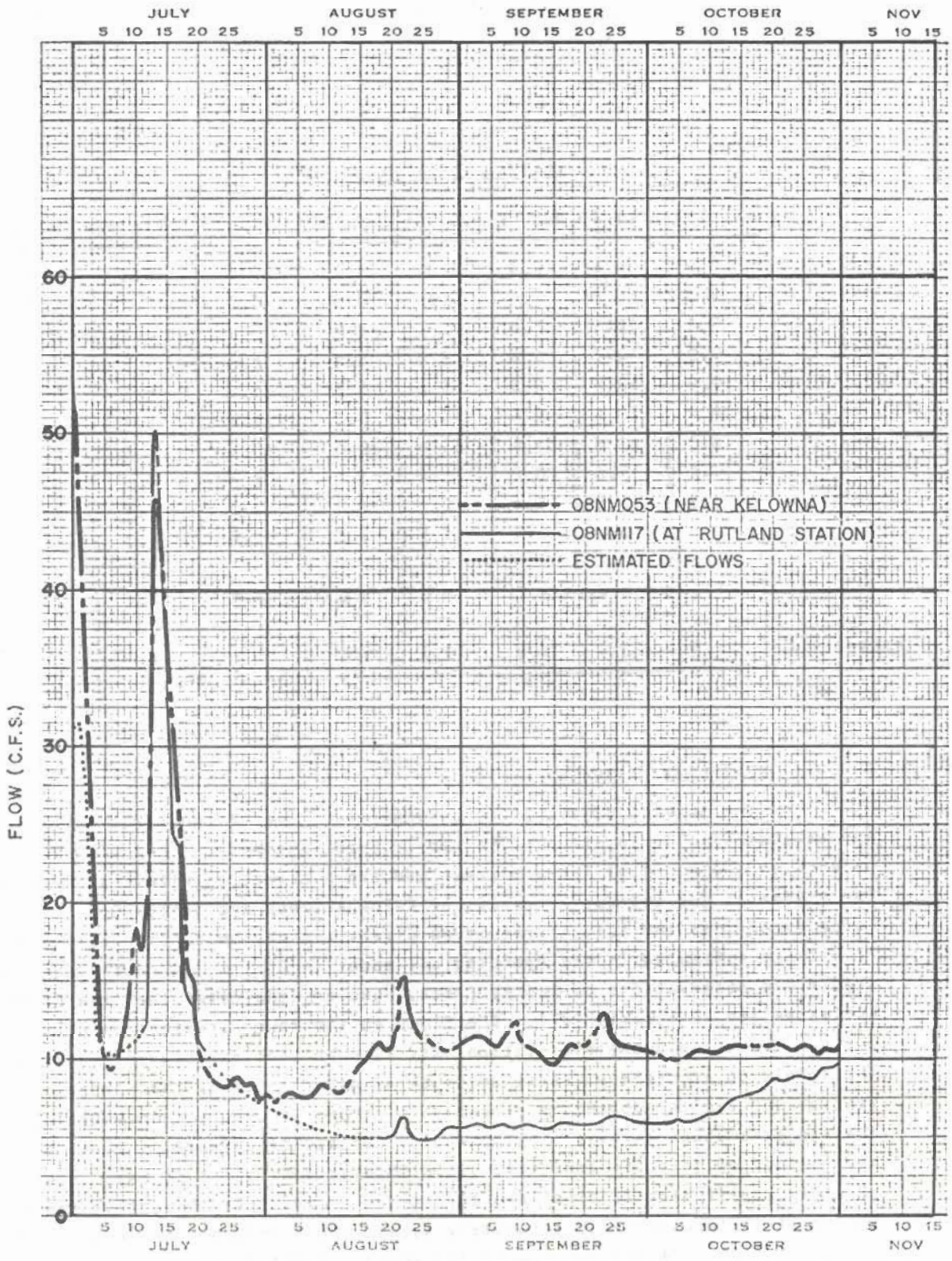
Daily flows at Stations 173 and 201 were estimated from the recorded flows at Rutland station, the calculated flows at Station 202 (Scotty Creek near the mouth), and the diversion requirements of Glenmore and Scotty Creek Irrigation Districts as presented in Technical Supplement I.

Flows at Stations 196 and 198 were extrapolated on an area basis from the data at hydrometric Stations 08NM053 and 08NM117. Stations 197 and 038 are located at or near the two lower hydrometric stations, and thus have direct flow measurements. Flows at Station 199 were assumed to be equal to those at Station 038, since these stations are separated by only a small drainage area. Similarly, flows at station 039 were assumed equal to those at Station 197.

Table 14.6 shows the recorded and estimated stream flows at the Kelowna Creek water quality stations. Also shown on this table are the estimated diversion rates above Station 203 and to Glenmore Irrigation District (out of the watershed) for use in the drainage area co-efficient calculations in Section 6 of this study (T.S.I).



SCHEMATIC OF KELOWNA CREEK WATERSHED Figure 14.8



KELOWNA CREEK HYDROGRAPHS

Figure 14.9

TABLE 14.6

KELOWNA CREEK FLOWS (CFS)

	JULY 6	JULY 19	AUG. 2	AUG. 16	AUG. 30	SEPT. 13	SEPT. 27	OCT. 10	AVG. OF ESTIMATES
0500039	9.3	14.6	7.4	9.9	10.3	10.0	10.4	10.4	10.3
0500197	9.3	14.6	7.4	9.9	10.3	10.0	10.4	10.4	10.3
0500196	9.4	14.4	7.0	9.1	9.3	9.1	9.5	9.5	9.7
0500198	9.9	13.7	6.0	6.4	6.4	6.5	7.0	7.0	7.9
0500038	10.0	13.5	5.6	5.6	5.5	5.6	6.1	6.1	7.3
0500199	10.0	13.5	5.6	5.6	5.5	5.6	6.1	6.1	7.3
0500173	18.8	27.8	21.8	23.0	22.8	11.3	11.6	3.7	17.6
0500201	8.6	17.6	10.2	11.4	11.2	8.2	8.5	2.5	9.8
0500202	10.8	5.3	3.4	2.2	2.2	2.2	2.4	2.4	3.9
0500203	7.5	3.7	2.4	1.5	1.5	1.5	1.7	1.7	2.7
Diversion at 0500203	6.0	6.0	6.0	6.0	6.0	2.4	2.4	0.0	4.4
Divsion to Glenmore I.D.	19.6	19.6	19.6	19.6	19.6	7.9	7.9	0.0	14.2

14.3.3 Discussion of Flow Estimates

From the outline above, it is evident that some of the stream flow estimates may be considerably in error. The Lambly Creek estimates check with the water balance at the mouth of Terrace Creek and are accurate to within a few percent. The estimates for the upper reaches of Kelowna Creek and Scotty Creek may have large errors, as the actual irrigation diversions may be considerably different from those estimated in the hydrological model in T.S. I. A comparison with limited field observations on Scotty Creek, however, indicates that the Scotty Creek estimates are reasonable (37). The flows at the lower stations on Kelowna Creek between the two hydrometric stations may also be considerably in error, as it is impossible to accurately assess the flow of groundwater to the stream. Also, Station 039 (at the mouth) is probably in error, as reduced concentrations of water quality parameters at this station would indicate groundwater inflow which has not been accounted for. In addition, field observations point to small contributions of storm runoff from Kelowna into the stream immediately above this station. Although it is impossible to accurately assess the magnitude of these errors, the small change in flow from Station 038 to 197 would suggest that these estimates are correct to within 10 to 15 percent. Inaccuracies in stream flows will result in errors in calculated stream loadings, and hence the loading co-efficient calculations for some of the stations on Kelowna Creek may be in error. These calculations are particularly sensitive to stream flow errors.

An important point to note is the movement of groundwater in the Kelowna Creek watershed to and from the stream during the summer study period. Field observations indicate that a significant amount of water from the stream infiltrated to the ground in the upper reaches (above the junction of Kelowna Creek and Scotty Creek) (37). Below Stations 173 and 202, groundwater flows to the stream. This water may come from the adjacent irrigated area or may be from recharge at higher elevations. In either case, the stream flow in the lower reaches at times is composed solely of groundwater flowing from irrigated land.

It is interesting to note the effect of topography and regulation on runoffs from these two creeks. Although their drainage areas are approximately equal, Lambly Creek yielded a total of 58,800 acre-feet at its mouth in 1972, or three times the runoff of 18,700 acre-feet for Kelowna Creek. Of these total annual runoffs, 16% or 3,000 acre-feet were recorded at the mouth of Kelowna Creek during the study period (July to October) as compared to 7% or 3,900 acre-feet for Lambly Creek. This is largely due to the storage of water in the spring in the Kelowna Creek headwaters and release for irrigation during the summer. In either case, the volume of runoff during the period of this study is only a small portion of the total annual runoff.

14.3.4 Loading Contributions to Kelowna and Lambly Creeks Affecting Water Quality

On the basis of the flow data, the concentrations were converted to loadings or mass fluxes at each station. Since the loadings between each station were of interest, the increases in loading between station pairs (i.e. incremental loadings) were calculated (Appendix J.2), and were average for the period July 5 to October 10, 1972. For convenience, the incremental loadings will be termed loadings in this section. The loading areas considered have been presented in Table 14.7.

TABLE 14.7

STATIONS BETWEEN SPECIFIC LAND USE AREAS

KELOWNA Stations	LAMBLY Stations
197-039	170-041*
196-197	190-170
198-196	192-191
038-198	193-194
199-038	195-193
173+202-199*	
201-173	
203-202	
above 203*	
above 038*	
038-197	

* diversions included

Since hydrometric stations were located at Stations 038 and 197, the stream loadings for these locations were considered the most reliable. The area above Station 038 consists mainly of agricultural land use activities. Between Stations 038 and 197, land use is residential, industrial and agricultural. Included in the following discussion is a comparison of the relative contributions to Kelowna Creek of these two areas based on their land use. The stream loading data considered the two diversions on Kelowna Creek and the one diversion on Lambly Creek.

Negative loadings resulted from some calculations chiefly in areas 197-039. This stems from the failure of the flow estimation model to account for groundwater flow into Kelowna Creek between Stations 1972 and 039. (The stream flow rates at these two stations were assumed identical). The concentration data also indicated a general decrease between Stations 197 to 039. According to the flow model, an increase in flow did occur between 196 and 197, but this increase apparently did not compensate for the decrease in concentrations, and negative loading values resulted. Negative loadings could also indicate a removal of the substance by sedimentation or by aquatic life.

14.3.5 Water Quality Loadings

(a) Calcium

Calcium loadings between stations on Lambly Creek ranged between 106 and 11,840 (lbs. x 10^{-6}) sec. The major calcium loading originated from the area between Stations 192 and 191. This is the largest forest and range drainage area. For Kelowna Creek, the calcium loadings ranged from -3073 to 11,490 (lbs. x 10^{-6}) sec. The major loadings originated in two of the larger areas, 198 - 196 and 173 + 202-199. The lower calcium loading from the area above 203 is attributed to the lower flow rate of Scotty Creek. Calcium loadings were proportional to the two drainage areas from the area above 038 and the area between 038 and 197.

(b) Chloride

The chloride loadings to Lambly Creek ranged between 8.1 and 154.3 (lbs. x 10^{-6}) sec. while loadings to Kelowna Creek ranged between 62 and 2262 (lbs. x 10^{-6}) sec. for individual subdrainage areas. The chloride loadings were contributed by the small drainage area between Stations 196 and 197 and by the larger drainage area between Stations 198 and 196. Also, the chloride loadings from the lower parts of Kelowna Creek were considerably higher than from the upper parts.

(c) Solids

In the Lambly watershed, total residue loadings ranged between 4676 and 54,150 (lbs. x 10^{-6}) sec. The total fixed residue loadings were the greatest in the drain-

age area between Stations 190 and 170. The total residue, total fixed residue, and filterable residue loadings were each considerably greater in lower Kelowna Creek.

(d) Nitrogen

In Lambly Creek, the differences in loadings did not reflect land use. The largest loadings occurred in the largest drainage areas.

The total kjeldahl nitrogen loading from above Station 038 in the Kelowna watershed was approximately five times greater than that between Stations 038 and 197. Locations of livestock confinement lots in areas 203-202, 199-038 and 198-196 correspond to the largest kjeldahl nitrogen loadings. The nitrate-nitrite loadings from area 0.38 to 197 were approximately six times greater than from the area above 038. This indicates loadings from groundwater resulting from non-natural sources, such as extensive irrigation and residential areas.

(e) Total Organic and Inorganic Carbon

Total organic carbon (TOC) loadings from areas below Station 199 of Kelowna Creek were lower than from any parts of Lambly Creek. The total inorganic carbon (TIC) loadings from Kelowna Creek drainage areas were comparable to those from Lambly Creek. The TIC and TOC loadings to Kelowna Creek were substantially higher for the area above 038 than that for the composite area below 038.

(f) Phosphorus

The Total phosphorus loadings for Lambly Creek were between 0.89 and 9.80 (lbs. x 10^{-6}) sec. Area 190-170, which is the smallest drainage area, had the highest loading. For Kelowna Creek, the total phosphorus loading from the area above 038 was considerably higher than that of the area between 038 and 197, again reflecting the larger drainage area. The highest loading occurred in the area between 201 and 173 which is undisturbed range.

The largest orthophosphorus contribution to Lambly Creek originated from the area closest to the mouth. This could have been conveyed to the stream by groundwater or the insoluble fraction of the total phosphorus in the stream may have been solubilized to a large extent between these two stations. In Kelowna Creek, the major orthophosphorus loading occurred in area 038 to 198.

(g) Hardness

Input of hardness to the Lambly Creek ranged between 353 and 39,130 (lbs. x 10^{-6}) sec. for the areas examined. To Kelowna, hardness input ranged from -5005 to 42,370 (lbs. x 10^{-6}) sec. The largest hardness contribution occurred in the composite area

above 038 on Kelowna Creek. This was approximately twice that of the contribution between 038 and 197, reflecting the much larger area above 038 and the subterranean flow between 173 and 199, 203 and 202. Individual increases were greatest in the lower reaches, with the highest between 198 and 196.

14.3.6 Drainage Area Coefficients

Drainage area coefficients have been calculated for each parameter and date for all cases in which inter-station areas can be meaningfully defined. These coefficients represent the contribution per acre to the stream by the individual areas.

Tables 14.8 and 14.9 show the drainage area coefficients for Lambly and Kelowna Creeks respectively. An Analysis of Variance, using a randomized block design, was used to determine if a significant difference existed among the values of drainage area coefficients for each date and drainage area.

TABLE 14.8

LAMBLY CREEK

DRAINAGE AREA COEFFICIENTS (lbs x 10^{-6}/ acre-sec)

	170-041	190-170	192-191	193-194	195-193
ORTHO-P	a .00035	a .00060	a .00013	a .00024	a .00001
TOTAL P	a .00012	a .00033	b .00227	a .00051	a .0001 *
N: KJELDAHL	a .00054	a .01106	a .00669	a .00610	a .00017
N:NO_3 + NO_2	a .0008	a -.00136	a .00029	a .00013	a .00004
TIC	a -.0334	c .655	bc .421	ab .266	a .039 *
TOC	a -.107	a .144	a .214	a .141	a .0602
Residue:filterable	bc 2.421	c 3.777	bc 3.241	ab 1.633	a .271 *
Residue:total	a .643	a 11.01	a 3.42	a 3.98	a .529
Total Fixed Residue	a .31	a 10.47	a 2.52	a 1.38	a .464
IRON	a -.00035	a -.00112	a .00367	a .00254	a .00130
CALCIUM	a .602	a 1.734	a .754	a .367	a .0119
CHLORIDE	b .00976	c .01749	ab .00744	ab .00742	a .00092 *
HARDNESS	a 1.9943	a 5.781	a 2.311	a 1.1249	a .0401

*Significant Differences Among Stations (5% or better)

a<b<c<d<e

TABLE 14.9

KELOWNA CREEK

DRAINAGE AREA COEFFICIENTS (lbs x 10^{-6}/acre-sec)

PARAMETERS \ DRAINAGE AREA	039-197	196-197 197to196	196to198	198to038	199-038 038to199	199to173 202	173to201	202to203	203	038*	197to038*
ORTHO-P	b -.00262	a -.00976	bc .0010	c .00369	bc .00177	bc .00071	bc .00066	c .00318	bc .00061	.000841	.000368
TOTAL P	b .0169	a .0133	b .0010	b .0042	b .0000	b .0008	b .0018	b .0062	b .0015	.0017	.0014
N: KJELDAHL	a -.0169	a .0553	a .0098	a -.0027	a .0517	a -.0061	a .0180	a .0199	a .0196	.0181	.0099
N:NO_3 + NO_3	a -.114	c .403	b .0623	b .0257	b .0292	b -.00471	b .0046	b .0254	b .00071	.0041	.0766
TIC	a -.720	a -1.36	a .724	a .658	a 1.36	a .750	a .316	a 1.03	a .428	.452	.569
TOC	a -.550	a .594	a -.0167	a .225	a .301	a -.262	a .463	a .261	a .695	.445	.0841
Residue:filterable	a -9.765	a -15.248	b 6.556	b 8.811	b 13.597	b 5.645	b 3.806	b 8.137	b 4.961	4.756	5.662
Residue:total	b -2.79	a -16.9	b 7.51	b 4.74	b 19.9	c 5.65	b 4.33	b 8.81	b 5.33	5.44	5.21
Total Fixed Residue	b 4.822	a -15.663	b 3.754	b 3.753	c 18.903	b 4.184	b 2.774	b 5.991	b 2.840	3.731	2.456
IRON	a -.0286	c +.0440	ab +.00406	ab -.00631	abc -.00907	ab -.0104	bc .0225	abc .00598	bc .0155	.0131	.0029
CALCIUM	a -3.6915	b -.4500	cd 1.0999	cd 1.1863	d 2.3131	cd 1.6161	bc .4131	cd 1.6448	bcd .8025	.8025	1.020
CHLORIDE	a .2274	b 1.6567	a .2434	a .1516	a .0330	a .0405	a .0160	a .1396	a .0266	.0351	.3172
HARDNESS	a -8.52	a -5.50	bc 4.56	bc 3.95	c 10.4	bc 4.95	b 1.69	bc 6.04	b 2.78	2.87	3.75

* not included in statistical analysis a<b<c<d<c

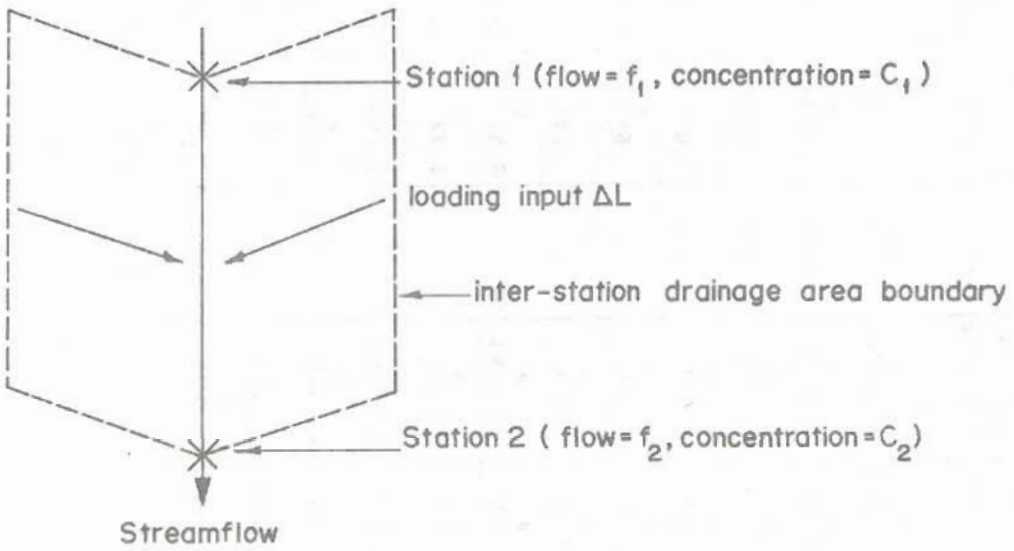
\+ significant differences among means

Because all calculations were performed by hand or with a Wang Model 500 desk-top calculator, missing data were supplied by estimation of concentration and subsequent calculation, instead of statistical techniques.

Duncan's New Multiple Range Test (38) was used to determine, for those groups of station means that shows significant differences at the 5% level or better, exactly which stations were significantly different.

Tables 14.8 and 14.9 give the values of the drainage area coefficients for Kelowna and Lambly Creeks. On these tables, asterisks indicate those parameters for which the Analysis of Variance indicated that significant differences exist among the coefficients. The superscripts indicate exactly where the significant differences occur. Those means with common super-scripts are not significantly different, as determined by Duncan's New Multiple Range Test. Means or groups of means with no common superscripts are significantly different. Table 14.8 also presents coefficient values for the two composite ares (above 038 and 038-197) which were not included in the statistical analysis.

14.3.7 Method of Calculation of Drainage Area Coefficients



Two water quality stations are assumed to exist on a section of a creek. Concentrations C_1 and C_2 at the two stations have been determined by sampling and analysis; flows f_1 and f_2 have been determined by hydrometric measurement or interpolation between measurements. The change in loading (mass flux) between the stations is calculated by the following:

$$\Delta L = 62.37\ (f_2 \times C_2) - 62.37\ (f_1 \times C_1)$$

where ΔL = change in loading (lbs x 10^{-6}/sec.)

This change in loading is attributed to the input to the creek between the stations.

The means of these values have been presented and discussed in Section 5 of this report. Where applicable, loadings removed by stream diversion have been estimated and included in the calculations. The "drainage area coefficient" is calculated by dividing the change in loading (L) by the area contributing to the creek.

$$a = \frac{\Delta L}{A}$$

a = drainage area coefficient $\frac{(\text{lbs} \times 10^{-6})}{(\text{acre-sec})}$

(a) Kelowna Creek

The high occurrence of negative values for drainage areas 197-039 and 196-197 results from negative loading values at these stations and indicates possible error in the hydrologic model.

Among the seven remaining non-composite drainage areas in Table 14.8 it is evident that there are few significant differences between drainage area coefficients. This indicates that generally the different make-up of land uses has made little difference in the effect of drainage on water quality. Several differences may be apparent but cannot be attributed to factors other than random distribution, due to the small number of samples under consideration.

Drainage area 199-038 stands out from the other drainage areas, with significantly different coefficients for total residue (105°C), total fixed residue (550°C), calcium, and hardness, and high values (although not statistically significant) kjeldahl nitrogen, total inorganic carbon, and filterable residue.

These observations would tend to indicate an inflow of groundwater or return irrigation flow.

A large portion of the increase in residue is in the form of "non-volatile" or fixed residue (550°C).

The high value for kjeldahl nitrogen may be due to near-short livestock operations, but is not supported by the other indicator parameter coefficients.

(b) Lambly Creek

Analysis of Variance of the Lambly Creek drainage area coefficients indicates that significant differences among stations occurred with only four parameters: total phosphorus (significant at 1%), total inorganic carbon (5%), filterable residue (1%), and chloride (1%). (See Table 14.9).

No specific land use nor point source can explain the higher input of phosphorus from the area between Station 192 and Station 191.

The drainage area coefficients for total inorganic carbon, filterable residue and chloride for the area between Stations 170 and 190 are indicative of the effects of soil disturbance in the form of road-building, log yarding, land slides, and drainage from the well-used logging roads that are tangent to the Creek at many points.

Figure 14.10 indicates, in terms of groups of significant difference, the total inorganic carbon, filterable residue and chloride inputs for the five drainage areas considered. Generally the extent of near-creek activity due to the forest harvesting in these areas corresponds to the contours of these three charts. On the other hand, logging farther from the creek in the drainage area between Stations 195 and 193 of Lambly Creek is not manifested in higher drainage area coefficients for that area over other areas on Lambly Creek.

(c) Comparison of Lambly and Kelowna Creeks

For every parameter, the maximum drainage area coefficients for Lambly Creek are lower than the maxima for Kelowna Creek, indicative of the different nature of the creeks in terms of slope, accessibility, population density, agriculture, and near-creek activities.

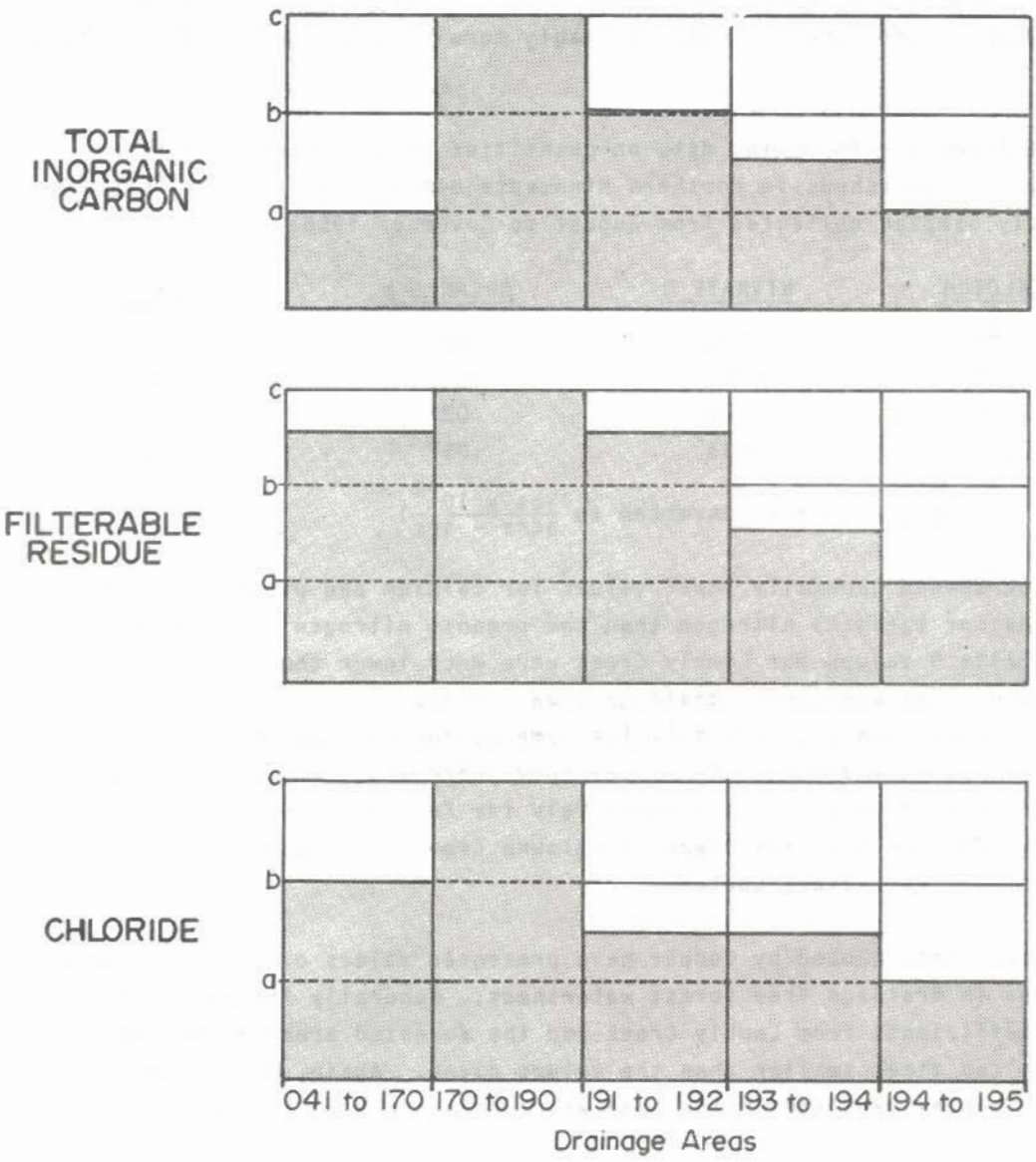
Drainage area coefficients for the upper reaches of Kelowna Creek were found to be comparable to those for Lambly Creek. These areas are relatively similar in topography and land use. In contrast, the coefficients for the upper reaches of Kelowna Creek were found to be comparable to those for Lambly Creek. These areas are relatively similar in topography and land use. In contrast, the coefficients for the lower stretch of Kelowna Creek were considerably larger, thus reflecting the more intensive land use.

(d) Comparison with Other Studies

Patel and Johnston (39) give the following contributions by 200 square miles of rural area on the Speed River near Guelph, Ontario:

Parameter	lbs x 10^{-6}/acre-sec
NO_3-N	0.108
NO_2-N	0.000506
Total - N	0.143
Chloride	1.2
Orthophosphate	0.0121

The corresponding drainage area coefficients for Kelowna Creek are, with the exception of chloride, up to an order of magnitude smaller than the values shown. (Chloride is much lower on Kelowna Creek). Assuming that the rural land areas are similar, these differences can be attributed in part to the full year sampling period on the Speed River, as opposed to the summer sampling period of this Study.



LAMBLY CREEK - LEVELS of SIGNIFICANT DIFFERENCES in DRAINAGE AREA COEFFICIENTS.

Figure 14.10

Loadings to Okanagan Lake in the sampling period represented about 10% of the annual loading from Kelowna Creek. This indicates the importance of sampling the heavy spring freshet in a Study of this type. Sampling over a full year would yield higher drainage area coefficients, probably more closely approximating those shown above.

Cooper (67) presented the following data on quantities of selected elements removed from forested watersheds in Northern Minnesota determined from the weighted average of weekly samples collected from August to November 1966:

AREA	CALCIUM	NITRATE N	ORGANIC N	PHOSPHORUS
2	6.65	.075	.061	.0031
3	6.65	.062	.059	.0052
4	1.16	.007	.027	.0024
6	2.67	.033	.057	.0038

(Original data converted to $\frac{\text{lbs} \times 10^{-6}}{\text{acre - sec}}$)

Lambly Creek showed generally lower values for calcium and phosphorus and much lower values for kjeldahl nitrogen than the organic nitrogen shown above. Nitrate plus nitrite N values for Lambly Creek were much lower than the nitrate values shown above. The phosphorus drainage area coefficients for the forested areas of Kelowna Creek were approximately the same as for the lowest values recorded by Cooper. Calcium and nitrate values above were about the same as calcium and nitrate plus nitrite values respectively for Kelowna Creek. Kjeldahl nitrogen coefficients for the same areas of Kelowna Creek were about one-half the magnitude of the smallest values quoted.

Several researchers quoted by Cooper have presented values of annual elemental contributions in drainage from forest watersheds. Generally the values of drainage-area coefficients from Lambly Creek and the forested areas of Kelowna Creek are two to ten times smaller than the values given. Again, this difference is accounted for by the sampling period upon which this study is based.

14.3.8 Conclusions and Recommendations

The exact effects of specific land use activities on stream water quality were not determined; hence, predictions of future water quality based on population growth and land use requirements could not be made.

The following reasons are cited for this inability:

(1) The sampling period encompassed only the summer period of a year of above-average precipitation.

(2) The number and locations of water quality and hydrometric stations were inadequate to provide a sensitive and accurate estimate of the dynamic water quality and quantity of the streams under study.

(3) Land use activities on Kelowna Creek were not sufficiently segregated and independent to permit determination of their specific effects.

Despite the inability to extrapolate the results of this study to other tributaries in the Okanagan Basin, the following can be concluded regarding Kelowna and Lambly Creeks:

(1) that forest-harvesting outside the immediate area of Lambly Creek watercourse has had little effect on stream water quality;

(2) that logging road construction and use close to Lambly Creek has caused deterioration of stream water quality, as evidenced by significantly higher drainage area coefficients and higher concentrations of indicator parameters;

(3) that specific point-sources of pollution on Kelowna Creek have more effect on water quality than general land use activities, and sources near the creek have a more direct effect than those located at a greater distance.

Based on the findings of this Study, these recommendations are made:

(1) Future logging road locations be such that the effects of construction and use be minimized. Roads should be located so that soil disturbances are kept to a minimum and are remote from stream courses. Road runoff should be dispersed into forest areas rather than channeled into streams.

(2) Objectives should be established for improving shoreline land use and land management to eliminate sources of pollution adjacent to or on streams. Examples of sources of pollution considered undesirable for near-stream locations are animal confinement units, refuse piles, and unrestricted access by large numbers of agricultural animals.

(3) Buffer zones of natural vegetation should be established along creeks and streams to minimize the effects of future development on water quality and to maintain nutrient loadings to the Okanagan Basin at their present levels.

PART III

RECOMMENDED QUALITY CONTROL PROGRAMS

CHAPTER 15

Future Monitoring Program

15.1 INTRODUCTION

The Okanagan Study has revealed the need for an improved monitoring system with respect to water quality and waste treatment. Only through an adequate sampling of existing conditions and the changes or trends that are taking place is it possible to check the adequacy of the proposed water management plans as outlined in the final report.

Even prior to the signing of the Okanagan Basin Agreement in October, 1969, it was recognized that there was a serious lack of hydrometric, meteorological and water quality stations in the basin, and in the spring of 1969 the two governments undertook to initiate a number of new stations.

While such additional stations would provide only two or three years of record prior to the evaluation stage of the study they would at least provide some information particularly in the tributaries where little or no data were available. Moreover, these new stations provided an improved base for water management decisions.

Fortunately, during 1969 to 1973 some extreme hydrological events occurred including two single year droughts in 1970 and 1973 as well as a record flood in 1972 which in total volume exceeded the 1948 flood.

Also during the study period, and in particular in 1971, excessive nutrient input to several main valley lakes produced algae and other aquatic plant growths.

15.1.1 Implementation of Monitoring Program

It is important that the water quality and quantity surveillance system be integrated in such a fashion that specifications are uniform as to the accuracy of data to be obtained and to insure system compatibility. Previous systems have tended to be ineffective because of lack of coordination.

Therefore, a single agency should serve to coordinate the pollution evaluation and related water quality surveillance activities. Surveillance systems development and standardization, as well as primary data-handling responsibility, should be with this single agency.

(a) Water Quality

There are a number of existing surveillance agencies which are involved in the monitoring of water quality in the Okanagan Valley. These agencies should continue their involvement in water quality and quantity monitoring through a modified surveillance program. The following is a brief comment on the various existing agencies.

The British Columbia Pollution Control Branch (PCB) has an established program of monitoring positive discharges. Significant waste discharges are monitored by the discharger in compliance with waste discharge requirements stipulated by the PCB. These data are supplemented by sampling conducted by the PCB's District staff who monitor the effluent discharge, water quality above the zone of influence and water quality in the zone of influence.

The Department of Public Health requires public water suppliers to periodically report certain water quality parameters of importance to public health.

In addition to the various provincial agencies, several federal agencies collect water quality information within their respective areas of interest and conduct studies. Particularly significant among these is the Environmental Protection Service (EPS).

The B.C. Pollution Control Branch is currently preparing and implementing a data management system capable of satisfying the needs of a provincial surveillance program. Similarly, the EPS has established a data management system capable of satisfying the national interest.

15.1.2 Objective and Scope of Monitoring System

Effective management of the water resource requires four categories of water quantity and quality monitoring. First, quantity and quality measurements are required of controllable sources of inputs and outputs to and from the resource pool. Included in these controllable sources are water storages, diversions, irrigation discharges, waste treatment discharges. Monitoring of these controllable sources and sinks is necessary to provide day to day decisions on water management. Secondly, the river, lake and groundwater quantity and quality must be measured to

TABLE 15.1

WATER QUANTITY, QUALITY AND WASTE TREATMENT MONITORING

	(1) and (2)	(3)	(4)
OBJECTIVES	To provide current data on water storages, diversions, discharges, precipitation, temperature, water quality and waste water treatment for day to day decisions on water management.	To provide a check on the water quantity models developed during the Okanagan Study as well as the nutrient loadings and Limnology changes that have been forecast for the next 10 to 15 years assuming tertiary or equivalent treatment is undertaken as outlined in the findings and recommendations.	To provide a basic data bank on hydrology, Limnology and water quality of sufficient length and detail for a comprehensive statistical analysis.
LIMITS			
Quantity	Exclusive of storage reservoirs 100 ac.ft. Exclusive of diversions 50 ac.ft./year Exclusive of minor tributaries	Same as for (1)	Modifications indicated from experience gained under (1) and (2).
Quality	Main beach areas, water supply sources, main valley lake and river system and selected tributaries.		
Waste Water Treatment	All municipal, industrial and areas served by septic tanks having positive effluent discharges		
ACCURACY			
Quantity	Main valley lake system within 10% Principle tributary discharges within 20%	Same as for (1)	Accuracy main valley lake system as in (1). Principle tributaries accuracy improved to those shown in Table
Quality	Commensurate with water quality.		
Waste Treatment	Commensurate with water quality.		
APPROACH	Operating monitoring stations as required to provide interpretations needed.	Same as for (1)	Establishment of 25 years of continuous records of water discharges in principle tributaries. Through regression analysis establish relationships between basin and climatic factors and runoff for use in ungauged minor streams.

assure compliance and non-compliance with federal and provincial standards based upon beneficial use and water quality requirements. Thirdly, the effects on water quality and quantity from manipulation of the water resource must be determined and evaluated. The water quantity models developed during the Okanagan Study as well as the nutrient loadings and acceptable limnological nutrient loads can be checked to determine if the tertiary treatment recommended is adequate for the following 10 to 15 years. Fourthly, the monitoring stations and data for the above three objectives are to a large degree complementary and provide a data bank of sufficient detail and, in time, length for a comprehensive statistical analysis and a basis for future planning and design.

Based on the four objectives, a framework monitoring program is summarized in Table 15.1. The Table indicates the limits, accuracy and approach for each of the four objectives with an understanding that a review of the study will be undertaken in 1980.

The design of a surveillance program must take into account general considerations relating to the program objectives, the constraints imposed by resource and information availability, and the sensitivities of various factors which influence the choice between management alternatives as determined from the sampling programs which were conducted during the Okanagan Study. Furthermore, limits must be placed on the monitoring to make it practical and economical. Thus, minor storages and diversions are not included because they do not have a significant effect on water quantity modelling. Further, stations are limited for the most part to valley lake and river systems and the principle tributaries. Under objective four it is anticipated that 25 years of quantity records are needed at the mouths of selected tributaries. The suggested 25 year period of continuous common record for selected tributary streams is based on U.S. Geological Survey Paper 2028 entitled "A National Study of the Streamflow Data-Collection Program" from which the following Table 15.2 has been selected.

TABLE 15.2

ACCURACY STANDARDS FOR ARIZONA STREAM GAUGING BASED ON 25 YEARS OF RECORDS FOR PRINCIPLE STREAMS FROM WHICH ARE DERIVED STATISTICAL DATA FOR MINOR STREAMS HAVING AN ESTIMATED ORDER OF ACCURACY EQUIVALENT TO 10 YEARS

CHARACTERISTICS	ACCURACY (Standard Error in) (Percent of Mean)	
	MINOR STREAMS	PRINCIPLE STREAMS
Mean Annual Discharge	33	21
Mean Monthly Discharge (Average	65	41
Standard Deviation of Mean Annual Discharge	22	14
Standard Deviation of Monthly Discharge (Ave)	22	14
Seasonal Discharge (July-September)	40	25
50 Year Flood	60	37
50 Year 7 Day High Flood	60	37
2 Year 7 Day Low Flood	18	12
20 Year 7 Day Low Flood	29	18

15.1.3 Water Quality Requirements

Surveillance of the resource pool requires a knowledge of the present quality level and the beneficial uses for which the water resource is required. The following categories have been established to aid in delineating the water quality parameters required for analysis.

(a) Domestic Water Quality Requirements

Domestic water supply, being the most necessary for the continuance of human life, is generally considered the highest beneficial use of water. Similarly, the nature of the return surface and groundwaters has historically caused most concern to man for health and aesthetic reasons. Therefore, municipal use seems worthy of first attention.

The quality of water which in the resource pool, for example, Lake Okanagan, varies widely. In general, the following considerations generally apply. To be suitable for domestic purposes, the raw water supply should meet the B.C. Health Branch's Recommended Receiving Water Quality Standards, in all factors where absolute limits are specified. These recommendations are for drinking water treatment plants having normal water treatment technology, i.e. sedimentation, coagulation, filtration and chlorination.

The quality standards which are recommended, but not obligatory, should be exceeded only as a result of characteristics of the natural water and not as a result of the increments added by return waste waters; for example, tolerances of such things as salinity and hardness, should not be imposed as a result of quality depressions by previous beneficial use of the raw water. Table 15.3 lists the recommended and acceptable standards. Concentrations in excess of these limits are cause for action by the Health Branch or the overall coordinating agency in rejecting the water for consumption. The recommended characteristics may, in some instances, be less than those which naturally occur in the raw water supplies. A full presentation of the significance of various quality factors is beyond the scope of this work but may be found in the work of McKee and Wolf.

Many raw water sources which do not meet these permissible criteria have been used to provide potable water. Equipment may be added to the conventional treatment system to bring the quality up to standard. These standards, Table 15.3, are considered realistic for B.C. as most of the treatment plants are relatively small without sophisticated controls. The list of water quality parameters is extensive and therefore only a few water quality parameters commonly of concern in the Okanagan will be selected for routine monitoring, unless problems dictate otherwise.

TABLE 15.3

B.C. HEALTH BRANCH RECOMMENDED RECEIVING WATER QUALITY STANDARDS

	LIMITS - mg/l	
	STANDARD (MAX. PERMISSIBLE CONCENTRATION)	OBJECTIVE
Toxicant		
Arsenic (As)	0.05	N.D.[1]
Barium (Ba)	1.0	N.D.
Boron (B)	5.0	5.0
Cadmium (Cd)	0.01	N.D.
Chromium (Cr^{+6})	0.05	N.D.
Cyanide (CN)	0.20	N.D.
Lead (Pb)	0.05	N.D.
Nitrate + Nitrite (N)	10.0	10.0
Selenium (Se)	0.01	N.D.
Silver (Ag)	0.05	-
Biocide[2]		
Aldrin	0.017	NOT
Chlordane	0.003	
DDT	0.042	DETECTABLE
Dieldrin	0.017	
Endrin	0.001	BY
Heptachlor	0.018	
Heptachlor Epoxide	0.018	ACCEPTABLE
Lindane	0.056	
Methoxychlor	0.035	CURRENT
Organic Phosphates + Carbamates	0.100[3]	
Toxaphene	0.005	TESTS
Herbicides (2, 4-D, 2, 4, 5-T, 2, 4, 5-TP)	0.100	
Radioactive Substances	The ICRP occupational (MPC)w for 168-hour week.	1/10 of the ICRP occupation (MPC)w for 168-hour week[4,5]
Chemical		
Calcium (Ca)	200	75
Chloride (Cl)	250	250
Copper (Cu)	1.0	0.01
Fluoride (F)	1.5	1.2+0.2
Magnesium (Mg)	150	50
Manganese (Mn)	0.05	0.01
Methylene Blue Active Subst.[6]	0.5	0.2
Organics as CCE + CAE[7]	0.2	0.05
Phenolics (Phenol)	0.002	N.D.
Phosphates (inorganic) (PO_4)	0.2	0.2
Sulphate (SO_4)	500	250
Sulphide (H_2S)	0.05[8]	N.D.
Total Dissolved Solids	1000	500
Total Hardness ($CaCO_3$)	180	120
Zinc (Zn)	5.0	1.0

[1] Not detectable by the method described in the latest edition of "Standard Methods" (AWWA, APHA, WPCF) or by any other acceptabe method approved by the Minister.

[2] As parathion in cholinesterase inhibition.

[3] Conventional water treatment has little effect on all biocides.

[4] ICRP - International Commission on Radiological Protection.

[5] (MPC)w - Maximum Permissible Concentration in Water.

[6] Measures the presence of detergents.

[7] Total of carbon chloroform and carbon alcohol extractibles.

[8] Based on taste and odour considerations.

(b) Industrial Water Requirements

By far the most varied spectrum of quality requirements of beneficial uses is found in industrial water needs. Table 15.4 indicates the water quality tolerances for several industrial applications, as well as illustrating that the needs of industry cannot become the criterion by which the quality of fresh water in the Okanagan is managed. Therefore it would seem axiomatic that industry will have to continue to treat water in accordance with its own needs for process water.

(c) Agriculture Water Quality Requirements

Only a few of the more important factors which define the quality of water acceptable to growing plants are outlined. They are, of course, based on the limitations of current species of plants and presuppose the maintenance of a situation in which the crops to be planted by the farmer are governed by factors other than water quality.

The water quality requirements for irrigation are broadly developed on the basis of salinity, sodium, boron, calcium, magnesium and bicarbonate concentrations. Salts affect the growth response of plants which have difficulty in obtaining water from saline solution; however soil characteristics are not adversely affected by high concentrations of salts if sodium is low in comparison with calcium and magnesium. Sodium renders soils impermeable to air and water and when wet, the soils become plastic and sticky. For irrigation water with low salt concentration, as can usually be expected in the Okanagan tributaries, the bicarbonate content of water presents the greatest problem.

Water having high carbonates can have $CaCO_3$ precipitated during the evaptranspiration process. This results in a rapid increase in the ratio of sodium to magnesium and calcium (SAR). Table 15.5 presents recommended criteria for water used to irrigate a number of crops.

(d) Recreational Water Quality Requirements

Recreational uses of water refers to boating, bathing, swimming, and other water-contact sports. The general criterion for recreational use of water is freedom from obnoxious suspended or floating material, objectionable colour, or foul odours. Toxic materials and pathogenic organisms should also be excluded. The following Table 15.6 is a list of water quality guidelines for evaluating recreational water.

(e) Domestic Animal Water Quality Requirements

Water quality for domestic animals is not as stringent as drinking water criteria; however, the sensitivity of animals varies considerably. The following Table 15.7 is a list of chemical parameters most likely to cause concern. Of particular concern is nitrate concentration. Nitrate levels in water have been considered responsible

TABLE 15.4

TYPICAL QUALITY FACTOR LIMITS FOR SELECTED INDUSTRIES (Values in mg/liter)

TYPE OF INDUSTRY	TURBIDITY	COLOR	HARDNESS	ALKALINITY	pH	TOTAL DISSOLVED SOLIDS	Fe and Mn
Baking	10	10	...	...	...	...	0.5
Boiler Feed[1]							
0-150 psi	20	80	75	...	8.0+	3000-1000	
150-250 psi	10	40	40	...	9.5+	2500-500	
250 psi	5	5	8	...	9.0+	1500-100	
Brewing[2]							
Light	10	...	...	75	6.5-7	500	0.1
Dark	10	...	...	150	7.0	1000	0.1
Canning							
General	10	...	...	...	...	...	0.2
Legumes	10	...	25-75	...	...	...	0.2
Carbonated beverages	2	10	250	50	...	850	0.3
Confectionery	...	...	50	...	...	100	0.2
Cooling	50	...	50	...	...	...	0.5
Ice making	1-5	5	...	30-50	...	300	0.2
Laundering	...	...	50	...	...	...	0.2
Clear Plastics	2	2	...	...	...	200	0.02
Pulp and Paper							
Groundwood	50	20	180	...	...	...	1.0
Kraft	25	15	100	...	...	300	0.2
Soda and Sulfite	15	10	100	...	...	200	0.1
Light Paper	5	5	50	...	...	200	0.1
Rayon (viscose)							
Production	5	5	8	50	...	...	0.005
Manufacture	0.3	...	55	...	7.8-8.3	...	0.0
Tanning	20	10-100	50-135	133	8.0	...	0.2
Textiles							
General	5	20	20				
Dyeing	5	5-20	20	...	...	...	0.25
Wool Scouring		70	20	...	...	...	1.0
Cotton Bandage	5	5	20	...	...	...	0.2

[1] No D.O.; Al_2O_3, 5-0.5; SiO_2, 40-5; CO_3, 200-40; HCO_3, 50-5; OH, 50-30.

[2] Ca, 100-500; $CaSO_4$, 100-500; low odor.

SOURCE: American Water Works Association

TABLE 15.5

CRITERIA FOR EVALUATING THE QUALITY OF WATER USED FOR IRRIGATION

PARAMETER	THRESHOLD[1]	LIMITING[2]
Coliform organisms, MPN/100 ml	1000***	---
Total dissolved solids (TDS), mg/l	500	1500
Electrical conductivity, umhos/cm	750	2250
Range of pH	7.0-8.5	6.9-9.0
Sodium absorption rate (SAR)	6.0	15.0
Inorganic Carbon, mg/l	Depends on salinity	
Boron, mg/l	0.5	2.0
Copper, mg/l	0.1	1.0
Chloride, mg/l	100	350
Sulphate, mg/l	0.1	1.0

[1]Threshold value is the value at which an appraisal of irrigation rate should be reconsidered.

[2]A detailed sampling program should be considered to adequately protect the supply.

[3]This level applies to raw fruits and vegetables.

SOURCE: McKee and Wolf

TABLE 15.6

RECOMMENDED CRITERIA FOR RECREATIONAL WATERS

DETERMINATION	WATER CONTACT		BOATING AND AESTHETIC	
	NOTICEABLE THRESHOLD	LIMITING THRESHOLD	NOTICEABLE THRESHOLD	LIMITING THRESHOLD
Coliforms, MPN per 100 ml	1000	*	--	--
Visible solids of sewage origin	None	None	None	None
ABS (detergent), mg/liter	1	2	1	5
Suspended solids, mg/liter	20	100	20	100
Floatable oil and grease,mg/liter	0	5	0	10
Emulsified oil and grease, mg/liter	10	20	20	50
Turbidity, silica scale units	10	50	20	**
Colour,standard cobalt scale units	15	100	15	100
Threshold odour number	32	256	32	256
Range of pH	6.9-9.0	6.0-10.0	6.5-9.0	6.0-10.0
Temperature, maximum °C	30	50	30	50
Transparency, Secchi disk, ft.	--	--	20	--

*No limiting concentration can be specified on the basis of epidemiological evidence, provided no fecal pollution is evident. (Note: Noticeable threshold represents the level at which people begin to notice and perhaps to complain. Limiting threshold is the level at which recreational use of water is prohibited or seriously impaired).

SOURCE: McKee and Wolf.

for losses in milk and meat production, for stock breeding difficulties and for the death of farm animals, particularly ruminants. Because plants can supply enough nitrogen to poison animals, nitrate-free water is recommended.

TABLE 15.7
RECOMMENDED CRITERIA FOR DOMESTIC ANIMALS

PARAMETER	THRESHOLD CONCENTRATION[1]	LIMITING CONCENTRATION[2]
Sodium, mg/l	1000	2000
Bicarbonate, mg/l	500	500
Nitrate, mg/l	50	100
Sulfate, mg/l	500	1000

[1]Threshold values represent concentrations at which poultry or sensitive animals might show slight effects from prolonged use of such water. Lower concentrations are of little or no concern.

[2]Adverse effects have been observed in animals lactating.

(f) Aquatic Life Water Quality Requirements

The literature is extensive concerning the effects of pollution on aquatic life. Traditionally, oxygen has been the key parameter; however, recently organic pesticides and other toxic materials have become a problem. The values presented in Table 15.8 are significant parameters to monitor. A complete list of water quality parameters are too numerous to mention here.

TABLE 15.8
RECOMMENDED CRITERIA FOR AQUATIC LIFE

PARAMETER	THRESHOLD CONCENTRATION
Floatable oil and grease, mg/l	N.D.[1]
Emulsified oil and grease, mg/l	10
Detergent ABS, mg/l	2.0
Ammonia (free), mg/l	0.5
Chlorine (Total Residual)	0.002
Copper, mg/l	0.02
Mercury, mg/l	0.01
Phenolic compounds, as phenol, mg/l	1.0
Sulfide, dissolved, mg/l	0.5

[1]not detectable

15.1.4 Parameters and Frequency of Measurements

Rather than go through the procedure of listing for each proposed water quality monitoring site the parameters to be measured and frequency required, the following procedure has been selected. A short analysis Table 15.9 is required a+

TABLE 15.9

SHORT NEAR-TERM ANALYSIS FOR MONITORING THE QUALITY OF RECEIVING WATERS

	RECEIVING WATER			
	LAKE	STREAM	RECRE-ATION	GROUND-WATER
PARAMETERS ANALYSED				
1. Visible Floatables	0	0	0	
2. Fecal Coliform	0	0	0	0
3. Water Table, Lake Level	0	0		0
4. Light Penetration	0		0	
5. pH	0	0	0	0
6. Conductivity				0
7. Dissolved Oxygen	0	0		
8. Temperature	0	0	0	0
9. Chlorides				0
10. Nitrate plus Nitrite Nitrogen	0	0		0
11. Total Kjeldahl-Nitrogen	0	0		0
12. Soluble Phosphorus	0	0		
13. Total Phosphorus	0	0		0
14. Total Organic Carbon	0	0		
15. Inorganic Carbon	0	0		0
16. Algal Blooms	0			
FREQUENCY OF SAMPLING				
1. Three times during freshet period, if possible before peak, at peak and after peak.		0		
2. Monthly during tourist season.				
3. Once during July	0		0	
4. Once during January		0		0
5. Once during August		0		0
6. Once during fall isothermal conditions.	0			
7. Once during Spring isothermal conditions.	0			
SAMPLE DEPTH				
1. Epilimnion: (Mid-depth)	0			
2. Thermocline (if present)	0			
3. Hypolimnion (Mid-depth)	0			
4. Wells				0
5. Mid-depth of lake	0			
6. Representative Sample		0	0	
7. Temperature and Oxygen profile	0			

0 during periods of complete mixing.

TABLE 15.10

ADDITIONAL NEAR-TERM ANALYSIS OPTIONAL FOR MONITORING THE QUALITY OF RECEIVING WATERS

	RECEIVING WATER			
	LAKE	STREAM	RECRE-ATION	GROUND-WATER
PARAMETERS ANALYSED				
1. Turbidity	0	0	0	
2. Color			0	
3. Conductivity	0	0		
4. Linear Alkyl Benzene Sulfonate	0	0		
5. Pesticides	0	0		0
6. Calcium	0	0		0
7. Magnesium	0	0		0
8. Sodium	0	0		0
9. Iron	0	0		0
10. Sulphates	0	0		0
11. Chlorophyll a				0
12. Total Dissolved Solids			0	
13. Suspended Solids			0	
FREQUENCY OF SAMPLING				
1. Once during August		0		0
2. Once during January		0		0
3. Monthly during tourist season			0	
4. Once during mid-summer	0			
5. Once during spring isothermal conditions	0			
SAMPLE DEPTH				
1. Epilimnion (mid-depth)	0			
2. Hypolimnion (mid-depth)	0			
3. Wells				0
4. Mid-depth of lake	0			
5. Representative Sample		0		

0 during periods of complete mixing.

all stations. A full analysis, Table 15.10, includes additional measurements which should be conducted on specified samples. A full analysis should be conducted at sites where routine sampling indicates statistically significant deviation from the expected levels. Analysis of lake samples generally falls within the category of short analysis with several additional parameters.

As an aside, the optimum program to monitor the lake would require sampling bi-weekly to observe the change in the lake environment during stratification and lake turn-over periods; however, resources are limited as they are for sampling streams; however, when samples are taken it is imperative to be aware of the state of stratification; therefore, a profile of temperature and oxygen concentration should be taken during sampling.

15.1.5 Location of Monitoring Stations

When selecting stations for sampling, the particular major use of the resource at that site must be determined. The use of the water resource pool dictates also the type and number of samples required. This section will deal with the selection of sampling location.

(a) Stream Surveillance

It is of prime importance that water quality surveillance stations be placed to protect those waters which are used for potable water supplies, domestic use, irrigation use, industrial use, and recreational use. The criteria which determine if a location should be designated for surveillance are dependent on population, amount of water required and potential use of the water resource pool.

The eight creeks listed in Table 15.11 are utilized extensively as industrial, agricultural and domestic sources of water. Lambly (3), Shorts (4), Trepanier (5), Whiteman (7) and Deep (11) Creeks have flows equal to or greater than those creeks listed, however they have not been utilized to the same degree, being located in the north-west corner of the watershed, an area not as well developed as other areas around Okanagan Lake. All thirteen creeks should be monitored for quantity and quality as a result of present use or potential use.

A consideration in the assignment of water quantity and quality monitoring stations is the necessity to monitor major upstream pollution sources. This is of particular value when a pollution source is not amenable to immediate treatment. This type of surveillance is time-varying and presently falls within the monitoring program established by the Pollution Control Branch. This program of monitoring all industrial sources should be continued while these industries discharge to streams. Creeks which have been receivers of munitipal or industrial wastes should

( ) designated number, the lower the number of more major the flow.

TABLE 15.11

WATER LICENSES OF EIGHT MAJOR CREEKS,[1] 1970

DESIG-NATED NO.		TOTAL LICENSED STORAGE (K.ac.ft.)[2]	LICENSED DIVERSION				COMPUTED DIVERSION REQUIREMENT (K.ac.ft.)[2]
			AGRICULTURE (K.ac.ft.)[2]	DOMESTIC (K.ac.ft.)[2]	INDUSTRY (K.ac.ft.)[2]	TOTAL (K.ac.ft.)[2]	
1	Mission Creek	25.7	44.4	1.4	1.0	46.8	31.7
2	Trout Creek	11.0	11.0	0.4	3.4	14.8	13.3
6	Vernon Creek	47.7	53.0	9.9	0.6	63.5	33.5
8	Penticton Creek	13.3	5.0	5.5	0	10.5	11.1
9	Powers Creek	5.4	4.5	0.7	0	5.2	5.3
10	Equesis Creek	2.1	3.4	0	0	3.4	1.0
12	Kelowna Creek	7.7	16.0	0.5	0	16.5	12.8
13	Peachland Creek	12.5	3.1	0.1	13.4	16.6	3.4

[1]Received from The Water Investigation Branch, November 1, 1973.

[2]Kilo-acre feet.

be monitored at the creek mouth to determine the actual nutrient load being discharged to the lake. Minor streams should be considered if the nutrient load is significant. Table 15.12 is a list of streams which receive significant amounts of municipal or industrial wastes.

TABLE 15.12

STREAMS WHICH RECEIVE MAJOR WASTE INPUTS

DESIGNATED NO.	CREEK	TYPE OF WASTE
11	Deep	municipal
6	Vernon	municipal
14	Westbank (Smith	municipal
15	Brandt's	industrial
12	Kelowna	industrial

All interconnecting waterways between the major lakes should be monitored both flowing into a lake and flowing out of a lake. (Table 15.13).

TABLE 15.13

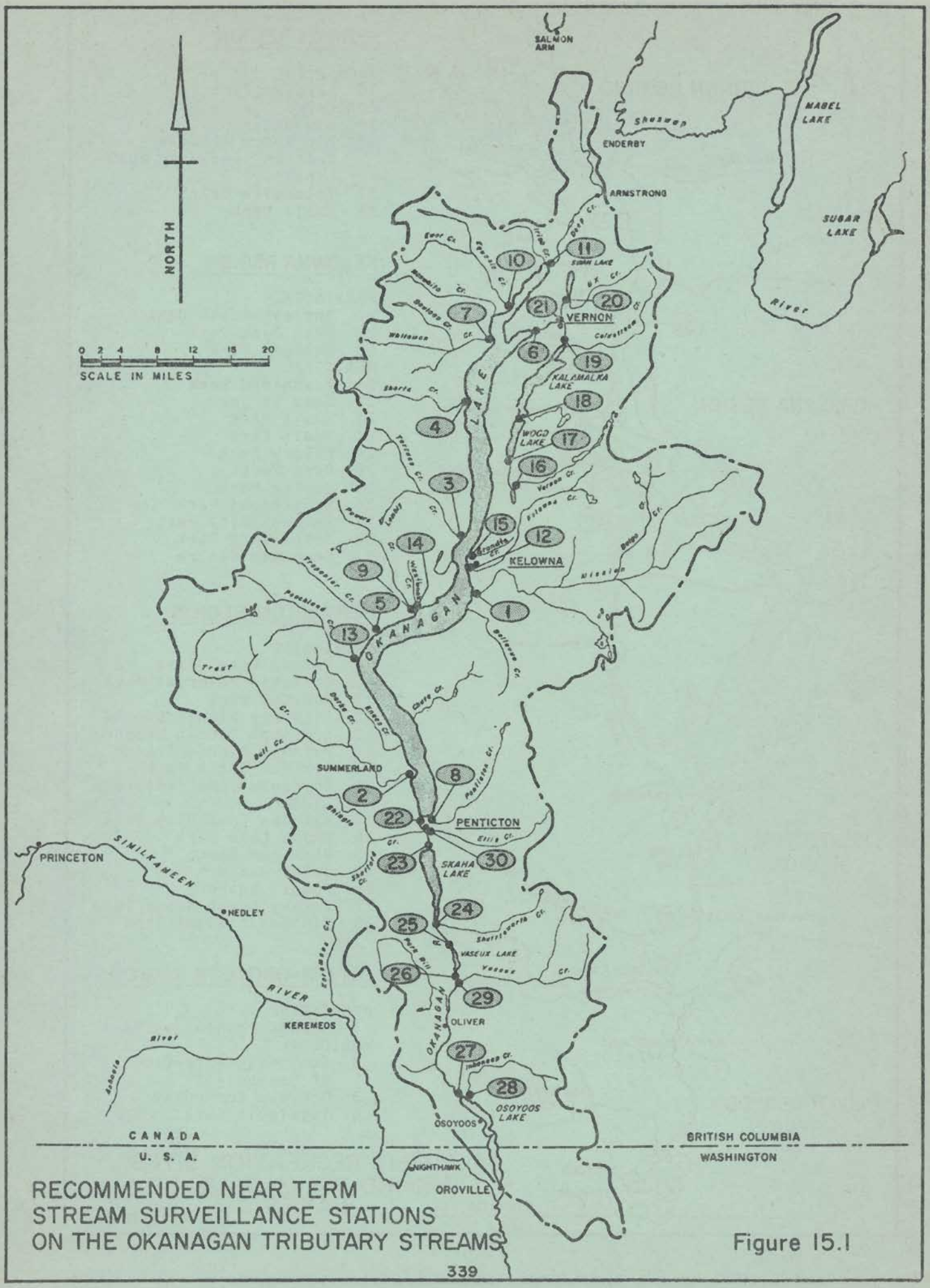
STREAMS WHICH CONNECT MAJOR LAKES

DESIGNATED NO.	INTERCONNECTING WATERWAY	LAKES JOINED BY INTERCONNECTING WATERWAY
16	Vernon Creek	Ellison Lake to Wood Lake
18	---	Wood Lake to Kalamalka Lake
19	Vernon Creek	Kalamalka Lake to Okanagan Lake
20	B.X. Creek	Swan Lake to Okanagan Lake
21	Below confluence of Vernon	and B.C. Creeks
22-23	Okanagan River	Okanagan Lake to Skaha Lake
24-25	Okanagan River	Skaha Lake to Vaseux Lake
26-27	Okanagan River	Vaseux Lake to Osoyoos Lake

To provide for future comprehensive analysis in areas where streams have not been sampled, representative streams should be selected. The streams recommended for sampling are Inkaneep (28), Vaseux (29) and Ellis Creeks (30). Figure 15.1 illustrates the location of the sampling site. Co-ordinates and description are given in Appendix

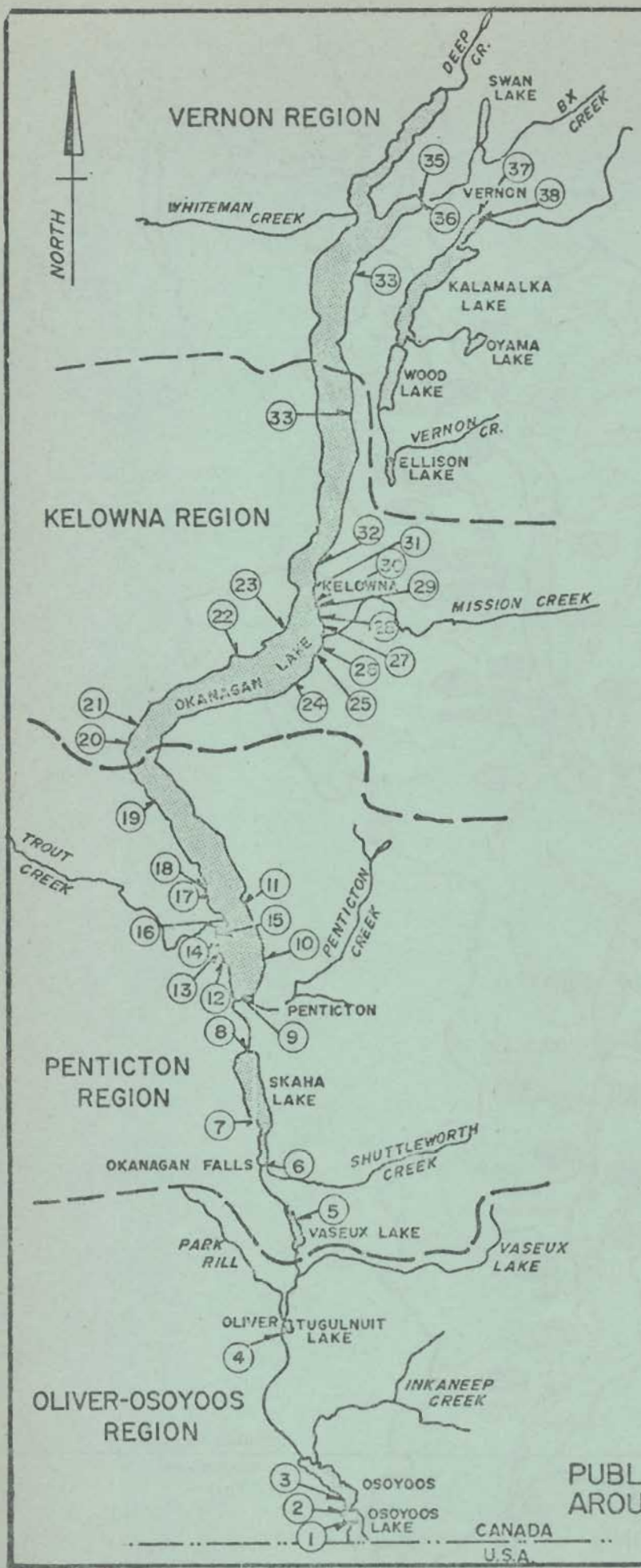
(b) Recreational Surveillance

All waters off beaches should be monitored routinely during the tourist season. However, if problems are reported by the public or threshold concentrations of water quality parameters are approached, more frequent sampling should be undertaken until water quality parameters reach reasonable levels. Figure 15.2 illustrates the location of public recreation sites around the mainstem lakes. The Department of Health presently manages the sampling of water quality in recreational areas.



RECOMMENDED NEAR TERM STREAM SURVEILLANCE STATIONS ON THE OKANAGAN TRIBUTARY STREAMS

Figure 15.1



VERNON REGION

PROVINCIAL
34 Ellison Park
MUNICIPAL
35 Kin Beach
36 Kin Beach (Indian Reserve Section leased by municipality)
37 Kalamalka Beach
38 Small Park

KELOWNA REGION

PROVINCIAL
20 Antlers Beach Park
22 West Bank Park
23 Kalmoir Park
MUNICIPAL
21 Peachland Park
24 Beau Se Jour
25 Small Park
26 Small Park
27 Rotary Park
28 Gyro Park
29 Warlaw Park
30 Strathcona Park
31 Kelowna City Park
32 Sutherland Park
33 Okanagan Centre

PENTICTON REGION

PROVINCIAL
5 Vaseux Prov. Park
6 Christie Memorial Park
11 Manitou Park
12 Kickinee Picnic Ground
13 Soorimpt Picnic Ground
14 Pyramid Picnic Ground
15 Sun-Oka Beach Park
19 Okanagan Lake Prov.Park
MUNICIPAL
7 Kaleden Community Park
8 Skaha Lake Park
9 Okanagan Beach
10 Third Beach
16 Powell Beach
17 Rotary Beach Summerland
18 Kin Beach Summerland

OLIVER-OSOYOOS REGION

PROVINCIAL
1 Haynes Point Prov.Park
MUNICIPAL
2 Community Park (south of Causeway)
3 Osoyoos Community
4 Tugulnuit Park

PUBLIC RECREATION SITES AROUND THE MAIN VALLEY LAKES.

Figure 15.2

(c) Lake Surveillance

Central Lake monitoring of the Okanagan system should continue. Base line water quality can then be determined over a number of years. Furthermore, the quality of water in the central lake should be of superior quality than waters at the near shore stations. These central stations are therefore necessary to determine statistically significant quality variation of near shore stations as well as variation in water quality of the central lake stations, as treatment and discharge of wastes varies within the Okanagan Valley. (Figure 15.3 and Table 15.14)

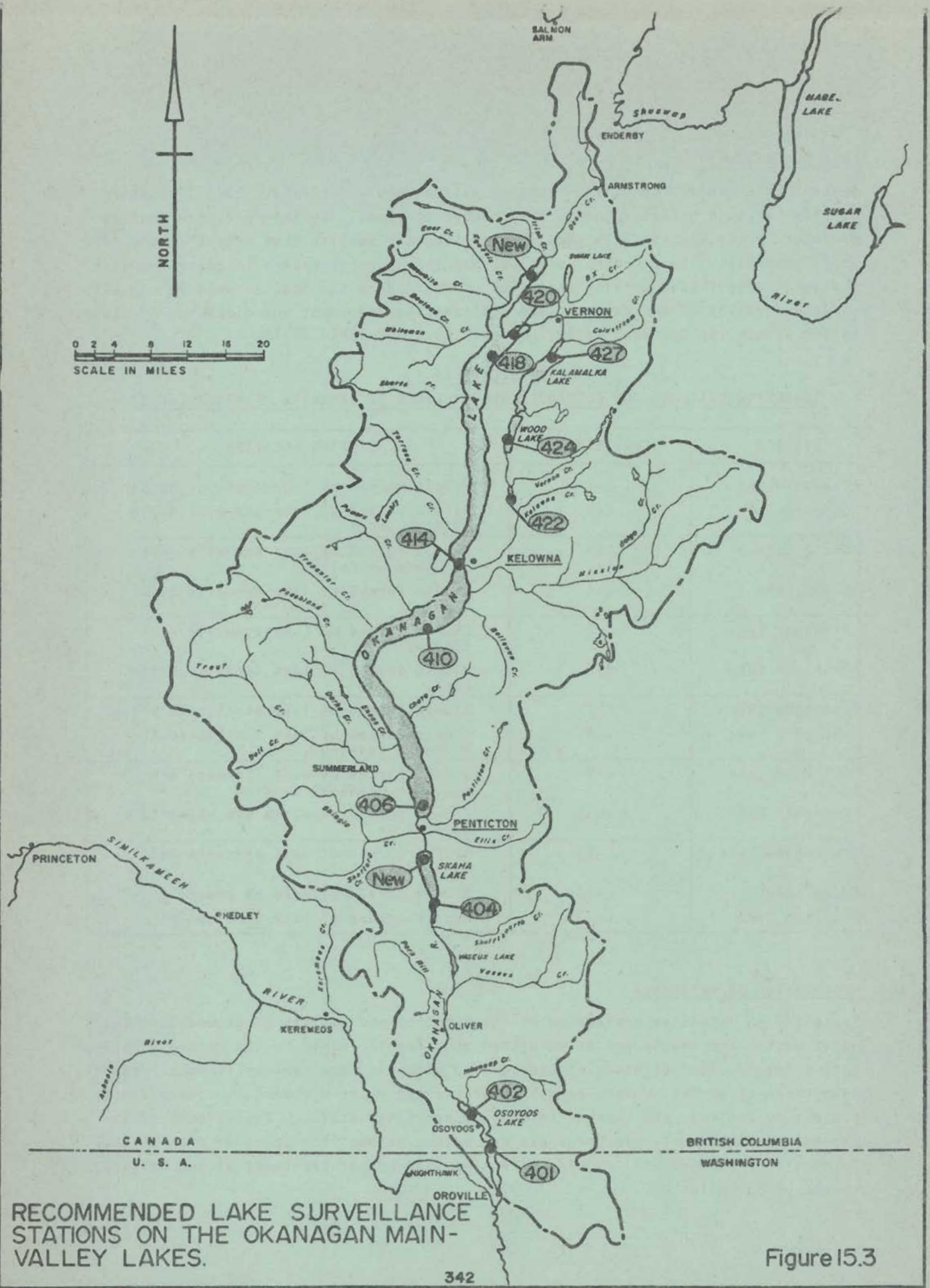
TABLE 15.14

SUGGESTED STATIONS FOR CONTINUED SURVEILLANCE OF OKANAGAN MAINSTEM LAKES

STATION	STUDY STN. NO.	STATION LOCATION
Osoyoos Lake	L-1	Middle thread of lower lake at border
Osoyoos Lake	L-2	Middle thread of lake one mile north of Mica Creek
Skaha Lake	L-3	Middle thread of lake one mile north of Okanagan Falls
Skaha Lake	L-4	Middle thread of lake opposite Skaha Creek
Okanagan Lake	L-5	Middle thread of Lake opposite Penticton.
Okanagan Lake	L-6	Middle thread of lake opposite Westbank.
Okanagan Lake	L-7	Middle thread of lake at Kelowna bridge
Okanagan Lake	L-8	Middle thread of lake 3 miles south of Okanagan Landing.
Okanagan Lake	L-9	Middle thread of east (Vernon) arm opposite Okanagan Landing
Okanagan Lake	L-10	Middle thread of north arm opposite Newport Cr.
Kalamalka Lake	L-11	Middle thread of lake opposite Rattlesnake Point
Wood Lake	L-12	Middle thread of lake at midpoint
Ellison Lake	L-13	Middle thread of lake at midpoint

(d) Groundwater Surveillance

Presently no extensive monitoring of the quantity and quality of groundwater to which wastes are discharged is conducted on a regular basis in the Okanagan Basin. Unfortunately, the pollution of underground water is more serious in some instances than that of surface water, because subterranean water movement is slow and not subject to control, and changes in quality are long lasting. The effects of improperly treated waste discharge may not become evident for years or even decades. Correction of damage will require more time than proper treatment of the original source of pollution.



RECOMMENDED LAKE SURVEILLANCE STATIONS ON THE OKANAGAN MAIN-VALLEY LAKES.

Figure 15.3

Although the location of sampling stations are not specified here, necessary groundwater wellssshould be placed and maintained and sampled yearly at low flow periods. A separate study is required to determine the need and the type of monitoring required.

The findings of the septic tank report as presented in Technical Supplement VI indicate that a system should be established to classify regions suitable for groundwater dishcarge according to soil type, location of groundwater table and type of discharge. The findings of the septic tank report are also relevant to industrial and municipal discharges to the ground. Further studies are required to evaluate the significance of groundwater discharge in the Okanagan Valley.

CHAPTER 16

Recommended Land Use Practices to Reduce Loadings

16.1 INTRODUCTION

The origin of the pollutants is primarily from point sources in the developed areas of the basin including industrial and municipal waste discharges to streams and cattle feedlots, riding stables, and poultry farms adjacent to streams. Soil erosion resulting from forestry and agricultural operations, particularly logging road construction, also contributes significant amounts of nutrients to tributary streams. Because the amount of waste material that various streams can assimilate varies from creek to creek, from month to month, and from year to year, depending on the size of the sub-basin and the amount of available runoff, it is difficult if not impractical to establish general stream loading or effluent standards to meet acceptable criteria for stream water quality in the Okanagan Basin. Also, there are few streams in the basin that carry sufficient water on a year round basis to assimilate any waste products other than natural pollutants from the basin itself. Therefore, the removal of all municipal and industrial discharges containing pollutants is required to achieve established water quality standards in most streams. However, where such waste discharges can be proved acceptable and free of pollutants, the additional water provided by such discharges is often beneficial, and should be encouraged. Community or regional treatment plants would be the most suitable in achieving the above objective particularly in respect to industrial outfalls.

Logging-road construction and land cultivation adjacent to streams are major sources of soil erosion from surface runoff. Eroded soils greatly increase the turbidity of water, and provide a base in lakebeds for rooted aquatic vegetation. They also contribute a substantial amount of nutrients and other chemical elements to the main valley lakes. Improved landuse management over a period of time may reduce such erosion, but continued monitoring and surveillance of stream water quality may also indicate the need for appropriate green belts (strips of permanend vegetation) along the entire course of streams where logging and cultivation are practiced. Such green belts must be maintained to ensure their effectiveness in minimizing soil erosion and stream pollution.

The remaining increases in stream loadings are expected to come from forestry operations, diffuse agricultural sources, and septic tanks. No estimate of the future contribution from forestry operations has been made, but if there is no increase in the annual amount of timber harvested, there should be no significant increase in loading from this source to the basin as a whole. The tributaries affected, however, will depend on the areas being logged and the care taken to keep logging road and other construction away from streams.

Projections of phosphorus loadings from diffuse agricultural sources and septic tanks to tributary streams show significant increases to the year 2020 for streams tributary to Okanagan Lake. Agricultural source loadings are expected to increase from 2800 pounds per year in 1969-71 to 6500 pounds per year in 2020. Septic tank loadings are expected to increase from 4500 lbs per year in 1969-71 to 13,000 pounds per year in 2020 under a low economic growth rate, assuming no change in waste treatment policy. Projected phosphorus loadings from septic tank sources located near streams tributary to Kalamalka Lake are also expected to increase from 20 pounds peryear in 1969-71 to 1600 pounds per year in 2020 under a low economic growth rate. Changes in source loadings to streams tributary to the other main valley lakes are estimated to be relatively minor.

16.2 Alternatives (Stream Water Quality)

The continuation of present management practices for water quality in the tributary streams, while an option, would mean that most stream water would not be acceptable for consumptive use purposes without prior treatment. A continued decline in the existing quality should also be expected with economic growth over the next 50 years, resulting in more expensive treatment of these raw water sources with time if they are to be used for consumptive purposes.

The implementation of management policies to meet the objective of providing a water quality compatible with various consumptive uses, would require positive steps in the control waste discharges and land use practices. Alternatives considered included the following:

16.2.1 Removal of Positive Waste Discharges

The removal of all direct municipal and industrial waste discharges causing pollution may be the only way in which the quality of many of the streams in their lower reaches can be improved to a level that will meet acceptable water quality standards. However, because the flow in the majority of streams during the greater part of the year is small, the return of unpolluted water from waste outfalls could help support fishery and other recreational uses. Waste treatment facilities that provide a high quality effluent should therefore be encouraged where such discharges can be proved acceptable and free of pollutants.

16.2.2 Green Belts

The primary purpose of green belts is to prevent surface runoff, from urban and agricultural areas, reaching tributary streams directly. Green belts along the perephery of all tributary streams through developed areas could help reduce stream oxygen deficits and high coliform levels resulting from agricultural and urban developments. These green belts in the form of natural cover, grass, and trees and elevated where necessary would ensure that all surface runoff waters

pass through a soil column before reaching a stream. This would provide a filter and form of treatment for surface runoff from cattle feedlots, riding stables, poultry farms, and pastured grassland, etc. located near streams but outside of the green belt area. While this form of treatment would reduce coliform levels and oxygen deficits, the effect on nutrient loadings would be dependent on the soil type and cover crops and in most cases may be minimal.

Green strips between streams and logging roads would also reduce loadings from logging and other forestry operations in the headwaters of the basin. Streams on which these should be given special consideration are those that are important to the fishery resource including Mission, Vernon, Equesis and Trepanier Creeks.

16.2.3 Agricultural and Watershed Management Practices

Certain land use practices in stream sub-basins may have a detrimental effect on stream water quality. In forestry operations these may include poor harvesting practices, forest fires, logging road construction adjacent to streams, erosion, and the application of chemicals for insect or growth control. Clear-cutting of forest areas causes accelerated nutrient loss to streams and effects the runoff by increasing the intensity of spring melt and storm runoff.

Logging methods which greatly disturb the soil cause increases in stream turbidity, nutrient concentrations, and sediment loads. Disturbance of stream banks and subsequent land slides caused by road construction expose soil to erosion and leaching.

Various agricultural practices affect stream quality through erosion or groundwater flow. Excess applications of fertilizers and manure, or application at the wrong time of the year, and excess irrigation can all result in increased nutrient loadings through groundwater return flows.

All of the above reflect management practices over which presently there is little direct control by governments. Education along with positive incentives for improving such landuse practices may be the only alternative for reducing loadings and improving stream quality in these management areas under the present institutional and legal system.

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APPENDICES

APPENDIX A

EXPLANATION OF METHODS OF CALCULATION AND COMPUTOR PRINTOUT DATA FOR STREAMS AND OUTFALL QUALITY DATA

1969 TO 1971

A.1 - Methods of Calculation

A.2 - Computer Output

A.3 - File Contents

A.4 - Method of Analyses for Okanagan Outfall Samples - Water Resources Laboratory, Vancouver

A.5 - Estimated Annual Discharge in I.M.G. Of 19 Frequently Sampled Outfalls

A.6 - Estimated Annual Discharge of 36 Supplementary Outfalls

EXPLANATION OF METHODS OF CALCULATION AND COMPUTOR PRINTOUT DATA FOR STREAMS AND OUTFALL QUALITY DATA 1969 TO 1971

A.1 METHOD OF CALCULATION

A.1.1 Combinations of Water Quality and Water Quantity Data

The frequencies of water quality and quantity (flow) measurements in the stream and outfall studies may be summarized in the following table:

TYPE	QUALITY		QUANTITY		CLASS
	WEEKLY	MONTHLY	DAILY	MONTHLY	
Streams	✓	✓	✓		B, B_1
Outfalls (Sewage)		✓	✓		B
Outfalls (Industrial)		✓		✓	A

As both quality and quantity measurements must be available in any period in order to calculate nutrient loadings, Table 1 suggests that two basic classes of calculation can be considered with one sub-class. These will be designated as follows:

Class A Monthly measurement only for both quality and quantity (i.e. industrial outfalls).

Class B Monthly quality and daily quantity measurements (i.e. sewage outfalls and all streams).

Class B_1 Sub-class of B in which weekly quality and daily quantity measures are also available (i.e. streams).

Methods of calculation will be described for each class.

A.1.2 Class A: Monthly Readings of Both Quality and Quantity

The calculation in this case merely consisted of multiplying flow by concentration in appropriate units and scaling-up to represent the accumulated loading for the particular month. In instances where monthly data were missing, the procedure was as follows:

For a missing flow rate, the average of the two months on either side was used. (Printout Message - 'INTERPOLATED VALUE'). If rates for two months together

in flow (which might unnecessarily distort the loading values) without destroying gross flow patterns. This linear relationship was then applied to develop daily concentration values. These interpolated daily concentration values were multiplyed by the actual daily flows to produce daily loadings which were accumulated to the desired monthly or weekly figures.

This approach, although technically successful, finally had to be abandoned when it became clear that for many nutrients there was not real correlation between concentration and flow readings. In these cases significant errors would be introduced whenever flow readings fluctuated widely. Due to programming and time constraints it was decided that to discard the approach for some parameters involved abandoning it altogether, at least for this particular investigation.

(iii) Calculation of Nutrient Loadings

With the abandonment of the attempt to interpolate quality values between weekly or monthly measurements, each week's (month's) quality reading had to be taken as an estimate valid for the entire week (month), regardless of how the flow varied during that period.

As for Class A, the calculation was a matter of multiplying flow by concentrations and accumulating to obtain the loading for the week or month.

In the cases where there was no quality reading for a particular parameter during a period, then the preceding or following period's value was used, with preference given to the preceding value. If none of the three periods contained a quality reading for the parameter, then its loading was not calculated. (Printout Message = 'INSUFFICIENT DATA').

A.2 COMPUTER OUTPUT

A.2.1 General Comments

When interpreting the output, the sampling frequencies of the original quality and quantity data should be kept in mind, and these are indicated at the top of each report. In addition, the actual date for each quality reading taken during the report period is shown for reference. Only those nutrients for which data were generally available have been included in each report's list of parameters.

A.2.2 Completeness

Output covers the period August 1969 to July 1971. Water quality files contain some sets of data outside this range (see file contents) but water quantity files contain data only in this 24 month span.

The output shows all the data collected, the only exception being stream station BC4-503, where due to lack of data the last few months are omitted entirely.

A.2.3 Output Messages

These have already been covered above, under "Methods of Calculation", summarized here for convenience.

'INTERPOLATED VALUE'
- refers to flow data
- occurs only with respect to monthly flow data (industrial outfalls)
- means that a value has been interpolated from adjacent monthly readings.

'INSUFFICIENT FLOW DATA FOR THIS PERIOD'
- self explanatory
- occurs usually only with respect to monthly flow data (industrial outfalls)
- means that no value for the period exists and there is sufficient data in adjacent period to interpolate.

'INSUFFICIENT DATA'
- Refers to quality data
- occurs in all reports
- means that no value for a particular nutrient is available in the period (see exception case).

A.2.4 Identifying Information

Sampling date - day, month, year

Location type
- B for BC4-500 to BC4-541 Federal Stations
- O for outfalls O-1 to O-19 Provincial Stations
- S for streams S-1 to S-17 Provincial Stations
- C for coliform locations C-1 to C-5 Provincial
- L for lake locations L-1 to L-11 Provincial

Location number - within type

Sample type - A through F indicating on which source document type the data was provided.

Record number - each sample is divided up into three records for convenience.

Lab-ID - identifies laboratory where sample was analyzed.
- A - Provincial Health Laboratory Vancouver
- B - Water Quality Laboratory E.M. & R., Calgary

Sample number - assigned by lab (if provided on source document)

Date analysis completed - day, month, year (if provided on source document)

Depth - necessary for lake samples.

Parameters which can be stored for each sample, and the units in which each is recorded (N.B. ppm = parts per million) are listed in Table A 1. The records are sorted by station, and by date of sampling within station.

TABLE A 1

PARAMETERS AND UNITS USED FOR COMPUTER STORAGE

PARAMETER	UNITS
Temperature at sampling	°C
Temperature at testing	°C
Dissolved O_2	ppm
Oxygen Saturation	%
Carbon Dioxide	ppm
pH	pH units
Colour	Hazen units
Turbidity	Jackson units
Alkalinity Phenophalien as $CaCO_3$	ppm
Alkalinity Total as $CaCO_3$	ppm
Specific Conductance	m-mhos
Hardness - Total	ppm
Hardness - Non-car.	ppm
Nutrients:	
Ammonia as N	ppm
Organic nitrogen as N	ppm
Total Kjeldahl as N	ppm
Nitrate as N	ppm
Nitrite as N	ppm
Total nitrogen as N	ppm
Dissolved phosphorus as P	ppm
Orthophosphorus as P	ppm
Inorganic phosphorus as P	ppm
Total phosphorus as P	ppm
SiO_2	ppm
Industrial Waste:	
Cyanide	ppm
Arsenic	ppm
Phenol	ppm
Surfactants (MBAS)	ppm
Coliforms:	
Total coliforms	MPN per 100 ml
Faecal coliforms	MPN per 100 ml
Oxygen Demand:	
BOD, 5 day	ppm
Temperature at arrival at lab	°C
Chemical oxygen demand	ppm
Oxygen consumed ($KMnO_4$)	ppm

PARAMETER	UNITS
Carbon:	
*Carbon Dioxide	ppm
*Carbonate	ppm
*Bicarbonate	ppm
*Alkalinity - P as $CaCO_3$	ppm
*Alkalinity Total as $CaCO_3$	ppm
Total Organic Carbon	ppm
Total inorganic Carbon	ppm
Solids:	
Total solids	ppm
Volatile solids	ppm
Fixed solids	ppm
Dissolved solids	ppm
Total suspended solids	ppm
Volatile suspended solids	ppm
General Ions:	
Calcium	ppm
Magnesium	ppm
Sodium	ppm
Potassium	ppm
Carbonate	ppm
Sulphate	ppm
Chloride	ppm
Fluoride	ppm
Metals:	
Iron-total	ppm
Iron dissolved	ppm
Aluminum	ppm
Manganese	ppm
Heavy Metals:	
Copper	ppm
Zinc	ppm
Lead	ppm
Barium	ppm
Strontium	ppm
Chromium (hexavalent)	ppm
Boron	ppm

* Occur twice on file to facilitate grouping.

A.3 FILE CONTENTS

A.3.1 Water Quality Analyses File

This file consists of records containing both sample identity and analytic information. For each sample, storage is provided for 67 analyses, although for any one sample only some of these were performed. An indicator for each analysis provides information as to whether (a) the analysis was done on this sample, (b) whether the result stored for this analysis is in fact an upper limit of the possible value (i.e., Nitrite 0.005), and (c) whether the result is a lower limit of the possible value (i.e. Coliform 160900). For the purposes of nutrient loading calculation the value has had to be taken as if it were at its given limit in (b) and (c).

Where analyses are recorded in different units by different agencies, conversions are carried out before data are entered in the file, so that all measurements of a given parameter are compatible. (No conversion is done between mg/l and parts per million).

A.3.2 Data Currently on File are:

(a) Outfalls - September 1969 - August 1971 inclusive.

(b) Streams, short analyses - June 1969 - October 1971 inclusive.

(c) Streams, full analyses - June 1969 - October 1971 inclusive.

Note on (b) and (c): All analysis results available for this period have been entered on the file. These were not necessarily for every station for a given week or month. Dry streams or other factors may have meant sampling was not carried out.

A.3.3 Water Quantity (Flow) File

This file consists of records of stream and outfall flows. Some of these are actual measurements and others are estimates only.

Information on each record is:

Location type	- B for BC4-500 to BC4-541 Federal Stations
	- O for outfalls O-1 to O-19 Provincial stations
Location number	- within type
Date	- day, month, year (monthly estimates are given as day #1)
Flow	- in millions of imperial gallons per day

Flows at Federal stations which were provided in cu. ft./sec. and flows at outfalls given in U.S. gallons per day, millions of U.S. gallons per day and imperial gallons per day were converted to millions of imperial gallons per day before being stored on the file.

The records are sorted by station and by date of sampling within station. The data on the file is for the period August 1969 to July 1971 inclusive.

APPENDIX A.4

METHOD OF ANALYSES FOR OKANAGAN OUTFALL SAMPLES
WATER RESOURCES LABORATORY, VANCOUVER

PHYSICAL PARAMETERS	METHOD OF ANALYSIS	MINIMAL DETECTABLE CONCENTRATION
COLOUR	Hellige Aqua Tester-visual comparison with Pt-Co disc standard (1)	5 units (Hazen)
TURBIDITY	Hach Turbidimeter Model 2100-A strong beam of light is sent through the cell containing the sample and the light reflected by the suspended particles is measured by the Hach Turbidimeter (1).	0.1 J.T.U.
FIXED TOTAL MATTER (550°C)	Gravimetric - The platinum crucible with the retained residue from the test for total residue is ignited at 550°C for one hour. The increase in weight over that of the ignited empty crucible represents fixed total residue. (1)	1 mg/l
TOTAL SUSPENDED MATTER (105°C)	Gravimetric - A well mixed sample is evaporated in a weighed platinum crucible on a steam bath. The residue is oven-dried to a constant weight at 105°C (1).	1 mg/l
DISSOLVED OXYGEN	Winkler azide modification titration (1) - field measurement.	0.1 mg/l
TEMPERATURE	Temperature (measured in the field, (1)	0.1°C
ALKALINITY TOTAL ($CaCO_3$)	Colourimetric titration with standard acid performed in the laboratory (1).	0.5 mg/l
CALCIUM DISSOLVED (Ca)	EDTA Titration-calcium indicator Betz Code 293 (1)	0.4 mg/l
CHLORIDE DISSOLVED (Cl)	Titration - Mercuric Nitrate (1)	0.3 mg/l
COPPER DISSOLVED	Atomic Absorption - Direct Aspiration (1,3)	0.01 mg/l
IRON DISSOLVED (Fe)	Phenanthroline Method - Colourimetric (1)	0.02 mg/l
LEAD DISSOLVED (Pb)	Atmoic Absorption - Boat Technique (3)	0.003 mg/l
MAGNESIUM DISSOLVED (Mg)	Calculated (TH-2.5 (Ca)) x 0.243 (5)	0.5 mg/l
MANGANESE DISSOLVED (Mn)	Atmoic Absorption - Direct Aspiration (3)	0.01 mg/l
NITRATE DISSOLVED (N)	Phenoldisulphonic Acid Method (1) to March 1971.	0.02 mg/l
	(Nitrate & Nitrite) - Nitrite (Nitrate & Nitrite) determined by automated hydrazine sulphate reduction method and the Nitrite determined by the automated diazotization (6).	0.02 mg/l
HYDROGEN ION (pH)	Electometric in laboratory (1)	0.1 units
PHOSPHORUS DISSOLVED ORTHO-PHOSPHATE (P)	Automated colourimetric with ammonia molybdate and stannous chloride (1)	0.003 mg/l
PHOSPHORUS TOTAL PHOSPHATE (P)	Manual sulphuric acid and potassium persulphate digestion followed by automated ortho-phosphate determination with ammonia molybdate and stannous chloride (1).	0.003 mg/l
POTASSIUM DISSOLVED (K)	Flame Photometric - Beckman D.U. (1).	0.1 mg/l
SILICA REACTIVE (SiO_2)	Hetropoly blue method - without sodium bicarbonate digestion determines the molybdate reactive silica (1).	0.2 mg/l
SODIUM DISSOLVED (Na)	Flame Photometry - Beckman (D.U.) (1).	0.1 mg/l
SULPHATE DISSOLVED (SO_4)	Turbidimetric Method to Sept. 1970 (1)	1 mg/l
	Thorin Titration Method - Sulphate is titrated in an alcoholic solution under controlled acid conditions, with standard borium perchlorate (1).	5 mg/l
ZINC DISSOLVED (Zn)	Atmoic Absorption - Boat Technique (3).	0.005 mg/l
BIOCHEMICAL OXYGEN DEMAND (BOD) (5 day)	FIVE DAY BOD - seeded diluation method dropping mercury electrode (standardized against Winkler method) (1)	10 mg/l
TOTAL ORGANIC CARBON (C)	Combustion - one infra red method (2) (Beckman TOC Analyzer)	1 mg/l

APPENDIX A.5

ESTIMATED ANNUAL DISCHARGE IN I.M.G. OF 19
FREQUENTLY SAMPLED OUTFALLS

NUMBER	NAME	ANNUAL DISCHARGE 69-70	70-71	ESTIMATED DISCHARGE
0-1	Monashee Co-Op	3.65	6.44	5.1
0-2	Oliver-Osoyoos Co-Op	0.06	0.06	0.06
0-3	Village of Oliver	65.0	60.8	60.8*
0-4	Canadian Canners Limited	175.2	-	175.2
0-5	City of Penticton	438.0	463.0	463.0*
0-6	Lakeshore Bottline Co.	0.3	0.3	0.3
0-7	Fish and Wildlife Hatchery	354.0	326.5	340.3
0-8	Cornwall Canners Limited	27.4	37.1	32.3
0-9	Westbank Waterworks	51.1	18.2	18.2*
0-10	Okanagan Beverages & Calona Wines	3.5	6.2	4.9
0-11	Kelowna Grower's Exchange & Sun Rype No. 2	40.1	36.7	38.4
0-12	American Can Company	0.6	0.5	0.6
0-13	Kelowna Beverages & Ok. Packers	124.1	121.8	122.9
0-14	B.C. Orchards Co-Op	26.3	26.3	26.3
0-15	City of Kelowna	620.5	577.4	577.4*
0-16	Vernon Fruit Union	18.6	20.7	19.8
0-17	City of Vernon	438.0	527.7	482.8**
0-18	Dutch Dairies Ltd.	5.8	5.5	5.7
0-19	City of Armstrong	47.4	54.8	54.8*

* Assumed to be more representative value of flow

** Some of the effluent is disposed of by spray irrigation.

APPENDIX A.6

ESTIMATED ANNUAL DISCHARGE OF 36 SUPPLEMENTARY OUTFALLS

(In million gallons per year)

NO.	STATION NAME	ESTIMATED FLOW
1	McLean & Fitzpatrick	31.5
2	Oliver-Osoyoos Co-Op.	99.7
3	International Curling Club	7.8
4	Haynes Co-Op.	2.5
5	Southern Co-Op.	Closed
6	Sun-Rype Products	Closed
7	McLean & Fitzpatrick (now owned by Oliver-Osoyoos Co-Op.)	2.5
8	Oliver-Osoyoos (Kaleden) Co-Op.	28.8
9	Penticton Sawmills	26.3
10	Pyramid Co-Op.	5.5
11	Naramata Co-Op.	1.4
12	Summerland Arena	
13	Summerland Sweets	0.7
14	Westbank Co-Op.*	Closed
15	Westbank Orchards	16.2
16	S.M. Simpson Ltd.	15.5
17	Kelowna Memorial Arena	2.6
18	Caravel Motor Inn	No data available
19	Provincial Building	" " "
20	Cascade Co-Op.	5.0
21	Valley Bldg. Matls.	5.3
22	S. DeBoer	0.02
23	L.M. Heemsiterk	0.04
24	Doyle Avenue Storm Sewer	-
25	Calona Distilleries	11.9
26	McLean & Fitzpatrick	33.3
27	Kelowna Growers Exchange	14.2
28	Winoka Co-Op.	Closed
29	Hiram Walker & Sons	1898×10^6
30	Vernon Fruit Union	5.4
31	Tom Collins	0.04
32	Coldstream Ranch	0.04
33	R.H. MacDonald	0.79
34	Bulman Products Ltd.	6.6
35	Inland Ice & Storage Ltd.	-
36	Hawking Dairy Farm	0.02

APPENDIX B

STATISTICAL SUMMARY OF ANALYTICAL RESULTS

STREAM WATER QUALITY

STATISTICAL SUMMARY OF ANALYTICAL RESULTS

STREAM WATER QUALITY

LIST OF ABBREVIATIONS

ALK TOT	-	Alkalinity (Total)
BOD	-	Biochemical Oxygen Demand (5 Day)
COND	-	Specific Conductance (Micro MHO/CM)
DISS 02	-	Dissolved Oxygen
D. O. SAT	-	Dissolved Oxygen (Saturated)
FX TOT M	-	Fixed Total Matter
HARD TOT	-	Hardness (Total)
MAGNES	-	Magnesium (Dissolved)
MANGAN	-	Manganese (Dissolved)
MAX CONC	-	Maximum Concentration
MG/L	-	Milligrams per liter
MIN CONC	-	Minimum Concentration
NO. VAL	-	No. of Values (Samples)
ORTHO P	-	Phosphate (Ortho Dissolved), as P
TOTAL P	-	Phosphate (Total), as P
POTASS	-	Potassium
TEMP	-	Temperature
TIC	-	Total Inorganic Carbon
TOTAL N	-	Total Nitrogen
TOC	-	Total Organic Carbon
TO SUS M	-	Total Suspended Matter
TURBID	-	Turbidity

APPENDIX B

STATISTICAL SUMMARY OF ANALYTICAL RESULTS - STREAM WATER QUALITY

STREAM WATER QUALITY

STATION: 8500 OK. RIVER:CAUSEWAY AT OSOYOOS

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	10	15.0	5.00	10.0	9.10	8	7.00	0.0	7.00	4.62	4	15.0	5.00	10.0	7.50
TURBID	28	3.50	0.800	2.70	1.78	38	6.20	0.800	5.40	1.75	20	8.50	0.300	8.20	1.45
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
DISS O2	29	11.0	7.90	3.10	9.23	39	14.0	3.20	10.8	10.9	20	13.6	8.10	5.50	10.6
D.O. SAT	29	106.	17.0	89.0	90.4	41	117.	85.0	32.0	102.	20	106.	80.0	26.0	95.7
TEMP	7	24.0	4.40	19.6	15.3	8	31.0	2.40	28.6	17.0	4	24.9	7.80	17.1	17.4
INORGANIC PARAMETERS															
ALK TOT	29	125.	88.3	36.7	106.	41	127.	100.	27.0	117.	20	129.	99.0	30.0	114.
CALCIUM	7	36.2	29.4	6.80	33.2	8	41.2	34.5	6.70	36.8	4	38.2	30.6	7.60	34.4
CHLORIDE	7	1.40	1.10	0.300	1.27	8	1.80	1.20	0.600	1.39	4	1.70	0.700	1.00	1.30
COPPER	7	0.003	0.001L	0.002	0.002	8	0.003	0.001L	0.002	0.001	4	0.007	0.001L	0.006	0.003
FLUORIDE	7	0.250	0.180	0.070	0.214	8	0.230	0.210	0.020	0.222	4	0.230	0.190	0.040	0.202
HARD TOT	7	125.	102.	23.0	116.	8	131.	119.	12.0	125.	4	135.	107.	28.0	124.
IRON	6	0.020	0.010	0.010	0.013	8	0.030	0.010	0.020	0.016	4	0.010	0.010L	0.0	0.010
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.034	0.005L	0.029	0.012	4	0.010L	0.005L	0.005	0.007
MAGNES	7	8.90	6.60	2.30	7.91	8	10.0	3.90	6.10	8.11	1	9.60	9.60	0.0	9.60
MANGAN	7	0.001	0.001L	0.0	0.001	8	0.010L	0.002	0.008	0.003	4	0.014L	0.010L	0.004	0.011
NITRATE	29	0.190	0.010L	0.180	0.049	41	0.180	0.010L	0.170	0.044	20	0.190	0.010L	0.180	0.047
TOTAL N	29	0.540	0.170	0.370	0.321	40	0.930	0.130	0.800	0.332	20	1.26	0.010L	1.25	0.364
PH	29	8.70	7.00	1.70	7.99	41	9.00	7.60	1.40	8.40	20	8.80	7.80	1.00	8.22
ORTHO P	29	0.033	0.003L	0.030	0.008	41	0.023	0.003L	0.020	0.007	20	0.023	0.003L	0.020	0.007
TOTAL P	29	0.052	0.003	0.049	0.016	41	0.052	0.003	0.049	0.020	20	0.055	0.010	0.045	0.021
POTASS	7	2.40	2.00	0.400	2.21	8	2.60	2.00	0.600	2.22	4	2.50	2.00	0.500	2.30
SILICA	7	5.90	4.30	1.60	4.97	8	6.00	0.010	5.99	2.72	4	10.3	1.20	9.10	5.42
SODIUM	7	10.2	8.20	2.00	9.27	8	10.5	8.70	1.80	9.70	4	10.8	8.90	1.90	9.95
SULPHATE	7	29.1	24.1	5.00	27.0	8	35.9	26.8	9.10	29.3	4	31.6	26.2	5.40	29.2
TIC	0	0.0	0.0	0.0	0.0	16	28.0	20.0	8.00	24.4	16	30.0	7.00	23.0	21.3
ORGANIC PARAMETERS															
ZINC	7	0.006	0.001L	0.005	0.002	8	0.010	0.001L	0.009	0.004	4	0.029	0.002	0.027	0.009
TOC	29	9.00	2.00	7.00	5.41	41	13.0	2.00L	11.0	6.29	19	21.0	4.00	17.0	8.16

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8501 INKANEEP CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	9	60.0	5.00	55.0	26.1	8	55.0	10.0	45.0	20.6	3	75.0	15.0	60.0	35.0
TURBID	28	165.	3.00	162.	52.5	34	61.0	1.80	59.2	8.19	3	92.0	2.30	89.7	34.2
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	5	309.	4.80	304.	86.1	6	21.6	2.00	19.6	12.1	2	197.	29.2	168.	113.
DISS O2	29	13.2	8.00	5.20	10.3	35	14.1	9.00	5.10	11.3	3	12.7	9.30	3.40	10.9
D.O. SAT	29	101.	85.0	16.0	94.7	37	111.	85.0	26.0	99.3	3	95.0	93.0	2.00	94.0
TEMP	7	19.3	1.60	17.7	11.2	8	25.1	0.0	25.1	13.0	3	24.9	7.70	17.2	16.9
INORGANIC PARAMETERS															
ALK TOT	29	382.	98.0	284.	119.	36	126.	29.8	96.2	93.5	3	104.	18.0	86.0	71.0
CALCIUM	7	31.1	26.0	5.10	27.9	8	30.2	11.5	18.7	24.1	3	26.7	5.10	21.6	18.0
CHLORIDE	7	2.80	0.700	2.10	1.30	8	1.50	0.700	0.800	0.912	3	1.20	0.500	0.700	0.833
COPPER	7	0.002	0.001L	0.001	0.002	8	0.005	0.001L	0.004	0.002	3	0.006	0.001	0.005	0.003
FLUORIDE	7	0.440	0.370	0.070	0.406	8	0.490	0.240	0.250	0.369	3	0.370	0.150	0.220	0.287
HARD TOT	7	99.8	89.2	10.6	94.2	8	98.3	37.3	61.0	81.0	3	93.0	19.0	74.0	64.3
IRON	7	0.270	0.060	0.210	0.114	8	0.170	0.070	0.100	0.130	3	0.170	0.060	0.110	0.100
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.010L	0.006L	0.004	0.007
MAGNES	7	7.10	5.00	2.10	5.96	8	6.90	2.10	4.80	5.06	1	6.30	6.30	0.0	6.30
MANGAN	7	0.044	0.001L	0.043	0.022	8	0.022	0.007	0.015	0.015	3	0.035	0.010L	0.025	0.018
NITRATE	29	0.630	0.010L	0.620	0.034	37	0.090	0.010L	0.080	0.014	3	0.480	0.010	0.470	0.173
TOTAL N	29	0.940	0.040	0.900	0.270	36	1.00	0.010	0.990	0.245	3	0.480	0.060	0.420	0.320
PH	29	8.50	6.90	1.60	7.93	37	9.00	7.30	1.70	8.08	3	8.10	6.80	1.30	7.63
ORTHO P	29	0.072	0.003	0.069	0.028	37	0.055	0.007	0.048	0.031	3	0.055	0.020	0.035	0.034
TOTAL P	29	0.359	0.007	0.352	0.103	37	0.245	0.020	0.225	0.059	3	0.295	0.036	0.259	0.129
POTASS	7	3.10	2.30	0.800	2.67	8	2.60	1.40	1.20	2.21	3	2.50	1.10	1.40	2.00
SILICA	7	31.0	17.5	13.5	25.7	8	28.6	20.2	8.40	25.2	3	29.4	24.7	4.70	27.2
SODIUM	7	10.5	8.20	2.30	9.34	8	9.90	5.40	4.50	8.61	3	9.20	3.40	5.80	7.27
SULPHATE	7	7.70	4.30	3.40	6.49	8	7.90	3.30	4.60	6.12	3	7.90	0.800	7.10	5.30
TIC	0	0.0	0.0	0.0	0.0	11	31.0	18.0	13.0	24.6	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	7	0.005	0.001L	0.004	0.003	8	0.008	0.001L	0.007	0.003	3	0.002	0.001L	0.001	0.001
TOC	29	11.0	2.00L	9.00	5.41	37	12.0	2.00	10.0	6.81	3	15.0	5.00	10.0	9.67

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: B502 OK. RIVER:1.2 MILES UPSTREAM OSOYOOS LK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	10	10.0	5.00	5.00	6.00	8	5.00	0.0	5.00	4.37	4	35.0	0.0	35.0	12.2
TURBID	28	5.90	1.00	4.90	2.50	38	5.40	0.800	4.60	2.29	20	9.40	0.600	8.80	2.00
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	2	3.40	1.00	2.40	2.20	3	8.00	0.800	7.20	5.33	1	14.8	14.8	0.0	14.8
DISS O2	29	13.1	8.40	4.70	10.3	39	14.3	8.70	5.60	11.3	20	13.0	8.20	4.80	10.6
D.O. SAT	29	107.	93.0	14.0	100.	41	111.	89.0	22.0	103.	19	101.	78.0	23.0	93.6
TEMP	7	21.7	2.70	19.0	13.9	8	31.5	1.60	29.9	17.2	4	25.0	7.20	17.8	16.3
INORGANIC PARAMETERS															
ALK TOT	29	129.	87.0	42.0	110.	41	317.	63.7	253.	122.	20	147.	74.0	73.0	116.
CALCIUM	7	37.5	32.6	4.90	35.0	8	40.8	35.2	5.60	37.6	4	45.8	29.2	16.6	36.0
CHLORIDE	7	1.40	1.10	0.300	1.30	8	1.80	1.20	0.600	1.40	4	2.20	1.20	1.00	1.62
COPPER	7	0.003	0.001L	0.002	0.002	8	0.002	0.001L	0.001	0.001	4	0.009	0.001L	0.008	0.004
FLUORIDE	7	0.240	0.200	0.040	0.217	8	0.280	0.200	0.080	0.237	4	0.270	0.160	0.110	0.212
HARD TOT	7	130.	114.	16.0	121.	8	143.	118.	25.0	128.	4	166.	91.0	75.0	126.
IRON	7	0.110	0.010	0.100	0.034	8	0.030	0.010	0.020	0.021	4	0.090	0.010	0.080	0.045
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.027	0.005L	0.022	0.011	4	0.010L	0.005L	0.005	0.007
MAGNES	7	8.80	7.00	1.80	8.17	7	10.0	7.60	2.40	8.60	1	12.5	12.5	0.0	12.5
MANGAN	7	0.006	0.001L	0.005	0.004	8	0.044	0.003	0.041	0.014	4	0.050	0.010L	0.040	0.022
NITRATE	29	0.120	0.010L	0.110	0.040	41	0.190	0.010L	0.180	0.065	20	1.15	0.010L	1.14	0.151
TOTAL N	29	0.430	0.070	0.360	0.275	40	2.38	0.030	2.35	0.391	20	1.40	0.040	1.36	0.442
PH	29	8.50	7.20	1.30	8.03	41	8.40	7.80	0.600	8.20	20	8.30	7.70	0.600	8.07
ORTHO P	29	0.016	0.003L	0.013	0.005	41	0.052	0.003L	0.049	0.009	20	0.030	0.003L	0.027	0.007
TOTAL P	29	0.390	0.003	0.387	0.030	41	0.157	0.007	0.150	0.029	20	0.130	0.013	0.117	0.030
POTASS	7	2.50	2.00	0.500	2.27	8	2.90	2.00	0.900	2.32	4	2.80	1.70	1.10	2.32
SILICA	7	4.90	4.10	0.800	4.54	8	6.10	1.10	5.00	3.94	4	9.50	4.80	4.70	6.90
SODIUM	7	10.6	8.20	2.40	9.57	8	10.9	9.40	1.50	9.89	4	11.9	7.20	4.70	9.75
SULPHATE	7	31.3	26.3	5.00	29.0	8	35.9	27.1	8.80	31.1	4	43.1	21.9	21.2	31.5
TIC	0	0.0	0.0	0.0	0.0	16	30.0	18.0	12.0	25.4	16	32.0	15.0	17.0	22.9
ORGANIC PARAMETERS															
ZINC	7	0.003	0.001L	0.002	0.002	8	0.007	0.001L	0.006	0.002	4	0.004	0.001	0.003	0.003
TOC	29	30.0	2.00L	28.0	6.10	41	49.0	2.00L	47.0	6.78	19	10.0	2.00	8.00	7.00

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: B503 PARK RILL CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	2	7.00	5.00	2.00	6.00	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TURBID	5	4.50	1.00	3.50	2.58	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	2.40	2.40	0.0	2.40	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
DISS O2	5	8.80	0.05	8.80	6.48	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	5	92.0	9.009	83.0	72.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	1	16.5	16.5	0.0	16.5	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
INORGANIC PARAMETERS															
ALK TOT	5	101.	97.0	4.00	99.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
CALCIUM	1	31.6	31.6	0.0	31.6	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
CHLORIDE	1	1.40	1.40	0.0	1.40	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
COPPER	1	0.001L	0.001L	0.0	0.001	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
FLUORIDE	1	0.230	0.230	0.0	0.230	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
HARD TOT	1	111.	111.	0.0	111.	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
IRON	1	0.020	0.020	0.0	0.020	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
LEAD	1	0.010L	0.010L	0.0	0.010	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
MAGNES	1	7.80	7.80	0.0	7.80	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
MANGAN	1	0.002	0.002	0.0	0.002	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
NITRATE	5	0.010	0.010L	0.0	0.010	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TOTAL N	5	0.400	0.210	0.190	0.310	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
PH	5	8.50	7.60	0.900	8.14	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
ORTHO P	5	0.046	0.0L	0.046	0.011	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TOTAL P	5	0.046	0.007	0.039	0.026	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
POTASS	1	2.10	2.10	0.0	2.10	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
SILICA	1	1.60	1.60	0.0	1.60	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
SODIUM	1	9.20	9.20	0.0	9.20	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
SULPHATE	1	28.2	28.2	0.0	28.2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TIC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	1	0.003	0.003	0.0	0.003	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TOC	5	6.00	0.00	6.00	4.20	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8504 VASEAUX CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	7	40.0	10.0	30.0	25.0	3	40.0	5.00	35.0	25.0	2	65.0	25.0	40.0	45.0
TURBID	13	5.50	0.400	5.10	2.35	10	11.0	0.200	10.8	2.99	7	8.70	0.400	8.30	2.73
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	0.500L	0.500L	0.0	0.500	1	2.40	2.40	0.0	2.40	1	17.2	17.2	0.0	17.2
DISS O2	14	13.7	8.10	5.60	11.0	9	14.0	9.80	4.20	11.8	7	11.7	9.30	2.40	10.7
D.O. SAT	14	114.	87.0	27.0	98.4	10	101.	96.0	5.00	97.4	7	111.	95.0	16.0	98.9
TEMP	4	21.5	3.30	18.2	12.0	3	25.1	0.0	25.1	8.37	2	17.8	6.00	11.8	11.9
INORGANIC PARAMETERS															
ALK TOT	14	74.0	15.7	58.3	45.3	10	89.0	13.6	75.4	39.2	7	46.0	12.0	34.0	23.6
CALCIUM	4	17.2	6.60	10.6	11.9	3	19.0	7.30	11.7	11.6	2	9.80	4.40	5.40	7.10
CHLORIDE	4	0.600	0.300	0.300	0.400	3	0.600	0.400	0.200	0.467	2	0.600	0.400	0.200	0.500
COPPER	4	0.002L	0.001L	0.001	0.001	3	0.001	0.001	0.0	0.001	2	0.006	0.002	0.004	0.004
FLUORIDE	4	0.350	0.150	0.200	0.252	3	0.340	0.210	0.130	0.257	2	0.200	0.130	0.070	0.165
HARD TOT	4	61.3	21.7	39.6	43.6	3	68.8	22.4	46.4	39.7	2	35.0	16.0	19.0	25.5
IRON	4	0.050	0.020	0.030	0.032	3	0.070	0.010	0.060	0.043	2	0.130	0.030	0.100	0.080
LEAD	4	0.010L	0.005L	0.005	0.007	3	0.010L	0.005L	0.005	0.008	2	0.006L	0.006L	0.0	0.006
MAGNES	4	4.50	1.30	3.20	3.40	3	5.20	1.00	4.20	2.60	0	0.0	0.0	0.0	0.0
MANGAN	4	0.001	0.001L	0.0	0.001	3	0.004	0.002	0.002	0.003	2	0.010L	0.010L	0.0	0.010
NITRATE	14	0.040	0.010L	0.030	0.013	10	0.020	0.010L	0.010	0.011	7	0.010	0.010L	0.0	0.010
TOTAL N	13	0.340	0.040	0.300	0.147	10	0.320	0.050	0.270	0.149	7	1.06	0.010L	1.05	0.317
PH	14	8.20	7.40	0.800	7.75	10	8.20	7.30	0.900	7.68	7	7.80	6.60	1.20	7.29
ORTHO P	14	0.007	0.003L	0.004	0.003	10	0.010	0.003L	0.007	0.006	7	0.010	0.003	0.007	0.005
TOTAL P	14	0.029	0.003L	0.026	0.009	10	0.039	0.007	0.032	0.016	7	0.039	0.007	0.032	0.019
POTASS	4	1.20	0.800	0.400	0.950	3	1.10	0.800	0.300	0.933	2	0.900	0.600	0.300	0.750
SILICA	4	17.5	14.5	3.00	15.9	3	18.1	15.3	2.80	16.7	2	18.7	17.5	1.20	18.1
SODIUM	4	4.80	2.30	2.50	3.65	3	5.50	2.50	3.00	3.67	2	3.20	1.80	1.40	2.50
SULPHATE	4	6.70	1.10	5.60	4.20	3	8.20	2.40	5.80	4.80	2	4.50	2.60	1.90	3.55
TIC	0	0.0	0.0	0.0	0.0	2	19.0	5.00	14.0	12.0	5	6.00	2.00	4.00	3.60
ORGANIC PARAMETERS															
ZINC	4	0.008	0.001	0.007	0.003	3	0.008	0.001L	0.007	0.003	2	0.002	0.001	0.001	0.001
TOC	14	19.0	2.00	17.0	7.36	10	13.0	3.00	10.0	8.00	7	14.0	8.00	6.00	10.6

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2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8505 OK. RIVER 1.5 MILES UPSTREAM VASEAUX LK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	10	10.0	5.00	5.00	7.20	8	5.00	0.0	5.00	3.12	4	7.00	0.0	7.00	4.25
TURBID	28	25.0	0.800	24.2	2.87	38	19.0	0.300	18.7	2.13	20	4.80	0.300	4.50	1.57
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	12.0	12.0	0.0	12.0	2	9.60	5.60	4.00	7.60	2	8.80	2.00	6.80	5.40
DISS O2	29	12.9	9.00	3.90	10.7	39	14.9	8.90	6.00	12.2	20	13.9	8.50	5.40	11.3
D.O. SAT	29	125.	95.0	30.0	107.	41	137.	99.0	38.0	112.	20	112.	85.0	27.0	98.9
TEMP	7	22.7	2.70	20.0	14.7	8	25.1	0.0	25.1	13.0	4	25.0	6.00	19.0	16.1
INORGANIC PARAMETERS															
ALK TOT	29	128.	93.5	34.5	105.	41	119.	35.5	83.5	109.	20	118.	101.	17.0	108.
CALCIUM	7	34.7	28.1	6.60	32.5	8	34.9	33.8	1.10	34.3	4	34.2	30.6	3.60	32.5
CHLORIDE	7	1.30	1.00	0.300	1.16	8	1.60	1.10	0.500	1.29	4	1.60	0.700	0.900	1.22
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.006	0.001L	0.005	0.002	4	0.003	0.001L	0.002	0.002
FLUORIDE	7	0.220	0.170	0.050	0.196	8	0.240	0.190	0.050	0.207	4	0.210	0.170	0.040	0.192
HARD TOT	7	118.	110.	8.00	115.	8	122.	115.	7.00	118.	4	122.	110.	12.0	117.
IRON	7	0.060	0.010L	0.050	0.021	8	0.030	0.010	0.020	0.016	4	0.020	0.010L	0.010	0.012
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.010L	0.005L	0.005	0.007
MAGNES	7	10.6	7.10	3.50	8.11	8	9.00	7.30	1.70	7.92	1	8.90	8.90	0.0	8.90
MANGAN	7	0.002	0.001L	0.001	0.002	8	0.010L	0.002	0.008	0.005	4	0.028	0.010L	0.018	0.015
NITRATE	29	0.140	0.010L	0.130	0.032	41	0.560	0.010L	0.550	0.045	20	0.090	0.010L	0.080	0.021
TOTAL N	28	1.15	0.130	1.02	0.354	39	0.640	0.003L	0.637	0.293	20	1.48	0.010L	1.47	0.361
PH	29	9.00	7.50	1.50	8.34	41	8.90	5.50	3.40	8.52	20	8.80	8.00	0.800	8.39
ORTHO P	29	0.029	0.003L	0.026	0.006	41	0.026	0.003L	0.023	0.007	20	0.020	0.003L	0.017	0.007
TOTAL P	29	0.104	0.003	0.101	0.020	41	0.059	0.007	0.052	0.022	20	0.130	0.010	0.120	0.031
POTASS	7	2.20	1.90	0.300	2.10	8	2.30	1.70	0.600	2.05	4	2.30	2.00	0.300	2.13
SILICA	7	9.20	2.80	6.40	4.13	8	4.00	0.100	3.90	1.89	4	5.20	0.800	4.40	2.35
SODIUM	7	10.0	8.60	1.40	9.16	8	9.70	8.40	1.30	9.27	4	10.0	9.40	0.600	9.65
SULPHATE	7	27.6	25.4	2.20	26.6	8	28.4	27.3	1.10	27.7	4	27.8	27.0	0.800	27.4
TIC	0	0.0	0.0	0.0	0.0	16	38.0	18.0	20.0	23.9	16	26.0	18.0	8.00	21.1
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001L	0.003	0.002	8	0.003	0.001	0.002	0.002	4	0.002	0.001L	0.001	0.001
TOC	28	9.00	2.00	7.00	5.32	41	11.0	2.00L	9.00	5.59	20	10.0	2.00	8.00	6.95

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STREAM WATER QUALITY

STATION: 8506 SHUTTLEWORTH CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	10	65.0	0.0	65.0	20.0	8	40.0	0.0	40.0	6.25	3	75.0	10.0	65.0	33.3
TURBID	28	17.0	0.200	16.8	2.95	33	140.	0.200	140.	3.92	3	46.0	1.70	44.3	18.4
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	2	23.0	1.20	21.8	12.1	1	25.2	25.2	0.0	25.2	2	144.	2.40	142.	73.2
DISS O2	28	8.90	4.20	4.70	5.79	34	16.4	4.20	12.2	6.91	3	13.1	10.1	3.00	11.3
D.O. SAT	28	96.0	40.0	56.0	55.8	36	105.	40.0	65.0	62.9	3	109.	93.0	16.0	98.7
TEMP	7	22.7	5.50	17.2	13.0	8	31.5	8.50	23.0	18.8	3	25.0	8.50	16.5	18.0
INORGANIC PARAMETERS															
ALK TOT	29	208.	34.3	174.	166.	36	220.	9.60	210.	172.	3	238.	13.0	225.	108.
CALCIUM	7	66.7	17.0	49.7	50.9	8	68.1	12.7	55.4	57.4	3	79.1	5.20	73.9	35.7
CHLORIDE	7	2.60	0.500	2.10	1.79	8	2.90	0.700	2.20	2.07	3	11.5	0.700	10.8	4.37
COPPER	7	0.002	L0.001	L0.001	0.001	8	0.006	0.001	L0.005	0.002	3	0.003	0.002	0.001	0.002
FLUORIDE	7	0.280	0.220	0.060	0.247	8	0.250	0.200	0.050	0.230	3	0.140	0.120	0.020	0.247
HARD TOT	7	201.	57.6	143.	156.	8	204.	40.5	163.	174.	3	262.	17.0	245.	120.
IRON	7	0.060	0.010	0.050	0.030	8	0.100	0.010	L0.090	0.034	3	0.280	0.060	0.220	0.173
LEAD	7	0.010	L0.005	L0.005	0.009	8	0.010	0.005	L0.005	0.009	3	0.010	L0.006	L0.004	0.009
MAGNES	7	9.10	3.00	6.10	6.90	8	9.00	2.10	6.90	7.36	1	5.50	5.50	0.0	5.50
MANGAN	7	0.010	0.001	L0.009	0.003	8	0.021	0.001	L0.020	0.007	3	0.100	0.010	L0.090	0.040
NITRATE	29	0.840	0.010	L0.830	0.484	36	0.810	0.010	L0.800	0.549	3	1.20	0.010	L 1.19	0.453
TOTAL N	28	1.25	0.150	1.10	0.612	35	1.25	0.110	1.14	0.712	3	1.56	0.230	1.33	0.733
PH	29	8.20	7.20	1.00	7.61	36	8.00	7.50	0.500	7.72	3	8.30	6.70	1.60	7.57
ORTHO P	29	0.026	0.003	L0.023	0.004	36	0.036	0.003	L0.033	0.006	3	0.036	0.013	0.023	0.022
TOTAL P	29	0.068	0.003	L0.065	0.012	36	0.424	0.003	0.421	0.037	3	0.254	0.036	0.218	0.114
POTASS	7	2.90	2.00	0.900	2.46	8	2.90	1.40	1.50	2.44	3	5.90	0.900	5.00	2.97
SILICA	7	18.0	15.6	2.40	17.1	8	19.1	16.4	2.70	18.0	3	20.5	15.9	4.90	18.7
SODIUM	7	15.1	4.80	10.3	11.6	8	15.0	3.70	11.3	12.6	3	22.4	2.10	20.3	10.2
SULPHATE	7	34.9	8.50	26.4	26.4	8	35.4	8.10	27.3	29.3	3	54.8	2.90	51.9	25.1
TIC	0	0.0	0.0	0.0	0.0	11	48.0	22.0	26.0	37.8	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001	L0.003	0.002	8	0.005	0.001	L0.004	0.002	3	0.005	0.001	L0.004	0.002
TOC	29	12.0	2.00	L 10.0	3.21	36	14.0	2.00	L 12.0	5.61	3	16.0	5.00	11.0	10.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8507 MC LEAN CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	3	30.0	5.00	25.0	12.7	7	10.0	5.00	5.00	7.14	3	35.0	5.00	30.0	16.7
TURBID	19	17.0	0.400	16.6	3.32	30	9.00	0.500	8.50	2.03	3	3.20	0.900	2.30	1.87
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	2	2.40	1.60	0.800	2.00	1	8.80	8.80	0.0	8.80	1	43.2	43.2	0.0	43.2
DISS O2	20	12.7	7.00	5.70	9.70	28	13.8	8.30	5.50	11.7	3	12.3	9.30	3.00	10.9
D.O. SAT	20	95.0	75.0	20.0	87.2	30	110.	10.05	100.	95.1	3	95.0	90.0	5.00	93.3
TEMP	6	16.7	1.10	15.6	11.7	8	24.4	0.0	24.4	12.5	3	25.0	7.10	17.9	15.8
INORGANIC PARAMETERS															
ALK TOT	20	178.	53.0	125.	126.	30	160.	31.8	128.	136.	3	137.	29.0	108.	99.3
CALCIUM	6	48.6	32.6	16.0	40.7	8	54.9	31.2	23.7	48.3	3	46.9	10.4	36.5	33.7
CHLORIDE	6	1.30	1.10	0.200	1.20	8	1.80	0.700	1.10	1.20	3	1.90	0.800	1.10	1.23
COPPER	6	0.007	0.001	L0.006	0.002	8	0.004	0.001	L0.003	0.002	3	0.002	0.001	L0.001	0.001
FLUORIDE	6	0.230	0.150	0.080	0.205	8	0.260	0.180	0.080	0.219	3	0.210	0.090	0.120	0.170
HARD TOT	6	150.	104.	46.0	136.	8	166.	94.7	71.3	149.	3	154.	31.0	123.	108.
IRON	6	0.090	0.030	0.060	0.065	8	0.060	0.010	L0.050	0.035	3	0.060	0.030	0.030	0.043
LEAD	6	0.010	L0.005	L0.005	0.008	8	0.010	L0.005	L0.005	0.009	3	0.010	L0.006	L0.004	0.007
MAGNES	6	12.4	5.50	6.90	8.28	8	8.50	4.10	4.40	6.89	1	9.00	9.00	0.0	9.00
MANGAN	6	0.017	0.0	0.017	0.006	8	0.014	0.002	0.012	0.008	3	0.013	0.010	L0.003	0.011
NITRATE	20	0.450	0.010	0.440	0.165	30	0.450	0.010	L0.440	0.180	3	0.680	0.010	L0.670	0.277
TOTAL N	19	0.850	0.130	0.720	0.347	30	1.14	0.010	1.13	0.365	3	0.940	0.270	0.670	0.500
PH	20	8.30	7.50	0.800	7.90	30	8.60	7.00	1.60	8.09	3	8.20	7.30	0.900	7.83
ORTHO P	20	0.029	0.003	L0.026	0.010	30	0.062	0.003	L0.059	0.023	3	0.065	0.016	0.049	0.032
TOTAL P	20	0.088	0.003	0.085	0.027	30	0.091	0.013	0.078	0.039	3	0.075	0.029	0.046	0.049
POTASS	6	2.10	1.60	0.500	1.88	8	2.30	1.10	1.20	1.77	3	3.00	0.700	2.30	1.80
SILICA	6	19.7	17.9	1.80	18.9	8	20.5	17.7	2.80	19.5	3	22.5	18.4	4.10	19.9
SODIUM	6	9.40	6.50	2.90	7.90	8	8.50	5.30	3.20	7.86	3	8.80	2.30	6.50	6.27
SULPHATE	6	25.3	16.7	8.60	23.1	8	27.0	16.9	10.1	24.5	3	30.2	5.80	24.4	18.9
TIC	0	0.0	0.0	0.0	0.0	5	35.0	28.0	7.00	32.2	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	6	0.005	0.001	L0.004	0.002	8	0.005	0.001	L0.004	0.002	3	0.007	0.002	0.005	0.004
TOC	20	39.0	2.00	L 37.0	7.10	30	14.0	0.0	L 14.0	5.27	3	9.00	5.00	4.00	6.67

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: B508 OK. RIVER AT ENTRANCE TO SKAHA LAKE

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	10	15.0	5.00	10.0	7.00	8	5.00	0.0	5.00	2.50	4	25.0	0.0	25.0	8.75
TURBID	30	4.60	0.400	4.20	1.67	39	7.40	0.700	6.70	2.51	20	15.6	0.300	15.3	2.78
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	0.500L	0.500L	0.0	0.500	2	10.4	5.60	4.80	8.00	2	16.0	1.80	14.2	8.90
DISS O2	30	12.2	7.90	4.30	10.0	40	12.9	8.40	4.50	11.1	20	12.8	8.30	4.50	10.6
O.D. SAT	30	117.	87.0	30.0	99.6	42	118.	68.0	50.0	98.9	20	105.	81.0	24.0	93.6
TEMP	7	22.0	4.40	17.6	14.3	8	26.0	2.70	23.3	16.9	4	25.0	5.60	19.4	16.1
INORGANIC PARAMETERS															
ALK TOT	30	144.	93.0	51.0	106.	42	190.	74.7	115.	112.	20	117.	72.0	45.0	104.
CALCIUM	7	34.2	31.0	3.20	33.2	8	37.5	34.1	3.40	35.1	4	34.2	28.4	5.80	31.9
CHLORIDE	6	1.30	1.10	0.200	1.22	8	1.70	1.00	0.700	1.30	4	3.40	0.800	2.60	1.70
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.004	0.001L	0.003	0.001	4	0.004	0.001	0.003	0.003
FLUORIDE	7	0.200	0.160	0.040	0.183	8	0.200	0.170	0.030	0.186	4	0.200	0.160	0.040	0.172
HARD TOT	7	119.	112.	7.00	116.	8	120.	114.	6.00	118.	4	121.	96.0	25.0	112.
IRON	7	0.320	0.010	0.310	0.061	8	0.050	0.010	0.040	0.031	4	0.070	0.020	0.050	0.050
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.010L	0.005L	0.005	0.007
MAGNES	7	8.40	7.70	0.700	8.00	8	8.20	5.70	2.50	7.35	1	8.70	8.70	0.0	8.70
MANGAN	7	0.004	0.001L	0.003	0.002	8	0.013	0.003	0.010	0.008	4	0.047	0.010L	0.037	0.020
NITRATE	30	0.250	0.010L	0.240	0.045	42	0.360	0.010L	0.350	0.053	20	0.140	0.010L	0.130	0.046
TOTAL N	28	1.82	0.090	1.73	0.368	42	1.31	0.050	1.26	0.373	20	2.52	0.050	2.47	0.603
PH	30	8.50	7.30	1.20	8.05	42	8.50	7.70	0.800	8.16	20	8.50	7.70	0.800	8.05
ORTHO P	30	0.039	0.003L	0.036	0.016	42	0.160	0.003	0.157	0.035	20	0.160	0.003	0.157	0.051
TOTAL P	30	0.085	0.007	0.078	0.034	40	0.241	0.023	0.218	0.056	20	0.232	0.016	0.216	0.082
POTASS	6	2.30	1.90	0.400	2.12	8	2.40	2.00	0.400	2.14	4	2.40	1.70	0.700	2.10
SILICA	6	7.70	5.20	2.50	5.80	8	6.20	5.30	0.900	5.84	4	8.50	5.10	3.40	6.57
SODIUM	6	10.3	8.50	1.80	9.40	8	10.0	8.10	1.90	9.20	4	11.1	8.00	3.10	9.45
SULPHATE	7	28.0	25.4	2.60	26.8	8	28.8	25.5	3.30	27.2	4	33.3	23.0	10.3	27.4
TIC	0	0.0	0.0	0.0	0.0	16	26.0	19.0	7.00	23.1	16	26.0	15.0	11.0	20.5
ORGANIC PARAMETERS															
ZINC	7	0.005	0.001L	0.004	0.002	8	0.004	0.001L	0.003	0.002	4	0.009	0.001L	0.008	0.003
TOC	29	14.0	2.00	12.0	5.97	42	10.0	2.00L	8.00	5.31	20	10.0	2.00L	8.00	6.85

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: B509 SHINGLE CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	10	40.0	10.0	30.0	17.0	7	37.0	2.90	34.1	12.4	2	13.0	5.00	8.00	9.00
TURBID	30	7.00	0.300	6.70	1.93	27	32.0	0.600	31.4	4.83	6	9.00	1.10	7.90	4.88
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	2	6.00	0.500L	5.50	3.25	0	0.0	0.0	0.0	0.0	1	40.0	40.0	0.0	40.0
DISS O2	30	13.3	7.80	5.50	10.7	27	15.1	3.10	12.0	11.1	6	12.7	10.1	2.60	11.5
O.D. SAT	30	124.	83.0	41.0	100.	28	108.	22.0	86.0	90.2	6	92.0	81.0	11.0	87.8
TEMP	7	20.3	1.60	18.7	11.0	7	25.0	0.0	25.0	14.5	2	25.1	7.10	18.0	16.1
INORGANIC PARAMETERS															
ALK TOT	30	166.	42.2	124.	133.	28	186.	30.7	155.	139.	6	170.	30.0	140.	120.
CALCIUM	7	39.6	12.9	26.7	31.7	7	45.2	22.4	22.8	39.1	2	39.0	14.4	24.6	26.7
CHLORIDE	6	5.70	0.700	5.00	2.00	7	2.50	0.700	1.80	1.44	2	1.70	0.800	0.900	1.25
COPPER	7	0.003	0.001L	0.002	0.002	7	0.005	0.001L	0.004	0.002	2	0.002	0.001	0.001	0.001
FLUORIDE	7	0.340	0.130	0.210	0.256	7	0.340	0.160	0.180	0.283	2	0.290	0.130	0.160	0.210
HARD TOT	7	137.	42.8	94.2	106.	7	150.	68.1	81.9	130.	2	140.	47.0	93.0	93.5
IRON	7	0.180	0.040	0.140	0.066	7	0.090	0.020	0.070	0.051	2	0.110	0.040	0.070	0.075
LEAD	7	0.010L	0.005L	0.005	0.009	7	0.010L	0.005L	0.005	0.009	2	0.010L	0.006L	0.004	0.008
MAGNES	7	9.30	1.80	7.50	6.46	7	9.40	3.00	6.40	7.91	1	10.4	10.4	0.0	10.4
MANGAN	7	0.035	0.001L	0.034	0.009	7	0.360	0.002	0.358	0.055	2	0.010L	0.006L	0.004	0.008
NITRATE	30	0.200	0.010L	0.190	0.028	28	0.110	0.010L	0.100	0.034	6	0.150	0.010	0.140	0.055
TOTAL N	28	1.18	0.010	1.17	0.215	28	0.980	0.010L	0.970	0.237	6	1.20	0.090	1.11	0.502
PH	30	8.50	7.60	0.900	8.13	28	8.60	6.80	1.80	8.02	6	8.00	7.30	0.700	7.77
ORTHO P	30	0.023	0.003L	0.020	0.005	28	0.023	0.001L	0.022	0.005	6	0.016	0.003	0.013	0.007
TOTAL P	30	0.111	0.003	0.108	0.020	27	0.189	0.007	0.182	0.033	6	0.091	0.007	0.084	0.036
POTASS	6	2.40	1.00	1.40	1.88	7	2.70	1.70	1.00	2.23	2	2.20	1.20	1.00	1.70
SILICA	6	17.9	12.0	5.90	15.6	7	19.8	3.00	16.8	14.9	2	20.8	16.6	4.20	18.7
SODIUM	6	30.9	7.80	23.1	15.6	7	16.5	7.10	9.40	14.7	2	16.4	5.40	11.0	10.9
SULPHATE	7	15.4	7.10	8.30	11.1	7	19.7	12.7	7.00	15.2	2	17.4	6.50	10.9	11.9
TIC	0	0.0	0.0	0.0	0.0	4	44.0	17.0	27.0	28.5	4	38.0	6.00	32.0	27.7
ORGANIC PARAMETERS															
ZINC	7	0.010L	0.001L	0.009	0.003	7	0.002	0.001L	0.001	0.001	2	0.001	0.001L	0.0	0.001
TOC	29	16.0	2.00	14.0	4.93	28	13.0	2.00L	11.0	5.36	6	13.0	2.00L	11.0	6.83

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: B510 ELLIS CREEK

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	10	70.0	5.00	65.0	46.0	8	55.0	10.0	45.0	29.4	3	85.0	15.0	70.0	40.0
TURBID	29	62.0	1.60	60.4	10.7	37	62.0	2.20	59.8	11.7	14	260.	0.900	259.	25.6
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	5	16.6	4.20	12.4	8.08	7	52.5	2.80	49.7	12.5	2	253.	31.2	222.	142.
DISS O2	29	13.2	2.80	10.4	8.26	38	13.9	6.30	7.60	10.1	14	12.8	4.90	7.90	10.3
D.O. SAT	29	103.	31.0	72.0	78.0	40	121.	63.0	58.0	90.0	13	94.0	48.0	45.0	81.2
TEMP	7	19.8	1.10	18.7	11.8	8	26.0	1.10	24.9	16.7	3	22.8	6.00	16.8	14.1
INORGANIC PARAMETERS															
ALK TOT	29	154.	10.6	143.	48.0	40	197.	10.7	186.	48.5	14	52.0	7.00	45.0	32.1
CALCIUM	7	391.	3.40	388.	67.8	8	17.0	7.80	9.20	13.4	3	12.2	3.00	9.20	9.00
CHLORIDE	6	8.20	1.30	6.90	3.75	8	10.2	1.10	9.10	5.10	3	3.70	0.600	3.10	2.20
COPPER	7	0.002	0.001L	0.001	0.001	8	0.011	0.001L	0.010	0.003	3	0.015	0.001	0.014	0.007
FLUORIDE	7	0.290	0.070	0.220	0.181	8	0.230	0.150	0.080	0.189	3	0.210	0.120	0.090	0.160
HARD TOT	7	138.	12.8	125.	60.8	8	58.0	27.1	30.9	44.5	3	41.0	11.0	30.0	30.3
IRON	7	0.650	0.020	0.630	0.336	8	0.480	0.210	0.270	0.279	3	0.220	0.190	0.030	0.210
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.017	0.005L	0.012	0.010	3	0.010L	0.006L	0.004	0.007
MAGNES	7	9.80	1.00	8.80	4.10	8	4.20	1.40	2.80	2.66	1	2.40	2.40	0.0	2.40
MANGAN	7	0.750	0.001	0.749	0.157	8	0.100	0.028	0.072	0.062	3	0.120	0.010L	0.110	0.052
NITRATE	28	2.12	0.010L	2.11	0.173	40	0.200	0.010L	0.190	0.034	14	0.890	0.010L	0.880	0.109
TOTAL N	28	2.68	0.110	2.57	0.571	39	0.760	0.041	0.719	0.376	14	2.67	0.030	2.64	0.471
PH	29	8.10	5.50	1.60	7.09	40	8.10	6.90	1.20	7.20	14	7.80	6.60	1.20	7.06
ORTHO P	29	0.107	0.003L	0.104	0.025	40	0.117	0.003	0.114	0.036	14	0.033	0.007	0.026	0.013
TOTAL P	29	0.241	0.007	0.234	0.099	39	0.457	0.020	0.437	0.126	14	0.424	0.016	0.408	0.076
POTASS	6	2.40	1.30	1.10	1.68	8	1.70	0.800	0.900	1.19	3	1.30	0.400	0.900	0.967
SILICA	6	19.4	15.8	3.60	17.4	8	19.2	15.5	3.70	17.5	3	22.5	16.3	6.20	19.7
SODIUM	6	15.7	6.70	9.00	8.73	8	11.7	4.20	7.50	7.97	3	7.70	1.90	5.80	5.20
SULPHATE	7	18.1	1.40	16.7	11.6	8	17.8	4.90	12.9	10.1	3	9.70	1.60	8.10	6.40
TIC	0	0.0	0.0	0.0	0.0	15	15.0	7.00	8.00	10.7	11	12.0	2.00L	10.0	6.73
ORGANIC PARAMETERS															
ZINC	7	0.008	0.001L	0.007	0.002	8	0.011	0.002L	0.009	0.005	3	0.008	0.001L	0.007	0.005
TOC	29	16.0	5.00	11.0	8.59	40	14.0	2.00L	12.0	7.80	14	19.0	2.00	17.0	10.1

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: B511 PENTICTON CREEK

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	10	70.0	30.0	40.0	50.0	7	60.0	10.0	50.0	33.6	4	45.0	15.0	30.0	30.0
TURBID	30	29.0	0.900	28.1	4.70	26	62.0	0.800	61.2	6.11	15	8.80	0.700	8.10	3.23
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	3	33.2	0.500L	32.7	14.7	1	2.40	2.40	0.0	2.40	2	30.4	2.40	28.0	16.4
DISS O2	30	13.8	8.20	5.60	10.4	26	14.5	8.80	5.70	12.0	15	13.7	8.00	5.70	10.9
D.O. SAT	30	104.	90.0	14.0	96.4	27	111.	60.0	51.0	97.6	14	105.	90.0	15.0	96.3
TEMP	7	20.6	1.60	19.0	11.4	7	24.6	0.200	24.4	14.9	4	22.8	6.60	16.2	14.4
INORGANIC PARAMETERS															
ALK TOT	30	45.5	10.0	35.5	22.9	27	229.	7.80	221.	40.9	15	46.0	7.00	39.0	21.3
CALCIUM	7	11.4	4.10	7.30	6.27	7	17.2	5.30	11.9	9.51	4	11.6	3.20	8.40	7.67
CHLORIDE	6	9.70	0.400	8.30	1.98	7	1.70	0.500	1.20	0.814	4	1.50	0.600	0.900	0.875
COPPER	7	0.006	0.001L	0.005	0.002	7	0.004	0.001L	0.003	0.003	4	0.008	0.002	0.006	0.005
FLUORIDE	6	0.100	0.060	0.040	0.075	7	0.150	0.070	0.080	0.100	4	0.100	0.050	0.050	0.080
HARD TOT	7	33.2	14.2	19.0	20.7	7	57.7	17.8	39.9	32.5	4	40.0	11.0	29.0	26.7
IRON	7	0.680	0.090	0.590	0.383	7	0.640	0.090	0.550	0.441	4	0.360	0.210	0.150	0.280
LEAD	7	0.019	0.005L	0.014	0.010	7	0.010L	0.005	0.005	0.009	4	0.010L	0.005L	0.005	0.007
MAGNES	7	1.40	1.00	0.400	1.23	7	3.90	1.10	2.80	2.14	1	2.30	2.30	0.0	2.30
MANGAN	7	0.090	0.001L	0.089	0.017	7	0.022	0.005	0.017	0.011	4	0.020	0.010L	0.010	0.015
NITRATE	30	0.220	0.010L	0.210	0.028	27	0.120	0.010L	0.110	0.036	15	0.200	0.010L	0.190	0.057
TOTAL N	30	0.870	0.040	0.790	0.260	27	9.27	0.010	9.26	0.627	15	2.20	0.080	2.12	0.567
PH	30	8.10	6.80	1.30	7.47	27	8.80	6.80	2.00	7.64	15	7.90	6.60	1.30	7.20
ORTHO P	30	0.013	0.003L	0.010	0.004	27	0.029	0.003L	0.026	0.005	15	0.020	0.003L	0.017	0.007
TOTAL P	30	0.065	0.003	0.062	0.019	26	0.359	0.010	0.349	0.036	15	0.065	0.007	0.058	0.026
POTASS	6	1.00	0.600	0.400	0.817	7	1.30	0.600	0.700	0.871	4	1.30	0.400	0.900	0.850
SILICA	6	13.6	11.4	2.20	12.4	7	18.5	10.9	7.60	14.5	4	18.4	12.6	5.80	14.3
SODIUM	6	16.5	1.90	14.6	5.43	7	5.00	2.20	2.80	3.40	4	3.80	1.60	2.20	2.82
SULPHATE	7	3.00	0.300	2.70	2.09	7	10.8	1.60	9.20	5.41	4	9.80	3.70	6.10	7.05
TIC	0	0.0	0.0	0.0	0.0	3	19.0	3.00	16.0	8.67	11	9.00	2.00L	7.00	3.55
ORGANIC PARAMETERS															
ZINC	7	0.018	0.001L	0.017	0.004	7	0.080	0.001	0.079	0.014	4	0.036	0.002	0.034	0.011
TOC	29	19.0	3.00	16.0	8.69	27	15.0	2.00L	13.0	6.93	15	15.0	6.00	9.00	10.9

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8512 TROUT CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	5	40.0	0.0	40.0	19.0	7	30.0	0.0	30.0	15.0	4	40.0	10.0	30.0	23.0
TURBID	31	150.	0.600	149.	33.1	36	165.	0.200	165.	55.3	18	210.	0.300	210.	28.0
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	5	182.	4.00	178.	75.2	6	581.1	5.20	576.	268.	2	1744.	164.	1580.	954.
DISS O2	31	14.2	7.60	6.60	10.7	37	15.3	8.70	6.60	11.3	18	13.6	8.10	5.50	11.0
D.O. SAT	31	118.	80.0	38.0	101.	39	116.	91.0	25.0	101.	18	120.	87.0	33.0	98.7
TEMP	7	26.2	1.10	25.1	13.6	7	25.0	1.60	23.4	18.2	4	22.8	5.60	17.2	14.0
INORGANIC PARAMETERS															
ALK TOT	31	170.	37.2	133.	105.	39	203.	36.8	166.	124.	18	156.	24.0	132.	84.6
CALCIUM	7	33.3	25.4	7.90	28.8	7	68.0	23.7	44.3	37.0	4	28.0	10.0	18.0	22.8
CHLORIDE	6	1.60	0.900	0.700	1.17	7	4.40	1.00	3.40	2.01	4	1.90	0.800	1.10	1.22
COPPER	7	0.006	0.001L	0.005	0.003	7	0.015	0.001L	0.014	0.006	4	0.009	0.001	0.008	0.004
FLUORIDE	7	0.240	0.150	0.090	0.190	7	0.240	0.180	0.060	0.214	4	0.230	0.090	0.140	0.162
HARD TOT	7	135.	77.2	57.8	107.	7	203.	81.8	121.	132.	4	119.	32.0	87.0	86.7
IRON	7	0.080	0.020	0.060	0.047	7	0.070	0.020	0.050	0.037	4	0.120	0.010L	0.110	0.055
LEAD	7	0.010L	0.005L	0.005	0.009	7	0.029	0.005L	0.024	0.012	4	0.010L	0.005L	0.005	0.007
MAGNES	7	13.3	3.30	10.0	8.46	7	13.2	5.50	7.70	9.66	1	11.9	11.9	0.0	11.9
MANGAN	7	0.014	0.001L	0.013	0.005	7	0.019	0.003	0.016	0.011	4	0.060	0.010L	0.050	0.025
NITRATE	31	0.680	0.010L	0.670	0.152	39	0.610	0.010L	0.600	0.251	18	0.710	0.010L	0.700	0.201
TOTAL N	30	1.05	0.190	0.860	0.395	39	1.32	0.180	1.14	0.551	18	2.86	0.060	2.80	0.602
PH	31	8.80	6.50	2.30	8.21	39	9.40	7.40	2.00	8.40	18	9.20	7.30	1.90	8.11
ORTHO P	31	0.010	0.003L	0.007	0.005	39	0.033	0.003L	0.030	0.007	18	0.016	0.003L	0.013	0.006
TOTAL P	31	0.323	0.003L	0.320	0.051	38	0.684	0.020	0.664	0.184	18	1.27	0.016	1.25	0.236
POTASS	6	2.50	1.60	0.900	1.98	7	2.90	1.50	1.40	2.06	4	2.20	1.00	1.20	1.72
SILICA	6	17.3	5.40	11.9	14.6	7	17.9	14.5	3.40	15.9	4	21.8	13.3	8.50	16.9
SODIUM	6	16.8	5.40	11.4	10.5	7	19.2	9.00	10.2	15.4	4	14.8	2.40	12.4	9.37
SULPHATE	7	41.2	16.9	24.3	27.1	7	54.9	22.2	32.7	39.4	4	40.3	5.70	34.6	23.8
TIC	0	0.0	0.0	0.0	0.0	14	51.0	16.0	35.0	29.3	14	29.0	3.00	26.0	15.2
ORGANIC PARAMETERS															
ZINC	7	0.013	0.001L	0.012	0.004	7	0.014	0.001	0.013	0.006	4	0.029	0.001	0.028	0.009
TOC	30	22.0	3.00	19.0	6.60	39	15.0	2.00	13.0	7.51	18	23.0	4.00	19.0	11.4

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8513 CHUTE CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	5	70.0	25.0	45.0	38.0	8	60.0	15.0	45.0	35.6	3	55.0	45.0	10.0	48.3
TURBID	25	18.0	0.600	17.4	2.51	28	13.0	0.700	12.3	2.94	3	3.50	0.600	2.90	2.20
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	2	0.500L	0.500L	0.0	0.500	1	2.40	2.40	0.0	2.40	1	1.60	1.60	0.0	1.60
DISS O2	25	13.2	8.60	4.60	10.4	27	14.1	10.0	4.10	12.1	3	12.6	8.20	4.40	10.5
D.O. SAT	25	100.	87.0	13.0	98.4	29	110.	93.0	17.0	99.5	3	94.0	88.0	6.00	90.0
TEMP	6	15.1	1.10	14.0	9.02	8	25.0	0.0	25.0	15.6	3	22.8	9.30	13.5	16.3
INORGANIC PARAMETERS															
ALK TOT	25	54.0	17.0	37.0	32.2	29	42.7	16.6	26.1	30.4	3	28.0	16.0	12.0	23.7
CALCIUM	6	13.8	6.30	7.50	10.0	8	11.5	6.10	7.40	10.1	3	9.60	6.00	3.60	8.03
CHLORIDE	5	1.20	0.500	0.700	0.720	8	0.900	0.400	0.500	0.625	3	0.800	0.600	0.200	0.700
COPPER	6	0.002	0.001L	0.001	0.001	8	0.004	0.001L	0.003	0.001	3	0.005	0.001	0.004	0.003
FLUORIDE	6	0.120	0.080	0.040	0.098	8	0.130	0.090	0.040	0.110	3	0.100	0.080	0.020	0.090
HARD TOT	6	38.6	21.4	17.2	31.1	8	41.2	20.2	21.0	31.7	3	31.0	21.0	10.0	27.3
IRON	6	0.330	0.100	0.230	0.153	8	0.340	0.090	0.250	0.192	3	0.360	0.210	0.150	0.273
LEAD	6	0.010L	0.005L	0.005	0.008	8	0.010L	0.005L	0.005	0.009	3	0.010L	0.005L	0.004	0.007
MAGNES	6	2.20	0.300	1.90	1.50	8	2.00	0.800	1.20	1.59	1	2.40	2.40	0.0	2.40
MANGAN	6	0.005	0.001	0.004	0.003	8	0.010L	0.002	0.008	0.005	3	0.010L	0.010L	0.0	0.010
NITRATE	25	0.080	0.010L	0.070	0.022	29	0.450	0.010L	0.440	0.047	3	0.120	0.010L	0.110	0.073
TOTAL N	25	0.430	0.100	0.330	0.302	28	0.550	0.040	0.510	0.323	3	2.36	0.340	2.02	1.06
PH	25	8.00	7.10	0.900	7.67	29	8.40	7.00	1.40	7.68	3	7.50	7.10	0.500	7.30
ORTHO P	25	0.010	0.003L	0.007	0.005	29	0.013	0.003L	0.010	0.005	3	0.007	0.007	0.0	0.007
TOTAL P	25	0.020	0.007	0.013	0.010	28	0.029	0.007	0.022	0.015	3	0.023	0.016	0.007	0.020
POTASS	5	1.30	0.800	0.500	1.10	8	1.80	0.400	1.40	1.00	3	1.20	0.700	0.500	0.967
SILICA	5	18.0	15.0	3.00	16.6	8	19.2	14.2	5.00	16.3	3	18.2	13.5	4.70	16.4
SODIUM	5	4.50	2.50	2.00	3.52	8	4.80	2.60	2.20	3.85	3	3.40	2.00	1.40	2.87
SULPHATE	6	22.5	2.70	19.8	9.18	8	10.9	4.40	6.50	7.10	3	8.40	5.80	2.60	7.13
TIC	0	0.0	0.0	0.0	0.0	5	6.00	5.00	1.00	5.60	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	6	0.005	0.001L	0.004	0.002	8	0.004	0.001L	0.003	0.002	3	0.005	0.001	0.004	0.003
TOC	24	27.0	8.00	19.0	11.1	29	17.0	5.00	12.0	10.8	3	14.0	11.0	3.00	12.7

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8514 PEACHLAND CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	25.0	5.00	20.0	14.2	8	20.0	0.0	20.0	8.37	3	65.0	5.00	60.0	26.7
TURBID	30	23.0	0.800	22.2	6.47	38	40.0	0.200	39.8	6.58	14	57.0	0.300	56.7	13.2
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	5	15.4	4.00	11.4	8.28	4	35.6	8.00	27.6	17.9	2	113.	56.8	56.2	84.9
DISS O2	30	13.2	8.60	4.60	10.6	39	13.7	9.60	4.10	11.5	14	13.2	8.90	4.30	11.5
D.O. SAT	30	104.	88.0	16.0	95.0	42	112.	89.0	23.0	98.9	14	100.	90.0	10.0	95.6
TEMP	7	16.8	2.70	14.1	10.6	8	25.1	1.60	23.5	15.8	3	22.8	8.80	14.0	15.6
INORGANIC PARAMETERS															
ALK TOT	30	191.	101.	90.0	145.	41	203.	69.3	134.	141.	14	192.	58.0	134.	142.
CALCIUM	7	64.2	34.8	29.4	49.6	8	72.7	25.6	47.1	49.2	3	59.1	34.4	24.7	48.8
CHLORIDE	6	1.30	0.0	1.30	0.900	8	1.30	0.800	0.500	1.06	3	1.30	0.600	0.700	1.03
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.011	0.001L	0.010	0.002	3	0.003	0.001	0.002	0.002
FLUORIDE	7	0.640	0.250	0.390	0.390	8	0.660	0.130	0.530	0.365	3	0.520	0.160	0.360	0.353
HARD TOT	7	198.	110.	88.0	150.	8	215.	73.8	141.	148.	3	189.	101.	88.0	152.
IRON	7	0.090	0.010	0.080	0.034	8	0.180	0.010	0.170	0.041	3	0.040	0.010L	0.030	0.023
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.010L	0.006L	0.004	0.007
MAGNES	7	9.10	4.20	4.90	6.36	8	8.50	2.40	6.10	6.15	1	7.90	7.90	0.0	7.90
MANGAN	7	0.006	0.001L	0.005	0.003	8	0.010L	0.002	0.008	0.005	3	0.010	0.010L	0.0	0.010
NITRATE	30	0.750	0.010	0.740	0.400	42	1.69	0.040	1.65	0.559	14	0.780	0.190	0.590	0.496
TOTAL N	30	0.890	0.180	0.710	0.629	42	2.06	0.040	2.02	0.843	14	2.79	0.350	2.44	0.881
PH	30	8.50	7.40	1.10	8.17	42	8.60	7.50	1.10	8.25	14	8.40	7.70	0.700	8.15
ORTHO P	30	0.030	0.003L	0.027	0.012	42	0.062	0.003L	0.059	0.017	14	0.029	0.003	0.026	0.015
TOTAL P	30	0.117	0.003L	0.114	0.032	41	0.134	0.007	0.127	0.039	14	0.245	0.016	0.229	0.065
POTASS	6	3.00	1.90	1.10	2.42	8	2.90	1.80	1.10	2.21	3	2.80	1.70	1.10	2.37
SILICA	6	19.3	15.7	3.60	17.5	8	19.5	14.0	5.50	16.9	3	23.0	15.0	8.00	18.1
SODIUM	6	10.0	5.40	4.60	7.05	8	10.8	3.80	7.00	6.71	3	9.30	3.40	5.90	6.67
SULPHATE	7	22.1	12.9	9.20	17.3	8	26.0	8.80	17.2	18.3	3	26.8	15.1	11.7	21.5
TIC	0	0.0	0.0	0.0	0.0	17	47.0	22.0	25.0	34.7	11	43.0	7.00	36.0	26.2
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001L	0.003	0.002	8	0.004	0.001L	0.003	0.002	3	0.004	0.001	0.003	0.002
TOC	30	10.0	2.00	8.00	4.93	42	12.0	2.00L	10.0	5.64	14	24.0	2.00L	22.0	8.00

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8515 TREPANIER CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	20.0	5.00	15.0	9.33	8	30.0	0.0	30.0	9.00	3	55.0	7.00	48.0	24.0
TURBID	30	7.50	0.200	7.30	2.13	32	26.0	0.100	25.9	3.17	7	5.30	0.400	4.90	1.54
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	2	1.60	0.600	1.00	1.10	1	2.00	2.00	0.0	2.00	1	34.0	34.0	0.0	34.0
DISS O2	30	13.8	3.00	10.8	10.6	32	14.2	9.10	5.10	11.9	7	14.0	8.80	5.20	12.0
D.O. SAT	30	114.	13.0	101.	95.6	34	109.	94.0	15.0	99.3	7	99.0	92.0	7.00	95.1
TEMP	7	18.3	0.500	17.8	10.4	8	25.1	0.0	25.1	15.7	3	22.5	6.60	16.0	15.2
INORGANIC PARAMETERS															
ALK TOT	30	107.	52.0	55.0	84.5	34	102.	25.6	76.4	83.3	7	102.	27.0	75.0	74.7
CALCIUM	7	29.0	3.80	25.2	22.9	8	28.1	13.6	14.5	25.1	3	25.7	8.90	16.8	20.0
CHLORIDE	6	0.500	0.080	0.420	0.347	3	0.400	0.200	0.200	0.337	3	0.800	0.400	0.400	0.600
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.003	0.001L	0.002	0.001	3	0.004	0.001	0.003	0.002
FLUORIDE	7	0.090	0.060	0.020	0.071	8	0.110	0.050	0.060	0.080	3	0.090	0.050L	0.040	0.070
HARD TOT	7	85.7	61.6	24.1	79.8	8	87.3	42.2	45.1	76.2	3	82.0	28.0	54.0	63.3
IRON	6	0.060	0.010	0.050	0.022	8	0.060	0.010L	0.050	0.021	3	0.060	0.020	0.040	0.033
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.010L	0.006L	0.004	0.007
MAGNES	7	4.60	0.0	4.60	2.94	8	4.30	1.80	2.50	3.32	1	4.50	4.50	0.0	4.50
MANGAN	7	0.003	0.001L	0.002	0.002	7	0.010	0.001	0.009	0.003	3	0.010L	0.010L	0.0	0.010
NITRATE	30	0.410	0.003	0.407	0.029	33	0.120	0.010L	0.110	0.021	7	0.090	0.010L	0.080	0.031
TOTAL N	30	0.890	0.010	0.880	0.166	33	0.490	0.010L	0.480	0.149	7	0.390	0.030	0.360	0.184
PH	30	8.50	7.30	1.20	8.07	34	8.60	7.40	1.20	8.09	7	8.20	7.20	1.00	7.86
ORTHO P	30	0.060	0.003L	0.057	0.007	34	0.026	0.003L	0.023	0.005	7	0.010	0.003	0.007	0.007
TOTAL P	30	0.062	0.003L	0.059	0.012	33	0.173	0.0	0.173	0.018	7	0.042	0.007	0.035	0.015
POTASS	6	1.90	0.0	1.90	1.37	8	1.80	1.10	0.700	1.46	3	1.60	0.800	0.800	1.33
SILICA	6	16.3	14.4	1.90	15.1	8	16.4	15.2	1.20	15.7	3	19.0	14.2	4.80	16.4
SODIUM	6	4.80	1.30	3.50	3.48	8	4.40	2.50	1.90	3.91	3	4.20	1.60	2.60	3.17
SULPHATE	6	4.80	3.50	1.30	4.15	8	6.20	1.90	4.30	3.57	3	5.50	1.00	4.50	3.93
TIC	0	0.0	0.0	0.0	0.0	9	22.0	14.0	8.00	17.9	4	22.0	7.00	15.0	17.0
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001L	0.003	0.002	8	0.002	0.001L	0.001	0.001	3	0.003	0.002	0.001	0.003
TOC	30	17.0	0.0	17.0	3.93	34	25.0	2.00	23.0	6.06	7	13.0	2.00L	11.0	6.29

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8516 POWERS CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	30.0	7.00	23.0	17.0	8	50.0	5.00	45.0	22.5	4	65.0	0.0	65.0	25.0
TURBID	29	9.10	0.600	8.50	1.90	38	60.0	0.600	59.4	4.45	20	36.0	0.300	35.7	3.56
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	11.2	11.2	0.0	11.2	1	28.8	28.8	0.0	28.8	2	108.	11.6	96.8	60.0
DISS O2	29	13.6	8.60	5.00	10.9	40	13.9	9.20	4.70	11.7	20	13.4	8.50	4.90	11.3
D.O. SAT	29	105.	86.0	19.0	95.8	42	113.	78.0	35.0	96.5	20	131.	89.0	42.0	97.4
TEMP	7	16.3	2.40	13.9	10.1	8	24.2	1.10	23.1	14.3	4	22.6	5.70	16.9	12.9
INORGANIC PARAMETERS															
ALK TOT	29	221.	66.3	155.	135.	42	231.	31.6	199.	125.	20	200.	24.0	176.	104.
CALCIUM	7	59.4	25.5	33.9	38.5	8	47.0	13.0	34.0	34.1	4	48.0	8.80	39.2	29.7
CHLORIDE	6	2.80	0.900	1.90	1.85	8	2.40	0.600	1.80	1.46	4	2.80	0.600	2.20	1.62
COPPER	7	0.007	0.001L	0.006	0.002	8	0.008	0.001L	0.007	0.003	4	0.003	0.001L	0.002	0.002
FLUORIDE	7	0.390	0.140	0.250	0.230	8	0.290	0.070	0.220	0.189	4	0.240	0.020	0.220	0.157
HARD TOT	7	232.	84.2	148.	143.	8	173.	37.9	135.	120.	4	202.	28.0	174.	117.
IRON	7	0.050	0.010	0.040	0.027	8	0.250	0.010L	0.240	0.065	4	0.080	0.020	0.060	0.047
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.010L	0.005L	0.005	0.007
MAGNES	7	20.3	5.00	15.3	11.5	8	13.8	1.30	12.5	8.57	1	11.8	11.8	0.0	11.8
MANGAN	7	0.012	0.001L	0.011	0.004	8	0.010L	0.002	0.008	0.005	4	0.030	0.010L	0.020	0.016
NITRATE	29	1.09	0.090	1.00	0.534	42	2.08	0.010	2.07	0.675	20	1.27	0.010	1.26	0.543
TOTAL N	28	1.40	0.360	1.04	0.760	41	2.17	0.140	2.03	0.978	20	2.13	0.330	1.80	0.842
PH	29	8.20	7.30	0.900	7.92	42	8.40	7.50	0.900	8.09	20	8.30	7.10	1.20	7.91
ORTHO P	29	0.028	0.003L	0.025	0.015	42	0.039	0.007	0.032	0.023	20	0.049	0.007	0.042	0.025
TOTAL P	29	0.088	0.007	0.081	0.030	41	0.330	0.010	0.320	0.045	20	0.173	0.016	0.157	0.044
POTASS	6	2.60	1.50	1.10	1.95	8	3.50	0.900	2.60	1.85	4	2.60	0.800	1.80	1.72
SILICA	6	19.0	5.40	13.6	15.1	8	19.8	15.8	4.00	17.6	4	22.4	16.2	6.20	18.0
SODIUM	6	22.0	8.40	13.6	14.3	8	17.2	3.40	13.8	11.0	4	19.0	1.80	17.2	10.8
SULPHATE	7	71.8	17.3	54.5	39.1	8	51.2	6.50	44.7	32.2	4	67.2	2.90	64.3	33.9
TIC	0	0.0	0.0	0.0	0.0	16	51.0	17.0	34.0	31.9	16	40.0	5.00	35.0	20.7
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001L	0.003	0.002	8	0.006	0.001L	0.005	0.002	4	0.003	0.001	0.002	0.002
TOC	28	15.0	2.00	13.0	5.96	42	15.0	2.00L	13.0	8.57	20	16.0	4.00	12.0	9.15

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8517 SMITH CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	30.0	10.0	20.0	16.7	8	20.0	5.00	15.0	11.9	3	45.0	10.0	35.0	23.3
TURBID	28	225.	7.30	218.	28.3	38	110.	11.0	99.0	27.0	14	230.	4.00	226.	29.8
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	6	56.0	15.6	40.4	34.5	7	225.	12.4	213.	83.0	2	96.0	74.0	22.0	85.0
DISS O2	29	12.9	8.60	4.30	10.6	40	13.5	9.20	4.30	11.3	14	13.0	8.80	4.20	11.0
D.O. SAT	29	101.	89.0	12.0	95.3	42	109.	88.0	21.0	96.6	14	97.0	86.0	11.0	93.1
TEMP	7	16.3	4.40	11.9	10.7	8	24.2	3.00	21.2	14.9	3	22.7	12.6	10.1	16.8
INORGANIC PARAMETERS															
ALK TOT	29	356.	3.00	353.	308.	42	386.	241.	145.	324.	14	373.	202.	171.	316.
CALCIUM	7	101.	83.3	17.7	91.6	8	427.	74.8	352.	132.	3	125.	58.1	66.9	91.0
CHLORIDE	6	9.00	6.10	2.90	7.35	8	8.60	5.60	3.00	7.25	3	11.0	5.00	6.00	8.87
COPPER	7	0.002	0.001L	0.001	0.002	8	0.005	0.001L	0.004	0.003	3	0.007	0.002	0.005	0.004
FLUORIDE	7	0.500	0.420	0.080	0.463	8	0.440	0.360	0.080	0.414	3	0.420	0.290	0.130	0.367
HARD TOT	7	491.	336.	155.	387.	8	511.	306.	205.	382.	3	602.	250.	352.	406.
IRON	7	0.100	0.010	0.090	0.033	8	0.030	0.010L	0.020	0.017	3	0.020	0.010L	0.010	0.017
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.010L	0.006L	0.004	0.007
MAGNES	7	58.0	31.1	26.9	38.5	8	55.0	28.8	26.2	40.5	1	34.2	34.2	0.0	34.2
MANGAN	7	0.005	0.001L	0.004	0.002	8	0.014	0.001	0.013	0.006	3	0.018	0.010L	0.008	0.013
NITRATE	29	0.900	0.320	0.580	0.528	42	1.54	0.320	1.22	0.769	14	1.11	0.130	0.980	0.669
TOTAL N	28	2.13	0.590	1.54	1.14	41	3.14	0.630	2.51	1.55	14	4.66	0.640	4.02	2.17
PH	29	8.80	7.90	0.900	8.34	42	8.50	8.00	0.500	8.39	14	8.50	7.80	0.700	8.32
ORTHO P	29	0.554	0.030	0.524	0.210	42	0.978	0.023	0.955	0.235	14	1.17	0.042	1.13	0.404
TOTAL P	29	0.848	0.078	0.770	0.333	41	1.08	0.039	1.04	0.349	14	1.27	0.088	1.18	0.527
POTASS	6	5.70	3.90	1.80	4.57	8	5.50	3.30	2.20	4.55	3	6.30	2.70	3.60	4.83
SILICA	6	28.3	22.7	5.60	25.8	8	26.2	24.3	1.90	25.3	3	34.7	23.5	11.2	27.9
SODIUM	6	248.	49.0	199.	89.0	8	73.0	46.0	27.0	55.4	3	98.0	34.4	63.6	61.1
SULPHATE	7	310.	134.	176.	180.	8	311.	112.	199.	189.	3	413.	113.	300.	225.
TIC	0	0.0	0.0	0.0	0.0	16	78.0	11.0	67.0	64.1	11	75.0	29.0	46.0	63.2
ORGANIC PARAMETERS															
ZINC	7	0.005	0.001L	0.004	0.002	8	0.018	0.001	0.017	0.005	3	0.013	0.001L	0.012	0.005
TOC	29	16.0	2.00L	14.0	6.79	41	23.0	2.00L	21.0	10.5	14	28.0	5.00	23.0	10.1

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8518 MC DOUGALL CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	1	10.0	10.0	0.0	10.0	4	50.0	0.0	50.0	15.0	3	55.0	0.0	55.0	20.0
TURBID	4	5.90	0.900	5.00	3.20	17	24.0	0.200	23.8	4.28	14	16.0	0.100	15.9	3.14
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	1	31.6	31.6	0.0	31.6	1	62.0	62.0	0.0	62.0
DISS O2	5	10.3	9.00	1.30	9.56	18	12.3	9.60	2.70	11.2	14	11.6	9.20	2.40	10.7
D.O. SAT	5	96.0	90.0	6.00	93.4	18	101.	81.0	20.0	91.7	14	103.	83.0	20.0	90.5
TEMP	2	14.8	14.1	0.700	14.4	4	24.2	4.10	20.1	18.6	3	22.7	7.70	15.0	15.0
INORGANIC PARAMETERS															
ALK TOT	5	218.	206.	12.0	211.	18	244.	48.3	196.	172.	14	212.	36.0	176.	153.
CALCIUM	2	61.2	61.1	0.100	61.1	4	64.5	15.7	48.8	47.9	3	60.6	11.6	49.0	42.8
CHLORIDE	1	2.20	2.20	0.0	2.20	4	2.80	0.900	1.90	2.00	3	2.80	0.700	2.10	2.07
COPPER	2	0.002L	0.002L	0.0	0.002	4	0.006	0.001L	0.005	0.003	3	0.004	0.001L	0.003	0.002
FLUORIDE	2	0.350	0.330	0.020	0.340	4	0.330	0.120	0.210	0.270	3	0.330	0.100	0.230	0.247
HARD TOT	2	205.	201.	4.00	203.	4	209.	47.9	161.	159.	3	206.	37.0	169.	146.
IRON	2	0.010	0.010	0.0	0.010	4	0.110	0.010L	0.100	0.040	3	0.070	0.010L	0.060	0.030
LEAD	2	0.005L	0.005L	0.0	0.005	4	0.010L	0.005L	0.005	0.009	3	0.010L	0.006L	0.004	0.007
MAGNES	2	12.7	11.8	0.900	12.2	4	13.2	2.10	11.1	9.62	1	13.0	13.0	0.0	13.0
MANGAN	2	0.001L	0.001L	0.0	0.001	4	0.022	0.001L	0.021	0.009	3	0.010L	0.010L	0.0	0.010
NITRATE	5	0.110	0.010L	0.100	0.040	18	0.190	0.010L	0.180	0.043	14	0.360	0.010	0.350	0.145
TOTAL N	5	0.280	0.130	0.150	0.218	16	0.550	0.030	0.520	0.285	14	0.780	0.220	0.560	0.454
PH	5	8.40	8.20	0.200	8.32	18	8.20	7.30	0.900	7.97	14	8.10	7.30	0.800	7.86
ORTHO P	5	0.078	0.036	0.042	0.057	18	0.092	0.039	0.053	0.065	14	0.108	0.068	0.040	0.083
TOTAL P	5	0.122	0.036	0.086	0.075	17	0.179	0.068	0.111	0.088	14	0.170	0.072	0.098	0.103
POTASS	1	2.00	2.00	0.0	2.00	4	2.20	1.00	1.20	1.72	3	2.10	0.800	1.30	1.63
SILICA	1	26.0	26.0	0.0	26.0	4	26.3	22.0	4.30	24.5	3	35.6	23.2	12.4	27.8
SODIUM	1	20.3	20.3	0.0	20.3	4	20.4	4.70	15.7	14.7	3	19.4	3.30	16.1	14.0
SULPHATE	2	20.7	20.1	0.600	20.4	4	22.6	3.50	19.1	15.9	3	32.3	3.20	29.1	20.5
TIC	0	0.0	0.0	0.0	0.0	2	46.0	44.0	2.00	45.0	11	51.0	14.0	37.0	34.5
ORGANIC PARAMETERS															
ZINC	2	0.001	0.001L	0.0	0.001	4	0.006	0.002L	0.004	0.003	3	0.003	0.002	0.001	0.002
TOC	5	4.00	2.00L	2.00	3.20	18	16.0	2.00L	14.0	8.28	14	15.0	2.00L	13.0	8.00

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8519 BELLEVUE CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	15.0	5.00	10.0	6.67	8	30.0	0.0	30.0	5.62	3	60.0	0.0	60.0	21.0
TURBID	29	11.0	0.300	10.7	1.76	35	6.30	0.300	6.00	2.33	7	35.0	0.200	34.8	5.71
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	1	13.6	13.6	0.0	13.6	1	199.	199.	0.0	199.
DISS O2	30	12.3	1.40	10.9	10.3	37	13.3	8.70	4.60	11.4	7	12.7	8.70	4.00	11.4
D.O. SAT	29	118.	87.0	31.0	98.0	39	133.	10.0J	123.	98.6	6	98.0	85.0	13.0	91.5
TEMP	6	15.6	5.50	10.1	10.4	8	24.2	3.30	20.9	15.3	3	21.6	4.40	17.2	14.2
INORGANIC PARAMETERS															
ALK TOT	30	112.	1.00	111.	88.8	39	218.	10.8	207.	105.	7	118.	6.00	112.	82.0
CALCIUM	7	34.5	22.1	12.4	29.0	8	34.8	18.3	16.5	31.8	3	33.3	2.80	30.5	22.8
CHLORIDE	5	2.70	1.50	1.20	2.10	8	2.80	1.00	1.80	2.21	3	3.30	0.700	2.60	2.23
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.008	0.001	0.007	0.003	3	0.007	0.001L	0.006	0.003
FLUORIDE	7	0.150	0.090	0.060	0.127	8	0.140	0.100	0.040	0.120	3	0.110	0.050	0.060	0.087
HARD TOT	7	110.	72.0	38.0	97.2	9	118.	58.2	59.8	108.	3	120.	10.0	110.	82.3
IRON	7	0.040	0.010	0.030	0.021	8	0.060	0.010	0.050	0.025	3	0.120	0.010L	0.110	0.050
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.012L	0.004L	0.008	0.009
MAGNES	7	7.70	4.00	3.70	6.03	8	8.40	3.00	5.40	6.96	1	9.60	9.60	0.0	9.60
MANGAN	7	0.008	0.001L	0.007	0.004	8	0.011	0.002	0.009	0.007	3	0.050	0.010L	0.040	0.023
NITRATE	29	1.06	0.010L	1.05	0.560	39	1.36	0.010L	1.35	0.727	7	1.10	0.010	1.09	0.471
TOTAL N	30	1.40	0.170	1.23	0.711	38	1.98	0.060	1.92	1.01	7	1.11	0.220	0.890	0.744
PH	30	8.40	7.30	1.10	7.86	39	8.60	7.10	1.50	8.07	7	8.30	6.30	2.00	7.60
ORTHO P	30	0.023	0.003L	0.020	0.007	39	0.946	0.003	0.943	0.033	7	0.030	0.003	0.027	0.011
TOTAL P	30	0.033	0.003	0.030	0.015	38	1.24	0.010	1.23	0.055	7	0.870	0.010	0.860	0.136
POTASS	6	1.80	1.50	0.300	1.60	8	1.90	1.00	0.900	1.60	3	1.90	0.500	1.40	1.33
SILICA	6	24.1	15.0	9.10	21.3	8	27.9	16.5	11.4	22.9	3	23.3	14.8	8.50	19.4
SODIUM	6	9.20	5.50	3.70	7.48	8	8.50	2.70	5.80	6.90	3	8.70	1.20	7.50	6.00
SULPHATE	7	17.3	11.6	5.70	15.5	8	23.0	10.2	12.8	18.4	3	20.8	1.90	18.9	14.3
TIC	0	0.0	0.0	0.0	0.0	13	49.0	19.0	30.0	26.6	4	26.0	2.00L	24.0	18.0
ORGANIC PARAMETERS															
ZINC	7	0.005	0.001L	0.004	0.002	8	0.041	0.002L	0.039	0.007	3	0.003	0.002	0.001	0.003
TOC	29	11.0	2.00L	9.00	3.72	39	15.0	0.0L	15.0	5.33	7	15.0	2.00	13.0	7.14

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 0520 MISSION CREEK: BRIDGE ON LAKESHORE ROAD

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	40.0	10.0	30.0	20.0	8	30.0	5.00	25.0	12.2	4	50.0	5.00	45.0	21.2
TURBID	28	27.0	0.600	26.4	4.25	38	43.0	0.800	42.2	6.29	20	37.0	0.500	36.5	7.82
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	56.0	56.0	0.0	56.0	1	32.4	32.4	0.0	32.4	2	228.	9.80	219.	118.
DISS O2	29	14.0	7.90	6.10	11.5	40	15.0	9.40	5.60	12.4	20	13.8	8.50	5.30	11.6
O.D. SAT	28	123.	80.0	43.0	103.	42	143.	82.0	61.0	107.	20	120.	86.0	34.0	98.5
TEMP	6	15.8	2.40	13.4	9.67	8	24.2	1.60	22.6	14.7	4	21.6	5.50	16.1	13.4
INORGANIC PARAMETERS															
ALK TOT	29	227.	22.3	205.	105.	42	230.	17.7	212.	137.	20	182.	18.0	164.	100.
CALCIUM	7	63.0	12.3	50.7	26.2	8	65.8	12.7	53.1	39.7	4	48.5	6.80	41.8	24.3
CHLORIDE	6	1.90	0.300	1.60	0.867	8	1.90	0.400	1.50	1.19	4	1.70	0.500	1.10	1.12
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.011L	0.001L	0.010	0.003	4	0.005	0.001L	0.004	0.002
FLUORIDE	7	0.170	0.050	0.120	0.091	8	0.170	0.060	0.110	0.126	4	0.140	0.050	0.090	0.097
HARD TOT	7	270.	41.1	229.	101.	8	274.	41.3	233.	163.	4	208.	22.0	186.	121.
IRON	7	0.090	0.040	0.050	0.060	8	0.100	0.010	0.090	0.069	4	0.090	0.030	0.060	0.057
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.003	4	0.012L	0.005L	0.007	0.008
MAGNES	7	27.0	2.40	24.6	8.70	8	26.7	2.10	24.6	15.5	1	21.1	21.1	0.0	21.1
MANGAN	7	0.013	0.001L	0.012	0.008	8	0.038	0.006	0.032	0.020	4	0.056	0.010L	0.046	0.028
NITRATE	29	0.410	0.010L	0.400	0.110	42	0.970	0.010L	0.960	0.278	20	0.700	0.020	0.680	0.230
TOTAL N	29	2.08	0.090	1.99	0.376	41	1.39	0.031	1.36	0.515	20	1.00	0.130	0.870	0.499
PH	28	8.40	7.50	0.900	7.89	42	8.70	6.80	1.90	8.10	20	8.80	7.00	1.80	7.81
ORTHO P	29	0.030	0.003L	0.027	0.008	42	0.157	0.003L	0.154	0.015	20	0.039	0.003	0.036	0.014
TOTAL P	29	0.065	0.003	0.062	0.018	41	0.196	0.010	0.186	0.042	20	0.781	0.013	0.770	0.112
POTASS	6	2.70	0.800	1.90	1.35	8	3.40	0.900	2.50	1.90	4	2.30	0.500	1.80	1.57
SILICA	5	18.3	13.4	4.90	15.1	8	19.4	12.2	7.20	16.2	4	17.2	13.4	3.80	14.7
SODIUM	6	20.0	2.90	17.1	8.18	8	21.7	3.50	18.2	12.4	4	16.0	1.70	14.3	9.57
SULPHATE	7	93.2	8.70	84.5	30.5	8	121.	8.70	112.	57.7	4	79.9	8.00	71.9	39.8
TIC	0	0.0	0.0	0.0	0.0	16	44.0	8.00	36.0	30.2	16	43.0	2.00	41.0	19.7
ORGANIC PARAMETERS															
ZINC	7	0.034	0.001L	0.033	0.006	8	0.010	0.001	0.009	0.004	4	0.013	0.001	0.012	0.004
TOC	29	9.00	2.00L	7.00	5.00	42	15.0	2.00L	13.0	6.40	20	21.0	3.00	18.0	9.30

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 0521 KELOWNA CREEK: BRIDGE ON ABBOT STREET

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	30.0	15.0	15.0	20.0	8	30.0	10.0	20.0	15.0	4	65.0	5.00	60.0	33.7
TURBID	28	47.0	1.80	45.2	6.30	38	45.0	2.00	44.0	6.53	20	97.0	1.30	95.7	10.2
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	4	3.00	1.40	1.60	1.95	5	55.6	1.20	54.4	15.6	3	114.	0.800	113.	44.3
DISS O2	29	12.2	7.60	4.60	9.67	40	14.1	7.10	7.00	10.9	20	14.4	6.90	7.50	10.2
O.D. SAT	28	103.	78.0	24.0	88.5	42	127.	76.0	51.0	97.1	20	128.	78.0	50.0	89.8
TEMP	6	16.6	3.90	12.8	10.6	8	24.2	1.60	22.6	15.0	4	21.9	8.30	13.6	15.2
INORGANIC PARAMETERS															
ALK TOT	29	328.	157.	71.0	197.	42	244.	112.	132.	208.	20	241.	59.0	182.	186.
CALCIUM	7	61.1	45.2	15.9	55.0	8	66.3	33.6	32.7	56.0	4	61.4	31.7	29.7	46.5
CHLORIDE	6	13.4	5.00	8.40	7.22	8	7.70	3.50	4.20	5.64	4	8.00	3.10	5.80	6.82
COPPER	7	0.002	0.001L	0.001	0.001	8	0.007	0.001	0.006	0.002	4	0.005	0.001	0.004	0.003
FLUORIDE	7	0.260	0.230	0.030	0.243	8	0.270	0.160	0.110	0.227	4	0.250	0.130	0.120	0.210
HARD TOT	7	328.	171.	47.0	203.	8	244.	121.	123.	202.	4	245.	110.	135.	195.
IRON	7	0.080	0.010	0.070	0.056	8	0.180	0.020	0.160	0.092	4	0.210	0.040	0.170	0.127
LEAD	6	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.013L	0.004L	0.008	0.008
MAGNES	7	17.7	14.1	3.60	16.0	8	19.1	9.00	10.1	15.9	1	22.3	22.3	0.0	22.3
MANGAN	7	0.100	0.001L	0.099	0.041	8	0.230	0.072	0.158	0.134	4	0.230	0.068	0.162	0.127
NITRATE	29	1.18	0.010L	1.17	0.696	42	1.15	0.150	1.00	0.695	20	1.60	0.110	1.49	0.893
TOTAL N	28	1.70	0.440	1.06	1.04	42	3.83	0.310	3.52	1.13	20	4.09	0.770	3.32	1.71
PH	28	8.30	7.00	1.30	7.92	42	8.40	7.50	0.900	8.10	20	8.50	7.60	0.900	7.99
ORTHO P	29	0.556	0.013	0.543	0.087	42	0.088	0.007	0.081	0.040	20	0.173	0.020	0.153	0.054
TOTAL P	29	0.750	0.029	0.721	0.142	41	0.192	0.020	0.172	0.085	20	0.424	0.055	0.369	0.140
POTASS	6	4.50	2.90	1.60	3.50	8	5.40	2.20	3.20	3.35	4	7.20	0.200L	7.00	3.20
SILICA	5	21.4	17.1	4.30	18.4	8	20.6	15.7	4.90	17.9	4	23.1	18.0	5.10	20.5
SODIUM	6	28.9	22.3	6.60	24.6	8	29.0	14.4	14.6	23.1	4	33.5	11.6	21.9	24.6
SULPHATE	7	59.0	39.4	19.6	50.7	8	65.2	26.4	38.8	46.0	4	78.7	26.0	52.7	49.4
TIC	0	0.0	0.0	0.0	0.0	16	51.0	27.0	24.0	41.2	16	55.0	12.0	43.0	37.7
ORGANIC PARAMETERS															
ZINC	7	0.037	0.002	0.035	0.004	8	0.015	0.001L	0.014	0.006	4	0.010	0.001	0.009	0.004
TOC	29	14.0	2.00L	12.0	5.62	42	18.0	2.00L	16.0	6.67	20	19.0	2.00L	17.0	10.6

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8522 BRANDT CREEK: ON GUY STREET

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	70.0	10.0	60.0	30.0	6	60.0	10.0	50.0	26.7	4	20.0	15.0	5.00	18.7
TURBID	26	48.0	4.50	43.5	23.4	46	115.	3.40	112.	18.8	40	50.0	2.40	47.6	12.6
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	4	68.0	16.4	51.6	30.0	7	80.4	4.40	76.0	23.3	3	74.8	16.4	58.4	38.4
DISS O2	28	9.60	0.0	9.60	3.34	47	10.1	0.0	10.1	4.38	40	13.8	0.0	13.8	6.65
D.O. SAT	28	72.0	0.0	72.0	30.1	49	85.0	0.0	85.0	38.1	39	147.	0.0	147.	62.2
TEMP	4	13.4	6.60	6.80	10.6	7	24.3	5.20	19.1	18.6	4	21.9	10.3	11.6	17.4
INORGANIC PARAMETERS															
ALK TOT	28	445.	159.	286.	341.	50	980.	218.	762.	340.	40	605.	134.	471.	338.
CALCIUM	4	82.6	66.1	16.5	74.7	7	112.	55.0	57.0	75.6	4	172.	83.2	88.8	115.
CHLORIDE	4	30.0	14.5	15.5	22.9	7	41.5	11.6	29.9	23.5	4	29.0	16.0	13.0	23.0
COPPER	4	0.008	0.002	0.006	0.005	7	0.011	0.005	0.006	0.007	4	0.009	0.001	0.008	0.005
FLUORIDE	4	0.720	0.340	0.380	0.547	7	0.990	0.390	0.600	0.710	4	0.690	0.370	0.320	0.515
HARD TOT	4	488.	337.	151.	404.	7	781.	330.	451.	436.	4	649.	456.	193.	515.
IRON	4	0.520	0.110	0.410	0.305	7	0.340	0.030	0.310	0.121	4	0.380	0.030	0.350	0.160
LEAD	4	0.010L	0.010L	0.0	0.010	7	0.010L	0.005L	0.005	0.009	4	0.012L	0.005L	0.007	0.008
MAGNES	4	68.9	41.8	27.1	52.8	7	122.	43.2	78.8	60.1	1	97.4	97.4	0.0	97.4
MANGAN	4	0.610	0.230	0.380	0.345	7	0.390	0.011	0.379	0.199	4	0.450	0.140	0.310	0.340
NITRATE	28	0.950	0.010L	0.940	0.239	50	1.09	0.010L	1.08	0.259	40	1.60	0.010L	1.59	0.351
TOTAL N	37	5.56	0.540	5.12	2.04	50	7.69	0.190	7.50	1.50	40	4.51	0.490	4.03	1.52
PH	28	8.50	6.30	2.30	7.63	50	8.90	6.70	2.20	7.85	40	8.70	7.00	1.70	8.01
ORTHO P	28	2.13	0.049	2.08	0.192	50	0.750	0.023	0.727	0.325	40	1.37	0.036	1.33	0.309
TOTAL P	28	2.70	0.270	2.43	0.708	49	1.66	0.075	1.58	0.605	40	1.43	0.058	1.37	0.545
POTASS	4	10.4	6.60	3.80	7.92	7	9.40	5.10	4.30	6.90	4	13.5	0.600	12.9	7.22
SILICA	4	22.7	11.3	11.4	16.6	7	18.5	8.20	10.3	13.9	4	18.5	7.30	11.2	14.3
SODIUM	4	213.	125.	87.0	155.	7	296.	123.	173.	171.	4	256.	170.	86.0	201.
SULPHATE	4	464.	278.	186.	348.	7	831.	263.	568.	430.	4	769.	224.	545.	472.
TIC	0	0.0	0.0	0.0	0.0	24	106.	23.0	83.0	67.0	16	105.	43.0	62.0	70.9
ORGANIC PARAMETERS															
ZINC	4	0.013	0.004	0.009	0.008	7	0.023	0.007	0.016	0.016	4	0.017	0.007	0.010	0.010
TOC	28	109.	2.00L	106.	20.5	50	246.	6.00	240.	66.2	40	224.	2.00L	224.	60.6

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8523 LAMBLY CREEK

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	6	30.0	7.00	23.0	18.7	8	60.0	0.0	60.0	14.5	3	75.0	8.00	67.0	31.0
TURBID	23	5.20	0.100	5.10	1.43	30	16.0	0.100	15.9	3.43	13	12.0	0.200	11.8	2.62
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	1	2.20	2.20	0.0	2.20	2	3.20	1.20	2.00	2.20	1	39.2	39.2	0.0	39.2
DISS O2	24	14.1	4.70	9.40	11.0	32	19.1	8.90	5.20	12.1	13	13.7	7.90	5.80	11.9
D.O. SAT	24	99.0	45.0	54.0	91.4	32	104.	45.0	19.0	96.8	13	99.0	86.0	13.0	95.0
TEMP	7	15.8	0.900	15.0	8.80	8	24.3	0.0	24.3	14.1	3	22.7	6.60	16.1	16.0
INORGANIC PARAMETERS															
ALK TOT	24	98.5	55.0	43.5	82.6	32	127.	26.7	100.	93.9	13	135.	27.0	98.0	81.1
CALCIUM	7	32.8	23.9	8.90	27.3	8	38.0	12.0	26.0	28.6	3	32.9	10.1	22.8	25.1
CHLORIDE	6	1.00	0.400	0.600	0.633	8	0.600	0.400	0.200	0.500	3	0.600	0.600	0.0	0.600
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.004	0.001L	0.003	0.002	3	0.003	0.001L	0.002	0.002
FLUORIDE	7	0.110	0.070	0.040	0.090	8	0.130	0.070	0.060	0.100	3	0.120	0.060	0.060	0.093
HARD TOT	7	99.9	68.9	31.0	81.5	8	119.	39.1	79.9	92.1	3	107.	31.0	76.0	79.0
IRON	7	0.050	0.010	0.040	0.030	8	0.180	0.010	0.170	0.054	3	0.090	0.010L	0.080	0.053
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.010L	0.006L	0.004	0.007
MAGNES	7	4.70	2.20	2.50	3.21	8	7.90	2.20	5.70	5.02	1	6.00	6.00	0.0	6.00
MANGAN	7	0.015	0.001L	0.014	0.004	8	0.015	0.001	0.014	0.004	3	0.011	0.010L	0.001	0.010
NITRATE	24	0.050	0.010L	0.040	0.014	32	0.950	0.010L	0.940	0.044	13	0.200	0.010L	0.190	0.035
TOTAL N	23	0.270	0.020	0.250	0.136	31	6.55	0.010L	6.54	0.695	13	0.630	0.010L	0.620	0.262
PH	24	8.20	6.90	1.30	7.84	32	8.40	7.40	1.00	7.94	13	8.20	7.30	0.900	7.90
ORTHO P	24	0.090	0.003	0.087	0.009	32	0.554	0.003	0.551	0.026	13	0.046	0.007	0.039	0.014
TOTAL P	24	0.028	0.007	0.021	0.013	31	1.79	0.007	1.78	0.075	13	0.121	0.010	0.111	0.029
POTASS	6	1.60	1.00	0.600	1.27	8	1.80	0.900	0.900	1.31	3	1.80	0.800	1.00	1.37
SILICA	6	18.9	16.2	2.70	17.4	8	20.6	16.5	4.10	18.0	3	21.4	16.8	4.60	19.2
SODIUM	6	5.40	3.70	2.70	4.75	8	6.30	3.20	3.10	5.42	3	5.80	1.90	3.90	4.43
SULPHATE	7	11.8	6.30	5.50	9.21	8	14.2	3.40	10.8	10.9	3	15.0	2.90	12.1	9.67
TIC	0	0.0	0.0	0.0	0.0	8	27.0	16.0	11.0	22.7	16	26.0	3.00	23.0	16.4
ORGANIC PARAMETERS															
ZINC	7	0.003	0.001L	0.002	0.001	8	0.005	0.001L	0.004	0.002	3	0.006	0.002	0.004	0.003
TOC	24	10.0	3.00	7.00	6.29	32	285.	2.00L	283.	15.5	13	18.0	2.00	16.0	9.46

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8524 VERNON CREEK AT INLET TO ELLISON LAKE

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	1	40.0	40.0	0.0	40.0	5	70.0	10.0	60.0	29.0	4	110.	0.0	110.	35.5
TURBID	7	85.0	0.700	84.3	15.8	22	1000.	L0.500	999.	79.4	19	31.0	0.200	30.8	4.31
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	4	1397.	30.8	1366.	598.	1	228.	228.	0.0	228.
DISS O2	8	9.40	6.90	2.50	8.30	23	13.1	9.30	3.80	11.4	19	14.5	8.30	6.20	10.8
D.O. SAT	8	100.	81.0	19.0	90.7	23	107.	81.0	26.0	95.6	18	115.	80.0	35.0	95.3
TEMP	2	25.2	21.7	3.50	23.4	5	24.3	2.70	21.6	15.8	4	22.1	11.0	11.1	15.9
INORGANIC PARAMETERS															
ALK TOT	8	62.5	31.5	31.0	46.3	23	110.	38.1	71.9	72.7	19	108.	28.0	80.0	66.3
CALCIUM	2	12.0	9.00	3.00	10.5	5	21.0	12.1	8.90	16.4	4	19.5	14.5	5.00	16.9
CHLORIDE	1	0.400	0.400	0.0	0.400	5	1.10	0.400	0.700	0.640	4	1.70	0.700	1.00	1.12
COPPER	2	0.002L	0.002L	0.0	0.002	5	0.013	0.001L	0.012	0.007	4	0.007	0.001	0.006	0.004
FLUORIDE	2	0.070	0.060	0.010	0.065	5	0.120	0.080	0.040	0.100	4	0.150	0.090	0.060	0.115
HARD TOT	2	42.8	34.7	8.10	38.7	5	85.8	41.9	43.9	63.5	4	100.	46.0	54.0	69.5
IRON	2	0.070	0.050	0.020	0.060	5	0.160	0.010	0.150	0.068	4	0.160	0.020	0.140	0.065
LEAD	2	0.005L	0.005L	0.0	0.005	5	0.010L	0.005L	0.005	0.009	4	0.010L	0.004L	0.006	0.007
MAGNES	2	3.10	3.00	0.100	3.05	5	8.10	2.80	5.30	5.50	1	6.20	6.20	0.0	6.20
MANGAN	2	0.007	0.001L	0.006	0.004	5	0.130	0.009	0.121	0.043	4	0.095	0.010L	0.085	0.036
NITRATE	8	0.030	0.010L	0.020	0.014	23	0.090	0.010L	0.080	0.039	19	0.230	0.010L	0.220	0.053
TOTAL N	8	0.630	0.120	0.510	0.304	22	3.61	0.020	3.59	0.541	18	0.840	0.010L	0.830	0.172
PH	8	7.70	7.30	0.400	7.50	23	8.70	7.20	1.50	8.03	19	9.50	7.30	2.20	8.15
ORTHO P	8	0.039	0.010	0.029	0.017	23	0.108	0.003L	0.105	0.020	19	0.110	0.003	0.107	0.018
TOTAL P	8	0.075	0.020	0.055	0.034	22	6.69	0.007	6.68	0.471	19	1.20	0.010	1.19	0.098
POTASS	1	1.20	1.20	0.0	1.20	5	1.60	1.20	0.400	1.38	4	2.00	1.10	0.900	1.55
SILICA	1	12.7	12.7	0.0	12.7	5	23.1	10.5	12.6	14.0	4	35.0	6.00	29.0	14.4
SODIUM	1	3.70	3.70	0.0	3.70	5	9.40	4.60	4.80	6.30	4	8.00	4.20	3.80	6.05
SULPHATE	2	4.50	3.00	1.50	3.75	5	12.3	3.00	9.30	8.08	4	22.2	2.40	19.8	12.8
TIC	0	0.0	0.0	0.0	0.0	3	22.0	12.0	10.0	18.3	15	25.0	7.00	18.0	13.4
ORGANIC PARAMETERS															
ZINC	2	0.001	0.001L	0.0	0.001	5	0.020	0.002	0.018	0.007	4	0.034	0.004	0.030	0.017
TOC	8	11.0	7.00	4.00	9.00	22	47.0	2.00	45.0	10.6	19	38.0	5.00	33.0	15.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8525 VERNON CREEK AT INLET TO WOOD LAKE

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	70.0	10.0	60.0	27.5	8	40.0	10.0	30.0	20.6	3	15.0	10.0	5.00	11.7
TURBID	28	28.0	1.70	26.3	6.54	36	36.0	1.30	34.7	7.67	20	23.0	0.900	22.1	7.06
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	3	24.8	0.500L	24.3	10.4	7	9.60	2.80	6.80	5.54	4	41.2	0.400	40.8	17.3
DISS O2	29	12.4	6.70	5.70	9.94	38	13.0	7.80	5.20	11.0	20	14.3	6.70	7.60	10.1
D.O. SAT	29	103.	70.0	33.0	90.9	40	112.	81.0	31.0	94.5	20	126.	84.0	42.0	97.8
TEMP	7	24.2	3.30	20.9	13.3	8	24.3	2.20	22.1	15.0	4	22.1	7.20	14.9	15.6
INORGANIC PARAMETERS															
ALK TOT	29	191.	37.0	154.	138.	40	189.	109.	80.0	155.	20	208.	69.0	139.	135.
CALCIUM	7	44.6	16.5	28.1	33.2	8	47.2	29.7	17.5	37.5	4	47.9	18.1	29.8	29.0
CHLORIDE	6	2.90	0.800	2.10	2.28	8	3.30	1.60	1.70	2.40	4	4.00	0.900	3.10	2.37
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.010	0.001L	0.009	0.003	4	0.004	0.001	0.003	0.002
FLUORIDE	7	0.280	0.130	0.150	0.210	8	0.230	0.170	0.060	0.199	4	0.260	0.130	0.130	0.182
HARD TOT	7	180.	56.6	123.	134.	8	184.	120.	64.0	153.	4	213.	79.0	134.	137.
IRON	7	0.160	0.060	0.100	0.101	8	0.230	0.010	0.220	0.089	4	0.130	0.060	0.070	0.092
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.012L	0.004L	0.008	0.008
MAGNES	7	16.9	3.70	13.2	12.4	7	16.1	11.1	5.00	13.8	1	22.7	22.7	0.0	22.7
MANGAN	7	0.060	0.001L	0.059	0.019	8	0.130	0.020	0.110	0.049	4	0.250	0.021	0.229	0.087
NITRATE	29	1.49	0.140	1.31	0.981	40	1.38	0.010L	1.37	0.855	20	1.50	0.200	1.30	0.752
TOTAL N	28	1.73	0.950	0.780	1.38	39	25.0	0.670	24.3	1.85	19	1.82	0.590	1.23	1.32
PH	29	8.50	7.20	1.30	7.80	40	8.50	7.50	1.00	8.08	20	8.50	7.40	1.10	7.88
ORTHO P	29	0.062	0.003	0.059	0.019	40	0.055	0.010	0.045	0.028	20	0.075	0.007	0.068	0.031
TOTAL P	29	0.082	0.013	0.069	0.045	39	0.157	0.029	0.128	0.068	20	0.251	0.029	0.222	0.111
POTASS	6	3.50	1.10	2.40	2.60	8	3.20	1.90	1.30	2.43	4	4.40	2.00	2.40	3.15
SILICA	6	21.1	14.1	7.00	18.2	8	22.5	2.06	20.4	18.2	4	25.2	12.8	12.4	18.2
SODIUM	6	15.1	5.10	10.0	12.4	8	14.7	0.900	13.8	10.6	4	19.0	6.70	12.3	13.3
SULPHATE	7	32.8	7.10	25.7	19.7	9	24.4	16.4	8.00	19.7	4	36.4	9.90	26.5	24.3
TIC	0	0.0	0.0	0.0	0.0	14	42.0	26.0	16.0	35.5	14	49.0	14.0	35.0	27.4
ORGANIC PARAMETERS															
ZINC	7	0.006	0.001	0.005	0.002	8	0.010	0.001L	0.009	0.005	4	0.005	0.002	0.003	0.003
TOC	28	18.0	3.00	15.0	7.18	40	16.0	3.00	13.0	7.15	20	17.0	3.00	14.0	11.4

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8526 SHORTS CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	5	20.0	5.00	15.0	10.0	8	50.0	0.0	50.0	10.0	3	100.	5.00	95.0	36.7
TURBID	22	12.0	0.300	11.7	2.24	30	17.0	0.200	16.8	2.62	3	150.	0.900	149.	50.8
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	1	1370.	1370.	0.0	1370.
DISS O2	21	13.8	8.10	5.50	11.4	31	14.1	6.50	7.60	11.9	3	13.4	8.60	4.80	11.0
D.O. SAT	23	115.	86.0	29.0	97.7	33	116.	71.0	45.0	100.	3	93.0	90.0	3.00	91.5
TEMP	6	15.8	1.10	14.7	8.53	8	24.2	0.500	23.7	14.8	3	22.8	4.60	18.2	14.6
INORGANIC PARAMETERS															
ALK TOT	23	144.	70.0	65.0	118.	33	213.	38.3	175.	130.	3	131.	42.0	89.0	100.
CALCIUM	6	40.0	28.1	11.9	34.4	8	42.0	17.4	24.6	36.6	3	38.4	14.9	23.5	30.0
CHLORIDE	5	0.500	0.300	0.200	0.380	8	0.600	0.300	0.300	0.412	3	0.900	0.200	0.700	0.567
COPPER	6	0.002	0.001L	0.001	0.001	7	0.006	0.001L	0.005	0.002	3	0.005	0.001	0.004	0.003
FLUORIDE	6	0.280	0.110	0.170	0.168	8	0.180	0.020	0.160	0.147	3	0.150	0.090	0.060	0.130
HARD TOT	6	132.	84.1	47.9	111.	8	138.	56.1	81.9	118.	3	126.	45.0	81.0	98.7
IRON	6	0.050	0.010	0.040	0.023	7	0.070	0.0	0.070	0.021	3	0.130	0.010L	0.120	0.053
LEAD	5	0.010L	0.005L	0.005	0.008	7	0.010L	0.010L	0.0	0.010	3	0.012L	0.005L	0.007	0.009
MAGNES	5	8.70	3.40	5.30	6.08	8	8.50	3.10	5.40	6.40	1	8.20	8.20	0.0	8.20
MANGAN	6	0.004	0.001L	0.003	0.002	7	0.010L	0.001	0.009	0.003	3	0.010L	0.010L	0.0	0.010
NITRATE	23	0.060	0.010L	0.050	0.019	33	0.080	0.010L	0.070	0.018	3	0.050	0.010L	0.040	0.023
TOTAL N	23	0.620	0.020	0.600	0.160	30	1.03	0.010L	1.02	0.162	3	4.50	0.070	4.43	1.69
PH	23	8.30	7.30	1.30	7.97	33	8.60	7.50	1.10	8.20	3	8.10	7.00	1.10	7.57
ORTHO P	23	0.013	0.003L	0.010	0.008	32	0.016	0.003L	0.013	0.007	3	0.160	0.013	0.147	0.062
TOTAL P	23	0.111	0.007	0.104	0.018	33	0.238	0.007	0.231	0.034	3	3.40	0.020	3.38	1.15
POTASS	5	1.10	0.800	0.300	0.960	8	1.60	0.800	0.800	1.02	3	1.40	1.20	0.200	1.27
SILICA	5	17.2	15.6	1.60	16.4	8	18.7	15.9	2.80	16.9	3	20.3	14.2	6.10	17.5
SODIUM	5	6.20	5.30	0.900	5.74	8	6.50	3.40	3.10	5.66	3	6.80	2.20	4.30	5.00
SULPHATE	6	8.30	4.50	3.80	6.95	8	9.20	3.70	5.50	7.74	3	10.2	1.80	8.40	6.83
TIC	0	0.0	0.0	0.0	0.0	10	33.0	24.0	9.00	29.0	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	6	0.009	0.001L	0.008	0.003	7	0.002	0.001	0.001	0.002	3	0.007	0.001L	0.006	0.003
TOC	23	20.0	2.00L	18.0	5.52	33	16.0	2.00L	14.0	5.33	3	125.	3.00	122.	44.7

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8527 WHITEMAN CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	20.0	5.00	15.0	9.17	8	40.0	0.0	40.0	10.0	3	7.00	5.00	2.00	6.33
TURBID	29	4.80	0.300	4.50	1.54	36	9.00	0.200	8.80	2.01	13	110.	0.300	110.	11.2
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	1	2.40	2.40	0.0	2.40	1	770.	770.	0.0	770.
DISS O2	30	13.5	9.70	8.50	11.4	36	14.3	6.30	8.00	11.8	13	14.0	9.40	4.60	11.8
D.O. SAT	30	105.	85.0	20.0	98.3	38	112.	92.0	20.0	100.	12	100.	91.0	9.00	95.1
TEMP	7	13.8	3.20	11.6	8.94	8	24.5	1.10	23.4	14.0	3	22.8	4.90	17.9	14.2
INORGANIC PARAMETERS															
ALK TOT	30	135.	55.5	79.5	104.	38	146.	37.8	108.	109.	13	120.	34.0	86.0	81.6
CALCIUM	7	41.2	24.6	16.6	34.3	8	47.1	19.4	27.9	37.1	3	41.7	12.4	29.3	28.8
CHLORIDE	6	19.4	0.400	19.0	3.67	8	1.20	0.200	1.00	0.550	3	0.700	0.600	0.100	0.633
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.005	0.001L	0.004	0.002	3	0.005	0.002	0.003	0.003
FLUORIDE	7	0.290	0.130	0.160	0.223	8	0.330	0.170	0.160	0.268	3	0.290	0.130	0.160	0.210
HARD TOT	7	130.	58.4	61.6	111.	8	151.	60.8	92.2	119.	3	130.	37.0	102.	93.7
IRON	7	0.050	0.010	0.040	0.021	8	0.060	0.010L	0.050	0.025	3	0.110	0.010L	0.100	0.053
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.012L	0.005L	0.007	0.009
MAGNES	7	7.70	1.60	6.10	5.76	8	8.50	3.00	5.50	6.35	1	8.50	8.50	0.0	8.50
MANGAN	7	0.004	-.003	0.007	0.001	8	0.012	0.001	0.011	0.005	3	0.010L	0.010L	0.0	0.010
NITRATE	30	0.110	0.010L	0.100	0.045	38	0.150	0.010L	0.140	0.063	13	0.140	0.010L	0.130	0.062
TOTAL N	30	0.530	0.080	0.450	0.196	37	0.460	0.030	0.430	0.204	13	3.34	0.110	3.23	0.748
PH	30	8.60	7.40	1.20	8.06	38	8.60	7.50	0.300	8.16	13	8.20	6.90	1.30	7.82
ORTHO P	30	0.039	0.016	0.023	0.027	38	0.046	0.003	0.043	0.028	13	0.140	0.023	0.117	0.037
TOTAL P	29	0.101	0.023	0.078	0.040	38	0.052	0.020	0.032	0.037	13	1.20	0.029	1.17	0.136
POTASS	6	1.50	1.30	0.500	1.20	8	1.50	0.300	0.700	1.14	3	1.40	1.20	0.200	1.30
SILICA	5	20.2	0.400	19.8	15.4	8	20.0	18.8	1.20	19.6	3	22.4	18.2	4.20	19.9
SODIUM	6	7.50	4.30	2.70	6.05	8	7.20	2.90	4.30	5.75	3	6.50	2.30	4.20	4.80
SULPHATE	7	31.6	13.3	18.3	25.0	8	46.1	11.0	35.1	29.8	3	45.5	4.90	40.6	23.2
TIC	0	0.0	0.0	0.0	0.0	15	30.0	18.0	12.0	25.4	10	25.0	6.00	19.0	17.1
ORGANIC PARAMETERS															
ZINC	7	0.006	0.001L	0.005	0.002	8	0.002	0.001L	0.001	0.001	3	0.011	0.001L	0.010	0.005
TOC	29	9.00	2.00L	7.00	3.31	38	12.0	2.00L	10.0	5.34	12	87.0	3.00	84.0	14.2

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8528 EQUESIS CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	10.0	0.0	10.0	5.00	8	20.0	0.0	20.0	6.25	3	45.0	0.0	45.0	15.7
TURBID	29	4.70	0.500	4.20	1.68	30	22.0	0.700	21.3	3.11	3	160.	1.60	158.	56.0
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	2	12.4	5.20	7.20	8.80	1	1860.	1860.	0.0	1860.
DISS O2	29	12.9	9.80	3.10	11.3	31	13.7	10.0	3.70	12.0	3	12.2	9.60	2.60	10.5
O.D. SAT	29	112.	85.0	27.0	97.6	33	108.	89.0	19.0	98.5	3	90.0	80.0	10.0	86.7
TEMP	7	13.3	3.30	10.0	8.27	8	24.9	0.0	24.9	14.9	3	23.3	5.70	17.6	13.6
INORGANIC PARAMETERS															
ALK TOT	29	212.	62.0	150.	183.	33	220.	86.7	133.	190.	3	211.	64.0	147.	156.
CALCIUM	7	59.8	46.8	13.0	55.0	8	65.3	1.00	64.3	51.0	3	62.8	21.2	41.6	45.7
CHLORIDE	6	0.600	0.400	0.200	0.450	8	0.600	0.200	0.300	0.400	3	0.800	0.500	0.300	0.633
COPPER	7	0.002	L0.001	L0.001	0.001	8	0.006	0.001	L0.005	0.002	3	0.003	0.001	0.002	0.002
FLUORIDE	7	0.290	0.220	0.070	0.251	8	0.260	0.180	0.080	0.220	3	0.230	0.120	0.110	0.187
HARD TOT	7	226.	181.	45.0	207.	8	237.	116.	121.	206.	3	243.	71.0	172.	174.
IRON	7	0.100	0.010	0.090	0.027	8	0.040	0.010	L0.030	0.024	3	0.090	0.010	L0.080	0.037
LEAD	7	0.010	L0.005	L0.005	0.006	8	0.010	L0.005	L0.005	0.009	3	0.012	L0.005	L0.007	0.009
MAGNES	7	19.3	13.4	5.90	17.0	8	20.0	9.40	10.6	16.8	1	20.9	20.9	0.0	20.0
MANGAN	7	0.002	0.001	L0.001	0.001	8	0.010	L0.001	L0.009	0.003	3	0.047	0.010	L0.037	0.022
NITRATE	29	0.170	0.010	L0.160	0.077	33	0.140	0.010	L0.130	0.080	3	0.160	0.080	0.080	0.133
TOTAL N	29	1.11	0.030	1.09	0.239	32	0.490	0.040	0.450	0.204	3	7.15	0.300	6.85	2.61
PH	29	8.90	6.90	2.00	8.24	33	8.60	8.00	0.600	8.38	3	8.50	7.50	1.00	8.03
ORTHO P	29	0.055	0.007	0.048	0.017	33	0.160	0.003	0.157	0.025	3	0.029	0.023	0.006	0.025
TOTAL P	28	0.095	0.009	0.086	0.033	32	0.114	0.016	0.098	0.036	3	1.21	0.039	1.17	0.446
POTASS	6	3.10	2.60	0.500	2.75	8	3.20	2.00	1.20	2.67	3	3.20	1.90	1.30	2.73
SILICA	6	25.5	19.3	6.20	22.1	8	26.3	21.8	4.50	23.1	3	32.4	21.2	11.2	25.7
SODIUM	6	9.30	8.30	1.50	8.93	8	10.1	5.50	4.60	8.21	3	9.00	2.90	6.10	6.97
SULPHATE	7	38.1	29.1	9.00	33.6	8	43.2	18.0	25.2	35.2	3	50.3	11.6	38.7	35.7
TIC	0	0.0	0.0	0.0	0.0	10	48.0	30.0	18.0	40.1	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	7	0.001	0.001L	0.0	0.001	8	0.003	0.001	L0.002	0.001	3	0.004	0.001	L0.003	0.002
TOC	28	20.0	2.00L	18.0	4.36	33	11.0	2.00L	9.00	4.85	3	336.	4.00	332.	116.

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8529 DEEP CREEK OFF WEST SIDE ROAD

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	100.	20.0	80.0	37.5	8	30.0	10.0	20.0	23.7	4	55.0	20.0	35.0	32.5
TURBID	29	31.0	1.30	29.7	8.59	43	70.0	1.90	68.1	12.2	40	22.0	0.500	21.5	5.95
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	5	12.4	6.80	5.60	8.08	5	56.8	6.00	50.8	30.6	2	26.4	8.00	18.4	17.2
DISS O2	29	11.1	5.20	5.90	7.37	44	13.5	5.30	8.20	8.21	40	12.4	3.80	8.60	6.66
O.D. SAT	29	128.	45.0	83.0	89.6	46	113.	55.0	58.0	72.8	40	107.	31.0	76.0	58.8
TEMP	7	22.5	4.40	18.1	13.2	8	24.2	2.70	21.5	15.2	4	23.3	4.70	18.6	15.6
INORGANIC PARAMETERS															
ALK TOT	29	357.	166.	191.	233.	46	281.	162.	119.	262.	40	377.	101.	276.	229.
CALCIUM	7	87.6	56.4	31.1	76.9	8	112.	84.1	27.9	92.2	4	111.	60.2	50.8	84.5
CHLORIDE	6	3.10	2.20	0.900	2.67	8	43.0	2.40	40.6	8.67	4	3.90	2.50	1.40	3.05
COPPER	7	0.002	L0.001	L0.001	0.001	9	0.007	0.001	L0.006	0.003	4	0.003	0.001	L0.002	0.002
FLUORIDE	7	0.300	0.240	0.060	0.273	8	0.310	0.260	0.050	0.277	4	0.290	0.150	0.130	0.247
HARD TOT	7	320.	236.	134.	317.	8	390.	299.	91.0	353.	4	414.	194.	220.	327.
IRON	7	0.220	0.010	0.210	0.080	8	0.110	0.030	0.080	0.060	4	0.140	0.030	0.110	0.095
LEAD	7	0.010	L0.005	L0.005	0.009	8	0.010	L0.005	L0.005	0.009	4	0.012	L0.006	L0.006	0.009
MAGNES	7	40.9	23.1	17.8	30.4	8	37.4	21.6	15.8	29.8	1	33.2	33.2	0.0	33.2
MANGAN	7	0.270	0.001	L0.269	0.174	8	0.340	0.001	0.339	0.197	4	0.290	0.110	0.180	0.185
NITRATE	29	1.71	0.010	1.70	0.320	46	0.970	0.010	L0.960	0.135	40	0.970	0.010	L0.960	0.249
TOTAL N	29	3.75	0.340	3.41	1.45	45	2.44	0.220	2.22	1.44	40	3.13	0.510	2.61	1.74
PH	29	9.20	7.20	2.00	7.97	45	8.60	7.40	1.20	8.07	40	8.30	7.40	0.900	7.94
ORTHO P	29	0.235	0.003	0.232	0.105	46	0.391	0.023	0.368	0.207	40	0.554	0.023	0.531	0.283
TOTAL P	29	0.587	0.052	0.535	0.234	45	0.587	0.228	0.359	0.366	40	0.717	0.173	0.544	0.415
POTASS	6	8.40	7.10	1.30	7.58	9	7.80	0.0	7.80	5.29	4	10.0	4.50	5.50	7.45
SILICA	6	30.8	25.0	5.80	27.4	8	31.2	10.0	21.2	24.2	4	27.7	14.9	12.8	23.6
SODIUM	5	30.4	21.0	9.40	23.2	8	24.9	16.9	8.00	21.9	4	30.5	9.70	20.8	21.9
SULPHATE	7	162.	111.	51.0	137.	8	199.	136.	63.0	159.	4	203.	106.	97.3	149.
TIC	0	0.0	0.0	0.0	0.0	23	62.0	34.0	28.0	55.9	36	67.0	20.0	47.0	48.2
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001	L0.003	0.002	8	0.010	0.001	L0.009	0.003	4	0.005	0.001	L0.004	0.002
TOC	28	25.0	2.00	23.0	7.43	46	20.0	2.00	18.0	11.3	39	27.0	6.00	21.0	14.7

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8530 VERNON CREEK AT INLET TO OKANAGAN LAKE

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	15.0	5.00	10.0	10.3	8	20.0	5.00	15.0	11.5	4	20.0	7.00	13.0	13.0
TURBID	28	61.0	3.00	58.0	12.3	43	37.0	1.90	35.1	13.0	40	37.0	1.80	35.2	10.8
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	5	31.6	3.00	28.6	20.1	7	80.4	6.00	74.4	40.1	3	138.	9.20	119.	62.7
DISS O2	29	13.2	7.30	4.70	9.53	44	12.3	7.50	4.80	10.2	40	12.3	6.20	6.10	9.35
D.O. SAT	29	121.	80.0	41.0	91.3	44	114.	73.0	45.0	97.0	40	99.0	64.0	35.0	81.8
TEMP	7	24.2	3.80	20.4	13.8	8	24.8	3.30	21.5	16.1	4	20.6	5.30	15.3	14.2
INORGANIC PARAMETERS															
ALK TOT	29	193.	145.	48.0	169.	46	211.	145.	66.0	183.	40	244.	107.	137.	193.
CALCIUM	7	68.3	47.0	21.3	57.2	8	69.4	47.9	21.5	59.4	4	87.0	36.0	51.0	63.5
CHLORIDE	6	35.1	1.60	33.5	9.03	8	16.4	3.50	12.9	7.22	4	17.0	3.60	13.4	10.6
COPPER	7	0.003	0.001L	0.002	0.002	8	0.009	0.001	0.008	0.004	4	0.008	0.003	0.005	0.005
FLUORIDE	7	0.310	0.230	0.080	0.280	8	0.290	0.240	0.050	0.264	4	0.260	0.150	0.110	0.225
HARD TOT	7	240.	181.	59.0	217.	8	297.	181.	116.	232.	4	372.	143.	229.	249.
IRON	7	0.140	0.010	0.130	0.056	8	0.040	0.010	0.030	0.030	4	0.050	0.010L	0.040	0.035
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.012L	0.005L	0.007	0.008
MAGNES	7	19.8	15.2	4.60	18.0	8	30.1	14.9	15.2	20.4	1	40.7	40.7	0.0	40.7
MANGAN	7	0.055	0.001L	0.055	0.018	8	0.330	0.010	0.320	0.059	4	0.065	0.018	0.047	0.043
NITRATE	29	2.08	0.220	1.86	0.818	46	2.60	0.270	2.33	1.12	40	2.50	0.140	2.36	0.982
TOTAL N	28	2.84	0.640	2.15	1.42	46	12.0	0.710	11.3	2.18	40	5.21	0.190	5.02	2.37
PH	29	8.60	7.20	1.40	7.99	46	8.30	7.60	0.700	7.99	40	8.00	7.50	1.40	7.93
ORTHO P	29	0.946	0.013	0.933	0.438	46	1.50	0.023	1.48	0.589	40	1.50	0.055	1.44	0.547
TOTAL P	28	1.17	0.062	1.11	0.552	45	1.66	0.039	1.62	0.712	40	1.86	0.095	1.76	0.675
POTASS	6	6.10	4.80	1.30	5.28	8	6.10	4.60	1.50	5.45	4	9.00	4.00	5.00	6.30
SILICA	6	15.4	9.00	6.40	12.7	8	15.0	11.3	3.70	13.1	4	16.2	10.2	6.00	13.3
SODIUM	6	42.2	18.2	24.0	24.1	8	29.4	16.8	12.6	24.1	4	41.0	13.6	27.4	25.7
SULPHATE	7	91.5	58.6	32.9	79.6	8	153.	61.4	91.6	95.6	4	224.	53.7	170.	112.
TIC	0	0.0	0.0	0.0	0.0	23	48.0	24.0	24.0	39.7	35	51.0	20.0	31.0	38.5
ORGANIC PARAMETERS															
ZINC	7	0.007	0.003	0.004	0.005	8	0.009	0.003	0.006	0.006	4	0.013	0.003	0.010	0.007
TOC	28	21.0	3.00L	19.0	5.89	46	18.0	2.00L	16.0	7.59	38	25.0	4.00	21.0	10.3

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8531 BX CREEK: BRIDGE AT HIGHWAY 97

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	6	45.0	5.00	40.0	25.0	8	90.0	10.0	80.0	26.2	5	60.0	0.0	60.0	25.0
TURBID	28	80.0	4.50	75.5	28.3	36	48.0	1.00	47.0	13.1	20	150.	0.800	149.	12.0
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	6	120.	5.80	114.	56.1	6	47.6	4.80	42.8	27.2	3	1160.	4.40	1156.	392.
DISS O2	29	13.4	3.70	9.70	9.42	36	14.2	9.60	4.60	11.6	20	13.8	3.30	10.5	10.5
D.O. SAT	29	146.	40.0	106.	87.9	38	184.	75.0	109.	104.	20	129.	36.0	93.0	90.7
TEMP	7	24.0	3.10	20.7	12.5	8	24.8	2.20	22.6	16.1	4	19.5	4.20	15.3	13.4
INORGANIC PARAMETERS															
ALK TOT	29	337.	105.	232.	237.	38	324.	70.6	253.	238.	20	310.	56.0	254.	223.
CALCIUM	7	87.9	42.1	45.8	73.5	8	92.4	31.0	61.4	75.0	4	91.9	22.7	69.2	68.7
CHLORIDE	6	8.40	4.40	4.00	5.62	8	13.3	0.700	12.6	6.75	4	15.2	0.700	14.5	7.42
COPPER	7	0.003	0.002L	0.001	0.002	8	0.006	0.001L	0.005	0.002	4	0.004	0.001L	0.003	0.002
FLUORIDE	7	0.260	0.100	0.160	0.197	8	0.260	0.100	0.160	0.197	4	0.260	0.070	0.190	0.190
HARD TOT	7	328.	126.	202.	266.	8	367.	92.5	274.	278.	4	392.	68.0	324.	275.
IRON	7	0.300	0.010	0.290	0.091	8	0.190	0.020	0.170	0.068	4	0.150	0.030	0.120	0.067
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.039	0.005L	0.034	0.013	4	0.012L	0.005L	0.007	0.008
MAGNES	7	26.4	5.10	21.3	20.1	8	36.0	3.70	32.3	22.1	1	39.5	39.5	0.0	39.5
MANGAN	7	0.160	0.001L	0.159	0.064	8	0.170	0.008	0.162	0.065	4	0.130	0.010	0.120	0.052
NITRATE	29	2.25	0.040	2.21	1.14	38	3.30	0.140	3.16	1.53	20	5.00	0.080	4.92	1.93
TOTAL N	29	9.55	0.520	9.03	3.01	38	6.65	0.360	6.29	2.28	20	6.11	0.160	5.95	2.76
PH	29	8.80	7.20	1.60	8.04	38	8.70	7.70	1.00	8.23	20	8.40	7.40	1.00	8.04
ORTHO P	29	1.89	0.003	1.89	0.355	38	0.848	0.010	0.838	0.225	20	0.717	0.007	0.710	0.211
TOTAL P	29	2.54	0.007	2.53	0.558	37	1.30	0.033	1.27	0.321	20	0.978	0.026	0.952	0.324
POTASS	6	8.60	5.00	3.60	6.32	8	18.5	1.60	16.9	6.79	4	16.5	2.10	14.4	8.02
SILICA	6	19.6	16.0	3.60	17.6	8	19.7	12.3	7.40	16.1	4	19.0	13.3	5.70	16.8
SODIUM	6	44.3	18.5	25.8	28.9	8	46.0	3.30	42.7	28.1	4	44.0	1.90	42.1	30.7
SULPHATE	7	105.	25.4	79.6	78.4	8	128.	19.9	108.	91.9	4	163.	15.0	147.	97.9
TIC	0	0.0	0.0	0.0	0.0	15	71.0	36.0	35.0	55.9	16	71.0	10.0	61.0	46.8
ORGANIC PARAMETERS															
ZINC	7	0.010	0.001	0.009	0.006	8	0.019	0.001	0.018	0.005	4	0.005	0.001	0.004	0.002
TOC	28	16.0	3.00	13.0	8.18	38	22.0	4.00	18.0	7.82	19	54.0	4.00	50.0	12.6

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8532 COLDSTREAM CREEK

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	6	10.0	5.00	5.00	6.67	8	45.0	0.0	45.0	10.5	4	35.0	0.0	35.0	12.5
TURBID	27	46.0	1.50	44.5	5.67	42	51.0	1.10	49.9	5.29	39	44.0	0.400	43.6	8.12
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	3	15.6	6.60	9.00	11.6	4	64.4	6.40	58.0	23.7	2	224.	4.40	220.	114.
DISS O2	29	13.4	7.30	6.10	10.7	43	14.1	9.00	5.10	11.6	40	13.9	7.10	6.80	11.2
D.O. SAT	29	105.	85.0	20.0	98.8	45	124.	75.0	49.0	99.7	40	117.	67.0	50.0	94.7
TEMP	7	16.8	3.80	13.0	10.6	8	24.7	3.30	21.4	16.2	4	23.2	4.50	18.7	12.7
INORGANIC PARAMETERS															
ALK TOT	29	258.	180.	78.0	211.	45	261.	112.	149.	222.	40	274.	100.	174.	208.
CALCIUM	7	79.1	31.4	47.7	66.4	8	82.5	39.6	42.9	70.4	4	80.3	35.6	44.7	65.1
CHLORIDE	7	2.70	1.70	1.00	2.19	8	3.90	0.900	3.00	2.61	4	5.00	1.40	3.60	3.07
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.007	0.001L	0.006	0.003	4	0.012	0.001L	0.011	0.004
FLUORIDE	7	0.380	0.260	0.120	0.320	8	0.360	0.170	0.190	0.311	4	0.360	0.130	0.210	0.247
HARD TOT	7	287.	242.	45.0	259.	8	320.	130.	190.	256.	4	306.	117.	189.	235.
IRON	7	0.080	0.010L	0.070	0.030	8	0.050	0.010L	0.040	0.025	4	0.060	0.010L	0.050	0.030
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	4	0.012L	0.005L	0.007	0.008
MAGNES	7	19.7	19.1	21.6	22.6	8	27.7	7.60	20.1	19.4	1	26.5	26.5	0.0	26.5
MANGAN	7	0.005	0.001L	0.004	0.003	8	0.022	0.004	0.018	0.010	4	0.060	0.010L	0.050	0.026
NITRATE	29	1.67	0.170	1.50	1.21	45	1.94	0.320	1.62	1.31	40	2.20	0.010L	2.19	1.27
TOTAL N	27	2.06	0.620	1.44	1.50	44	3.42	0.790	3.13	1.64	40	3.11	0.140	2.97	1.76
PH	29	8.70	7.50	1.20	8.23	45	8.70	7.80	0.900	8.34	40	11.4	7.80	3.60	8.33
ORTHO P	29	0.135	0.003	0.132	0.018	45	0.359	0.007	0.352	0.030	40	0.088	0.003	0.085	0.028
TOTAL P	29	0.210	0.016	0.194	0.043	44	0.522	0.020	0.502	0.063	40	0.750	0.023	0.727	0.099
POTASS	7	6.80	4.00	2.80	5.00	8	6.60	2.20	4.40	5.04	4	9.10	2.60	6.50	5.40
SILICA	7	19.3	17.4	1.90	18.2	8	20.0	16.5	3.50	18.2	4	18.8	18.0	0.800	18.4
SODIUM	7	18.2	12.0	6.20	14.8	8	22.7	6.20	16.5	15.9	4	25.3	5.00	20.3	15.4
SULPHATE	7	77.6	54.7	22.9	63.3	8	104.	27.1	76.9	68.3	4	106.	21.9	84.1	62.7
TIC	0	0.0	0.0	0.0	0.0	22	53.0	27.0	26.0	45.0	36	58.0	12.0	46.0	41.3
ORGANIC PARAMETERS															
ZINC	7	0.004	0.001	0.003	0.002	8	0.014	0.002L	0.012	0.004	4	0.084	0.001L	0.083	0.022
TOC	28	9.00	2.00L	7.00	3.50	44	26.0	2.00L	24.0	6.14	39	45.0	2.00L	43.0	8.41

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8533 NASWHITO CREEK

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	6	30.0	7.00	23.0	14.5	8	50.0	0.0	50.0	13.7	3	70.0	5.00	65.0	28.3
TURBID	28	5.50	0.400	5.10	1.75	29	12.0	0.400	11.6	2.59	3	87.0	0.800	86.2	29.8
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	2	6.00	2.00	4.00	4.00	1	585.	585.	0.0	585.
DISS O2	29	13.8	1.30	12.5	11.0	30	14.0	9.80	4.20	12.1	3	13.2	8.70	4.50	11.1
D.O. SAT	29	105.	9.00	96.0	93.7	32	108.	89.0	19.0	98.0	3	93.0	89.0	4.00	90.7
TEMP	7	13.8	0.500	13.3	8.20	8	24.7	0.0	24.7	14.7	3	23.3	4.40	18.9	14.4
INORGANIC PARAMETERS															
ALK TOT	29	175.	48.0	127.	100.	32	154.	24.8	129.	110.	3	109.	34.0	75.0	77.3
CALCIUM	7	29.6	15.8	13.8	24.1	8	38.7	15.1	23.6	28.5	3	27.9	10.9	17.0	20.8
CHLORIDE	6	0.700	0.400	0.300	0.500	8	0.800	0.400	0.400	0.525	3	0.700	0.400	0.300	0.533
COPPER	7	0.002L	0.001L	0.001	0.001	8	0.005	0.001L	0.004	0.002	3	0.003	0.001	0.002	0.002
FLUORIDE	7	0.260	0.090	0.170	0.146	8	0.200	0.080	0.120	0.150	3	0.160	0.080	0.080	0.120
HARD TOT	7	103.	48.4	54.6	82.2	8	142.	49.8	92.2	99.6	3	104.	35.0	69.0	74.3
IRON	7	0.050	0.010	0.040	0.024	8	0.080	0.010L	0.070	0.029	3	0.090	0.010L	0.080	0.040
LEAD	7	0.010L	0.005L	0.005	0.009	8	0.010L	0.005L	0.005	0.009	3	0.012L	0.005L	0.007	0.009
MAGNES	7	7.30	2.20	5.10	5.34	8	11.0	2.90	8.10	6.89	1	8.30	8.30	0.0	8.30
MANGAN	7	0.003	0.001L	0.002	0.001	8	0.010L	0.001L	0.009	0.003	3	0.010L	0.010L	0.0	0.010
NITRATE	29	0.110	0.010L	0.100	0.017	32	0.110	0.010L	0.100	0.019	3	0.030	0.010L	0.020	0.020
TOTAL N	29	0.380	0.020	0.360	0.147	30	0.970	0.0	0.970	0.178	3	1.49	0.080	1.41	0.557
PH	29	8.50	7.50	1.00	8.04	32	8.40	7.60	0.800	8.11	3	8.00	7.10	0.900	7.67
ORTHO P	29	0.520	0.0	0.520	0.068	32	0.104	0.020	0.084	0.060	3	0.065	0.059	0.006	0.063
TOTAL P	28	9.95	0.020	9.93	0.434	31	0.130	0.023	0.107	0.067	3	0.750	0.065	0.685	0.296
POTASS	6	2.40	1.50	0.900	1.83	8	2.30	1.70	0.600	2.00	3	2.40	1.20	1.20	1.83
SILICA	6	31.0	25.6	5.40	28.6	8	31.0	26.9	4.10	28.9	3	28.8	27.0	1.80	27.7
SODIUM	6	7.80	5.10	2.70	6.55	8	10.0	4.20	5.80	7.54	3	8.20	2.50	5.70	5.73
SULPHATE	7	13.0	5.30	7.70	9.30	8	16.3	4.90	11.4	11.5	3	12.9	10.5	2.40	11.4
TIC	0	0.0	0.0	0.0	0.0	9	28.0	13.0	15.0	22.0	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
ZINC	7	0.002	0.001L	0.001	0.001	8	0.003	0.001L	0.002	0.001	3	0.002	0.001L	0.001	0.001
TOC	29	8.00	0.02	8.00	4.76	32	12.0	2.00L	10.0	6.06	3	36.0	5.00	31.0	16.7

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8534 GARBAGE CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	2	50.0	10.0	40.0	30.0	2	70.0	10.0	60.0	40.0
TURBID	0	0.0	0.0	0.0	0.0	9	25.0	3.90	21.1	9.40	12	29.0	4.00	25.0	9.38
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	1	3.60	3.60	0.0	3.60	3	11.6	0.200L	11.4	6.07
DISS O2	0	0.0	0.0	0.0	0.0	10	9.70	2.60	7.10	6.40	12	10.3	1.70	8.60	5.84
D.O. SAT	0	0.0	0.0	0.0	0.0	10	85.0	20.0	65.0	56.9	11	82.0	14.0	68.0	50.5
TEMP	0	0.0	0.0	0.0	0.0	2	23.7	20.6	3.10	22.1	3	24.2	13.2	11.0	19.8
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	10	231.	152.	79.0	191.	12	240.	129.	111.	185.
CALCIUM	0	0.0	0.0	0.0	0.0	2	36.6	34.0	2.60	35.3	3	57.1	32.2	24.9	43.0
CHLORIDE	0	0.0	0.0	0.0	0.0	2	2.50	2.40	0.100	2.45	3	5.50	2.10	3.40	3.27
COPPER	0	0.0	0.0	0.0	0.0	2	0.003	0.001L	0.002	0.002	3	0.007	0.001L	0.006	0.004
FLUORIDE	0	0.0	0.0	0.0	0.0	2	0.260	0.240	0.020	0.250	3	0.380	0.170	0.210	0.270
HARD TOT	0	0.0	0.0	0.0	0.0	2	140.	114.	26.0	127.	3	258.	130.	128.	182.
IRON	0	0.0	0.0	0.0	0.0	2	0.120	0.100	0.020	0.110	3	0.580	0.040	0.540	0.260
LEAD	0	0.0	0.0	0.0	0.0	2	0.010L	0.005L	0.005	0.007	3	0.012L	0.004L	0.008	0.009
MAGNES	0	0.0	0.0	0.0	0.0	2	13.4	12.8	0.600	13.1	1	28.0	28.0	0.0	28.0
MANGAN	0	0.0	0.0	0.0	0.0	2	0.450	0.290	0.160	0.370	3	0.390	0.026	0.364	0.239
NITRATE	0	0.0	0.0	0.0	0.0	10	0.100	0.030	0.070	0.058	12	0.860	0.020	0.840	0.123
TOTAL N	0	0.0	0.0	0.0	0.0	10	1.11	0.270	0.840	0.760	12	3.03	0.570	2.46	1.08
PH	0	0.0	0.0	0.0	0.0	10	8.10	7.40	0.700	7.70	12	8.40	7.40	1.00	7.61
ORTHO P	0	0.0	0.0	0.0	0.0	10	0.026	0.007	0.019	0.016	12	0.150	0.013	0.137	0.051
TOTAL P	0	0.0	0.0	0.0	0.0	10	0.280	0.014	0.266	0.170	12	0.850	0.137	0.713	0.293
POTASS	0	0.0	0.0	0.0	0.0	2	3.60	2.40	1.20	3.00	3	9.00	2.00	7.00	4.50
SILICA	0	0.0	0.0	0.0	0.0	2	26.2	23.6	2.60	24.9	2	27.3	25.3	2.00	26.3
SODIUM	0	0.0	0.0	0.0	0.0	2	19.5	17.7	1.80	18.6	3	38.0	15.0	23.0	24.3
SULPHATE	0	0.0	0.0	0.0	0.0	2	7.80	6.90	0.900	7.35	3	88.4	10.0	78.4	36.7
TIC	0	0.0	0.0	0.0	0.0	5	55.0	39.0	16.0	44.8	9	51.0	29.0	22.0	40.1
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	2	0.002L	0.001	0.001	0.001	3	0.022	0.002	0.020	0.010
TOC	0	0.0	0.0	0.0	0.0	10	10.0	2.00L	8.00	6.30	12	22.0	2.00L	20.0	10.5

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8535 WOLFCUB CREEK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	5.00	5.00	0.0	5.00	4	5.00	0.0	5.00	1.25
TURBID	0	0.0	0.0	0.0	0.0	5	11.5	0.400	11.1	4.98	20	6.70	0.100	6.60	1.65
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	1	1.80	1.80	0.0	1.80
DISS O2	0	0.0	0.0	0.0	0.0	5	9.00	4.50	4.50	6.20	20	11.1	3.00	8.10	6.73
D.O. SAT	0	0.0	0.0	0.0	0.0	5	85.0	44.0	41.0	56.4	20	105.	29.0	76.0	62.5
TEMP	0	0.0	0.0	0.0	0.0	1	24.4	24.4	0.0	24.4	4	25.1	11.1	14.0	18.4
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	5	214.	197.	17.0	207.	20	219.	204.	15.0	212.
CALCIUM	0	0.0	0.0	0.0	0.0	1	68.9	68.9	0.0	68.9	4	69.8	66.9	2.90	68.6
CHLORIDE	0	0.0	0.0	0.0	0.0	1	4.60	4.60	0.0	4.60	4	5.00	4.20	0.800	4.52
COPPER	0	0.0	0.0	0.0	0.0	1	0.002	0.002	0.0	0.002	4	0.002	0.001L	0.001	0.001
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.400	0.400	0.0	0.400	4	0.360	0.310	0.050	0.332
HARD TOT	0	0.0	0.0	0.0	0.0	1	239.	239.	0.0	239.	4	249.	244.	5.00	246.
IRON	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.020	0.010L	0.010	0.012
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.010L	0.006L	0.004	0.007
MAGNES	0	0.0	0.0	0.0	0.0	1	16.3	16.3	0.0	16.3	1	18.0	18.0	0.0	18.0
MANGAN	0	0.0	0.0	0.0	0.0	1	0.010	0.010	0.0	0.010	4	0.010L	0.010L	0.0	0.010
NITRATE	0	0.0	0.0	0.0	0.0	5	2.20	1.76	0.440	1.96	20	2.60	0.970	1.63	2.12
TOTAL N	0	0.0	0.0	0.0	0.0	5	3.32	1.95	1.37	2.57	20	2.79	1.38	1.41	2.37
PH	0	0.0	0.0	0.0	0.0	5	7.90	7.60	0.300	7.78	20	8.10	7.40	0.700	7.74
ORTHO P	0	0.0	0.0	0.0	0.0	5	0.075	0.042	0.033	0.058	20	0.652	0.003	0.649	0.076
TOTAL P	0	0.0	0.0	0.0	0.0	5	0.153	0.052	0.101	0.096	20	0.684	0.016	0.668	0.093
POTASS	0	0.0	0.0	0.0	0.0	1	4.90	4.90	0.0	4.90	4	4.80	3.80	1.00	4.27
SILICA	0	0.0	0.0	0.0	0.0	1	17.1	17.1	0.0	17.1	4	17.0	14.3	2.70	15.6
SODIUM	0	0.0	0.0	0.0	0.0	1	10.3	10.3	0.0	10.3	4	14.5	13.1	1.40	13.8
SULPHATE	0	0.0	0.0	0.0	0.0	1	51.8	51.8	0.0	51.8	4	54.8	52.7	2.10	53.4
TIC	0	0.0	0.0	0.0	0.0	4	49.0	33.0	16.0	42.5	16	52.0	27.0	25.0	43.0
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.003	0.003	0.0	0.003	4	0.009	0.001	0.008	0.006
TOC	0	0.0	0.0	0.0	0.0	5	8.00	2.00	6.00	5.20	20	21.0	2.00L	19.0	6.10

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8536 MISSION CREEK AT GAUGING STATION

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	5.00	5.00	0.0	5.00	4	50.0	5.00	45.0	21.2
TURBID	0	0.0	0.0	0.0	0.0	3	1.60	0.400	1.20	1.00	10	24.0	0.500	23.5	4.88
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TD SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	2	134.	2.80	131.	70.9
DISS O2	0	0.0	0.0	0.0	0.0	3	13.7	11.1	2.60	12.8	10	13.7	8.00	5.70	11.4
D.O. SAT	0	0.0	0.0	0.0	0.0	3	108.	96.0	12.0	103.	10	102.	88.0	14.0	98.4
TEMP	0	0.0	0.0	0.0	0.0	1	20.2	20.2	0.0	20.2	4	22.1	5.30	16.8	13.2
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	3	121.	102.	19.0	108.	10	127.	15.0	112.	73.1
CALCIUM	0	0.0	0.0	0.0	0.0	1	28.4	28.4	0.0	28.4	4	26.5	5.20	21.3	15.7
CHLORIDE	0	0.0	0.0	0.0	0.0	1	0.700	0.700	0.0	0.700	4	0.800	0.400	0.400	0.625
COPPER	0	0.0	0.0	0.0	0.0	1	0.004	0.004	0.0	0.004	4	0.002	0.001L	0.001	0.001
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.110	0.110	0.0	0.110	4	0.150	0.050	0.100	0.100
HARD TOT	0	0.0	0.0	0.0	0.0	1	105.	105.	0.0	105.	4	103.	18.0	85.0	66.7
IRON	0	0.0	0.0	0.0	0.0	1	0.050	0.050	0.0	0.050	4	0.080	0.050	0.030	0.052
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.012L	0.004L	0.008	0.008
MAGNES	0	0.0	0.0	0.0	0.0	1	8.30	8.30	0.0	8.30	1	9.00	9.00	0.0	9.00
MANGAN	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.018	0.010L	0.008	0.013
NITRATE	0	0.0	0.0	0.0	0.0	3	0.230	0.050	0.180	0.113	10	0.310	0.010	0.300	0.092
TOTAL N	0	0.0	0.0	0.0	0.0	3	0.440	0.050	0.390	0.230	9	0.730	0.030	0.700	0.271
PH	0	0.0	0.0	0.0	0.0	3	9.60	8.10	1.50	8.63	10	8.60	7.00	1.60	7.80
ORTHO P	0	0.0	0.0	0.0	0.0	3	0.033	0.003	0.030	0.014	10	0.010	0.003L	0.007	0.006
TOTAL P	0	0.0	0.0	0.0	0.0	3	0.049	0.007	0.042	0.023	10	0.205	0.007	0.198	0.038
POTASS	0	0.0	0.0	0.0	0.0	1	1.20	1.20	0.0	1.20	4	1.30	0.600	0.700	1.07
SILICA	0	0.0	0.0	0.0	0.0	1	13.3	13.3	0.0	13.3	4	14.3	13.2	1.10	13.6
SODIUM	0	0.0	0.0	0.0	0.0	1	8.60	8.60	0.0	8.60	4	9.30	1.70	7.60	5.75
SULPHATE	0	0.0	0.0	0.0	0.0	1	17.7	17.7	0.0	17.7	4	21.3	3.10	18.2	12.5
TIC	0	0.0	0.0	0.0	0.0	2	21.0	19.0	2.00	20.0	6	29.0	5.00	24.0	15.7
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.002L	0.002L	0.0	0.002	4	0.005	0.001L	0.004	0.003
TOC	0	0.0	0.0	0.0	0.0	3	6.00	4.00	2.00	4.67	10	13.0	2.00	11.0	7.90

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8537 KELOWNA CREEK AT HIGHWAY 97 BRIDGE

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	10.0	10.0	0.0	10.0	4	90.0	5.00	85.0	40.0
TURBID	0	0.0	0.0	0.0	0.0	3	4.40	2.50	1.90	3.40	10	44.0	1.70	42.3	10.5
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TD SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	4	47.6	1.60	46.0	17.8
DISS O2	0	0.0	0.0	0.0	0.0	3	11.0	9.50	1.50	10.3	10	11.7	7.00	4.70	9.37
D.O. SAT	0	0.0	0.0	0.0	0.0	3	88.0	84.0	4.00	86.3	10	109.	69.0	40.0	81.1
TEMP	0	0.0	0.0	0.0	0.0	1	19.7	19.7	0.0	19.7	4	23.3	7.20	16.1	14.3
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	3	198.	191.	7.00	195.	10	204.	35.0	171.	167.
CALCIUM	0	0.0	0.0	0.0	0.0	1	66.0	66.0	0.0	66.0	4	68.5	23.3	45.2	48.2
CHLORIDE	0	0.0	0.0	0.0	0.0	1	2.00	2.00	0.0	2.00	4	4.90	1.10	3.80	2.62
COPPER	0	0.0	0.0	0.0	0.0	1	0.001	0.001	0.0	0.001	4	0.010	0.001L	0.009	0.004
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.200	0.200	0.0	0.200	4	0.230	0.100	0.130	0.187
HARD TOT	0	0.0	0.0	0.0	0.0	1	217.	217.	0.0	217.	4	245.	73.0	172.	182.
IRON	0	0.0	0.0	0.0	0.0	1	0.040	0.040	0.0	0.040	4	0.190	0.040	0.150	0.102
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.012L	0.004L	0.008	0.008
MAGNES	0	0.0	0.0	0.0	0.0	1	12.7	12.7	0.0	12.7	1	18.3	18.3	0.0	18.3
MANGAN	0	0.0	0.0	0.0	0.0	1	0.073	0.073	0.0	0.073	4	0.200	0.044	0.156	0.094
NITRATE	0	0.0	0.0	0.0	0.0	3	0.210	0.070	0.140	0.147	10	1.89	0.050	1.84	0.309
TOTAL N	0	0.0	0.0	0.0	0.0	3	0.480	0.160	0.320	0.333	9	3.30	0.080	3.22	0.962
PH	0	0.0	0.0	0.0	0.0	3	8.10	8.00	0.100	8.07	10	8.60	7.36	1.30	7.89
ORTHO P	0	0.0	0.0	0.0	0.0	3	0.062	0.055	0.007	0.059	10	0.179	0.029	0.150	0.064
TOTAL P	0	0.0	0.0	0.0	0.0	3	0.088	0.085	0.003	0.086	10	0.303	0.072	0.231	0.146
POTASS	0	0.0	0.0	0.0	0.0	1	3.60	3.60	0.0	3.60	4	6.60	1.20	5.40	3.67
SILICA	0	0.0	0.0	0.0	0.0	1	21.7	21.7	0.0	21.7	4	26.4	18.4	8.00	20.8
SODIUM	0	0.0	0.0	0.0	0.0	1	13.6	13.6	0.0	13.6	4	19.5	4.90	14.6	11.0
SULPHATE	0	0.0	0.0	0.0	0.0	1	48.1	48.1	0.0	48.1	4	77.7	15.0	62.7	45.4
TIC	0	0.0	0.0	0.0	0.0	2	44.0	27.0	17.0	35.5	6	46.0	7.00	39.0	35.5
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.002L	0.002L	0.0	0.002	4	0.009	0.001L	0.008	0.003
TOC	0	0.0	0.0	0.0	0.0	3	6.00	5.00	1.00	5.33	10	23.0	6.00	17.0	12.9

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: BS38 BRANDT CREEK AT GOLFVIEW ROAD

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	20.0	20.0	0.0	20.0	3	60.0	7.00	53.0	35.7
TURBID	0	0.0	0.0	0.0	0.0	6	7.40	1.20	6.20	3.97	20	47.0	0.400	46.6	13.8
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TD SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	2	49.6	8.80	40.8	29.2
DISS O2	0	0.0	0.0	0.0	0.0	6	13.6	10.8	2.80	12.1	20	14.4	6.70	7.70	10.6
O.D. SAT	0	0.0	0.0	0.0	0.0	6	111.	81.0	30.0	98.8	20	112.	72.0	40.0	90.6
TEMP	0	0.0	0.0	0.0	0.0	1	24.6	24.6	0.0	24.6	3	22.1	6.10	16.0	15.3
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	6	602.	415.	187.	528.	20	598.	112.	486.	418.
CALCIUM	0	0.0	0.0	0.0	0.0	1	203.	203.	0.0	203.	3	178.	82.8	95.2	128.
CHLORIDE	0	0.0	0.0	0.0	0.0	1	36.0	36.0	0.0	36.0	3	50.8	26.0	24.8	38.6
COPPER	0	0.0	0.0	0.0	0.0	1	0.002	0.002	0.0	0.002	3	0.019	0.003	0.016	0.009
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.480	0.480	0.0	0.480	3	0.450	0.420	0.030	0.433
HARD TOT	0	0.0	0.0	0.0	0.0	1	1491.	1491.	0.0	1491.	3	1382.	814.	568.	1189.
IRON	0	0.0	0.0	0.0	0.0	1	0.020	0.020	0.0	0.020	3	0.060	0.040	0.020	0.050
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	3	0.010L	0.004L	0.006	0.006
MAGNES	0	0.0	0.0	0.0	0.0	1	239.	239.	0.0	239.	1	225.	225.	0.0	225.
MANGAN	0	0.0	0.0	0.0	0.0	1	0.340	0.340	0.0	0.340	3	0.830	0.018	0.812	0.406
NITRATE	0	0.0	0.0	0.0	0.0	6	1.25	0.290	0.960	0.578	20	3.30	0.040	3.26	0.858
TOTAL N	0	0.0	0.0	0.0	0.0	6	2.37	0.810	1.56	1.33	19	5.21	0.790	4.42	1.94
PH	0	0.0	0.0	0.0	0.0	5	8.60	8.20	0.400	8.37	20	8.50	7.70	0.800	8.24
ORTHO P	0	0.0	0.0	0.0	0.0	6	0.359	0.192	0.167	0.299	20	0.750	0.117	0.633	0.378
TOTAL P	0	0.0	0.0	0.0	0.0	6	0.391	0.225	0.166	0.324	20	0.750	0.157	0.593	0.449
POTASS	0	0.0	0.0	0.0	0.0	1	11.6	11.6	0.0	11.6	3	14.6	10.0	4.60	11.6
SILICA	0	0.0	0.0	0.0	0.0	1	15.8	15.8	0.0	15.8	3	23.0	15.6	7.40	18.2
SODIUM	0	0.0	0.0	0.0	0.0	1	615.	615.	0.0	615.	3	578.	386.	232.	473.
SULPHATE	0	0.0	0.0	0.0	0.0	1	2117.	2117.	0.0	2117.	3	1922.	132.11790.		1013.
TIC	0	0.0	0.0	0.0	0.0	5	120.	71.0	49.0	107.	17	117.	39.0	78.0	77.9
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.002L	0.002L	0.0	0.002	3	0.009	0.003	0.006	0.005
TOC	0	0.0	0.0	0.0	0.0	6	35.0	8.00	27.0	18.0	20	34.0	6.00	28.0	22.9

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: BS39 BX CREEK UPSTREAM ON SILVER STAR ROAD

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	5.00	5.00	0.0	5.00	4	25.0	5.00	20.0	10.5
TURBID	0	0.0	0.0	0.0	0.0	3	3.40	0.100	3.30	1.43	10	140.	0.200	140.	16.5
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TD SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	1	965.	965.	0.0	965.
DISS O2	0	0.0	0.0	0.0	0.0	3	12.8	10.1	2.70	11.5	10	12.7	7.40	5.30	10.8
O.D. SAT	0	0.0	0.0	0.0	0.0	3	93.0	86.0	7.00	89.3	10	100.	67.0	33.0	89.0
TEMP	0	0.0	0.0	0.0	0.0	1	24.3	24.3	0.0	24.3	4	23.4	1.70	21.7	11.7
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	3	164.	130.	34.0	151.	10	184.	44.0	140.	130.
CALCIUM	0	0.0	0.0	0.0	0.0	1	50.7	50.7	0.0	50.7	4	56.2	18.8	37.4	41.9
CHLORIDE	0	0.0	0.0	0.0	0.0	1	0.900	0.900	0.0	0.900	4	1.60	0.600	1.00	1.00
COPPER	0	0.0	0.0	0.0	0.0	1	0.001L	0.001L	0.0	0.001	4	0.003	0.001	0.002	0.002
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.100	0.100	0.0	0.100	4	0.110	0.060	0.050	0.092
HARD TOT	0	0.0	0.0	0.0	0.0	1	165.	165.	0.0	165.	4	179.	54.0	125.	133.
IRON	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.060	0.010L	0.050	0.027
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.013L	0.005L	0.007	0.008
MAGNES	0	0.0	0.0	0.0	0.0	1	9.30	9.30	0.0	9.30	1	9.80	9.80	0.0	9.80
MANGAN	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	2.71	0.010L	2.72	0.690
NITRATE	0	0.0	0.0	0.0	0.0	3	0.090	0.010L	0.080	0.060	10	3.60	0.010L	3.59	0.497
TOTAL N	0	0.0	0.0	0.0	0.0	3	0.480	0.190	0.290	0.317	10	3.60	0.070	3.53	0.857
PH	0	0.0	0.0	0.0	0.0	3	8.20	7.90	0.300	8.03	10	8.20	7.40	0.800	7.85
ORTHO P	0	0.0	0.0	0.0	0.0	3	0.003	0.003	0.0	0.003	10	0.010	0.003L	0.007	0.004
TOTAL P	0	0.0	0.0	0.0	0.0	3	0.010	0.003	0.007	0.005	10	0.913	0.003	0.910	0.103
POTASS	0	0.0	0.0	0.0	0.0	1	2.20	2.20	0.0	2.20	4	2.60	1.50	0.900	2.02
SILICA	0	0.0	0.0	0.0	0.0	1	13.4	13.4	0.0	13.4	4	16.6	10.4	6.20	13.1
SODIUM	0	0.0	0.0	0.0	0.0	1	5.20	5.20	0.0	5.20	4	5.60	1.50	4.10	3.90
SULPHATE	0	0.0	0.0	0.0	0.0	1	41.6	41.6	0.0	41.6	4	46.1	11.8	34.3	29.2
TIC	0	0.0	0.0	0.0	0.0	2	35.0	23.0	12.0	29.0	4	43.0	13.0	30.0	30.8
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.002L	0.002L	0.0	0.002	4	0.001	0.001L	0.0	0.001
TOC	0	0.0	0.0	0.0	0.0	3	7.00	4.00	3.00	5.33	9	51.0	2.00L	49.0	12.4

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8540 DEEP CREEK AT YOUNG ROAD

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	5.00	5.00	0.0	5.00	4	75.0	5.00	70.0	23.7
TURBID	0	0.0	0.0	0.0	0.0	6	3.50	0.300	3.20	1.72	20	11.0	0.500	10.5	2.78
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	1	34.4	34.4	0.0	34.4
DISS O2	0	0.0	0.0	0.0	0.0	5	12.3	8.10	4.20	9.55	20	12.1	7.60	4.50	9.57
D.O. SAT	0	0.0	0.0	0.0	0.0	6	88.0	66.0	22.0	78.7	20	95.0	65.0	30.0	80.4
TEMP	0	0.0	0.0	0.0	0.0	1	24.0	24.0	0.0	24.0	4	20.8	3.90	16.9	12.4
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	6	222.	151.	71.0	203.	20	310.	70.0	240.	190.
CALCIUM	0	0.0	0.0	0.0	0.0	1	93.5	93.5	0.0	93.5	4	91.5	37.3	54.2	76.5
CHLORIDE	0	0.0	0.0	0.0	0.0	1	1.20	1.20	0.0	1.20	4	1.50	1.20	0.300	1.27
COPPER	0	0.0	0.0	0.0	0.0	1	0.001L	0.001L	0.0	0.001	4	0.005	0.001L	0.004	0.002
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.300	0.300	0.0	0.300	4	0.280	0.140	0.140	0.232
HARD TOT	0	0.0	0.0	0.0	0.0	1	289.	289.	0.0	289.	4	303.	109.	194.	249.
IRON	0	0.0	0.0	0.0	0.0	1	0.030	0.030	0.0	0.030	4	0.090	0.030	0.060	0.050
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.012L	0.005L	0.007	0.008
MAGNES	0	0.0	0.0	0.0	0.0	1	13.5	13.5	0.0	13.5	1	20.5	20.5	0.0	20.5
MANGAN	0	0.0	0.0	0.0	0.0	1	0.027	0.027	0.0	0.027	4	0.210	0.014	0.196	0.104
NITRATE	0	0.0	0.0	0.0	0.0	6	0.840	0.010L	0.830	0.215	20	6.30	0.030	6.17	0.465
TOTAL N	0	0.0	0.0	0.0	0.0	5	1.00	0.180	0.820	0.574	20	9.06	0.080	8.98	0.941
PH	0	0.0	0.0	0.0	0.0	6	8.50	7.90	0.600	8.08	20	8.20	7.10	1.10	7.96
ORTHO P	0	0.0	0.0	0.0	0.0	6	0.039	0.023	0.016	0.031	20	0.055	0.020	0.035	0.036
TOTAL P	0	0.0	0.0	0.0	0.0	5	0.072	0.033	0.039	0.046	20	0.108	0.039	0.069	0.065
POTASS	0	0.0	0.0	0.0	0.0	1	5.30	5.30	0.0	5.30	4	5.50	2.40	3.10	4.60
SILICA	0	0.0	0.0	0.0	0.0	1	26.2	26.2	0.0	26.2	4	28.7	25.0	3.70	26.7
SODIUM	0	0.0	0.0	0.0	0.0	1	8.40	8.40	0.0	8.40	4	9.20	3.60	5.60	7.52
SULPHATE	0	0.0	0.0	0.0	0.0	1	94.7	94.7	0.0	94.7	4	107.	39.1	67.9	85.9
TIC	0	0.0	0.0	0.0	0.0	5	52.0	14.0	38.0	39.0	16	53.0	16.0	37.0	38.6
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.002L	0.002L	0.0	0.002	4	0.001	0.001L	0.0	0.001
TOC	0	0.0	0.0	0.0	0.0	6	11.0	2.00	9.00	6.50	19	39.0	2.00L	37.0	12.7

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

STREAM WATER QUALITY

STATION: 8541 VERNON CREEK AT EXIT FROM KALAMALKA LAK

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	0.0	0.0	0.0	0.0	4	0.0	0.0	0.0	0.0
TURBID	0	0.0	0.0	0.0	0.0	6	2.80	0.500	2.30	1.42	19	8.00	0.200	7.80	1.61
FX SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TO SUS M	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	1	15.2	15.2	0.0	15.2
DISS O2	0	0.0	0.0	0.0	0.0	5	12.4	8.90	3.50	10.9	19	14.7	7.90	6.80	10.8
D.O. SAT	0	0.0	0.0	0.0	0.0	5	114.	87.0	27.0	97.4	19	104.	91.0	13.0	96.8
TEMP	0	0.0	0.0	0.0	0.0	1	24.0	24.0	0.0	24.0	5	21.1	4.50	16.6	14.5
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	6	231.	127.	104.	156.	19	159.	133.	26.0	146.
CALCIUM	0	0.0	0.0	0.0	0.0	1	38.7	38.7	0.0	38.7	4	39.5	37.3	2.20	38.0
CHLORIDE	0	0.0	0.0	0.0	0.0	1	1.20	1.20	0.0	1.20	4	1.50	1.30	0.200	1.42
COPPER	0	0.0	0.0	0.0	0.0	1	0.001L	0.001L	0.0	0.001	4	0.003	0.001L	0.002	0.002
FLUORIDE	0	0.0	0.0	0.0	0.0	1	0.300	0.300	0.0	0.300	4	0.290	0.280	0.010	0.285
HARD TOT	0	0.0	0.0	0.0	0.0	1	166.	166.	0.0	166.	4	167.	165.	2.00	166.
IRON	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.010	0.010L	0.0	0.010
LEAD	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.012L	0.005L	0.007	0.008
MAGNES	0	0.0	0.0	0.0	0.0	1	16.9	16.9	0.0	16.9	1	17.8	17.8	0.0	17.8
MANGAN	0	0.0	0.0	0.0	0.0	1	0.010L	0.010L	0.0	0.010	4	0.012L	0.010L	0.002	0.010
NITRATE	0	0.0	0.0	0.0	0.0	6	0.040	0.010L	0.030	0.020	19	0.040	0.010L	0.030	0.021
TOTAL N	0	0.0	0.0	0.0	0.0	6	1.28	0.090	1.19	0.432	19	0.550	0.010L	0.540	0.233
PH	0	0.0	0.0	0.0	0.0	6	8.60	8.20	0.400	8.43	19	8.50	7.90	0.600	8.32
ORTHO P	0	0.0	0.0	0.0	0.0	6	0.001	0.003L	0.0	0.003	19	0.029	0.003L	0.026	0.004
TOTAL P	0	0.0	0.0	0.0	0.0	6	0.013	0.007	0.006	0.008	19	0.046	0.003	0.043	0.014
POTASS	0	0.0	0.0	0.0	0.0	1	4.60	4.60	0.0	4.60	4	4.80	4.50	0.300	4.67
SILICA	0	0.0	0.0	0.0	0.0	1	10.3	10.3	0.0	10.3	4	10.7	9.90	0.800	10.3
SODIUM	0	0.0	0.0	0.0	0.0	1	15.7	15.7	0.0	15.7	4	16.5	6.40	10.1	13.9
SULPHATE	0	0.0	0.0	0.0	0.0	1	52.1	52.1	0.0	52.1	4	56.4	37.8	18.6	50.4
TIC	0	0.0	0.0	0.0	0.0	5	34.0	22.0	12.0	30.2	15	34.0	21.0	13.0	30.0
ORGANIC PARAMETERS															
ZINC	0	0.0	0.0	0.0	0.0	1	0.002L	0.002L	0.0	0.002	4	0.004	0.001L	0.003	0.002
TOC	0	0.0	0.0	0.0	0.0	5	8.00	2.00	6.00	5.00	18	15.0	2.00L	13.0	6.17

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

APPENDIX C

STATISTICAL SUMMARY OF ANALYTICAL RESULTS

FOR 19 MAJOR OUTFALLS

STATISTICAL SUMMARY OF ANALYTICAL RESULTS FOR 19 MAJOR OUTFALLS

OUTFALL WATER QUALITY

STATION: 0 1 MONASHEE CO-OP OSOYOOS *See Appendix B for any Abbreviations.

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	4	10.0	0.0	10.0	5.00	3	5.00	5.00	0.0	5.00	7	30.0	5.00L	25.0	12.1
TURBID	4	0.500	0.300	0.200	0.425	3	1.10	0.300	0.800	0.667	7	64.0	0.100L	63.9	10.9
FX SUS M	4	322.	103.	219.	162.	10	301.	80.0	221.	148.	7	381.	100.	281.	189.
TO SUS M	4	7.00	1.00	6.00	3.62	1	2.00	2.00	0.0	2.00	3	72.0	0.500L	71.5	25.1
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	24.0	15.4	8.60	20.3	10	26.0	5.50	20.5	14.9	6	21.0	3.50	17.5	14.2
INORGANIC PARAMETERS															
ALK TOT	4	288.	111.	177.	157.	6	296.	112.	184.	151.	7	299.	97.0	202.	167.
CALCIUM	4	91.7	34.2	57.5	48.8	5	34.7	33.0	1.70	33.9	7	75.2	11.0	64.2	36.8
CHLORIDE	4	5.40	1.30	4.10	2.37	3	1.80	1.40	0.400	1.63	0	0.0	0.0	0.0	0.0
COPPER	4	0.020	0.0	0.020	0.015	9	0.080	0.0	0.080	0.028	0	0.0	0.0	0.0	0.0
FLUORIDE	4	0.320	0.200	0.120	0.252	3	0.280	0.240	0.040	0.253	0	0.0	0.0	0.0	0.0
HARD TOT	4	326.	123.	203.	177.	8	342.	69.7	272.	171.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	5	0.110	0.0	0.110	0.034	0	0.0	0.0	0.0	0.0
LEAD	4	0.040	0.0	0.040	0.015	10	1.80	0.003	1.80	0.188	0	0.0	0.0	0.0	0.0
MAGNES	4	23.5	9.00	14.5	13.6	10	24.0	8.60	15.4	13.8	0	0.0	0.0	0.0	0.0
MANGAN	4	0.100	0.010L	0.090	0.055	10	0.070	0.020	0.050	0.041	0	0.0	0.0	0.0	0.0
NITRATE	4	5.50	0.020L	5.48	1.43	9	8.00	0.020L	7.98	0.946	7	3.40	0.020L	3.38	0.539
PH	4	8.30	7.90	0.400	8.07	9	9.20	7.00	2.20	7.94	7	9.70	6.80	2.90	8.26
ORTHO P	4	0.042	0.0	0.042	0.014	9	1.80	0.003L	1.80	0.210	7	7.79	0.002	7.79	2.28
TOTAL P	4	0.143	0.016L	0.127	0.048	9	2.60	0.006	2.59	0.310	7	17.7	0.015	17.7	3.82
POTASS	4	5.40	2.30	3.10	3.22	10	6.80	2.30	4.50	3.11	7	4.70	2.00	2.70	3.29
SILICA	4	19.2	5.20	14.0	9.40	5	5.80	0.500L	5.30	4.00	0	0.0	0.0	0.0	0.0
SODIUM	4	27.5	5.00	22.5	12.7	8	26.5	8.60	17.9	13.2	7	112.	8.40	104.	31.3
SULPHATE	4	73.0	26.8	46.2	40.0	9	83.0	25.6	57.4	34.9	7	35.2	3.50	31.7	26.5
ZINC	4	0.020	0.0	0.020	0.010	10	0.180	0.0	0.180	0.053	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
BOD	4	10.0L	10.0L	0.0	10.0	1	10.0L	10.0L	0.0	10.0	3	44.0	10.0L	34.0	21.3
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 2 OLIVER-OSOYOOS CO-OP OLIVER

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	4	125.	1.50	123.	86.6	8	140.	20.0	120.	98.7	7	300.	5.00L	295.	142.
TURBID	4	18.0	4.00	14.0	12.5	8	140.	3.40	137.	34.9	7	170.	0.500	169.	60.4
FX SUS M	4	251.	158.	93.0	217.	9	1562.	140.	1422.	373.	7	944.	90.0	854.	494.
TO SUS M	4	48.0	36.0	12.0	43.5	5	108.	9.50	98.5	58.5	4	72.0	1.20	70.8	36.1
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	18.0	14.0	4.00	15.8	9	22.0	9.00	13.0	15.1	7	17.0	4.40	12.6	12.4
INORGANIC PARAMETERS															
ALK TOT	4	196.	137.	59.0	174.	9	1105.	0.500	1104.	252.	7	704.	93.5	610.	351.
CALCIUM	4	51.1	38.0	13.1	46.1	8	54.4	4.00	50.4	40.0	7	73.2	15.2	58.0	38.3
CHLORIDE	4	5.00	4.00	1.00	4.50	3	28.9	3.50	25.4	12.8	0	0.0	0.0	0.0	0.0
COPPER	0	0.0	0.0	0.0	0.0	1	0.050	0.050	0.0	0.050	0	0.0	0.0	0.0	0.0
FLUORIDE	4	0.560	0.280	0.280	0.450	2	0.380	0.370	0.010	0.375	0	0.0	0.0	0.0	0.0
HARD TOT	4	190.	157.	33.0	176.	5	200.	109.	91.0	165.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	2	0.510	0.100	0.410	0.305	0	0.0	0.0	0.0	0.0
LEAD	0	0.0	0.0	0.0	0.0	1	0.010	0.010	0.0	0.010	0	0.0	0.0	0.0	0.0
MAGNES	4	17.7	13.3	4.40	14.9	5	17.7	8.30	9.40	14.5	0	0.0	0.0	0.0	0.0
MANGAN	0	0.0	0.0	0.0	0.0	2	0.070	0.010	0.060	0.040	0	0.0	0.0	0.0	0.0
NITRATE	4	0.090	0.0	0.090	0.052	7	0.300	0.020L	0.280	0.091	7	3.29	0.020L	3.27	0.519
PH	4	8.30	7.60	0.700	7.82	8	10.0G	4.90	5.10	7.69	7	10.0G	7.30	2.70	8.54
ORTHO P	4	0.313	0.091	0.222	0.214	8	8.15	0.097	8.06	1.29	7	20.8	0.003	20.8	5.98
TOTAL P	4	0.554	0.273	0.281	0.441	8	8.81	0.136	8.67	1.90	7	18.8	0.016	18.8	8.31
POTASS	4	12.0	6.40	5.60	8.82	9	20.0	8.10	11.9	11.8	7	26.0	1.90	24.1	10.7
SILICA	4	26.5	10.8	15.7	20.2	5	250.	16.2	234.	66.2	0	0.0	0.0	0.0	0.0
SODIUM	4	34.0	21.5	12.5	27.0	7	450.	16.5	433.	96.9	7	322.	8.40	314.	136.
SULPHATE	4	62.0	45.2	16.8	52.9	8	55.1	28.0	27.1	43.9	7	85.5	25.0	60.5	55.3
ZINC	0	0.0	0.0	0.0	0.0	2	0.110	0.110	0.0	0.110	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
BOD	4	160.	50.0	110.	105.	7	160.	10.0L	150.	93.7	4	250.	114.	136.	181.
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 3 OLIVER S.T.P.

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	25.0	5.00	20.0	17.5	9	25.0	5.00	20.0	15.6	7	20.0	5.00L	15.0	9.29
TURBID	4	4.00	1.80	2.20	2.67	8	5.00	1.30	3.70	2.97	7	5.10	1.80	3.30	3.41
FX SUS M	4	293.	282.	11.0	288.	10	362.	233.	129.	287.	7	341.	290.	51.0	306.
TO SUS M	4	14.0	4.50	9.50	8.87	10	9.00	2.10	6.90	6.31	7	10.4	5.70	4.70	8.31
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	20.0	9.30	10.7	13.8	10	19.0	9.00	10.0	13.6	7	19.5	7.50	12.0	12.9
INORGANIC PARAMETERS															
ALK TOT	4	191.	142.	49.0	172.	10	238.	75.5	162.	131.	7	183.	71.5	111.	136.
CALCIUM	4	49.4	31.4	18.0	42.7	11	55.2	1.00	54.2	39.4	7	52.2	38.4	13.8	45.5
CHLORIDE	4	35.3	26.5	8.80	30.8	10	47.4	27.9	19.5	34.2	7	40.8	29.3	11.5	33.8
COPPER	4	0.020L	0.020L	0.0	0.020	9	0.060	0.020L	0.040	0.027	7	0.070	0.010	0.060	0.024
FLUORIDE	4	0.890	0.400	0.490	0.610	3	0.490	0.380	0.110	0.440	0	0.0	0.0	0.0	0.0
HARD TOT	4	209.	159.	50.0	185.	10	202.	150.	52.0	178.	4	212.	154.	58.0	178.
IRON	0	0.0	0.0	0.0	0.0	7	0.100	0.0	0.100	0.037	6	0.120	0.0	0.120	0.057
LEAD	4	0.050	0.0	0.050	0.012	10	0.050	0.005	0.045	0.014	7	0.016	0.003	0.013	0.007
MAGNES	4	25.0	14.6	10.4	19.0	10	23.6	12.3	11.3	16.9	7	24.8	9.60	15.2	17.1
MANGAN	4	0.050L	0.010	0.040	0.027	10	0.050	0.010L	0.040	0.019	7	0.030	0.010L	0.020	0.013
NITRATE	4	8.60	2.00	6.60	5.22	9	30.0	0.860	29.1	9.45	7	28.9	0.290	28.6	13.5
PH	4	7.30	7.10	0.200	7.22	8	7.30	6.40	0.900	6.90	7	7.10	6.60	0.500	6.84
ORTHO P	4	9.46	3.26	6.20	6.69	9	8.81	2.71	6.10	6.45	7	8.09	2.72	5.37	5.26
TOTAL P	4	9.78	5.54	4.24	7.66	9	9.13	2.71	6.42	6.91	7	9.36	2.95	6.41	5.82
POTASS	4	20.0	14.5	5.50	16.2	10	18.0	11.0	7.00	14.3	7	18.5	12.0	6.50	13.6
SILICA	4	22.2	14.5	7.70	19.3	10	21.4	7.80	13.6	16.3	7	24.2	14.9	9.30	19.7
SODIUM	4	53.5	46.5	7.00	49.2	8	53.5	41.5	12.0	47.1	7	53.0	39.5	13.5	47.1
SULPHATE	4	66.6	54.6	12.0	59.1	10	72.0	42.8	29.2	58.5	7	79.0	56.4	22.6	66.1
ZINC	4	0.090	0.020L	0.070	0.065	10	0.150	0.050	0.100	0.110	7	0.150	0.070	0.080	0.097
ORGANIC PARAMETERS															
BOD	2	10.0	10.0L	0.0	10.0	8	31.0	10.0L	21.0	14.6	6	10.0	10.0L	0.0	10.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 4 CANADIAN CANNERS PENTICTON

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	60.0	20.0	40.0	41.2	7	90.0	15.0	75.0	45.0	0	0.0	0.0	0.0	0.0
TURBID	4	150.	5.00	145.	60.5	2	85.0	13.0	72.0	49.0	0	0.0	0.0	0.0	0.0
FX SUS M	4	124.	61.0	63.0	87.2	9	1467.	53.0	1414.	277.	0	0.0	0.0	0.0	0.0
TO SUS M	3	160.	78.0	82.0	107.	2	104.	26.0	78.0	65.0	0	0.0	0.0	0.0	0.0
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	20.0	6.00	14.0	13.0	9	27.0	3.80	23.2	14.7	0	0.0	0.0	0.0	0.0
INORGANIC PARAMETERS															
ALK TOT	4	31.0	0.0	31.0	15.0	8	75.5	0.0	75.5	16.6	0	0.0	0.0	0.0	0.0
CALCIUM	4	6.90	5.00	1.90	5.62	7	22.4	3.00	19.4	10.3	0	0.0	0.0	0.0	0.0
CHLORIDE	4	30.5	2.20	28.3	11.4	8	83.0	2.70	80.3	18.2	0	0.0	0.0	0.0	0.0
COPPER	4	0.050	0.010	0.040	0.025	8	0.060	0.020L	0.040	0.040	0	0.0	0.0	0.0	0.0
FLUORIDE	4	0.170	0.100L	0.070	0.135	2	0.130	0.130	0.0	0.130	0	0.0	0.0	0.0	0.0
HARD TOT	4	43.6	18.8	24.8	32.1	5	97.0	20.0	77.0	43.3	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	6	2.50	0.140	2.36	1.44	0	0.0	0.0	0.0	0.0
LEAD	4	0.090	0.020	0.070	0.052	8	0.440	0.022	0.418	0.154	0	0.0	0.0	0.0	0.0
MAGNES	4	7.40	1.10	6.30	4.30	5	13.3	2.00	11.3	5.48	0	0.0	0.0	0.0	0.0
MANGAN	4	0.040	0.010	0.030	0.025	9	0.080	0.020	0.060	0.049	0	0.0	0.0	0.0	0.0
NITRATE	4	0.210	0.020L	0.190	0.095	8	0.120	0.010	0.110	0.052	0	0.0	0.0	0.0	0.0
PH	4	6.60	4.00	2.60	5.25	8	6.90	4.10	2.80	5.66	0	0.0	0.0	0.0	0.0
ORTHO P	4	0.978	0.019	0.959	0.390	8	2.48	0.003	2.47	0.403	0	0.0	0.0	0.0	0.0
TOTAL P	4	2.15	0.587	1.56	1.37	8	4.92	0.104	4.82	0.928	0	0.0	0.0	0.0	0.0
POTASS	4	15.0	1.80	13.2	10.2	9	43.0	2.30	40.7	12.0	0	0.0	0.0	0.0	0.0
SILICA	4	27.0	13.0	14.0	20.4	3	32.6	9.70	22.9	20.3	0	0.0	0.0	0.0	0.0
SODIUM	4	14.5	3.20	11.3	6.82	8	516.	5.40	511.	71.9	0	0.0	0.0	0.0	0.0
SULPHATE	4	22.4	12.2	10.2	17.1	8	25.2	1.00L	24.2	9.94	0	0.0	0.0	0.0	0.0
ZINC	4	0.110	0.0	0.110	0.032	9	0.310	0.0	0.310	0.141	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
BOD	3	435.	122.	313.	296.	9	1695.	75.0	1620.	664.	0	0.0	0.0	0.0	0.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 5 PENTICTON S.T.P.

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	70.0	40.0	30.0	51.2	10	125.	25.0	100.	49.5	7	45.0	30.0	15.0	35.0
TURBID	4	11.0	6.00	5.00	8.10	3	3.00	2.40	0.600	2.60	0	0.0	0.0	0.0	0.0
FX SUS M	4	182.	136.	46.0	165.	10	213.	99.0	114.	152.	7	194.	152.	42.0	175.
TO SUS M	3	22.0	8.00	14.0	14.0	11	177.	3.20	174.	24.0	7	40.0	3.20	36.8	15.2
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	18.0	14.0	4.00	15.6	11	22.5	8.80	13.7	14.5	7	17.5	6.70	10.8	11.6
INORGANIC PARAMETERS															
ALK TOT	4	143.	59.0	84.0	89.4	11	157.	73.5	83.5	128.	7	157.	35.5	121.	117.
CALCIUM	4	18.7	11.6	7.10	14.4	11	16.2	9.70	6.50	13.1	7	24.8	12.0	12.8	17.6
CHLORIDE	4	29.0	28.2	0.800	28.7	11	38.3	27.8	10.5	31.3	7	38.8	26.7	12.1	30.8
COPPER	4	0.080	0.020L	0.060	0.039	11	0.090	0.0	0.090	0.035	7	0.120	0.020	0.100	0.049
FLUORIDE	4	0.290	0.210	0.080	0.247	10	0.370	0.150	0.220	0.247	6	0.310	0.150	0.160	0.247
HARD TOT	4	74.0	49.2	24.8	56.6	11	66.0	42.4	23.6	53.4	6	97.0	59.0	38.0	75.7
IRON	0	0.0	0.0	0.0	0.0	7	0.440	0.060	0.380	0.210	7	0.460	0.040	0.420	0.249
LEAD	4	0.050	0.0	0.050	0.017	11	0.180	0.009	0.171	0.035	7	0.018	0.003L	0.015	0.008
MAGNES	4	6.60	3.70	2.90	5.00	11	7.90	3.00	4.90	5.03	7	8.20	3.30	4.90	6.17
MANGAN	4	0.080	0.040	0.040	0.060	11	0.070	0.030	0.040	0.050	7	0.110	0.030	0.080	0.057
NITRATE	4	12.3	1.00	11.3	7.27	10	1.70	0.030	1.67	0.434	7	15.4	0.030	15.4	4.62
PH	4	7.30	6.90	0.400	7.00	10	7.50	6.20	1.30	7.04	7	9.30	6.00	3.30	7.26
ORTHO P	4	8.81	6.52	2.28	7.26	10	7.17	3.82	3.36	4.83	7	5.09	2.95	2.14	4.02
TOTAL P	4	11.1	7.17	3.91	8.40	10	7.83	4.47	3.36	6.09	7	6.59	4.04	2.54	5.15
POTASS	4	10.6	9.30	1.30	10.1	11	15.0	8.20	6.80	10.2	7	10.0	7.60	2.40	9.31
SILICA	4	21.5	14.7	6.80	18.4	11	27.0	4.20	22.8	19.4	7	24.0	11.1	12.9	18.9
SODIUM	4	47.5	30.5	17.0	39.4	10	48.0	24.0	24.0	32.6	7	38.5	25.5	13.0	31.7
SULPHATE	4	46.8	30.8	16.0	40.6	11	40.4	23.0	17.4	30.1	7	48.5	25.0	23.5	35.1
ZINC	4	0.060	0.0	0.060	0.027	11	0.350	0.0	0.350	0.090	7	0.110	0.050	0.060	0.083
ORGANIC PARAMETERS															
BOD	1	21.0	21.0	0.0	21.0	11	94.0	10.0L	84.0	17.6	7	55.0	10.0L	45.0	19.1
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS). DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 6 LAKESHORE BOTTLING PENTICTON

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	100.	40.0	60.0	70.0	10	300.	5.00	295.	79.0	5	110.	25.0	85.0	60.0
TURBID	4	40.0	10.0	30.0	19.5	3	44.0	3.00	41.0	20.7	0	0.0	0.0	0.0	0.0
FX SUS M	4	485.	150.	335.	281.	11	503.	38.0	465.	246.	7	600.	164.	436.	304.
TO SUS M	3	81.0	23.0	58.0	49.3	6	79.0	5.00	74.0	38.8	5	55.0	7.80	47.2	36.7
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	24.0	14.3	9.70	18.3	11	28.0	3.00	25.0	15.5	7	24.0	6.70	17.3	16.1
INORGANIC PARAMETERS															
ALK TOT	4	428.	90.0	338.	229.	11	328.	22.0	306.	171.	7	574.	123.	451.	269.
CALCIUM	4	6.30	5.30	1.00	5.75	6	19.4	2.00	17.4	7.28	0	0.0	0.0	0.0	0.0
CHLORIDE	4	2.00	0.0	2.00	0.950	3	6.00	0.500	5.50	2.67	0	0.0	0.0	0.0	0.0
COPPER	4	0.350	0.030	0.320	0.155	9	0.100	0.010	0.090	0.040	7	0.170	0.030	0.140	0.079
FLUORIDE	4	0.280	0.140	0.140	0.195	3	0.170	0.010	0.160	0.107	0	0.0	0.0	0.0	0.0
HARD TOT	4	24.8	15.8	9.00	20.0	11	102.	7.10	94.9	26.1	7	31.6	9.60	22.0	23.4
IRON	0	0.0	0.0	0.0	0.0	7	1.44	0.350	1.09	0.819	5	0.940	0.520	0.420	0.688
LEAD	4	0.060	0.030	0.030	0.045	9	0.110	0.012	0.098	0.045	7	0.052	0.017	0.035	0.030
MAGNES	4	2.30	0.500L	1.80	1.40	11	13.0	0.500	12.5	2.69	7	3.80	0.400	3.40	2.53
MANGAN	4	0.050L	0.010L	0.040	0.025	9	0.040	0.010L	0.030	0.017	7	0.020	0.010L	0.010	0.011
NITRATE	4	0.270	0.020L	0.250	0.085	9	0.080	0.010	0.070	0.046	7	0.080	0.020L	0.060	0.057
PH	4	87.0	9.60	77.4	29.5	11	81.0	7.00	74.0	16.3	7	11.7	6.30	5.40	9.91
ORTHO P	4	0.140	0.052	0.088	0.097	10	7.79	0.003L	7.79	1.11	7	0.224	0.002L	0.222	0.059
TOTAL P	4	0.652	0.218	0.434	0.437	10	23.4	0.042	23.4	2.87	7	0.332	0.027	0.305	0.111
POTASS	4	2.50	1.30	1.20	2.02	11	2.60	0.700	1.90	1.67	7	2.10	0.900	1.20	1.54
SILICA	4	14.8	12.5	2.30	13.5	4	25.7	0.03	25.7	11.2	0	0.0	0.0	0.0	0.0
SODIUM	4	187.	41.0	146.	109.	11	146.	11.0	135.	80.7	6	153.	14.0	139.	79.2
SULPHATE	4	22.0	8.00	14.0	12.6	10	82.0	1.80	80.2	21.7	7	20.0	4.50	15.5	11.1
ZINC	4	0.170	0.060	0.110	0.135	9	0.140	0.030	0.110	0.091	7	0.180	0.036	0.144	0.082
ORGANIC PARAMETERS															
BOD	4	260.	58.0	202.	151.	10	350.	12.0	338.	154.	7	305.	90.0	215.	213.
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS). DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 7 HATCHERY SUMMERLAND

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	5.00	0.0	5.00	3.75	3	5.00	0.0	5.00	1.67	0	0.0	0.0	0.0	0.0
TURBID	4	0.800	0.300	0.500	0.550	3	0.800	0.200	0.600	0.467	0	0.0	0.0	0.0	0.0
FX SUS M	4	249.	239.	10.0	243.	11	292.	212.	80.0	245.	6	323.	264.	59.0	290.
TO SUS M	4	9.00	1.00	8.00	3.75	3	4.70	3.00	1.70	3.90	1	2.00	2.00	0.0	2.00
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	12.0	8.80	3.20	10.6	11	13.0	7.70	5.30	10.8	6	12.0	7.00	5.00	9.97
INORGANIC PARAMETERS															
ALK TOT	4	222.	216.	6.00	220.	11	229.	216.	13.0	224.	6	229.	225.	4.00	227.
CALCIUM	4	81.2	76.4	4.80	78.9	11	82.6	74.9	7.70	80.0	6	82.6	81.4	1.20	82.2
CHLORIDE	4	6.50	3.90	2.60	4.75	9	4.80	3.40	1.40	4.18	6	4.80	1.30	3.50	3.83
COPPER	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
FLUORIDE	4	0.420	0.320	0.100	0.382	3	0.370	0.340	0.030	0.357	0	0.0	0.0	0.0	0.0
HARD TOT	4	266.	254.	12.0	260.	11	273.	244.	29.0	259.	6	279.	251.	28.0	267.
IRON	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
LEAD	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
MAGNES	4	16.4	13.7	2.70	15.4	7	15.0	13.5	1.50	14.4	0	0.0	0.0	0.0	0.0
MANGAN	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
NITRATE	4	4.46	1.60	2.86	3.11	11	5.40	3.20	2.20	4.32	6	5.00	0.240	4.76	3.74
PH	4	8.10	7.40	0.700	7.72	11	8.00	7.40	0.600	7.69	6	8.10	7.50	0.600	7.68
ORTHO P	4	0.022	0.0	0.022	0.011	10	0.088	0.013	0.075	0.034	6	0.048	0.017	0.031	0.039
TOTAL P	4	0.042	0.016	0.026	0.024	10	0.958	0.019	0.939	0.157	6	0.165	0.031	0.134	0.091
POTASS	4	4.30	3.80	0.500	4.00	11	8.70	3.80	4.90	4.66	6	4.40	3.10	1.30	3.92
SILICA	4	19.3	17.7	1.60	18.4	3	18.5	17.5	1.00	17.9	0	0.0	0.0	0.0	0.0
SODIUM	4	29.0	19.5	9.50	22.3	10	24.0	17.5	6.50	20.9	6	21.5	12.5	9.00	18.8
SULPHATE	4	71.0	53.0	18.0	59.2	10	66.0	54.8	11.2	58.2	6	62.3	6.00	56.3	50.0
ZINC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
BOD	4	10.0L	10.0L	0.0	10.0	2	10.0L	10.0L	0.0	10.0	2	10.0L	10.0L	0.0	10.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 8 MAC DONALDS CONSOL. SUMMERLAND

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	150.	10.0	140.	68.7	10	50.0	5.00	45.0	11.0	5	5.00L	5.00L	0.0	5.00
TURBID	4	65.0	8.00	57.0	35.7	3	2.80	1.30	1.50	2.17	0	0.0	0.0	0.0	0.0
FX SUS M	4	389.	151.	238.	292.	10	640.	109.	531.	285.	6	549.	157.	392.	396.
TO SUS M	4	572.	35.0	537.	195.	8	458.	6.00	452.	89.4	6	13.8	1.20	12.6	7.17
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	24.0	7.10	16.9	13.8	10	24.0	6.60	17.4	13.1	6	19.0	6.10	12.9	10.2
INORGANIC PARAMETERS															
ALK TOT	4	243.	86.0	157.	142.	10	248.	65.0	183.	152.	6	234.	108.	126.	199.
CALCIUM	4	64.2	33.0	31.2	42.5	9	105.	35.6	69.4	67.3	6	130.	36.6	93.4	100.
CHLORIDE	4	14.9	2.00	12.9	6.65	10	8.00	0.800	7.20	5.40	6	7.80	2.00	5.80	6.13
COPPER	3	0.052	0.010L	0.042	0.037	9	0.020	0.0	0.020	0.009	6	0.010	0.010L	0.0	0.010
FLUORIDE	4	0.500	0.210	0.290	0.317	3	0.320	0.290	0.030	0.300	0	0.0	0.0	0.0	0.0
HARD TOT	4	227.	104.	123.	146.	10	481.	35.6	445.	234.	6	464.	127.	337.	352.
IRON	0	0.0	0.0	0.0	0.0	6	0.460	0.040	0.420	0.267	5	0.060	0.0	0.060	0.012
LEAD	4	0.090	0.0	0.090	0.042	10	0.110	0.006	0.104	0.031	6	0.009	0.003L	0.006	0.004
MAGNES	4	16.2	2.30	13.9	9.72	10	75.4	1.60	73.8	20.5	6	33.7	8.20	25.5	24.5
MANGAN	4	0.130	0.030	0.100	0.077	10	0.140	0.010	0.130	0.063	6	0.110	0.020	0.090	0.073
NITRATE	4	0.060	0.0	0.060	0.015	10	1.30	0.020L	1.28	0.292	6	0.490	0.020L	0.470	0.270
PH	4	10.4	6.50	3.90	7.80	10	8.00	6.30	1.70	7.42	6	8.50	7.50	1.00	7.73
ORTHO P	4	6.52	0.016L	6.51	1.65	9	0.358	0.003L	0.355	0.062	6	0.050	0.001	0.049	0.017
TOTAL P	4	8.81	0.198	8.61	2.72	9	0.750	0.065	0.685	0.221	6	0.130	0.049	0.081	0.081
POTASS	4	30.0	4.10	25.9	12.8	10	24.0	3.50	20.5	8.30	6	8.00	1.90	6.10	6.10
SILICA	4	29.4	9.00	20.4	20.4	3	17.0	15.7	1.30	16.1	0	0.0	0.0	0.0	0.0
SODIUM	4	103.	15.0	88.0	42.4	10	36.0	9.20	26.8	17.8	6	31.0	9.20	21.8	23.1
SULPHATE	4	105.	33.2	71.8	59.3	10	286.	29.8	256.	114.	6	268.	57.7	210.	193.
ZINC	4	0.160	0.0	0.160	0.067	10	0.110	0.020	0.090	0.053	6	0.050	0.011	0.039	0.027
ORGANIC PARAMETERS															
BOD	4	655.	90.0	565.	403.	6	1920.	80.0	1840.	459.	2	18.0	10.0	8.00	14.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 9 WESTBANK LAGOON

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	0	0.0	0.0	0.0	0.0	1	25.0	25.0	0.0	25.0	0	0.0	0.0	0.0	0.0
TURBID	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
FX SUS M	0	0.0	0.0	0.0	0.0	1	312.	312.	0.0	312.	5	419.	273.	146.	326.
TO SUS M	0	0.0	0.0	0.0	0.0	1	31.0	31.0	0.0	31.0	5	111.	15.0	96.0	45.6
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	0	0.0	0.0	0.0	0.0	1	7.00	7.00	0.0	7.00	5	17.0	2.70	14.3	8.52
INORGANIC PARAMETERS															
ALK TOT	0	0.0	0.0	0.0	0.0	1	282.	282.	0.0	282.	5	338.	199.	139.	273.
CALCIUM	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
CHLORIDE	0	0.0	0.0	0.0	0.0	1	32.8	32.8	0.0	32.8	5	41.2	0.0	41.2	16.3
COPPER	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	5	0.050	0.030	0.020	0.038
FLUORIDE	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	3	0.310	0.190	0.120	0.247
HARD TOT	0	0.0	0.0	0.0	0.0	1	224.	224.	0.0	224.	5	246.	138.	108.	200.
IRON	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	4	0.140	0.060	0.080	0.090
LEAD	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	5	0.030	0.003L	0.027	0.016
MAGNES	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	5	28.0	11.3	16.7	19.8
MANGAN	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	5	0.030	0.010L	0.020	0.018
NITRATE	0	0.0	0.0	0.0	0.0	1	0.110	0.110	0.0	0.110	5	0.450	0.020L	0.430	0.198
PH	0	0.0	0.0	0.0	0.0	1	7.50	7.50	0.0	7.50	5	8.80	7.10	1.70	7.60
ORTHO P	0	0.0	0.0	0.0	0.0	1	9.95	9.95	0.0	9.95	5	9.95	4.43	5.51	7.27
TOTAL P	0	0.0	0.0	0.0	0.0	1	11.7	11.7	0.0	11.7	5	10.9	6.26	4.63	8.47
POTASS	0	0.0	0.0	0.0	0.0	1	9.50	9.50	0.0	9.50	5	11.5	10.5	1.00	10.9
SILICA	0	0.0	0.0	0.0	0.0	1	28.6	28.6	0.0	28.6	1	25.2	25.2	0.0	25.2
SODIUM	0	0.0	0.0	0.0	0.0	1	51.0	51.0	0.0	51.0	0	0.0	0.0	0.0	0.0
SULPHATE	0	0.0	0.0	0.0	0.0	1	29.8	29.8	0.0	29.8	3	37.9	17.0	20.9	28.2
ZINC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	5	0.090	0.030	0.060	0.070
ORGANIC PARAMETERS															
BOD	0	0.0	0.0	0.0	0.0	1	10.0L	10.0L	0.0	10.0	5	75.0	29.0	46.0	56.4
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

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2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: 0 10 OKANAGAN BEVERAGES KELOWNA

	1969 NO. VAL	1969 MAX CONC	1969 MIN CONC	1969 RANGE	1969 MEAN	1970 NO. VAL	1970 MAX CONC	1970 MIN CONC	1970 RANGE	1970 MEAN	1971 NO. VAL	1971 MAX CONC	1971 MIN CONC	1971 RANGE	1971 MEAN
PHYSICAL PARAMETERS															
COLOUR	4	150.	5.00	145.	42.5	7	50.0	1.00	49.0	14.4	5	55.0	5.00L	50.0	19.0
TURBID	4	1750.	9.00	1741.	460.	9	100.	4.40	95.6	21.0	6	56.0	1.40	54.6	16.2
FX SUS M	4	1868.	188.	1680.	633.	10	430.	159.	271.	261.	6	936.	200.	736.	381.
TO SUS M	1	18.0	18.0	0.0	18.0	3	51.0	12.4	38.6	26.5	4	85.0	1.90	83.1	40.5
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	19.8	6.00	13.8	11.4	8	18.0	5.00	13.0	12.0	6	15.5	6.10	9.40	10.6
INORGANIC PARAMETERS															
ALK TOT	4	213.	101.	112.	139.	10	358.	12.5	345.	190.	6	694.	178.	516.	305.
CALCIUM	4	38.0	33.4	4.60	36.4	9	41.2	12.2	29.0	32.6	5	36.0	13.6	22.4	27.0
CHLORIDE	4	17.5	0.900	16.6	9.05	8	37.5	0.0	37.5	8.92	6	3.70	0.0	3.70	1.75
COPPER	3	0.130	0.025	0.105	0.078	10	0.116	0.020L	0.096	0.043	6	0.150	0.020	0.130	0.058
FLUORIDE	4	0.930	0.200	0.730	0.435	3	0.800	0.740	0.060	0.760	0	0.0	0.0	0.0	0.0
HARD TOT	4	141.	123.	18.0	134.	9	170.	107.	63.0	134.	5	128.	75.6	52.4	111.
IRON	0	0.0	0.0	0.0	0.0	7	1.32	0.120	1.20	0.694	5	1.72	0.100	1.62	0.712
LEAD	3	0.080	0.030	0.050	0.057	10	0.100	0.010	0.090	0.033	6	0.100	0.015	0.085	0.037
MAGNES	4	11.2	9.50	1.70	10.5	10	18.0	7.70	10.3	11.5	6	18.2	7.50	10.7	12.0
MANGAN	3	0.060	0.030	0.030	0.050	10	0.060	0.010L	0.050	0.023	6	0.030	0.010L	0.020	0.015
NITRATE	4	0.110	0.0	0.110	0.027	10	0.090	0.020L	0.070	0.045	6	0.500	0.020L	0.480	0.163
PH	4	10.3	6.40	3.90	7.60	9	10.8	5.20	5.60	8.84	6	13.2	6.70	6.50	9.92
ORTHO P	4	0.554	0.016	0.538	0.250	9	2.61	0.055	2.55	0.553	6	2.80	0.053	2.75	0.719
TOTAL P	4	2.61	0.185	2.42	1.22	9	4.57	0.215	4.35	1.64	6	9.10	0.861	8.24	2.67
POTASS	4	27.5	3.90	23.6	14.0	10	100.	3.30	96.7	15.1	6	16.0	2.50	13.5	8.12
SILICA	4	23.5	7.50	16.0	14.1	3	7.50	6.80	0.700	7.10	0	0.0	0.0	0.0	0.0
SODIUM	4	100.	17.0	83.0	47.4	9	158.	31.0	127.	64.9	6	304.	20.0	284.	99.8
SULPHATE	4	44.0	26.0	18.0	34.9	9	89.0	28.8	60.2	43.9	6	47.0	31.2	15.8	36.1
ZINC	3	0.200	0.0	0.200	0.083	10	0.220	0.0	0.220	0.074	6	0.140	0.020	0.120	0.057
ORGANIC PARAMETERS															
BOD	1	215.	215.	0.0	215.	6	525.	42.0	483.	226.	6	1070.	65.0	1005.	414.
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

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2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 11 KELOWNA GROWERS & SUN RYPE #2

	1969				1970				1971			
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	90.0	10.0	80.0	38.7	7	45.0	5.00	40.0	18.6	7	80.0	5.00L	75.0	22.9
TURBID	4	60.0	30.0	30.0	41.0	3	45.0	15.0	30.0	28.7	2	27.0	5.60	21.4	16.3
FX SUS M	4	270.	176.	94.0	208.	11	600.	111.	489.	208.	7	192.	122.	70.0	152.
TO SUS M	1	130.	130.	0.0	130.	9	429.	10.0	419.	107.	7	141.	29.0	112.	79.9
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	22.0	15.9	6.10	18.7	8	30.0	11.6	18.4	19.2	7	21.0	13.4	7.60	17.5
INORGANIC PARAMETERS															
ALK TOT	4	115.	69.5	45.5	93.9	11	438.	5.00	433.	118.	7	104.	79.5	24.5	95.1
CALCIUM	4	34.2	31.8	2.40	32.5	11	51.4	25.3	26.1	33.6	7	34.2	27.8	6.40	31.7
CHLORIDE	4	46.6	4.30	42.3	23.3	10	31.6	1.30	30.3	8.17	7	9.30	2.70	6.60	4.50
COPPER	3	0.030	0.020	0.010	0.023	10	0.050	0.020L	0.030	0.027	7	0.040	0.010L	0.030	0.020
FLUORIDE	4	1.00	0.210	0.790	0.450	3	0.850	0.740	0.110	0.797	0	0.0	0.0	0.0	0.0
HARD TOT	4	136.	114.	22.0	122.	10	208.	72.7	135.	127.	6	123.	101.	22.0	112.
IRON	0	0.0	0.0	0.0	0.0	8	12.0	0.120	11.9	2.09	7	0.820	0.120	0.700	0.397
LEAD	3	0.080	0.030	0.050	0.050	11	0.200	0.020	0.180	0.055	7	0.035	0.005	0.030	0.016
MAGNES	4	13.4	6.90	6.50	9.75	11	29.9	2.30	27.6	10.4	7	9.10	7.10	2.00	8.16
MANGAN	3	0.030	0.020	0.010	0.023	11	0.170	0.010L	0.160	0.050	7	0.030	0.010L	0.020	0.016
NITRATE	4	0.020L	0.0	0.020	0.005	11	0.080	0.0	0.080	0.036	7	0.440	0.020L	0.420	0.149
PH	4	7.10	1.20	5.90	5.40	9	11.3	4.90	6.40	7.37	7	8.00	6.60	1.40	7.24
ORTHO P	4	0.133	0.013	0.120	0.081	10	0.394	0.003	0.391	0.097	7	0.949	0.009	0.940	0.316
TOTAL P	4	0.848	0.365	0.483	0.588	10	2.34	0.052	2.29	0.663	7	1.38	0.210	1.17	0.781
POTASS	4	13.5	5.80	7.70	9.07	11	18.5	2.70	15.8	7.89	7	13.5	2.70	10.8	7.47
SILICA	4	16.8	10.0	6.80	12.4	4	13.8	7.30	6.50	9.57	0	0.0	0.0	0.0	0.0
SODIUM	4	35.5	10.0	25.5	23.0	10	176.	10.0	166.	37.0	7	23.5	10.0	13.5	13.4
SULPHATE	4	34.0	25.6	8.40	30.5	11	40.8	24.8	16.0	30.1	7	37.5	27.5	10.0	31.2
ZINC	3	0.100	0.020L	0.080	0.070	11	0.440	0.020L	0.420	0.101	7	0.110	0.040	0.070	0.063
ORGANIC PARAMETERS															
BOD	1	400.	400.	0.0	400.	7	990.	145.	845.	520.	7	980.	15.0	965.	422.
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

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2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 12 AMERICAN CAN KELOWNA

	1969				1970				1971			
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	50.0	0.0	50.0	17.5	3	5.00	0.0	5.00	3.33	0	0.0	0.0	0.0	0.0
TURBID	4	280.	0.200	280.	70.7	2	1.80	0.400	1.40	1.10	0	0.0	0.0	0.0	0.0
FX SUS M	4	225.	111.	114.	160.	10	123.	99.0	24.0	108.	6	122.	104.	18.0	109.
TO SUS M	0	0.0	0.0	0.0	0.0	1	2.00	2.00	0.0	2.00	4	3.40	1.90	1.50	2.45
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	29.7	10.0	19.7	18.2	8	28.5	11.5	17.0	21.4	6	24.0	13.9	10.1	19.6
INORGANIC PARAMETERS															
ALK TOT	4	106.	74.5	31.5	89.6	10	109.	102.	7.00	106.	6	114.	88.0	26.0	105.
CALCIUM	4	34.8	24.8	10.0	30.9	5	33.8	32.6	1.20	33.1	0	0.0	0.0	0.0	0.0
CHLORIDE	4	29.0	2.20	26.8	12.6	3	2.70	2.30	0.400	2.47	0	0.0	0.0	0.0	0.0
COPPER	4	0.050	0.0	0.050	0.022	9	0.060	0.0	0.060	0.031	6	0.060	0.020	0.040	0.038
FLUORIDE	4	0.920	0.170	0.750	0.407	2	1.15	0.740	0.410	0.945	0	0.0	0.0	0.0	0.0
HARD TOT	4	121.	98.0	23.0	109.	9	125.	114.	11.0	120.	5	126.	109.	17.0	119.
IRON	0	0.0	0.0	0.0	0.0	7	0.100	0.0	0.100	0.037	6	0.120	0.020L	0.100	0.053
LEAD	4	0.220	0.050	0.170	0.097	10	0.800	0.010	0.790	0.178	6	1.20	0.022	1.18	0.303
MAGNES	4	9.00	6.60	2.40	7.72	10	9.40	7.80	1.60	8.66	6	9.50	7.60	1.90	8.62
MANGAN	4	0.230	0.0	0.230	0.125	9	0.030	0.010L	0.020	0.017	6	0.020	0.010L	0.010	0.012
NITRATE	4	0.160	0.020	0.140	0.072	10	0.070	0.020L	0.050	0.041	6	0.180	0.040	0.140	0.080
PH	4	8.40	7.60	0.800	7.90	9	8.30	7.90	0.400	8.09	6	9.00	7.70	1.30	8.08
ORTHO P	4	0.016L	0.0	0.016	0.007	6	0.008	0.002L	0.006	0.004	6	0.012	0.002L	0.010	0.005
TOTAL P	4	0.251	0.0	0.251	0.071	9	0.228	0.002L	0.226	0.048	6	0.031	0.003	0.028	0.011
POTASS	4	2.50	1.60	0.900	1.95	9	2.70	2.00	0.700	2.29	6	2.30	1.90	0.400	2.13
SILICA	4	19.0	4.90	14.1	8.90	3	6.20	4.50	1.70	5.17	0	0.0	0.0	0.0	0.0
SODIUM	4	11.5	7.80	3.70	9.32	2	12.5	8.00	4.50	10.2	0	0.0	0.0	0.0	0.0
SULPHATE	4	27.2	21.6	5.60	24.8	8	28.8	26.0	2.80	27.1	6	30.0	24.5	5.50	27.4
ZINC	4	2.90	0.070	2.83	0.847	10	0.750	0.080	0.670	0.296	6	1.40	0.120	1.28	0.428
ORGANIC PARAMETERS															
BOD	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 13 KEL. BEV. & OKANAGAN PACKERS

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	10.0	5.00	5.00	8.75	10	10.0	5.00L	5.00	6.00	6	5.00	5.00L	0.0	5.00
TURBID	4	2.00	0.300	1.70	1.25	3	2.80	0.900	1.90	1.53	0	0.0	0.0	0.0	0.0
FX SUS M	4	120.	95.0	25.0	110.	11	646.	104.	542.	172.	6	457.	106.	351.	175.
TO SUS M	3	12.5	2.50	10.0	7.00	3	14.0	4.00	10.0	8.00	1	4.80	4.80	0.0	4.80
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	21.0	16.5	4.50	18.4	10	23.0	11.0	12.0	18.6	6	20.0	12.0	8.00	15.8
INORGANIC PARAMETERS															
ALK TOT	4	109.	104.	5.00	106.	11	118.	101.	17.0	107.	6	363.	105.	258.	150.
CALCIUM	4	36.1	31.8	4.30	33.4	11	35.2	31.1	4.10	33.0	6	79.2	33.0	46.2	41.1
CHLORIDE	4	5.70	2.00	3.70	3.05	11	347.	2.40	345.	35.3	6	3.90	0.0	3.90	2.32
COPPER	4	0.030	0.0	0.030	0.012	11	0.050	0.020L	0.030	0.026	6	0.020	0.010L	0.010	0.013
FLUORIDE	4	0.250	0.190	0.060	0.217	11	1.40	0.180	1.22	0.852	6	1.35	0.180	1.17	0.692
HARD TOT	4	122.	113.	9.00	117.	8	128.	112.	16.0	119.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	6	0.540	0.040	0.500	0.247	6	0.080	0.020L	0.060	0.040
LEAD	4	0.020	0.020L	0.0	0.020	11	0.020L	0.006	0.014	0.013	6	0.022	0.003L	0.019	0.010
MAGNES	4	9.10	6.60	2.50	8.17	11	11.4	8.00	3.40	8.85	6	32.5	8.50	24.0	12.8
MANGAN	4	0.050L	0.0	0.050	0.020	11	0.030	0.010L	0.020	0.015	6	0.230	0.010L	0.220	0.047
NITRATE	4	0.070	0.020	0.050	0.040	11	14.5	0.020L	14.5	1.37	6	0.370	0.020L	0.350	0.097
PH	4	8.10	7.50	0.600	7.75	11	8.00	7.40	0.600	7.68	6	7.70	7.50	0.200	7.57
ORTHO P	4	0.225	0.0	0.225	0.086	10	0.150	0.003L	0.147	0.037	6	0.099	0.012	0.087	0.056
TOTAL P	4	0.247	0.016L	0.231	0.129	10	0.433	0.019	0.414	0.116	6	0.251	0.019	0.232	0.137
POTASS	4	3.00	1.70	1.30	2.32	11	3.10	1.90	1.20	2.50	6	3.70	1.80	1.90	2.52
SILICA	4	5.30	4.00	1.30	4.87	11	7.50	2.00	5.50	5.19	6	19.1	4.70	14.4	8.53
SODIUM	4	11.0	9.00	2.00	9.87	3	10.5	9.20	1.30	9.80	0	0.0	0.0	0.0	0.0
SULPHATE	4	29.2	24.8	4.40	27.5	11	29.0	24.4	4.60	27.1	6	95.5	26.5	69.0	39.5
ZINC	4	0.090	0.030	0.060	0.065	11	0.180	0.020	0.160	0.085	6	0.070	0.019	0.051	0.041
ORGANIC PARAMETERS															
BOD	3	13.0	10.0L	3.00	11.7	9	34.0	10.0L	24.0	14.1	6	22.0	10.0L	12.0	12.8
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 14 CAWSTON AVE. STORM SEWER KELOWNA

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	30.0	10.0	20.0	18.7	11	25.0	5.00	20.0	9.55	5	5.00	5.00L	0.0	5.00
TURBID	4	9.00	1.70	7.30	5.17	3	6.00	3.60	2.40	4.70	0	0.0	0.0	0.0	0.0
FX SUS M	4	325.	144.	181.	251.	11	376.	138.	238.	280.	5	431.	236.	195.	347.
TO SUS M	3	50.0	14.5	35.5	28.8	5	27.0	8.00	19.0	15.4	0	0.0	0.0	0.0	0.0
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	19.5	13.2	6.30	16.9	9	23.0	8.00	15.0	14.7	5	13.0	8.30	4.70	10.7
INORGANIC PARAMETERS															
ALK TOT	4	224.	187.	37.0	208.	11	380.	130.	250.	250.	5	328.	203.	125.	276.
CALCIUM	4	51.7	46.7	5.00	48.7	11	79.6	38.0	41.6	57.6	4	74.4	52.8	21.6	63.9
CHLORIDE	4	27.5	12.9	14.6	19.2	11	12.8	0.0	12.8	7.22	5	8.30	0.0	8.30	3.12
COPPER	4	0.040	0.020L	0.020	0.025	10	0.040	0.0	0.040	0.018	5	0.020	0.010L	0.010	0.012
FLUORIDE	4	0.460	0.300	0.160	0.387	11	0.900	0.340	0.560	0.657	5	1.05	0.270	0.780	0.582
HARD TOT	4	198.	175.	23.0	190.	8	328.	212.	116.	253.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	6	1.42	0.040	1.38	0.540	5	0.040	0.0	0.040	0.016
LEAD	4	0.040	0.020L	0.020	0.030	11	0.400	0.004	0.396	0.094	5	0.008	0.003L	0.005	0.005
MAGNES	4	18.1	14.2	3.90	16.5	11	31.5	10.2	21.3	19.9	5	29.0	16.8	12.2	23.8
MANGAN	4	0.460	0.050L	0.410	0.205	11	0.360	0.030	0.330	0.215	5	0.340	0.040	0.300	0.184
NITRATE	4	0.220	0.030	0.190	0.142	11	0.600	0.020L	0.580	0.170	5	0.370	0.070	0.300	0.172
PH	4	7.50	7.30	0.200	7.40	11	7.90	7.40	0.500	7.61	5	7.80	7.50	0.300	7.62
ORTHO P	4	0.652	0.358	0.294	0.472	10	0.153	0.006	0.147	0.060	5	0.035	0.029	0.006	0.032
TOTAL P	4	0.815	0.456	0.359	0.635	10	0.456	0.061	0.395	0.207	5	0.149	0.050	0.099	0.111
POTASS	4	4.80	3.00	1.80	3.95	11	4.90	2.70	2.20	3.87	5	3.60	2.80	0.800	3.28
SILICA	4	15.0	10.2	4.80	12.8	11	25.0	4.50	20.5	14.3	5	19.0	14.5	4.50	16.9
SODIUM	4	54.0	34.5	19.5	45.9	3	65.0	57.5	7.50	60.2	0	0.0	0.0	0.0	0.0
SULPHATE	4	62.0	42.0	20.0	53.8	11	102.	36.0	66.0	67.0	5	93.3	57.1	36.2	77.3
ZINC	4	0.140	0.030	0.110	0.080	11	0.415	0.0	0.415	0.139	5	0.070	0.030	0.040	0.050
ORGANIC PARAMETERS															
BOD	3	20.0	10.0	10.0	15.3	9	33.0	10.0L	23.0	14.6	5	22.0	10.0L	12.0	12.4
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 15 KELOWNA S.T.P.

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	3	55.0	20.0	35.0	35.0	9	60.0	5.00	55.0	36.7	5	25.0	10.0	15.0	15.0
TURBID	3	21.0	8.50	12.5	13.8	3	58.0	12.0	46.0	31.0	0	0.0	0.0	0.0	0.0
FX SUS M	3	303.	274.	29.0	285.	11	362.	237.	125.	295.	7	384.	305.	79.0	326.
TO SUS M	3	52.0	38.0	14.0	43.3	11	134.	6.00	128.	40.7	7	116.	7.00	109.	29.2
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	3	20.0	8.80	11.2	14.6	10	22.0	9.00	13.0	14.6	7	21.0	8.90	12.1	13.3
INORGANIC PARAMETERS															
ALK TOT	3	238.	215.	23.0	228.	11	278.	80.5	197.	166.	7	266.	147.	119.	222.
CALCIUM	3	42.2	33.9	8.30	38.0	11	41.9	30.1	11.8	36.4	7	55.2	34.6	20.6	42.3
CHLORIDE	3	49.8	40.8	9.00	43.9	11	64.0	35.5	28.5	52.6	7	61.8	1.50	60.3	39.5
COPPER	3	0.086	0.020L	0.066	0.059	11	180.	0.020L	180.	16.4	7	0.050	0.010	0.040	0.030
FLUORIDE	3	0.970	0.300	0.670	0.550	11	1.20	0.420	0.780	0.802	7	1.20	0.280	0.920	0.689
HARD TOT	3	173.	152.	21.0	165.	11	192.	153.	39.0	171.	7	224.	154.	70.0	180.
IRON	0	0.0	0.0	0.0	0.0	8	0.600	0.040	0.560	0.180	7	0.100	0.020L	0.080	0.066
LEAD	3	0.070	0.020	0.050	0.047	11	0.680	0.005	0.675	0.108	6	0.037	0.003L	0.034	0.011
MAGNES	3	18.5	16.3	2.20	17.0	11	22.1	17.4	4.70	19.4	7	20.9	12.8	8.10	16.7
MANGAN	3	0.120	0.050L	0.070	0.093	11	0.200	0.050	0.150	0.112	7	0.170	0.060	0.110	0.114
NITRATE	3	2.20	1.80	0.400	2.03	11	46.0	0.120	45.9	12.0	7	8.45	0.410	8.04	2.80
PH	3	7.30	6.90	0.400	7.13	11	7.70	6.60	1.10	7.15	7	7.50	7.10	0.400	7.29
ORTHO P	3	7.83	4.89	2.93	6.09	10	9.46	5.22	4.24	6.54	7	5.84	3.65	2.19	5.20
TOTAL P	3	7.83	5.61	2.22	6.44	10	14.7	6.20	8.48	8.11	7	8.09	4.14	3.95	5.91
POTASS	3	16.2	10.0	6.20	12.1	11	12.0	1.60	10.4	9.61	7	12.5	8.80	3.70	10.5
SILICA	3	19.7	13.0	6.70	15.4	10	23.5	4.50	19.0	13.5	7	18.0	13.6	4.40	15.1
SODIUM	3	62.5	52.0	10.5	57.3	10	75.0	23.5	51.5	56.3	7	83.5	52.0	31.5	63.9
SULPHATE	3	55.6	54.0	1.60	54.9	10	88.0	54.4	33.6	63.6	7	83.8	50.0	33.8	66.7
ZINC	3	0.100	0.030	0.070	0.057	11	0.260	0.020	0.240	0.124	7	0.200	0.040	0.160	0.093
ORGANIC PARAMETERS															
BOD	2	50.0	38.0	12.0	44.0	11	130.	10.0L	120.	48.9	7	25.0	10.0L	15.0	14.1
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 16 VERNON FRUIT UNION WOODS LAKE

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	5.00	0.0	5.00	2.50	6	5.00	0.0	5.00	4.17	4	5.00L	5.00L	0.0	5.00
TURBID	4	0.900	0.0	0.900	0.275	2	0.300	0.0	0.300	0.150	0	0.0	0.0	0.0	0.0
FX SUS M	4	368.	278.	90.0	310.	6	493.	269.	224.	315.	4	336.	307.	29.0	317.
TO SUS M	3	3.50	0.0	3.50	1.83	2	1.50	1.20	0.300	1.35	0	0.0	0.0	0.0	0.0
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	18.0	13.2	4.80	15.3	6	16.7	11.0	5.70	14.4	4	15.9	12.5	3.40	14.6
INORGANIC PARAMETERS															
ALK TOT	4	279.	240.	39.0	257.	6	328.	239.	89.0	257.	4	259.	250.	9.00	253.
CALCIUM	4	73.2	56.9	16.3	63.1	2	57.4	56.6	0.800	57.0	0	0.0	0.0	0.0	0.0
CHLORIDE	4	18.9	8.60	10.3	12.1	6	9.30	0.0	9.30	3.93	4	10.9	0.0	10.9	4.32
COPPER	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
FLUORIDE	4	0.620	0.400	0.220	0.475	2	0.440	0.390	0.050	0.415	0	0.0	0.0	0.0	0.0
HARD TOT	4	318.	246.	72.0	274.	3	408.	238.	170.	295.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
LEAD	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
MAGNES	4	32.9	25.1	7.80	27.9	3	24.3	23.5	0.800	23.8	0	0.0	0.0	0.0	0.0
MANGAN	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
NITRATE	4	0.610	0.190	0.420	0.352	6	0.330	0.110	0.220	0.208	4	0.370	0.130	0.240	0.257
PH	4	7.60	7.20	0.400	7.47	6	7.80	7.20	0.600	7.53	4	7.40	7.20	0.200	7.27
ORTHO P	4	0.035	0.029	0.006	0.032	5	0.048	0.035	0.013	0.041	4	0.044	0.035	0.009	0.040
TOTAL P	4	0.110	0.032	0.078	0.058	5	0.054	0.035	0.019	0.044	4	0.047	0.035	0.012	0.042
POTASS	4	6.00	4.20	1.80	5.00	6	8.40	3.70	4.70	5.15	4	5.00	4.20	0.800	4.60
SILICA	4	18.8	17.5	1.30	18.1	6	20.5	11.5	9.00	16.6	4	20.5	18.5	2.00	19.3
SODIUM	4	58.0	40.5	17.5	47.7	2	40.5	40.0	0.500	40.2	0	0.0	0.0	0.0	0.0
SULPHATE	4	157.	75.0	82.0	105.	5	200.	74.0	126.	104.	4	102.	79.3	22.7	88.6
ZINC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
ORGANIC PARAMETERS															
BOD	3	10.0L	10.0L	0.0	10.0	2	10.0L	10.0L	0.0	10.0	0	0.0	0.0	0.0	0.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 17 VERNON S.T.P.

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	45.0	30.0	15.0	38.7	11	70.0	25.0	45.0	44.5	6	55.0	20.0	35.0	35.8
TURBID	4	10.0	5.50	4.50	7.75	3	12.0	6.00	6.00	9.00	1	15.0	15.0	0.0	15.0
FX SUS M	4	320.	253.	67.0	290.	11	383.	257.	126.	319.	6	371.	287.	84.0	327.
TO SUS M	3	28.0	18.0	10.0	22.7	10	37.0	10.0	27.0	22.0	6	31.0	9.60	21.4	21.4
DISS 02	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	17.5	9.90	7.60	13.8	11	24.0	7.00	17.0	13.4	6	20.0	6.00	14.0	12.7
INORGANIC PARAMETERS															
ALK TOT	4	188.	167.	21.0	177.	11	210.	178.	32.0	193.	6	246.	176.	70.0	204.
CALCIUM	4	58.2	42.0	16.2	46.8	7	62.2	33.4	28.8	44.8	1	52.0	52.0	0.0	52.0
CHLORIDE	4	70.5	33.8	36.7	46.0	11	87.3	34.8	52.5	52.2	6	71.5	5.30	66.2	43.3
COPPER	4	0.040	0.030	0.010	0.035	10	0.090	0.020L	0.070	0.039	6	0.090	0.020	0.070	0.038
FLUORIDE	4	1.08	0.540	0.540	0.835	11	0.690	0.320	0.370	0.503	6	0.720	0.280	0.440	0.423
HARD TOT	4	219.	171.	48.0	188.	8	226.	161.	65.0	188.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	6	0.500	0.100	0.400	0.203	6	0.180	0.080	0.100	0.110
LEAD	4	0.020	0.0	0.020	0.015	10	0.031	0.009	0.022	0.019	6	0.030	0.004	0.026	0.012
MAGNES	4	19.4	15.7	3.70	17.3	10	24.5	17.2	7.30	20.8	6	23.3	13.0	10.3	17.5
MANGAN	4	0.050L	0.030	0.020	0.040	10	0.050	0.030	0.020	0.037	6	0.050	0.030	0.020	0.040
NITRATE	4	6.80	2.50	4.30	4.17	11	42.0	1.60	40.4	7.88	6	9.60	2.58	7.02	4.61
PH	4	7.20	6.90	0.300	7.10	11	7.40	6.80	0.600	7.22	6	7.30	6.90	0.400	7.08
ORTHO P	4	8.81	4.57	4.24	7.06	10	8.81	5.71	3.10	7.37	6	6.33	3.59	2.74	5.21
TOTAL P	4	12.4	7.83	4.57	9.29	10	13.0	0.0	13.0	8.28	6	7.89	4.11	3.78	6.57
POTASS	4	18.0	10.0	8.00	13.6	11	15.0	11.0	4.00	13.3	6	14.0	8.80	5.20	11.7
SILICA	4	18.8	15.0	3.80	16.7	11	21.7	12.0	9.70	18.0	6	25.5	14.7	10.8	19.5
SODIUM	4	68.0	47.5	20.5	55.0	4	57.5	46.0	11.5	51.9	2	56.0	1.30	54.7	28.6
SULPHATE	4	88.0	50.0	38.0	65.6	11	88.2	58.4	29.8	69.5	5	77.0	62.5	14.5	71.0
ZINC	4	0.060	0.0	0.060	0.032	10	0.110	0.0	0.110	0.059	6	0.090	0.040	0.050	0.067
ORGANIC PARAMETERS															
BOD	2	40.0	16.0	24.0	28.0	11	41.0	10.0L	31.0	24.9	6	39.0	12.0	27.0	22.3
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 18 DUTCH DAIRIES ARMSTRONG

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	30.0	10.0	20.0	17.5	11	110.	5.00L	105.	22.7	7	10.0	5.00L	5.00	6.43
TURBID	4	220.	5.00	215.	110.	11	1600.	3.70	1596.	295.	7	150.	18.0	132.	67.9
FX SUS M	4	199.	100.	99.0	160.	11	1468.	96.0	1372.	517.	7	666.	178.	488.	360.
TO SUS M	4	174.	34.0	140.	122.	11	4213.	7.00	4206.	807.	7	615.	53.0	562.	225.
DISS 02	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	16.0	8.80	7.20	12.4	10	22.0	8.00	14.0	13.2	7	17.5	6.70	10.8	11.8
INORGANIC PARAMETERS															
ALK TOT	3	88.0	63.0	25.0	72.3	8	300.	0.0	300.	81.8	7	225.	0.0	225.	84.8
CALCIUM	4	36.2	28.5	7.70	32.3	11	121.	10.5	110.	61.9	7	60.8	23.6	37.2	39.6
CHLORIDE	4	55.0	2.80	52.2	25.8	4	162.	1.00	161.	55.1	0	0.0	0.0	0.0	0.0
COPPER	4	0.020	0.010L	0.010	0.015	9	0.030	0.0	0.030	0.020	7	0.050	0.010L	0.040	0.020
FLUORIDE	4	0.100L	0.080	0.020	0.095	3	0.160	0.100L	0.060	0.120	0	0.0	0.0	0.0	0.0
HARD TOT	4	102.	76.0	26.0	90.3	8	427.	88.9	338.	204.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	5	0.480	0.020L	0.460	0.216	7	0.780	0.0	0.780	0.249
LEAD	4	0.030	0.0	0.030	0.017	10	0.025	0.012	0.013	0.018	7	0.018	0.003L	0.015	0.009
MAGNES	4	2.90	1.20	1.70	2.37	11	49.1	2.20	46.9	13.9	7	28.7	2.70	26.0	9.33
MANGAN	4	0.050L	0.0	0.050	0.017	10	0.040	0.010	0.030	0.023	7	0.020	0.010L	0.010	0.011
NITRATE	4	0.290	0.020	0.270	0.160	9	0.270	0.0	0.270	0.054	7	0.110	0.020L	0.090	0.054
PH	3	6.80	6.40	0.400	6.63	10	7.50	3.90	3.60	5.70	7	8.00	4.60	3.40	6.60
ORTHO P	4	5.35	1.04	4.31	3.18	10	18.3	0.339	17.9	9.55	7	29.4	1.20	28.2	10.2
TOTAL P	4	8.48	1.50	6.98	4.98	10	30.7	0.489	30.2	14.6	6	26.2	5.51	20.7	12.4
POTASS	4	25.5	3.50	22.0	14.1	11	350.	1.90	348.	87.0	6	125.	2.80	122.	40.2
SILICA	4	40.4	13.7	26.7	27.8	8	130.	11.0	119.	42.9	7	39.0	12.0	27.0	23.2
SODIUM	4	38.0	9.50	28.5	21.9	3	88.0	4.00	84.0	50.8	0	0.0	0.0	0.0	0.0
SULPHATE	4	33.2	18.0	15.2	23.7	11	52.3	10.4	41.9	24.1	7	34.1	16.0	18.1	25.0
ZINC	4	0.020	0.0	0.020	0.010	10	0.090	0.0	0.090	0.052	7	0.120	0.020	0.100	0.060
ORGANIC PARAMETERS															
BOD	4	1275.	250.	1025.	839.	11	8200.G	50.0	8150.	2634.	7	3330.	120.	3210.	1120.
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

OUTFALL WATER QUALITY

STATION: O 19 ARMSTRONG LAGOONS ARMSTRONG

	1969					1970					1971				
	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN	NO. VAL	MAX CONC	MIN CONC	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	120.	40.0	80.0	66.2	7	100.	30.0	70.0	63.6	3	100.	40.0	60.0	61.7
TURBID	4	62.0	20.0	42.0	32.7	3	30.0	6.60	23.4	17.9	0	0.0	0.0	0.0	0.0
FX SUS M	4	256.	245.	11.0	250.	11	303.	201.	102.	259.	7	319.	243.	76.0	281.
TO SUS M	4	88.0	62.0	26.0	75.5	10	120.	9.00	111.	43.3	7	70.0	16.2	53.8	31.2
DISS O2	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
D.O. SAT	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
TEMP	4	15.0	2.20	12.8	9.05	11	24.0	1.00	23.0	11.0	7	24.0	1.00	23.0	11.6
INORGANIC PARAMETERS															
ALK TOT	4	249.	180.	69.0	214.	11	299.	134.	165.	242.	7	288.	226.	62.0	256.
CALCIUM	4	50.4	42.6	7.80	45.8	11	56.2	38.2	18.0	47.0	7	61.3	42.4	18.9	49.6
CHLORIDE	4	30.0	25.3	4.70	28.4	10	30.0	1.00	29.0	22.2	7	25.4	1.30	24.1	11.0
COPPER	4	0.040	0.012	0.028	0.024	10	0.050	0.020	0.030	0.030	7	0.060	0.010L	0.050	0.021
FLUORIDE	4	0.200	0.160	0.040	0.172	3	0.240	0.110	0.130	0.160	0	0.0	0.0	0.0	0.0
HARD TOT	4	185.	154.	31.0	172.	8	238.	117.	121.	186.	0	0.0	0.0	0.0	0.0
IRON	0	0.0	0.0	0.0	0.0	7	0.260	0.040	0.220	0.117	7	0.280	0.100	0.180	0.169
LEAD	4	0.040	0.0	0.040	0.015	10	0.023	0.007	0.016	0.013	7	0.013	0.003L	0.010	0.006
MAGNES	4	18.5	10.5	8.00	14.5	11	24.0	4.30	19.7	17.5	7	23.4	13.6	9.80	19.4
MANGAN	4	0.170	0.0	0.170	0.092	10	0.190	0.030	0.160	0.103	7	0.150	0.020	0.130	0.093
NITRATE	4	0.180	0.050	0.130	0.112	11	2.30	0.020	2.28	0.272	7	0.120	0.020L	0.100	0.069
PH	4	9.10	7.50	1.60	8.15	11	10.0G	7.10	2.90	7.86	7	9.60	6.90	2.70	7.60
ORTHO P	4	10.4	4.89	5.54	7.99	10	8.61	2.09	6.52	5.88	7	6.82	2.50	4.31	5.85
TOTAL P	4	10.4	6.20	4.24	8.40	10	10.0	3.26	6.75	7.52	7	11.6	4.34	7.27	7.25
POTASS	4	15.0	3.30	11.7	11.2	11	15.0	11.5	3.50	12.6	7	18.0	6.10	11.9	10.5
SILICA	4	31.4	20.0	11.4	23.6	11	37.5	14.2	23.3	23.3	7	25.0	14.6	10.4	19.7
SODIUM	4	48.0	37.5	10.5	42.4	3	40.0	36.0	4.00	38.0	0	0.0	0.0	0.0	0.0
SULPHATE	4	55.2	32.4	22.8	40.5	10	66.0	37.6	28.4	49.8	7	91.5	45.1	46.4	57.8
ZINC	4	0.020L	0.0	0.020	0.005	10	0.050	0.020L	0.030	0.033	7	0.170	0.008	0.162	0.050
ORGANIC PARAMETERS															
BOD	4	58.0	50.0	8.00	52.5	11	95.0	15.0	80.0	55.7	7	101.	50.0	51.0	75.0
TOC	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

NOTES: 1. AN L OR G AFTER A CONCENTRATION INDICATES THE RESULT IS LESS THAN (OR GREATER THAN) THE VALUE SHOWN.

2. ALL CONCENTRATIONS ARE IN MG/L EXCEPT FOR COLOUR, TURBIDITY AND PH (UNITS), DISSOLVED OXYGEN (PER CENT), AND TEMPERATURE (DEGREES CENTIGRADE).

APPENDIX D

STATISTICAL SUMMARY OF ANALYTICAL RESULTS

FOR 36 MINOR OUTFALLS

STATION: Oliver-Osoyoos Co-Op LOCATION: Osoyoos(Was MacLean-FitzP)					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	3			0	<5
TURBID	1				0.03
FX SUS M					
TO SUS M	3	12.4	<.5	12.2	4.41
DISS 02	3	10.0	8.7	1.3	9.4
COND.	4	1100	700	400	813
TEMP.	2	16°	0.4	15.6	8.2
INORGANIC PARAMETERS					
ALK TOT	4	255	214	41	2.42
CALCIUM	0				
CHLORIDE	2	148	9.3	138.7	7.9
COPPER	0				
FLUORIDE	0				
HARD TOT	1				427
IRON	0				
LEAD	0				
MAGNES	0				
MANGAN	0				
NITRATE	3	17.0	12.7	4.3	14.2
TOTAL N	3	17.0	13.22	3.78	43.52
PH	4	8.3	7.5	0.8	7.8
PRTHO P	1				0.014
TOTAL P	3	.026	.014	.012	.021
POTASS	1				4.6
SILICA	1				19.0
SODIUM	0				
SULPHATE	1				52.6
ZINC	0				
ORGANIC PARAMETERS					
BOD	0				
TOC	0				

STATION: Oliver Osoyoos Co-Op LOCATION: Osoyoos					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
	4			0	<5
	1				0.1
	2	0.4	<0.5	0	0.4
	1				8.1
	4	648	560	88	600
	2	23	22	1	22.5
	4	235	212	23	2.19
	1				70.8
	3	33.4	7.0	26.4	16.2
	0				
	1				0.31
	1				257
	0				
	0				
	0				
	0				
	4	3.95	2.6	1.35	3.26
	3	11.22	2.90	8.32	6.1
	3	7.7	7.3	.4	7.6
	3	0.078	0.032	.046	.056
	3	0.083	0.066	.017	.075
	1				4.7
	3	20.5	18.1	2.4	19.4
	1				31.0
	3	65.4	55.0	10.4	60.5
	0				
	1				10
	0				

STATION: International Curling Club LOCATION: Osoyoos					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
	0				
	0				
	1				<0.5
	1				7.9
	1				635
	1				18
	1				230
	0				
	0				
	0				
	0				
	0				
	0				
	1				4.8
	1				4.96
	1				7.3
	1				0.12
	0				
	0				
	0				
	1				18.9
	0				
	0				
	1				<10
	0				

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: Haynes Co-Op LOCATION: Oliver						STATION: MacLean-FitzPatrick LOCATION: Oliver					STATION: Penticton Sawmills LOCATION: Penticton				
	1969 - 1972					1969 - 1972					1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	4	5	1.0	4.0	4.3*	2			0	5	1				80
TURBID	2	350	0.8	349.2	59*	1				0.5	2	3.1	2.4	.7	2.75
FX SUS M															
TO SUS M	4	619	2.0	617	106*	2	1.2	0.5	0.7	.85	3	14.3	13.2	1.1	13.4
DISS 02	2	12.5	5.2	7.3	6.4*	2	11.4	9.3	2.1	10.3	3	14.6	5.5	9.1	9.9
COND.	4	1275	756	519	922*	2	1400	950	450	1175	4	350	259	91	289
TEMP.	4	17	7	10	13	2	13	7.5	5.5	9.75	4	11	1	10	7.9
INORGANIC PARAMETERS															
ALK TOT	4	548	319	229	369*	2	301	288	13	294	3	115	104	11	108
CALCIUM	2	111	72.0	39	104.5*	0					2	32.8	31.8	1.0	32.3
CHLORIDE	3	25	0	25	4.1*	0					3	3.5	1.8	1.7	2.3
COPPER	1				<0.01	0					1				<0.01
FLUORIDE	1				0.28	0					0				
HARD TOT	0					0					1				115
IRON	1				<0.02	0					1				0.30
LEAD	1				<0.03	0					1				0.003
MAGNES	1				23.1	0					1				7.9
MANGAN	1				0.03	0					1				0.10
NITRATE	4	3.2	0.11	3.09	1.79*	2	1.94	1.49	.5	1.74	3			0	0.02
TOTAL N	4	45.8	1.64	44.1	9.66*	2	2.21	1.89	.32	2.05	2	0.68	0.34	0.34	0.51
PH	4	8.6	7.1	1.5	7.8*	2	7.5	7.2	.3	7.3	4	7.4	6.1	1.3	6.8
ORTHO P	4	0.530	<.003	0.527	0.101*	1				.024	3	.163	.040	.123	.098
TOTAL P	3	3.40	<.003	3.397	0.675*	1				.027	4	.231	.129	.102	.179
POTASS	3	34.5	6.0	28.5	11.3*	0					2	3.6	3.5	0.1	3.55
SILICA	3	26.5	3.8	22.7	18.4*	1				18.8	1				10.8
SODIUM	2	201	23.0	178	50.3*	1				67.0	2	9.1	8.1	1.0	8.6
SULPHATE	2	126.0	88.2	37.8	107.1*	1				85.0	1				26.5
ZINC	1				0.02	0					1				0.02
ORGANIC PARAMETERS															
BOD	2	390	<10	>380	73.3*	0					3	25	<10	>15	18.6
TOC	0					0					0				

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: Pyramid Co-Op LOCATION: Penticton						STATION: Naramata Co-Op LOCATION: Naramata					STATION: S.M. Simpson Ltd. LOCATION: Kelowna				
	1969 - 1972					1969 - 1972					1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	1				<5	4	175	30	145	63*	0				
TURBID	2	6	1.2	4.8	1.28*	4	50	1.5	48.4	10.8*	0				
FX SUS M															
TO SUS M	1				6.9	4	192	<.5	>187	26.8*	0				
DISS 02	1				10.0	2	10.5	9.4	1.1	9.95*	2	8.8	6.5	2.3	8.7*
COND.	3	640	242	398	46.2*	4	360	76	284	506*	2	1500	350	1150	355*
TEMP.	2	10	9	1	9.5*	3	22	11	11	14.8*	2	48	24.5	23.5	25*
INORGANIC PARAMETERS															
ALK TOT	3	114	105	9	106*	4	163	23	140	73.2*	2	191	105	86	1.06*
CALCIUM	2	33.6	21.8	11.8	33.4*	3	10.4	7.4	3.0	854*	0				
CHLORIDE	3	56.0	1.3	54.7	36.0*	2	4.0	2.8	1.2	3.95*	0				
COPPER	0					0					1				0.01
FLUORIDE	1				.2	1				0.17	2	.45	.22	.23	0.23*
HARD TOT	1				118	2	28.4	24.0	4.4	24.2*	2	118	76	42	117*
IRON	0					0					0				
LEAD	0					0					1				.007
MAGNES	0					1				2.3	1				6.4
MANGAN	0					0					1				<.01
NITRATE	3	.03	.02	.01	.020*	4	0.11	.02	.09	.0596*	2	1.35	<.02	1.33	0.03*
TOTAL N	3	.79	.02	.77	.131*	4	.44	.297	.14	.577*	2	1.61	0.28	1.33	0.29*
PH	3			0	8.1	4	9.9	7.0	2.9	7.9*	2	10.4	8.3	2.1	8.4*
ORTHO P	3	.044	.012	.032	.028*	3	6.20	.012	6.1	.417*	2	0.131	0.011	0.12	0.012*
TOTAL P	3	.124	.024	.100	.073*	4	8.15	.024	8.12	.543*	2	5.20	0.044	5.156	.05*
POTASS	2	3.0	2.5	0.5	2.51*	3	2.9	1.3	1.6	2.13*	2	3.6	2.3	1.3	2.4*
SILICA	2	97	6.3	3.4	9.6	3	22.5	14.4	12.1	18.5*	1				13.2
SODIUM	2	18.5	9.5	9.0	18.4*	3	78	57.5	20.5	41.5*	2	128	9.7	118.3	9.8*
SULPHATE	1				29.6	3	14.4	6.0	8.4	7.92*	0				
ZINC	0					0					0				.09
ORGANIC PARAMETERS															
BOD	2			0	<10	3	80	<10	70	20.7*	0				
TOC	0					0					0				

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: Summerland Arena LOCATION: Summerland					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	0				
TURBID	1				0.5
FX SUS M	0				
TO SUS M	1				<0.5
DISS 02	1				8.1
COND.	1				160
TEMP.	1				15
INORGANIC PARAMETERS					
ALK TOT	0				
CALCIUM	0				
CHLORIDE	1				1.3
COPPER	0				
FLUORIDE	0				
HARD TOT	0				
IRON	0				
LEAD	0				
MAGNES	0				
MANGAN	0				
NITRATE	1				0.04
TOTAL N	1				0.16
PH	1				7.9
ORTHO P	0				
TOTAL P	1				0.003
POTASS	0				
SILICA	0				
SODIUM	1				4.3
SULPHATE	0				
ZINC	0				
ORGANIC PARAMETERS					
BOD	1				<10
TOC	0				

STATION: Summerland Sweets LOCATION: Summerland					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	1				50
TURBID	1				32
FX SUS M	1				38
TO SUS M	2	12	10.0	2	11
DISS 02	2			0	180
COND.	2	19.0	8	11	13.5
TEMP.					
INORGANIC PARAMETERS					
ALK TOT	2	58.5	39.5	19	49
CALCIUM	1				19.8
CHLORIDE	1				7.8
COPPER	0				
FLUORIDE	0				
HARD TOT	0				
IRON	0				
LEAD	0				
MAGNES	0				
MANGAN	0				
NITRATE	2	0.47	0.28	.19	.375
TOTAL N	2	4.22	0.55	3.67	2.38
PH	2	6.8	6.2	.6	6.5
ORTHO P	1				.004
TOTAL P	2	.655	0.101	.554	.378
POTASS	0				
SILICA	1				17.2
SODIUM	1				4.6
SULPHATE	1				9.2
ZINC	0				
ORGANIC PARAMETERS					
BOD	2	557	255	302	406
TOC	0				

STATION: Westbank Orchards LOCATION: Westbank					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	2			0	<5
TURBID	1				9.7
FX SUS M	0				
TO SUS M	2	14.2	6.5	7.7	10.35
DISS 02	1				11.6
COND.	1				700
TEMP.	1				13.5
INORGANIC PARAMETERS					
ALK TOT	2	263	214	49	238.5
CALCIUM	0				
CHLORIDE	0				
COPPER	0				
FLUORIDE	0				
HARD TOT	1				298
IRON	0				
LEAD	0				
MAGNES	0				
MANGAN	0				
NITRATE	1				3.64
TOTAL N	1				4.01
PH	1				7.8
ORTHO P	0				
TOTAL P	0				
POTASS	0				
SILICA	0				
SODIUM	0				
SULPHATE	0				
ZINC	0				
ORGANIC PARAMETERS					
BOD	0				
TOC	0				

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: Kelowna Memorial Area LOCATION: Kelowna						STATION: Cascade Co-Op LOCATION: Kelowna					STATION: Calona Distillers LOCATION: Rutland				
	1969 - 1972					1969 - 1972					1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	1				<5	2	200	<5	195	27*	1				<5
TURBID	0					1				1.7	0				
FX SUS M															
TO SUS M	1				1.5	2	60	16.7	43.3	21.5*	2	14	6.2	7.8	10.1
DISS 02	1				14.6	1				4.0	0				
COND.	2	260	255	5	257	2	1296	450	846	1202*	1				351
TEMP.	2	17.5	14.5	3	16.0	2	11	6	5	8.5*	2	37	23	14	30
INORGANIC PARAMETERS															
ALK TOT	2	108	105	3	106.5	2	498	160		460*	1				180
CALCIUM	2	32.6	31.6	1	32.1	1				70.9	1				44.2
CHLORIDE	1				2.4	0					1				0.8
COPPER	0					0					1				<0.01
FLUORIDE	0					0					1				0.27
HARD TOT	2	118	116	1	117	1				383	1				161
IRON	0					1				NIL	1				<.02
LEAD	0					1				.005	1				.003
MAGNES	0					1				49.9	1				12.2
MANGAN	0					1				.5	1				.03
NITRATE	1				.02	2	.05	.02	.03	.035*	1				0.19
TOTAL N	1				.09	2	3.53	.035	3.51	.703*	1				0.50
PH	2	8.5	8.1	.4	8.3	2	7.5	7.0	.5	7.4*	1				8.5
ORTHO P	0					2	0.347	0.161	.186	.182*	1				.204
TOTAL P	1				.027	1				.187	1				.240
POTASS	0					1				5.9	1				3.7
SILICA	1				1.8	0									
SODIUM	0					1				160					
SULPHATE	1				28.8	1				221	1				9.2
ZINC	0					1				.02	1				.02
ORGANIC PARAMETERS															
BOD	0					2	175	<10	165	27.3*	2	20	<10	10	<15
TOC	0					0									

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: MacLean-Fitzpatrick LOCATION: Rutland						STATION: Kelowna Growers Exchange LOCATION: Rutland					STATION: Vernon Fruit Union LOCATION: Oyama				
	1969 - 1972					1969 - 1972					1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	3	140	5	135	52	2	60	5	55	6.72*	2			0	<5
TURBID	1				18	0					0				
FX SUS M	0					0					0				
TO SUS M	3	37	2.9	34.1	17.9	2	33	2.9	30.1	3.84*	1				2.3
DISS 02	1				14.0	1				346	2			0	4.5
COND.	3	580	475	105	512	2	529	460	69	527*	4	680	551	129	614
TEMP.	3	11.5	6.0	5.5	8	2	8.0	3.0	5.0	7.84*	4	17.0	13.5	3.5	15.9
INORGANIC PARAMETERS															
ALK TOT	3	214	204	10	208	2	217	212	5	216*	4	324	230	94	256
CALCIUM	1				29.6	1				67.4	0				
CHLORIDE	0					1				2.9	3	2.8	NIL	2.8	1.8
COPPER	0					1				<0.01	2			0	<.01
FLUORIDE	0					1				0.19	0				
HARD TOT	0					0					2	225	220	5	222
IRON	0					1				NIL	2			0	NIL
LEAD	0					1				0.004	2			0	0.004
MAGNES	0					1				18.6	2	15.8	14.6	1.2	15.2
MANGAN	0					1				<0.01	2	0.36	0.34	0.02	0.35
NITRATE	3	1.76	0.14	1.62	0.7	2	1.75	0.27	1.48	1.70*	4	0.04	0.02	.02	.035
TOTAL N	3	2.25	0.57	1.65	1.64	2	3.03	2.05	0.98	2.08*	4	.90	0.05	.85	0.465
PH	3	8.4	8.2	0.2	8.2	2	8.2	7.9	0.3	7.91*	4	7.9	7.4	0.5	7.07
ORTHO P.	1				11.7	1				0.152	4	0.025	0.003	.022	.011
TOTAL P	1				12.35	2	.252	.175	.077	.178*	2	.047	.008	.039	.014
POTASS	1				9.0	1				3.8	2	4.6	4.5	0.1	4.55
SILICA	0					0					3	28.4	19.7	8.7	22.9
SODIUM	2	63	15.5	47.5	39.2	0					1				5.5
SULPHATE	1				29.0	0					1				51.0
ZINC	0					1				0.006	2			0	0.04
ORGANIC PARAMETERS															
BOD	1				99	1				22	0				
TOC	0										0				

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: Doyle Ave.Storm Sewer LOCATION: Kelowna					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	1				5
TURBID	1				1.2
FX SUS M	0				
TO SUS M	1				3
DISS 02	0				
COND.	1				280
TEMP.	1				18
INORGANIC PARAMETERS					
ALK TOT	1				108
CALCIUM	1				32.2
CHLORIDE	1				1.7
COPPER	1				NIL
FLUORIDE	1				0.24
HARD TOT	1				117
IRON	0				
LEAD	1				<.02
MAGNES	1				9.0
MANGAN	1				NIL
NITRATE	1				<.02
TOTAL N	0				
PH	1				8.0
ORTHO P	1				<.02
TOTAL P	1				<.02
POTASS	1				2.3
SILICA	1				3.7
SODIUM	1				8.7
SULPHATE	1				26.0
ZINC	1				<.02
ORGANIC PARAMETERS					
BOD	1				<10
TOC	0				

STATION: Hiram Walker & Sons LOCATION: Winfield					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	9			0	<5
TURBID	12	1.5	0.3	1.2	0.78
FX SUS M	0				
TO SUS M	9	2.8	0.5	2.3	1.23
DISS 02	12	13.4	7.3	6.1	10.22
COND.	14	280	260	20	2.73
TEMP.	14	24	8	16	16.4
INORGANIC PARAMETERS					
ALK TOT	13	119	107	12	109.3
CALCIUM	5	75.6	32.2	43.4	41.2
CHLORIDE	0				
COPPER	0				
FLUORIDE	3	0.23	0.19	0.04	0.21
HARD TOT	10	285	117	168	135.6
IRON	0				
LEAD	0				
MAGNES	0				
MANGAN	0				
NITRATE	6	2.43	<0.02	2.41	0.44
TOTAL N	8	2.47	0.12	2.35	0.56
PH	16	8.6	7.8	0.8	8.21
ORTHO P	5	0.008	0.003	0.005	.005
TOTAL P	8	0.033	0.006	0.027	.017
POTASS	6	5.4	2.1	3.3	2.8
SILICA	9	19.4	2.7	16.7	7.44
SODIUM	15	44.0	6.8	37.2	11.84
SULPHATE	1				27.0
ZINC	0				
ORGANIC PARAMETERS					
BOD	9			0	10
TOC	2	8.0	3.0	5.0	5.5

STATION: Tom Collins Dairy Farm LOCATION: Lavington					
	1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS					
COLOUR	9	110	<5	105	26.1
TURBID	13	56	3	53	20.7
FX SUS M	0				
TO SUS M	15	221	12.3	208.7	66.1
DISS 02	12	12.8	6.6	6.2	984
COND.	15	1782	600	1182	762
TEMP.	16	16	3.5	12.5	10.7
INORGANIC PARAMETERS					
ALK TOT	8	695	285	410	373
CALCIUM	8	95.2	82.4	12.8	88.8
CHLORIDE	2	15.1	1.8	13.3	8.45
COPPER	0				
FLUORIDE	0				
HARD TOT	2	303	181	122	242
IRON	1				<.1
LEAD	0				
MAGNES	0				
MANGAN	0				
NITRATE	16	6.3	0.07	6.23	3.8
TOTAL N	15	17.06	2.62	14.44	8.13
PH	16	8.4	7.1	1.3	7.86
ORTHO P	15	114	0.059	114	6.22
TOTAL P	16	214	0.058	214	18.03
POTASS	8	21.0	8.5	12.5	13.5
SILICA	0				
SODIUM	1				420
SULPHATE	9	162	19	143	41.6
ZINC	0				
ORGANIC PARAMETERS					
BOD	14	79	40	69	14.2
TOC	3	93	15	78	56

OKANAGAN BASIN STUDY

OUTFALL TASK 130

STATION: Coldstream Ranch LOCATION: Coldstream						STATION: Inland Ice & Cold Storage Ltd. LOCATION: Vernon					STATION: Hawkins Dairy Farm LOCATION: Armstrong				
	1969 - 1972					1969 - 1972					1969 - 1972				
	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN	NO. VAL.	MAX. CONC.	MIN. CONC.	RANGE	MEAN
PHYSICAL PARAMETERS															
COLOUR	8	1500	10	1490	329	1				5	0				
TURBID	25	5200	1.6	5200	555.3	1				7.0	2	55	3.2	51.8	29.1
FX SUS M	0					0					0				
TO SUS M	26	35695	1.4	35695	3059	0					2	143	10.5	132.5	76.7
DISS 02	26	9.0	4.2	4.8	6.2	1				9.0	2	6.5	5.7	.8	6.1
COND.	26	7000	60	6940	1986	1				600	2	2600	580	2020	1590
TEMP.	26	43	14	29	26.5	1				21	2	46	42	4	44
INORGANIC PARAMETERS															
ALK TOT	24	4850	0	4850	836	1				205	2	1146	234	912	690
CALCIUM	6	105	4	101	22.7	0					0				
CHLORIDE	6	38.2	4.1	34.1	65.2	0					1				33.6
COPPER	0					0					0				
FLUORIDE	0					0					0				
HARD TOT	4	305	21.4	283.6	95.3	0					0				
IRON	0					0					0				
LEAD	0					0					0				
MAGNES	5	2.4	1.87	0.53	3.84	0					0				
MANGAN	0					0					0				
NITRATE	23	1.46	.02	1.44	.266	1				1.67	2	0.3	.08	.22	.19
TOTAL N	24	768	0.17	767.8	94.3	1				2.25	2	25.66	0.75	25	13.2
PH	25	12.6	2.5	10.1	8.55	1				7.8	2	9.5	8.0	1.5	8.75
ORTHO P	11	217	0.124	216.8	38.6	0					2	135	2.6	132.4	68.8
TOTAL P	26	360	0.053	360	107.4	1				0.045	2	293	5.18	287.8	149.1
POTASS	5	140	1.2	139.8	30.5	0					0				
SILICA	0					0					0				
SODIUM	5	1285	56		343.2	0					0				
SULPHATE	0					0					0				
ZINC	0					0					0				
ORGANIC PARAMETERS															
BOD	25	30300	10	30300	4371	1				10	2	189	10	179	99.5
TOC	20	8689	15	8674	1571	0					0				

APPENDIX E

DATA TABLES

NUTRIENT LOADINGS BY GROUNDWATER

TRANSPORT

E.1 - Agricultural Cultivated Land Distribution and Subdivision Classification.

E.2 - Agricultural Animal Distribution and Corresponding Potential Nutrient Loading

E.3 - Boundary Condition Distribution Corresponding to Total Cultivated Acreage.

E.4 - Irrigation Water Distribution and Corresponding Potential Nutrient Loading

E.5 - Fertilizer Distribution and Corresponding Potential Nutrient Loading

E.6 -- Annual Nitrogen and Phosphorus Production of Livestock

E.7 - Potential Nutrient Loading "Other Sources"

E.8 - Nutrient Contribution by "Other Sources" in Vicinity of Source

E.9 - Virgin Groundwater Quantity

E.10 - Water Quality for Groundwater and Surface Stream

E.11 - Estimation of Net Stream Discharge

APPENDIX E.1

AGRICULTURAL CULTIVATED LAND DISTRIBUTION & SUBDIVISION CLASSIFICATION

BASIN	SUB DIV	SUBDIVISION DESCRIPTION	TOTAL CULTIVATED ACREAGE				TOTAL
			P*1	G*2	A*3	H*4	
I	1T1*	Vernon Cr. - Clark Cr.	-	-	-	-	-
Ellison-Wood	1D1	Winfield Area-Wood Lake	600	930	-	5	1,535
Lake	1D2	Wood Lake - West	600	1,650	-	25	2,275
	TOTAL		1,200	2,580	-	30	3,810
II							
Kalamalka Lake	2T1	Oymaha Creek	30	-	-	-	30
	2T2	Coldstream Creek	3,800	740	-	225	4,765
	2D1	Oyama	45	90	-	-	135
	2D2	Kalamalka Lake - West	300	160	-	-	460
	2D3	Kalamalka Lake - East	135	145	-	-	280
	2D4	Kalamalka Lake - North	-	30	-	-	30
	TOTAL		4,310	1,165	-	225	5,700
III	3T1	Vernon	2,540	480	-	110	3,130
Okanagan North	3T2	B.X. Creek - Lower	1,000	90	-	40	1,130
	3T3	B.X. Creek - Upper	725	350	-	15	1,090
	3T4	Greennow Creek	5	-	20	-	25
	3T5	Deep Creek	3,115	35	15,385	875	19,410
	3T6	Irish Creek	440	-	-	5	445
	3T7	Newport Creek	30	-	-	-	30
	3T8	Equesis Creek	300	-	-	10	310
	3T9	Nashwito Creek	35	-	-	10	45
	3T10	Whiteman Creek	50	-	-	-	50
	3T11	Shorts Creek	65	5	-	-	70
	3D1	O.K. Lake-Ellison Park	10	-	-	-	10
	3D2	Okanagan Landing	820	-	-	-	820
	3D3	O.K. Lake-Vernon West	900	40	-	10	950
	3D4	Swan Lake - West	850	35	130	50	1,065
	3D5	Swan Lake - East	775	650	15	-	1,440
	3D6	O.K. Lake - North Tip	125	-	-	-	125
	3D7	O.K. Lake - North Arm West	395	-	-	-	395
	3D8	O.K. Lake - North Arm West	360	-	-	50	410
	3D9	O.K. Lake - North Arm West	230	-	-	25	255
	3D10	O.K. Lake - North Arm West	75	5	-	25	105
	3D11	O.K. Lake - Ewing	30	30	-	-	60
	3D12	O.K. Lake - Nahun	20				20
	TOTAL		12,895	1,720	15,550	1,225	31,390

APPENDIX E.1

AGRICULTURAL CULTIVATED LAND DISTRIBUTION & SUBDIVISION CLASSIFICATION (cont'd)

BASIN	SUB DIV	SUBDIVISION DESCRIPTION	TOTAL CULTIVATED ACREAGE				TOTAL
			P*1	G*2	A*3	H*4	
IV	4T1	Kelowna Creek	3,615	2,740	-	395	6,750
Okanagan Central	4T2	McDougal Creek	150	220	-	35	405
	4T3	West Bank Creek	355	650	-	10	1,015
	4T4	Mission Creek	2,300	3,200	-	75	5,575
	4T5	Trepanier Creek	95	25	-	-	120
	4T6	Bellevue Creek	160	75	-	5	240
	4T7	Peachland Creek	15	5	-	-	20
	4T8	Powers Creek	235	245	-	20	500
	4D1	Okanagan Centre	1,200	2,570	-	10	3,780
	4D2	O.K. Lake Westside	235	1,425	-	50	1,710
	4D3	O.K. Lake Kelowna South	500	275	-	20	795
	4D4	O.K. Lake Mt.Boucherie S.	70	115	-	-	185
	4D5	O.K.Lake O.K. Mission N.	400	280	-	160	840
	4D6	O.K. Lake - Gellatly	20	375	-	-	395
	4D7	O.K. Lake - Drought Cr.	15	185	-	-	200
	4D8	O.K. Lake - Peachland	90	490	-	-	580
	4U1	Terrace Cr. - Lambly Cr.	-	25	-	-	25
	4U2	Lebanon Cr. - Deeper Cr.	90	320	-	20	430
	TOTAL		9,545	13,220	-	800	23,565
V	5T1	Trout Creek	980	1,290	-	30	2,300
Okanagan South	5T2	Naramata Creek	15	255	-	-	270
	5T3	Penticton Creek	55	130	-	-	185
	5D1	Eneas Creek	425	2,440	-	20	2,885
	5D2	O.K. Lk. Niggertoe Mtn.	45	135	-	5	185
	5D3	O.K. Lk. - Penticton N.	90	1,855	-	15	1,960
	5D4	Penticton Municipality	-	-	-	-	-
	5U1	O.K. Lk - Okanagan Mtn.	60	190	-	10	260
	TOTAL		1,670	6,295	-	80	8,045
VI	6T1	Ellis Creek	-	35	-	-	35
Skaha Lake	6T2	Shingle Ck/Shafford Cr.	990	-	-	-	990
	6T3	McLean Creek	380	130	-	-	510
	6D1	Skaha Lk. - Mt. Christie	110	985	-	-	1,095
	6D2	Skaha Lk. - Kaleden	130	550	-	65	745
	6D3	Skaha Lk. - O.K. Falls	165	170	-	-	335
	6D4	Penticton West	-	200	-	-	200
	6D5	Penticton South	-	-	-	-	-
	TOTAL		1,775	2,070	-	65	3,910

APPENDIX E.1

AGRICULTURAL CULTIVATED LAND DISTRIBUTION & SUBDIVISION CLASSIFICATION (cont'd)

BASIN	SUB DIV	SUBDIVISION DESCRIPTION	TOTAL CULTIVATED ACREAGE				TOTAL
			P*1	G*2	A*3	H*4	
VII Vaseux Lake	7T1	Shuttleworth Creek	95	65	-	-	160
	7D1	Vaseux Lake East	340	100	-	-	440
	7D2	Vaseux Lake West	40	35	-	-	75
	TOTAL		475	200			675
VIII Okanagan River	8T1	Park Rill	400	200	-	30	630
	8T2	Vaseux	-	25	-	-	25
	8T3	Testalinden	-	250	-	-	250
	8T4	Wolfcub Creek	110	-	-	-	110
	8D1	O.K. River East	65	55	25	-	145
	8D2	O.K. River West	155	200	-	250	605
	8D3	Tuglnuit Lake	85	190	-	350	625
	8D4	Oliver West	245	1,660	-	30	1,935
	8D5	Oliver East	10	225	-	-	235
	TOTAL		1,070	2,805	25	660	4,560
IX Osoyoos Lake	9T1	Inkaneep Creek	200	-	-	-	200
	9T2	Haynes Creek	10	220	-	-	230
	9T3	Nine Mile Creek	2,300	100	-	-	2,400
	9D1	Deadman Lake	155	350	-	-	505
	9D2	Oosyoos Lake North-East	-	-	-	-	-
	9D3	Osoyoos Lake West	80	550	-	-	630
	9D4	Osoyoos Lake Mt. Kruger	380	2,065	-	30	2,475
	9D5	Anarchist Lookout	-	100	-	-	100
	TOTAL		3,125	3,385	-	30	6,540
	TOTAL CULTIVATED ACREAGE		36,065	33,440	15,575	3,115	88,195

*1 Improved Pasture and Forage Crops - hay,alfalfa, corn silage and other forage crops.

*2 Orchards and Vineyards - tree fruits and grapes.

*3 Cropland - oilseeds, sugar beets, potatoes, field vegetables, associated fallow and land in the process of being cleared for cultivation.

*4 Horticulture - vegetables, market gardens, nurseries, flowers, and sod farms.

APPENDIX E.2

AGRICULTURAL ANIMAL DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING

BASIN	SUB DIV	ANIMAL POPULATION						POTENTIAL NUTRIENT LOADING - POUNDS	
		BEEF		DAIRY	POULTRY	HOGS	MISC.	TOTAL NITROGEN	TOTAL PHOSPHORUS
		#	MOS.	#	#	#	#		
I	1D1	30-15	6		5,000			14,167	2,116
	1D2	781-515	6					89,077	5,686
	TOTAL	811-530			5,000			103,244	7,802
II	2T1	160-60	6				200	19,400	1,506
	2T2	244-35	12	459-222		5	59		
		1050-832	6					252,286	20,284
	2D3			29-19				5,059	606
	TOTAL	1434-927		488-241		5	259	276,745	22,396
III	3T1	140-35	6	115-55				33,092	3,154
		5-	12						
	3T2			56				7,358	879
	3T3	400-200	12	20					
		350-150	6					124,858	8,116
	3T5	527-70	6						
		365-121	12	277-198	3,450	2,400		221,962	23,499
	3T8	500-	12					85,775	5,475
	3T10	300-	6					25,733	1,642
	3D2	120-	6					10,293	657
	3D3	250-105	6					25,947	1,656
	3D4	27-4	12	30-10				9,574	867
	3D5	118	6					10,122	646
	3D6	100-	6					8,578	548
	3D8	400-200	6					42,888	2,738
	TOTAL	3602-885		498-263	3,450	2,400		606,180	49,877
IV	4T1	266-62	12	36-21					
		150-	6					69,927	4,804
	4T3				10,000			21,900	3,822
	4T4	235-60	6	30-22		225			
		30	12					37,370	3,224
	4T5	24-10	12					4,975	318
	4T7	40	12					6,862	438
	4T8	40	12		4,000			15,622	1,967
	4D1	186-180	6	68-56	12,000			62,568	7,605
	4D5			30-15			50	13,505	1,136
	TOTAL	971-312		164-114	26,000	225	50	232,730	23,314

APPENDIX E.2

AGRICULTURAL ANIMAL DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING (cont'd)

BASIN	SUB DIV	ANIMAL POPULATION						POTENTIAL NUTRIENT LOADING - POUNDS	
		BEEF		DAIRY	POULTRY	HOGS	MISC.		
		#	MOS.	#	#	#	#	TOTAL NITROGEN	TOTAL PHOSPHORUS
V	5T1	240-10			7,000			57,359	5,358
	5D1	11	12						
		90	6		3,500		90	18,093	2,056
	5D3	25	6					2,144	137
	TOTAL	366-10			10,500		90	77,596	7,551
VI	6T2	1175-300	12					227,304	14,509
	6T3	365-50	6					33,452	2,135
	6D2	360	6					30,879	1,971
	6D3	298-287	6					37,870	2,417
	TOTAL	2198-637						329,505	21,032
VII	7D1	205	6					17,584	1,123
	TOTAL	205						17,584	1,123
VIII	8T1	960	12					164,688	10,512
	8D3				65,000			667,950	116,571
	TOTAL	960			65,000			832,638	127,083
IX	9T2	300-300	6					38,599	2,464
	9D1	400	6					34,310	2,190
	9D4	150	6					12,866	821
	TOTAL	850-300						85,775	5,475
							TOTAL	2,561,997	265,653

APPENDIX E.3

BOUNDARY CONDITION DISTRIBUTION CORRESPONDING TO TOTAL CULTIVATED ACREAGE

BASIN	SUB DIV	COMBINATIONS OF SOIL TYPE & DEPTH TO GROUNDWATER*										TOTAL ACREAGE
		FS	FI	FD	MS	MI	MD	CS	CI	CD	MKS	
I	1D1	38	4		114	153	81	918	156	59	5	1,535
	1D2		286	34	9	116		200	1615	10	5	2,275
II	2T1						30					30
	2T2	110	766		297	1741	1087	445	319			4,765
	2D1		60			50					25	135
	2D2		15		28				417			460
	2D3		61			173				46		280
	2D4					30						30
III	3T1	316	1155	255	305	965	29		105			3,130
	3T2		668			337			125			1,130
	3T3	55	135	4	328	247	173	97	51			1,090
	3T4								25			25
	3T5	15	6521	563	57	4045	169	66	5078	2229	667	19,410
	3T6		30			301			35	70	9	445
	3T7								30			30
	3T8					10			300			310
	3T9								45			45
	3T10								50			50
	3T11					70						70
	3D1		10									10
	3D2		335			330			155			820
	3D3		18	325		547			60			950
	3D4	196	551		54	5	4		250			1,065
	3D5	235	14	3	321	470		335	62			1,440
	3D6		20			105						125
	3D7		105				285		5			395
	3D8					410						410
	3D9					225			30			255
	3D10								105			105
	3D11								60			60
	3D12					20						20
IV	4T1	47	1522	39		311		199	4633			6,750
	4T2					298			107			405
	4T3		291			200			524			1,015
	4T4		527	596		440	41		3936	35		5,575
	4T5								120			120
	4T6								220	20		240

APPENDIX E.3

BOUNDARY CONDITION DISTRIBUTION CORRESPONDING TO TOTAL CULTIVATED ACREAGE (cont'd)

BASIN	SUB DIV	COMBINATIONS OF SOIL TYPE & DEPTH TO GROUNDWATER*										TOTAL ACREAGE
		FS	FI	FD	MS	MI	MD	CS	CI	CD	MKS	
IV	4T7								20			20
	4T8		135			122			243			500
	4D1		2743						1037			3,780
	4D2		760			760			190			1,710
	4D3		320			360			115			795
	4D4		165						20			185
	4D5					154			640	46		840
	4D6		387						8			395
	4D7		25			65			110			200
	4D8					40			540			580
	4U1								25			25
	4U2					30			400			430
V	5T1				16	429		129	1505	221		2,300
	5T2					100			170			270
	5T3								185			185
	5D1					900		1650	335			2,885
	5D2					145			40			185
	5D3					1960						1,960
	5U1					260						260
VI	6T1								35			35
	6T2		120			85			690		95	990
	6T3								510			510
	6D1					495			600			1,095
	6D2								745			745
	6D3					67		35	233			335
	6D4					200						200
VII	7T1					117			43			160
	7D1					165			275			440
	7D2								35		40	75
VIII	8T1			87		30		22	490			630
	8T2								25			25
	8T3								250			250
	8T4								110			110
	8D1					90			55			145
	8D2				65	50		20	470			605
	8D3		44		36	80	15	115	335			625

APPENDIX E.3

BOUNDARY CONDITION DISTRIBUTION CORRESPONDING TO TOTAL CULTIVATED ACREAGE (cont'd)

BASIN	SUB DIV	COMBINATIONS OF SOIL TYPE & DEPTH TO GROUNDWATER*									TOTAL ACREAGE
		FS	FI	FD	MS	MI	MD	CS	CI	CD	MKS	
VIII	8D4		313		195	432			995			1,935
	8D5							150	85			235
IX	9T1								200			200
	9T2							90	140			230
	9D1		450						55			505
	9D3								630			630
	9D4		338		5	435		150	1327	220		2,475
	9D5							10	10	80		100

ABBREVIATIONS*

FS - Fine Soil, shallow depth to groundwater (less than 6 feet)
FI - Fine Soil, Intermediate depth to groundwater (6 to 30 feet)
FD - Fine Soil, Deep depth to Groundwater (over 30 inches)
MS - Medium Soil, Shallow depth to groundwater (less than 6 feet)
MI - Medium Soil, Intermediate depth to groundwater (6 to 30 feet)
MD - Medium Soil, Deep depth to groundwater (over 30 inches)
CS - Coarse Soil, Shallow depth to groundwater (less than 6 feet)
CI - Coarse Soil, Intermediate depth to groundwater (6 to 30 feet)
CD - Coarse Soil, Deep depth to groundwater (over 30 inches)
MKS - Muck Soil Shallow depth to groundwater (less than 6 feet)

APPENDIX E.4

IRRIGATION WATER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING

BASIN	SUB-DIVISION	WATER SOURCE	WATER QUANTITY				WATER QUALITY		POTENTIAL NUTRIENT LOADING POUNDS	
			ACRES	PERCENTAGE OF CULTIVATED	APPLICATION RATE in	ESTIMATED VOLUME ACRE-FEET	CONCENTRATION TOTAL NITROGEN (N)	CONCENTRATION TOTAL PHOSPHORUS (P)	TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)
I	1D1	Vernon Cr.	255		2.23	569	.998	.266	1,545	412
		Well	60		2.75	165	.42	.011	188	5
		Oyama	815		2.25	1,834	.452	.031	2,254	155
			1,130	73.6		2,568			3,987	572
	1D2	Oyama Well	315		2.75	866	.42	.011	989	26
		Vernon Cr.	1,415		2.23	3,155	.998	.04	8,564	343
		Kelowna Cr.	50		2.05	103	.16	.085	45	24
		Wood Lake	38		2.75	105	.751	.043	214	16
		Vernon Cr.	432		2.23	972	.392	.056	1,036	148
			2,250	98.6		5,201			10,848	557
	TOTAL		3,380			7,769			14,835	1,129
II	2T1	Oyama Cr.	30	100	2.25	68	.452	.031	84	6
	2T2	Duteau Cr.	3,792	79.6	2.2	8,722	.1	.01	2,372	237
	2D1	Oyama Well	65		2.75	179	.545	.007	265	3
		Wood Lake	50		2.75	138	.751	.043	282	16
			115	85.2		317			547	19
	2D2	Oyama Well	145		2.75	399	.545	.007	591	8
		Kalamalka Lk.	137		2.2	301	.233	.014	191	11
			282	61.3		700			782	19
	2D3	Duteau Cr.	247	88.2	2.2	568	.1	.01	154	15
	2D4	Duteua Cr.	30	100	2.2	66	.1	.01	18	2
	TOTAL		4,496			10,441			3,957	298
III	3T1	Duteau Cr.	1,936		2.2	4,453	.1	.01	1,211	121
		Vernon Cr.	260		2.23	580	.233	.014	368	22
			2,196	70.2		5,033			1,579	143
	3T2	Duteau Cr.	891	78.8	2.2	2,049	.1	.01	557	56
	3T3	Duteau Cr.	800	73.4	2.2	1,840	.1	.01	500	50
	3T4	Duteau Cr.	10	40	2.2	22	.1	.01	6	1
	3T5	Duteau Cr.	219		2.2	504	.1	.01	137	14
		Deep Cr.	821		2.2	1,806	.94	.65	4,618	3,001
			1,040	5.4		2,310			4,755	3,015
	3T6	Irish Creek	60	13.5	2.2	132	.42	.057	150	20
	3T7	Newport Cr.	30	100	2.2	66	.42	.109	75	19
	3T8	Equesis Cr.	256	82.6	3.3	845	.42	.057	965	131
	3T9	Naswito	45	100	3.3	148	.12	.109	48	44
	3T11	Shorts Cr.	70	100	3.3	231	.054	.02	34	13
	3D2	Vernon Cr.	30	3.6	2.23	67	.233	.014	42	3
	3D3	Duteau Cr.	123	12.9	2.2	283	.1	.01	77	8
	3D4	Duteau Cr.	586	55	2.2	1,348	.1	.01	367	37
	3D5	Duteau Cr.	1,217	85.2	2.2	2,799	.1	.01	761	76
	3D8	Equesis Cr.	347	84.6	3.3	1,145	.42	.057	1,308	177
	3D9	Naswito	25	9.8	3.3	83	.12	.109	27	25
	3D10	Whiteman	105	100	2.43	255	.127	.033	88	23
	3D11	Shorts Cr.	55	91.6	3.3	182	.054	.02	27	10
	3D12	Shorts Cr.	20	100	3.3	66	.054	.02	10	4
	TOTAL		7,906			18,904			11,376	3,855

APPENDIX E.4

IRRIGATION WATER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING (cont'd)

BASIN	SUB-DIVISION	WATER SOURCE	WATER QUANTITY				WATER QUALITY		POTENTIAL NUTRIENT LOADING POUNDS	
			ACRES	PERCENTAGE OF CULTIVATED	APPLICATION RATE in	ESTIMATED VOLUME ACRE-FEET	CONCENTRATION TOTAL NITROGEN (N)	CONCENTRATION TOTAL PHOSPHORUS (P)	TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)
IV	4T1	Kelowna	1,012		2.05	2,075	.16	.085	903	480
		Mission	3,700		2.3	8,510	.110	.015	2,546	347
		Scotty	750		2.3	1,725	.110	.015	516	70
			5,462	80.9		12,310			3,965	897
	4T2	Lambley	30		2.8	84	.119	.018	27	4
		McDougal	186		3.3	614	.190	.069	317	115
			216	53.3		698			344	119
	4T3	Powers Cr.	680		2.85	1,952	.47	.025	2,495	133
		Westbank	335		2.3	771	.642	.088	1,346	185
			1,015	100		2,723			3,841	318
	4T4	Mission	5,170	92.7	2.3	11,891	.110	.015	3,584	489
	4T5	Trepanier	120	100	4.6	487	.067	.007	89	9
	4T6	Bellevue	80		2.18	174	.374	.028	177	13
		O.K. Lake	160		2.7	432	.1	.04	118	47
			240	100		606			295	60
	4T7	Peachland Ck.	20	100	3.53	71	.388	.025	75	5
	4T8	Powers Cr.	300	60	2.85	855	.47	.025	1,093	58
	4D1	Vernon Cr.	710		2.23	1,583	.168	.075	723	323
		Kelowna Cr.	2,365		2.05	4,848	.110	.015	1,451	197
		O.K. Lake	580		2.7	1,566	.1	.04	426	170
			3,655	96.6		7,997			2,600	690
	4D2	Powers Cr.	237		2.85	675	.47	.025	863	46
		Lambly	1,171		2.8	3,279	.119	.018	1,061	161
			1,408	82.3		3,954			1,924	207
	4D3	Kelowna	615		2.05	1,261	.110	.015	377	51
		O.K. Lake	180		2.7	486	.1	.04	132	53
			795	100		1,747			509	104
	4D4	McDougal Cr.	185	100	3.3	611	.190	.069	316	115
	4D5	Mission Cr.	663		2.3	1,525	.110	.015	456	62
		Bellevue	40		2.18	87	.374	.028	89	7
		O.K. Lake	85		2.70	230	.1	.04	63	25
			788	93.8		1,762			608	94
	4D6	Powers Cr.	395	100	2.85	1,126	.47	.026	1,439	77
	4D7	Trepanier	200	100	4.06	812	.067	.007	148	15
	4D8	Peachland	580	100	3.53	2,047	.388	.025	2,160	139
	4U2	O.K. Lake	295		2.7	797	.1	.04	217	87
		Bellevue	135		2.18	294	.374	.028	299	22
			430	100		1,091			516	109
	TOTAL		20,979			50,788			23,506	3,505
V	5T1	Eneas	162		3.85	624	.181	.061	306	104
		Darke	521		2.3	1,198	.181	.061	590	199
		Trout	1,617		3.80	6,144	.181	.061	3,024	1,019
			2,300	100		7,966			3,920	1,322
	5T2	Naramata Cr.	270	100	2.86	772	.190	.070	399	147
	5T3	Penticton Cr.	182	98.4	2.75	501	.190	.070	259	95

APPENDIX E.4

IRRIGATION WATER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING (cont'd)

BASIN	SUB-DIVISION	WATER SOURCE	WATER QUANTITY				WATER QUALITY		POTENTIAL NUTRIENT LOADING POUNDS	
			ACRES	PERCENTAGE OF CULTIVATED	APPLICATION RATE in	ESTIMATED VOLUME ACRE-FEET	CONCENTRATION TOTAL NITROGEN (N)	CONCENTRATION TOTAL PHOSPHORUS (P)	TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)
V	5D1	Eneas	225		3.85	866	.181	.061	426	144
		Trout	2,454		3.8	9,325	.181	.061	4,591	1,547
			2,679	92.9		10,191			5,017	1,691
	5D2	O.K. Lake	185	100	2.7	450	.1	.04	122	49
	5D3	Penticton Cr.	1,249		2.25	2,810	.190	.07	1,452	535
		Naramata Cr.	585		2.86	1,673	.190	.07	865	319
			1,834	93.5		4,483			2,317	854
	5U1	Naramata Cr.	190		2.86	543	.190	.07	281	103
		O.K. Lake	30		2.7	81	.1	.04	22	9
			220	84.6		624			303	112
	TOTAL		7,670			24,987			12,337	4,270
VI	6T1	Ellis Cr.	35	100	2.75	96	.198	.031	52	8
	6T2	Shingle Cr.	990	100	3.22	3,188	.351	.03	3,044	260
	6T3	Shuttleworth	49		2.58	126	.337	.082	115	28
		McLean Cr.	461		2.3	1,060	.260	.023	750	66
			510	100		1,186			865	94
	6D1	Ellis Cr.	793		2.75	2,181	.198	.031	1,175	184
		Skaha Lake	272		2.68	729	.1	.025	198	50
			1,065	97.3		2,910			1,373	234
	6D2	Skaha Lake	615		2.68	1,648	.1	.025	448	112
		Marion Cr.	100		3	300	.09	.007	73	6
		Skaha Lake	30		2.68	80	.1	.025	22	5
			745	100		2,028.			543	123
	6D3	Shuttleworth	70		2.58	180	.337	.082	165	40
		Wells	25		2.3	58	.357	.027	56	4
		Skaha	127		2.68	340	.1	.025	92	23
			222	66.3		578			313	68
	6D4	O.K. Lake	200	100	2.7	540	.1	.04	147	59
	TOTAL		3,767			10,526			6,337	846
VII	7T1	Wells	139		2.3	320	.357	.027	311	24
		Shuttleworth	21		2.58	54	.337	.082	49	12
			160	100		374			360	36
	7D1	O.K. River	440	100	4.4	1,936	.353	.027	1,859	142
	7D2	O.K. River	35	46.6	4.4	154	.353	.027	148	11
	TOTAL		635			2,464			2,367	189
VIII	8T1	O.K. River	245		4.4	1,078	.353	.027	1,035	79
		Park Rill	385		3.3	1,271	.243	.013	840	45
			630	100		2,349			1,875	124
	8T2	O.K. River	25	100	4.4	110	.353	.027	106	8
	8T3	O.K. River	250	100	4.4	1,100	.353	.027	1,056	81
	8T4	Wolf Cub Cr.	110	100	3.3	363	.193	.074	191	73
	8D1	O.K. River	145	100	4.4	638	.353	.027	613	47
	8D2	O.K. River	605	100	4.4	2,662	.353	.027	2,556	195

APPENDIX E.4

IRRIGATION WATER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING (cont'd)

BASIN	SUB-DIVISION	WATER SOURCE	WATER QUANTITY				WATER QUALITY		POTENTIAL NUTRIENT LOADING POUNDS	
			ACRES	PERCENTAGE OF CULTIVATED	APPLI-CATION RATE in	ESTIMATED VOLUME ACRE-FEET	CONCENTRATION			
							TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)	TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)
VIII	8D3	O.K. River	625	100	4.4	2,750	.353	.027	2,642	202
	8D4	O.K. River	1,935	100	4.4	8,514	.353	.027	8,177	625
	8D5	O.K. River	235	100	4.4	1,034	.353	.027	993	76
	TOTAL		4,560			19,520			18,209	1,431
IX	9T1	Inkaneep	200	100	3.27	657	.117	.041	209	73
	9T2	Osoyoos Lk.	225	97.8	4.66	1,049	.3	.035	856	100
	9D1	O.K. River	505	100	4.4	2,222	.353	.027	2,133	163
	9D3	Osoyoos Lk.	630	100	4.66	2,936	.3	.035	2,395	280
	9D4	O.K. River	1,420		4.4	6,248	.353	.027	5,999	458
		Osoyoos Lk.	1,055		4.66	4,916	.3	.035	4,011	468
			2,475	100		11,164			10,010	926
	9D5	Osoyoos Lk.	100	100	4.66	466	.3	.035	380	44
	TOTAL		4,135			18,494			15,983	1,586
GRAND TOTAL			57,528			163,893			108,907	17,109

APPENDIX E.5

FERTILIZER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING

BASIN	SUB DIV		LOADINGS OF NITROGEN AND PHOSPHORUS							POTENTIAL NUTRIENT LOADING POUNDS	
										TOTAL N NITROGEN	TOTAL P PHOSPHORUS
Fertilizer Classification			34-0-0	16-20-0	13-16-10	26-13-10	16-16-16	21-0-0	REMAINDER		
I	1D1	N	20,247	2,512	1,690	2,288	704		7,870	35,311	
		P		1,372	909	500	308		88		3,177
	1D2	N	29,052	19,456	6,675	1,170	1,280	2,909	2,925	63,467	
		P		10,628	3,590	256	559		3		15,036
	TOTAL	N	49,299	21,968	8,365	3,458	1,984	2,909	10,795	98,778	
		P		12,000	4,499	756	867		91		18,213
Fertilizer Classification			34-0-0	16-20-0	13-16-10	21-0-0	46-0-0	10-4-7	REMAINDER		
II	2T2	N	15,504	1,572	1,859	1,040	759		9,296	30,030	
		P		858	1,000				2,031		3,889
	2D1	N	1,700				46			1,746	
		P									-
	2D2	N	340		130					470	
		P			70						70
	2D3	N	867	1,408				10	7	2,292	
		P		769				2	8		779
	TOTAL	N	18,411	2,980	1,989	1,040	805	10	9,303	34,538	
		P		1,627	1,070			2	2,039		4,738
Fertilizer Classification			34-0-0	16-20-0	21-0-0	46-0-0	26-13-10	13-16-10	REMAINDER		
III	3T1	N	16,745	5,256	4,253	3,128		2,249	1,160	32,791	
		P		2,871				1,210	2,164		6,245
	3T2	N	6,341	728	872	1,932			11	9,884	
		P		398					6		404
	3T3	N	13,413	72	2,331	271		1,683	95	17,865	
		P		39				905	154		1,098
	3T4	N							678	678	
		P							148		148
	3T5	N	45,024	25,003	10,395	15,668	5,122		6,736	107,948	
		P		13,658			2,697		75,165		91,520
	3D3	N							506	506	
		P							111		111
	3D4	N	309	1,800	525	46		267	2,100	5,047	
		P		983				143	2,716		3,842
	3D5	N	53,720	640	10,773	281		754	34	66,202	
		P		350				406	64		820
	TOTAL	N	135,552	33,499	29,149	21,326	5,122	4,953	11,320	240,921	
		P		18,299			2,697	2,664	80,528		104,188
Fertilizer Classification			34-0-0	16-20-0	21-0-0	46-0-0	13-16-10	26-13-10	REMAINDER		
IV	4T1	N	126,786	27,248	23,184	11,670	12,356		3,397	204,641	
		P		14,884			6,646		1,674		23,204
	4T3	N	12,920	240	210		260			13,630	
		P		131			140				271
	4T4	N	109,471	22,760	15,162	7,027	2,971		1,737	159,128	
		P		12,433			1,598		687		14,718
	4T5	N	2,040				260			2,300	
		P					140				140
	4T6	N	5,432	5,536	3,801	460	436			15,665	
		P		3,024			234				3,258
	4T7	N	102							102	
		P									-
	4T8	N	9,758	8						9,766	
		P		4							4
	4D1	N	77,311	7,312		4,250	4,004	11,960	25,161	129,998	
		P		3,994			2,154	2,613	863		9,624
	4D2	N	36,856	2,360	357	1,191	1,765		25	42,554	
		P		1,289			949		7		2,245
	4D3	N	4,726	3,016	5,775	1,826	1,391		21	16,755	
		P		1,647			748		13		2,408

APPENDIX E.5

FERTILIZER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING (cont'd)

BASIN	SUB DIV		LOADINGS OF NITROGEN AND PHOSPHORUS							POTENTIAL NUTRIENT LOADING POUNDS	
										TOTAL N NITROGEN	TOTAL P PHOSPHORUS
Fertilizer Classification			34-0-0	16-20-0	21-0-0	46-0-0	13-16-10	26-13-10	REMAINDER		
IV	4D5	N	33,949	5,088	21,882	610	1,391		908	63,828	
		P		2,779			748		967		4,494
	4D6	N	170							170	
		P									-
	4D7	N					390			390	
		P					210				210
	4D9	N	595				182			777	
		P					98				98
	4U2	N	6,120							6,120	
		P									-
	TOTAL	N	426,236	73,568	70,371	27,034	25,406	11,960	31,249	665,824	
		P		40,185			13,665	2,613	4,211		60,674
Fertilizer Classification			34-0-0	21-0-0	16-20-0	13-16-10	46-0-0	8-12-0	REMAINDER		
V	5T1	N	29,070	17,619	3,416		529		203	50,837	
		P			1,866				131		1,997
	5T2	N	7,327	6,563	116	130	1,594		101	15,831	
		P			63	160			66		289
	5T3	N	2,450		640	137				3,227	
		P			350	74					424
	5D1	N	56,576	48,679	13,248	3,507	1,242		1,109	124,361	
		P			7,237	1,892			709		9,838
	5D2	N	2,686	241	208	97				3,232	
		P			114	53					167
	5D3	N	73,080	29,810	3,036	2,771	1,028	164		109,889	
		P			1,658	1,561		14			3,233
	5U1	N	6,783	4,515	184	59	8		16	11,565	
		P			101	32			11		144
	TOTAL	N	177,972	107,427	20,848	6,701	4,401	164	1,429	318,942	
		P			11,389	3,772		14	917		16,092
Fertilizer Classification			34-0-0	21-0-0	16-20-0	13-16-10	46-0-0	8-12-0	REMAINDER		
VI	6T1	N	272	378	160	26			12	848	
		P			87	14			8		109
	6D1	N	20,094	2,489	1,104	384	46			24,116	
		P			603	206					809
	6D2	N	21,964	4,725	1,432	173	100		82	28,476	
		P			782	54			53		889
	6D3	N	1,734					40		1,774	
		P						26			26
	6D4	N	2,788	830	392	124				4,134	
		P			214	66					280
	TOTAL	*N*	*46,852*	*8,422*	*3,088*	*707*	*146*	*40*	*94*	*59,349*	
		P			1,686	340		26	61		2,113
Fertilizer Classification			34-0-0	16-20-0	46-0-0	8-12-0			REMAINDER		
VII	7D1	N	19,720	320	23	12				20,075	
		P		175		8					183
	TOTAL	N	19,720	320	23	12				20,075	
		P		175		8					183
Fertilizer Classification			34-0-0	16-20-0	21-0-0	13-16-10	46-0-0	11-48-0	REMAINDER		
VIII	8T1	N	12,846	1,240		1,560	634	880	802	17,962	
		P		677		839		1,678	13		3,207
	8T3	N	10,189	1,763	490	154	138		170	12,904	
		P		963		83			519		1,565
	8T4	N	1,095							1,095	
		P									-
	8D1	N	800	672					35	1,507	
		P		367					730		1,097

APPENDIX E.5

FERTILIZER DISTRIBUTION & CORRESPONDING POTENTIAL NUTRIENT LOADING (cont'd)

BASIN	SUB-DIV		LOADINGS OF NITROGEN AND PHOSPHORUS							POTENTIAL NUTRIENT LOADING POUNDS	
										TOTAL N NITROGEN	TOTAL P PHOSPHORUS
Fertilizer Classification			34-0-0	16-20-0	21-0-0	13-16-10	46-0-0	11-48-0	REMAINDER		
VIII	8D2	N	646	104	693	293				1,736	
		P		57		157					214
	8D3	N	25,160	2,480	1,806	1,116	3,082		56	33,700	
		P		1,355		600			37		1,992
	8D4	N	209,686	23,998	31,747	11,767	10,153		12,054	299,405	
		P		13,109		6,329			5,645		25,083
	8D5	N	8,007	5,664	18,932	728	46		332	33,709	
		P		3,094		392			218		3,704
	TOTAL	N	268,429	35,921	53,668	15,618	14,053	880	13,449	402,018	
		P		19,622		8,400		1,678	7,162		36,862
Fertilizer Classification			34-0-0	16-20-0	21-0-0	13-16-10	16-16-16	46-0-0	REMAINDER		
IX	9T2	N	23,616	3,739	21	65				27,441	
		P		2,043		35					2,078
	9D1	N	24,962	1,856	1,481	904		184	51	29,438	
		P		1,014		486			390		1,890
	9D3	N	35,514	4,350	1,155	176		230	16	41,441	
		P		2,376		94			10		2,480
	9D4	N	211,958	22,303	26,639	9,895	1,552		6,313	278,660	
		P		12,183		5,322	1,030		3,225		21,760
	9D5	N	14,408	2,032	42	7			48	16,537	
		P		1,110		4			31		1,145
	TOTAL	N	310,458	34,280	29,338	11,047	1,552	414	6,428	393,517	
		P		18,726		5,941	1,030		3,656		29,353
			GRAND TOTAL							2,233,962	272,416

APPENDIX E.6

ANNUAL NITROGEN AND PHOSPHORUS PRODUCTION OF LIVESTOCK

per 1000 pounds Live Weight

LIVESTOCK	NITROGEN (pounds)	PHOSPHORUS (pounds)	AVE. LIVE WEIGHT (pounds)
Dairy Cattle - Mature	131.40	15.70	1,000
- Young	131.40	15.70	500
Beef Cattle - Mature	171.55	10.95	1,000
- Young	171.55	10.95	500
Laying Hens	730.00	127.40	3
Turkeys	730.00	127.40	15
Pigs	146.00	28.47	125
Sheep	124.10	18.62	125
Horses	171.55	10.95	1,000

APPENDIX E.7

POTENTIAL NUTRIENT LOADING "OTHER SOURCES"[1]

BASIN		DISCHARGE TO GROUNDWATER (lbs)							DISCHARGE TO SURFACE WATER		
		INDUSTRIAL			DUSTFALL		MISCELLANEOUS		INDUSTRIAL		
		VOLUME acre-ft	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P	R.F.[2] acre-ft	TOTAL N	TOTAL P
I	T	270	10930	7300	-	-	2335	580	6726	10220	310
	D	-	-	-	11490	14196	-	-	-	-	-
	Σ	270	10930	7300	11490	14196	2335	580	6726	10220	310
II	T				8025	1529	780	195		35	46
	D				1415	270	1615	403		-	-
	Σ				9440	1799	2395	598		35	46
III	T				14035	4856	2070	549	2518	102005	47076
	D				6520	2257	6455	1711	-	-	-
	Σ				20555	7113	8525	2260	2518	102005	47076
IV	T	172	7010	3361	37630	2509	28840	4412	476	2515	515
	D	-	-	-	25310	1687	10540	2720	-	-	-
	Σ	172	7010	3361	62940	4196	39380	7132	476	2515	515
V	T				29995	3578	27170	10348	25	15	3
	D				53605	6393	14560	5530	-	-	-
	Σ				83600	9971	41730	15878	25	15	3
VI	T				3160	561	1770	442			
	D				13840	2455	19435	1979			
	Σ				17000	3016	21205	2421			
VII	T				1025	64	140	36			
	D				3040	190	375	94			
	Σ				4065	254	515	130			
VIII	T				3960	1015	1630	407			
	D				13825	3545	370	93			
	Σ				17785	4560	2000	500			
IX	T				1660	425	3090	770			
	D				14470	3710	-	-			
	Σ				16130	4135	3090	770			
TOTAL	T	442	17940	10661	99490	14537	67825	17739	9745	114790	47950
	D	-	-	-	143515	34703	53350	12530	-	-	-
	Σ	442	17940	10661	243005	49240	121175	30269	9745	114790	47950

[1] Some of this raw data comes from Task 105.

[2] R.F. signifies return flow in acre-feet.

APPENDIX E.8

NUTRIENT CONTRIBUTION BY "OTHER SOURCES" IN VICINITY OF SOURCE

BASIN		NUTRIENTS TO GROUNDWATER (lbs)							NUTRIENTS TO SURFACE WATER		
		INDUSTRIAL			DUSTFALL		MISCELLANEOUS		INDUSTRIAL		
		VOLUME acre-ft	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P	R.F.	TOTAL N	TOTAL P
I	T	243	4370	730	-	-	425	21	6726	10220	310
	D	-	-	-	2090	511	-	-	-	-	-
	Σ	243	4370	730	2090	511	425	21	6726	10220	310
II	T	-	-	-	1050	11	100	1	-	35	46
	D	-	-	-	185	2	210	3	-	-	-
	Σ	-	-	-	1235	13	310	4	-	35	46
III	T	-	-	-	1570	49	230	6	2518	102005	47076
	D	-	-	-	730	23	725	17	-	-	-
	Σ	-	-	-	2300	72	955	23	2518	102005	47076
IV	T	155	1400	168	5680	58	4355	102	476	2515	515
	D	-	-	-	3820	39	1590	63	-	-	-
	Σ	155	1400	168	9500	97	5945	165	476	2515	515
V	T	-	-	-	4980	97	4510	279	25	15	3
	D	-	-	-	9000	173	2415	149	-	-	-
	Σ	-	-	-	13980	270	6925	428	25	15	3
VI	T	-	-	-	520	17	290	13	-	-	-
	D	-	-	-	2285	74	3205	59	-	-	-
	Σ	-	-	-	2805	91	3495	72	-	-	-
VII	T	-	-	-	210	2	30	1	-	-	-
	D	-	-	-	615	6	75	3	-	-	-
	Σ				825	8	105	4	-	-	-
VIII	T	-	-	-	810	34	335	13	-	-	-
	D	-	-	-	2820	117	75	3	-	-	-
	Σ	-	-	-	3630	151	410	16	-	-	-
IX	T	-	-	-	325	15	605	28	-	-	-
	D	-	-	-	2835	134	-	-	-	-	-
	Σ	-	-	-	3160	149	605	28	-	-	-
TOTAL	T	398	5770	898	15145	283	10880	464	9745	114790	47950
	D	-	-	-	24380	1079	8295	297	-	-	-
	Σ	398	5770	898	39525	1362	19175	761	9745	114790	47950

APPENDIX E.9

VIRGIN GROUNDWATER QUANTITY

BASIN	VIRGIN SURFACE RUNOFF (V.S.R.)		NATURAL QUANTITY REACHING RECEIVING WATER AS GROUNDWATER		NATURAL QUANTITY REACHING STREAMS
	TRIBUTARY SUB-BASINS (T.S.B.)	DIRECT DRAINAGE (D.D.)	2% of VSR TSB	8% of VSR DD	4% of VSR TSB
	acre-feet				
I	13,600	1,380	272	110	544
II	18,000	1,972	360	158	720
III	132,700	4,120	2,654	330	5,308
IV	279,800	11,752	5,596	940	11,192
V	105,500	7,776	2,110	662	4,220
VI	39,000	2,946	780	236	1,560
VII	6,700	1,007	134	81	268
VIII	37,400	2,647	748	212	1,496
IX	6,650	3,091	133	247	266
TOTAL	639,350	36,691	12,787	2,976	25,574

APPENDIX E.10

WATER QUALITY FOR GROUNDWATER AND SURFACE STREAM

BASIN	CONCENTRATIONS				QUALITY STATION	CREEK	CONCENTRATIONS			
	VIRGIN GROUNDWATER		FINAL GROUNDWATER				VIRGIN STREAM		FINAL STREAM	
	TOTAL N	TOTAL P	TOTAL N	TOTAL P			TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)	TOTAL NITROGEN (N)	TOTAL PHOSPHORUS (P)
I	2.542	0.040	3.439	0.054	B525	Vernon	1.127	0.050	1.517	0.075
II	1.53	0.024	2.07	0.032		Oyama	0.274	0.033	0.463	0.057
					B532	Coldstream	1.075	0.044	1.633	0.068
III					B530	Vernon	1.26	0.356	1.99	0.646
					B529	Deep	0.952	0.245	1.543	0.338
						Irish	0.569	0.097	1.018	0.172
					B528	Equesis	0.569	0.097	1.018	0.172
	1.897	0.056	2.567	0.076	B533	Nashwito	0.147	0.151	0.261	0.266
					B527	Whiteman	0.228	0.048	0.383	0.071
					B526	Shorts	0.352	0.206	0.671	0.401
IV					B521	Kelowna	0.933	0.079	1.293	0.122
					B518	McDougal	0.223	0.074	0.319	0.089
					B517	Westbank	1.12	0.236	1.62	0.403
					B520	Mission	0.274	0.033	0.463	0.057
					B515	Trepanier	0.092	0.009	0.166	0.015
	3.042	0.067	4.116	0.090	B519	Bellevue	0.486	0.039	0.822	0.069
					B514	Peachland	0.487	0.027	0.704	0.045
					B516	Powers	0.569	0.026	0.86	0.040
					B523	Lambly	0.189	0.024	0.364	0.039
V	3.655	0.060	4.945	0.081	B512	Trout	0.330	0.085	0.516	0.157
						Naramata	0.271	0.017	0.485	0.027
					B511	Penticton	0.271	0.017	0.485	0.027
VI	3.655	0.060	4.945	0.081	B510	Ellis	0.267	0.057	0.473	0.100
					B509	Shingle	0.178	0.018	0.318	0.030
					B507	McLean	0.271	0.027	0.404	0.038
VII	7.494	0.133	10.138	0.178	B506	Shuttleworth	0.425	0.034	0.686	0.054
VIII	1.249	0.024	1.689	0.032	B503	Park Rill	0.087	0.006	0.103	0.009
					B504	Vaseux	0.119	0.011	0.204	0.015
					B535	Wolfcub	1.379	0.043	1.647	0.063
IX	2.738	0.204	3.704	0.276	B501	Inkaneep	0.158	0.059	0.278	0.097
						Hayes	0.27	0.05	0.4	0.097

APPENDIX E.11

ESTIMATION OF NET STREAM DISCHARGE

BASIN		CREEK	Q VIRGIN TASK 33 K-ac-ft	DIVERSIONS (K-ACRE-FT)				NET STREAM FLOW (S_n')			RETURN FLOW TO STREAM
				IRRIG. TASK 139	INDUST. TASK 54	DOMESTIC TASK 54	TOTAL	NET CAL.	NET TASK 105 K-ac.-ft	AVERAGE	
I	1T1	Vernon	[13.6][1]	6.3 (7.7)	0.3 (0.3)	- (0)	6.6 (8.0)	7.0 (8.8)	2.3	6.0	
	TOTAL		[13.6]	6.3	0.3	-	6.6	7.0	2.3	6.0	0.1
II	2T1	Oyama	[3.5]	1.902	-	-	1.902	1.6		1.6	
	2T1	Coldstream	[14.5]	- (0.9)	- (0)	- (0)	- (.9)	14.5 (13.6)	10.0	12.7	
	TOTAL		[18.0]	1.902	-	-	1.9	16.1	10.0	14.3	0.6
III	3T1	Vernon	[20.3]	0.6	1.62	2.588	4.8	15.5 (16.9)	20.7	17.7	
	3T5	Deep Creek	8.4	1.806	-	0.044	1.85	6.55	9.3	7.9	
	3T6	Irish Creek	2.0	0.132	-	0.002	.13	1.87		1.9	
	3T7	Newport	-	0.066	-	-		-	-	-	
	3T8	Equesis	23.8	1.99 (1)	13.756 (0)	0.008 (0)	15.75 (1)	8.05 (19.7)	12.7	13.5	
	3T9	Nashito	12.6	0.231	-	0.001	.23	12.37	1.3	6.8	
	3T10	Whiteman	33.0	0.255	-	0.003	.26	32.74	-	32.7	
	3T11	Shorts	32.6	0.479	0.906	0.001	1.39	31.21	-	31.2	
	TOTAL		132.7	5.559	16.282	2.647	24.41	108.29	44.0	111.7	0.7
IV	4T1	Kelowna	17.4	9.987 (12.9)	0.053 (0)	0.254 (0)	10.3 (12.9)	7.1 (10.9)	8.4	9.3	
	4T2	McDougal	4.4	1.225	-	0.004	1.23	3.17	1.1	2.1	
	4T3	Westbank	-	0.771	-	-		-	1.1	1.1	
	4T4	Mission	150.2	21.926 (30.7)	1.086 (1.2)	1.169 (0)	24.181 (31.9)	126.02 (127)	116.7	123.2	
	4T5	Trepanier	28.0	1.299	2.435	0.008	3.742	24.26	23.0	23.6	
	4T6	Bellevue	15.1	0.555	-	0.042	.597	14.50	5.9	10.2	
	4T7	Peachland	14.6	2.118 (1.9)	0.029 (1.5)	0.008 (0)	2.155 (3.4)	12.45 (14.3)	7.2	11.3	
	4T8	Powers Creek	14.7	4.608 (5)	0.067 (0)	0.342 (.3)	5.017 (5.3)	9.68 (10.7)	14.3	11.6	
	4U1	Lambly	35.4	3.363		0.262	3.625	31.78	28.7	30.2	
	TOTAL		279.8	45.852	3.67	2.089	50.84	228.96	206.4	222.6	2.2
V	5T1	Trout	75.0	15.469 (13)	0.303 (.3)	2.35 (0)	18.122 (13.3)	56.88 (53.3)	30.5	46.9	
	5T2	Naramata	5.9	2.988	-	0.279	3.27	2.63		2.6	
	5T3	Penticton	21.5	3.311 (5)	1.832 (6.1)	3.744 (0)	8.89 (11.1)	12.61 (27.3)	16.7	18.9	
	5D1	Eneas	3.1	1.49	2.172	0.003	>3.1	0		-	
	TOTAL		105.5	23.258	4.307	6.376	33.38	72.12	47.2	68.4	1.0
VI	6T1	Ellis	15.3	2.277			2.277	13.02		13.0	
	6T2	Shingle	20.2	3.488	.012	.017	3.517	16.68		16.7	
	6T3	McLean	3.5	1.060			1.06	2.44		2.4	
	TOTAL		39.0	6.825	.012	.017	6.854	32.14		32.1	0.5
VII	7T1	Shuttleworth	6.7	0.360		0.008	0.368	6.33	3.4	4.9	
	TOTAL		6.7	0.360		0.008	0.368	6.33	3.4	4.9	1.0
VIII	8T1	Park Rill	6.3	1.271	0.020	0.008	1.299	5.0		5.0	
	8T2	Vaseux	28.7			0.004	0.004	28.7		28.7	
	8T3	Testalinden	0.7		0.75	0.002	0.752	0		-	
	8T4	Wolfcub	1.7	0.363		0.008	0.371	1.33		1.3	
	TOTAL		37.4	1.634	0.77	0.022	2.426	35.03		35.0	0.5
IX	9T1	Inkaneep	[5.76]	0.657		0.010	0.667	5.1	1.4	3.3	
	9T2	Hayes	[.89]				0	.9		.9	
	TOTAL		[6.65]	0.657		0.010	0.667	6.0	1.4	4.2	0.2
GRAND TOTAL			639.4	92.4	25.3	11.2	127.4	512.0	314.7	499.2	6.8

[ ] = Task 35

( ) = Task 139

APPENDIX F

PESTICIDE USE AND SALES IN THE OKANAGAN BASIN

1960 TO 1970

F.1 - Recommended Rate of Pesticide Use on Tree Fruits * Okanagan Basin 1960 - 1970

F.2 - Recommended Rate of Pesticide Use on Vegetables & Field Crops* Okanagan Water Basin 1960 - 1970

F.3 - Estimated Pesticide Sales in the Okanagan Water Basin Area

APPENDIX F.1

RECOMMENDED RATE OF PESTICIDE USE ON TREE FRUITS*

OKANAGAN BASIN

1960 - 1970

PESTICIDE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Amid Thin	---	5-10 lbs.	1 1/4 lbs.	1 1/4 lbs	1 1/4 lbs	1 1/4 lbs	1 1/4 lbs	1 1/4 lbs	1 1/4 lbs	1 1/2 lbs	1 1/4 lbs
Amitrole 50% SP (non bearing)	---	---	---	---	---	---	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs
Bordeaux	3 lbs	---	---	---	---	---	---	---	---	---	---
Botran 75 W	---	---	---	---	---	---	---	5 lbs	5 lbs	---	---
Captan 50% WP	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs
Casoron 4 G	---	---	---	---	---	---	---	---	---	---	150 lbs
Copper Sulphate & Hydrated Lime	---	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs	3&3 lbs
DDT 50% WP (not for codling moth)	12 lbs	6-12 lbs	12 lbs	---	---	12 lbs	12 lbs	12 lbs	12 lbs	12 lbs	---
Demeton (Systox 28.5% EC)	---	8 pts	4.5-6 pts	6 pts	6 pts	6 pts	6 pts	6 pts	6 pts	6 pts	6 pts
Diazinon 25% WP	12 lbs	8 lbs	8 lbs	8 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs
Dichlone (Pygon)	1/2 lbs	2 lbs	2 lbs	2 lbs	2 lbs	2 lbs	2 lbs	2 lbs	2 lbs	2 lbs	2 lbs
Dieldrin 50% WP	3 lbs	3 lbs	---	---	---	---	---	---	---	---	---
Dimethoate (Rogor-Cygon)	---	12 lbs	---	4.5/6 pts	4.5/6 pts	4.5/6 pt	4.5/6 pt	4.5/6 pt	/4.5 pt	/4.5 pt	4.5 pt
Dinitrocresol Sodium Salt 75%	6 lbs	3-6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs
Dithane M 45	---	---	---	---	---	---	---	---	---	---	---
Dodine (Cyprex)	---	2-3 lbs	2-3 lbs	2-3 lbs	2-3 lbs	2-3 lbs	2-3 lbs	2-3lbs	2-3 lbs	2-3 lbs	2-3 lbs
Ethion 25% WP	---	---	---	---	---	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs
Fenson 50% WP (not recommended)	4 lbs	2 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	---
Ferbam	2 1/2-10 lbs	2 1/2-5-10 lbs	2 1/2-5-10 lbs	5-8 lbs	2 1/2-5 lbs	2 1/2-5 lbs	2 1/2-5 lbs	2 1/2-5 lbs	2 1/2-5 lbs	2 1/2-5 lbs	2 1/2-5 lbs
Fixed Copper 50%	---	---	---	---	1 1/2 lbs	1 1/2 lbs	1 1/2 lbs	1 1/2 lbs	1 1/2 lbs	1 1/2 lbs	3 lbs
Glyodin	---	---	---	---	---	---	---	---	---	---	---
Glyodex	---	---	---	---	---	---	2 1/2 lbs	2 1/2 lbs	2 lbs	2 lbs	2 lbs
Gramozone	---	---	---	---	---	1 gal	1 gal	1 gal	1 gal	1 gal	1 gal
Guthion 25% WP	1 1/2 lbs	5 lbs	5 lbs	---	5 lbs	5 lbs	5 lbs	5 lbs	2 1/2 lbs	1 1/4 lbs	1 1/2 lbs
Karathane	---	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs
Kelthane 18.5% WP	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs
Lime Sulphur	12 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal	8-15 gal
Lindane	---	---	---	---	---	---	---	---	---	---	---
Malathion 25% WP	12 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	10 lbs	10 lbs	10 lbs	10 lbs
Maneb	10 lbs	5-10 lbs	5-10 lbs	5-8 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs
Mercuric Chloride	small amount	---	---	---	---	---	---	---	---	---	---
Mercurous Chloride	small amount	---	---	---	---	---	---	---	---	---	---
Morestan 25% WP	---	---	---	---	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs

APPENDIX F.1 (cont'd)

RECOMMENDED RATE OF PESTICIDE USE ON TREE FRUITS*

OKANAGAN BASIN

1960 - 1970

PESTICIDE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Morocide 50%	---	---	---	---	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs
Nicotine Sulphate	1/2 gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	---	---	---
Ovex 50% WP	4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	2-4 lbs	---	---
Parathion 15T WP	---	6-10 lbs	6-10 lbs	6-10 lbs	6-10 lbs	6-10 lbs	6-10 lbs	6-10 lbs	6-10 lbs	6-10 lbs	---
Perthane 40% WP	---	---	---	---	---	---	---	2 1/2 lbs	---	---	---
Perthane 4 liquid	---	---	---	---	---	---	---	---	---	1-2 qt	1-2 qt
Phosdrin 20% EC	---	1 pt	1 pt	1 pt	1 pt	1 pt	1 pt	1 pt	1 pt	1 pt	---
Phosdex 8M	---	---	1/2 gal	1/2gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	1/2 gal	---
Rotenone Oil	1 gal	1 gal	1 gal	1 gal	1 gal	1 gal	1 gal	---	---	---	---
Sevin 50% WP	8 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs	6 lbs
Simazine 50% WP	---	---	---	---	---	---	---	---	---	4 lbs	4 lbs
Sodium Fluoride	small amount	---	---	---	---	---	---	---	---	---	---
Sodium Silico Fluoride	small amount	---	---	---	---	---	---	---	---	---	---
Sulphenone 50% WP	---	16 lbs	16 lbs	16 lbs	---	---	---	---	---	---	---
Sulphur Paste	---	---	---	---	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs
Sulphur Wett	2 lbs	4 lbs	15 lbs	15 lbs	---	---	---	---	---	---	---
Strychnine	small amount	---	---	---	---	---	---	---	---	---	---
Tedion 25% EC	---	4-8 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs	4 lbs	not recommended
TEPP 20% EC	---	5 pts	5 pts	5 pts	5 pts	5 pts	5 pts	5 pts	5 pts	5 pts	5 pts
Thiodan 50% WP	---	---	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs	3 lbs	8 lbs	3 lbs	3 lbs
Trithion 25% WP	---	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	8 lbs	3 lbs
Trithion 25% WP	---	---	---	---	---	8 lbs	8 lbs	5 lbs	8 lbs	8-11 lbs	8 lbs
Ziram	10 lbs	5-10 lbs	5-10 lbs	5-8 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs	5 lbs
2,4,5 - TP 10%	---	20 ozs	20 ozs	20 ozs	20 ozs	20 ozs	20 ozs	20 ozs	20 ozs	20 ozs	20 ozs

* As recommended in British Columbia Department of Agriculture Spray Calendars and Production Guides.

APPENDIX F.2

RECOMMENDED RATE OF PESTICIDE USE ON VEGETABLES & FIELD CROPS*

OKANAGAN WATER BASIN

1960 - 1970

PESTICIDE	RECOMMENDED RATE PER ACRE		
	1960-1963	1964-1967	1968-1970
Aatrex 80W	-	-	1 - 1 1/2 lbs.
Aero Cyanate	-	-	9 - 11 lbs.
Agriculture Weed	-	-	-
Alanap 3	-	-	3 - 4 gallons
Adrin 20% E.C.	2 gallons	2 pints	-
Adrin 2 1/2% E.C.	200 pounds	-	-
Adrin	-	-	-
Anticarie 80.5%	-	-	20 oz/1000 ft.
Arasan 75%	-	-	-
Atrazine 50% WP	-	-	4 - 6 lbs.
Bardox	-	-	1 gallon
Birlane 10%	-	-	20 oz/1000 ft.
Bordeaux	-	-	-
Botran 75% WP	-	-	3 pounds
Captan 50% WP	2 pounds	2 pounds	3 pounds
Captan 75%	-	-	-
Chlordane 65.5% E.C.	1 1/4 gallons	1 1/4 gallons	1 1/4 gallons
Chlordare 5%	200 pounds	-	-
Cygon (Rogor)	-	-	15 fl. ozs.
Dacthal 75% WP	-	-	1-2-14 pounds
Dasanit 10%	-	-	20 oz/1000 ft.
Demeton (Systox)	-	-	-
DDT 5% WP	35-50 pounds	-	-
DDT 50% WP	-	2 pounds	-
DDT 50% WP	-	24 pounds	-
Diazinon 50% WP	2 pounds	2 pounds	1 pound
Dibrom 9.6% E.C.	-	1 pt.	10-20 fl. oz.
Dieldrin	-	-	20-30
Dieldrin 1 1/2%	200 pounds	-	-
Difolation 4.8 F	-	-	1 - 2 qts.
Dimethoate (Rogor-Cygon)	-	15 fl. oz.	-
Di-Syston 10% G	-	10 lbs.	-
Dithane M 45	-	3 pounds	3 pounds
Dithane M 22	-	3 pounds	3 pounds
Dithane Z-78	-	-	3 pounds
Dowpon	-	-	15 pounds
Dyfonate 10% G	-	-	50 pounds
Dylox 50% WP	-	2 pounds	-
Dymid 80% WP	-	-	5 - 7 1/2 lbs.
Dyrene 50% WP	-	31 pounds	-
Endrim 20% E.C.	-	1 pt.	-
Ethion 5% G	20 oz./1000 ft.	20 oz/1000 ft.	20 oz/1000 ft.
Ethylene Dibromide 65%	-	2 gallons	2 gallons
Eptam 7.2% EC	-	-	1 2/3 - 3 1/3 qt.
Ferbam 75% WP	-	-	2 pounds
Ferbam 76% WP	-	2 pounds	-
Fixed Copper 49-55%	-	5 pounds	5 pounds
Furadan 10% G	-	-	50 pounds
Gramozone	-	-	1 - 2 qts.

APPENDIX F.2 (Cont'd)

RECOMMENDED RATE OF PRESTICIDE USE ON VEGETABLES & FIELD CROPS*

OKANAGAN WATER BASIN

1960 - 1970

PESTICIDE	RECOMMENDED RATE PER ACRE		
	1960-1963	1964-1967	1968-1970
Guthion	-	-	-
Heptachlor	-	-	-
Karathane W.P.	1/2 pound	1/2 pound	1/2 pound
Kelthane 18.5%	2 pounds	2 pounds	2 pounds
Killer No. 1	-	-	-
Lindane	-	-	-
Linuron 50% WP	-	-	2 - 4 pounds
Liquid Cyanimid	-	-	6 - 8 gallons
Malathion 50% EC	40 fl. oz.	40 fl. oz.	40 fl. oz.
Maneb 80%	-	3 pounds	-
Manzato 200	-	-	2 - 3 pounds
Melaldehyde 4%	-	20 pounds	-
Methaldehyde 4%	20 pounds	-	20 pounds
Methoxychlor 50% WP	2 - 6 pounds	2 - 6 pounds	2 - 6 pounds
Monuron	-	-	-
Morestan	-	-	-
Morocide 50% WP	-	-	1/2 - 3/4 lbs.
Nicotine Sulphate	-	-	-
Orthocide 75% WP	-	-	-
Parathion 60% EC	6 fl. oz.	6 fl. oz.	6 fl. oz.
Perthane 50%	-	2 pounds	-
Phosdrin 60% EC	7 fl. oz.	7 fl. oz.	7 fl. oz.
Polyram 80% WP	-	2 - 3 pounds	2 - 3 pounds
Premerge 30 lbs/gal	-	-	3 - 5 qts.
Premerge 36 lbs/gal	-	-	5 qts.
Pyramin 80% W	-	-	5 lbs.
Rotenone Oil 1%	-	30 pounds	30 pounds
Sevin 85% WP	-	2 1/2 pounds	2 1/2 pounds
Simazine	-	-	-
Sinox PE	-	-	4 - 5 gallons
Solan 4 E	-	-	1 gallon
Spergon WP	-	-	1 pound
Tedion	-	-	-
Telone	-	-	30 - 40 gal.
Teluar 80% WP	-	-	1 1/2 - 2 1/2 lbs.
T.E.P.P.	6 ozs.	6 ozs.	6 ozs.
Terrochlor 75% W	-	-	24 - 30 ozs.
Thiodan 4% EC	-	-	20 - 30 fl. oz.
Thiodan 50% WP	-	3/4 lb.	3/4 lbs.
Thiram 75%	-	-	-
Treflan 4 lbs/gal	-	-	1 - 1 1/2 qts.
Trithion 5%	20 ozs/1000 ft.	20 ozs/1000 ft.	20 ozs/1000 ft.
Tok E-25	-	-	2 - 4 qts.
Wett Sulphur	4 pounds	4 pounds	4 pounds
Vegadex	-	-	3 1/2 - 5 qts.
Zineb	1 1/2 lbs.	1 1/2 lbs.	1 1/2 lbs.
Zinophos 10% G	-	-	20 ozs/1000 ft.
Ziram (celery)	2 pounds	2 pounds	2 pounds
2,4D Amine	-	-	3 quarts

APPENDIX F.3

ESTIMATED PESTICIDE SALES IN THE OKANAGAN WATER BASIN AREA

PESTICIDE	PESTICIDE USE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Aldrin 5% Dust (lbs)	Insecticide	200	200	125	160	-	425	-	-	-	-	-
Aldrin 2 1/2% Dust(lb)	Insecticide	-	6,300	-	-	-	-	-	-	-	-	-
Aldrin 20EC (Qts)	Insecticide	25	25	-	84	-	-	-	-	-	-	-
Amid Thin(4 oz tins)	Hormone	1,100	800	800	1,200	450	101	1,600	2,500	6,600	5,100	3,200
Amino Triazole (lbs)	Weedicide	-	-	-	-	680	700	1,100	1,420	2,300	-	2,125
Amitrol T (Gals)	Weedicide	-	-	10	-	8	-	-	-	20	-	-
Amnate (lbs)	Weedicide	-	-	125	-	-	-	-	-	-	-	-
Animert	Insecticide	-	-	-	-	-	-	250	-	-	-	-
Aramite 15W (lbs)	Insecticide	-	-	1,500	1,900	480	-	-	-	-	-	-
Arsenate of Lead (lbs)	Insecticide	-	-	17	-	-	-	-	-	-	-	-
Atrazine 65W (lbs)	Weedicide	-	-	-	-	-	750	1,500	1,300	-	-	-
Atrazine 80W (lbs)	Weedicide	-	-	-	-	-	-	-	-	5,000	10,500	4,500
Benzene Hexachloride 10% (lbs)	Insecticide	2,600	1,200	950	1,300	750	-	-	-	-	-	-
Black Leaf 40 (Tins)	Insecticide	-	13	13	-	-	-	-	-	-	-	-
Black Leaf 155 (lbs)	Insecticide	-	100	-	-	-	-	-	-	-	-	-
Botran 50W (lbs)	Fungicide	-	-	-	3,450	2,750	-	2,600	2,360	280	-	2,120
Botran 75W (lbs)	Fungicide	-	-	-	-	-	-	-	1,400	1,070	-	500
Calmite (Gals)	Insecticide	397	428	239	326	554	244	184	943	473	53	-
Captan 50W (lbs)	Fungicide	2,100	2,500	1,676	12,350	7,740	200	1,500	3,200	880	-	-
Captan 80W (lbs)	Fungicide	-	-	-	-	-	-	-	-	-	-	-
Casoron 4G (Bags)	Weedicide	-	-	-	-	-	-	-	-	525	1,725	920
Chlordane Dust 5%	Insecticide	-	100	170	85	-	-	-	130	-	-	-
C.O.C.S.55 WP (lbs)	Fungicide	-	-	-	1,725	5,065	1,900	5,500	-	-	-	2,930
Copper, Fixed (lbs)	Fungicide	-	-	-	170	4,050	230	10,744	-	9,230	4,630	6,300
Copper, Sulphate (lbs)	Fungicide	2,100	2,520	3,780	3,570	2,940	2,070	4,460	7,350	10,500	6,430	8,660
Crag-Glyodin (Gals)	Fungicide	-	13	13	-	-	-	-	-	-	-	-
Cygon (Gals)	Insecticide	-	-	-	-	2	-	-	-	-	-	-
Cygon 16 oz.	Insecticide	-	-	-	-	230	530	65	980	350	500	280
Cygon 32 oz.	Insecticide	-	-	-	-	50	-	63	63	95	95	63
Cygon 4E (Gals)	Insecticide	-	-	-	-	-	2	-	80	10	25	120
Cyprex 65W (lbs)	Fungicide	890	35,700	45,700	47,650	56,900	4,680	-	39,300	-	48,590	35,850
Delapon (lbs)	Weedicide	-	-	-	85	200	-	80	-	-	-	-
DDT 50W (lbs)	Insecticide	472,100	335,500	305,000	181,200	159,800	836,000	171,800	198,800	108,000	72,300	27,700
DDT 10% Dust (lbs)	Insecticide	-	-	-	-	400	-	-	-	-	-	-
DDT 25% EC (Gals)	Insecticide	-	-	8	-	-	-	-	-	-	-	-
Diazinon 25E (Pts)	Insecticide	-	-	25	-	-	25	-	-	-	-	-
Diazinon 25E (Gals)	Insecticide	-	-	-	13	55	42	-	-	-	-	-
Diazinon 25W (Lbs)	Insecticide	48,200	44,000	43,450	1,100	-	-	-	-	-	-	-
Diazinon 50E (Gals)	Insecticide	-	-	-	-	-	40	200	380	470	325	1,040
Diazinon 50W (Lbs)	Insecticide	-	-	-	24,100	29,200	22,100	23,200	37,400	42,800	26,300	50,150
Death to Gophers (Lbs)	Rodenticide	-	30	-	-	-	-	-	-	-	-	-
Dibron 9.6E (Gals)	Insecticide	-	-	25	25	17	25	20	20	-	-	-
Dichlone (lbs)	Fungicide	-	-	-	3,125	2,570	2,080	125	-	525	-	-
Dieldrin 20EC (Gals)	Insecticide	110	840	378	-	-	-	-	-	-	-	-
Dieldrin 50W (Lbs)	Insecticide	15,700	7,800	1,400	-	200	100	-	370	-	-	-
Dithane Manzate 80W (Lbs)	Fungicide	-	-	-	-	-	-	250	-	-	-	-
Dithane M22 (Lbs)	Fungicide	-	-	-	3,900	4,560	4,930	3,900	-	-	-	-
Dithane M45 (Lbs)	Insecticide	-	-	-	-	-	-	-	-	-	-	3,300
Dithane Z78 (Lbs)	Fungicide	100	-	-	-	100	-	130	7,900	-	-	-
DN 1 (Lbs)	Insecticide	460	100	210	210	-	-	-	-	-	-	-
Dormant Oil (Gals)	Insecticide	-	-	-	-	-	-	55,800	92,900	109,400	113,300	142,300

APPENDIX F.3

ESTIMATED PESTICIDE SALES IN THE OKANAGAN WATER BASIN AREA (cont'd)

PESTICIDE	PESTICIDE USE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Dowpon (Lbs)	Weedicide	-	300	-	-	-	150	-	-	-	-	-
Dow Premerge (Gals)	Weedicide	-	-	2	-	-	-	-	-	-	-	-
Dylox (Lbs)	Insecticide	-	-	-	-	125	-	-	-	-	-	-
Dyrene Turf (Lbs)	Fungicide	-	-	-	-	100	-	-	-	-	-	-
Elgetol (Gals)	Insecticide	1,625	3,000	730	2,500	3,500	510	3,480	4,680	4,540	1,400	3,925
Eptam 6E (Gals)		-	-	-	-	-	-	32	21	-	-	-
Esteron (Gals)	Weedicide	-	2	4	4	-	-	-	-	-	-	-
Esteron 64 (Gals)	Weedicide	-	-	-	-	11	-	-	-	-	-	-
Esteron 245 (Gals)	Weedicide	-	-	-	-	2	-	-	-	-	-	-
Esteron Bush Killer (Gals)	Weedicide	-	-	-	-	4	3	-	-	-	-	-
Endrin 20EC (Gals)	Insecticide	-	-	-	-	6	19	-	-	-	-	-
Ethion 4 EC (Gals)	Insecticide	-	-	-	11	-	-	-	-	-	-	-
Ethion 25W (Lbs)	Insecticide	-	-	85	1,980	32,300	41,900	55,300	82,300	63,800	58,500	30,000
Ethion 220 Dormant Oil (Gals)	Insecticide	-	-	-	18,300	19,700	17,500	13,900	14,600	18,800	26,900	29,500
Fensone (Lbs)	Insecticide	22,800	17,800	16,880	15,900	14,800	7,660	10,460	20,400	10,080	-	-
Ferbam (Lbs)	Fungicide	57,450	15,200	20,400	18,600	13,300	6,100	4,650	5,000	6,650	3,860	4,400
Formaldehyde (Lbs)	Fungicide	-	-	-	95	-	-	-	-	-	-	-
Glyodex (Lbs)	Fungicide	-	-	-	-	-	63	3,500	580	145	-	-
Gopher Foe (12 oz)	Rodenticide	-	-	4	-	-	-	-	32	-	-	-
Gramoxone (Gals)	Weedicide	-	-	-	-	340	360	1,600	2,045	2,400	3,000	3,375
Guthion 25W (Lbs)	Insecticide	30,400	71,000	146,600	200,500	185,100	108,500	165,200	173,400	166,800	35,900	-
Guthion 50W (Lbs)	Insecticide	-	-	-	-	-	-	-	-	-	238,900	51,660
Imidan 50W (Lbs)	Insecticide	-	-	-	-	-	-	-	200	-	99,700	80,675
Karathane (Lbs)	Fungicide	-	12,700	9,175	-	-	-	-	-	-	-	-
Karathane (Gals) LC	Fungicide	-	-	-	-	-	-	-	-	8	-	50
Karathane (WD) (Lbs)	Fungicide	1,700	-	-	8,450	13,000	600	11,600	19 800	28,700	7,200	9,450
Karmex (Lbs)	Weedicide	-	65	105	210	170	85	160	650	-	-	-
Kelthane 185 WP (LBS)	Insecticide	46,500	125,600	129,030	166,350	139,400	71,700	244,150	179,800	77,300	17,340	5,550
Lime-Sulphur (Gals)	Fungicide	53,000	53,000	53,000	56,000	56,000	57,000	57,000	59,000	56,000	30,000	25,000
Lime-Sulphur (Gals)	Fungicide	11	-	-	-	-	-	-	-	-	-	-
Lindane 25WP (Lbs)	Insecticide	420	-	-	-	-	-	-	-	-	-	-
Linuron (Lbs)	Weedicide	-	-	-	-	-	-	250	190	-	1,100	-
Malathion E8 (1 Gal)	Insecticide	6,400	2,600	1,800	900	970	270	370	480	150	80	40
Malthion E8 (5 Gals)	Insecticide	-	1,850	750	440	-	-	-	-	-	-	15
Malthion 25WP (Lbs)	Insecticide	13,600	23,850	12,185	4,700	5,200	1,900	3,450	4,000	250	-	-
Moreston 25 WP (Lbs)	Insecticide	-	-	-	-	1,229	11,122	11,865	-	15,960	13,524	11,088
Morocide Dust 4% (Lbs)	Insecticide	-	-	-	1,150	-	-	-	-	-	-	-
Morocide 50W (Lbs)	Insecticide	-	-	-	5,040	12,500	10,700	14,900	16,450	15,600	5,040	500
Nicotine Sulphate (Gal)	Insecticide	85	140	200	60	170	30	24	-	-	-	-
Omite 30W (Lbs)	Insecticide	-	-	-	-	-	-	-	-	-	88,660	46,620
Ovex (Lbs)	Insecticide	-	-	-	-	-	-	3,650	380	200	-	-
Ovatran (Lbs)	Insecticide	7,775	13,450	6,350	1,125	8,750	4,300	-	-	-	-	-
Parathion 15% (Lbs)	Insecticide	7,500	27,100	25,775	12,095	11,730	10,450	15,300	18,900	9,500	7,000	3,750
Parathion E4 (Gals)	Insecticide	-	-	-	-	-	-	-	430	100	-	-
Parathion Aqua(1/2 Gal)	Insecticide	-	-	-	50	140	190	400	125	170	-	-
Parathion Aqua (Gal)	Insecticide	-	-	-	-	-	8	260	85	25	-	-
Parathion Liquid (Gal)	Insecticide	-	-	-	-	-	-	-	-	-	-	110
Perthane 40WP (Lbs)	Insecticide	-	-	-	-	33,425	41,000	56,850	5,250	-	22,125	8,310
Perthane F4 (Gals)	Insecticide	-	-	-	95	-	-	-	11,350	9,700	-	-
Perthane F4 (1 Gal)	Insecticide	-	-	-	-	-	70	3,300	-	-	-	-
Perthane F4 (5 Gal)	Insecticide	-	-	-	-	-	-	750	-	-	-	-

APPENDIX F.3

ESTIMATED PESTICIDE SALES IN THE OKANAGAN WATER BASIN AREA (cont'd)

PESTICIDE	PESTICIDE USE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Phosdrin 20 oz (btl)	Insecticide	-	50	-	100	250	-	-	-	-	-	-
Phostex 8EC (Gal)	Insecticide	-	-	100	10	40	4	-	-	-	-	-
Pholyram (Lbs)	Fungicide	-	-	-	-	-	75	-	-	-	-	-
Phygon XL (Lbs)	Fungicide	16,800	-	4,600	-	-	-	-	-	-	-	-
Phygon Dichlone (Lbs)	Fungicide	-	114,400	-	-	-	-	-	-	-	-	-
Rogor E-20 oz 9 (Btls)	Insecticide	790	1,350	1,000	3,700	-	125	-	-	-	-	-
Rogor E-20 oz (Tins)	Insecticide	-	-	-	-	500	-	-	-	-	-	-
Rogor 40 Pints	Insecticide	-	-	-	-	-	-	560	880	1,075	560	880
Rogor 40 (Btls)	Insecticide	-	-	-	-	-	350	-	-	-	-	-
Rogor 40 (Gals)	Insecticide	-	-	-	-	-	-	-	150	180	100	100
Regolone (Gals)	Insecticide	-	-	-	-	-	13	-	-	-	-	-
Schradan (Gals)	Insecticide	2	-	-	-	-	--	-	-	-	-	-
Sevin 50W (Lbs)	Insecticide	36,900	27,000	77,175	42,900	60,220	15,550	37,500	41,025	17,350	21,150	15,200
Simazine 50W (Lbs)	Weedicide	11	125	750	750	300	-	-	-	1,575	-	2,625
Snip Fly Bands	Insecticide	-	-	-	-	25	-	-	-	-	-	-
Sodinoc	Insecticide	9,075	14,900	15,800	10,000	9,700	2,700	5,800	8,720	11,025	8,700	10,500
Sodium Arsenate (Gal)	Insecticide	-	-	11	-	-	-	-	-	-	-	-
Solan 4EC (Gals)	Weedicide	-	-	-	11	-	-	25	-	-	-	-
Sulphenone	Insecticide	-	1,100	300	655	-	-	-	-	-	-	-
Sulphur WP (Lbs)	Fungicide	39,600	15,000	27,100	30,100	20,700	4,550	8,600	29,525	31,100	-	-
Sulphur Magentic (Gals)	Fungicide	-	-	-	350	-	-	32	-	-	-	-
Sulphur Micro-Niasul (Lbs)	Fungicide	-	-	-	-	-	-	1,260	3,800	-	-	-
Sulphur-Wettable (Lbs)	Fungicide	-	-	-	-	-	-	-	-	-	4,000	10,800
Summer Oil (Gals)	Insecticide	-	-	-	-	-	-	-	-	29,000	5,500	1,050
Systox (Gals)	Insecticide	13	-	2	-	-	-	-	-	-	-	-
Tedion 25WP (Lbs)	Insecticide	2,350	48,800	110,900	132,200	173,300	74,800	-	-	47,200	-	-
Tedion EC	Insecticide	-	-	-	-	175	600	975	3,000	3,500	120	130
Tedion EC (Qts)	Insecticide	-	-	-	-	-	-	30	-	-	-	-
Tedion EC (5 Gals)	Insecticide	-	-	-	-	-	2,000	4,700	-	-	1,000	-
Tedion 25 WP (Lbs)	Insecticide	-	-	-	-	-	-	84,400	82,100	-	12,400	300
Telvar (Lbs)	Weedicide	-	-	-	-	-	100	-	-	-	-	-
TEPP 40% (1/2 Gal)	Insecticide	-	-	20	25	25	20	-	40	60	-	-
TEPP 40% (Gal)	Insecticide	-	-	20	-	-	20	8	3	-	30	-
Thiodan 2EC (Gals)	Insecticide	-	-	-	10	30	-	-	170	50	-	-
Thiodan 4EC (Gals)	Insecticide	-	-	-	-	-	-	150	-	15	-	-
Thiodan 50W (Lbs)	Insecticide	-	1,100	9,400	18,200	39,600	25,800	33,450	44,000	39,600	26,800	42,000
Triton B1956 (Gals)	Insecticide	-	-	-	-	-	-	350	-	-	-	-
Tronabor (Lbs)	Weedicide	-	256,400	236,250	293,200	284,800	2,593,500	-	-	-	-	-
Vapam (Gals)	Insecticide	-	-	-	-	8	-	-	-	-	-	-
Vegetation Killer (Lbs)	Weedicide	-	-	-	210	-	-	-	-	-	-	-
Visko (Lbs)	Insecticide	2,200	1,300	-	-	-	-	-	-	-	-	-
Warfarin (Lbs)						-	-	-	95	-	-	-
Weedazol (Lbs)	Weedicide	-	700	85	-	-	-	-	-	-	-	-
Weedazol (1 Lb)	Weedicide	25	-	-	125	-	-	-	-	-	-	-
Weedazol (4 Lbs)	Weedicide	135	-	-	300	-	-	-	-	-	-	-
Weedazol (25 Lbs)	Weedicide	-	-	-	600	-	-	-	-	-	-	-
Weed Foe (6 oz)	Weedicide	-	2	-	-	-	-	-	-	-	-	-
Weed Foe (Qt)	Weedicide	-	25	-	-	-	-	-	-	-	-	-
Ziram (Lbs)	Fungicide	69,200	21,700	25,000	19,000	14,400	6,200	12,400	11,200	-	17,900	69,700
Zolone (Lbs)	Insecticide	-	-	-	-	-	-	-	-	-	8,400	56,700
2,4-D-Dow Formula 40 Gals	Weedicide	-	-	95	-	-	-	-	-	-	-	-

APPENDIX G

STREAM WATER QUALITY

GRAPHICAL PRESENTATION OF VARIATION

IN CONCENTRATION OF SELECTED WATER

QUALITY PARAMETERS OVER MONITORING PERIOD

APPENDIX G

Graphical presentation selected water quality parameters: Colour, Turbidity, Dissolved Oxygen, Conductivity, PH, Phosphorus, Nitrogen and Carbon for the following streams:

(1) Inkaneep Creek
(2) Vaseux Creek
(3) Ellis Creek
(4) Penticton Creek
(5) Trout Creek
(6) Peachland Creek
(7) Powers Creek
(8) Mission Creek
(9) Kelowna Creek
(10) Brandt's Creek
(11) Lambly Creek
(12) Shorts Creek
(13) Equesis Creek
(14) Deep Creek
(15) BX Creek

Graphical flow data is also included for the majority of the above creeks.

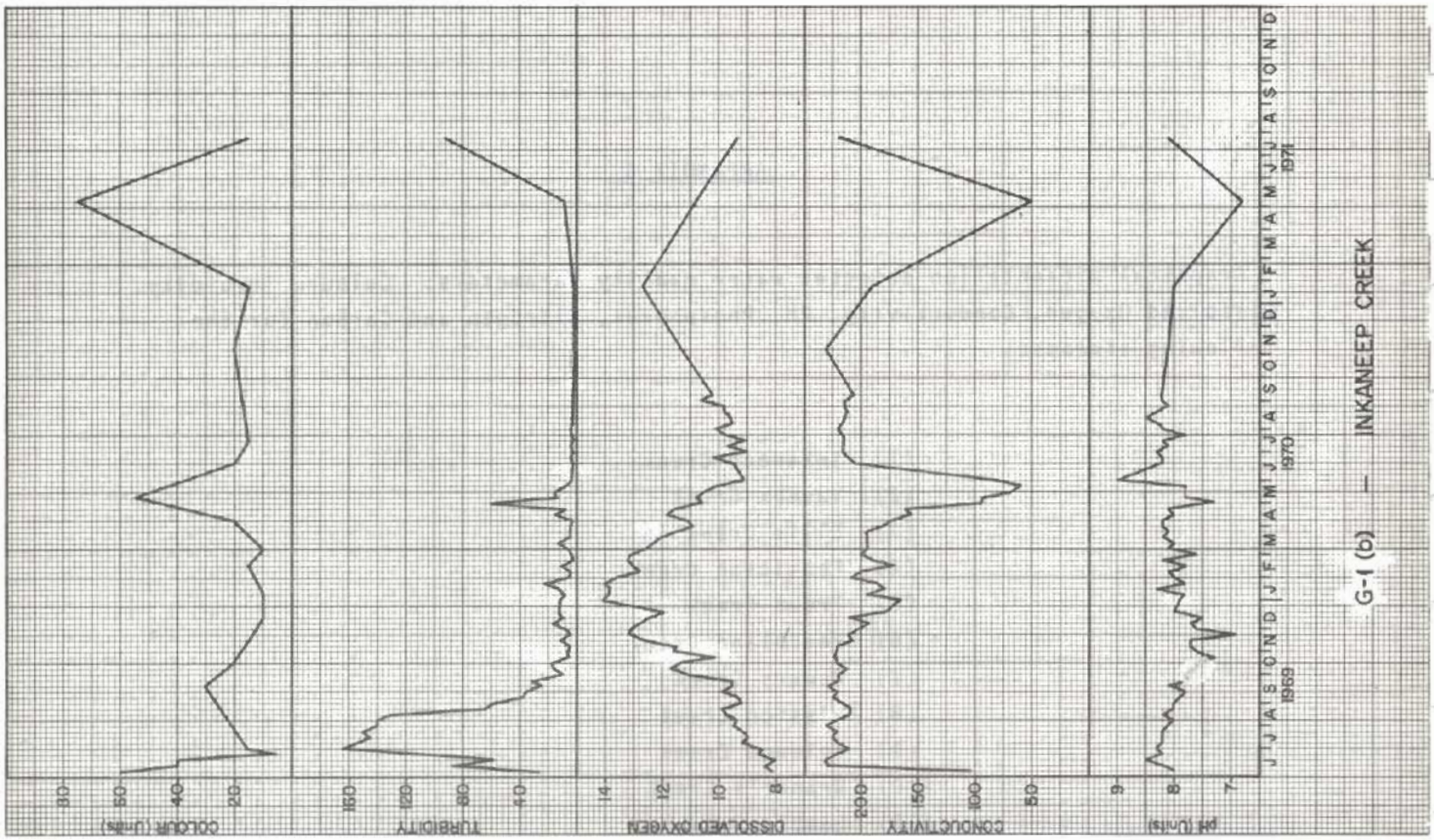
The Parameters plotted are:

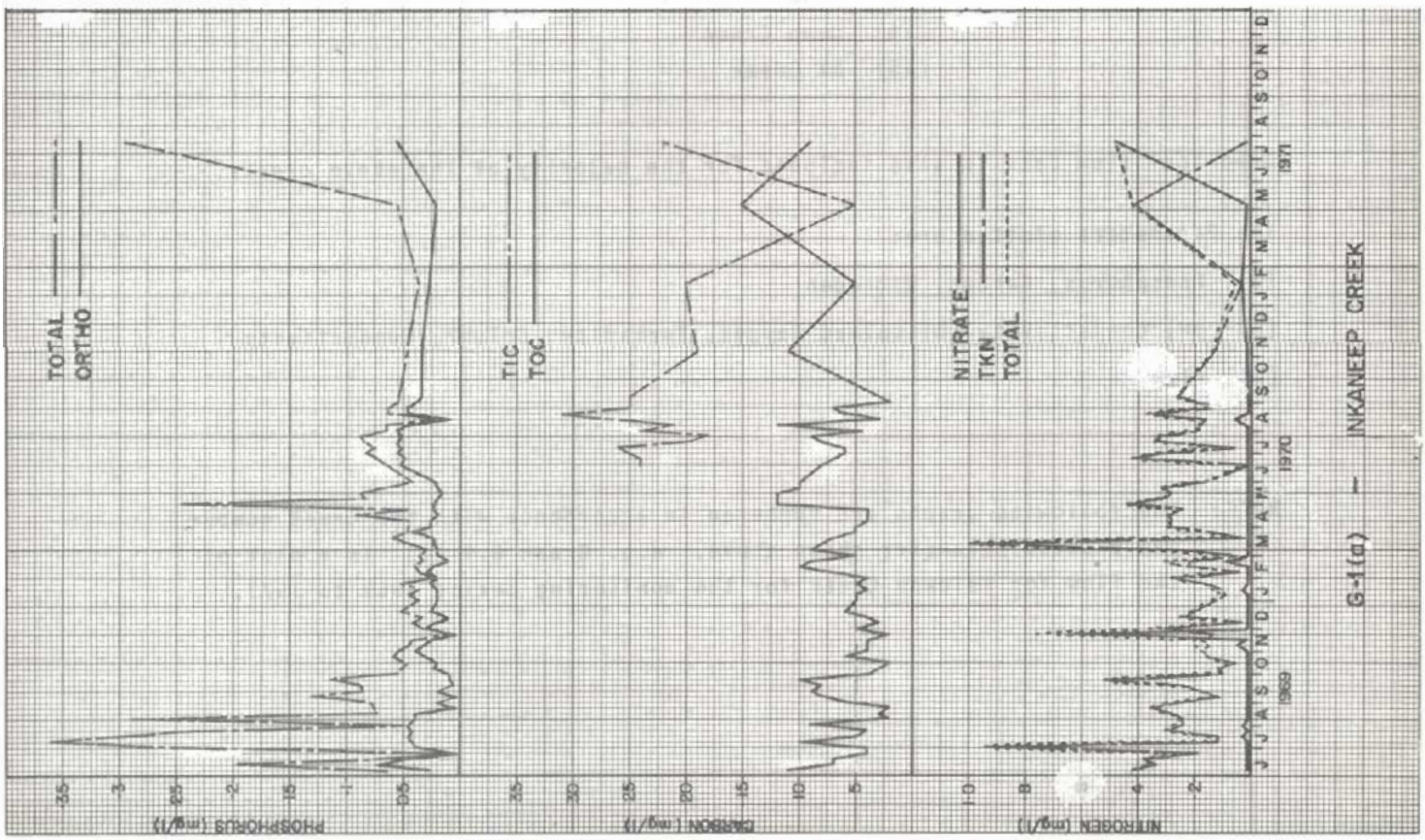
(a) Phosphorus, Carbon, Nitrogen

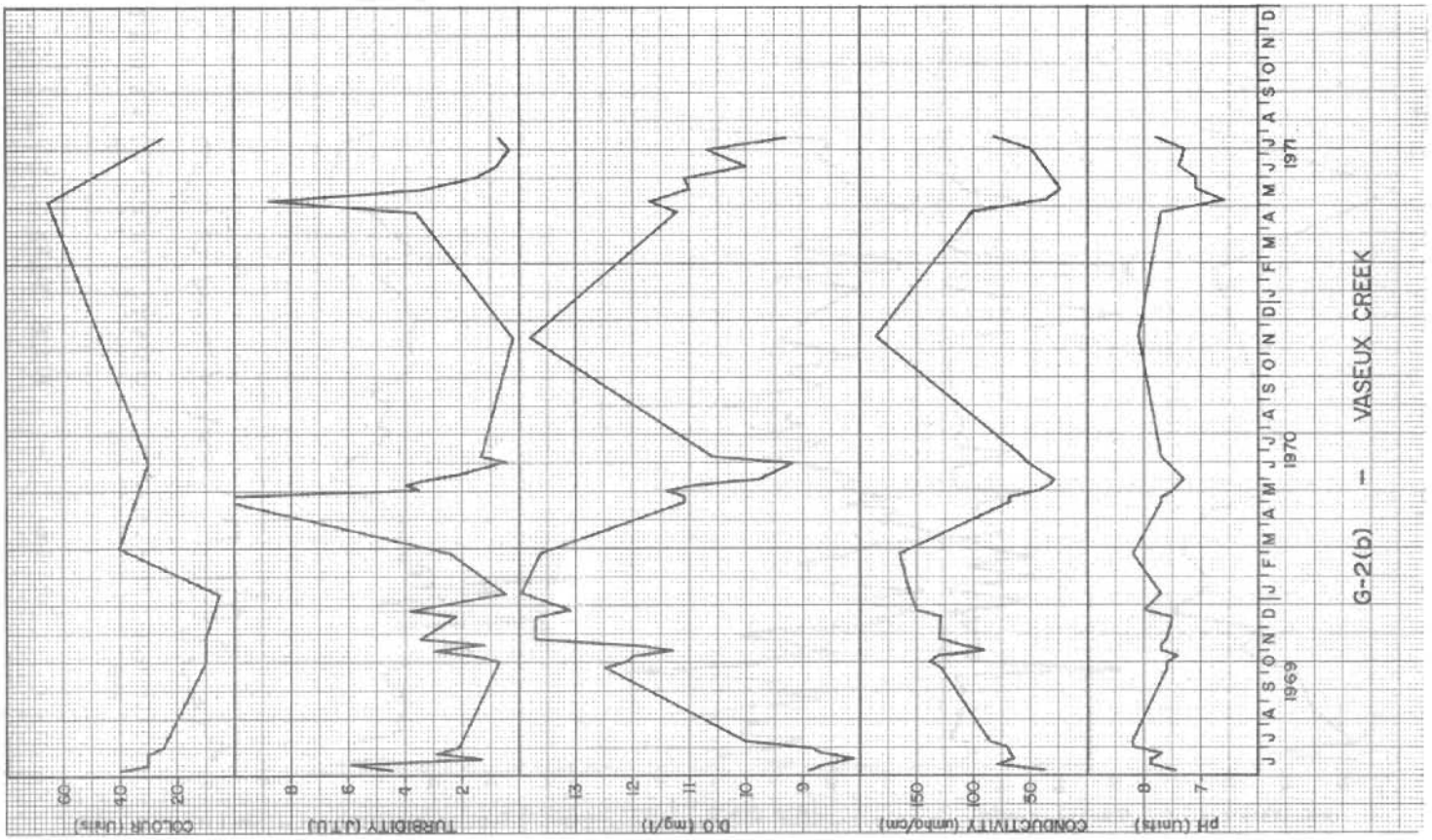
(b) pH, Conductivity, Dissolved Oxygen, Turbidity, Colour, Conductivity

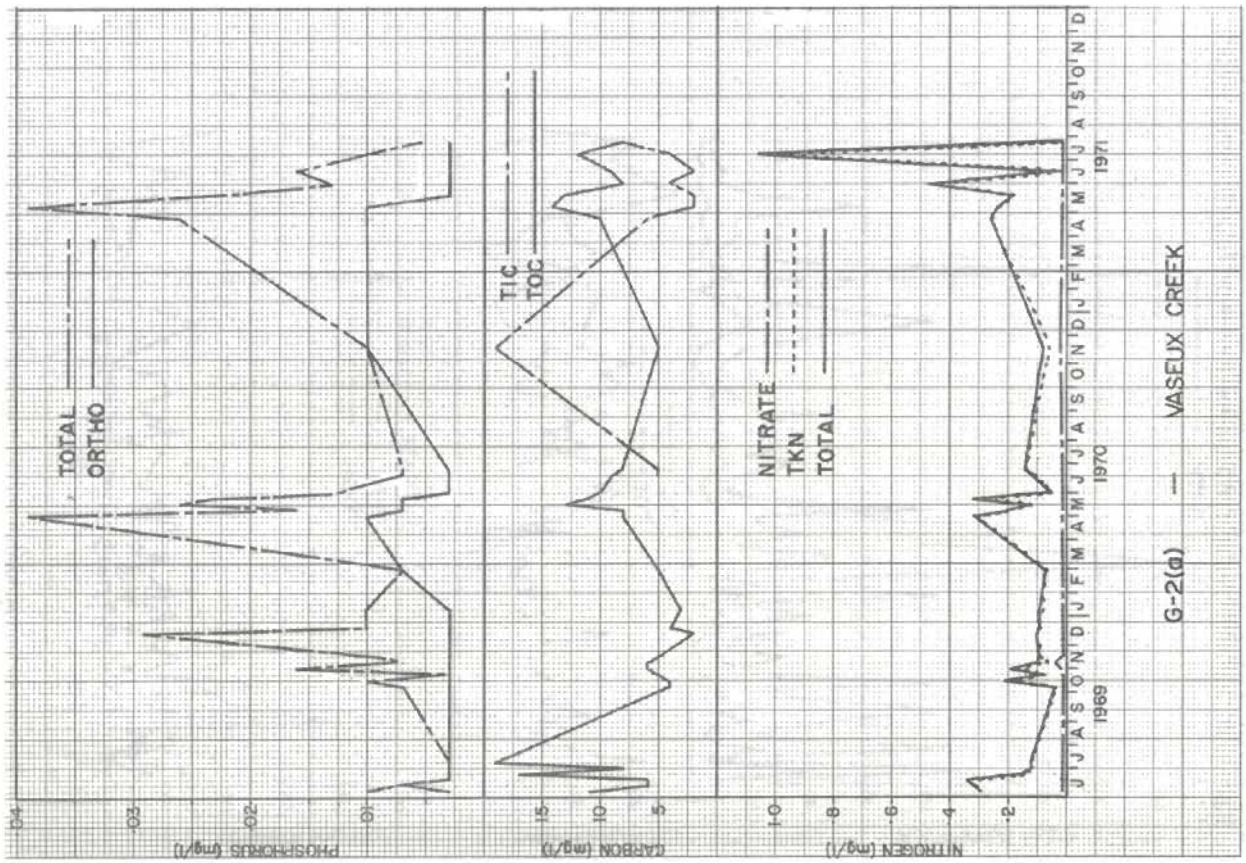
(c) Flow

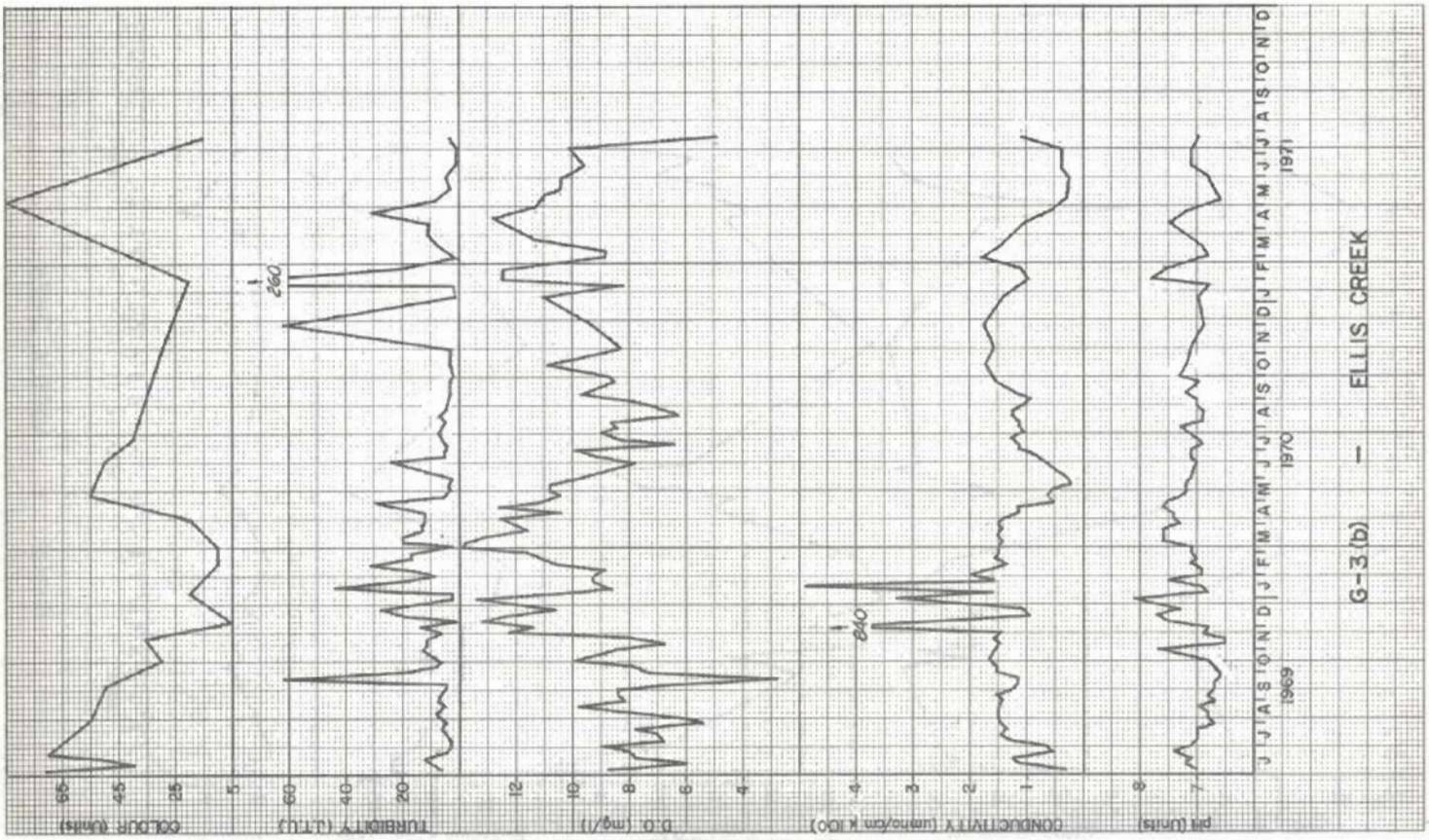
NOTE: The following graphs are numbered in accordance with the Creek number and plotted parameter shown above. e.g. Graph G.9 (c) is a plot of the flow for Kelowna Creek for the monitoring period 1969 to 1971.

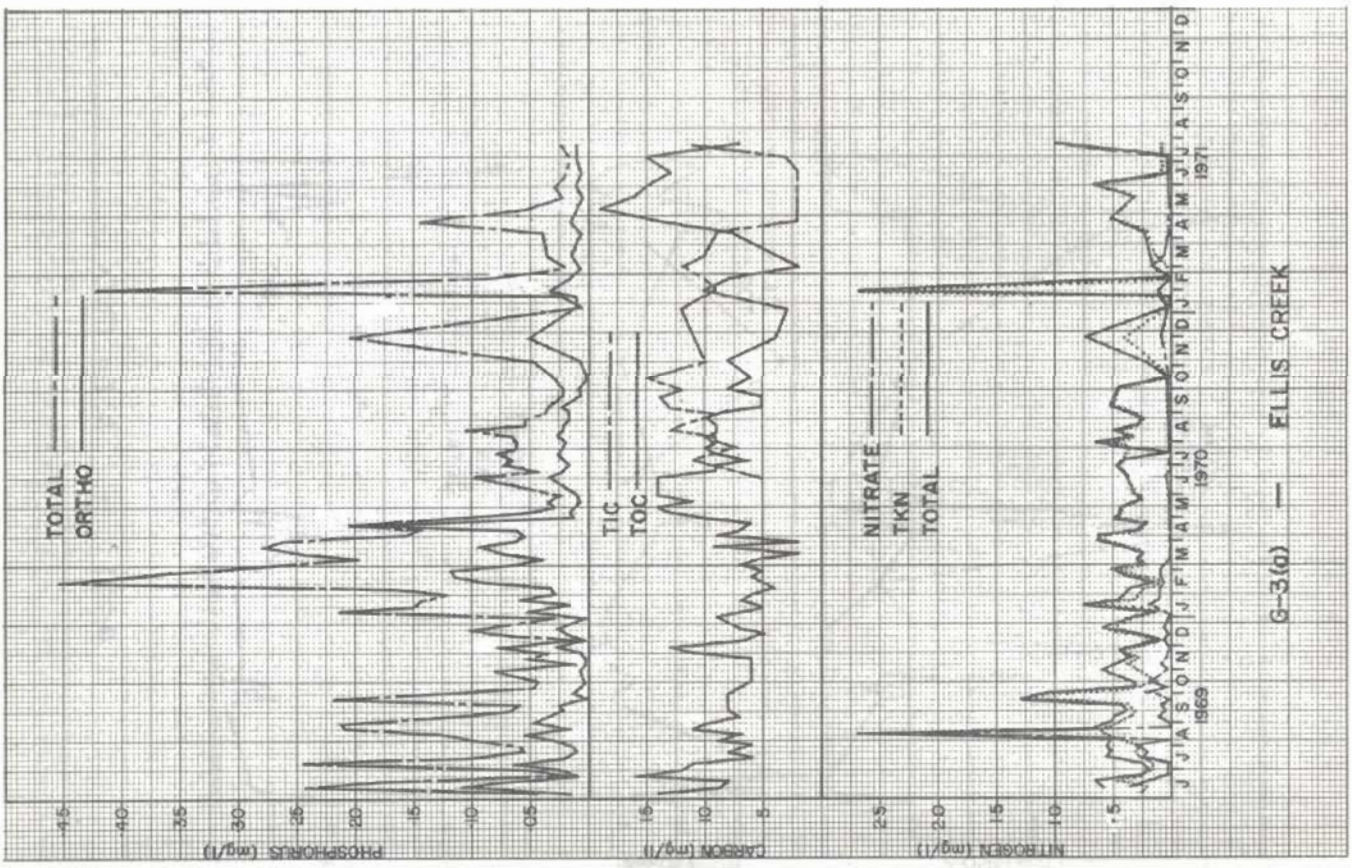

G-1(b) — INKANEEP CREEK
COLOUR (Units)
TURBIDITY
DISSOLVED OXYGEN
CONDUCTIVITY
pH (Units)
1969
1970
1971

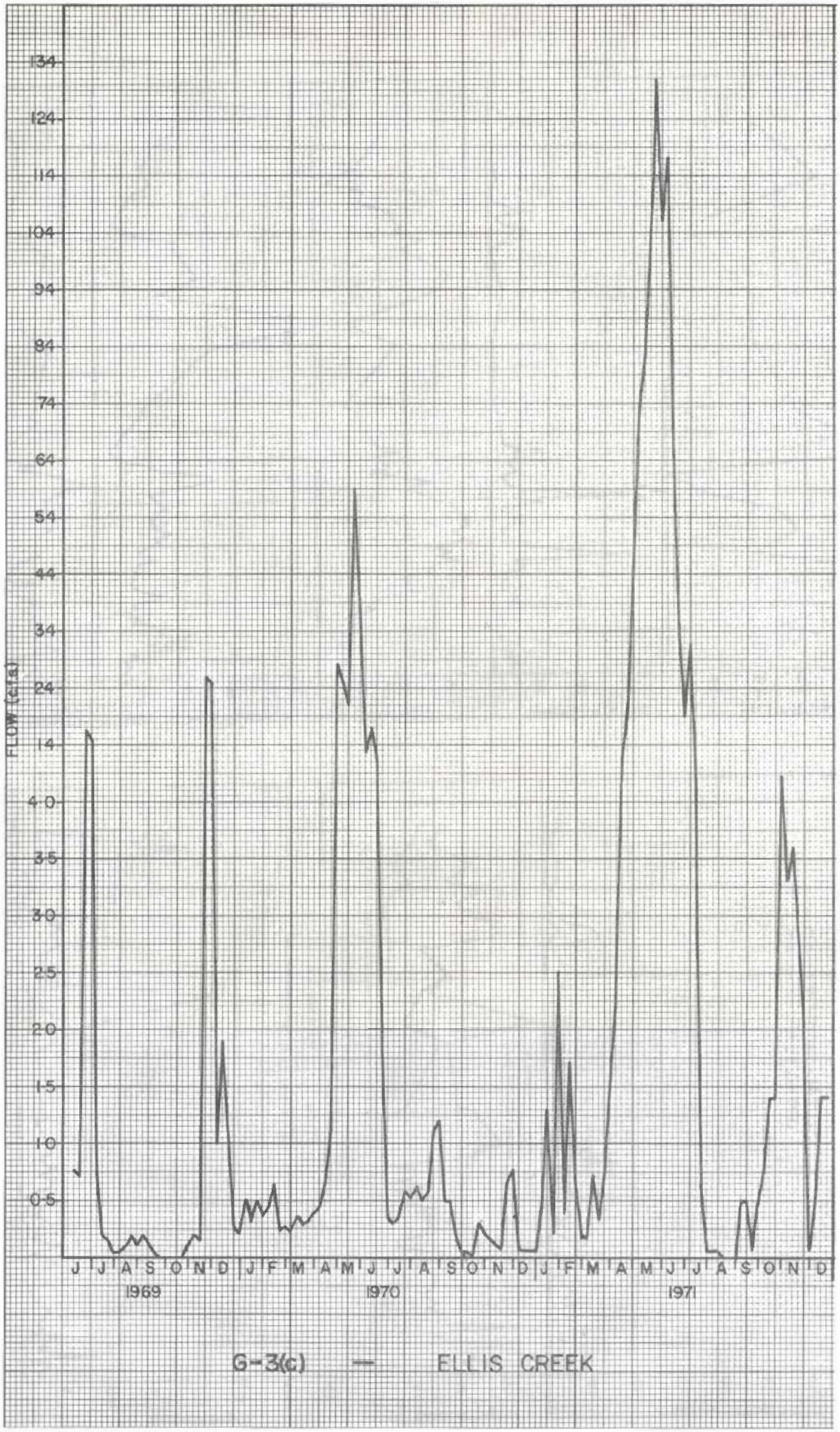

G-1(a) — INKANEEP CREEK
TOTAL
ORTHO
PHOSPHORUS (mg/l)
T.I.C.
T.O.C.
CARBON (mg/l)
NITRATE
TKN
TOTAL
NITROGEN (mg/l)
1969
1970
1971


G-2(b) — VASEUX CREEK
1969
1970
1971
pH (units)
CONDUCTIVITY (umho/cm)
D.O. (mg/l)
TURBIDITY (J.T.U.)
COLOUR (units)

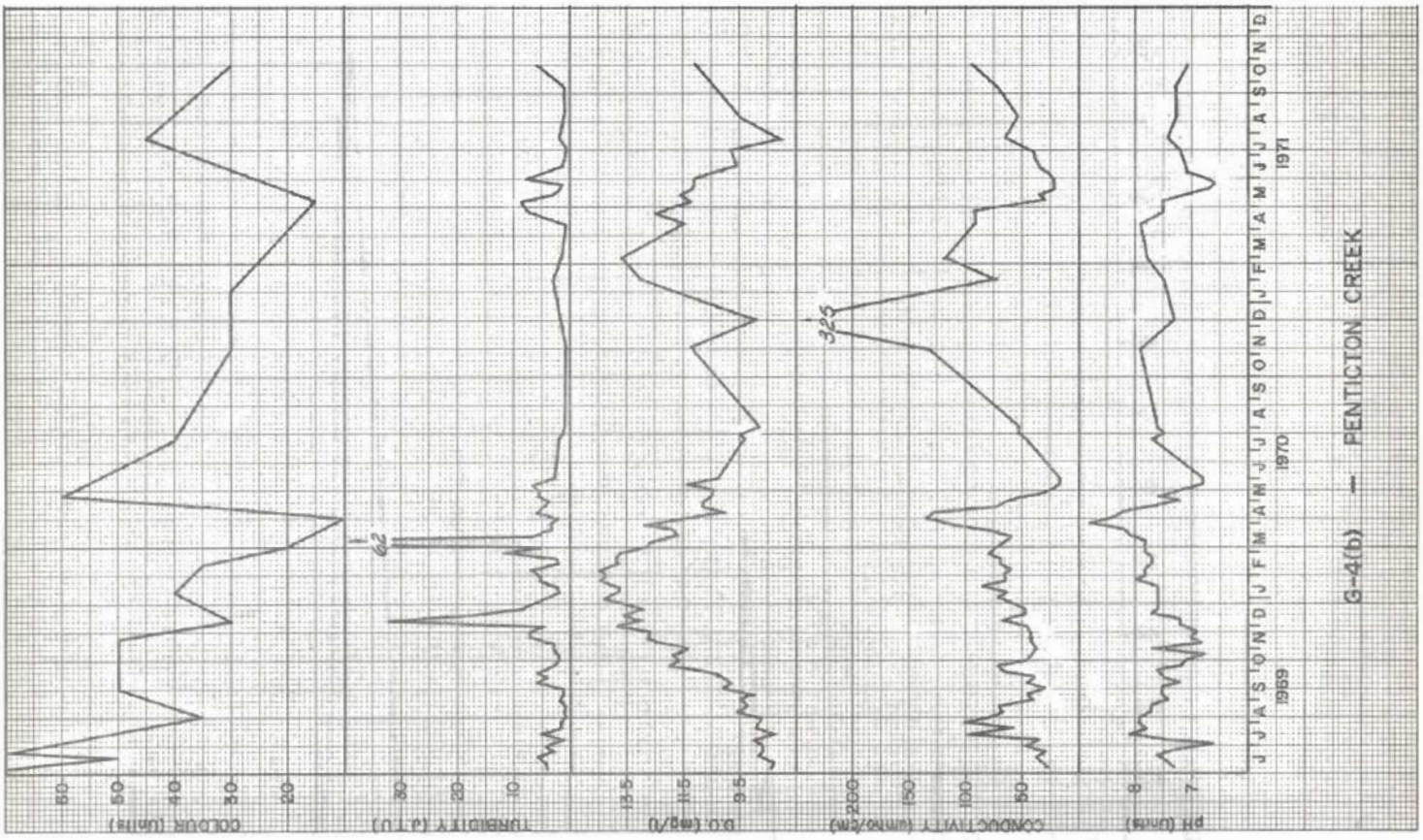

G-2(a) — VASEUX CREEK
1969
1970
1971
NITROGEN (mg/l)
NITRATE
TKN
TOTAL
CARBON (mg/l)
TIC
TOC
PHOSPHORUS (mg/l)
TOTAL
ORTHO

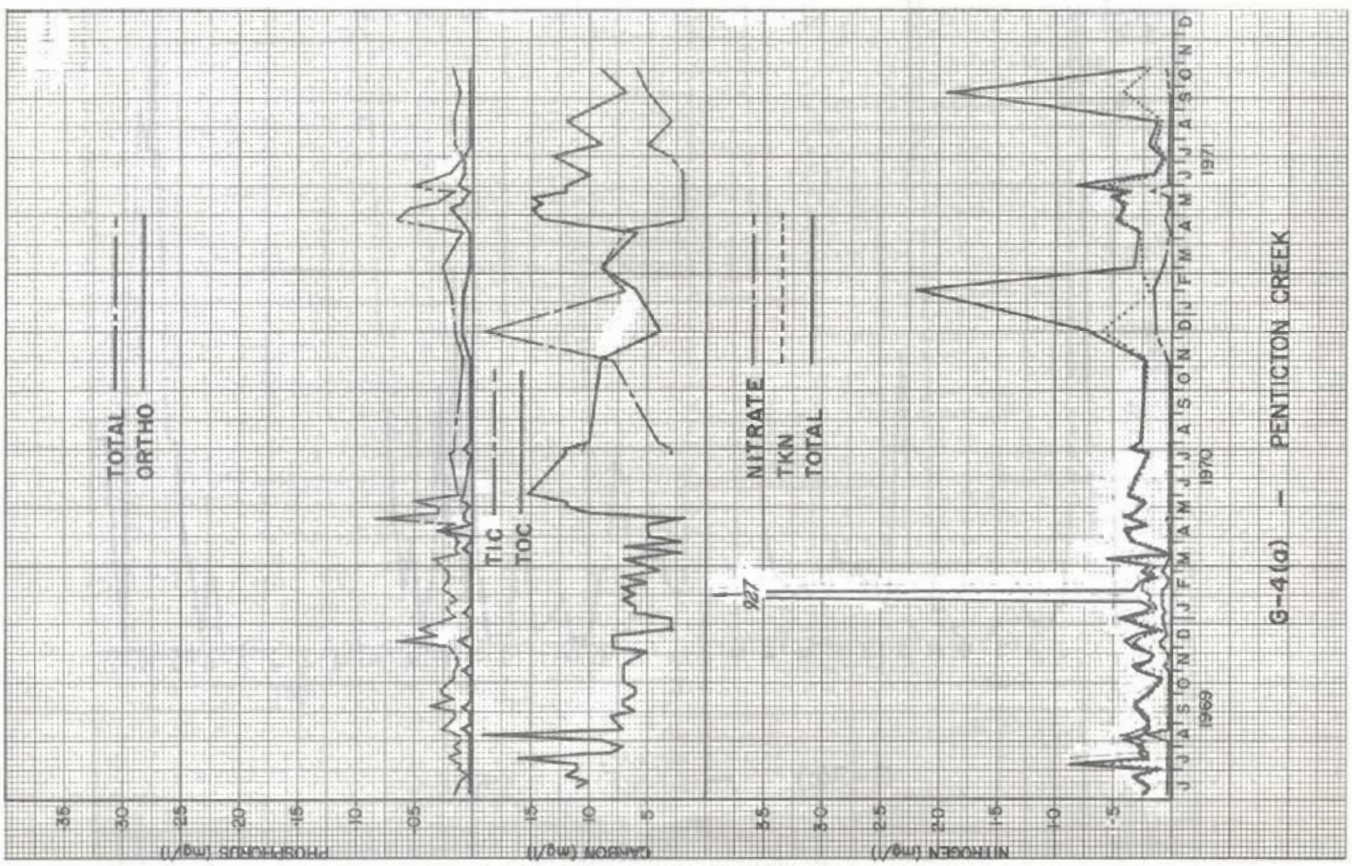

G-3(b) — ELLIS CREEK
COLOUR (Units)
TURBIDITY (J.T.U.)
D.O. (mg/l)
CONDUCTIVITY (micro/cm x 100)
pH (Units)
1969
1970
1971

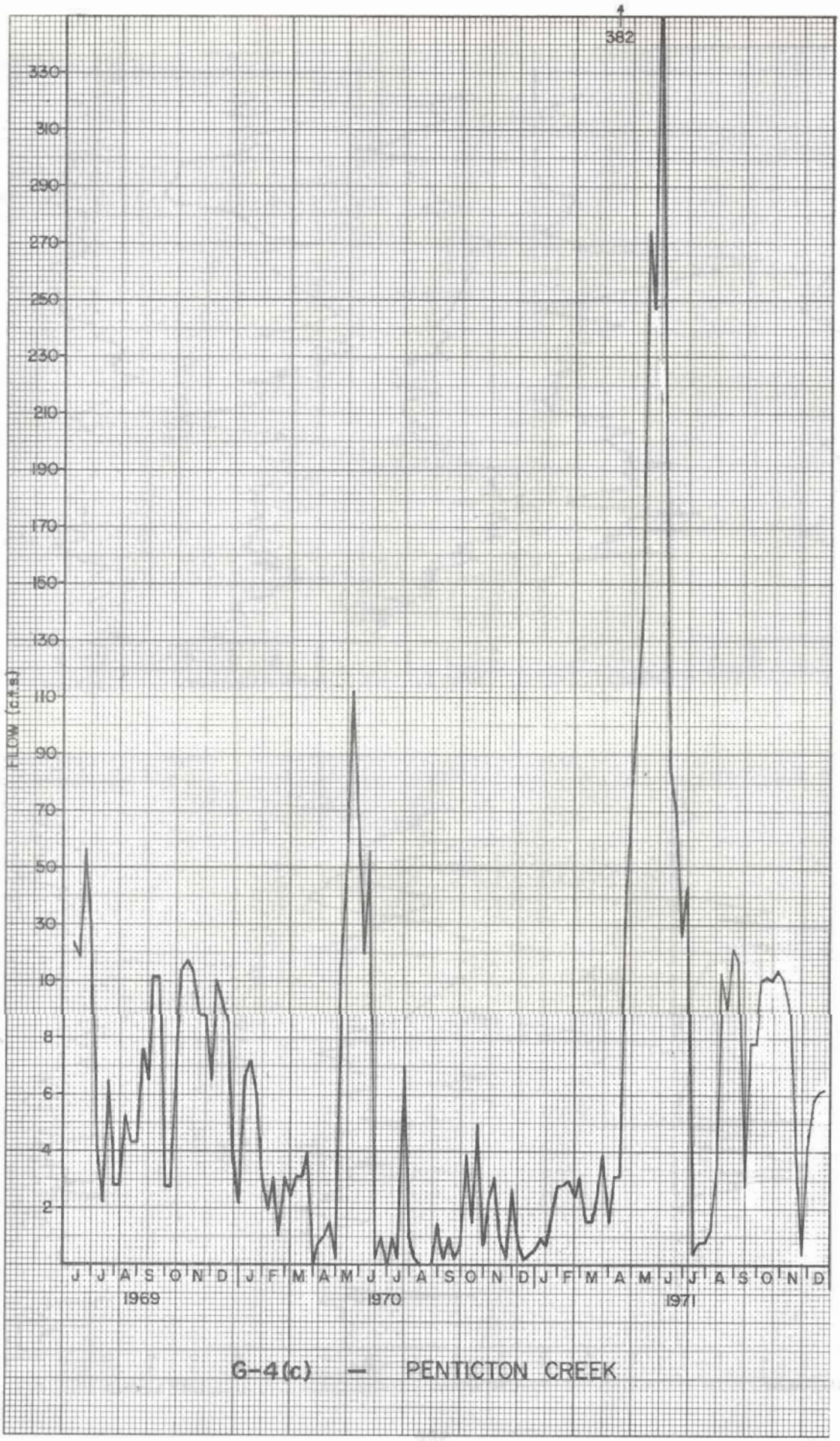

G-3(c) — ELLIS CREEK
TOTAL
ORTHO
PHOSPHORUS (mg/l)
TIC
TOC
CARBON (mg/l)
NITRATE
TKN
TOTAL
NITROGEN (mg/l)
1969
1970
1971



G-3(c) — ELLIS CREEK

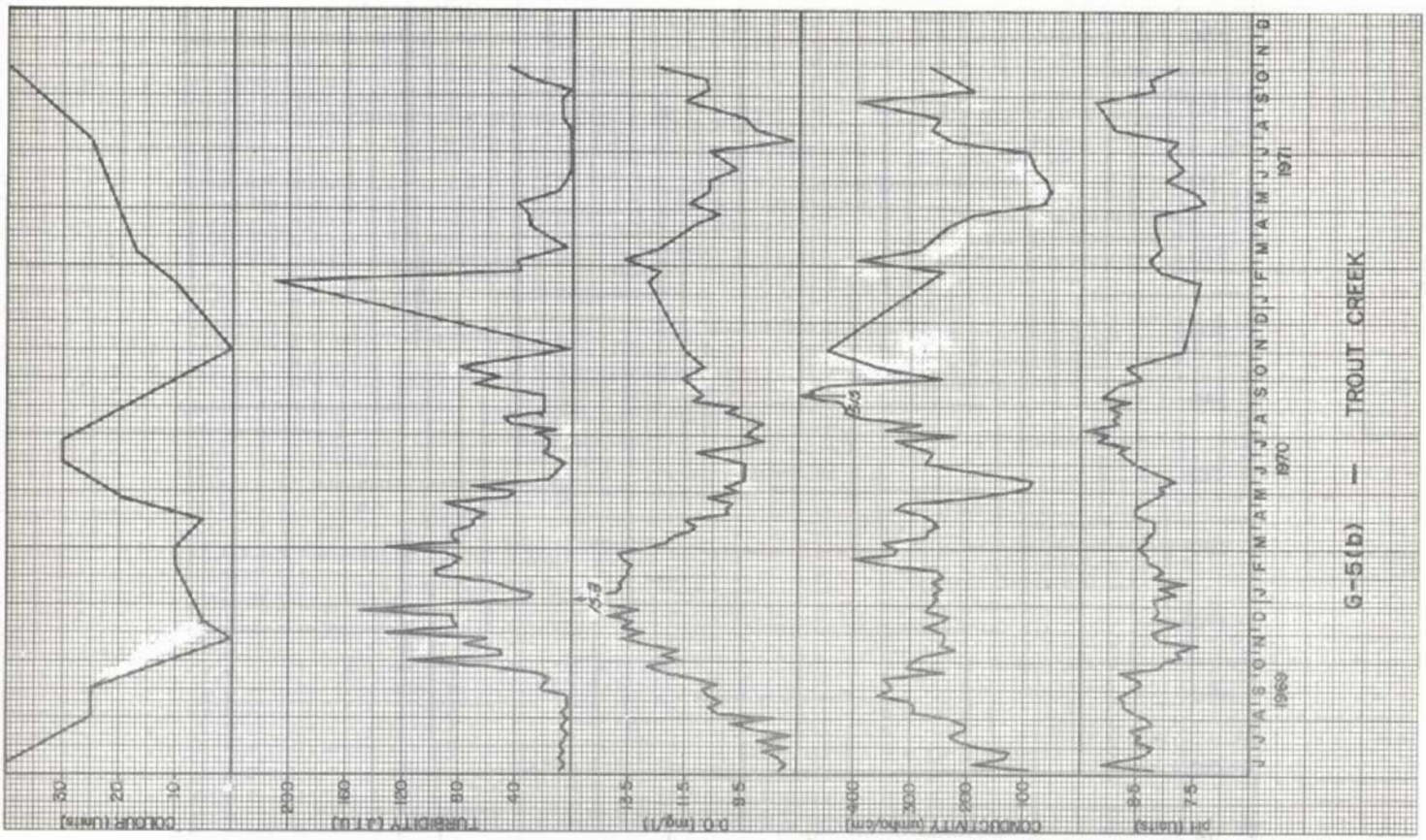

COLOUR (Units)
TURBIDITY (J.T.U.)
D.O. (mg/l)
CONDUCTIVITY (micro mhos/cm)
pH (Units)
1969
1970
1971
G-4(b) — PENTICTON CREEK

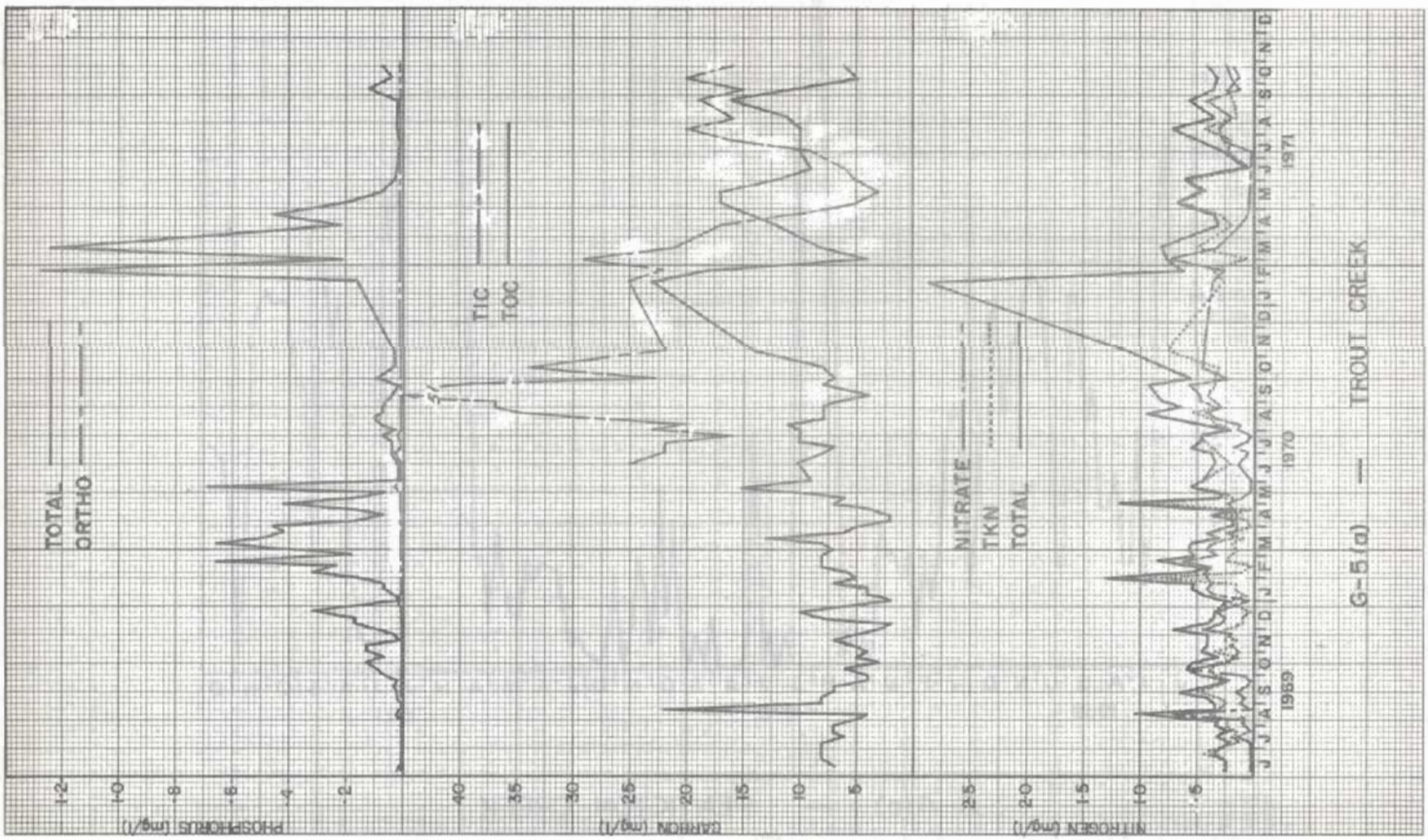

TOTAL
ORTHO
TIC
TOC
NITRATE
TKN
TOTAL
PHOSPHORUS (mg/l)
CARBON (mg/l)
NITROGEN (mg/l)
1969
1970
1971
G-4(a) — PENTICTON CREEK

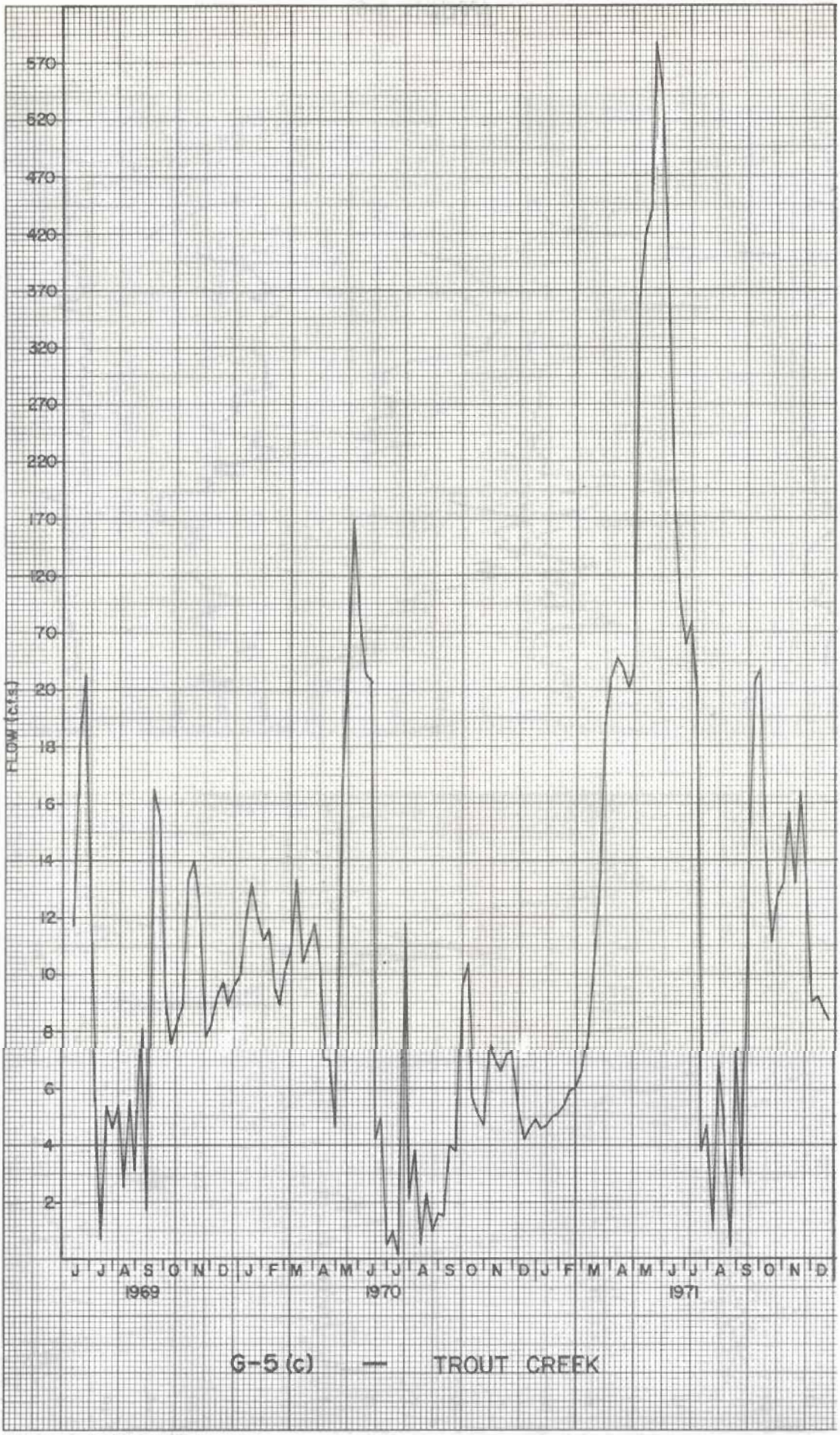


G-4(c) — PENTICTON CREEK

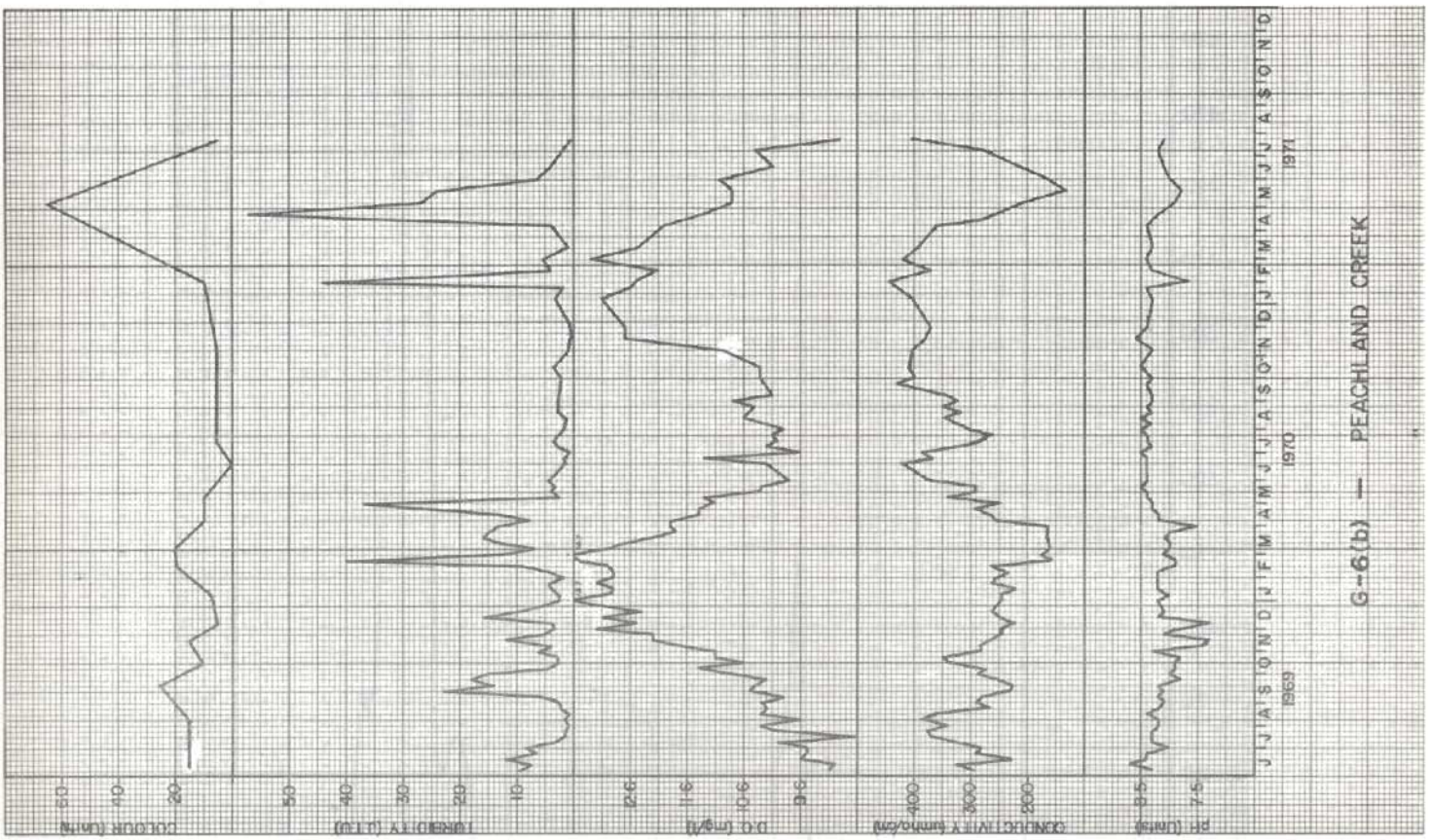
APPENDIX G-5

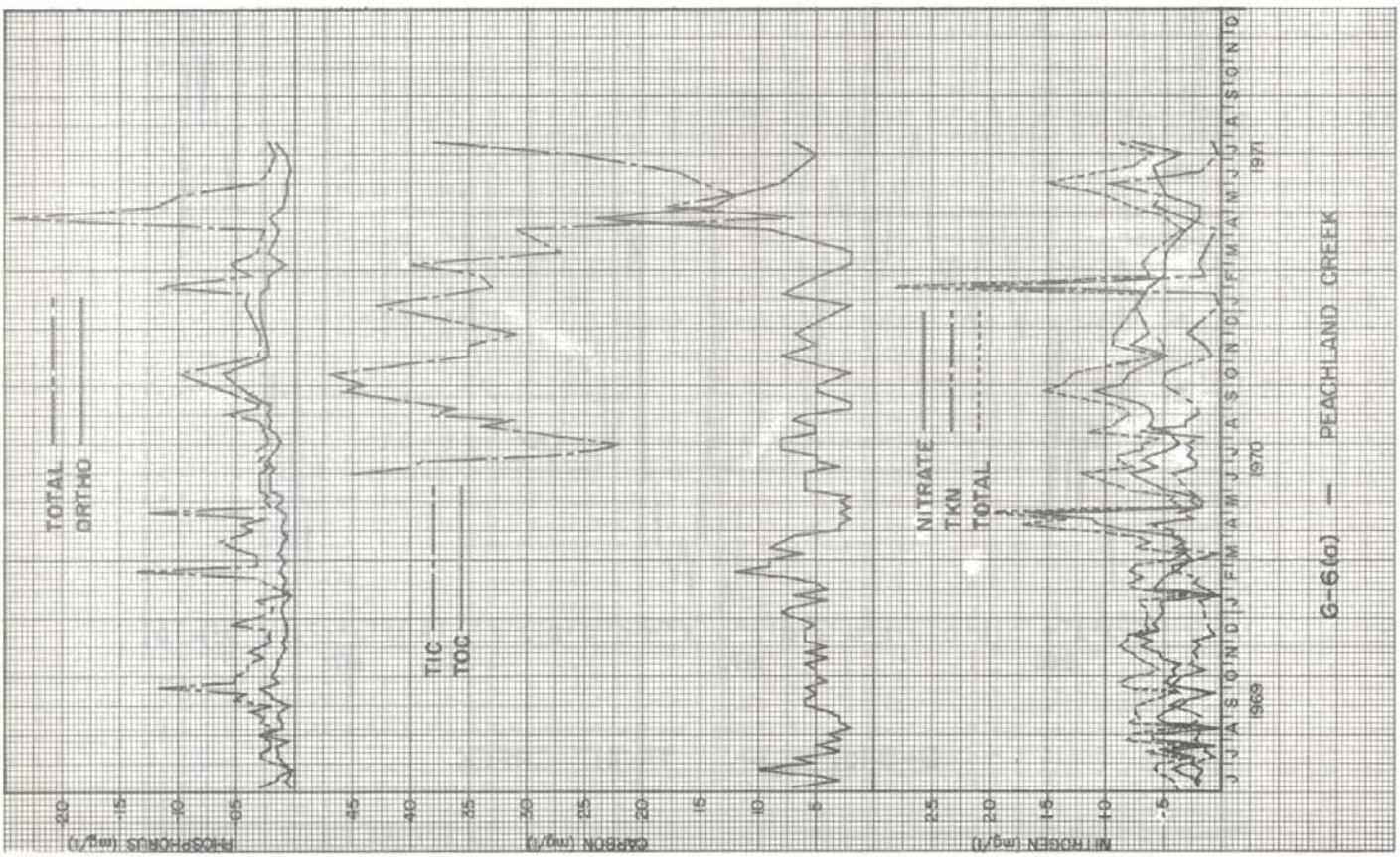

G-5(b) — TROUT CREEK
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
pH (units)
CONDUCTIVITY (umhos/cm)
D.O. (mg/l)
TURBIDITY (J.T.U.)
COLOUR (units)

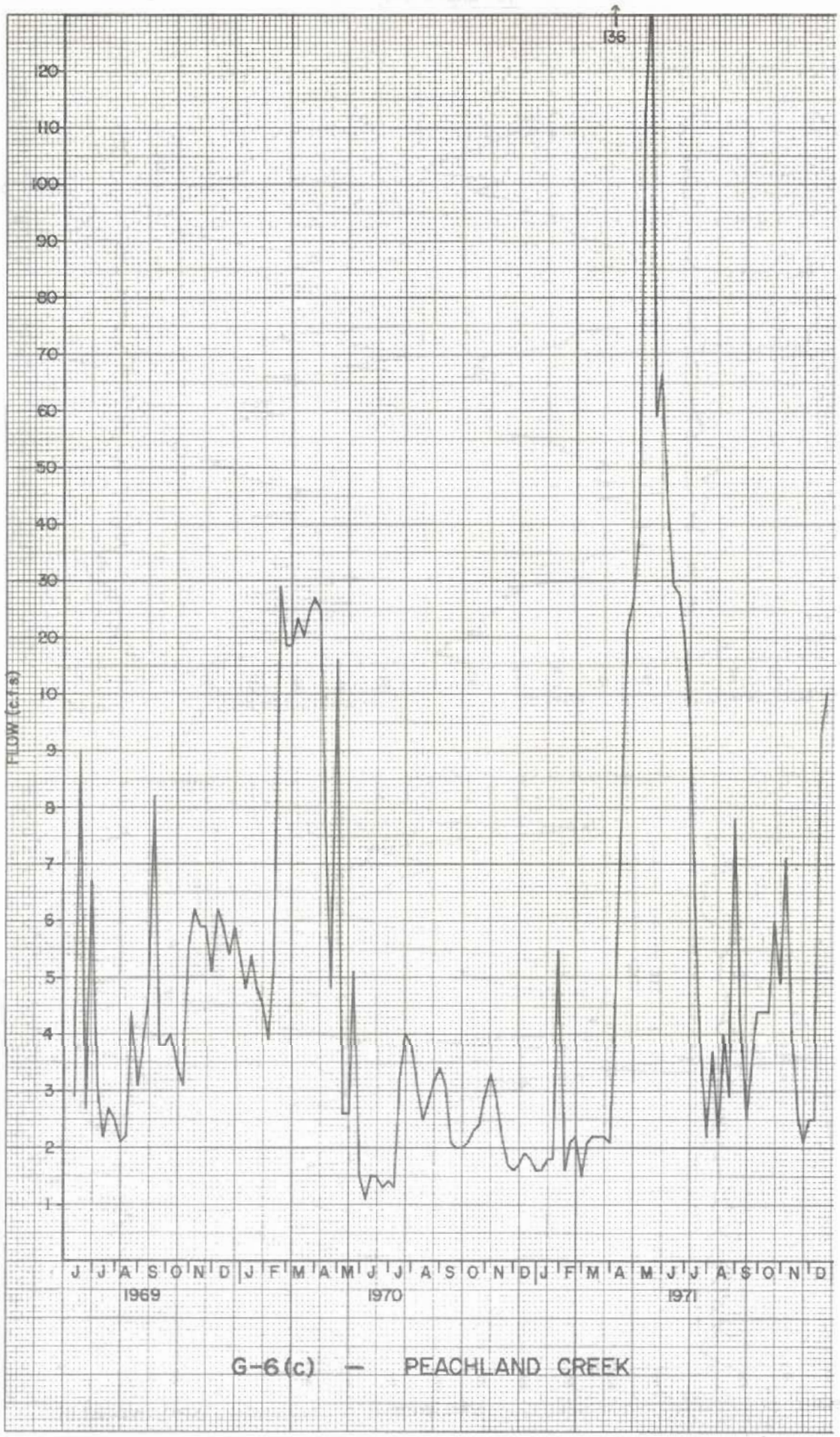

G-5(a) — TROUT CREEK
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
NITROGEN (mg/l)
CARBON (mg/l)
PHOSPHORUS (mg/l)
NITRATE
TKN
TOTAL
TIC
TOC
TOTAL
ORTHO



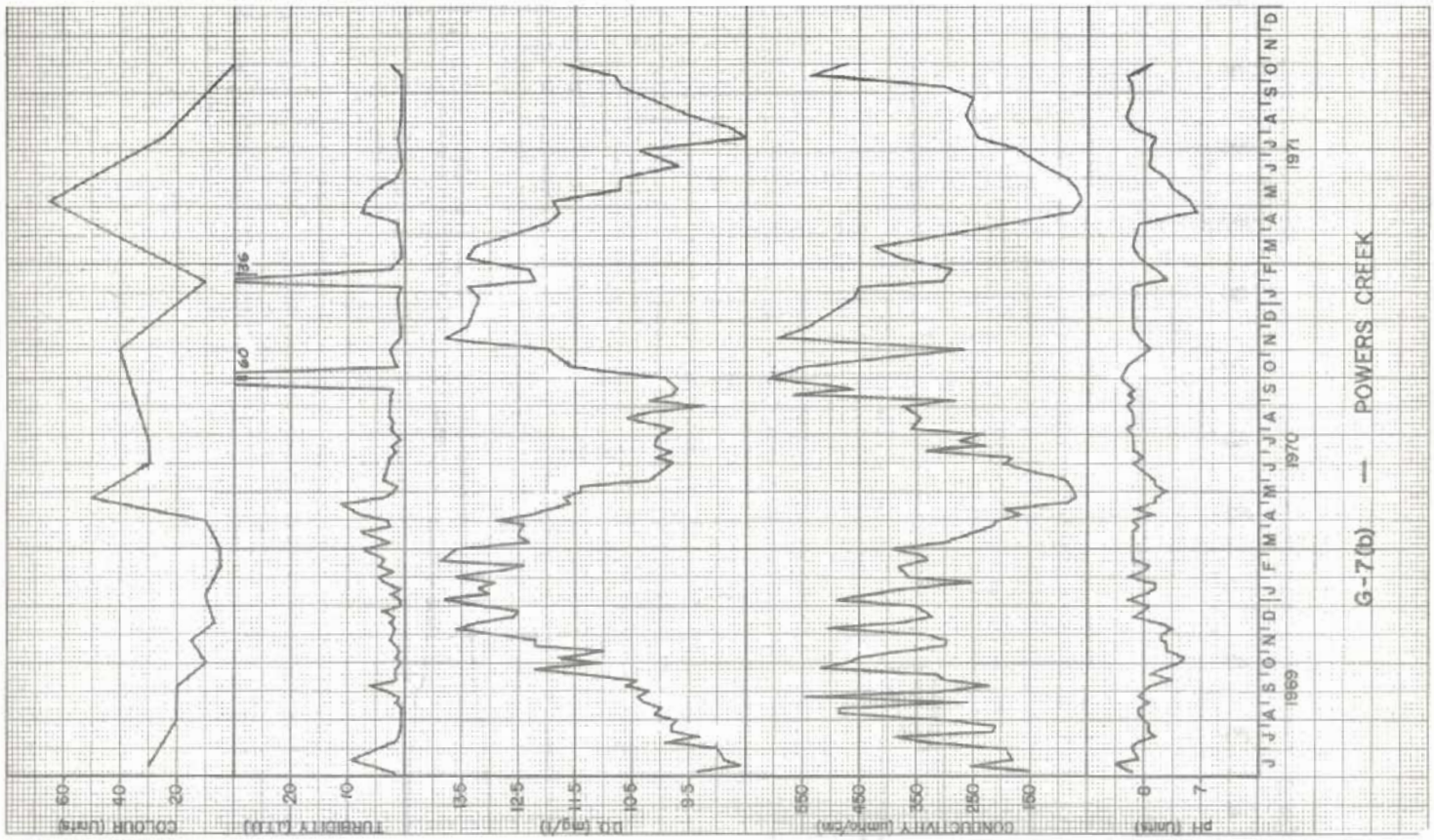
G-5 (c) — TROUT CREEK

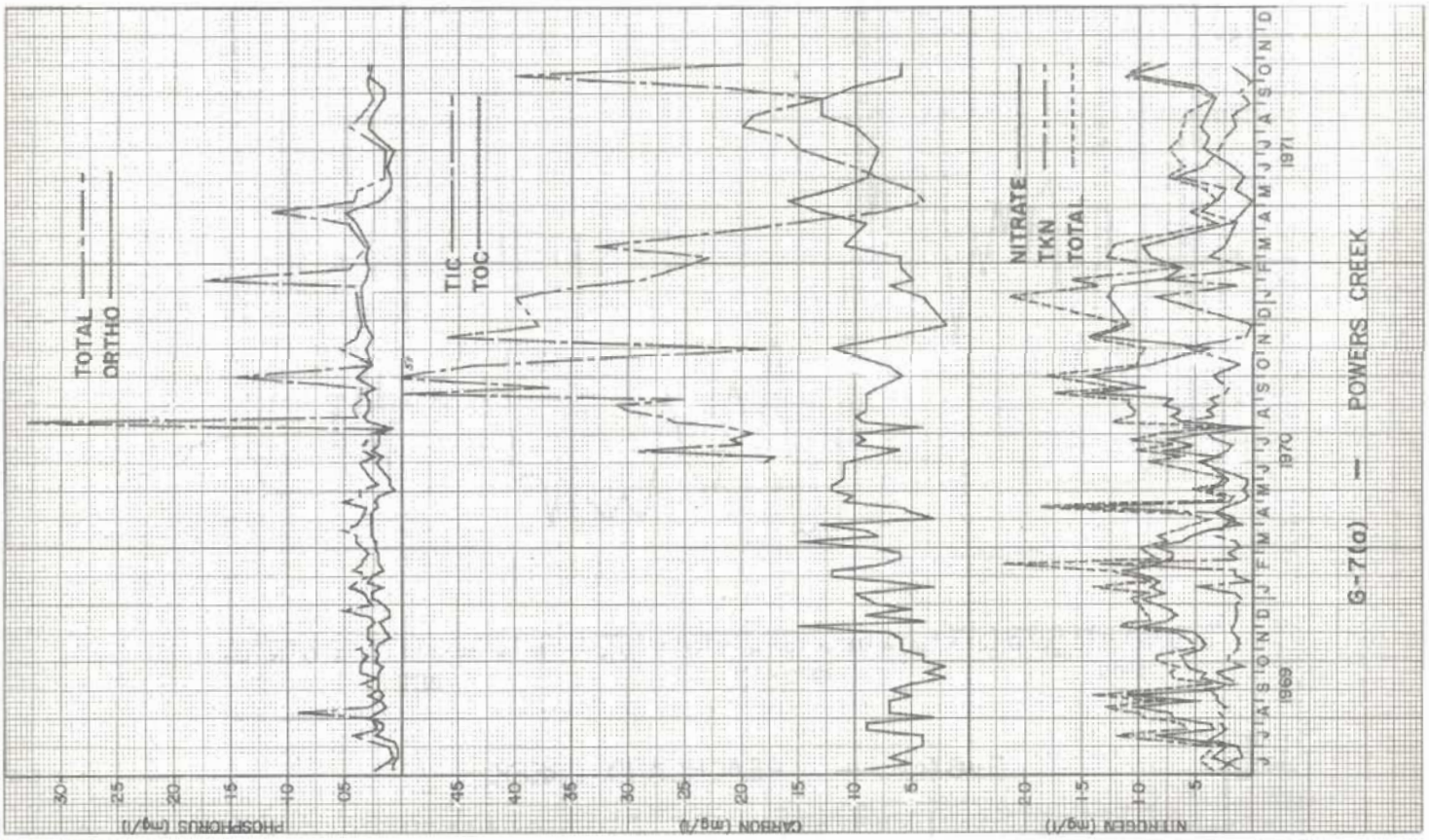

G-6(b) — PEACHLAND CREEK
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
COLOUR (Units)
TURBIDITY (J.T.U.)
D.O. (mg/l)
CONDUCTIVITY (µmho/cm)
PH (Units)

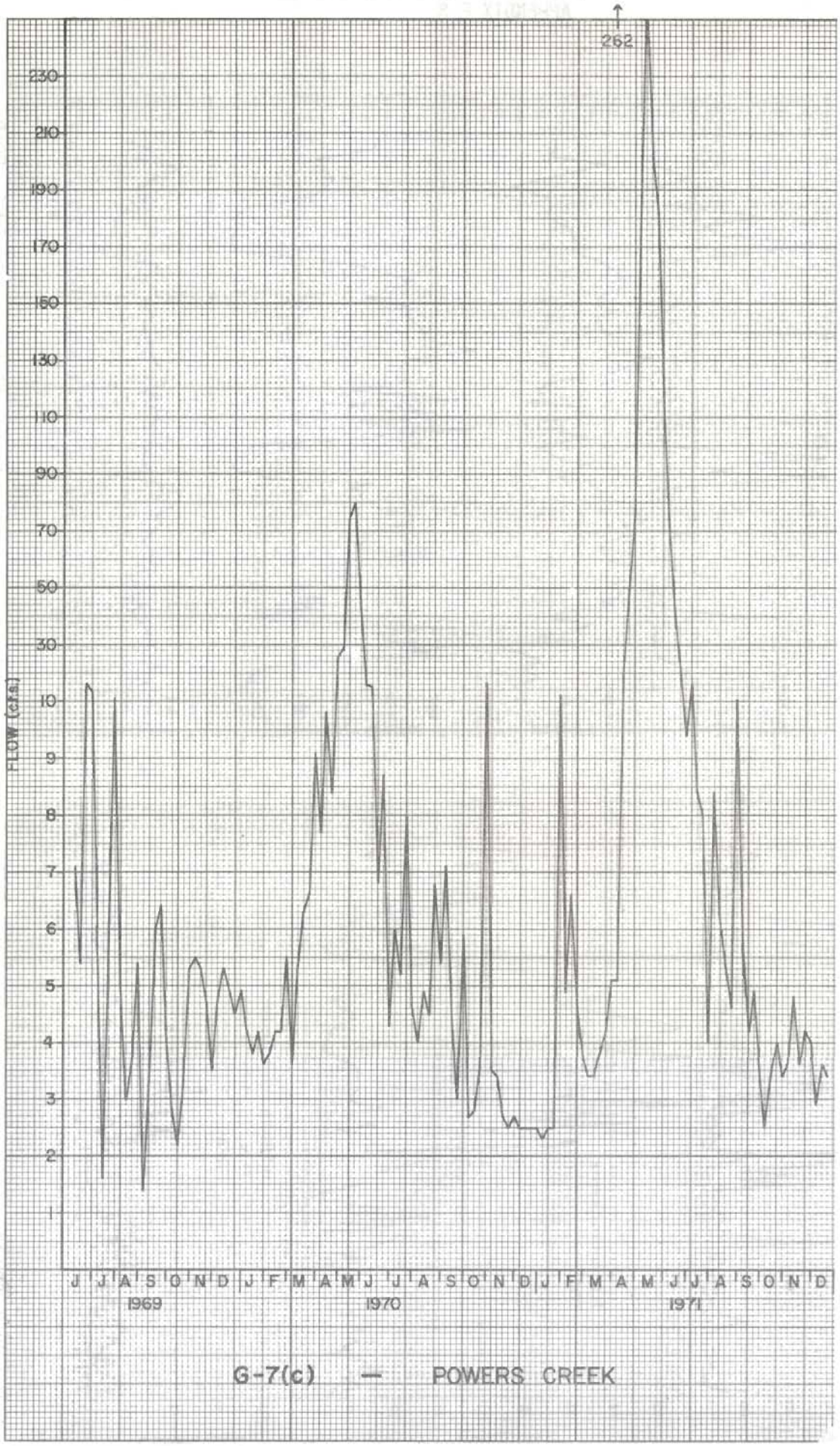

G-6(a) — PEACHLAND CREEK
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
TOTAL
ORTHO
PHOSPHORUS (mg/l)
T.I.C.
T.O.C.
CARBON (mg/l)
NITRATE
T.K.N.
TOTAL
NITROGEN (mg/l)



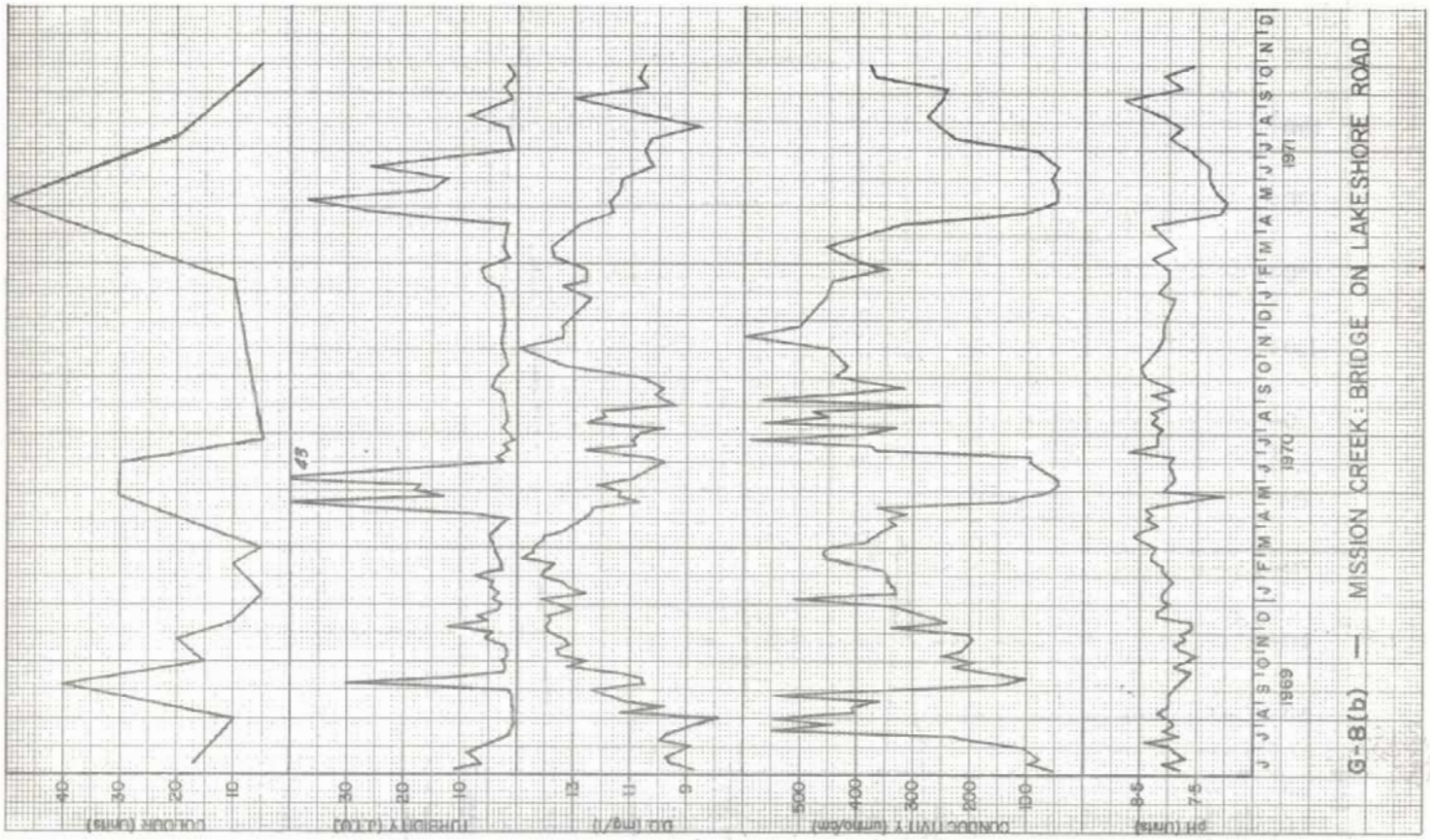
G-6(c) — PEACHLAND CREEK


COLOUR (Units)
TURBIDITY (JTU)
DO (mg/l)
CONDUCTIVITY (μmho/cm)
pH (Units)
J J A S O N D J F M A M J J A S O N D
1969
1970
1971
G-7(b) — POWERS CREEK

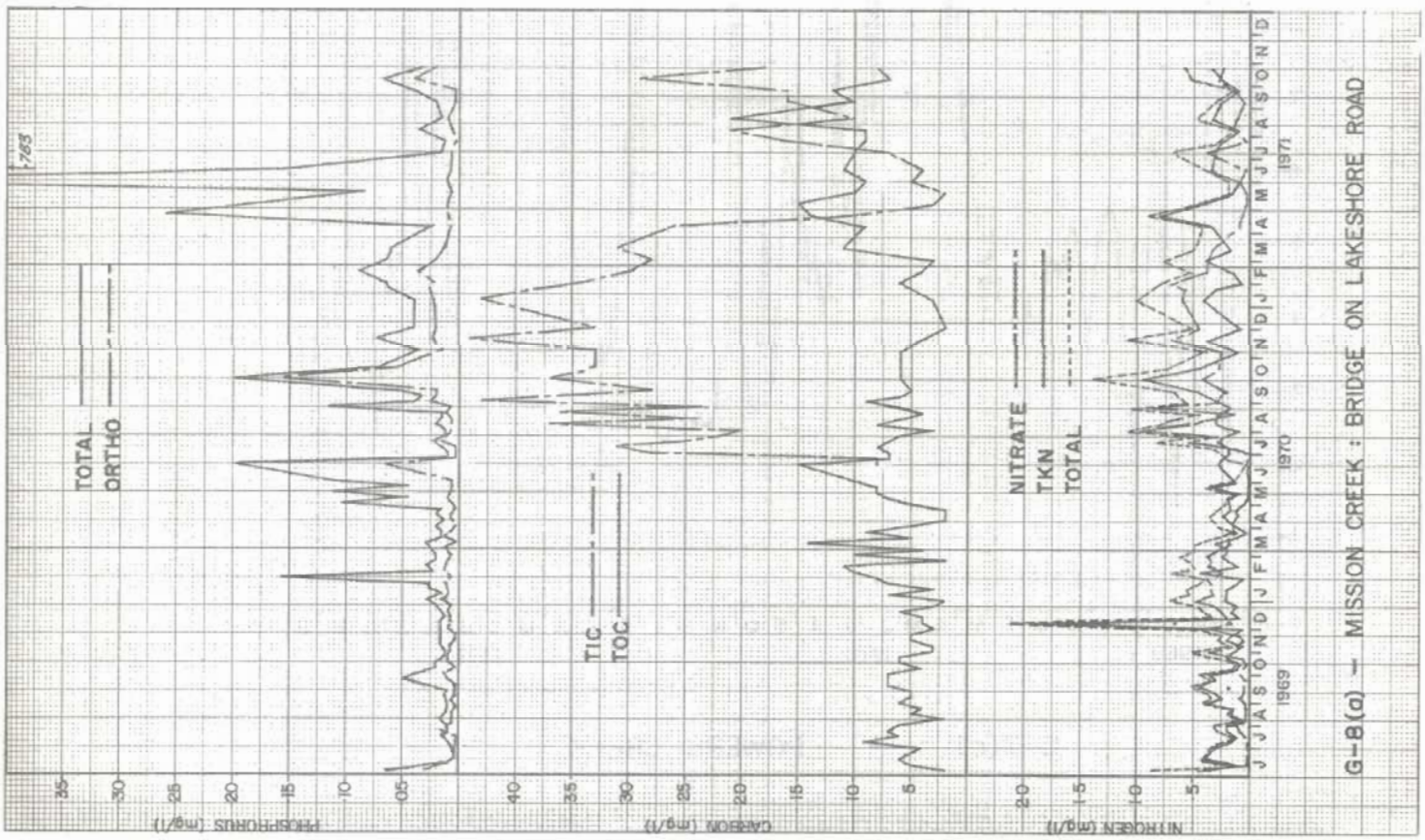

PHOSPHORUS (mg/l)
TOTAL
ORTHO
CARBON (mg/l)
TIC
TOC
NITROGEN (mg/l)
NITRATE
TKN
TOTAL
J J A S O N D J F M A M J J A S O N D
1969
1970
1971
G-7(a) — POWERS CREEK



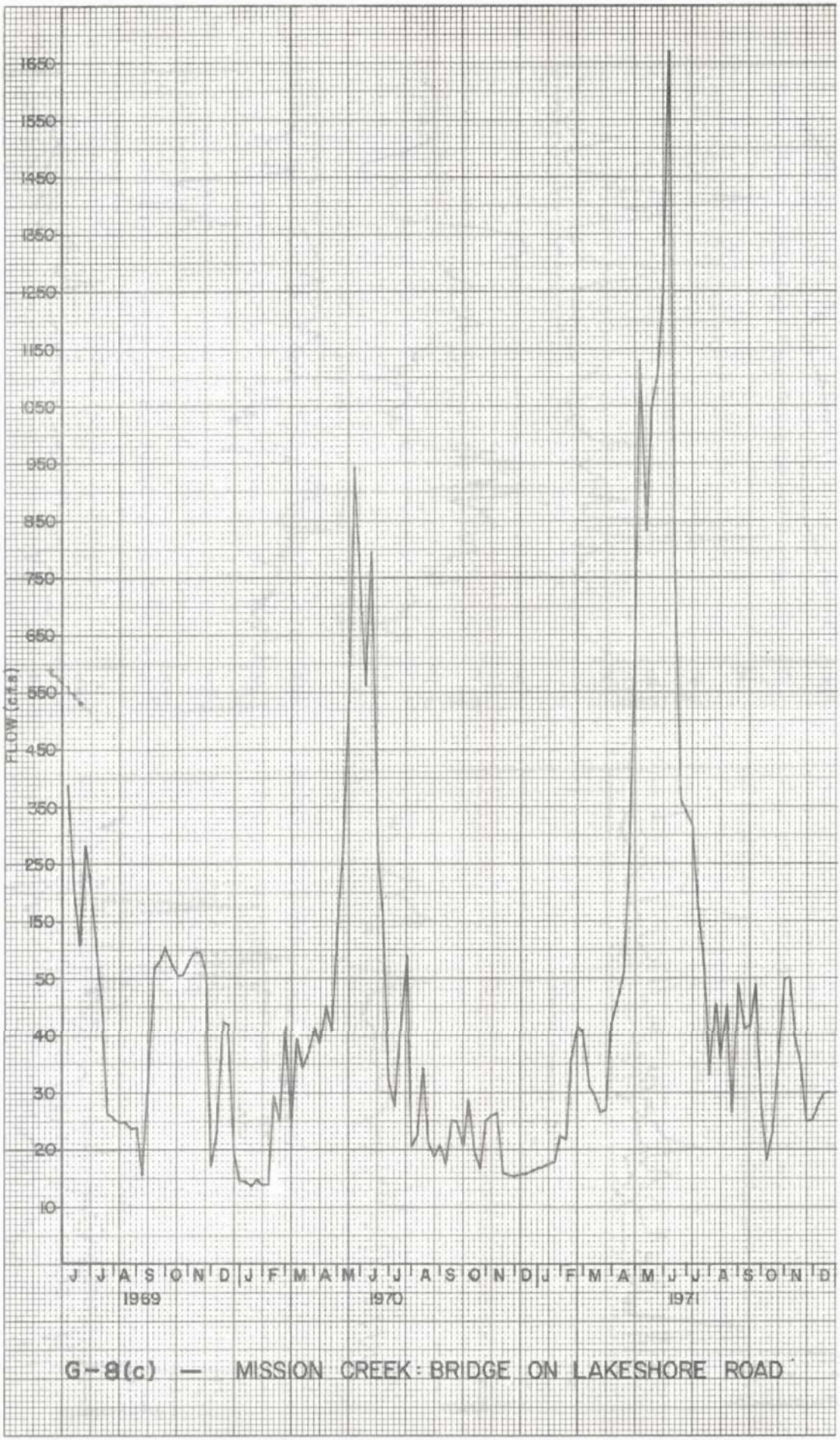
G-7(c) — POWERS CREEK



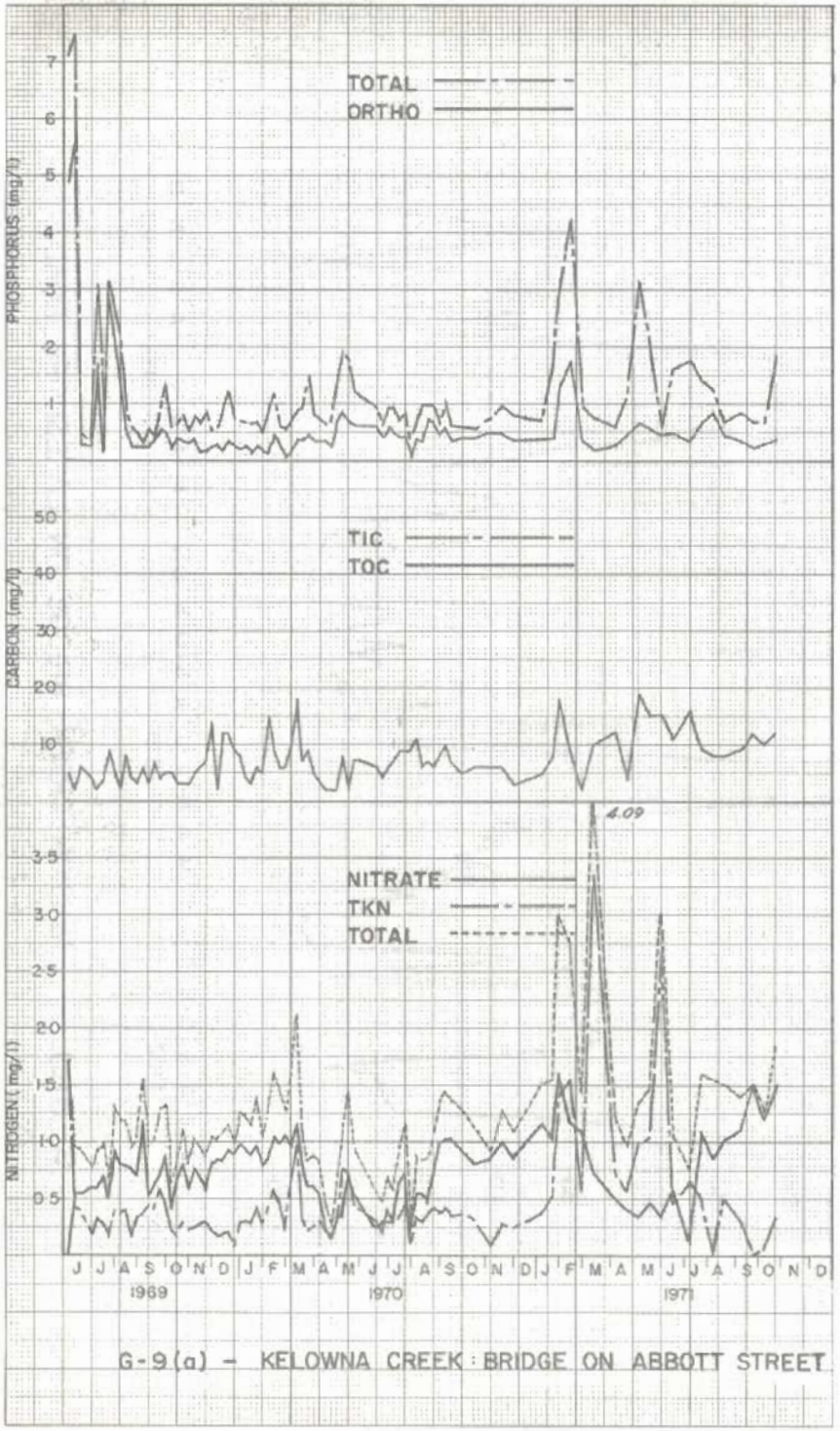
G-8(b) — MISSION CREEK: BRIDGE ON LAKESHORE ROAD



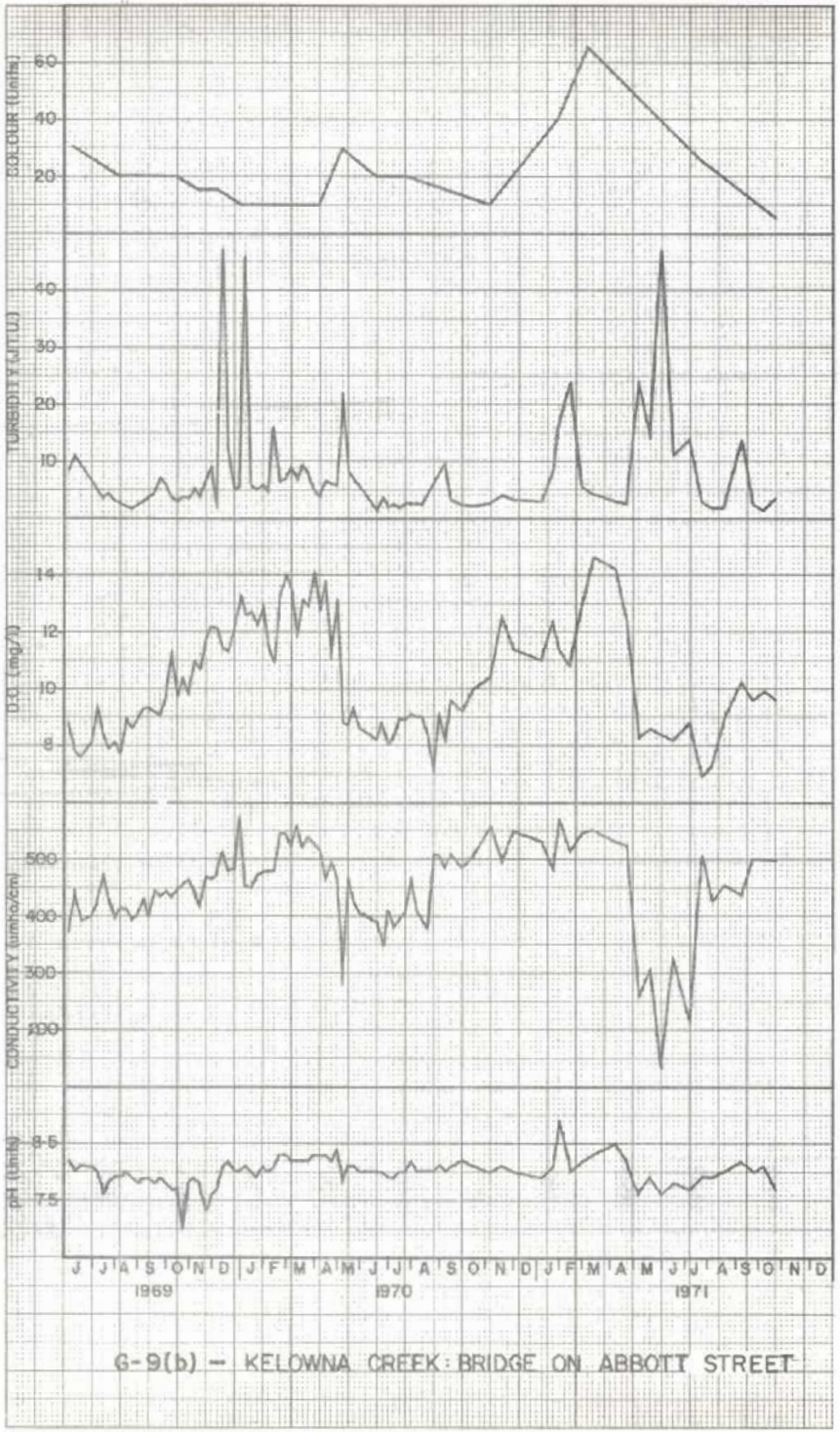
G-8(a) — MISSION CREEK : BRIDGE ON LAKESHORE ROAD



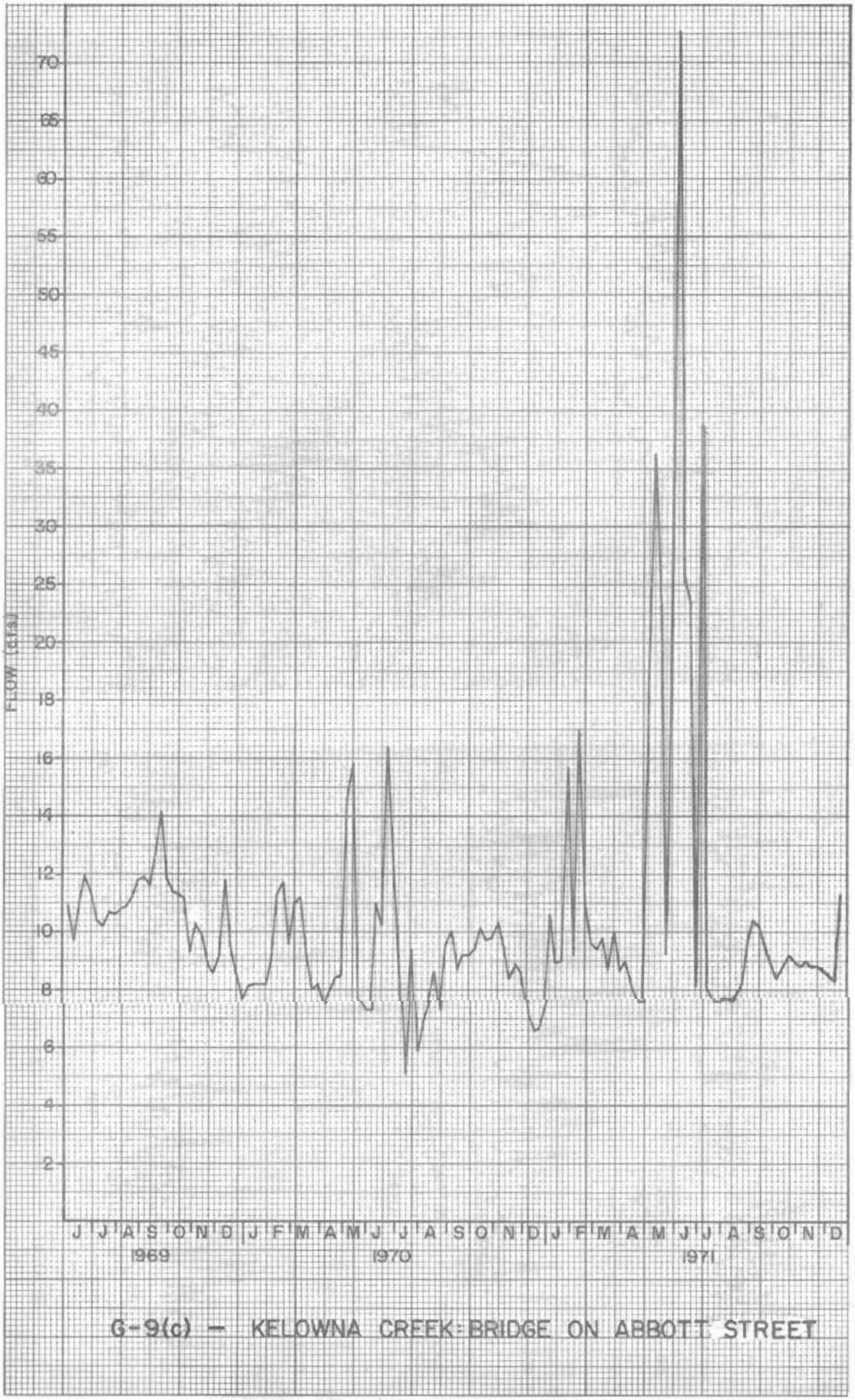
G-8(c) — MISSION CREEK: BRIDGE ON LAKESHORE ROAD



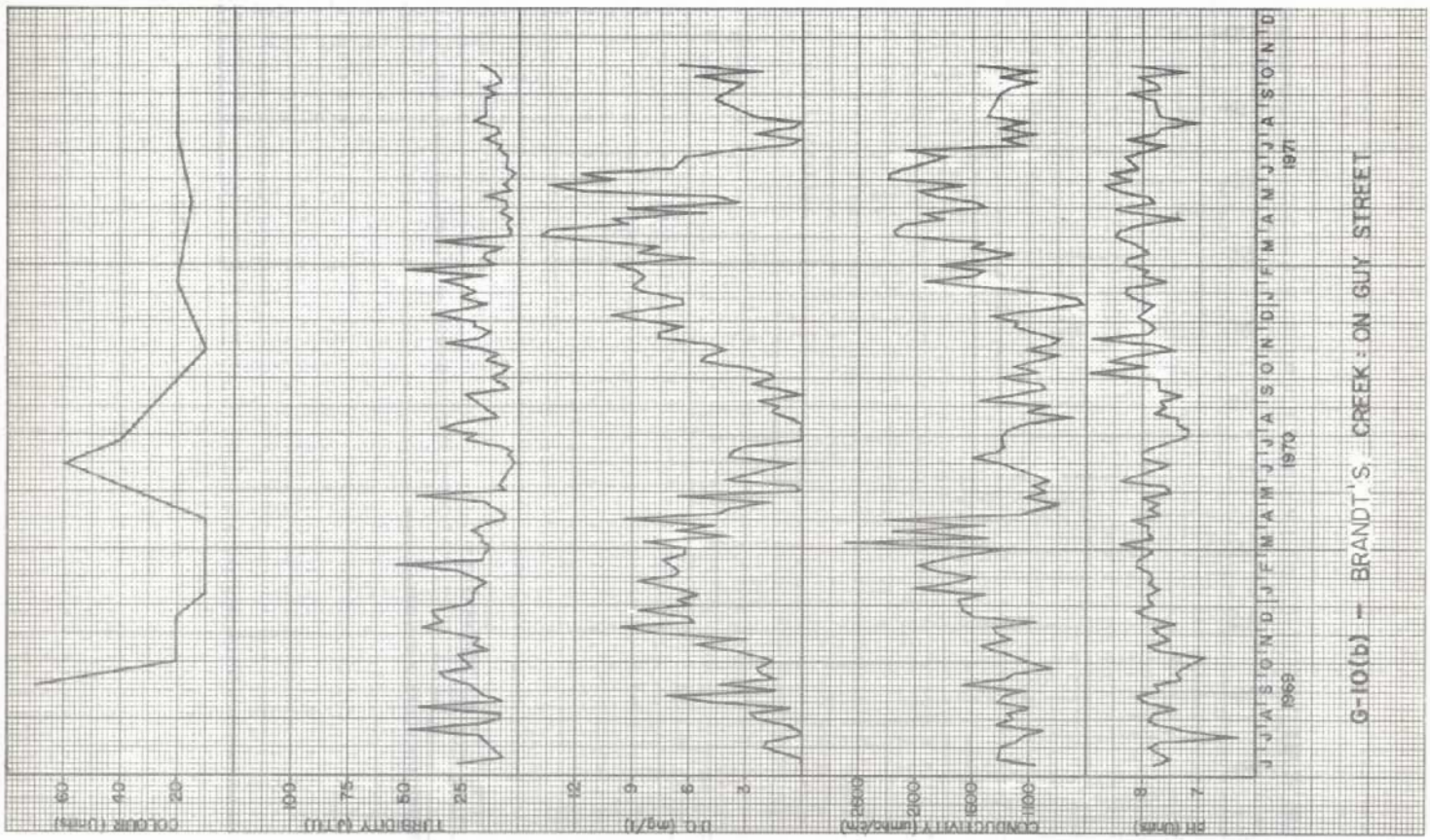
G-9(a) – KELOWNA CREEK: BRIDGE ON ABBOTT STREET

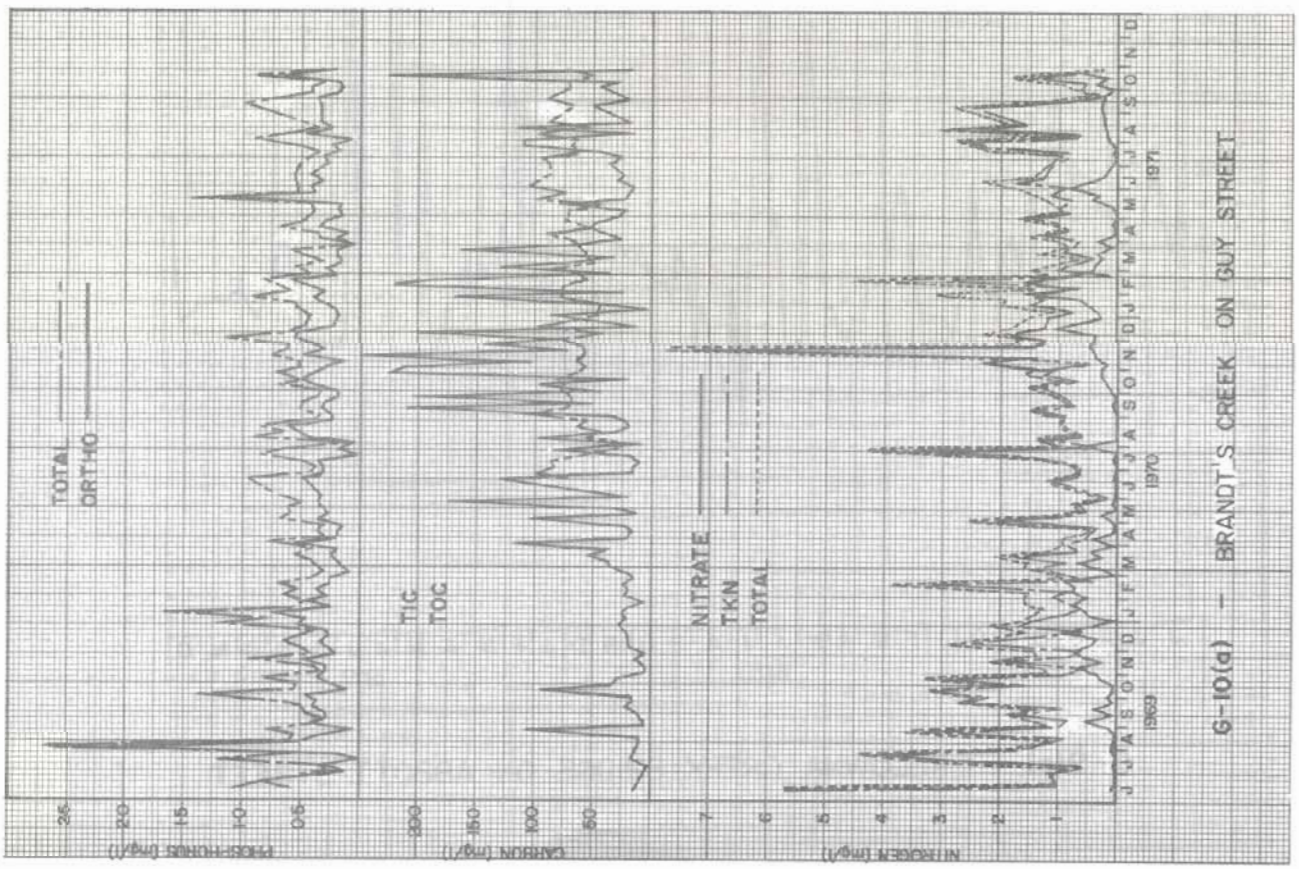


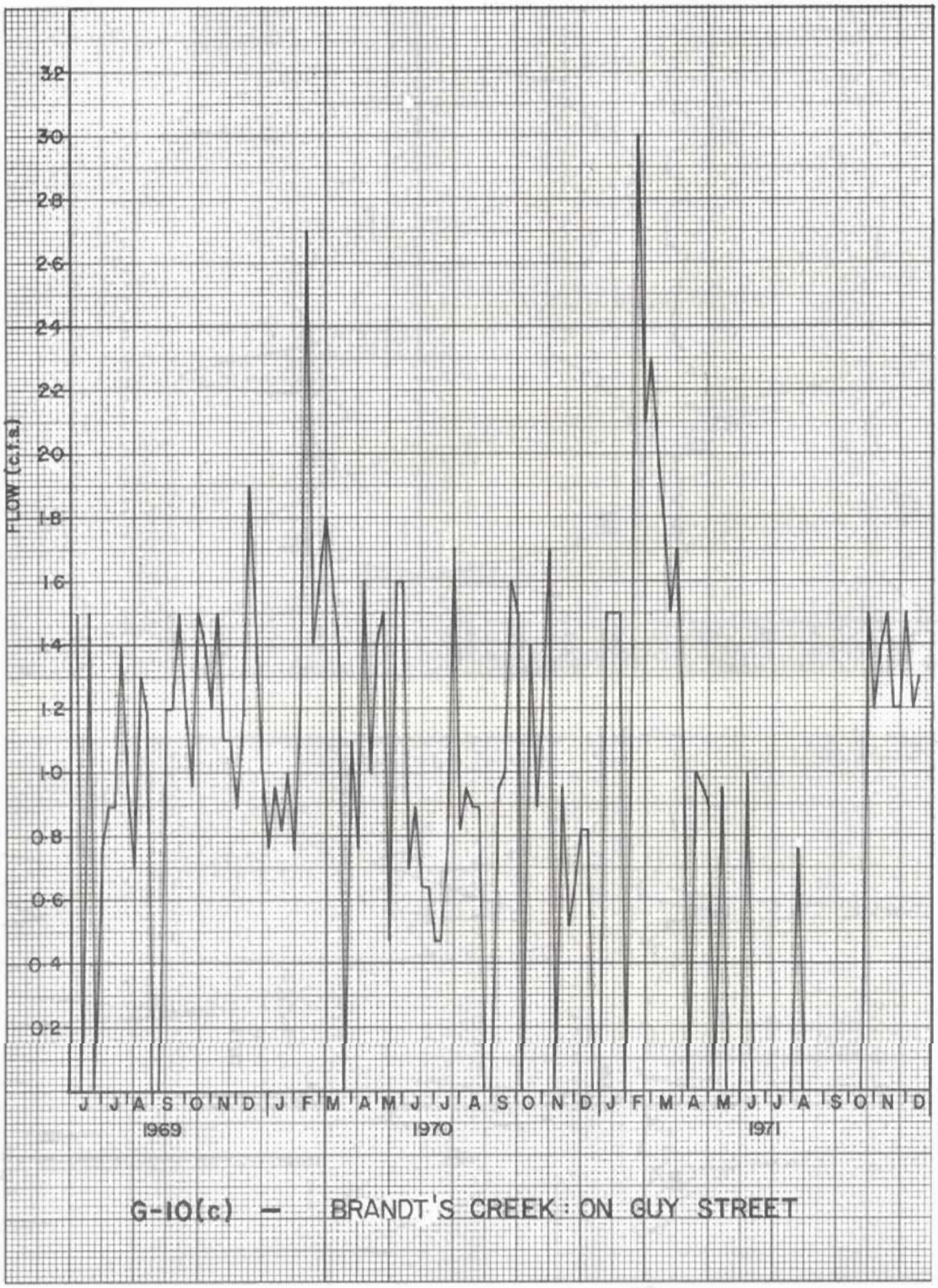
G-9(b) – KELOWNA CREEK: BRIDGE ON ABBOTT STREET



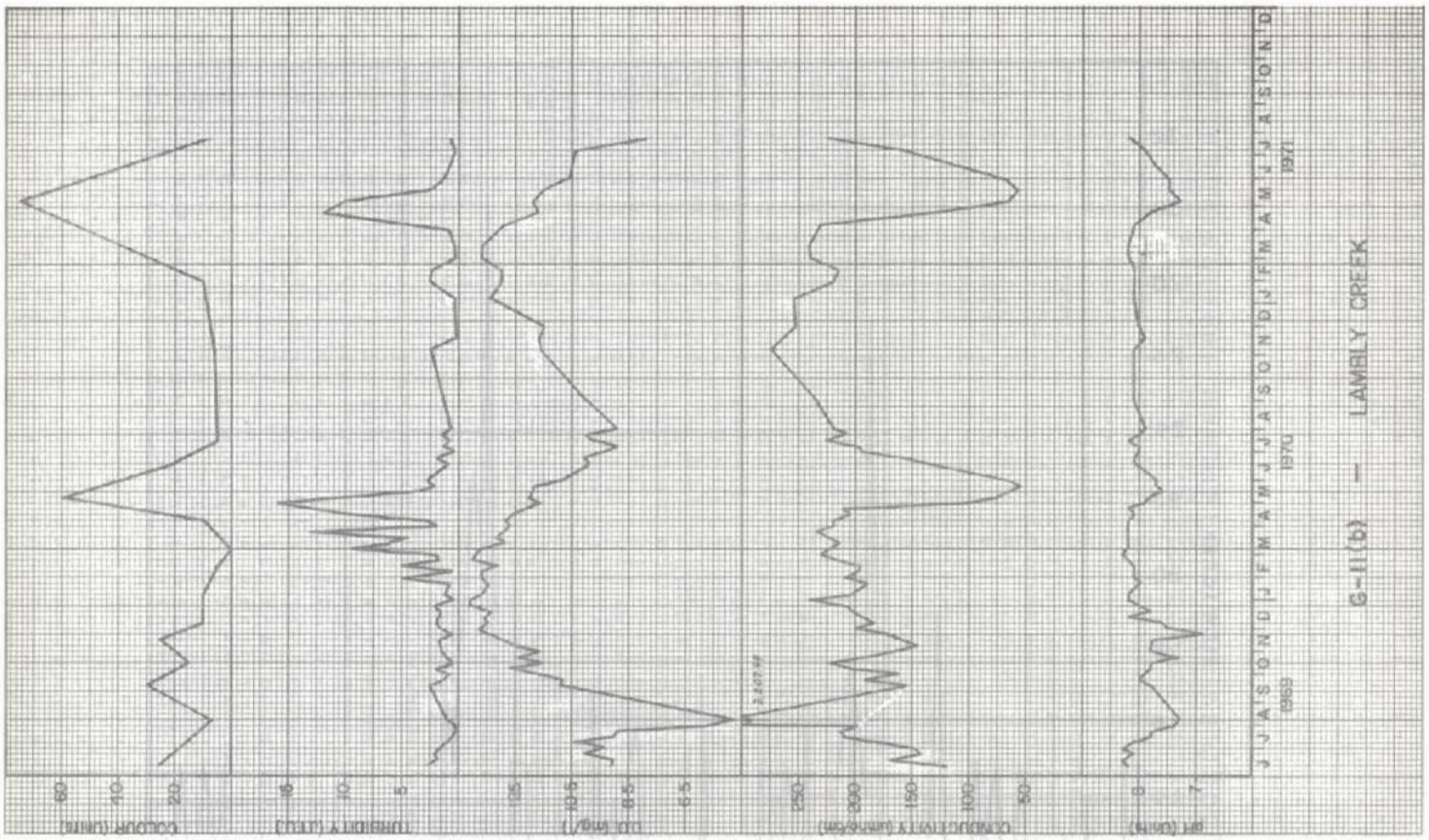
G-9(c) – KELOWNA CREEK BRIDGE ON ABBOTT STREET

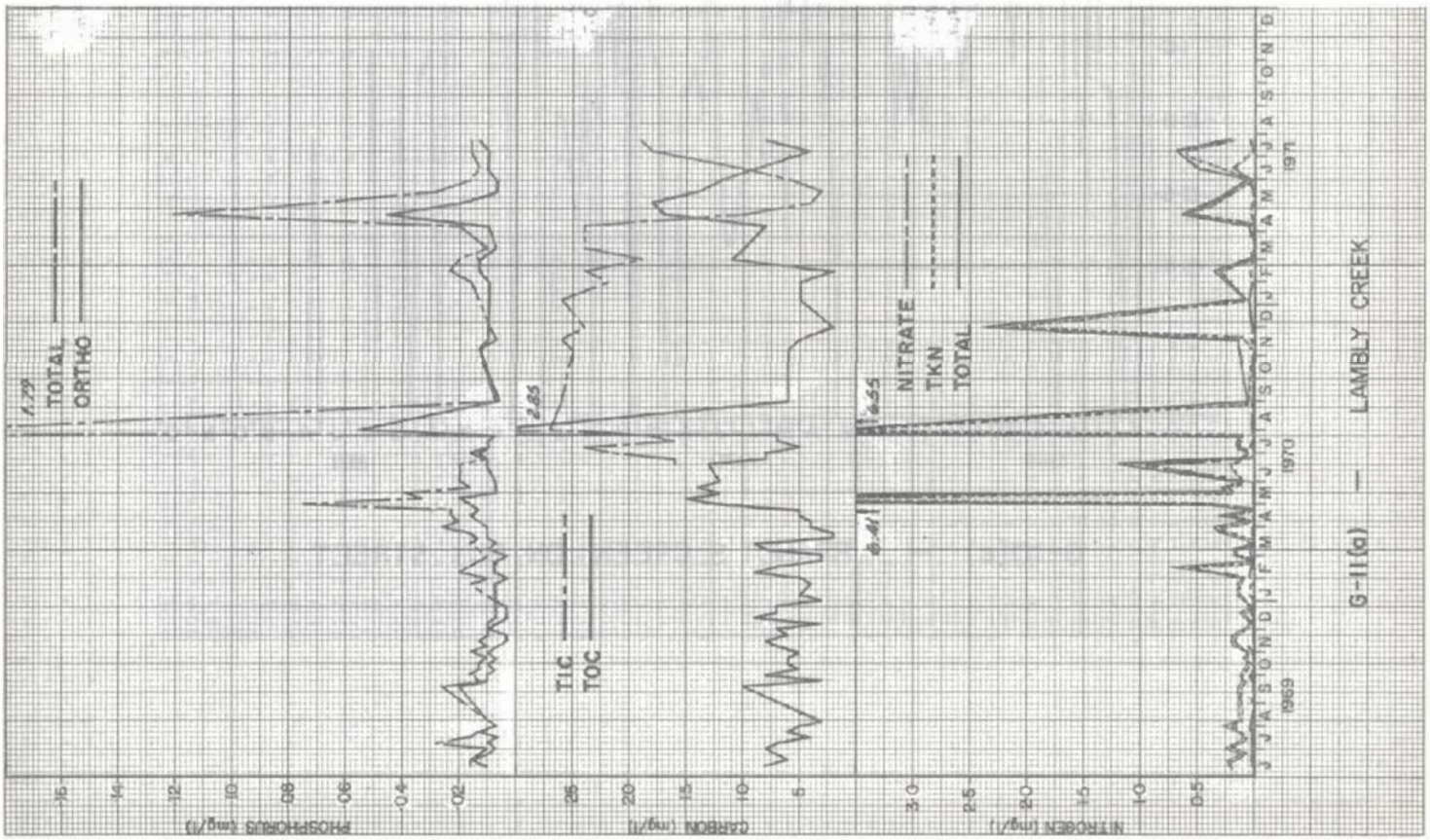

G-10(b) — BRANDT'S CREEK ON GUY STREET
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1968
1969
1970
1971
pH (units)
CONDUCTIVITY (umhos/cm)
D.O. (mg/l)
TURBIDITY (JTU)
COLOUR (Units)

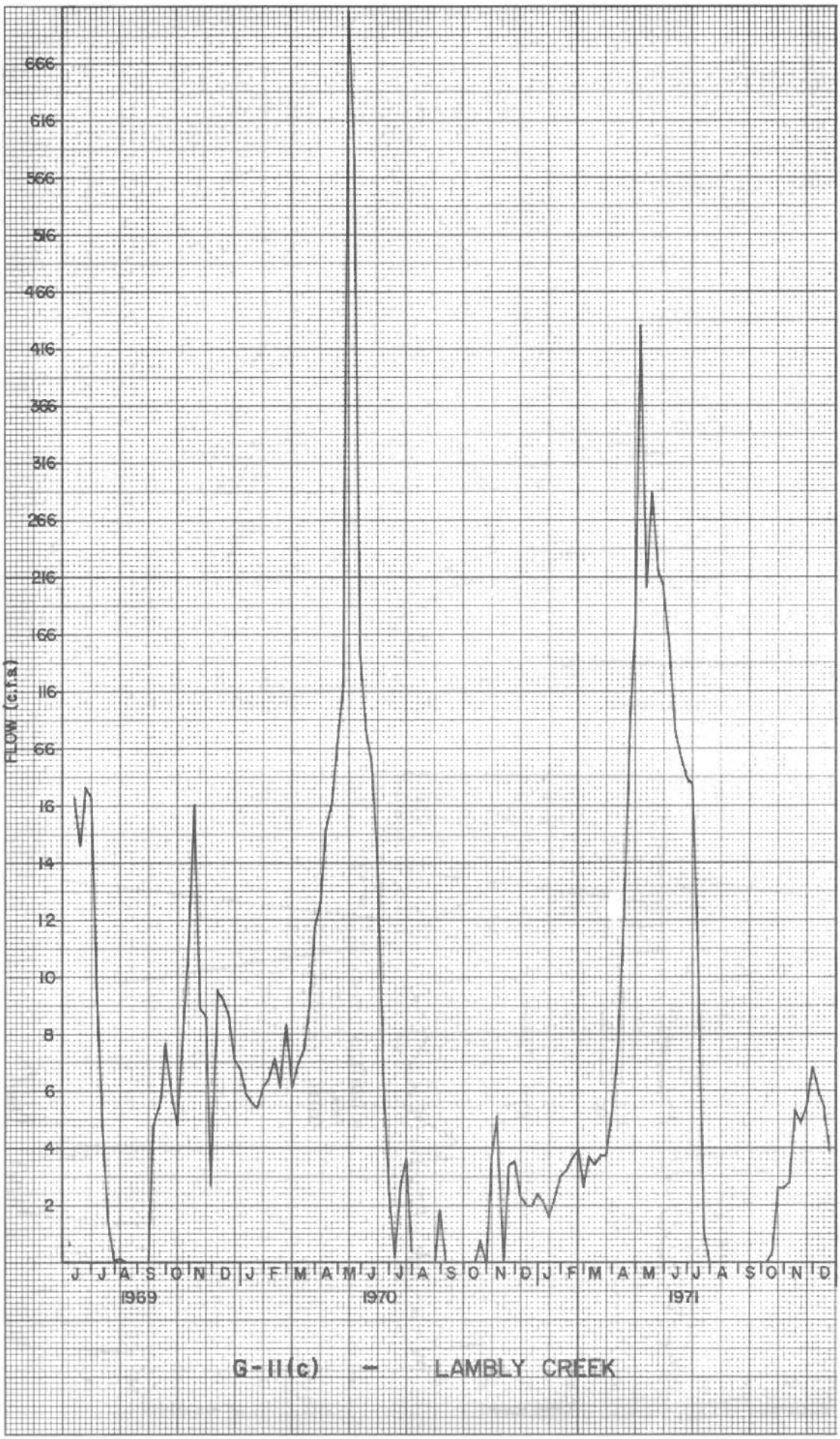

G-10(a) — BRANDT'S CREEK ON GUY STREET
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1968
1969
1970
1971
NITROGEN (mg/l)
CARBON (mg/l)
PHOSPHORUS (mg/l)
NITRATE
TKN
TOTAL
TIC
TOC
TOTAL
ORTHO



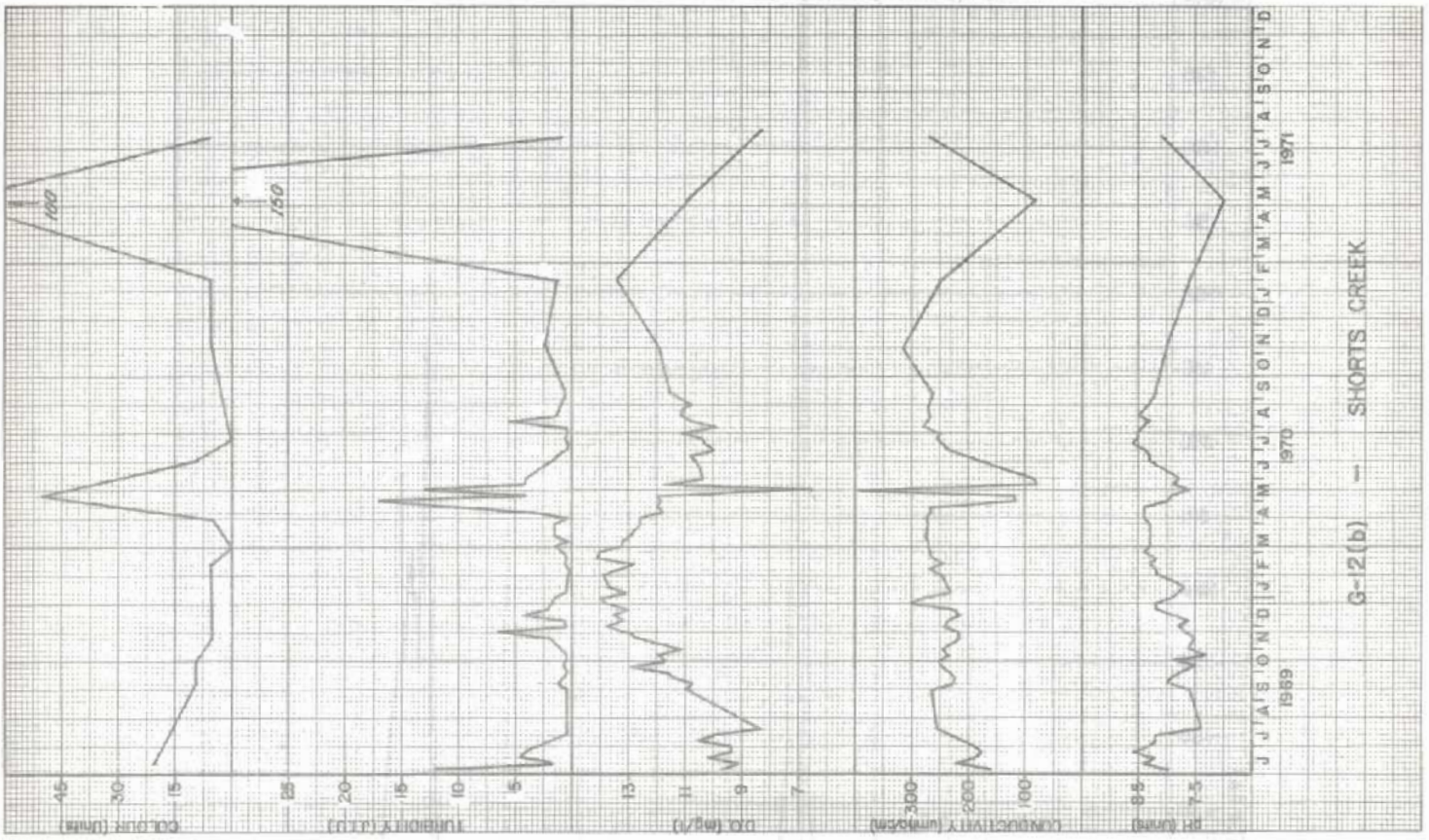
G-10(c) — BRANDT'S CREEK: ON GUY STREET

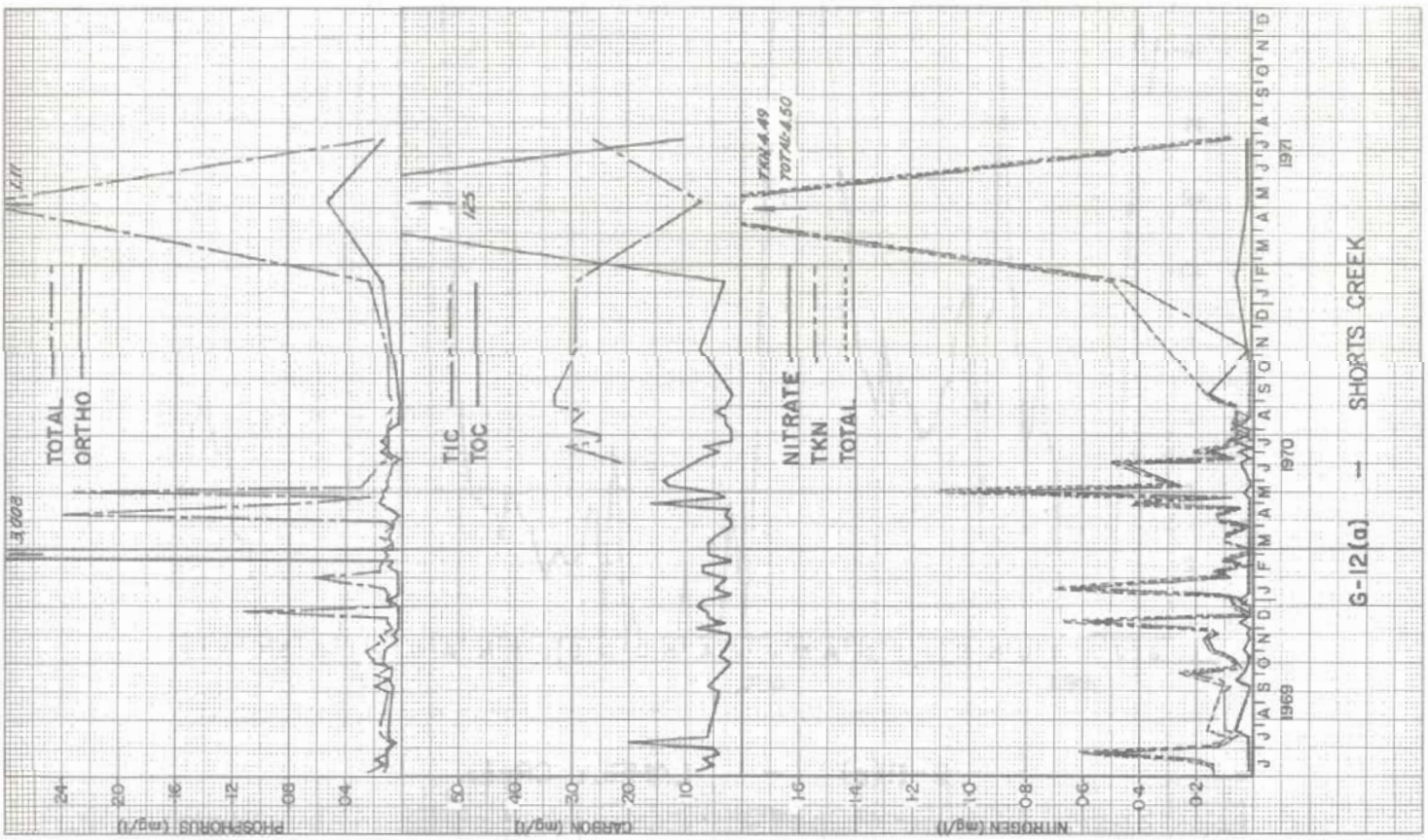

G-11(b) — LAMBLY CREEK
J J A S O N D J F M A M J J A S O N D
1969
1970
1971
COLOUR (UNITS)
TURBIDITY (JTU)
DO (mg/l)
CONDUCTIVITY (micromhos/cm)
pH (units)

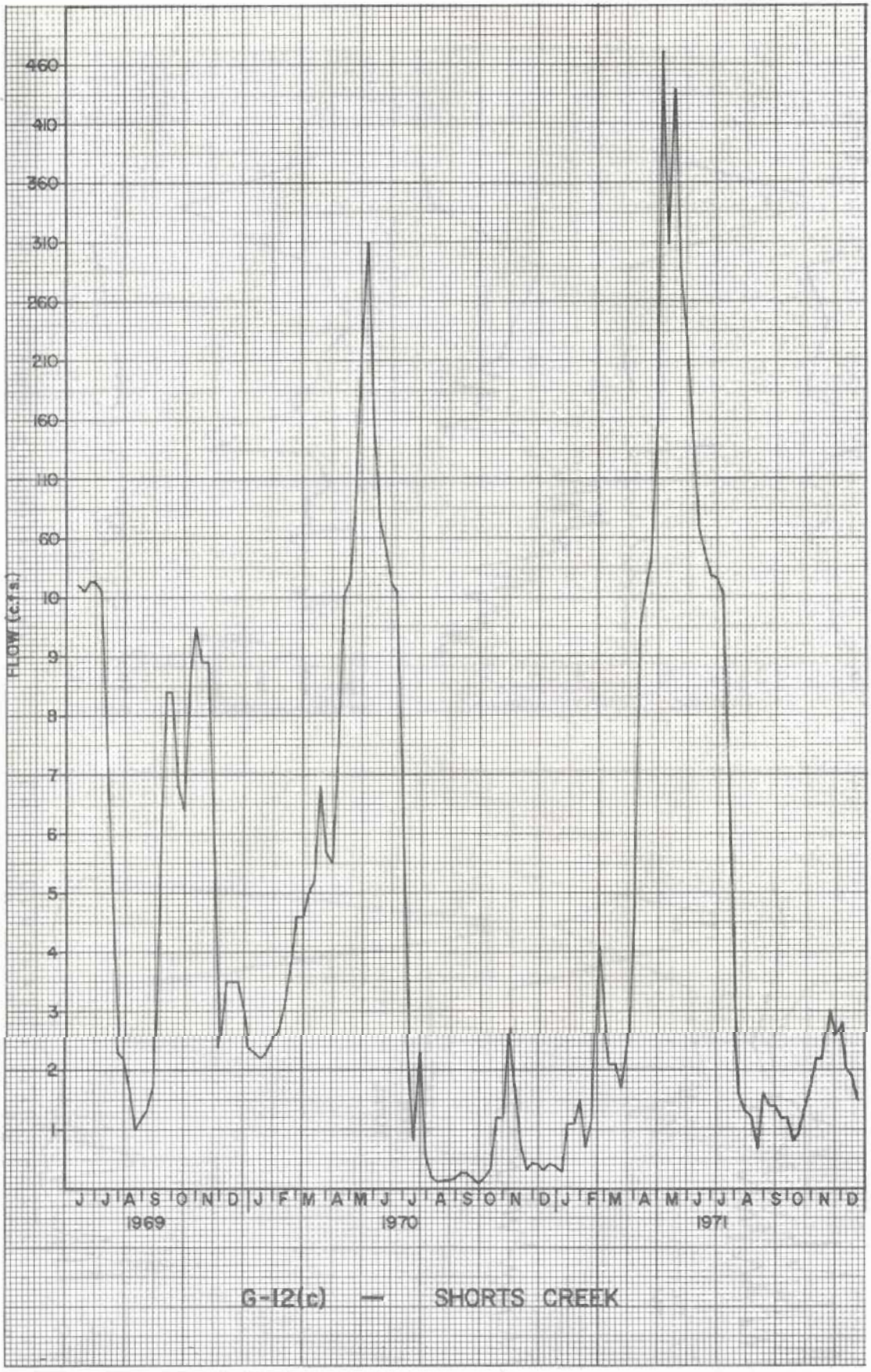

G-11(a) — LAMBLY CREEK
J J A S O N D J F M A M J J A S O N D
1969
1970
1971
TOTAL
ORTHO
TIC
TOC
NITRATE
TKN
TOTAL
PHOSPHORUS (mg/l)
CARBON (mg/l)
NITROGEN (mg/l)



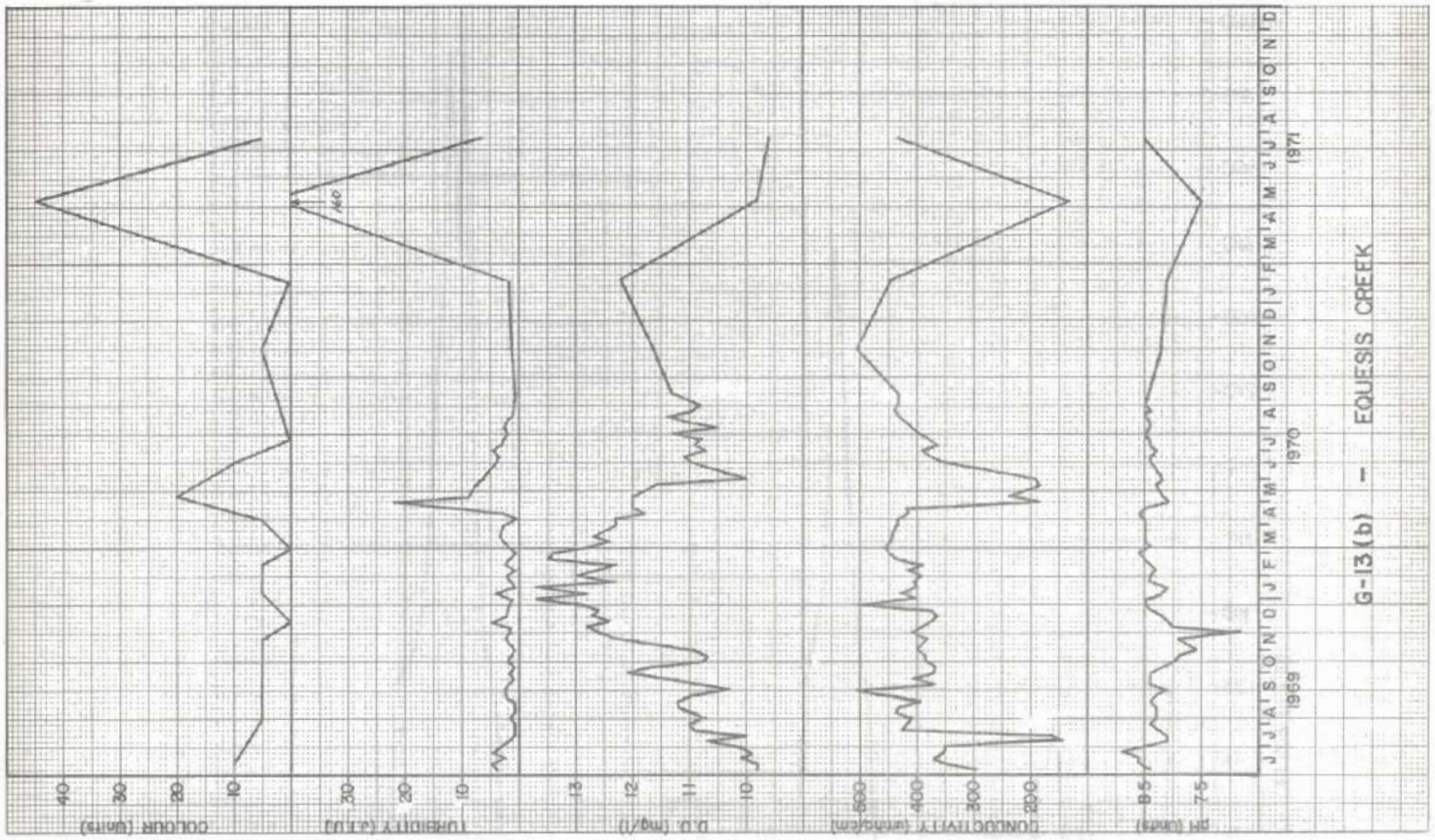
G-11(c) — LAMBLY CREEK

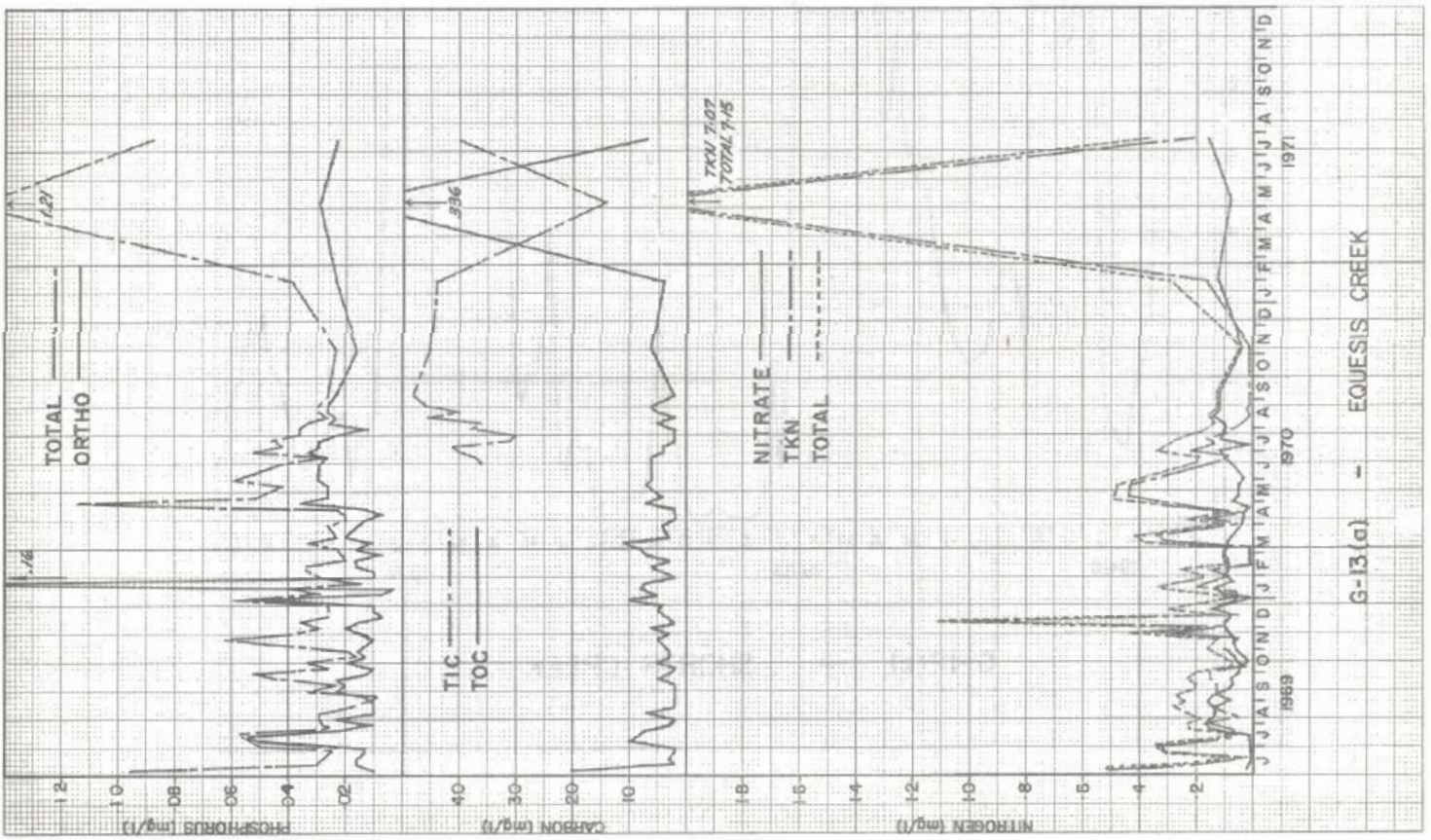

G-12(b) — SHORTS CREEK
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
COLOUR (Units)
TURBIDITY (J.T.U.)
D.O. (mg/l)
CONDUCTIVITY (micromhos)
pH (units)

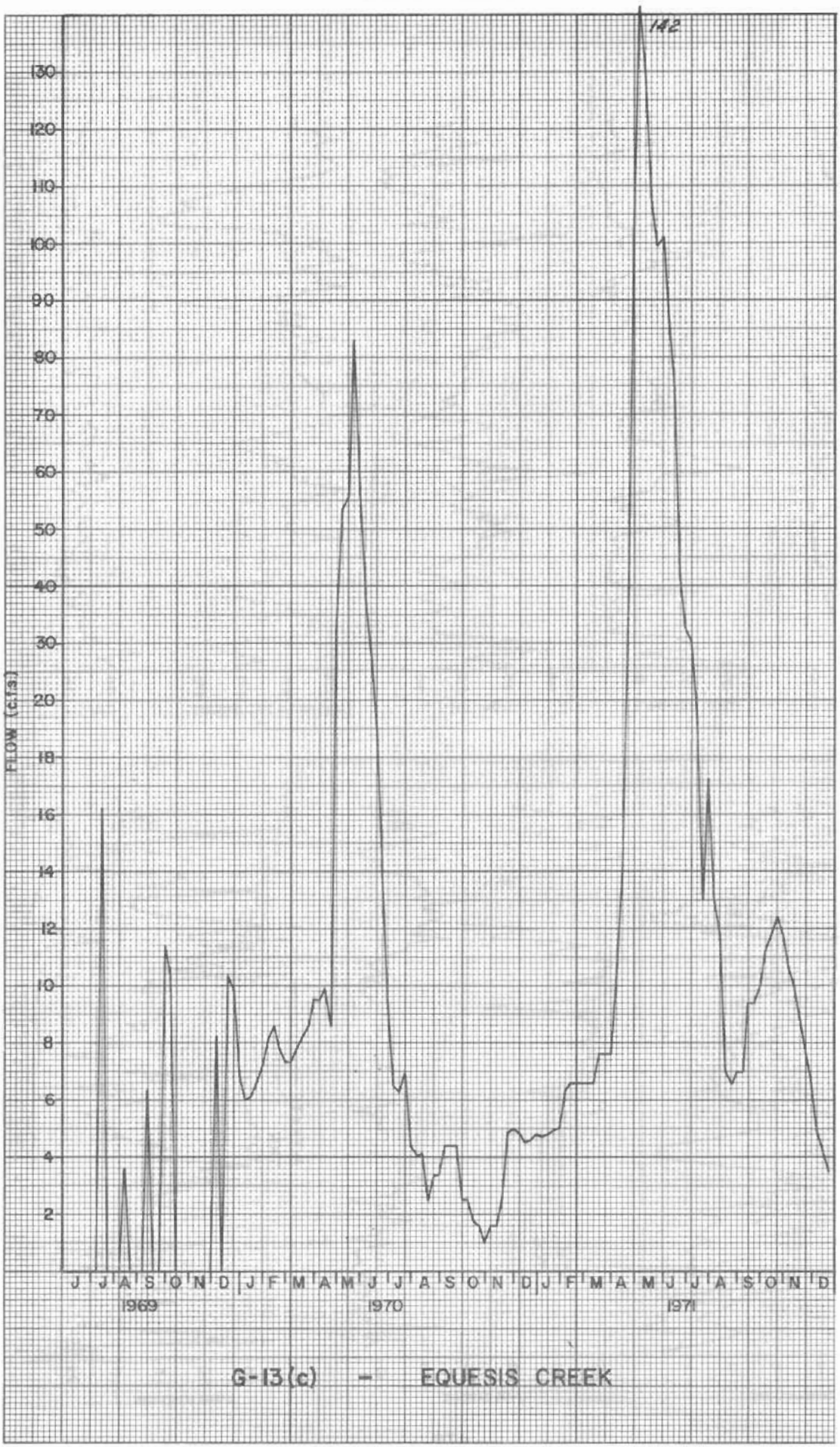

G-12(a) — SHORTS CREEK
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
PHOSPHORUS (mg/l)
CARBON (mg/l)
NITROGEN (mg/l)
TOTAL
ORTHO
TIC
TOC
NITRATE
TKN
TOTAL



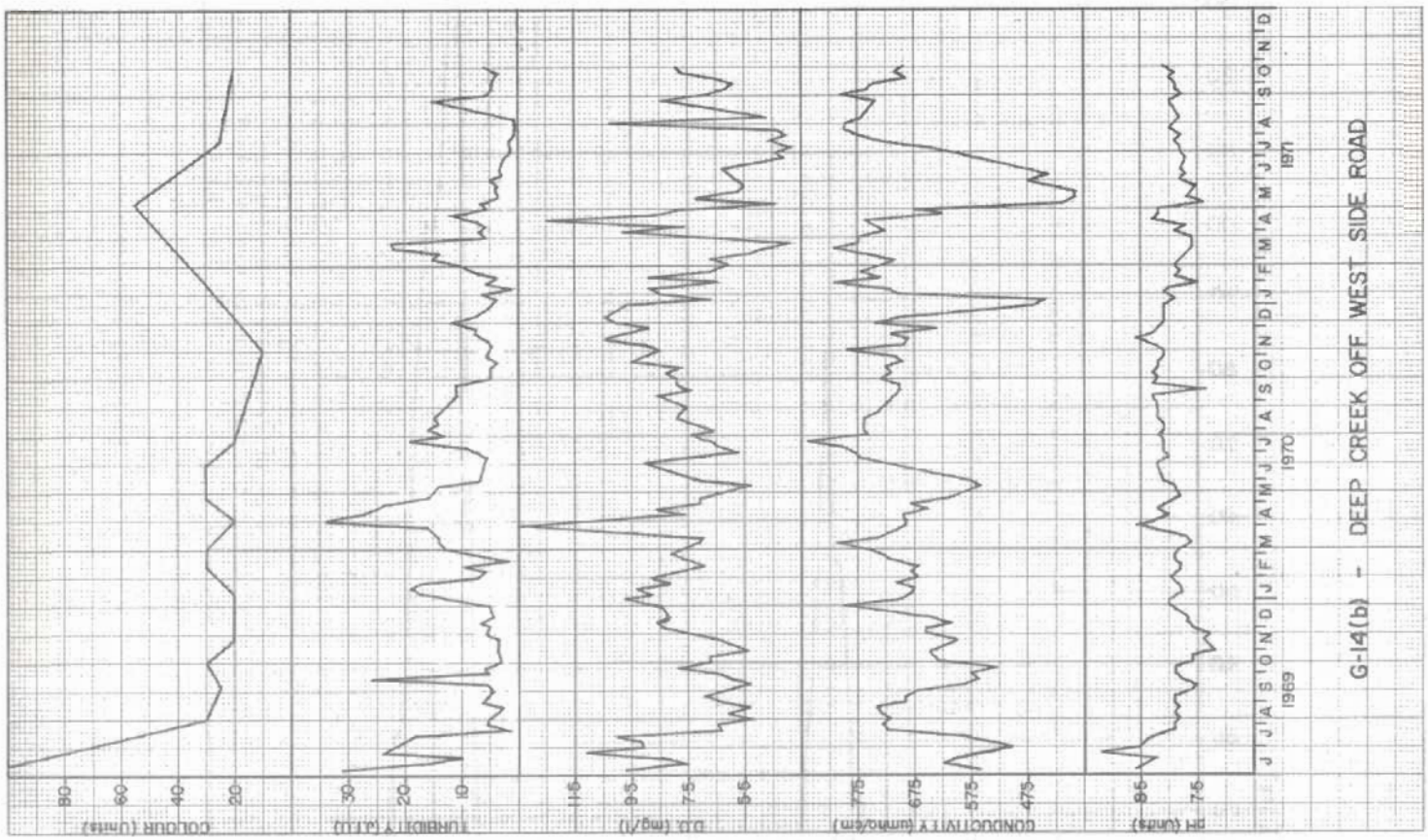
G-12(c) — SHORTS CREEK


G-13(b) - EQUESS CREEK
COLOUR (units)
TURBIDITY (J.T.U.)
D.O. (mg/l)
CONDUCTIVITY (micro/cm)
PH (units)
1969
1970
1971

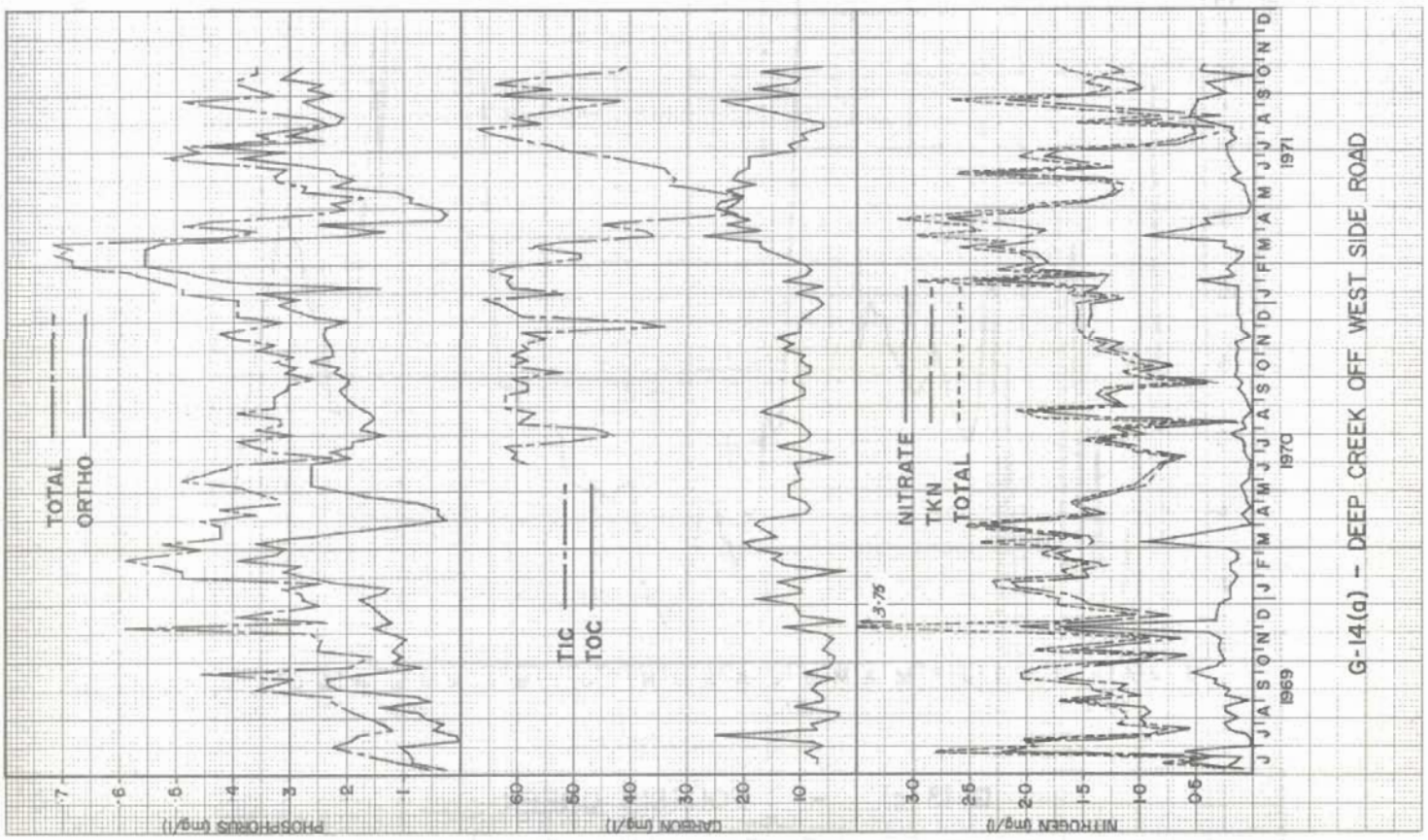

G-13(a) - EQUESS CREEK
PHOSPHORUS (mg/l)
TOTAL
ORTHO
CARBON (mg/l)
TIC
TOC
NITROGEN (mg/l)
NITRATE
TKN
TOTAL
TKN 7.07
TOTAL 7.15
1969
1970
1971



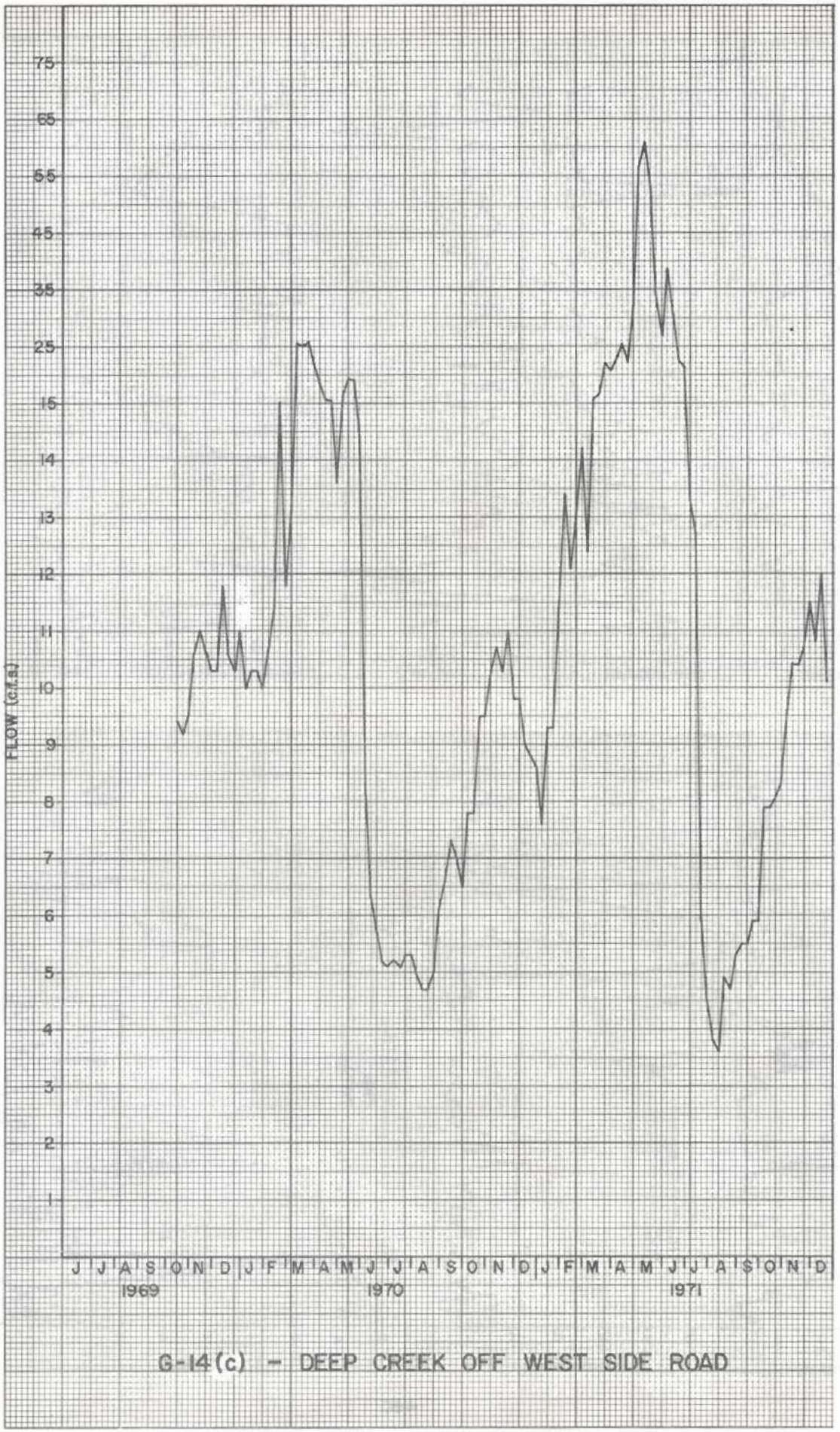
G-13(c) - EQUESIS CREEK



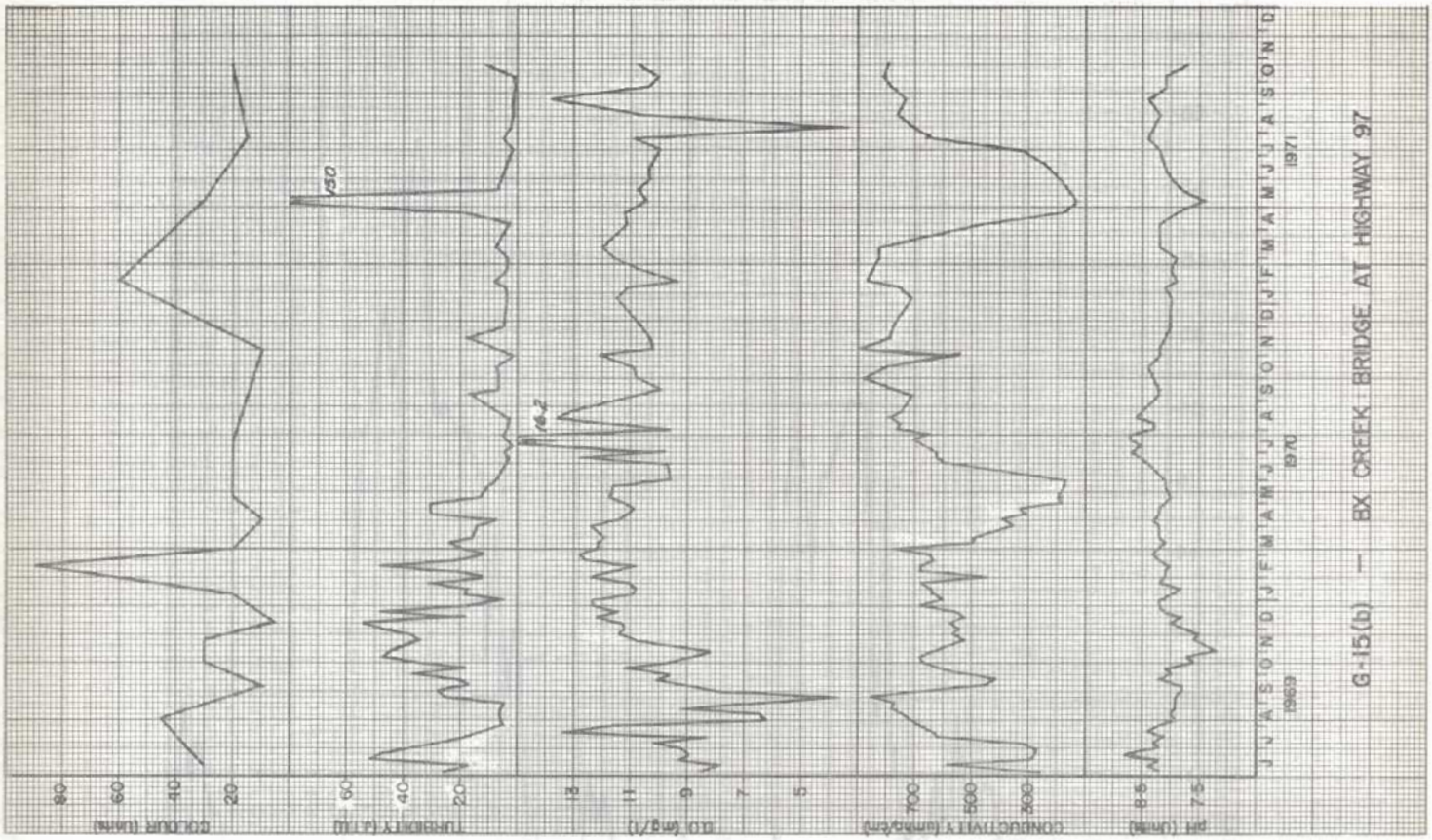
G-14(b) - DEEP CREEK OFF WEST SIDE ROAD

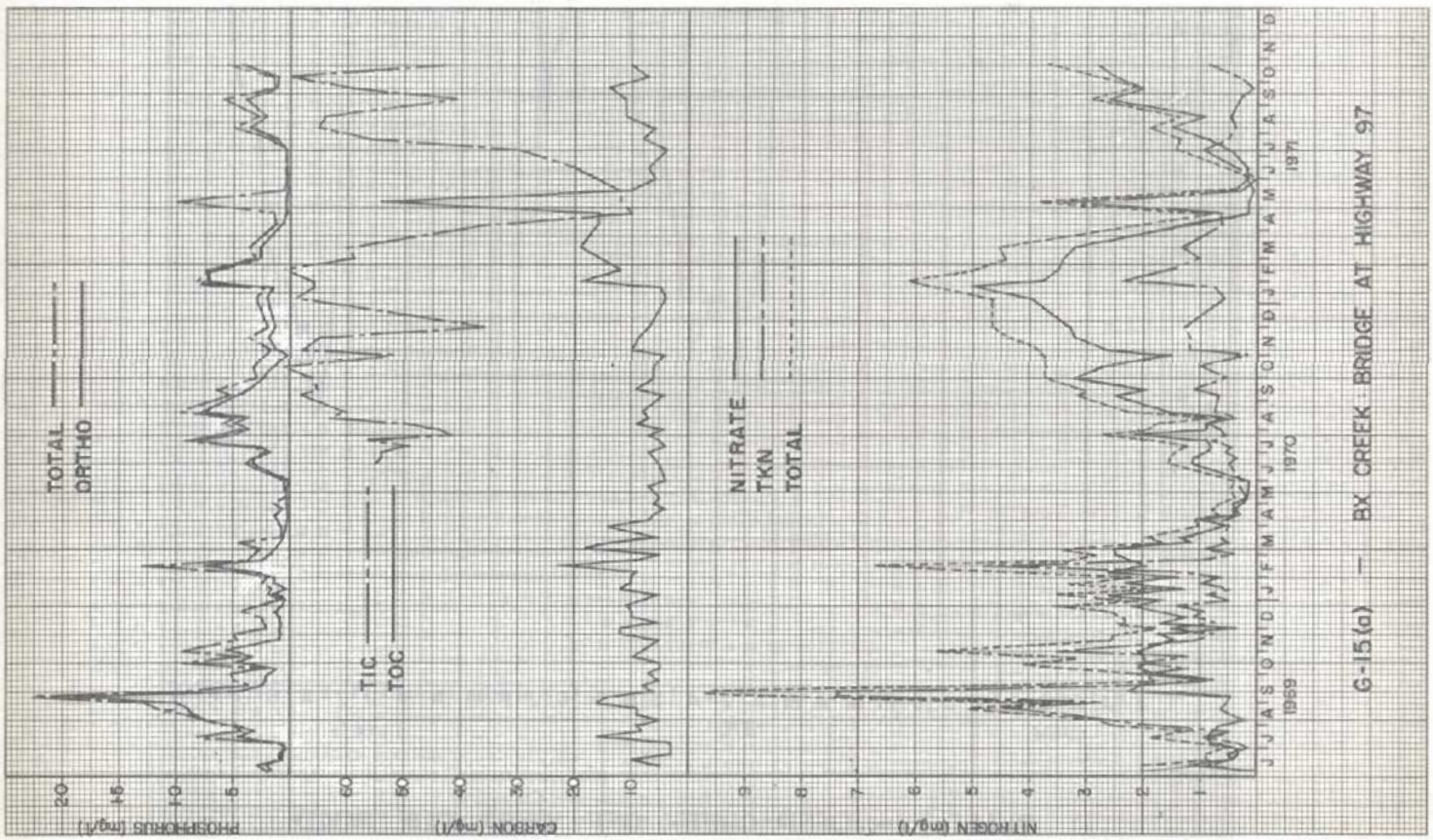


G-14(a) - DEEP CREEK OFF WEST SIDE ROAD



G-14(c) - DEEP CREEK OFF WEST SIDE ROAD


G-15(b) — BX CREEK BRIDGE AT HIGHWAY 97
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
COLOUR (Units)
TURBIDITY (J.T.U.)
D.O. (mg/l)
CONDUCTIVITY (umhos/cm)
pH (Units)


G-15(a) — BX CREEK BRIDGE AT HIGHWAY 97
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
TOTAL
ORTHO
PHOSPHORUS (mg/l)
T.I.C.
T.O.C.
CARBON (mg/l)
NITRATE
TKN
TOTAL
NITROGEN (mg/l)

APPENDIX H

SUMMARY OF OKANAGAN STREAM WATER QUALITY

1972

APPENDIX H - SUMMERY OF OKANAGAN STREAM WATER QUALITY - 1972

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500008 BRANDTS CREEK UPSTREAN

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	15	8.000	9.500	21.000	0.0
DISSOLVED 02	PPM	6	10.100	11.067	16.100	8.1000
PH	PH UNITS	18	8.200	8.267	9.100	7.9000
COLOUR	HAZEN	14	30.000	38.571	100.000	5.0000
TURBIDITY	JACKSON	12	5.750	11.725	41.000	1.4000
CONDUCTIVITY	M-MHOS	19	4000.	3765.	6100.	1830.
HARDNESS - TOTAL	PPM	18	1337.	1196.	1794.	538.00
SURFACTANTS	PPM	8	0.025	0.034	0.070	0.0250
TANNIN & LIGNIN	PPM	2	1.550	1.550	1.900	1.2000
SOLIDS						
TOTAL	PPM	18	3563.	3145.	4758.	1366.
FIXED	PPM	18	2989.	2626.	4006.	1144.
DISSOLVED	PPM	8	3646.	3647.	4687.	2632.
SUSPENDED	PPM	7	19.100	23.700	57.000	9.4000
GENERAL IONS						
CALCIUM	PPM	16	184.500	181.669	427.000	80.0000
MAGNESIUM	PPM	18	197.500	184.083	306.000	83.3000
SODIUM	PPM	13	500.000	496.000	746.000	265.00
POTASSIUM	PPM	18	13.000	19.661	140.000	9.0000
SULPHATE	PPM	18	1928.	1654.	2640.	675.00
CHLORIDE	PPM	13	0.700	13.738	34.000	0.0
FLUORIDE	PPM	10	0.475	0.521	0.920	0.3500
METALS						
IRON - TOTAL	PPM	9	0.320	0.687	2.400	0.1400
IRON - DISSOLVED	PPM	11	0.100	0.151	0.460	0.0200
MANGANESE - DISS	PPM	15	0.390	0.373	0.610	0.0900
COPPER	PPM	15	0.020	0.017	0.040	0.0
ZINC	PPM	15	0.020	0.027	0.060	0.0
LEAD	PPM	15	0.009	0.412	6.006	0.0
MERCURY - UNFILT	PPM	3	0.050	0.050 L	0.050 L	0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005 L	0.0050
NICKEL	PPM	3	0.010	0.013	0.020 L	0.0100
CADMIUM	PPM	3	0.001	0.000	0.001	0.0001
SEMI-METALS						
ARSENIC	PPM	10	0.002	0.003	0.008	0.0
OXYGEN						
BOD	PPM	3	3.700	5.267	L 10.000	2.1000
NUTRIENTS						
AMMONIA AS NH3	PPM	15	0.050	0.081	0.420	0.0
N-KJELDHAL	PPM	3	0.800	0.840	1.000	0.7200
NITRATE	PPM	15	0.300	0.357	0.830	0.0800
NITRITE	PPM	10	0.018	0.018	0.029	0.0050
NITRATE+NITRITE	PPM	3	0.400	0.653	1.360	0.2000
TOTAL N	PPM	11	1.120	1.047	2.160	0.2700

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500008 BRANDTS CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	11	1.200	1.088	1.700	0.3200
PHOS - TOTAL	PPM	11	1.400	1.525	2.500	0.6700
PHOSPHORUS-TOTAL	PPM	5	0.292	0.401	0.720	0.1750
PHOSPHORUS-DISS	PPM	3	0.525	0.420	0.660	0.0760
SILICATE	PPM	17	15.000	14.912	29.000	6.5000
ORGANIC N	PPM	15	0.190	0.384	1.160	0.0600
CARBON						
ALK - PHENOL	PPM	15	3.000	10.153	39.500	0.0
ALK - TOTAL	PPM	17	415.000	397.470	550.000	236.00
TOT ORG CARBON	PPM	6	24.000	24.333	43.000	10.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500009 BRANDTS CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	26	17.250	15.750	26.000	5.0000
DISSOLVED O2	PPM	8	8.550	8.837	16.100	3.3000
PH	PH UNITS	28	7.800	7.839	9.300	6.6000
COLOUR	HAZEN	16	20.000	22.813	45.000	10.0000
TURBIDITY	JACKSON	15	11.000	19.813	100.000	2.0000
CONDUCTIVITY	M-MHOS	21	1190.	1356.	2700.	910.00
HARDNESS - TOTAL	PPM	18	350.000	394.611	880.000	265.00
SURFACTANTS	PPM	15	0.110	0.153	0.780	0.0
TANNIN & LIGNIN	PPM	2	0.800	0.800	1.300	0.3000
OIL AND GREASE	PPM	1	21.600	21.600	21.600	21.6000
SOLIDS						
TOTAL	PPM	29	1078.	1117.	2246.	595.00
FIXED	PPM	28	731.000	831.143	1894.	424.00
DISSOLVED	PPM	21	1014.	1008.	1887.	548.00
SUSPENDED	PPM	9	23.000	41.100	108.000	11.2000
GENERAL IONS						
CALCIUM	PPM	16	60.800	66.969	126.000	49.7000
MAGNESIUM	PPM	18	49.200	56.122	133.000	32.1000
SODIUM	PPM	14	122.000	152.179	320.000	77.5000
POTASSIUM	PPM	18	8.200	8.383	13.000	4.7000
SULPHATE	PPM	17	296.000	371.176	1080.	180.00
CHLORIDE	PPM	13	13.500	13.038	26.500	L 0.3000
FLUORIDE	PPM	10	0.585	0.626	1.030	0.3800
METALS						
IRON - TOTAL	PPM	8	0.410	0.887	3.100	0.1800
IRON - DISSOLVED	PPM	12	0.230	0.252	0.540	0.1200
MANGANESE - DISS	PPM	15	0.180	0.203	0.510	0.0500
COPPER	PPM	15	0.020	0.014	0.030	0.0
ZINC	PPM	15	0.040	0.039	0.100	0.0
LEAD	PPM	15	0.014	0.019	0.042	L 0.0030
MERCURY - DISS	PPM	1	0.020	0.020	0.020	0.0200
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	4	0.010	0.035	0.110	L 0.0100
CADMIUM	PPM	4	0.000	0.000	0.000	L 0.0001
SEMI-METALS						
ARSENIC	PPM	8	0.0	0.000	0.001	0.0
OXYGEN						
BOD	PPM	13	215.000	185.385	540.000	G10.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	21	0.200	0.406	4.080	0.0
N-KJELDHAL	PPM	5	1.100	2.920	10.500	0.3300
NITRATE	PPM	26	0.065	0.596	9.500	0.0
NITRITE	PPM	21	0.008	0.018	0.080	L 0.0050

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500009 BRANDTS CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
NITRATE+NITRITE	PPM	3	0.160	0.390	0.940	0.0700
TOTAL N	PPM	16	1.130	2.054	11.450	0.4200
PHOS - ORTHO	PPM	15	0.390	0.513	2.100	0.0400
PHOS - TOTAL	PPM	20	1.320	1.283	2.500	0.1900
PHOSPHORUS-TOTAL	PPM	7	0.520	0.762	1.670	0.4400
PHOSPHORUS-DISS	PPM	4	0.405	0.408	0.540	0.2840
SILICATE	PPM	18	15.350	14.100	22.000	7.0000
ORGANIC N	PPM	24	0.700	1.250	6.000	0.1600
CARBON						
ALK - PHENOL	PPM	14	0.0	3.036	29.000	0.0
ALK - TOTAL	PPM	19	328.000	298.421	453.000	127.00
TOT ORG CARBON	PPM	6	101.500	123.000	300.000	32.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500010 BX CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	14	5.500	5.679	17.000	0.0
DISSOLVED O2	PPM	4	11.750	11.700	13.600	9.7000
PH	PH UNITS	14	7.650	7.743	8.300	7.5000
COLOUR	HAZEN	11	5.000	12.273	35.000	0.0
TURBIDITY	JACKSON	10	0.800	3.590	16.000	0.2000
CONDUCTIVITY	M-MHOS	16	245.000	236.750	458.000	75.0000
HARDNESS - TOTAL	PPM	15	117.000	113.840	236.000	29.9000
SURFACTANTS	PPM	7	0.025	0.019	0.030	0.0
TANNIN & LIGNIN	PPM	1	0.500	0.500	0.500	0.5000
SOLIDS						
TOTAL	PPM	15	158.000	163.400	290.000	69.0000
FIXED	PPM	15	109.000	113.800	194.000	45.0000
DISSOLVED	PPM	7	177.000	172.429	195.000	150.00
SUSPENDED	PPM	4	3.350	3.325	5.900	0.7000
GENERAL IONS						
CALCIUM	PPM	13	38.000	36.577	65.000	10.1000
MAGNESIUM	PPM	15	6.300	6.540	18.000	1.1000
SODIUM	PPM	11	3.400	4.255	8.100	2.7000
POTASSIUM	PPM	14	1.800	2.521	10.000	1.1000
SULPHATE	PPM	14	25.400	28.214	65.300	10.1000
CHLORIDE	PPM	11	1.100	1.836	7.000	0.5000
FLUORIDE	PPM	9	0.160	0.142	0.200	L 0.1000
METALS						
IRON - TOTAL	PPM	8	0.240	0.450	1.360	0.0
IRON - DISSOLVED	PPM	9	0.100	0.153	0.460	L 0.0400
MANGANESE - DISS	PPM	13	0.010	0.008	0.020	0.0
COPPER	PPM	13	0.010	0.018	0.100	0.0
ZINC	PPM	13	0.020	0.026	0.080	0.0
LEAD	PPM	13	0.007	0.008	0.020	0.0
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	L 0.0001
SEMI-METALS						
ARSENIC	PPM	7	0.0	0.0	0.0	0.0
OXYGEN						
BOD	PPM	2	1.050	1.050	1.500	0.6000
NUTRIENTS						
AMMONIA AS NH3	PPM	13	0.020	0.081	0.770	0.0
N-KJELDHAL	PPM	2	0.310	0.310	0.480	0.1400
NITRATE	PPM	13	0.050	0.054	0.100	L 0.0200
NITRITE	PPM	8	0.005	0.005	0.008	L 0.0050
NITRATE+NITRITE	PPM	2	0.210	0.210	0.350	0.0700
TOTAL N	PPM	9	0.380	0.407	1.190	0.0700

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500010 BX CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	10	0.010	0.026	0.090	0.0
PHOS - TOTAL	PPM	10	0.060	0.079	0.230	0.0200
PHOSPHORUS-TOTAL	PPM	4	0.010	0.014	0.029	0.0070
PHOSPHORUS-DISS	PPM	2	0.008	0.008	0.013	L 0.0030
SILICATE	PPM	14	13.000	13.414	20.600	7.3000
ORGANIC N	PPM	13	0.050	0.119	0.440	0.0
CARBON						
ALK - PHENOL	PPM	11	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	14	94.250	86.893	127.000	29.0000
TOT ORG CARBON	PPM	4	8.000	8.250	12.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500011 BX CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	8.000	9.600	17.500	1.5000
DISSOLVED 02	PPM	5	13.200	13.200	17.600	9.9000
PH	PH UNITS	5	8.200	8.160	8.500	7.8000
COLOUR	HAZEN	6	10.000	12.500	30.000	L 5.0000
TURBIDITY	JACKSON	5	2.300	3.200	6.800	1.2000
CONDUCTIVITY	M-MHOS	6	612.500	595.000	795.000	300.00
HARDNESS - TOTAL	PPM	6	290.500	256.667	346.000	137.00
TANNIN & LIGNIN	PPM	2	0.450	0.450	0.600	0.3000
SOLIDS						
TOTAL	PPM	6	424.000	384.333	570.000	204.00
FIXED	PPM	6	286.000	267.000	406.000	128.00
SUSPENDED	PPM	6	8.000	19.467	83.000	2.9000
GENERAL IONS						
CALCIUM	PPM	6	71.250	65.167	81.000	42.3000
MAGNESIUM	PPM	6	24.950	22.150	35.000	8.0000
SODIUM	PPM	6	23.000	21.383	36.000	4.7000
POTASSIUM	PPM	6	6.100	5.333	7.800	2.7000
SULPHATE	PPM	6	83.550	75.500	112.000	29.6000
CHLORIDE	PPM	5	10.500	9.340	13.000	2.5000
FLUORIDE	PPM	3	0.220	0.193	0.220	0.1400
METALS						
IRON - DISSOLVED	PPM	6	0.055	0.100	0.340	0.0200
MANGANESE - DISS	PPM	3	0.020	0.030	0.060	0.0100
COPPER	PPM	3	0.009	0.007	0.010	L 0.0010
ZINC	PPM	3	0.030	0.022	0.030	L 0.0050
LEAD	PPM	3	0.003	0.003	L 0.003	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	1	0.900	0.900	0.900	0.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.070	0.067	0.110	0.0200
N-KJELDHAL	PPM	3	0.620	0.650	1.000	0.3300
NITRATE	PPM	3	2.690	2.003	2.890	0.4300
NITRITE	PPM	3	0.013	0.011	0.015	L 0.0050
NITRATE+NITRITE	PPM	3	0.730	1.893	4.300	0.6500
TOTAL N	PPM	6	2.285	2.537	5.300	0.8300
PHOSPHORUS-TOTAL	PPM	6	0.061	0.106	0.226	0.0280
PHOSPHORUS-DISS	PPM	3	0.032	0.033	0.048	0.0180
SILICATE	PPM	6	17.750	17.733	20.000	14.0000
ORGANIC N	PPM	3	0.450	0.450	0.520	0.3800
CARBON						
ALK - PHENOL	PPM	2	9.500	9.500	19.000	0.0

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500011 BX CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	5	234.000	198.000	254.000	114.00
TOT ORG CARBON	PPM	6	9.500	11.000	19.000	7.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500012 BX CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	17	8.000	10.941	22.000	0.5000
DISSOLVED O2	PPM	6	10.650	10.783	13.900	8.5000
PH	PH UNITS	18	7.950	8.111	10.000	7.7000
COLOUR	HAZEN	17	10.000	11.765	25.000	5.0000
TURBIDITY	JACKSON	17	4.900	10.294	38.000	1.3000
CONDUCTIVITY	M-MHOS	19	490.000	512.263	820.000	358.00
HARDNESS - TOTAL	PPM	17	219.000	233.882	388.000	159.00
SURFACTANTS	PPM	11	0.025	0.024	0.040	0.0
TANNIN & LIGNIN	PPM	4	0.550	0.575	0.900	0.3000
SOLIDS						
TOTAL	PPM	18	343.000	358.444	560.000	257.00
FIXED	PPM	18	246.500	262.111	444.000	172.00
DISSOLVED	PPM	9	312.000	346.222	500.000	266.00
SUSPENDED	PPM	6	19.900	13.233	22.300	5.5000
GENERAL IONS						
CALCIUM	PPM	18	54.650	59.906	105.000	39.4000
MAGNESIUM	PPM	18	18.700	19.861	30.500	14.7000
SODIUM	PPM	18	16.500	17.733	29.000	12.0000
POTASSIUM	PPM	18	4.250	4.417	5.600	3.7000
SULPHATE	PPM	18	80.100	90.508	208.000	0.7400
CHLORIDE	PPM	18	4.650	5.489	10.500	2.4000
FLUORIDE	PPM	17	0.190	0.209	0.430	0.1000
METALS						
IRON - TOTAL	PPM	9	0.640	1.260	3.000	0.2600
IRON - DISSOLVED	PPM	11	0.060	0.118	0.540	0.0
MANGANESE - DISS	PPM	16	0.030	0.043	0.110	L 0.0100
COPPER	PPM	16	0.008	0.013	0.060	0.0
ZINC	PPM	16	0.030	0.027	0.040	L 0.0050
LEAD	PPM	16	0.011	0.018	0.060	0.0
MERCURY - UNFILT	PPM	5	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	4	0.005	0.006	0.010	L 0.0050
NICKEL	PPM	5	0.010	0.026	0.091	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.000	0.0001
SEMI-METALS						
ARSENIC	PPM	6	0.0	0.0	0.0	0.0
OXYGEN						
BOD	PPM	2	2.600	2.600	3.600	1.6000
NUTRIENTS						
AMMONIA AS NH3	PPM	17	0.040	0.104	1.000	0.0
N-KJELDHAL	PPM	1	0.620	0.620	0.620	0.6200
NITRATE	PPM	17	0.450	0.682	1.600	0.1500
NITRITE	PPM	12	0.010	0.013	0.027	L 0.0050
NITRATE+NITRITE	PPM	1	0.870	0.870	0.870	0.8700
TOTAL N	PPM	11	1.160	1.225	2.630	0.3100

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500012 BX CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	10	0.090	0.097	0.220	0.0200
PHOS - TOTAL	PPM	10	0.245	0.276	0.530	0.1000
PHOSPHORUS-TOTAL	PPM	7	0.050	0.089	0.330	0.0130
PHOSPHORUS-DISS	PPM	6	0.024	0.050	0.200	L 0.0030
SILICATE	PPM	18	13.400	13.333	17.700	6.8000
ORGANIC N	PPM	17	0.160	0.281	0.800	0.0400
CARBON						
ALK - PHENOL	PPM	14	0.0	1.714	7.500	0.0
ALK - TOTAL	PPM	17	156.000	167.529	229.000	117.00
TOT ORG CARBON	PPM	6	9.500	10.667	18.000	6.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500015 COLDSTREAM CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	5.000	5.250	9.000	2.0000
DISSOLVED O2	PPM	4	12.750	12.200	14.600	8.7000
PH	PH UNITS	4	8.300	8.300	8.500	8.1000
COLOUR	HAZEN	4	5.000	5.000	5.000	L 5.0000
TURBIDITY	JACKSON	4	1.300	2.050	5.200	0.4000
CONDUCTIVITY	M-MHOS	5	400.000	415.600	480.000	380.00
HARDNESS - TOTAL	PPM	4	211.000	214.350	242.400	193.00
TANNIN & LIGNIN	PPM	3	0.200	0.167	0.200	L 0.1000
SOLIDS						
TOTAL	PPM	4	266.000	275.000	316.000	252.00
FIXED	PPM	3	206.000	200.667	226.000	170.00
DISSOLVED	PPM	1	252.000	252.000	252.000	252.00
SUSPENDED	PPM	3	3.500	3.433	6.100	0.7000
GENERAL IONS						
CALCIUM	PPM	3	66.400	66.567	72.500	60.8000
MAGNESIUM	PPM	4	12.100	12.025	14.900	9.0000
SODIUM	PPM	4	4.450	4.975	6.900	4.1000
POTASSIUM	PPM	4	2.450	2.250	2.800	1.3000
SULPHATE	PPM	3	45.500	47.733	60.500	37.2000
CHLORIDE	PPM	4	0.800	0.725	1.000	L 0.3000
FLUORIDE	PPM	3	0.130	0.130	0.140	0.1200
METALS						
IRON - DISSOLVED	PPM	4	0.045	0.042	0.060	0.0200
MANGANESE - DISS	PPM	3	0.010	0.010	L 0.010	L 0.0100
COPPER	PPM	3	0.010	0.008	0.012	L 0.0010
ZINC	PPM	3	0.020	0.015	0.020	L 0.0050
LEAD	PPM	3	0.003	0.003	L 0.003	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	L 0.0001
OXYGEN						
BOD	PPM	1	1.700	1.700	1.700	1.7000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.010	0.020	0.040	L 0.0100
N-KJELDHAL	PPM	1	0.030	0.030	0.030	0.0300
NITRATE	PPM	3	0.020	0.045	0.110	0.0060
NITRITE	PPM	3	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	1	0.350	0.350	0.350	0.3500
TOTAL N	PPM	3	0.240	0.220	0.380	0.0400
PHOSPHORUS-TOTAL	PPM	4	0.024	0.027	0.046	0.0120
PHOSPHORUS-DISS	PPM	3	0.003	0.005	0.010	L 0.0030
SILICATE	PPM	4	15.250	15.050	15.600	14.1000
ORGANIC N	PPM	3	0.100	0.110	0.190	0.0400
CARBON						
ALK - PHENOL	PPM	1	2.500	2.500	2.500	2.5000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500015 COLDSTREAM CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	4	176.000	179.000	201.000	163.00
TOT ORG CARBON	PPM	4	4.500	5.000	10.000	1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500016 COLDSTREAM CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	8.000	7.400	12.000	3.0000
DISSOLVED 02	PPM	5	11.400	11.040	12.200	9.1000
PH	PH UNITS	6	8.300	8.333	8.600	8.1000
COLOUR	HAZEN	5	5.000	6.000	10.000	L 5.0000
TURBIDITY	JACKSON	5	2.200	3.100	6.300	0.6000
CONDUCTIVITY	M-MHOS	6	590.000	608.000	748.000	450.00
HARDNESS - TOTAL	PPM	5	277.000	276.400	332.000	218.00
TANNIN & LIGNIN	PPM	3	0.200	0.167	0.200	0.1000
SOLIDS						
TOTAL	PPM	5	392.000	387.200	476.000	306.00
FIXED	PPM	4	260.000	236.500	266.000	160.00
DISSOLVED	PPM	1	462.000	462.000	462.000	462.00
SUSPENDED	PPM	4	7.400	8.750	18.100	2.1000
GENERAL IONS						
CALCIUM	PPM	4	69.550	68.850	74.500	61.8000
MAGNESIUM	PPM	5	25.000	24.120	29.600	16.0000
SODIUM	PPM	5	17.000	17.040	24.000	9.7000
POTASSIUM	PPM	5	6.000	5.060	7.200	3.6000
SULPHATE	PPM	5	79.200	81.180	120.000	47.5000
CHLORIDE	PPM	5	4.800	4.520	6.800	2.5000
FLUORIDE	PPM	3	0.290	0.307	0.360	0.2700
METALS						
IRON - DISSOLVED	PPM	5	0.050	0.050	0.060	L 0.0400
MANGANESE - DISS	PPM	3	0.010	0.017	0.030	L 0.0100
COPPER	PPM	3	0.010	0.010	0.019	L 0.0010
ZINC	PPM	3	0.050	0.042	0.070	L 0.0050
LEAD	PPM	3	0.003	0.003	0.003	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	0.050	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	1	1.500	1.500	1.500	1.5000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.010	0.030	0.070	L 0.0100
N-KJELDHAL	PPM	2	0.325	0.325	0.450	0.2000
NITRATE	PPM	3	2.210	2.357	2.790	2.0700
NITRITE	PPM	3	0.010	0.009	0.013	0.0050
NITRATE+NITRITE	PPM	2	2.170	2.170	2.450	1.8900
TOTAL N	PPM	4	2.485	2.490	2.900	2.0900
PHOSPHORUS-TOTAL	PPM	5	0.040	0.039	0.070	0.0130
PHOSPHORUS-DISS	PPM	3	0.027	0.093	0.240	0.0130
SILICATE	PPM	5	18.000	17.920	19.500	16.2000
ORGANIC N	PPM	3	0.480	0.583	1.060	0.2100
CARBON						
ALK - PHENOL	PPM	2	4.000	4.000	4.000	4.0000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500016 COLDSTREAM CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	5	225.000	223.000	249.000	185.00
TOT ORG CARBON	PPM	4	2.500	4.250	11.000	L 1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500020 DEEP CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	10.000	10.143	20.500	3.0000
DISSOLVED O2	PPM	7	8.900	9.243	12.000	7.6000
PH	PH UNITS	8	8.600	106.012	790.000	7.1000
COLOUR	HAZEN	8	40.000	46.250	90.000	10.0000
TURBIDITY	JACKSON	7	4.300	7.514	18.000	1.3000
CONDUCTIVITY	M-MHOS	8	700.000	651.250	725.000	380.00
HARDNESS - TOTAL	PPM	8	347.500	319.375	368.000	173.00
SURFACTANTS	PPM	1	0.0	0.0	0.0	0.0
TANNIN & LIGNIN	PPM	3	0.700	0.900	1.600	0.4000
SOLIDS						
TOTAL	PPM	8	521.000	498.500	604.000	264.00
FIXED	PPM	6	418.000	390.333	510.000	198.00
DISSOLVED	PPM	2	506.000	506.000	512.000	500.00
SUSPENDED	PPM	6	15.200	31.133	93.000	7.4000
GENERAL IONS						
CALCIUM	PPM	7	85.000	82.100	102.000	52.4000
MAGNESIUM	PPM	7	27.500	26.429	35.000	10.3000
SODIUM	PPM	8	21.300	18.437	23.500	6.2000
POTASSIUM	PPM	7	7.100	6.871	8.300	3.7000
SULPHATE	PPM	7	141.000	137.443	212.000	78.1000
CHLORIDE	PPM	7	4.200	4.500	7.500	2.8000
FLUORIDE	PPM	6	0.265	0.265	0.330	0.2000
METALS						
IRON - DISSOLVED	PPM	7	0.130	0.187	0.400	0.1000
MANGANESE - DISS	PPM	6	0.110	0.157	0.320	0.0600
COPPER	PPM	6	0.005	0.007	0.020	0.0010
ZINC	PPM	6	0.035	0.040	0.110	L 0.0050
LEAD	PPM	6	0.003	0.004	0.006	L 0.0030
MERCURY - DISS	PPM	1	0.020	0.020	0.020	0.0200
MERCURY - UNFILT	PPM	4	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	5	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	6	0.015	0.017	0.030	L 0.0100
CADMIUM	PPM	6	0.000	0.001	0.001	0.0001
OXYGEN						
BOD	PPM	6	10.000	7.833	10.000	2.2000
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.065	0.185	0.700	0.0500
N-KJELDHAL	PPM	2	1.085	1.085	2.000	0.1700
NITRATE	PPM	7	0.270	0.337	0.910	0.0400
NITRITE	PPM	7	0.021	0.020	0.030	L 0.0050
NITRATE+NITRITE	PPM	2	0.565	0.565	0.940	0.1900
TOTAL N	PPM	8	1.155	1.526	3.420	0.5400
PHOSPHORUS-TOTAL	PPM	8	0.379	0.390	0.525	0.1650
PHOSPHORUS-DISS	PPM	6	0.269	0.254	0.492	0.0470
SILICATE	PPM	7	26.300	24.129	33.600	13.4000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500020 DEEP CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ORGANIC N	PPM	6	0.870	1.040	2.430	0.5200
CARBON						
ALK - PHENOL	PPM	1	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	7	244.000	210.429	251.000	114.00
TOT ORG CARBON	PPM	7	13.000	16.143	24.000	8.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500021 DEEP CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	22	9.250	8.955	18.000	0.0
DISSOLVED O2	PPM	12	6.900	7.208	11.700	3.4000
PH	PH UNITS	25	7.500	7.564	8.200	7.1000
COLOUR	HAZEN	22	25.000	30.000	90.000	10.0000
TURBIDITY	JACKSON	22	11.500	10.845	21.000	1.6000
CONDUCTIVITY	M-MHOS	26	552.500	561.538	790.000	400.00
HARDNESS - TOTAL	PPM	16	283.500	281.000	404.000	196.00
SURFACTANTS	PPM	16	0.055	0.087	0.330	0.0
TANNIN & LIGNIN	PPM	2	0.600	0.600	0.800	0.4000
SOLIDS						
TOTAL	PPM	24	427.000	425.917	627.000	306.00
FIXED	PPM	23	306.000	312.826	473.000	226.00
DISSOLVED	PPM	16	362.000	982.884	10002.	241.00
SUSPENDED	PPM	8	28.500	36.487	81.000	6.8000
GENERAL IONS						
CALCIUM	PPM	24	82.250	79.962	127.000	38.0000
MAGNESIUM	PPM	24	14.100	15.687	37.200	8.2000
SODIUM	PPM	24	14.500	13.855	23.000	0.0300
POTASSIUM	PPM	24	5.750	6.146	15.000	3.1000
SULPHATE	PPM	25	90.600	105.324	235.000	40.5000
CHLORIDE	PPM	24	6.100	7.071	17.400	2.7000
FLUORIDE	PPM	18	0.260	0.257	0.320	0.1700
METALS						
IRON - TOTAL	PPM	9	0.820	1.040	1.880	0.5400
IRON - DISSOLVED	PPM	16	0.215	0.337	0.960	0.1000
MANGANESE - DISS	PPM	20	0.070	0.091	0.210	0.0100
COPPER	PPM	20	0.020	0.032	0.180	0.0
ZINC	PPM	19	0.040	0.117	0.910	0.0
LEAD	PPM	20	0.006	0.013	0.060	0.0
MERCURY - UNFILT	PPM	2	0.065	0.065	0.070	0.0600
CHROMIUM	PPM	2	0.005	0.005 L	0.005 L	0.0050
NICKEL	PPM	2	0.010	0.010	0.010 L	0.0100
CADMIUM	PPM	2	0.001	0.001	0.001	0.0002
SEMI-METALS						
ARSENIC	PPM	11	0.0	0.001	0.005	0.0
OXYGEN						
BOD	PPM	10	10.000	16.590	72.000	1.3000
NUTRIENTS						
AMMONIA AS NH3	PPM	18	0.780	0.892	2.280	0.0400
N-KJELDHAL	PPM	7	2.000	2.584	6.000	0.2500
NITRATE	PPM	20	0.180	0.317	1.300	0.0300
NITRITE	PPM	15	0.017	0.021	0.063	0.0050
NITRATE+NITRITE	PPM	4	0.340	0.360	0.660	0.1000
TOTAL N	PPM	18	2.320	2.440	6.140	0.3900

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500021 DEEP CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	11	1.760	1.508	2.700	0.4800
PHOS - TOTAL	PPM	11	2.200	2.042	3.100	1.0700
PHOSPHORUS-TOTAL	PPM	13	0.930	1.200	3.630	0.1710
PHOSPHORUS-DISS	PPM	8	0.589	0.825	2.350	0.0760
SILICATE	PPM	23	22.700	22.483	27.700	16.4000
ORGANIC N	PPM	18	0.605	0.833	2.920	0.1400
CARBON						
ALK - PHENOL	PPM	19	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	24	186.000	180.875	205.000	128.00
TOT ORG CARBON	PPM	6	17.000	30.000	100.000	9.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500022 DEEP CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	16	7.000	7.250	16.000	0.0
DISSOLVED 02	PPM	4	11.750	11.250	12.600	8.9000
PH	PH UNITS	16	7.800	7.894	8.500	7.6000
COLOUR	HAZEN	16	10.000	24.375	80.000	0.0
TURBIDITY	JACKSON	13	1.200	1.485	5.800	0.1000
CONDUCTIVITY	M-MHOS	17	595.000	594.823	870.000	370.00
HARDNESS - TOTAL	PPM	15	292.000	297.866	472.000	216.00
SURFACTANTS	PPM	11	0.025	0.031	0.050	0.0250
TANNIN & LIGNIN	PPM	1	0.720	0.720	0.720	0.7200
SOLIDS						
TOTAL	PPM	16	411.000	433.125	745.000	324.00
FIXED	PPM	16	301.000	323.375	544.000	169.00
DISSOLVED	PPM	9	403.000	439.778	716.000	354.00
SUSPENDED	PPM	4	10.050	10.175	16.700	3.9000
GENERAL IONS						
CALCIUM	PPM	16	91.850	94.431	155.000	70.5000
MAGNESIUM	PPM	16	14.650	14.800	20.400	9.7000
SODIUM	PPM	16	8.700	8.894	11.500	7.1000
POTASSIUM	PPM	16	5.050	4.944	7.700	3.1000
SULPHATE	PPM	15	106.000	117.267	285.000	83.0000
CHLORIDE	PPM	16	1.700	2.125	5.200	0.3000
FLUORIDE	PPM	13	0.330	0.325	0.400	0.2400
METALS						
IRON - TOTAL	PPM	9	0.160	0.184	0.420	0.0200
IRON - DISSOLVED	PPM	9	0.140	0.241	1.200	0.0300
MANGANESE - DISS	PPM	13	0.060	0.092	0.440	0.0200
COPPER	PPM	13	0.010	0.011	0.030	0.0
ZINC	PPM	13	0.030	0.025	0.040	0.0
LEAD	PPM	13	0.012	0.013	0.030	0.0
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	1	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	1	0.001	0.001	0.001	0.0007
SEMI-METALS						
ARSENIC	PPM	8	0.0	0.000	0.001	0.0
OXYGEN						
BOD	PPM	2	5.550	5.550	L 10.000	1.1000
NUTRIENTS						
AMMONIA AS NH3	PPM	13	0.040	0.047	0.120	0.0
N-KJELDHAL	PPM	3	0.400	0.450	0.620	0.3300
NITRATE	PPM	13	0.370	0.600	2.500	0.0800
NITRITE	PPM	9	0.005	0.006	0.012	0.0050
NITRATE+NITRITE	PPM	3	0.830	0.920	1.440	0.4900
TOTAL N	PPM	9	1.110	1.166	2.890	0.3300

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500022 DEEP CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	11	0.090	0.109	0.200	0.0300
PHOS - TOTAL	PPM	11	0.150	0.173	0.340	0.0700
PHOSPHORUS-TOTAL	PPM	4	0.065	0.063	0.089	0.0330
PHOSPHORUS-DISS	PPM	1	0.056	0.056	0.056	0.0560
SILICATE	PPM	15	24.400	23.867	33.000	14.0000
ORGANIC N	PPM	13	0.150	0.185	0.700	0.0200
CARBON						
ALK - PHENOL	PPM	12	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	15	204.000	190.467	214.000	140.00
TOT ORG CARBON	PPM	4	13.500	12.000	18.000	3.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500024 BRANDTS CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	12.500	12.500	22.000	3.0000
DISSOLVED O2	PPM	6	11.100	11.350	15.600	7.7000
PH	PH UNITS	8	8.250	8.275	9.000	7.8000
COLUUR	HAZEN	8	25.000	26.875	60.000	10.0000
TURBIDITY	JACKSON	6	4.450	5.450	11.000	1.7000
CONDUCTIVITY	M-MHOS	9	2000.	2294.	3410.	1700.
HARDNESS - TOTAL	PPM	6	797.150	818.216	1130.	595.00
SURFACTANTS	PPM	2	0.027	0.027	0.030	0.0250
SOLIDS						
TOTAL	PPM	8	1732.	1799.	2930.	1291.
FIXED	PPM	8	1417.	1482.	2486.	1017.
DISSOLVED	PPM	2	1278.	1278.	1284.	1271.
SUSPENDED	PPM	6	21.800	32.750	107.000	4.7000
GENERAL IONS						
CALCIUM	PPM	6	120.500	117.333	148.000	83.0000
MAGNESIUM	PPM	6	119.000	125.250	186.000	82.5000
SODIUM	PPM	6	280.000	296.167	464.000	228.00
POTASSIUM	PPM	6	10.000	9.833	11.200	7.9000
SULPHATE	PPM	6	880.000	907.833	1460.	551.00
CHLORIDE	PPM	5	24.000	23.940	26.500	22.0000
FLUORIDE	PPM	2	0.495	0.495	0.500	0.4900
METALS						
IRON - DISSOLVED	PPM	6	0.075	0.122	0.400	0.0400
MANGANESE - DISS	PPM	2	0.405	0.405	0.470	0.3400
COPPER	PPM	2	0.006	0.006	0.010	0.0030
ZINC	PPM	2	0.017	0.017	0.030	0.0050
LEAD	PPM	2	0.003	0.003	0.004	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050	0.050	0.0500
CHROMIUM	PPM	2	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	0.0002
SEMI-METALS						
ARSENIC	PPM	1	0.004	0.004	0.004	0.0040
OXYGEN						
BOD	PPM	4	8.100	6.875	10.000	1.3000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.025	0.030	0.070	0.0
N-KJELDHAL	PPM	4	0.860	0.850	1.080	0.6000
NITRATE	PPM	4	0.745	1.035	2.280	0.2700
NITRITE	PPM	4	0.017	0.018	0.021	0.0150
NITRATE+NITRITE	PPM	4	1.475	1.510	2.560	0.5300
TOTAL N	PPM	8	2.080	2.089	3.160	1.1400
PHOS - ORTHO	PPM	2	0.875	0.875	0.910	0.8400
PHOS - TOTAL	PPM	2	1.025	1.025	1.100	0.9500

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500024 BRANDTS CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOSPHORUS-TOTAL	PPM	6	0.323	0.326	0.525	0.1190
PHOSPHORUS-DISS	PPM	2	0.147	0.147	0.208	0.0860
SILICATE	PPM	6	21.250	21.050	29.300	10.5000
ORGANIC N	PPM	4	0.705	0.735	0.930	0.6000
CARBON						
ALK - PHENOL	PPM	4	13.250	13.500	27.500	0.0
ALK - TOTAL	PPM	5	448.000	445.200	489.000	395.00
TOT ORG CARBON	PPM	6	14.000	19.167	37.000	7.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500026 ELLIS CREEK NEAR OKANAGAN RIVER

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	7.000	8.071	21.000	1.5000
DISSOLVED O2	PPM	7	12.000	11.414	13.000	8.8000
PH	PH UNITS	5	7.900	7.520	8.000	6.7000
COLOUR	HAZEN	7	45.000	52.143	130.000	15.0000
TURBIDITY	JACKSON	6	1.500	5.767	20.000	0.8000
CONDUCTIVITY	M-MHOS	7	100.000	94.286	140.000	L50.0000
HARDNESS - TOTAL	PPM	7	41.000	37.100	54.400	18.0000
TANNIN & LIGNIN	PPM	4	1.350	1.575	2.700	0.9000
SOLIDS						
TOTAL	PPM	7	104.000	98.857	142.000	68.0000
FIXED	PPM	6	69.000	66.000	96.000	34.0000
SUSPENDED	PPM	7	2.200	8.357	43.000	L 1.0000
GENERAL IONS						
CALCIUM	PPM	7	11.000	10.286	16.000	5.0000
MAGNESIUM	PPM	7	2.700	2.414	3.700	1.2000
SODIUM	PPM	7	5.300	5.000	7.000	2.7000
POTASSIUM	PPM	7	1.200	1.086	1.300	0.6000
SULPHATE	PPM	6	5.900	8.433	14.800	L 5.0000
CHLORIDE	PPM	5	1.000	0.960	1.100	0.6000
FLUORIDE	PPM	5	0.200	0.190	0.260	0.1100
METALS						
IRON - DISSOLVED	PPM	7	0.240	0.373	0.920	0.1500
MANGANESE - DISS	PPM	6	0.010	0.012	0.020	L 0.0100
COPPER	PPM	6	0.010	0.008	0.016	0.0010
ZINC	PPM	6	0.023	0.029	0.070	L 0.0050
LEAD	PPM	6	0.003	0.003	0.005	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	4	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	5	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.001	L 0.0001
OXYGEN						
BOD	PPM	1	10.000	10.000	10.000	10.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	5	0.030	0.044	0.080	L 0.0100
N-KJELDHAL	PPM	2	0.085	0.085	0.100	0.0700
NITRATE	PPM	6	0.020	0.022	0.030	L 0.0200
NITRITE	PPM	6	0.005	0.005	0.005	L 0.0050
NITRATE+NITRITE	PPM	1	0.080	0.080	0.080	0.0800
TOTAL N	PPM	7	0.210	0.214	0.370	0.0800
PHOSPHORUS-TOTAL	PPM	7	0.017	0.025	0.064	0.0100
PHOSPHORUS-DISS	PPM	5	0.007	0.008	0.013	L 0.0030
SILICATE	PPM	6	20.850	20.683	22.000	18.8000
ORGANIC N	PPM	5	0.200	0.190	0.290	0.0600
CARBON						
ALK - PHENOL	PPM	1	0.0	0.0	0.0	0.0

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500026 ELLIS CREEK NEAR OKANAGAN RIVER CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	6	36.500	35.417	59.500	17.5000
TOT ORG CARBON	PPM	6	12.500	13.833	29.000	6.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500027 ELLIS CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	6.750	9.563	25.000	1.5000
DISSOLVED O2	PPM	8	11.200	11.425	16.200	8.8000
PH	PH UNITS	6	7.800	7.850	8.100	7.1000
COLOUR	HAZEN	8	15.000	40.000	130.000	10.0000
TURBIDITY	JACKSON	7	2.300	7.086	24.000	1.0000
CONDUCTIVITY	M-MHOS	8	100.000	94.875	120.000	L 50.0000
HARDNESS - TOTAL	PPM	7	40.000	34.371	45.000	18.0000
TANNIN & LIGNIN	PPM	4	1.150	1.400	2.900	0.4000
SOLIDS						
TOTAL	PPM	8	102.000	116.250	178.000	72.0000
FIXED	PPM	6	69.000	80.667	136.000	30.0000
DISSOLVED	PPM	2	92.000	92.000	96.000	88.0000
SUSPENDED	PPM	6	2.150	22.750	75.000	L 1.0000
GENERAL IONS						
CALCIUM	PPM	7	10.800	9.443	12.000	5.2000
MAGNESIUM	PPM	7	2.600	2.359	3.300	1.2000
SODIUM	PPM	7	6.000	5.757	8.700	2.9000
POTASSIUM	PPM	7	1.200	1.200	1.800	0.7000
SULPHATE	PPM	6	7.550	7.317	9.200	L 5.0000
CHLORIDE	PPM	5	1.700	1.920	4.000	0.9000
FLUORIDE	PPM	5	0.190	0.184	0.260	0.1100
METALS						
IRON - DISSOLVED	PPM	7	0.300	0.390	0.880	0.1200
MANGANESE - DISS	PPM	7	0.010	0.022	0.060	L 0.0100
COPPER	PPM	6	0.310	0.011	0.020	0.0010
ZINC	PPM	6	0.050	0.198	0.980	L 0.0050
LEAD	PPM	6	0.003	0.004	0.006	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	0.050	L 0.250	L 0.0500
CHROMIUM	PPM	4	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	5	0.010	0.012	0.020	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.001	0.0001
OXYGEN						
BOD	PPM	3	10.000	7.133	10.000	1.4000
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.015	0.028	0.080	L 0.0100
N-KJELDHAL	PPM	2	0.125	0.125	0.130	0.1200
NITRATE	PPM	7	0.020	0.023	0.030	L 0.0200
NITRITE	PPM	7	0.005	0.005	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.030	0.030	0.040	L 0.0200
TOTAL N	PPM	8	0.165	0.196	0.450	0.0500
PHOSPHORUS-TOTAL	PPM	8	0.065	0.149	0.730	0.0140
PHOSPHORUS-DISS	PPM	5	0.014	0.021	0.042	0.0120
SILICATE	PPM	7	20.000	20.143	21.500	18.8000
ORGANIC N	PPM	6	0.150	0.175	0.400	0.0400
CARBON						
ALK - PHENOL	PPM	1	0.0	0.0	0.0	0.0

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500027 ELLIS CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	7	42.000	37.343	49.400	17.5000
TOT ORG CARBON	PPM	7	7.000	11.857	29.000	6.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500028 EQUESIS CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	5.500	6.300	13.000	2.5000
DISSOLVED O2	PPM	5	12.800	12.780	15.200	9.7000
PH	PH UNITS	4	8.500	8.350	8.900	7.5000
COLOUR	HAZEN	5	5.000	18.000	65.000	L 5.0000
TURBIDITY	JACKSON	5	1.500	5.200	21.000	1.0000
CONDUCTIVITY	M-MHOS	6	370.000	348.333	470.000	120.00
HARDNESS - TOTAL	PPM	5	191.000	191.200	257.000	134.00
TANNIN & LIGNIN	PPM	2	0.150	0.150	0.200	0.1000
SOLIDS						
TOTAL	PPM	5	244.000	242.800	300.000	180.00
FIXED	PPM	4	161.000	154.500	178.000	118.00
DISSOLVED	PPM	1	298.000	298.000	298.000	298.00
SUSPENDED	PPM	4	6.350	14.825	42.600	4.0000
GENERAL IONS						
CALCIUM	PPM	5	48.000	48.360	60.000	40.0000
MAGNESIUM	PPM	5	16.000	15.900	26.000	4.0000
SODIUM	PPM	5	9.600	8.840	10.500	6.2000
POTASSIUM	PPM	5	3.000	3.040	3.600	2.7000
SULPHATE	PPM	5	34.100	38.760	53.000	29.6000
CHLORIDE	PPM	4	0.800	0.750	0.900	0.5000
FLUORIDE	PPM	5	0.210	0.224	0.270	0.1700
METALS						
IRON - DISSOLVED	PPM	5	0.140	0.224	0.700	L 0.0400
MANGANESE - DISS	PPM	5	0.010	0.010	0.010	L 0.0100
COPPER	PPM	5	0.004	0.004	0.007	L 0.0010
ZINC	PPM	5	0.006	0.029	0.120	L 0.0050
LEAD	PPM	5	0.003	0.004	0.009	L 0.0030
MERCURY - UNFILT	PPM	4	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	5	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	5	0.010	0.024	0.080	L 0.0100
CADMIUM	PPM	5	0.000	0.001	0.002	L 0.0001
OXYGEN						
BOD	PPM	3	2.100	1.933	2.700	1.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	5	0.040	0.032	0.050	L 0.0100
N-KJELDHAL	PPM	1	0.280	0.280	0.280	0.2800
NITRATE	PPM	6	0.045	0.082	0.230	0.0140
NITRITE	PPM	5	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	5	0.250	0.254	0.410	0.1300
PHOSPHORUS-TOTAL	PPM	6	0.038	0.061	0.175	0.0260
PHOSPHORUS-DISS	PPM	5	0.029	0.038	0.087	0.0200
SILICATE	PPM	5	23.600	23.040	25.500	19.0000
ORGANIC N	PPM	5	0.080	0.132	0.350	0.0400
CARBON						
ALK - PHENOL	PPM	1	2.600	2.600	2.600	2.6000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500028 EQUESIS CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	3	180.000	176.333	185.000	164.00
TOT ORG CARBON	PPM	6	8.500	8.500	18.000	L 1.0000
TOT INORG CARBON	PPM	1	37.000	37.000	37.000	37.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500038 KELOWNA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	12.000	11.188	16.000	5.5000
DISSOLVED O2	PPM	6	7.200	7.333	8.200	6.6000
PH	PH UNITS	7	8.200	8.071	8.400	7.1000
COLOUR	HAZEN	8	15.000	20.625	40.000	10.0000
TURBIDITY	JACKSON	8	4.050	10.162	54.000	2.7000
CONDUCTIVITY	M-MHOS	7	449.000	420.571	470.000	300.00
HARDNESS - TOTAL	PPM	8	216.000	204.625	226.000	120.00
SOLIDS						
TOTAL	PPM	6	315.000	397.333	798.000	306.00
FIXED	PPM	6	235.000	291.333	622.000	184.00
SUSPENDED	PPM	6	307.000	304.000	314.000	290.00
GENERAL IONS						
CALCIUM	PPM	8	62.300	59.512	68.200	34.2000
CHLORIDE	PPM	8	2.100	2.137	2.800	1.4000
METALS						
IRON - DISSOLVED	PPM	8	0.160	0.231	0.720	0.0100
NUTRIENTS						
N-KJELDHAL	PPM	7	0.580	0.611	0.930	0.3200
NITRATE+NITRITE	PPM	8	0.170	0.281	1.000	0.1000
PHOSPHORUS-TOTAL	PPM	7	0.070	0.094	0.220	0.0490
PHOSPHORUS-DISS	PPM	8	0.047	0.048	0.068	0.0360
CARBON						
TOT ORG CARBON	PPM	8	10.000	9.250	15.000	5.0000
TOT INORG CARBON	PPM	8	30.500	30.750	40.000	23.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500039 KELOWNA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	11	13.000	12.636	19.000	6.0000
DISSOLVED O2	PPM	8	7.300	8.550	13.800	6.1000
PH	PH UNITS	10	8.200	8.190	8.500	7.5000
COLOUR	HAZEN	11	20.000	28.636	90.000	10.0000
TURBIDITY	JACKSON	11	5.600	10.718	43.000	1.8000
CONDUCTIVITY	M-MHOS	10	461.500	440.600	554.000	240.00
HARDNESS - TOTAL	PPM	11	196.000	185.636	239.000	101.00
SOLIDS						
TOTAL	PPM	11	326.000	322.727	378.000	232.00
FIXED	PPM	11	226.000	224.727	276.000	144.00
SUSPENDED	PPM	11	306.000	284.182	352.000	162.00
GENERAL IONS						
CALCIUM	PPM	11	52.800	50.227	65.500	26.0000
CHLORIDE	PPM	8	8.800	8.612	10.800	5.9000
METALS						
IRON - DISSOLVED	PPM	8	0.140	0.177	0.370	0.0300
NUTRIENTS						
N-KJELDHAL	PPM	8	0.565	0.639	0.950	0.4800
NITRATE+NITRITE	PPM	11	1.450	1.264	2.010	0.0200
PHOSPHORUS-TOTAL	PPM	10	0.083	0.096	0.189	0.0540
PHOSPHORUS-DISS	PPM	10	0.038	0.041	0.058	0.0290
CARBON						
TOT ORG CARBON	PPM	8	6.000	7.875	17.000	2.0000
TOT INORG CARBON	PPM	8	30.500	32.250	47.000	24.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500041 LAMBLY CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	9	13.000	9.833	14.000	2.5000
DISSOLVED O2	PPM	6	8.650	8.733	12.000	5.9000
PH	PH UNITS	8	8.750	8.712	9.000	8.4000
COLOUR	HAZEN	8	10.000	12.500	30.000	5.0000
TURBIDITY	JACKSON	8	0.990	1.101	2.000	0.2600
CONDUCTIVITY	M-MHOS	8	251.500	242.750	273.000	160.00
HARDNESS - TOTAL	PPM	8	118.500	108.887	132.000	68.8000
SOLIDS						
TOTAL	PPM	9	172.000	164.444	190.000	124.00
FIXED	PPM	9	118.000	112.889	134.000	80.0000
SUSPENDED	PPM	9	166.000	154.778	184.000	110.00
GENERAL IONS						
CALCIUM	PPM	8	36.300	33.912	41.600	22.6000
CHLORIDE	PPM	7	0.600	0.600	0.700	0.4000
METALS						
IRON - DISSOLVED	PPM	7	0.060	0.066	0.120	0.0300
NUTRIENTS						
N-KJELDHAL	PPM	7	0.280	0.327	0.680	0.1800
NITRATE+NITRITE	PPM	8	0.010	0.010	0.010	0.0100
PHOSPHORUS-TOTAL	PPM	7	0.025	0.021	0.030	0.0100
PHOSPHORUS-DISS	PPM	7	0.013	0.013	0.024	0.0050
CARBON						
TOT ORG CARBON	PPM	6	7.000	7.333	11.000	5.0000
TOT INORG CARBON	PPM	6	18.000	17.333	23.000	12.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500045 MISSION CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	15	6.000	6.980	21.000	0.0
DISSOLVED O2	PPM	4	11.700	11.750	13.000	10.6000
PH	PH UNITS	16	7.800	7.762	8.600	7.0000
COLOUR	HAZEN	11	15.000	16.364	40.000	5.0000
TURBIDITY	JACKSON	9	0.800	1.144	4.100	0.1000
CONDUCTIVITY	M-MHOS	15	120.000	151.800	280.000	35.0000
HARDNESS - TOTAL	PPM	14	48.800	66.593	136.000	16.6000
SURFACTANTS	PPM	7	0.025	0.014	0.025	0.0
TANNIN & LIGNIN	PPM	1	0.800	0.800	0.800	0.8000
SOLIDS						
TOTAL	PPM	14	129.500	146.143	447.000	68.0000
FIXED	PPM	13	87.000	105.385	405.000	40.0000
DISSOLVED	PPM	7	132.000	118.714	160.000	70.0000
SUSPENDED	PPM	4	2.250	3.950	10.100	1.2000
GENERAL IONS						
CALCIUM	PPM	14	16.700	18.586	33.000	4.9000
MAGNESIUM	PPM	14	5.200	6.114	13.000	1.1000
SODIUM	PPM	10	7.250	6.850	10.500	2.7000
POTASSIUM	PPM	14	1.100	1.150	3.000	0.5000
SULPHATE	PPM	11	20.000	15.791	24.100	L 5.0000
CHLORIDE	PPM	10	0.900	1.120	2.300	0.7000
FLUORIDE	PPM	7	0.190	0.179	0.290	L 0.1000
METALS						
IRON - TOTAL	PPM	8	0.200	0.352	1.120	0.1000
IRON - DISSOLVED	PPM	8	0.150	0.645	3.800	0.0600
MANGANESE - DISS	PPM	13	0.020	0.031	0.140	0.0
COPPER	PPM	12	0.020	0.013	0.020	0.0
ZINC	PPM	12	0.020	0.023	0.060	0.0
LEAD	PPM	12	0.005	0.008	0.020	0.0
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.025	0.025	0.040	L 0.0100
CADMIUM	PPM	1	0.001	0.001	0.001	0.0006
SEMI-METALS						
ARSENIC	PPM	9	0.0	0.000	0.002	0.0
OXYGEN						
BOD	PPM	2	6.200	6.200	10.000	2.4000
NUTRIENTS						
AMMONIA AS NH3	PPM	11	0.020	0.026	0.060	0.0
N-KJELDHAL	PPM	3	0.120	0.260	0.580	0.0800
NITRATE	PPM	12	0.075	0.096	0.230	0.0200
NITRITE	PPM	7	0.005	0.005	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.340	0.340	0.380	0.3000
TOTAL N	PPM	8	0.320	0.394	0.960	0.1300

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500045 MISSION CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	9	0.010	0.027	0.050	0.0
PHOS - TOTAL	PPM	9	0.050	0.146	0.730	0.0
PHOSPHORUS-TOTAL	PPM	4	0.010	0.013	0.023	0.0090
PHOSPHORUS-DISS	PPM	1	0.006	0.006	0.006	0.0060
SILICATE	PPM	13	14.300	14.485	19.100	11.5000
ORGANIC N	PPM	11	0.060	0.113	0.380	0.0200
CARBON						
ALK - PHENOL	PPM	11	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	13	48.000	59.669	114.000	14.0000
TOT ORG CARBON	PPM	3	7.000	7.333	12.000	3.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500046 MISSION CREEK AT MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	9	8.000	9.056	18.000	1.0000
DISSOLVED O2	PPM	8	11.200	11.362	13.600	9.1000
PH	PH UNITS	9	8.300	8.133	8.800	6.6000
COLOUR	HAZEN	8	20.000	25.625	65.000	5.0000
TURBIDITY	JACKSON	8	2.650	9.312	40.000	1.2000
CONDUCTIVITY	M-MHOS	10	268.000	256.200	480.000	L50.0000
HARDNESS - TOTAL	PPM	7	78.000	107.571	232.000	16.0000
SURFACTANTS	PPM	1	0.0	0.0	0.0	0.0
TANNIN & LIGNIN	PPM	4	0.500	0.725	1.600	0.3000
SOLIDS						
TOTAL	PPM	8	231.000	218.500	336.000	78.0000
FIXED	PPM	7	186.000	163.143	240.000	56.0000
SUSPENDED	PPM	8	6.350	28.050	137.000	2.3000
GENERAL IONS						
CALCIUM	PPM	8	26.000	28.437	52.400	4.6000
MAGNESIUM	PPM	8	9.300	11.087	23.000	1.1000
SODIUM	PPM	8	8.250	9.250	18.500	1.2000
POTASSIUM	PPM	8	1.300	1.425	2.400	0.4000
SULPHATE	PPM	7	22.500	38.329	90.600	L 5.0000
CHLORIDE	PPM	7	1.500	1.329	1.900	0.5000
FLUORIDE	PPM	4	0.120	0.125	0.160	L 0.1000
METALS						
IRON - DISSOLVED	PPM	7	0.120	0.111	0.200	0.0400
MANGANESE - DISS	PPM	6	0.010	0.018	0.040	L 0.0100
COPPER	PPM	6	0.003	0.007	0.017	0.0010
ZINC	PPM	6	0.009	0.020	0.060	L 0.0050
LEAD	PPM	6	0.003	0.004	0.006	L 0.0030
MERCURY - UNFILT	PPM	5	0.050	0.050	0.050	L 0.0500
CHROMIUM	PPM	5	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	6	0.010	0.015	0.040	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.000	L 0.0001
OXYGEN						
BOD	PPM	3	2.600	4.800	10.000	1.8000
NUTRIENTS						
AMMONIA AS NH3	PPM	5	0.030	0.032	0.070	L 0.0100
N-KJELDHAL	PPM	4	0.240	0.260	0.430	0.1300
NITRATE	PPM	7	0.050	0.137	0.530	0.0200
NITRITE	PPM	6	0.005	0.005	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.375	0.375	0.670	0.0800
TOTAL N	PPM	8	0.375	0.457	0.900	0.1900
PHOSPHORUS-TOTAL	PPM	9	0.018	0.028	0.081	0.0110
PHOSPHORUS-DISS	PPM	5	0.007	0.008	0.011	0.0060
SILICATE	PPM	8	16.450	15.600	18.700	8.8000
ORGANIC N	PPM	5	0.270	0.254	0.400	0.1200
CARBON						
ALK - PHENOL	PPM	3	3.500	3.333	6.500	0.0

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500046 MISSION CREEK AT MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	7	73.600	89.371	178.000	17.0000
TOT ORG CARBON	PPM	8	8.000	9.000	15.000	3.0000
TOT INORG CARBON	PPM	1	22.000	22.000	22.000	22.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500048 OKANAGAN R - BELOW OLIVER

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	8.000	11.583	22.000	4.0000
DISSOLVED O2	PPM	6	11.650	10.967	12.600	8.7000
PH	PH UNITS	6	8.250	8.183	8.400	7.8000
COLOUR	HAZEN	6	5.000	5.833	10.000	L 5.0000
TURBIDITY	JACKSON	4	2.650	2.475	3.500	1.1000
CONDUCTIVITY	M-MHOS	6	280.000	280.000	320.000	240.00
HARDNESS - TOTAL	PPM	6	121.500	123.667	142.000	104.00
TANNIN & LIGNIN	PPM	2	0.200	0.200	0.200	0.2000
SOLIDS						
TOTAL	PPM	6	177.000	176.667	194.000	158.00
FIXED	PPM	5	130.000	120.800	146.000	86.0000
DISSOLVED	PPM	1	160.000	160.000	160.000	160.00
SUSPENDED	PPM	5	2.100	4.980	13.600	1.5000
GENERAL IONS						
CALCIUM	PPM	6	33.550	34.133	39.500	29.0000
MAGNESIUM	PPM	6	8.400	8.700	10.500	7.0000
SODIUM	PPM	6	10.300	10.000	11.500	8.4000
POTASSIUM	PPM	6	2.300	2.300	2.600	1.9000
SULPHATE	PPM	6	30.400	28.800	33.400	22.0000
CHLORIDE	PPM	6	1.550	1.600	2.100	1.3000
FLUORIDE	PPM	3	0.220	0.230	0.260	0.2100
METALS						
IRON - DISSOLVED	PPM	5	0.040	0.038	0.050	0.0200
MANGANESE - TOT	PPM	1	0.020	0.020	0.020	0.0200
MANGANESE - DISS	PPM	2	0.020	0.020	0.030	0.0100
COPPER	PPM	3	0.009	0.007	0.010	0.0030
ZINC	PPM	3	0.020	0.015	0.020	0.0050
LEAD	PPM	3	0.003	0.003	0.004	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.001	0.002	0.0002
OXYGEN						
BOD	PPM	1	0.300	0.300	0.300	0.3000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.010	0.013	0.020	L 0.0100
N-KJELDHAL	PPM	3	0.320	0.307	0.420	0.1800
NITRATE	PPM	3	0.230	0.197	0.340	L 0.0200
NITRITE	PPM	3	0.005	0.005 L	0.005	L 0.0050
NITRATE+NITRITE	PPM	3	0.060	0.150	0.370	0.0200
TOTAL N	PPM	6	0.450	0.418	0.690	0.2000
PHOSPHORUS-TOTAL	PPM	6	0.030	0.035	0.069	0.0160
PHOSPHORUS-DISS	PPM	3	0.007	0.007	0.010	0.0040
SILICATE	PPM	6	4.850	4.417	6.300	1.0000
ORGANIC N	PPM	3	0.180	0.180	0.190	0.1700

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500048 OKANAGAN R - BELOW OLIVER CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - TOTAL	PPM	4	107.500	108.625	125.000	94.5000
TOT ORG CARBON	PPM	6	7.000	8.000	15.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500049 OKANAGAN R - NEAR OSOYOOS

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	6.000	10.600	23.000	2.0000
DISSOLVED O2	PPM	5	12.200	11.480	12.600	9.0000
PH	PH UNITS	6	8.150	8.167	8.900	7.2000
COLOUR	HAZEN	4	5.000	6.250	10.000	L 5.0000
TURBIDITY	JACKSON	3	1.400	1.433	1.600	1.3000
CONDUCTIVITY	M-MHOS	5	280.000	275.000	300.000	240.00
HARDNESS - TOTAL	PPM	5	118.000	115.800	125.000	104.00
TANNIN & LIGNIN	PPM	1	0.100	0.100	0.100	0.1000
SOLIDS						
TOTAL	PPM	5	168.000	165.200	176.000	144.00
FIXED	PPM	4	134.000	131.500	138.000	120.00
SUSPENDED	PPM	5	2.900	3.220	6.300	1.4000
GENERAL IONS						
CALCIUM	PPM	5	32.000	31.860	34.000	28.8000
MAGNESIUM	PPM	5	8.200	8.300	9.200	7.0000
SODIUM	PPM	4	9.050	9.175	10.000	8.6000
POTASSIUM	PPM	4	2.250	2.225	2.400	2.0000
SULPHATE	PPM	4	29.350	28.500	30.800	24.5000
CHLORIDE	PPM	5	1.600	1.480	1.700	1.0000
FLUORIDE	PPM	2	0.220	0.220	0.220	0.2200
METALS						
IRON - DISSOLVED	PPM	5	0.040	0.032	L 0.040	L 0.0200
MANGANESE - DISS	PPM	2	0.015	0.015	0.020	L 0.0100
COPPER	PPM	2	0.002	0.002	0.002	0.0020
ZINC	PPM	2	0.006	0.006	0.007	L 0.0050
LEAD	PPM	2	0.003	0.003	L 0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	2	0.020	0.020	0.030	L 0.0100
CADMIUM	PPM	2	0.001	0.001	0.001	L 0.0001
OXYGEN						
BOD	PPM	1	0.400	0.400	0.400	0.4000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.010	0.020	0.040	L 0.0100
N-KJELDHAL	PPM	2	0.185	0.185	0.190	0.1800
NITRATE	PPM	2	0.070	0.070	0.090	0.0500
NITRITE	PPM	2	10.005	10.005	20.005	L 0.0050
NITRATE+NITRITE	PPM	3	0.020	0.057	0.130	L 0.0200
TOTAL N	PPM	5	0.230	0.228	0.320	0.1400
PHOSPHORUS-TOTAL	PPM	5	0.029	0.027	0.039	0.0130
PHOSPHORUS-DISS	PPM	2	0.011	0.011	0.019	0.0040
SILICATE	PPM	4	3.900	3.600	4.100	2.5000
ORGANIC N	PPM	3	0.180	0.153	0.230	0.0500
CARBON						
ALK - PHENOL	PPM	1	4.100	4.100	4.100	4.1000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500049 OKANAGAN R - NEAR OSOYOOS CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	3	110.000	107.667	118.000	95.0000
TOT ORG CARBON	PPM	4	7.000	7.500	11.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500050 OKANAGAN R - WEST OF PENTICTON

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	15	10.500	11.033	25.000	2.0000
DISSOLVED O2	PPM	5	12.200	11.420	12.700	9.4000
PH	PH UNITS	13	7.800	7.885	8.500	7.6000
COLOUR	HAZEN	10	5.000	4.500	10.000	0.0
TURBIDITY	JACKSON	9	0.600	0.700	1.200	0.4000
CONDUCTIVITY	M-MHOS	17	265.000	263.823	300.000	190.00
HARDNESS - TOTAL	PPM	15	115.000	115.733	127.000	111.00
SURFACTANTS	PPM	4	0.025	0.019	0.025	0.0
TANNIN & LIGNIN	PPM	1	0.100	0.100	L 0.100	L 0.1000
SOLIDS						
TOTAL	PPM	15	161.000	162.067	179.000	146.00
FIXED	PPM	15	108.000	114.533	145.000	96.0000
DISSOLVED	PPM	5	160.000	162.000	170.000	152.00
SUSPENDED	PPM	6	1.450	1.450	2.000	0.9000
GENERAL IONS						
CALCIUM	PPM	12	32.100	31.783	33.900	28.5000
MAGNESIUM	PPM	15	8.500	8.567	10.200	7.7000
SODIUM	PPM	10	9.350	9.140	10.400	5.7000
POTASSIUM	PPM	15	2.200	2.147	2.400	1.9000
SULPHATE	PPM	15	27.600	27.713	34.000	22.0000
CHLORIDE	PPM	9	1.500	1.444	1.800	1.0000
FLUORIDE	PPM	7	0.210	0.213	0.260	0.1600
METALS						
IRON - TOTAL	PPM	6	0.050	0.057	0.140	0.0
IRON - DISSOLVED	PPM	11	0.040	0.038	0.100	0.0
MANGANESE - DISS	PPM	12	0.010	0.012	0.020	0.0
COPPER	PPM	9	0.0	0.006	0.050	0.0
ZINC	PPM	12	0.020	0.039	0.190	0.0
LEAD	PPM	12	0.008	0.013	0.048	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	L 0.0001
SEMI-METALS						
ARSENIC	PPM	4	0.0	0.0	0.0	0.0
OXYGEN						
BOD	PPM	1	10.000	10.000	L 10.000	L10.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	12	0.010	0.027	0.090	0.0
N-KJELDHAL	PPM	3	0.100	0.110	0.160	0.0700
NITRATE	PPM	12	0.025	0.026	0.040	L 0.0200
NITRITE	PPM	7	0.005	0.005	0.013	0.0
NITRATE+NITRITE	PPM	3	0.030	0.030	0.040	L 0.0200
TOTAL N	PPM	11	0.170	0.165	0.280	0.0400

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500050 OKANAGAN R - WEST OF PENTICTON CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	8	0.010	0.024	0.100	0.0
PHOS - TOTAL	PPM	8	0.040	0.051	0.140	0.0200
PHOSPHORUS-TOTAL	PPM	6	0.006	0.007	0.014	L 0.0030
PHOSPHORUS-DISS	PPM	3	0.003	0.003	L 0.003	L 0.0030
SILICATE	PPM	15	5.200	5.120	7.000	3.5000
ORGANIC N	PPM	12	0.095	0.102	0.200	0.0100
CARBON						
ALK - PHENOL	PPM	9	0.0	0.111	1.000	0.0
ALK - TOTAL	PPM	14	105.500	105.286	110.000	100.00
TOT ORG CARBON	PPM	6	6.000	6.333	8.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500051 OKANAGAN R - NEAR OKANAGAN FALLS

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	17	8.000	10.618	22.500	1.0000
DISSOLVED O2	PPM	5	12.100	11.900	13.200	9.5000
PH	PH UNITS	17	7.900	7.853	8.600	6.2000
COLOUR	HAZEN	13	5.000	4.615	10.000	0.0
TURBIDITY	JACKSON	10	1.050	1.150	2.800	0.1000
CONDUCTIVITY	M-MHOS	17	268.000	268.294	300.000	250.00
HARDNESS - TOTAL	PPM	17	117.000	115.647	119.000	110.00
SURFACTANTS	PPM	9	0.025	0.030	0.120	0.0
TANNIN & LIGNIN	PPM	1	0.100	0.100	L 0.100	L 0.1000
SOLIDS						
TOTAL	PPM	17	161.000	162.529	185.000	148.00
FIXED	PPM	15	106.000	108.133	140.000	60.0000
DISSOLVED	PPM	8	158.500	159.500	175.000	151.00
SUSPENDED	PPM	5	5.500	5.980	7.600	4.2000
GENERAL IONS						
CALCIUM	PPM	14	32.100	32.079	34.200	30.2000
MAGNESIUM	PPM	17	8.300	8.215	8.900	7.0000
SODIUM	PPM	12	9.250	9.308	11.000	8.3000
POTASSIUM	PPM	17	2.300	2.265	4.000	1.5000
SULPHATE	PPM	17	27.800	29.353	53.600	24.4000
CHLORIDE	PPM	13	1.500	1.585	3.200	1.2000
FLUORIDE	PPM	8	0.215	0.229	0.270	0.2000
METALS						
IRON - TOTAL	PPM	8	0.040	0.072	0.300	0.0
IRON - DISSOLVED	PPM	11	0.040	0.035	0.100	0.0
MANGANESE - DISS	PPM	13	0.010	0.014	0.040	0.0
COPPER	PPM	13	0.020	0.055	0.560	0.0
ZINC	PPM	13	0.020	0.033	0.140	0.0
LEAD	PPM	12	0.013	0.014	0.036	L 0.0030
MERCURY - UNFILT	PPM	2	0.105	0.105	0.160	L 0.0500
CHROMIUM	PPM	2	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010	0.010	L 0.0100
CADMIUM	PPM	2	0.001	0.001	0.001	0.0005
SEMI-METALS						
ARSENIC	PPM	8	0.0	0.0	0.0	0.0
OXYGEN						
BOD	PPM	1	10.000	10.000	L 10.000	L10.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	12	0.010	0.047	0.310	0.0
N-KJELDHAL	PPM	4	0.335	0.337	0.470	0.2100
NITRATE	PPM	12	0.040	0.047	0.100	0.0200
NITRITE	PPM	8	0.005	0.006	0.014	0.0
NITRATE+NITRITE	PPM	4	0.075	0.092	0.160	0.0600
TOTAL N	PPM	10	0.300	0.330	0.610	0.0400

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500051 OKANAGAN R - NEAR OKANAGAN FALLS CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	10	0.030	0.036	0.090	0.0100
PHOS - TOTAL	PPM	10	0.075	0.085	0.200	0.0200
PHOSPHORUS-TOTAL	PPM	6	0.020	0.025	0.050	0.0150
PHOSPHORUS-DISS	PPM	2	0.008	0.008	0.012	0.0040
SILICATE	PPM	17	3.200	2.906	6.500	0.5000
ORGANIC N	PPM	12	0.145	0.144	0.260	0.0
CARBON						
ALK - PHENOL	PPM	12	0.0	1.583	9.500	0.0
ALK - TOTAL	PPM	15	106.000	105.733	110.000	98.0000
TOT ORG CARBON	PPM	6	8.000	8.500	15.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500053 OKANAGAN R - BELOW VASEUX LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	14	7.500	10.214	25.000	0.5000
DISSOLVED O2	PPM	4	11.800	11.225	13.100	8.2000
PH	PH UNITS	14	7.950	8.064	8.600	7.7000
COLOUR	HAZEN	10	5.000	6.000	15.000	0.0
TURBIDITY	JACKSON	9	2.000	2.667	10.000	0.3000
CONDUCTIVITY	M-MHOS	15	260.000	262.067	290.000	240.00
HARDNESS - TOTAL	PPM	15	118.000	116.867	122.000	104.00
SURFACTANTS	PPM	7	0.025	0.029	0.040	0.0250
TANNIN & LIGNIN	PPM	2	0.150	0.150	0.200	0.1000
SOLIDS						
TOTAL	PPM	15	166.000	167.267	209.000	144.00
FIXED	PPM	15	107.000	111.733	165.000	88.0000
DISSOLVED	PPM	7	162.000	163.429	169.000	155.00
SUSPENDED	PPM	4	4.250	4.725	9.100	1.3000
GENERAL IONS						
CALCIUM	PPM	13	32.900	32.923	34.500	29.2000
MAGNESIUM	PPM	15	8.500	8.307	8.900	6.0000
SODIUM	PPM	10	9.350	9.380	11.000	8.3000
POTASSIUM	PPM	15	2.200	2.553	5.400	1.6000
SULPHATE	PPM	11	26.800	27.227	33.600	23.2000
CHLORIDE	PPM	11	1.400	1.718	4.700	1.3000
FLUORIDE	PPM	7	0.230	0.221	0.250	0.1800
METALS						
IRON - TOTAL	PPM	8	0.180	0.232	0.740	0.0200
IRON - DISSOLVED	PPM	9	0.040	0.062	0.140	0.0
MANGANESE - DISS	PPM	13	0.020	0.022	0.090	L 0.0100
COPPER	PPM	10	0.015	0.012	0.020	0.0
ZINC	PPM	13	0.020	0.033	0.180	0.0
LEAD	PPM	13	0.008	0.011	0.023	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	2	0.004	0.004	0.007	0.0001
SEMI-METALS						
ARSENIC	PPM	7	0.0	0.0	0.0	0.0
OXYGEN						
BOD	PPM	1	0.300	0.300	0.300	0.3000
NUTRIENTS						
AMMONIA AS NH3	PPM	13	0.010	0.100	0.670	0.0
N-KJELDHAL	PPM	2	0.255	0.255	0.280	0.2300
NITRATE	PPM	12	0.030	0.032	0.070	0.0
NITRITE	PPM	8	0.005	0.006	0.010	L 0.0050
NITRATE+NITRITE	PPM	2	0.045	0.045	0.070	0.0200
TOTAL N	PPM	8	0.215	0.205	0.350	0.0600

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500053 OKANAGAN R - BELOW VASEUX LAKE CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	10	0.030	0.038	0.110	0.0100
PHOS - TOTAL	PPM	10	0.110	0.132	0.350	0.0200
PHOSPHORUS-TOTAL	PPM	4	0.030	0.032	0.048	0.0180
PHOSPHORUS-DISS	PPM	2	0.004	0.004	0.005	0.0040
SILICATE	PPM	14	3.100	2.881	4.600	0.6000
ORGANIC N	PPM	13	0.130	0.148	0.310	0.0400
CARBON						
ALK - PHENOL	PPM	11	0.0	1.273	6.500	0.0
ALK - TOTAL	PPM	14	108.000	106.750	112.000	93.5000
TOT ORG CARBON	PPM	4	8.500	8.250	11.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500055 PEACHLAND CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	5.250	6.583	13.500	3.0000
DISSOLVED O2	PPM	5	11.400	11.380	13.400	9.6000
PH	PH UNITS	7	8.100	8.029	8.200	7.7000
COLOUR	HAZEN	5	20.000	25.000	55.000	10.0000
TURBIDITY	JACKSON	4	11.000	11.250	20.000	3.0000
CONDUCTIVITY	M-MHOS	7	160.000	179.714	241.000	150.00
HARDNESS - TOTAL	PPM	5	81.000	84.120	110.000	59.0000
TANNIN & LIGNIN	PPM	3	0.600	0.700	1.100	0.4000
SOLIDS						
TOTAL	PPM	7	164.000	143.143	190.000	80.0000
FIXED	PPM	7	106.000	92.143	120.000	51.0000
DISSOLVED	PPM	2	78.000	78.000	80.000	76.0000
SUSPENDED	PPM	6	11.650	15.783	41.000	0.9000
VOLATILE SUSP	PPM	1	2.000	2.000	2.000	2.0000
GENERAL IONS						
CALCIUM	PPM	7	23.400	25.457	35.000	19.2000
MAGNESIUM	PPM	7	3.000	3.629	5.400	2.5000
SODIUM	PPM	7	3.700	3.986	5.000	3.2000
POTASSIUM	PPM	7	1.900	1.957	2.300	1.7000
SULPHATE	PPM	7	10.000	12.114	22.000	9.2000
CHLORIDE	PPM	6	1.100	1.100	1.300	0.8000
FLUORIDE	PPM	7	0.100	0.101	0.110	L 0.1000
METALS						
IRON - DISSOLVED	PPM	7	0.060	0.074	0.160	0.0200
MANGANESE - DISS	PPM	6	0.010	0.010	0.010	L 0.0100
COPPER	PPM	7	0.008	0.012	0.040	0.0030
ZINC	PPM	7	0.014	0.031	0.150	L 0.0050
LEAD	PPM	7	0.003	0.003	0.003	L 0.0030
MERCURY - UNFILT	PPM	5	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	4	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	6	0.010	0.010	0.010	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.000	L 0.0001
MOLYBDENUM	PPM	1	0.100	0.100 L	0.100	L 0.1000
SEMI-METALS						
BORON	PPM	1	0.200	0.200	0.200	0.2000
ARSENIC	PPM	1	0.002	0.002	0.002	0.0020
OXYGEN						
BOD	PPM	2	0.750	0.750	0.900	0.6000
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.070	0.055	0.080	0.0120
N-KJELDHAL	PPM	1	0.250	0.250	0.250	0.2500
NITRATE	PPM	6	1.040	1.647	4.970	0.1900
NITRITE	PPM	6	0.005	0.026	0.080	L 0.0050
TOTAL N	PPM	6	1.335	2.103	6.010	0.6300

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500055 PEACHLAND CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOSPHORUS-TOTAL	PPM	6	0.023	0.025	0.046	L 0.0030
PHOSPHORUS-DISS	PPM	6	0.007	0.007	0.012	L 0.0030
SILICATE	PPM	6	15.000	15.183	19.000	11.8000
ORGANIC N	PPM	6	0.310	0.378	0.890	0.1600
CARBON						
ALK - PHENOL	PPM	2	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	6	64.750	64.750	80.000	48.5000
TOT ORG CARBON	PPM	5	12.000	10.200	13.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500056 PEACHLAND CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	6.000	7.971	16.000	2.0000
DISSOLVED O2	PPM	6	10.500	10.900	13.600	8.6000
PH	PH UNITS	6	8.150	8.100	8.600	7.7000
COLOUR	HAZEN	7	10.000	13.071	35.000	1.5000
TURBIDITY	JACKSON	5	9.000	21.260	76.000	0.9000
CONDUCTIVITY	M-MHOS	7	280.000	289.857	410.000	200.00
HARDNESS - TOTAL	PPM	6	130.000	136.833	210.000	86.0000
TANNIN & LIGNIN	PPM	3	0.500	1.233	2.900	0.3000
SOLIDS						
TOTAL	PPM	6	200.000	262.667	552.000	174.00
FIXED	PPM	6	144.000	195.000	440.000	114.00
DISSOLVED	PPM	1	268.000	268.000	268.000	268.00
SUSPENDED	PPM	5	19.200	72.260	296.000	1.9000
GENERAL IONS						
CALCIUM	PPM	6	42.300	44.000	65.000	28.6000
MAGNESIUM	PPM	6	5.950	6.600	11.500	3.9000
SODIUM	PPM	6	5.500	6.083	9.800	4.2000
POTASSIUM	PPM	6	2.300	2.383	3.200	1.8000
SULPHATE	PPM	6	18.850	20.600	32.400	12.0000
CHLORIDE	PPM	5	1.300	1.340	1.800	1.0000
FLUORIDE	PPM	5	0.230	0.232	0.320	0.1600
METALS						
IRON - DISSOLVED	PPM	6	0.070	0.100	0.280	L 0.0400
MANGANESE - DISS	PPM	5	0.010	0.010	0.010	L 0.0100
COPPER	PPM	6	0.004	0.005	0.010	0.0030
ZINC	PPM	5	0.011	0.039	0.140	L 0.0050
LEAD	PPM	5	0.003	0.004	0.008	L 0.0030
MERCURY - UNFILT	PPM	5	0.050	0.041 L	0.050	L 0.0050
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	5	0.010	0.027	0.096	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.000	L 0.0001
MOLYBDENUM	PPM	2	0.057	0.057 L	0.100	0.0148
SEMI-METALS						
ARSENIC	PPM	1	0.005	0.005 L	0.005	L 0.0050
OXYGEN						
BOD	PPM	2	1.250	1.250	1.600	0.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.045	0.042	0.070	L 0.0100
N-KJELDHAL	PPM	3	0.040	0.287	0.810	L 0.0100
NITRATE	PPM	6	0.970	1.250	3.160	0.2700
NITRITE	PPM	5	0.005	0.018	0.045	L 0.0050
NITRATE+NITRITE	PPM	2	1.015	1.015	1.030	1.0000
TOTAL N	PPM	6	1.110	1.720	4.220	0.9700
PHOSPHORUS-TOTAL	PPM	7	0.023	0.026	0.048	0.0100

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500056 PEACHLAND CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOSPHORUS-DISS	PPM	5	0.006	0.010	0.024	0.0050
SILICATE	PPM	6	17.250	16.967	19.300	13.6000
ORGANIC N	PPM	4	0.450	0.522	0.990	0.2000
CARBON						
ALK - TOTAL	PPM	5	128.000	113.400	132.000	77.0000
TOT ORG CARBON	PPM	7	8.000	7.429	17.000	1.0000
TOT INORG CARBON	PPM	1	30.000	30.000	30.000	30.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500057 PENTICTON CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	9.500	9.429	25.000	2.0000
DISSOLVED O2	PPM	7	10.300	10.686	12.600	9.4000
PH	PH UNITS	8	7.800	7.887	9.500	6.9000
COLOUR	HAZEN	7	30.000	32.143	65.000	L 5.0000
TURBIDITY	JACKSON	6	1.750	3.967	11.000	1.0000
CONDUCTIVITY	M-MHOS	8	74.000	121.000	300.000	L50.0000
HARDNESS - TOTAL	PPM	7	30.000	52.486	119.000	14.0000
TANNIN & LIGNIN	PPM	3	1.200	0.900	1.300	0.2000
SOLIDS						
TOTAL	PPM	7	90.000	105.429	216.000	46.0000
FIXED	PPM	5	54.000	72.800	174.000	32.0000
DISSOLVED	PPM	1	88.000	88.000	88.000	88.0000
SUSPENDED	PPM	6	3.300	6.550	19.000	1.6000
GENERAL IONS						
CALCIUM	PPM	7	9.000	14.157	31.000	3.8000
MAGNESIUM	PPM	7	2.200	3.854	10.000	0.5000
SODIUM	PPM	7	4.100	5.343	10.900	2.2000
POTASSIUM	PPM	7	1.400	1.357	2.500	0.6000
SULPHATE	PPM	6	8.900	18.833	60.200	L 5.0000
CHLORIDE	PPM	4	2.000	1.775	2.300	0.8000
FLUORIDE	PPM	4	0.130	0.130	0.150	0.1100
METALS						
IRON - DISSOLVED	PPM	7	0.340	0.281	0.550	0.0200
MANGANESE - DISS	PPM	5	0.010	0.012	0.020	L 0.0100
COPPER	PPM	5	0.008	0.009	0.012	0.0050
ZINC	PPM	5	0.020	0.029	0.050	0.0140
LEAD	PPM	5	0.004	0.004	0.006	L 0.0030
MERCURY - DISS	PPM	1	0.170	0.170	0.170	0.1700
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	4	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	4	0.000	0.000	0.000	0.0002
OXYGEN						
BOD	PPM	2	5.600	5.600	10.000	1.2000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.025	0.025	0.040	L 0.0100
N-KJELDHAL	PPM	3	0.170	0.167	0.200	0.1300
NITRATE	PPM	5	0.050	0.082	0.200	0.0200
NITRITE	PPM	5	0.005	0.005	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.085	0.085	0.150	0.0200
TOTAL N	PPM	6	0.235	0.230	0.280	0.1700
PHOSPHORUS-TOTAL	PPM	7	0.015	0.020	0.040	0.0080
PHOSPHORUS-DISS	PPM	4	0.005	0.006	0.010	L 0.0030
SILICATE	PPM	6	15.750	14.600	18.000	6.4000
ORGANIC N	PPM	4	0.155	0.295	0.750	0.1200

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500057 PENTICTON CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - PHENOL	PPM	1	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	6	26.750	44.833	96.500	13.0000
TOT ORG CARBON	PPM	5	11.000	11.000	16.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500058 PENTICTON CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	7.500	9.083	20.500	3.0000
DISSOLVED 02	PPM	6	10.500	10.317	13.400	6.6000
PH	PH UNITS	5	7.900	7.760	8.500	7.0000
COLOUR	HAZEN	6	42.500	41.667	70.000	5.0000
TURBIDITY	JACKSON	5	1.500	3.560	12.000	1.3000
CONDUCTIVITY	M-MHOS	7	60.000	64.000	100.000	L50.0000
HARDNESS - TOTAL	PPM	6	21.000	21.383	35.300	9.0000
TANNIN & LIGNIN	PPM	3	1.200	1.167	1.400	0.9000
SOLIDS						
TOTAL	PPM	6	69.000	73.333	102.000	50.0000
FIXED	PPM	6	37.000	41.333	66.000	20.0000
DISSOLVED	PPM	1	88.000	88.000	88.000	88.0000
SUSPENDED	PPM	5	3.700	7.820	17.100	1.5000
GENERAL IONS						
CALCIUM	PPM	6	5.600	5.867	10.000	2.0000
MAGNESIUM	PPM	6	1.525	1.462	2.500	0.5000
SODIUM	PPM	6	2.950	2.917	4.000	1.6000
POTASSIUM	PPM	6	0.800	0.833	1.200	0.4000
SULPHATE	PPM	6	5.000	7.000	15.500	L 5.0000
CHLORIDE	PPM	4	1.000	1.200	2.000	0.8000
FLUORIDE	PPM	4	0.110	0.112	0.130	L 0.1000
METALS						
IRON - DISSOLVED	PPM	6	0.255	0.215	0.420	0.0200
MANGANESE - DISS	PPM	4	0.015	0.022	0.050	0.0100
COPPER	PPM	4	0.005	0.006	0.009	0.0030
ZINC	PPM	4	0.008	0.015	0.040	L 0.0050
LEAD	PPM	4	0.003	0.004	0.009	L 0.0030
MERCURY - DISS	PPM	1	0.050	0.050	L 0.050	L 0.0500
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	4	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	4	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	4	0.000	0.000	0.001	0.0001
OXYGEN						
BOD	PPM	1	0.900	0.900	0.900	0.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.035	0.040	0.080	L 0.0100
N-KJELDHAL	PPM	2	0.115	0.115	0.220	L 0.0100
NITRATE	PPM	4	0.030	0.100	0.320	0.0200
NITRITE	PPM	4	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.270	0.270	0.510	0.0300
TOTAL N	PPM	5	0.280	0.316	0.510	0.2000
PHOSPHORUS-TOTAL	PPM	6	0.017	0.024	0.056	0.0090
PHOSPHORUS-DISS	PPM	3	0.005	0.009	0.019	L 0.0030
SILICATE	PPM	6	15.300	15.433	18.700	12.5000
ORGANIC N	PPM	4	0.220	0.255	0.430	0.1500

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500058 PENTICTON CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - TOTAL	PPM	5	14.000	18.900	35.000	9.5000
TOT ORG CARBON	PPM	6	10.000	10.333	15.000	7.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500059 POWERS CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	9.500	9.833	19.500	2.5000
DISSOLVED 02	PPM	6	11.150	10.967	12.800	9.1000
PH	PH UNITS	6	7.900	7.983	8.300	7.8000
COLOUR	HAZEN	6	27.500	30.000	70.000	10.0000
TURBIDITY	JACKSON	4	2.450	9.050	30.000	1.3000
CONDUCTIVITY	M-MHOS	6	215.000	251.667	540.000	60.0000
HARDNESS - TOTAL	PPM	6	92.500	111.167	230.000	30.0000
TANNIN & LIGNIN	PPM	2	0.650	0.650	0.800	0.5000
SOLIDS						
TOTAL	PPM	6	182.000	194.333	350.000	74.0000
FIXED	PPM	6	131.000	134.000	240.000	36.0000
DISSOLVED	PPM	1	252.000	252.000	252.000	252.00
SUSPENDED	PPM	5	6.500	19.460	75.000	2.2000
GENERAL IONS						
CALCIUM	PPM	6	22.750	27.683	55.000	9.6000
MAGNESIUM	PPM	6	8.050	9.950	22.400	1.4000
SODIUM	PPM	6	9.100	10.500	24.000	2.2000
POTASSIUM	PPM	6	1.850	2.483	7.200	0.9000
SULPHATE	PPM	6	23.300	32.133	75.000	L 5.0000
CHLORIDE	PPM	4	1.700	1.575	2.100	0.8000
FLUORIDE	PPM	4	0.165	0.190	0.330	L 0.1000
METALS						
IRON - DISSOLVED	PPM	6	0.040	0.082	0.230	L 0.0400
MANGANESE - DISS	PPM	4	0.010	0.012	0.020	L 0.0100
COPPER	PPM	4	0.004	0.004	0.007	0.0020
ZINC	PPM	4	0.030	0.026	0.040	0.0060
LEAD	PPM	4	0.003	0.003	L 0.003	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	4	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	4	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	4	0.000	0.000	0.001	0.0001
OXYGEN						
BOD	PPM	2	1.400	1.400	1.600	1.2000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.010	0.012	0.020	L 0.0100
N-KJELDHAL	PPM	2	0.200	0.200	0.270	0.1300
NITRATE	PPM	4	0.275	0.490	1.370	0.0400
NITRITE	PPM	4	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.645	0.645	1.080	0.2100
TOTAL N	PPM	6	0.610	0.822	1.600	0.4200
PHOSPHORUS-TOTAL	PPM	6	0.041	0.047	0.093	0.0170
PHOSPHORUS-DISS	PPM	4	0.022	0.021	0.029	0.0100
SILICATE	PPM	6	17.700	17.183	19.400	13.5000
ORGANIC N	PPM	4	0.295	0.312	0.440	0.2200
CARBON						
ALK - PHENOL	PPM	1	3.100	3.100	3.100	3.1000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500059 POWERS CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	5	62.000	85.200	197.000	26.5000
TOT ORG CARBON	PPM	6	9.000	10.833	22.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500060 MISSION CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	16	8.000	8.094	18.000	0.5000
DISSOLVED O2	PPM	5	10.400	9.940	11.200	7.7000
PH	PH UNITS	16	7.700	7.650	8.100	6.6000
COLOUR	HAZEN	12	20.000	31.667	110.000	5.0000
TURBIDITY	JACKSON	10	1.600	2.610	7.900	0.4000
CONDUCTIVITY	M-MHOS	17	1050.	875.588	1300.	120.00
HARDNESS - TOTAL	PPM	17	432.000	426.647	693.000	49.0000
SURFACTANTS	PPM	7	0.025	0.025	0.050	0.0
TANNIN & LIGNIN	PPM	1	3.000	3.000	3.000	3.0000
SOLIDS						
TOTAL	PPM	17	664.000	641.588	989.000	140.00
FIXED	PPM	17	483.000	462.117	738.000	90.0000
DISSOLVED	PPM	7	766.000	790.143	986.000	607.00
SUSPENDED	PPM	6	2.100	8.650	25.000	1.7000
GENERAL IONS						
CALCIUM	PPM	16	97.600	91.394	139.000	13.6000
MAGNESIUM	PPM	17	47.400	48.300	84.000	3.2000
SODIUM	PPM	14	35.250	30.643	45.500	3.8000
POTASSIUM	PPM	17	4.100	4.041	6.700	1.2000
SULPHATE	PPM	14	207.000	194.564	336.000	5.2000
CHLORIDE	PPM	11	1.200	2.936	10.500	0.0
FLUORIDE	PPM	8	0.245	0.257	0.440	0.1700
METALS						
IRON - TOTAL	PPM	8	0.180	0.195	0.460	0.0600
IRON - DISSOLVED	PPM	11	0.160	0.177	0.460	0.0400
MANGANESE - DISS	PPM	13	0.060	0.183	0.770	0.0200
COPPER	PPM	13	0.020	0.015	0.020	0.0
ZINC	PPM	13	0.030	0.037	0.100	0.0
LEAD	PPM	13	0.007	0.010	0.020	0.0
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	2	0.015	0.015	0.020	L 0.0100
CADMIUM	PPM	2	0.003	0.003	0.005	0.0002
OXYGEN						
BOD	PPM	1	1.800	1.800	1.800	1.8000
NUTRIENTS						
AMMONIA AS NH3	PPM	13	0.040	0.058	0.180	0.0
N-KJELDHAL	PPM	4	0.430	0.422	0.580	0.2500
NITRATE	PPM	13	0.310	0.355	0.920	0.0200
NITRITE	PPM	8	0.008	0.007	0.011	L 0.0050
NITRATE+NITRITE	PPM	4	0.165	0.167	0.250	0.0900
TOTAL N	PPM	11	0.470	0.521	1.140	0.1800
PHOS - ORTHO	PPM	10	0.180	0.192	0.400	0.0800
PHOS - TOTAL	PPM	10	0.230	0.254	0.500	0.1200
PHOSPHORUS-TOTAL	PPM	6	0.089	0.080	0.117	0.0190

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500060 MISSION CREEK TRIBUTARY CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOSPHORUS-DISS	PPM	2	0.043	0.043	0.068	0.0190
SILICATE	PPM	13	25.500	25.262	40.400	14.5000
ORGANIC N	PPM	13	0.100	0.144	0.480	0.0
CARBON						
ALK - PHENOL	PPM	11	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	15	284.000	262.800	420.000	44.5000
TOT ORG CARBON	PPM	6	19.500	67.667	321.000	10.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500066 SHINGLE CREEK NR OKANAGAN RIVER

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	6.000	6.750	13.000	2.0000
DISSOLVED O2	PPM	4	10.800	11.050	12.200	10.4000
PH	PH UNITS	3	8.300	8.467	9.000	8.1000
COLOUR	HAZEN	4	7.500	13.750	35.000	5.0000
TURBIDITY	JACKSON	4	1.600	2.550	6.000	1.0000
CONDUCTIVITY	M-MHOS	5	300.000	242.200	382.000	L50.0000
HARDNESS - TOTAL	PPM	3	130.000	116.333	153.000	66.0000
TANNIN & LIGNIN	PPM	1	0.200	0.200	0.200	0.2000
SOLIDS						
TOTAL	PPM	4	205.000	197.000	240.000	138.00
FIXED	PPM	3	132.000	135.333	182.000	92.0000
DISSOLVED	PPM	1	204.000	204.000	204.000	204.00
SUSPENDED	PPM	3	4.700	8.433	17.800	2.8000
GENERAL IONS						
CALCIUM	PPM	3	35.600	32.467	43.000	18.8000
MAGNESIUM	PPM	3	8.500	7.933	11.000	4.3000
SODIUM	PPM	3	13.500	13.100	18.700	7.1000
POTASSIUM	PPM	3	2.300	2.100	2.400	1.6000
SULPHATE	PPM	3	18.000	15.567	19.500	9.2000
CHLORIDE	PPM	2	1.500	1.500	1.800	1.2000
FLUORIDE	PPM	1	0.280	0.280	0.280	0.2800
METALS						
IRON - DISSOLVED	PPM	3	0.180	0.313	0.680	0.0800
MANGANESE - DISS	PPM	1	0.010	0.010	0.010	0.0100
COPPER	PPM	1	0.004	0.004	0.004	0.0040
ZINC	PPM	1	0.020	0.020	0.020	0.0200
LEAD	PPM	1	0.003	0.003	L 0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	1	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	1	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	2	5.800	5.800	L 10.000	1.6000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.015	0.015	0.020	L 0.0100
N-KJELDHAL	PPM	2	0.165	0.165	0.280	0.0500
NITRATE	PPM	2	0.035	0.035	0.050	L 0.0200
NITRITE	PPM	2	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	3	0.100	0.103	0.190	L 0.0200
TOTAL N	PPM	4	0.260	0.257	0.380	0.1300
PHOSPHORUS-TOTAL	PPM	4	0.017	0.019	0.033	0.0080
PHOSPHORUS-DISS	PPM	1	0.007	0.007	0.007	0.0070
SILICATE	PPM	4	17.700	17.375	18.300	15.8000
ORGANIC N	PPM	2	0.170	0.170	0.210	0.1300
CARBON						
ALK - TOTAL	PPM	4	151.500	138.250	179.000	71.0000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500067 SHORTS CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TOT ORG CARBON	PPM	4	9.500	9.000	12.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500067 SHORTS CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	5.750	6.583	12.000	3.0000
DISSOLVED O2	PPM	5	12.600	13.040	15.000	12.0000
PH	PH UNITS	4	8.150	8.025	8.800	7.0000
COLOUR	HAZEN	5	5.000	23.000	80.000	L 5.0000
TURBIDITY	JACKSON	5	1.000	9.900	45.000	0.7000
CONDUCTIVITY	M-MHOS	6	266.000	237.000	300.000	90.0000
HARDNESS - TOTAL	PPM	5	134.000	110.800	155.000	41.0000
TANNIN & LIGNIN	PPM	1	0.100	0.100	L 0.100	L 0.1000
SOLIDS						
TOTAL	PPM	5	178.000	177.600	214.000	136.00
FIXED	PPM	4	105.000	111.500	156.000	80.0000
DISSOLVED	PPM	1	188.000	188.000	188.000	188.00
SUSPENDED	PPM	4	2.250	25.525	97.000	0.6000
GENERAL IONS						
CALCIUM	PPM	5	34.800	30.840	45.000	10.6000
MAGNESIUM	PPM	5	8.800	7.280	10.300	2.6000
SODIUM	PPM	5	6.300	5.660	7.100	2.6000
POTASSIUM	PPM	5	1.200	1.160	1.200	1.0000
SULPHATE	PPM	5	10.200	8.560	11.600	L 5.0000
CHLORIDE	PPM	3	0.700	0.700	0.700	0.7000
FLUORIDE	PPM	5	0.170	0.154	0.190	L 0.1000
METALS						
IRON - DISSOLVED	PPM	5	0.040	0.236	1.000	L 0.0400
MANGANESE - DISS	PPM	5	0.010	0.012	0.020	L 0.0100
COPPER	PPM	5	0.003	0.004	0.010	L 0.0010
ZINC	PPM	5	0.010	0.059	0.250	0.0060
LEAD	PPM	5	0.003	0.005	0.012	L 0.0030
MERCURY - UNFILT	PPM	4	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	5	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	5	0.010	0.048	0.200	L 0.0100
CADMIUM	PPM	5	0.000	0.001	0.004	L 0.0001
OXYGEN						
BOD	PPM	2	0.900	0.900	1.200	0.6000
NUTRIENTS						
AMMONIA AS NH3	PPM	5	0.010	0.022	0.060	L 0.0100
N-KJELDHAL	PPM	1	0.330	0.330	0.330	0.3300
NITRATE	PPM	6	0.020	0.038	0.120	L 0.0200
NITRITE	PPM	5	0.005	0.005	L 0.005	L 0.0050
TOTAL N	PPM	5	0.210	0.202	0.410	0.0600
PHOSPHORUS-TOTAL	PPM	6	0.018	0.050	0.200	0.0160
PHOSPHORUS-DISS	PPM	5	0.015	0.016	0.024	0.0100
SILICATE	PPM	5	17.900	17.780	19.000	16.4000
ORGANIC N	PPM	5	0.150	0.176	0.390	0.0600
CARBON						
ALK - PHENOL	PPM	1	2.200	2.200	2.200	2.2000

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500067 SHORTS CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	4	113.500	102.500	142.000	41.0000
TOT ORG CARBON	PPM	6	9.500	9.333	19.000	1.0000
TOT INORG CARBON	PPM	1	28.000	28.000	28.000	28.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500078 TREPANIER CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	14	6.500	6.714	17.500	0.0
DISSOLVED O2	PPM	5	12.000	11.420	13.400	9.5000
PH	PH UNITS	14	7.800	7.786	8.700	7.0000
COLOUR	HAZEN	11	5.000	9.545	30.000	5.0000
TURBIDITY	JACKSON	9	0.700	0.844	2.900	0.1000
CONDUCTIVITY	M-MHOS	14	176.500	164.429	230.000	90.0000
HARDNESS - TOTAL	PPM	14	81.700	76.779	106.000	37.0000
SURFACTANTS	PPM	9	0.025	0.032	0.070	0.0250
TANNIN & LIGNIN	PPM	1	0.700	0.700	0.700	0.7000
SOLIDS						
TOTAL	PPM	14	118.500	115.571	136.000	80.0000
FIXED	PPM	14	75.500	80.643	114.000	50.0000
DISSOLVED	PPM	8	112.000	116.500	134.000	104.00
SUSPENDED	PPM	8	4.900	4.375	7.100	1.2000
GENERAL IONS						
CALCIUM	PPM	14	25.550	23.707	32.000	12.2000
MAGNESIUM	PPM	14	4.450	4.229	6.400	1.4000
SODIUM	PPM	11	4.300	4.282	6.000	2.5000
POTASSIUM	PPM	14	1.450	1.443	1.800	0.9000
SULPHATE	PPM	14	5.200	5.457	6.600	3.5000
CHLORIDE	PPM	10	0.500	0.770	3.000	0.3000
FLUORIDE	PPM	8	0.120	0.130	0.190	L 0.1000
METALS						
IRON - TOTAL	PPM	7	0.040	0.077	0.300	0.0
IRON - DISSOLVED	PPM	9	0.040	0.077	0.200	0.0200
MANGANESE - DISS	PPM	12	0.010	0.008	0.010	0.0
COPPER	PPM	12	0.003	0.008	0.020	0.0
ZINC	PPM	12	0.020	0.017	0.050	0.0
LEAD	PPM	12	0.006	0.008	0.020	0.0
MERCURY - UNFILT	PPM	3	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	L 0.0001
OXYGEN						
BOD	PPM	3	1.000	4.000	10.000	1.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	11	0.010	0.019	0.080	0.0
N-KJELDHAL	PPM	3	0.040	0.060	0.130	L 0.0100
NITRATE	PPM	12	0.040	0.035	0.060	L 0.0200
NITRITE	PPM	8	0.005	0.005	0.009	0.0
NITRATE+NITRITE	PPM	3	0.020	0.033	0.060	L 0.0200
TOTAL N	PPM	9	0.150	0.160	0.360	0.0400
PHOS - ORTHO	PPM	9	0.010	0.011	0.030	0.0
PHOS - TOTAL	PPM	9	0.050	0.047	0.080	0.0100
PHOSPHORUS-TOTAL	PPM	5	0.018	0.020	0.042	0.0100

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500078 TREPANIER CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOSPHORUS-DISS	PPM	3	0.009	0.014	0.028	0.0040
SILICATE	PPM	13	15.300	15.115	19.500	6.7000
ORGANIC N	PPM	11	0.060	0.093	0.270	0.0100
CARBON						
ALK - PHENOL	PPM	8	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	13	84.000	76.377	96.400	41.0000
TOT ORG CARBON	PPM	5	6.000	5.600	9.000	2.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500079 TREPANIER CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	8.000	8.700	16.000	3.0000
DISSOLVED 02	PPM	4	11.250	11.500	14.200	9.3000
PH	PH UNITS	5	8.000	7.880	8.200	7.2000
COLOUR	HAZEN	3	5.000	11.667	25.000	5.0000
TURBIDITY	JACKSON	3	0.700	1.167	2.500	0.3000
CONDUCTIVITY	M-MHOS	5	183.000	160.600	200.000	80.0000
HARDNESS - TOTAL	PPM	3	74.000	64.733	85.200	35.0000
TANNIN & LIGNIN	PPM	1	0.900	0.900	0.900	0.9000
SOLIDS						
TOTAL	PPM	5	118.000	113.600	136.000	78.0000
FIXED	PPM	5	76.000	73.200	102.000	40.0000
DISSOLVED	PPM	2	113.500	113.500	120.000	107.00
SUSPENDED	PPM	3	1.400	1.767	3.400	0.5000
GENERAL IONS						
CALCIUM	PPM	5	26.700	23.700	28.400	11.4000
MAGNESIUM	PPM	5	3.200	3.080	4.500	1.4000
SODIUM	PPM	5	3.700	3.500	4.300	2.6000
POTASSIUM	PPM	5	1.500	1.400	1.800	0.9000
SULPHATE	PPM	5	5.000	6.560	9.800	L 5.0000
CHLORIDE	PPM	4	0.500	0.575	0.800	0.5000
FLUORIDE	PPM	4	0.100	0.100	0.100	L 0.1000
METALS						
IRON - DISSOLVED	PPM	5	0.020	0.040	0.100	0.0200
MANGANESE - DISS	PPM	3	0.010	0.010	0.010	L 0.0100
COPPER	PPM	4	0.006	0.011	0.030	L 0.0010
ZINC	PPM	4	0.012	0.042	0.140	L 0.0050
LEAD	PPM	4	0.003	0.003	0.003	L 0.0030
MERCURY - UNFILT	PPM	2	0.450	0.450 L	0.850	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010	0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	L 0.0001
MOLYBDENUM	PPM	1	0.100	0.100	0.100	0.1000
SEMI-METALS						
BORON	PPM	1	0.200	0.200	0.200	0.2000
ARSENIC	PPM	1	0.002	0.002	0.002	0.0020
OXYGEN						
BOD	PPM	2	1.250	1.250	1.500	1.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.050	0.050	0.100	0.0
N-KJELDHAL	PPM	3	0.030	0.047	0.100	L 0.0100
NITRATE	PPM	4	0.025	0.027	0.040	L 0.0200
NITRITE	PPM	4	0.005	0.005	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.020	0.020	0.020	L 0.0200
TOTAL N	PPM	5	0.120	0.218	0.590	L 0.0200

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500079 TREPANIER CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOSPHORUS-TOTAL	PPM	5	0.007	0.007	0.014	0.0030
PHOSPHORUS-DISS	PPM	4	0.003	0.003	0.003	0.0030
SILICATE	PPM	5	16.000	16.000	19.100	14.0000
ORGANIC N	PPM	2	0.375	0.375	0.450	0.3000
CARBON						
ALK - PHENOL	PPM	2	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	5	90.500	77.600	93.000	36.5000
TOT ORG CARBON	PPM	3	6.000	6.667	9.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500080 TROUT CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	7.000	9.429	21.500	3.0000
DISSOLVED O2	PPM	8	10.900	11.412	14.600	8.7000
PH	PH UNITS	9	7.900	7.867	8.400	7.0000
COLOUR	HAZEN	8	17.500	23.750	70.000	5.0000
TURBIDITY	JACKSON	6	7.250	12.250	33.000	1.5000
CONDUCTIVITY	M-MHOS	7	200.000	194.000	278.000	60.0000
HARDNESS - TOTAL	PPM	8	81.000	79.750	112.000	12.0000
TANNIN & LIGNIN	PPM	4	1.050	1.000	1.400	0.5000
SOLIDS						
TOTAL	PPM	8	205.000	186.500	286.000	58.0000
FIXED	PPM	7	138.000	137.429	230.000	36.0000
DISSOLVED	PPM	2	159.000	159.000	172.000	146.00
SUSPENDED	PPM	6	15.300	35.700	113.000	3.3000
GENERAL IONS						
CALCIUM	PPM	8	23.600	22.137	30.000	2.6000
MAGNESIUM	PPM	8	5.150	5.712	9.000	1.3000
SODIUM	PPM	8	6.750	7.237	11.300	1.6000
POTASSIUM	PPM	8	1.800	1.612	2.300	0.4000
SULPHATE	PPM	8	15.000	16.637	26.900	L 5.0000
CHLORIDE	PPM	7	1.300	1.300	1.600	0.8000
FLUORIDE	PPM	7	0.150	0.151	0.190	L 0.1000
METALS						
IRON - DISSOLVED	PPM	8	0.130	0.219	0.730	L 0.0200
MANGANESE - DISS	PPM	7	0.010	0.013	0.030	L 0.0100
COPPER	PPM	7	0.004	0.004	0.010	L 0.0010
ZINC	PPM	7	0.020	0.031	0.090	0.0080
LEAD	PPM	7	0.003	0.004	0.007	L 0.0030
MERCURY - DISS	PPM	1	0.050	0.050	L 0.050	L 0.0500
MERCURY - UNFILT	PPM	5	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	7	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	7	0.010	0.010	0.010	L 0.0100
CADMIUM	PPM	7	0.000	0.000	0.001	L 0.0001
OXYGEN						
BOD	PPM	3	1.000	3.867	L 10.000	0.6000
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.010	0.020	0.050	L 0.0100
N-KJELDHAL	PPM	2	0.235	0.235	0.300	0.1700
NITRATE	PPM	7	0.100	0.144	0.380	L 0.0200
NITRITE	PPM	7	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.060	0.060	0.070	0.0500
TOTAL N	PPM	7	0.360	0.379	0.490	0.2400
PHOSPHORUS-TOTAL	PPM	8	0.056	0.064	0.127	0.0100
PHOSPHORUS-DISS	PPM	7	0.005	0.005	0.008	L 0.0030
SILICATE	PPM	8	17.350	16.962	19.000	12.3000
ORGANIC N	PPM	6	0.260	0.250	0.400	0.1100

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500080 TROUT CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - TOTAL	PPM	6	73.150	68.383	102.000	11.0000
TOT ORG CARBON	PPM	8	7.000	8.500	16.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500081 TROUT CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	8.000	8.417	14.000	4.5000
DISSOLVED O2	PPM	6	11.900	11.517	12.800	9.5000
PH	PH UNITS	9	8.000	7.967	8.100	7.8000
COLOUR	HAZEN	6	27.500	25.833	40.000	5.0000
TURBIDITY	JACKSON	5	2.400	3.240	6.200	1.5000
CONDUCTIVITY	M-MHOS	6	140.000	145.500	193.000	110.00
HARDNESS - TOTAL	PPM	6	63.000	66.467	82.000	51.6000
TANNIN & LIGNIN	PPM	3	0.700	0.600	0.700	0.4000
SOLIDS						
TOTAL	PPM	6	122.000	119.333	136.000	100.00
FIXED	PPM	5	76.000	80.400	98.000	66.0000
DISSOLVED	PPM	2	123.000	123.000	130.000	116.00
SUSPENDED	PPM	4	3.700	4.625	9.300	1.8000
GENERAL IONS						
CALCIUM	PPM	6	19.100	20.367	25.000	16.4000
MAGNESIUM	PPM	6	3.100	3.317	4.300	2.3000
SODIUM	PPM	6	4.850	4.600	5.800	2.8000
POTASSIUM	PPM	6	1.600	1.550	2.000	1.1000
SULPHATE	PPM	6	8.100	8.733	12.000	6.8000
CHLORIDE	PPM	6	0.900	0.900	1.300	0.5000
FLUORIDE	PPM	5	0.140	0.136	0.160	0.1100
METALS						
IRON - DISSOLVED	PPM	6	0.230	0.210	0.330	0.0200
MANGANESE - DISS	PPM	5	0.030	0.030	0.040	0.0100
COPPER	PPM	5	0.003	0.004	0.009	L 0.0010
ZINC	PPM	5	0.020	0.021	0.050	0.0060
LEAD	PPM	5	0.003	0.006	0.017	L 0.0030
MERCURY - DISS	PPM	2	0.050	0.050	0.050	L 0.0500
MERCURY - UNFILT	PPM	3	0.050	0.117	0.250	L 0.0500
CHROMIUM	PPM	5	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	5	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	5	0.000	0.000	0.001	L 0.0001
OXYGEN						
BOD	PPM	1	1.700	1.700	1.700	1.7000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.010	0.012	0.020	L 0.0100
N-KJELDHAL	PPM	2	0.165	0.165	0.300	0.0300
NITRATE	PPM	5	0.050	0.054	0.110	L 0.0200
NITRITE	PPM	5	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.025	0.025	0.030	L 0.0200
TOTAL N	PPM	5	0.160	0.214	0.400	0.0300
PHOSPHORUS-TOTAL	PPM	6	0.013	0.014	0.022	0.0090
PHOSPHORUS-DISS	PPM	5	0.003	0.004	0.008	L 0.0030
SILICATE	PPM	6	17.500	17.333	19.000	16.0000
ORGANIC N	PPM	4	0.175	0.195	0.380	0.0500

0500081 TROUT CREEK UPSTREAM CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - TOTAL	PPM	5	65.000	65.720	79.500	51.5000
TOT ORG CARBON	PPM	6	7.000	7.500	16.000	L 1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

0500085 WOLFCUB CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	16	14.000	12.719	19.000	6.0000
DISSOLVED O2	PPM	3	8.200	8.367	9.100	7.8000
PH	PH UNITS	16	7.500	7.581	8.300	7.2000
COLOUR	HAZEN	10	5.000	4.000	15.000	0.0
TURBIDITY	JACKSON	10	0.850	1.040	2.500	0.3000
CONDUCTIVITY	M-MHOS	16	515.000	535.000	610.000	485.00
HARDNESS - TOTAL	PPM	15	234.000	237.200	267.000	220.00
SURFACTANTS	PPM	9	0.025	0.020	0.030	0.0
TANNIN & LIGNIN	PPM	1	0.100	0.100	0.100	0.1000
SOLIDS						
TOTAL	PPM	16	323.000	326.750	358.000	305.00
FIXED	PPM	15	214.000	229.400	326.000	203.00
DISSOLVED	PPM	8	314.000	313.750	326.000	302.00
SUSPENDED	PPM	7	3.800	7.843	33.000	2.0000
GENERAL IONS						
CALCIUM	PPM	13	65.100	65.238	72.500	60.4000
MAGNESIUM	PPM	15	17.200	17.587	21.300	15.6000
SODIUM	PPM	10	16.750	17.740	24.800	13.0000
POTASSIUM	PPM	14	4.300	4.586	6.800	3.5000
SULPHATE	PPM	15	53.200	53.180	60.000	46.0000
CHLORIDE	PPM	10	5.150	6.660	16.500	2.8000
FLUORIDE	PPM	8	0.335	0.354	0.440	0.3200
METALS						
IRON - TOTAL	PPM	9	0.060	0.118	0.460	0.0
IRON - DISSOLVED	PPM	8	0.040	0.042	0.080	0.0
MANGANESE - DISS	PPM	13	0.010	0.015	0.050	0.0
COPPER	PPM	13	0.010	0.011	0.020	0.0
ZINC	PPM	13	0.020	0.034	0.110	0.0070
LEAD	PPM	13	0.007	0.009	0.030	0.0
MERCURY - UNFILT	PPM	1	0.850	0.850 L	0.850 L	0.8500
CHROMIUM	PPM	1	0.005	0.005 L	0.005 L	0.0050
NICKEL	PPM	1	0.010	0.010 L	0.010 L	0.0100
CADMIUM	PPM	1	0.001	0.001	0.001	0.0006
SEMI-METALS						
ARSENIC	PPM	10	0.0	0.000	0.002	0.0
OXYGEN						
BOD	PPM	6	10.000	10.000	10.000	L10.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	13	0.0	0.014	0.110	0.0
N-KJELDHAL	PPM	3	0.290	1.160	2.920	0.2700
NITRATE	PPM	13	2.300	2.281	3.450	1.5000
NITRITE	PPM	9	0.025	0.033	0.089	0.0080
NITRATE+NITRITE	PPM	2	2.915	2.915	3.250	2.5800
TOTAL N	PPM	8	2.635	3.029	5.650	1.5400

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500085 WOLFCUB CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
PHOS - ORTHO	PPM	11	0.090	0.095	0.180	0.0300
PHOS - TOTAL	PPM	12	0.155	0.168	0.370	0.0600
PHOSPHORUS-TOTAL	PPM	3	0.045	0.444	1.260	0.0280
PHOSPHORUS-DISS	PPM	1	0.039	0.039	0.039	0.0390
SILICATE	PPM	16	17.400	17.481	25.500	7.4000
ORGANIC N	PPM	13	0.050	0.107	0.340	0.0200
CARBON						
ALK - PHENOL	PPM	13	0.0	0.346	4.500	0.0
ALK - TOTAL	PPM	15	199.000	203.800	259.000	189.00
TOT ORG CARBON	PPM	3	4.000	4.333	8.000	L 1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500089 VERNON CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	8.000	9.125	17.500	3.0000
DISSOLVED O2	PPM	4	11.150	11.050	11.600	10.3000
PH	PH UNITS	5	8.000	8.100	8.600	7.5000
COLOUR	HAZEN	4	5.000	5.000	5.000	L 5.0000
TURBIDITY	JACKSON	3	1.000	0.933	1.200	0.6000
CONDUCTIVITY	M-MHOS	7	380.000	328.428	418.000	L50.0000
HARDNESS - TOTAL	PPM	4	162.000	162.500	170.000	150.00
TANNIN & LIGNIN	PPM	1	0.100	0.100	L 0.100	L 0.1000
SOLIDS						
TOTAL	PPM	4	241.000	241.000	248.000	234.00
FIXED	PPM	3	178.000	179.333	188.000	172.00
DISSOLVED	PPM	1	242.000	242.000	242.000	242.00
SUSPENDED	PPM	3	1.000	1.400	2.200	L 1.0000
GENERAL IONS						
CALCIUM	PPM	3	37.000	36.300	37.400	34.5000
MAGNESIUM	PPM	4	17.200	17.350	19.000	16.0000
SODIUM	PPM	4	15.800	15.775	16.000	15.5000
POTASSIUM	PPM	4	6.250	6.275	8.200	4.4000
SULPHATE	PPM	4	55.900	55.300	56.600	52.8000
CHLORIDE	PPM	3	3.300	3.033	4.400	1.4000
FLUORIDE	PPM	2	0.340	0.340	0.370	0.3100
METALS						
IRON - DISSOLVED	PPM	4	0.040	0.045	0.060	L 0.0400
MANGANESE - DISS	PPM	2	0.010	0.010	L 0.010	L 0.0100
COPPER	PPM	2	0.003	0.003	0.005	L 0.0010
ZINC	PPM	2	0.012	0.012	0.020	L 0.0050
LEAD	PPM	2	0.004	0.004	0.005	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	1	0.900	0.900	0.900	0.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.015	0.015	0.020	0.0100
N-KJELDHAL	PPM	2	0.185	0.185	0.200	0.1700
NITRATE	PPM	2	0.035	0.035	0.050	L 0.0200
NITRITE	PPM	2	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.085	0.085	0.120	0.0500
TOTAL N	PPM	3	0.250	0.240	0.290	0.1800
PHOSPHORUS-TOTAL	PPM	4	0.006	0.007	0.011	0.0060
PHOSPHORUS-DISS	PPM	2	0.003	0.003	L 0.003	L 0.0030
SILICATE	PPM	4	10.700	10.625	11.100	10.0000
ORGANIC N	PPM	2	0.130	0.130	0.170	0.0900
CARBON						
ALK - PHENOL	PPM	1	2.500	2.500	2.500	2.5000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500089 VERNON CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	3	146.000	145.333	147.000	143.00
TOT ORG CARBON	PPM	4	6.500	6.750	10.000	4.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500091 VERNON CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	7.000	9.750	19.000	6.0000
DISSOLVED O2	PPM	4	11.500	11.200	12.400	9.4000
PH	PH UNITS	5	8.300	8.160	8.400	7.7000
COLOUR	HAZEN	4	5.000	6.250	10.000	L 5.0000
TURBIDITY	JACKSON	3	8.800	9.100	14.000	4.5000
CONDUCTIVITY	M-MHOS	7	460.000	425.286	590.000	L50.0000
HARDNESS - TOTAL	PPM	4	207.500	207.000	239.000	174.00
TANNIN & LIGNIN	PPM	1	0.300	0.300	0.300	0.3000
SOLIDS						
TOTAL	PPM	4	341.000	340.500	400.000	280.00
FIXED	PPM	3	232.000	248.667	332.000	182.00
DISSOLVED	PPM	1	332.000	332.000	332.000	332.00
SUSPENDED	PPM	3	27.000	23.867	27.400	17.2000
GENERAL IONS						
CALCIUM	PPM	3	44.500	49.400	63.500	40.2000
MAGNESIUM	PPM	4	20.300	20.150	22.000	18.0000
SODIUM	PPM	4	20.750	20.950	25.500	16.8000
POTASSIUM	PPM	4	5.700	6.400	9.500	4.7000
SULPHATE	PPM	4	82.750	80.825	100.000	57.8000
CHLORIDE	PPM	4	6.800	6.850	11.200	2.6000
FLUORIDE	PPM	2	0.285	0.285	0.300	0.2700
METALS						
IRON - DISSOLVED	PPM	4	0.085	0.102	0.160	0.0800
MANGANESE - DISS	PPM	2	0.010	0.010	0.010	0.0100
COPPER	PPM	2	0.006	0.006	0.010	0.0030
ZINC	PPM	2	0.027	0.027	0.050	L 0.0050
LEAD	PPM	2	0.009	0.009	0.015	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	0.0001
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.215	0.215	0.320	0.1100
N-KJELDHAL	PPM	2	1.690	1.690	3.000	0.3800
NITRATE	PPM	2	0.520	0.520	0.550	0.4900
NITRITE	PPM	2	0.018	0.018	0.025	0.0120
NITRATE+NITRITE	PPM	2	0.800	0.800	1.350	0.2500
TOTAL N	PPM	3	0.940	1.973	4.350	0.6300
PHOSPHORUS-TOTAL	PPM	4	0.231	0.356	0.810	0.1500
PHOSPHORUS-DISS	PPM	2	0.186	0.186	0.220	0.1520
SILICATE	PPM	4	12.550	12.700	15.400	10.3000
ORGANIC N	PPM	2	0.335	0.335	0.360	0.3100
CARBON						
ALK - TOTAL	PPM	3	158.000	156.333	163.000	148.00
TOT ORG CARBON	PPM	4	8.500	8.000	14.000	1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500092 VERNON CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	1	7.000	7.000	7.000	7.0000
DISSOLVED O2	PPM	1	13.800	13.800	13.800	13.8000
PH	PH UNITS	1	7.400	7.400	7.400	7.4000
COLOUR	HAZEN	1	30.000	30.000	30.000	30.0000
TURBIDITY	JACKSON	1	5.800	5.800	5.800	5.8000
CONDUCTIVITY	M-MHOS	1	75.000	75.000	75.000	75.0000
HARDNESS - TOTAL	PPM	1	33.000	33.000	33.000	33.0000
TANNIN & LIGNIN	PPM	1	0.800	0.800	0.800	0.8000
SOLIDS						
TOTAL	PPM	1	94.000	94.000	94.000	94.0000
DISSOLVED	PPM	1	80.000	80.000	80.000	80.0000
GENERAL IONS						
CALCIUM	PPM	1	8.600	8.600	8.600	8.6000
MAGNESIUM	PPM	1	3.400	3.400	3.400	3.4000
SODIUM	PPM	1	3.200	3.200	3.200	3.2000
POTASSIUM	PPM	1	1.000	1.000	1.000	1.0000
SULPHATE	PPM	1	6.000	6.000	6.000	6.0000
CHLORIDE	PPM	1	0.800	0.800	0.800	0.8000
FLUORIDE	PPM	1	0.100	0.100 L	0.100 L	0.1000
METALS						
IRON - DISSOLVED	PPM	1	0.280	0.280	0.280	0.2800
MANGANESE - DISS	PPM	1	0.010	0.010 L	0.010 L	0.0100
COPPER	PPM	1	0.014	0.014	0.014	0.0140
ZINC	PPM	1	0.030	0.030	0.030	0.0300
LEAD	PPM	1	0.003	0.003	0.003	0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050 L	0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005 L	0.0050
NICKEL	PPM	1	0.010	0.010 L	0.010 L	0.0100
CADMIUM	PPM	1	0.000	0.000	0.000	0.0002
NUTRIENTS						
N-KJELDHAL	PPM	1	0.520	0.520	0.520	0.5200
NITRATE+NITRITE	PPM	1	0.120	0.120	0.120	0.1200
TOTAL N	PPM	1	0.640	0.640	0.640	0.6400
PHOSPHORUS-TOTAL	PPM	1	0.041	0.041	0.041	0.0410
SILICATE	PPM	1	8.100	8.100	8.100	8.1000
CARBON						
ALK - TOTAL	PPM	1	32.000	32.000	32.000	32.0000
TOT ORG CARBON	PPM	1	9.000	9.000	9.000	9.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500093 VERNON CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	6.250	8.250	19.000	1.5000
DISSOLVED O2	PPM	4	11.550	10.875	12.000	8.4000
PH	PH UNITS	4	8.450	8.300	8.700	7.6000
COLOUR	HAZEN	4	15.000	21.250	50.000	5.0000
TURBIDITY	JACKSON	3	21.000	18.267	30.000	3.8000
CONDUCTIVITY	M-MHOS	5	150.000	174.400	262.000	120.00
HARDNESS - TOTAL	PPM	4	75.500	77.250	107.000	51.0000
TANNIN & LIGNIN	PPM	1	1.200	1.200	1.200	1.2000
SOLIDS						
TOTAL	PPM	4	165.000	178.000	240.000	142.00
FIXED	PPM	3	106.000	107.333	124.000	92.0000
DISSOLVED	PPM	1	114.000	114.000	114.000	114.00
SUSPENDED	PPM	3	5.800	19.567	50.000	2.9000
GENERAL IONS						
CALCIUM	PPM	4	17.950	18.875	27.000	12.6000
MAGNESIUM	PPM	4	7.600	7.175	9.500	4.0000
SODIUM	PPM	4	6.350	6.475	8.700	4.5000
POTASSIUM	PPM	4	1.950	2.550	4.800	1.5000
SULPHATE	PPM	4	13.400	13.275	17.100	9.2000
CHLORIDE	PPM	3	1.700	2.233	4.000	1.0000
FLUORIDE	PPM	2	0.145	0.145	0.160	0.1300
METALS						
IRON - DISSOLVED	PPM	4	0.150	0.160	0.280	0.0600
MANGANESE - DISS	PPM	2	0.050	0.050	0.070	0.0300
COPPER	PPM	2	0.003	0.003	0.005	0.0020
ZINC	PPM	2	0.005	0.005 L	0.005 L	0.0050
LEAD	PPM	2	0.003	0.003 L	0.003 L	0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050 L	0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005 L	0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010 L	0.0100
CADMIUM	PPM	1	0.000	0.000 L	0.000 L	0.0001
MOLYBDENUM	PPM	1	0.100	0.100 L	0.100 L	0.1000
OXYGEN						
BOD	PPM	1	1.900	1.900	1.900	1.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	1	0.020	0.020	0.020	0.0200
N-KJELDHAL	PPM	3	0.480	0.477	0.550	0.4000
NITRATE	PPM	1	0.550	0.550	0.550	0.5500
NITRITE	PPM	1	0.010	0.010	0.010	0.0100
NITRATE+NITRITE	PPM	3	0.160	0.357	0.730	0.1600
TOTAL N	PPM	4	0.865	0.880	1.130	0.6600
PHOSPHORUS-TOTAL	PPM	4	0.045	0.051	0.112	L 0.0030
PHOSPHORUS-DISS	PPM	1	0.029	0.029	0.029	0.0290
SILICATE	PPM	4	11.450	11.550	15.000	8.3000
ORGANIC N	PPM	1	0.440	0.440	0.440	0.4400

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500093 VERNON CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - TOTAL	PPM	3	58.500	67.500	94.000	50.0000
TOT ORG CARBON	PPM	4	11.000	11.750	16.000	9.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500094 VERNON CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	8.250	9.375	18.000	3.0000
DISSOLVED O2	PPM	4	11.950	12.800	16.500	10.8000
PH	PH UNITS	5	8.800	8.720	9.200	7.8000
COLOUR	HAZEN	4	5.000	5.000	5.000	L 5.0000
TURBIDITY	JACKSON	3	3.400	3.133	3.800	2.2000
CONDUCTIVITY	M-MHOS	5	320.000	325.000	375.000	300.00
HARDNESS - TOTAL	PPM	4	139.500	137.250	148.000	122.00
SOLIDS						
TOTAL	PPM	4	218.000	216.000	232.000	196.00
FIXED	PPM	4	170.000	166.500	194.000	132.00
SUSPENDED	PPM	4	5.200	6.375	13.400	1.7000
GENERAL IONS						
CALCIUM	PPM	4	25.700	26.225	32.000	21.5000
MAGNESIUM	PPM	4	16.700	17.300	19.200	16.6000
SODIUM	PPM	4	17.700	17.725	18.000	17.5000
POTASSIUM	PPM	4	4.300	4.900	7.200	3.8000
SULPHATE	PPM	4	32.200	33.500	42.600	27.0000
CHLORIDE	PPM	3	2.600	3.467	5.600	2.2000
FLUORIDE	PPM	2	0.365	0.365	0.430	0.3000
METALS						
IRON - DISSOLVED	PPM	4	0.040	0.035	0.040	L 0.0200
MANGANESE - DISS	PPM	2	0.010	0.010 L	0.010	L 0.0100
COPPER	PPM	2	0.005	0.005	0.006	0.0050
ZINC	PPM	2	0.005	0.005 L	0.005	L 0.0050
LEAD	PPM	2	0.003	0.003 L	0.003	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000 L	0.000	L 0.0001
OXYGEN						
BOD	PPM	2	4.400	4.400	5.000	3.8000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.030	0.030	0.040	0.0200
N-KJELDHAL	PPM	2	0.485	0.485	0.620	0.3500
NITRATE	PPM	2	0.020	0.020	0.020	L 0.0200
NITRITE	PPM	2	0.005	0.005 L	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	0.075	0.075	0.130	L 0.0200
TOTAL N	PPM	4	0.590	0.605	0.760	0.4800
PHOSPHORUS-TOTAL	PPM	4	0.028	0.040	0.079	0.0240
PHOSPHORUS-DISS	PPM	2	0.013	0.013	0.024	L 0.0030
SILICATE	PPM	4	1.050	2.100	6.200	L 0.1000
ORGANIC N	PPM	2	0.620	0.620	0.720	0.5200
CARBON						
ALK - PHENOL	PPM	3	5.200	8.400	15.000	5.0000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500094 VERNON CREEK CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ALK - TOTAL	PPM	3	141.000	143.667	152.000	138.00
TOT ORG CARBON	PPM	4	11.000	11.250	18.000	5.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500096 SMITH CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	8.250	8.750	16.500	3.0000
DISSOLVED O2	PPM	6	9.800	9.567	11.500	7.4000
PH	PH UNITS	7	8.200	8.229	8.500	7.9000
COLOUR	HAZEN	7	10.000	9.286	15.000	L 5.0000
TURBIDITY	JACKSON	3	14.000	13.833	23.000	4.5000
CONDUCTIVITY	M-MHOS	8	800.000	807.500	950.000	700.00
HARDNESS - TOTAL	PPM	5	358.000	366.400	449.000	310.00
SURFACTANTS	PPM	1	0.0	0.0	0.0	0.0
TANNIN & LIGNIN	PPM	1	0.200	0.200	0.200	0.2000
SOLIDS						
TOTAL	PPM	6	605.000	632.667	792.000	488.00
FIXED	PPM	6	438.000	473.333	656.000	362.00
DISSOLVED	PPM	2	586.000	586.000	596.000	576.00
SUSPENDED	PPM	6	29.500	34.000	60.000	19.0000
VOLATILE SUSP	PPM	1	11.700	11.700	11.700	11.7000
GENERAL IONS						
CALCIUM	PPM	7	85.000	81.471	85.600	72.8000
MAGNESIUM	PPM	7	38.500	39.643	52.500	34.0000
SODIUM	PPM	6	51.250	53.217	70.400	43.5000
POTASSIUM	PPM	6	4.350	4.750	7.800	3.2000
SULPHATE	PPM	5	161.000	159.200	186.000	140.00
CHLORIDE	PPM	6	7.150	5.317	9.100	0.0
FLUORIDE	PPM	4	0.400	0.392	0.410	0.3600
METALS						
IRON - DISSOLVED	PPM	6	0.055	0.073	0.200	0.0200
MANGANESE - DISS	PPM	4	0.020	0.017	0.020	0.0100
COPPER	PPM	4	0.015	0.013	0.020	0.0030
ZINC	PPM	5	0.028	0.157	0.665	L 0.0050
LEAD	PPM	4	0.004	0.005	0.010	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	4	0.010	0.017	0.040	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.001	L 0.0001
OXYGEN						
BOD	PPM	2	5.200	5.200	10.000	0.4000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.940	0.650	1.000	L 0.0100
N-KJELDHAL	PPM	4	1.550	1.867	4.000	0.3700
NITRATE	PPM	4	1.055	1.007	1.100	0.8200
NITRITE	PPM	4	0.034	0.028	0.040	L 0.0050
NITRATE+NITRITE	PPM	3	1.080	1.027	1.220	0.7800
TOTAL N	PPM	7	3.050	2.704	5.080	1.1000
PHOSPHORUS-TOTAL	PPM	6	0.333	0.492	1.250	0.0290
PHOSPHORUS-DISS	PPM	3	0.608	0.455	0.645	0.1120
SILICATE	PPM	6	27.050	27.567	33.900	23.5000

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500096 SMITH CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
ORGANIC N	PPM	3	1.000	0.760	1.000	0.2800
CARBON						
ALK - PHENOL	PPM	2	0.800	0.800	1.600	0.0
ALK - TOTAL	PPM	5	318.000	315.000	346.000	285.00
TOT ORG CARBON	PPM	6	10.000	9.167	15.000	L 1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500097 SMITH CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	8.500	8.750	13.000	5.0000
DISSOLVED O2	PPM	4	10.850	10.725	12.000	9.2000
PH	PH UNITS	3	8.400	8.267	8.600	7.8000
COLOUR	HAZEN	4	7.500	11.250	25.000	L 5.0000
TURBIDITY	JACKSON	1	2.200	2.200	2.200	2.2000
CONDUCTIVITY	M-MHOS	4	530.000	520.000	600.000	420.00
HARDNESS - TOTAL	PPM	4	257.500	246.250	284.000	186.00
TANNIN & LIGNIN	PPM	1	0.700	0.700	0.700	0.7000
SOLIDS						
TOTAL	PPM	4	351.000	348.500	374.000	318.00
FIXED	PPM	4	252.000	247.000	272.000	212.00
DISSOLVED	PPM	1	324.000	324.000	324.000	324.00
SUSPENDED	PPM	3	21.000	17.133	29.000	1.4000
GENERAL IONS						
CALCIUM	PPM	4	66.000	61.575	67.500	46.8000
MAGNESIUM	PPM	4	23.700	23.050	28.000	16.8000
SODIUM	PPM	4	20.850	21.350	25.700	18.0000
POTASSIUM	PPM	4	2.600	2.350	2.600	1.6000
SULPHATE	PPM	3	18.100	15.967	23.000	6.8000
CHLORIDE	PPM	3	2.400	2.500	2.800	2.3000
FLUORIDE	PPM	2	0.320	0.320	0.330	0.3100
METALS						
IRON - DISSOLVED	PPM	4	0.105	0.112	0.200	L 0.0400
MANGANESE - DISS	PPM	2	0.030	0.030	0.050	L 0.0100
COPPER	PPM	2	0.003	0.003	0.004	0.0020
ZINC	PPM	2	0.022	0.022	0.040	0.0050
LEAD	PPM	2	0.003	0.003	0.003	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	1	1.100	1.100	1.100	1.1000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.010	0.010 L	0.010	L 0.0100
N-KJELDHAL	PPM	2	0.295	0.295	0.340	0.2500
NITRATE	PPM	2	0.305	0.305	0.480	0.1300
NITRITE	PPM	2	0.005	0.005 L	0.005	L 0.0050
NITRATE+NITRITE	PPM	2	4.625	4.625	5.200	4.0500
TOTAL N	PPM	4	2.485	2.682	5.450	0.3100
PHOSPHORUS-TOTAL	PPM	4	0.212	0.241	0.414	0.1250
PHOSPHORUS-DISS	PPM	2	0.278	0.278	0.332	0.2240
SILICATE	PPM	4	28.100	28.275	30.500	26.4000
ORGANIC N	PPM	2	0.140	0.140	0.180	0.1000
CARBON						
ALK - TOTAL	PPM	2	231.500	231.500	259.000	204.00

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500099 WHITEMAN CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TOT ORG CARBON	PPM	4	10.500	9.000	13.000	2.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500099 WHITEMAN CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	6.000	6.600	12.000	3.0000
DISSOLVED O2	PPM	4	12.600	12.000	13.200	9.6000
PH	PH UNITS	4	8.450	8.500	9.300	7.8000
COLOUR	HAZEN	4	5.000	10.000	25.000	L 5.0000
TURBIDITY	JACKSON	4	1.050	1.100	1.500	0.8000
CONDUCTIVITY	M-MHOS	5	260.000	281.800	350.000	200.00
HARDNESS - TOTAL	PPM	4	132.500	129.500	166.000	87.0000
TANNIN & LIGNIN	PPM	1	0.100	0.100	0.100	0.1000
SOLIDS						
TOTAL	PPM	4	195.000	197.500	264.000	136.00
FIXED	PPM	3	120.000	124.667	162.000	92.0000
DISSOLVED	PPM	1	234.000	234.000	234.000	234.00
SUSPENDED	PPM	3	2.300	2.633	3.300	2.3000
GENERAL IONS						
CALCIUM	PPM	4	39.200	37.950	48.000	25.4000
MAGNESIUM	PPM	4	8.450	8.375	11.100	5.5000
SODIUM	PPM	4	7.000	7.000	8.300	5.7000
POTASSIUM	PPM	4	1.550	1.575	1.700	1.5000
SULPHATE	PPM	4	27.050	27.100	39.800	14.5000
CHLORIDE	PPM	4	0.800	0.825	0.900	0.8000
FLUORIDE	PPM	3	0.310	0.297	0.310	0.2700
METALS						
IRON - DISSOLVED	PPM	4	0.070	0.075	0.120	L 0.0400
MANGANESE - DISS	PPM	3	0.010	0.013	0.020	L 0.0100
COPPER	PPM	3	0.002	0.005	0.012	L 0.0010
ZINC	PPM	3	0.006	0.010	0.020	0.0050
LEAD	PPM	3	0.003	0.003	0.003	L 0.0030
MERCURY - DISS	PPM	1	0.280	0.280	0.280	0.2800
MERCURY - UNFILT	PPM	3	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	L 0.0001
OXYGEN						
BOD	PPM	2	1.150	1.150	1.400	0.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.040	0.037	0.060	L 0.0100
N-KJELDHAL	PPM	2	0.255	0.255	0.430	0.0800
NITRATE	PPM	4	0.060	0.100	0.260	0.0200
NITRITE	PPM	3	0.005	0.005 L	0.005	L 0.0050
NITRATE+NITRITE	PPM	1	0.030	0.030	0.030	0.0300
TOTAL N	PPM	4	0.180	0.272	0.630	0.1000
PHOSPHORUS-TOTAL	PPM	5	0.050	0.070	0.150	0.0420
PHOSPHORUS-DISS	PPM	3	0.043	0.044	0.051	0.0370
SILICATE	PPM	4	20.950	21.050	22.500	19.8000
ORGANIC N	PPM	3	0.190	0.170	0.310	L 0.0100

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500099 WHITEMAN CREEK NEAR MOUTH CONTINUED

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
CARBON						
ALK - TOTAL	PPM	3	104.000	106.667	135.000	81.0000
TOT ORG CARBON	PPM	5	9.000	8.200	13.000	1.0000
TOT INORG CARBON	PPM	1	23.000	23.000	23.000	23.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500100 WINFIELD CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	4	9.000	9.750	16.000	5.0000
DISSOLVED O2	PPM	4	10.650	10.950	13.000	9.5000
PH	PH UNITS	5	8.300	8.300	8.700	7.8000
COLOUR	HAZEN	4	5.000	5.000	5.000	L 5.0000
TURBIDITY	JACKSON	3	1.400	1.333	1.700	0.9000
CONDUCTIVITY	M-MHOS	5	452.000	444.400	480.000	400.00
HARDNESS - TOTAL	PPM	4	209.000	208.000	216.000	198.00
TANNIN & LIGNIN	PPM	1	0.100	0.100	L 0.100	L 0.1000
SOLIDS						
TOTAL	PPM	4	304.000	305.500	328.000	286.00
FIXED	PPM	3	194.000	212.000	264.000	178.00
DISSOLVED	PPM	1	306.000	306.000	306.000	306.00
SUSPENDED	PPM	3	13.000	19.200	38.000	6.6000
GENERAL IONS						
CALCIUM	PPM	4	57.650	56.775	58.800	53.0000
MAGNESIUM	PPM	4	16.000	16.025	17.000	15.1000
SODIUM	PPM	4	14.950	14.900	15.000	14.7000
POTASSIUM	PPM	4	3.400	3.825	5.600	2.9000
SULPHATE	PPM	4	33.250	34.850	43.300	29.6000
CHLORIDE	PPM	3	3.200	3.767	5.100	3.0000
FLUORIDE	PPM	1	0.370	0.370	0.370	0.3700
METALS						
IRON - DISSOLVED	PPM	4	0.040	0.060	0.140	L 0.0200
MANGANESE - DISS	PPM	1	0.050	0.050	0.050	0.0500
COPPER	PPM	1	0.004	0.004	0.004	0.0040
ZINC	PPM	1	0.005	0.005	L 0.005	L 0.0050
LEAD	PPM	1	0.003	0.003	L 0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
CADMIUM	PPM	1	0.000	0.000	L 0.000	L 0.0001
OXYGEN						
BOD	PPM	1	2.200	2.200	2.200	2.2000
NUTRIENTS						
N-KJELDHAL	PPM	4	0.265	0.270	0.420	0.1300
NITRATE+NITRITE	PPM	4	1.890	1.527	2.150	0.1780
TOTAL N	PPM	4	2.095	1.797	2.570	0.4300
PHOSPHORUS-TOTAL	PPM	4	0.034	0.043	0.073	0.0300
SILICATE	PPM	4	22.150	22.275	23.900	20.9000
CARBON						
ALK - TOTAL	PPM	3	203.000	200.667	204.000	195.00
TOT ORG CARBON	PPM	4	6.000	6.250	11.000	2.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500170 LAMBLY CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	10.500	21.500	120.000	1.0000
DISSOLVED 02	PPM	5	7.400	8.560	12.700	5.8000
PH	PH UNITS	8	8.550	8.612	9.100	8.4000
COLOUR	HAZEN	8	10.000	15.625	40.000	5.0000
TURBIDITY	JACKSON	8	0.570	0.714	1.400	0.2900
CONDUCTIVITY	M-MHOS	8	192.000	418.750	2090.	120.00
HARDNESS - TOTAL	PPM	8	93.750	86.850	107.000	54.0000
SOLIDS						
TOTAL	PPM	9	138.000	142.000	202.000	106.00
FIXED	PPM	9	98.000	103.111	162.000	64.0000
SUSPENDED	PPM	9	132.000	126.333	142.000	102.00
GENERAL IONS						
CALCIUM	PPM	8	29.000	27.387	34.500	18.0000
CHLORIDE	PPM	6	0.450	0.467	0.600	0.3000
METALS						
IRON - DISSOLVED	PPM	6	0.090	0.102	0.240	0.0200
NUTRIENTS						
N-KJELDHAL	PPM	6	0.285	0.347	0.740	0.2000
NITRATE+NITRITE	PPM	8	0.010	0.010	0.010	0.0100
PHOSPHORUS-TOTAL	PPM	7	0.021	0.037	0.145	0.0100
PHOSPHORUS-DISS	PPM	7	0.007	0.008	0.013	0.0030
CARBON						
TOT ORG CARBON	PPM	5	8.000	7.800	9.000	7.0000
TOT INORG CARBON	PPM	5	17.000	17.000	19.000	15.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500171 SHORTS CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	3	6.000	7.000	11.000	4.0000
DISSOLVED 02	PPM	3	11.800	11.267	12.000	10.0000
PH	PH UNITS	3	8.400	8.100	8.700	7.2000
COLOUR	HAZEN	3	15.000	33.333	80.000	L 5.0000
TURBIDITY	JACKSON	3	0.700	4.433	12.000	0.6000
CONDUCTIVITY	M-MHOS	3	200.000	178.333	255.000	80.0000
HARDNESS - TOTAL	PPM	3	87.400	81.800	120.000	38.0000
TANNIN & LIGNIN	PPM	1	0.300	0.300	0.300	0.3000
SOLIDS						
TOTAL	PPM	3	124.000	127.333	138.000	120.00
FIXED	PPM	3	72.000	70.667	78.000	62.0000
SUSPENDED	PPM	3	1.500	7.200	19.500	0.6000
GENERAL IONS						
CALCIUM	PPM	3	25.400	23.533	34.400	10.8000
MAGNESIUM	PPM	3	5.200	5.167	8.000	2.3000
SODIUM	PPM	3	4.700	4.233	5.900	2.1000
POTASSIUM	PPM	3	1.000	0.933	1.000	0.8000
SULPHATE	PPM	3	5.000	6.733	10.200	L 5.0000
CHLORIDE	PPM	2	0.700	0.700	1.000	0.4000
FLUORIDE	PPM	3	0.120	0.123	0.150	L 0.1000
METALS						
IRON - DISSOLVED	PPM	3	0.060	0.143	0.310	0.0600
MANGANESE - DISS	*PPM*	3	*0.010*	*0.010*	*0.010*	*L 0.0100*
COPPER	PPM	3	0.003	0.003	0.004	0.0020
ZINC	PPM	3	0.020	0.032	0.070	L 0.0050
LEAD	PPM	3	0.003	0.006	0.011	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	L 0.050	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005	L 0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010	L 0.010	L 0.0100
CADMIUM	PPM	2	0.001	0.001	0.001	0.0005
OXYGEN						
BOD	PPM	2	1.050	1.050	1.400	0.7000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.040	0.033	0.050	L 0.0100
NITRATE	PPM	3	0.020	0.023	0.030	L 0.0200
NITRITE	PPM	3	0.005	0.005	L 0.005	L 0.0050
TOTAL N	PPM	3	0.170	0.233	0.360	0.1700
PHOSPHORUS-TOTAL	PPM	3	0.041	0.043	0.080	0.0080
PHOSPHORUS-DISS	PPM	3	0.008	0.012	0.023	0.0060
SILICATE	PPM	3	15.700	15.767	17.500	14.1000
ORGANIC N	PPM	3	0.120	0.187	0.340	0.1000
CARBON						
ALK - TOTAL	PPM	3	89.000	83.667	124.000	38.0000
TOT ORG CARBON	PPM	3	10.000	10.333	20.000	L 1.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500174 VASEUX CREEK NEAR OKANAGAN RIVER

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	3	9.500	9.667	10.000	9.5000
DISSOLVED O2	PPM	3	11.200	10.900	11.500	10.0000
PH	PH UNITS	3	7.400	7.567	8.300	7.0000
COLOUR	HAZEN	3	50.000	50.000	80.000	20.0000
TURBIDITY	JACKSON	3	2.300	4.633	9.500	2.1000
CONDUCTIVITY	M-MHOS	3	60.000	64.333	143.000	L50.0000
HARDNESS - TOTAL	PPM	3	28.000	35.667	60.000	19.0000
TANNIN & LIGNIN	PPM	2	1.000	1.000	1.600	0.4000
SOLIDS						
TOTAL	PPM	3	102.000	98.000	124.000	68.0000
FIXED	PPM	3	54.000	56.000	76.000	38.0000
SUSPENDED	PPM	3	6.700	10.967	24.000	2.2000
GENERAL IONS						
CALCIUM	PPM	3	6.000	8.667	15.600	4.4000
MAGNESIUM	PPM	3	1.800	2.567	4.600	1.3000
SODIUM	PPM	3	2.600	3.100	4.800	1.9000
POTASSIUM	PPM	3	1.100	1.000	1.400	0.5000
SULPHATE	PPM	3	5.000	5.933	7.800	L 5.0000
CHLORIDE	PPM	3	0.800	0.767	1.000	0.5000
FLUORIDE	PPM	3	0.250	0.250	0.320	0.1800
METALS						
IRON - DISSOLVED	PPM	3	0.280	0.420	0.860	0.1200
MANGANESE - DISS	PPM	3	0.010	0.010 L	0.010	L 0.0100
COPPER	PPM	3	0.003	0.005	0.008	0.0030
ZINC	PPM	3	0.005	0.007	0.012	L 0.0050
LEAD	PPM	3	0.003	0.004	0.006	L 0.0030
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	L 0.0001
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.040	0.030	0.040	L 0.0100
NITRATE	PPM	3	0.040	0.037	0.050	L 0.0200
NITRITE	PPM	3	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	3	0.310	0.280	0.380	0.1500
PHOSPHORUS-TOTAL	PPM	3	0.017	0.033	0.074	0.0070
PHOSPHORUS-DISS	PPM	3	0.006	0.020	0.049	0.0040
SILICATE	PPM	3	18.600	17.233	19.400	13.7000
ORGANIC N	PPM	3	0.220	0.223	0.300	0.1500
CARBON						
ALK - TOTAL	PPM	3	25.000	35.667	64.500	17.5000
TOT ORG CARBON	PPM	3	11.000	14.000	23.000	8.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500175 VASEUX CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	1	5.000	5.000	5.000	5.0000
DISSOLVED O2	PPM	1	10.200	10.200	10.200	10.2000
PH	PH UNITS	1	8.300	8.300	8.300	8.3000
COLOUR	HAZEN	1	25.000	25.000	25.000	25.0000
TURBIDITY	JACKSON	1	2.500	2.500	2.500	2.5000
CONDUCTIVITY	M-MHOS	1	418.000	418.000	418.000	418.00
HARDNESS - TOTAL	PPM	1	185.000	185.000	185.000	185.00
TANNIN & LIGNIN	PPM	1	0.300	0.300	0.300	0.3000
SOLIDS						
TOTAL	PPM	1	322.000	322.000	322.000	322.00
FIXED	PPM	1	196.000	196.000	196.000	196.00
SUSPENDED	PPM	1	7.900	7.900	7.900	7.9000
GENERAL IONS						
CALCIUM	PPM	1	43.600	43.600	43.600	43.6000
MAGNESIUM	PPM	1	17.300	17.300	17.300	17.3000
SODIUM	PPM	1	13.000	13.000	13.000	13.0000
POTASSIUM	PPM	1	8.000	8.000	8.000	8.0000
SULPHATE	PPM	1	55.500	55.500	55.500	55.5000
CHLORIDE	PPM	1	2.800	2.800	2.800	2.8000
FLUORIDE	PPM	1	0.610	0.610	0.610	0.6100
METALS						
IRON - DISSOLVED	PPM	1	0.020	0.020	0.020	0.0200
MANGANESE - DISS	PPM	1	0.010	0.010 L	0.010	L 0.0100
COPPER	PPM	1	0.006	0.006	0.006	0.0060
ZINC	PPM	1	0.005	0.005 L	0.005	L 0.0050
LEAD	PPM	1	0.003	0.003 L	0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	1	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	1	0.000	0.000	0.000	0.0002
NUTRIENTS						
AMMONIA AS NH3	PPM	1	0.010	0.010 L	0.010	L 0.0100
NITRATE	PPM	1	0.010	0.010	0.010	0.0100
NITRITE	PPM	1	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	1	0.390	0.390	0.390	0.3900
PHOSPHORUS-TOTAL	PPM	1	0.100	0.100	0.100	0.1000
PHOSPHORUS-DISS	PPM	1	0.067	0.067	0.067	0.0670
SILICATE	PPM	1	32.800	32.800	32.800	32.8000
ORGANIC N	PPM	1	0.380	0.380	0.380	0.3800
CARBON						
ALK - TOTAL	PPM	1	168.000	168.000	168.000	168.00
TOT ORG CARBON	PPM	1	8.000	8.000	8.000	8.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500176 BX CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	3	10.000	8.000	10.000	4.0000
DISSOLVED O2	PPM	3	10.200	10.867	12.500	9.9000
PH	PH UNITS	3	7.800	7.633	8.000	7.1000
COLOUR	HAZEN	3	5.000	20.000	50.000	5.0000
TURBIDITY	JACKSON	3	2.300	3.800	6.300	0.8000
CONDUCTIVITY	M-MHOS	3	200.000	200.000	240.000	160.00
HARDNESS - TOTAL	PPM	3	92.000	98.533	119.000	76.6000
TANNIN & LIGNIN	PPM	2	0.150	0.150	0.200	0.1000
SOLIDS						
TOTAL	PPM	3	162.000	143.333	164.000	104.00
FIXED	PPM	3	104.000	95.333	108.000	74.0000
SUSPENDED	PPM	3	2.300	2.467	4.100	1.0000
GENERAL IONS						
CALCIUM	PPM	3	28.800	32.400	41.600	26.8000
MAGNESIUM	PPM	3	3.000	3.333	5.200	1.8000
SODIUM	PPM	3	2.900	2.933	4.400	1.5000
POTASSIUM	PPM	3	2.000	1.833	2.100	1.4000
SULPHATE	PPM	3	22.000	19.500	22.000	14.5000
CHLORIDE	PPM	3	0.700	0.833	1.300	L 0.5000
FLUORIDE	PPM	3	0.100	0.117	0.150	L 0.1000
METALS						
IRON - DISSOLVED	PPM	3	0.040	0.307	0.840	L 0.0400
MANGANESE - DISS	PPM	3	0.010	0.013	0.020	L 0.0100
COPPER	PPM	3	0.012	0.012	0.013	0.0100
ZINC	PPM	3	0.005	0.010	0.020	L 0.0050
LEAD	PPM	3	0.003	0.003 L	0.003	L 0.0030
MERCURY - UNFILT	PPM	3	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.013	0.020	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	1	1.500	1.500	1.500	1.5000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.040	0.047	0.060	0.0200
NITRATE	PPM	3	0.020	0.023	0.030	L 0.0200
NITRITE	PPM	3	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	3	0.260	0.280	0.420	0.1600
PHOSPHORUS-TOTAL	PPM	3	0.005	0.015	0.037	0.0030
PHOSPHORUS-DISS	PPM	3	0.003	0.009	0.022	L 0.0030
SILICATE	PPM	3	15.000	16.500	22.500	12.0000
ORGANIC N	PPM	3	0.210	0.223	0.360	0.0800
CARBON						
ALK - TOTAL	PPM	3	80.500	82.333	102.000	64.5000
TOT ORG CARBON	PPM	3	9.000	10.000	13.000	8.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

OKANAGAN BASIN STUDY
STREAM DATA FROM 1 APRIL 1972

0500177 DEEP CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	3	10.000	10.833	17.500	5.0000
DISSOLVED O2	PPM	3	8.300	9.767	13.000	8.0000
PH	PH UNITS	3	7.500	6.300	7.900	1.4000
COLOUR	HAZEN	4	90.000	132.500	280.000	70.0000
TURBIDITY	JACKSON	4	2.200	7.350	23.000	2.0000
CONDUCTIVITY	M-MHOS	4	526.500	500.750	800.000	150.00
HARDNESS - TOTAL	PPM	4	272.000	265.000	440.000	76.0000
TANNIN & LIGNIN	PPM	1	1.220	1.220	1.220	1.2200
SOLIDS						
TOTAL	PPM	4	452.000	440.500	680.000	178.00
FIXED	PPM	4	314.000	321.500	552.000	106.00
SUSPENDED	PPM	4	7.800	9.800	22.000	1.6000
GENERAL IONS						
CALCIUM	PPM	4	83.300	85.900	152.000	25.0000
MAGNESIUM	PPM	4	11.350	10.450	16.200	2.9000
SODIUM	PPM	4	5.900	5.800	8.500	2.9000
POTASSIUM	PPM	4	4.450	3.900	4.800	1.9000
SULPHATE	PPM	4	123.050	135.400	276.000	19.5000
CHLORIDE	PPM	4	3.500	3.400	5.300	1.3000
FLUORIDE	PPM	4	0.180	0.210	0.330	0.1500
METALS						
IRON - DISSOLVED	PPM	4	0.460	0.485	0.800	0.2200
MANGANESE - DISS	PPM	4	0.040	1.587	6.250	0.0200
COPPER	PPM	4	0.009	0.010	0.013	0.0080
ZINC	PPM	4	0.030	0.046	0.120	L 0.0050
LEAD	PPM	4	0.003	0.004	0.005	L 0.0030
MERCURY - UNFILT	PPM	4	0.050	0.052	0.060	L 0.0500
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	4	0.010	0.025	0.070	L 0.0100
CADMIUM	PPM	4	0.001	0.001	0.002	0.0004
OXYGEN						
BOD	PPM	1	1.500	1.500	1.500	1.5000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.080	0.552	2.000	0.0500
NITRATE	PPM	4	0.225	0.742	2.490	0.0300
NITRITE	PPM	4	0.010	0.017	0.042	0.0080
TOTAL N	PPM	4	2.420	2.700	5.420	0.5400
PHOSPHORUS-TOTAL	PPM	4	0.173	0.312	0.848	0.0550
PHOSPHORUS-DISS	PPM	4	0.134	0.136	0.241	0.0330
SILICATE	PPM	4	21.300	20.600	29.800	10.0000
ORGANIC N	PPM	4	1.050	1.387	3.000	0.4500
CARBON						
ALK - TOTAL	PPM	4	133.000	124.500	175.000	57.0000
TOT ORG CARBON	PPM	4	24.000	28.500	46.000	20.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500178 TROUT CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	2	9.500	9.500	11.500	7.5000
DISSOLVED O2	PPM	2	10.000	10.000	10.500	9.5000
PH	PH UNITS	2	7.200	7.200	7.400	7.0000
COLOUR	HAZEN	2	37.500	37.500	50.000	25.0000
TURBIDITY	JACKSON	2	1.850	1.850	2.600	1.1000
CONDUCTIVITY	M-MHOS	2	95.000	95.000	130.000	60.0000
HARDNESS - TOTAL	PPM	2	41.500	41.500	58.000	25.0000
TANNIN & LIGNIN	PPM	2	0.800	0.800	1.100	0.5000
SOLIDS						
TOTAL	PPM	2	87.000	87.000	104.000	70.0000
FIXED	PPM	2	50.000	50.000	76.000	24.0000
SUSPENDED	PPM	2	3.400	3.400	5.500	1.3000
GENERAL IONS						
CALCIUM	PPM	2	12.500	12.500	18.200	6.8000
MAGNESIUM	PPM	2	1.950	1.950	2.800	1.1000
SODIUM	PPM	2	3.050	3.050	4.100	2.0000
POTASSIUM	PPM	2	1.000	1.000	1.300	0.7000
SULPHATE	PPM	2	5.900	5.900	6.800	L 5.0000
CHLORIDE	PPM	1	0.700	0.700	0.700	0.7000
FLUORIDE	PPM	2	0.110	0.110	0.120	0.1000
METALS						
IRON - DISSOLVED	PPM	2	0.140	0.140	0.260	0.0200
MANGANESE - DISS	PPM	2	0.030	0.030	0.040	0.0200
COPPER	PPM	2	0.002	0.002	0.002	0.0020
ZINC	PPM	2	0.165	0.165	0.325	0.0060
LEAD	PPM	2	0.005	0.005	0.005	0.0050
MERCURY - UNFILT	PPM	2	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.020	0.020	0.030	L 0.0100
CADMIUM	PPM	2	0.001	0.001	0.001	L 0.0001
OXYGEN						
BOD	PPM	1	0.900	0.900	0.900	0.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.060	0.060	0.100	0.0200
NITRATE	PPM	2	0.020	0.020	0.020	L 0.0200
NITRITE	PPM	2	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	2	0.340	0.340	0.480	0.2000
PHOSPHORUS-TOTAL	PPM	2	0.012	0.012	0.016	0.0090
PHOSPHORUS-DISS	PPM	2	0.005	0.005	0.005	0.0050
SILICATE	PPM	2	16.250	16.250	18.300	14.2000
ORGANIC N	PPM	2	0.270	0.270	0.360	0.1800
CARBON						
ALK - TOTAL	PPM	2	40.500	40.500	57.500	23.5000
TOT ORG CARBON	PPM	2	13.500	13.500	16.000	11.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500179 INKANEEP CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	2	14.250	14.250	20.000	8.5000
DISSOLVED O2	PPM	2	13.200	13.200	17.000	9.4000
PH	PH UNITS	2	7.750	7.750	8.000	7.5000
COLOUR	HAZEN	2	65.000	65.000	80.000	50.0000
TURBIDITY	JACKSON	2	3.450	3.450	4.800	2.1000
CONDUCTIVITY	M-MHOS	2	90.000	90.000	100.000	80.0000
HARDNESS - TOTAL	PPM	2	26.000	26.000	30.000	22.0000
TANNIN & LIGNIN	PPM	1	0.300	0.300	0.300	0.3000
SOLIDS						
TOTAL	PPM	2	97.000	97.000	100.000	94.0000
FIXED	PPM	2	59.000	59.000	62.000	56.0000
SUSPENDED	PPM	2	8.700	8.700	10.000	7.4000
GENERAL IONS						
CALCIUM	PPM	2	6.200	6.200	8.000	4.4000
MAGNESIUM	PPM	2	1.850	1.850	2.000	1.7000
SODIUM	PPM	2	5.100	5.100	5.200	5.0000
POTASSIUM	PPM	2	1.350	1.350	1.400	1.3000
SULPHATE	PPM	2	5.000	5.000 L	5.000	L 5.0000
CHLORIDE	PPM	2	0.750	0.750	0.800	0.7000
FLUORIDE	PPM	2	0.180	0.180	0.190	0.1700
METALS						
IRON - DISSOLVED	PPM	2	0.250	0.250	0.320	0.1800
MANGANESE - DISS	PPM	2	0.010	0.010 L	0.010	L 0.0100
COPPER	PPM	2	0.006	0.006	0.010	0.0020
ZINC	PPM	2	0.018	0.018	0.020	0.0160
LEAD	PPM	2	0.003	0.003	0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	2	0.002	0.002	0.003	0.0003
OXYGEN						
BOD	PPM	1	1.000	1.000	1.000	1.0000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.010	0.010 L	0.010	L 0.0100
NITRATE	PPM	2	0.020	0.020	0.020	L 0.0200
NITRITE	PPM	2	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	2	0.310	0.310	0.380	0.2400
PHOSPHORUS-TOTAL	PPM	2	0.034	0.034	0.041	0.0280
PHOSPHORUS-DISS	PPM	2	0.015	0.015	0.017	0.0130
SILICATE	PPM	2	20.650	20.650	23.000	18.3000
ORGANIC N	PPM	2	0.300	0.300	0.380	0.2200
CARBON						
ALK - TOTAL	PPM	2	31.750	31.750	36.500	27.0000
TOT ORG CARBON	PPM	2	13.500	13.500	15.000	12.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500180 INKANEEP CREEK NEAR MOUTH

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	2	14.500	14.500	20.000	9.0000
DISSOLVED O2	PPM	2	12.050	12.050	15.500	8.6000
PH	PH UNITS	2	7.800	7.800	8.100	7.5000
COLOUR	HAZEN	2	55.000	55.000	80.000	30.0000
TURBIDITY	JACKSON	2	14.050	14.050	22.000	6.1000
CONDUCTIVITY	M-MHOS	2	130.000	130.000	170.000	90.0000
HARDNESS - TOTAL	PPM	2	51.500	51.500	72.000	31.0000
TANNIN & LIGNIN	PPM	1	0.500	0.500	0.500	0.5000
SOLIDS						
TOTAL	PPM	2	189.000	189.000	228.000	150.00
FIXED	PPM	2	143.000	143.000	186.000	100.00
SUSPENDED	PPM	2	59.000	59.000	98.000	20.0000
GENERAL IONS						
CALCIUM	PPM	2	13.600	13.600	20.200	7.0000
MAGNESIUM	PPM	2	3.600	3.600	5.000	2.2000
SODIUM	PPM	2	6.650	6.650	7.700	5.6000
POTASSIUM	PPM	2	1.750	1.750	1.900	1.6000
SULPHATE	PPM	2	7.100	7.100	9.200	L 5.0000
CHLORIDE	PPM	2	0.900	0.900	1.000	0.8000
FLUORIDE	PPM	2	0.250	0.250	0.300	0.2000
METALS						
IRON - DISSOLVED	PPM	2	0.350	0.350	0.520	0.1800
MANGANESE - DISS	PPM	2	0.025	0.025	0.030	0.0200
COPPER	PPM	2	0.008	0.008	0.010	0.0060
ZINC	PPM	2	0.020	0.020	0.030	0.0100
LEAD	PPM	2	0.003	0.003 L	0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.000	0.0002
OXYGEN						
BOD	PPM	1	0.400	0.400	0.400	0.4000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.010	0.010	0.010	0.0100
NITRATE	PPM	2	0.020	0.020	0.020	L 0.0200
NITRITE	PPM	2	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	2	0.290	0.290	0.320	0.2600
PHOSPHORUS-TOTAL	PPM	2	0.110	0.110	0.132	0.0890
PHOSPHORUS-DISS	PPM	2	0.030	0.030	0.043	0.0180
SILICATE	PPM	2	24.400	24.400	27.500	21.3000
ORGANIC N	PPM	2	0.280	0.280	0.310	0.2500
CARBON						
ALK - TOTAL	PPM	2	60.250	60.250	83.000	37.5000
TOT ORG CARBON	PPM	2	17.000	17.000	21.000	13.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500181 EQUESIS CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	1	6.000	6.000	6.000	6.0000
DISSOLVED O2	PPM	1	10.200	10.200	10.200	10.2000
PH	PH UNITS	2	8.100	8.100	8.200	8.0000
COLOUR	HAZEN	2	12.500	12.500	15.000	10.0000
TURBIDITY	JACKSON	2	2.750	2.750	4.100	1.4000
CONDUCTIVITY	M-MHOS	1	180.000	180.000	180.000	180.00
HARDNESS - TOTAL	PPM	2	80.000	80.000	87.000	73.0000
TANNIN & LIGNIN	PPM	1	0.300	0.300	0.300	0.3000
SOLIDS						
TOTAL	PPM	2	136.000	136.000	142.000	130.00
FIXED	PPM	2	86.000	86.000	86.000	86.0000
SUSPENDED	PPM	2	10.000	10.000	15.700	4.3000
GENERAL IONS						
CALCIUM	PPM	2	17.500	17.500	19.000	16.0000
MAGNESIUM	PPM	2	8.300	8.300	9.000	7.6000
SODIUM	PPM	2	9.450	9.450	10.400	8.5000
POTASSIUM	PPM	2	2.250	2.250	2.300	2.2000
SULPHATE	PPM	2	8.500	8.500	12.000	L 5.0000
CHLORIDE	PPM	2	0.800	0.800	1.000	0.6000
FLUORIDE	PPM	2	0.255	0.255	0.280	0.2300
METALS						
IRON - DISSOLVED	PPM	2	0.070	0.070	0.090	0.0500
MANGANESE - DISS	PPM	2	0.010	0.010 L	0.010	L 0.0100
COPPER	PPM	2	0.003	0.003	0.006	0.0010
ZINC	PPM	2	0.037	0.037	0.070	L 0.0050
LEAD	PPM	2	0.003	0.003	0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	2	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	2	0.015	0.015	0.020	L 0.0100
CADMIUM	PPM	2	0.000	0.000	0.001	0.0001
OXYGEN						
BOD	PPM	1	0.100	0.100	0.100	0.1000
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.030	0.030	0.050	0.0100
NITRATE	PPM	2	0.085	0.085	0.090	0.0800
NITRITE	PPM	2	0.006	0.006 L	0.006	L 0.0050
TOTAL N	PPM	2	0.460	0.460	0.560	0.3600
PHOSPHORUS-TOTAL	PPM	2	0.089	0.089	0.124	0.0550
PHOSPHORUS-DISS	PPM	2	0.052	0.052	0.071	0.0330
SILICATE	PPM	2	19.550	19.550	21.100	18.0000
ORGANIC N	PPM	2	0.345	0.345	0.430	0.2600
CARBON						
ALK - TOTAL	PPM	2	96.000	96.000	100.000	92.0000
TOT ORG CARBON	PPM	1	10.000	10.000	10.000	10.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

0500182 POWERS CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	3	12.000	11.167	17.500	4.0000
DISSOLVED O2	PPM	3	9.400	10.333	12.500	9.1000
PH	PH UNITS	3	7.900	7.700	8.000	7.2000
COLOUR	HAZEN	3	35.000	45.000	70.000	30.0000
TURBIDITY	JACKSON	3	1.500	4.933	12.000	1.3000
CONDUCTIVITY	M-MHOS	3	70.000	75.000	100.000	55.0000
HARDNESS - TOTAL	PPM	3	30.000	33.200	41.600	28.0000
TANNIN & LIGNIN	PPM	2	0.700	0.700	0.700	0.7000
SOLIDS						
TOTAL	PPM	3	84.000	94.667	118.000	82.0000
FIXED	PPM	3	48.000	56.667	78.000	44.0000
SUSPENDED	PPM	3	3.800	12.267	31.000	2.0000
GENERAL IONS						
CALCIUM	PPM	3	9.800	9.667	12.000	7.2000
MAGNESIUM	PPM	3	1.300	1.533	2.000	1.3000
SODIUM	PPM	3	2.500	2.300	2.500	1.9000
POTASSIUM	PPM	3	1.100	1.067	1.300	0.8000
SULPHATE	PPM	3	5.000	5.000 L	5.000	L 5.0000
CHLORIDE	PPM	2	0.700	0.700	0.800	0.6000
FLUORIDE	PPM	3	0.100	0.107	0.120	L 0.1000
METALS						
IRON - DISSOLVED	PPM	3	0.100	0.123	0.170	0.1000
MANGANESE - DISS	PPM	3	0.010	0.010 L	0.010	L 0.0100
COPPER	PPM	3	0.002	0.004	0.009	0.0010
ZINC	PPM	3	0.005	0.009	0.016	L 0.0050
LEAD	PPM	3	0.003	0.003 L	0.003	L 0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050 L	0.050	L 0.0500
CHROMIUM	PPM	3	0.005	0.005 L	0.005	L 0.0050
NICKEL	PPM	3	0.010	0.010 L	0.010	L 0.0100
CADMIUM	PPM	3	0.000	0.000	0.000	0.0001
OXYGEN						
BOD	PPM	1	1.900	1.900	1.900	1.9000
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.010	0.013	0.020	L 0.0100
NITRATE	PPM	3	0.030	0.030	0.040	0.0200
NITRITE	PPM	3	0.005	0.005 L	0.005	L 0.0050
TOTAL N	PPM	3	0.250	0.307	0.430	0.2400
PHOSPHORUS-TOTAL	PPM	3	0.017	0.027	0.048	0.0150
PHOSPHORUS-DISS	PPM	3	0.010	0.013	0.022	0.0060
SILICATE	PPM	3	15.300	14.733	15.400	13.5000
ORGANIC N	PPM	3	0.220	0.270	0.410	0.1800
CARBON						
ALK - TOTAL	PPM	3	30.000	31.500	41.000	23.5000
TOT ORG CARBON	PPM	3	13.000	14.667	20.000	11.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500190 LAMBLY CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	9.000	8.083	13.000	2.0000
DISSOLVED O2	PPM	4	8.450	24.725	74.000	8.0000
PH	PH UNITS	8	8.550	8.487	8.700	8.2000
COLOUR	HAZEN	8	10.000	10.000	15.000	5.0000
TURBIDITY	JACKSON	8	0.380	0.369	0.490	0.2200
CONDUCTIVITY	M-MHOS	8	177.500	164.375	198.000	100.00
HARDNESS - TOTAL	PPM	8	91.600	81.850	111.000	13.3000
SOLIDS						
TOTAL	PPM	8	129.000	126.750	152.000	92.0000
FIXED	PPM	8	82.000	80.750	106.000	54.0000
SUSPENDED	PPM	8	122.000	115.750	136.000	80.0000
GENERAL IONS						
CALCIUM	PPM	8	29.000	26.642	38.700	4.2400
CHLORIDE	PPM	8	0.400	0.387	0.500	0.3000
METALS						
IRON - DISSOLVED	PPM	8	0.085	0.146	0.430	0.0200
NUTRIENTS						
N-KJELDHAL	PPM	8	0.295	0.280	0.400	0.1600
NITRATE+NITRITE	PPM	8	0.010	0.012	0.030	0.0100
PHOSPHORUS-TOTAL	PPM	7	0.009	0.013	0.025	0.0070
PHOSPHORUS-DISS	PPM	7	0.005	0.006	0.009	0.0030
CARBON						
TOT ORG CARBON	PPM	7	8.000	8.000	11.000	6.0000
TOT INORG CARBON	PPM	7	12.000	13.143	19.000	9.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500191 LAMBLY CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	9.000	7.667	12.000	1.0000
DISSOLVED O2	PPM	4	8.150	8.075	8.600	7.4000
PH	PH UNITS	7	8.600	8.557	8.800	8.3000
COLOUR	HAZEN	8	10.000	10.625	15.000	5.0000
TURBIDITY	JACKSON	8	0.530	0.685	1.900	0.2600
CONDUCTIVITY	M-MHOS	7	201.000	200.429	220.000	168.00
HARDNESS - TOTAL	PPM	8	94.950	87.337	105.000	56.3000
SOLIDS						
TOTAL	PPM	8	142.000	132.500	152.000	98.0000
FIXED	PPM	8	96.000	93.750	114.000	62.0000
SUSPENDED	PPM	8	132.000	123.000	140.000	96.0000
GENERAL IONS						
CALCIUM	PPM	8	31.200	28.912	34.900	19.6000
CHLORIDE	PPM	7	0.400	0.386	0.500	0.3000
METALS						
IRON - DISSOLVED	PPM	7	0.160	0.169	0.330	0.0200
NUTRIENTS						
N-KJELDHAL	PPM	7	0.250	0.291	0.570	0.1400
NITRATE+NITRITE	PPM	8	0.010	0.010	0.010	0.0100
PHOSPHORUS-TOTAL	PPM	7	0.017	0.027	0.110	0.0050
PHOSPHORUS-DISS	PPM	7	0.004	0.004	0.007	0.0030
CARBON						
TOT ORG CARBON	PPM	6	6.500	6.667	8.000	5.0000
TOT INORG CARBON	PPM	6	15.500	15.333	19.000	12.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500192 LAMBLY CREEK UPSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	9.000	7.000	13.000	0.0
DISSOLVED O2	PPM	4	7.700	7.550	7.900	6.9000
PH	PH UNITS	8	8.300	8.300	8.700	8.0000
COLOUR	HAZEN	8	10.000	11.250	30.000	5.0000
TURBIDITY	JACKSON	8	0.605	0.665	1.700	0.2500
CONDUCTIVITY	M-MHOS	8	240.500	236.250	248.000	210.00
HARDNESS - TOTAL	PPM	8	122.000	113.400	125.000	46.2000
SOLIDS						
TOTAL	PPM	8	180.000	178.000	198.000	162.00
FIXED	PPM	8	127.000	132.750	178.000	100.00
SUSPENDED	PPM	8	162.000	166.250	192.000	158.00
GENERAL IONS						
CALCIUM	PPM	8	40.350	37.300	41.900	15.7000
CHLORIDE	PPM	8	0.400	0.412	0.500	0.3000
METALS						
IRON - DISSOLVED	PPM	8	0.075	0.135	0.440	0.0200
NUTRIENTS						
N-KJELDHAL	PPM	8	0.315	0.512	2.120	0.1800
NITRATE+NITRITE	PPM	8	0.010	0.011	0.020	0.0100
PHOSPHORUS-TOTAL	PPM	7	0.014	0.012	0.020	0.0060
PHOSPHORUS-DISS	PPM	7	0.005	0.005	0.006	0.0030
CARBON						
TOT ORG CARBON	PPM	6	9.000	9.667	18.000	5.0000
TOT INORG CARBON	PPM	6	18.000	18.000	22.000	13.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500193 LAMBLY CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	8.000	6.583	11.000	0.0
DISSOLVED 02	PPM	4	9.100	8.575	9.600	6.5000
PH	PH UNITS	7	8.400	8.357	8.600	8.2000
COLOUR	HAZEN	7	20.000	26.429	40.000	15.0000
TURBIDITY	JACKSON	7	0.710	0.817	1.200	0.4000
CONDUCTIVITY	M-MHOS	7	63.000	62.857	70.000	51.0000
HARDNESS - TOTAL	PPM	7	27.800	28.329	36.600	20.6000
SOLIDS						
TOTAL	PPM	7	62.000	64.571	76.000	58.0000
FIXED	PPM	7	34.000	37.429	56.000	24.0000
SUSPENDED	PPM	7	56.000	52.000	74.000	30.0000
GENERAL IONS						
CALCIUM	PPM	7	9.100	8.796	9.530	6.9200
CHLORIDE	PPM	7	0.400	0.400	0.800	0.2000
METALS						
IRON - DISSOLVED	PPM	7	0.140	0.259	0.520	0.1000
NUTRIENTS						
N-KJELDHAL	PPM	7	0.300	0.297	0.410	0.1800
NITRATE+NITRITE	PPM	7	0.010	0.010	0.010	0.0100
PHOSPHORUS-TOTAL	PPM	6	0.014	0.012	0.018	0.0040
PHOSPHORUS-DISS	PPM	6	0.003	0.003	0.003	0.0030
CARBON						
TOT ORG CARBON	PPM	6	7.000	7.667	12.000	5.0000
TOT INORG CARBON	PPM	6	5.500	5.500	7.000	3.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500194 LAMBLY CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	5	7.000	7.600	13.000	2.5000
DISSOLVED 02	PPM	4	8.500	8.400	8.800	7.8000
PH	PH UNITS	6	8.450	8.417	8.600	8.0000
COLOUR	HAZEN	6	15.000	14.167	20.000	10.0000
TURBIDITY	JACKSON	6	0.410	0.472	1.100	0.1600
CONDUCTIVITY	M-MHOS	6	137.000	139.000	162.000	120.00
HARDNESS - TOTAL	PPM	6	69.550	67.033	78.200	55.9000
SOLIDS						
TOTAL	PPM	5	112.000	114.000	126.000	100.00
FIXED	PPM	5	70.000	79.200	108.000	62.0000
SUSPENDED	PPM	6	103.000	99.667	124.000	64.0000
GENERAL IONS						
CALCIUM	PPM	6	20.200	19.817	23.100	17.4000
CHLORIDE	PPM	6	0.450	0.450	0.700	0.3000
METALS						
IRON - DISSOLVED	PPM	6	0.180	0.208	0.410	0.0400
NUTRIENTS						
N-KJELDHAL	PPM	6	0.365	0.377	0.490	0.2600
NITRATE+NITRITE	PPM	6	0.010	0.010	0.010	0.0100
PHOSPHORUS-TOTAL	PPM	5	0.019	0.020	0.025	0.0130
PHOSPHORUS-DISS	PPM	5	0.012	0.012	0.017	0.0060
CARBON						
TOT ORG CARBON	PPM	5	9.000	8.800	10.000	7.0000
TOT INORG CARBON	PPM	5	12.000	12.400	15.000	10.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500195 LAMBLY CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	12.000	10.917	18.000	1.5000
DISSOLVED O2	PPM	7	6.600	4.129	7.600	0.0
PH	PH UNITS	7	8.000	8.071	8.500	7.7000
COLOUR	HAZEN	7	15.000	17.143	30.000	15.0000
TURBIDITY	JACKSON	7	0.480	0.811	1.700	0.3700
CONDUCTIVITY	M-MHOS	6	32.000	32.167	36.000	30.0000
HARDNESS - TOTAL	PPM	7	13.400	19.071	52.800	12.8000
SOLIDS						
TOTAL	PPM	7	42.000	40.000	48.000	28.0000
FIXED	PPM	7	18.000	20.000	36.000	12.0000
SUSPENDED	PPM	7	32.000	31.143	36.000	26.0000
GENERAL IONS						
CALCIUM	PPM	7	4.840	6.439	16.900	4.3000
CHLORIDE	PPM	7	0.300	0.329	0.500	0.2000
METALS						
IRON - DISSOLVED	PPM	7	0.070	0.174	0.510	0.0200
NUTRIENTS						
N-KJELDHAL	PPM	7	0.340	0.390	0.580	0.2600
NITRATE+NITRITE	PPM	7	0.010	0.010	0.010	0.0100
PHOSPHORUS-TOTAL	PPM	6	0.010	0.009	0.016	0.0030
PHOSPHORUS-DISS	PPM	6	0.003	0.003	0.005	0.0030
CARBON						
TOT ORG CARBON	PPM	5	9.000	8.000	10.000	6.0000
TOT INORG CARBON	PPM	5	3.000	2.600	3.000	2.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500196 KELOWNA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	14.000	12.688	17.000	6.0000
DISSOLVED O2	PPM	5	7.600	7.720	8.400	7.2000
PH	PH UNITS	8	8.500	8.375	8.700	7.4000
COLOUR	HAZEN	8	17.500	18.750	40.000	10.0000
TURBIDITY	JACKSON	8	2.950	4.362	14.000	1.8000
CONDUCTIVITY	M-MHOS	8	580.000	553.750	620.000	400.00
HARDNESS - TOTAL	PPM	8	259.000	243.875	267.000	149.00
SOLIDS						
TOTAL	PPM	8	403.000	386.250	418.000	250.00
FIXED	PPM	8	270.000	257.250	302.000	154.00
SUSPENDED	PPM	8	383.000	360.500	398.000	184.00
GENERAL IONS						
CALCIUM	PPM	8	69.300	66.600	76.800	40.8000
CHLORIDE	PPM	8	6.450	6.312	7.900	3.6000
METALS						
IRON - DISSOLVED	PPM	8	0.095	0.182	0.560	0.0200
NUTRIENTS						
N-KJELDHAL	PPM	6	0.610	0.602	0.750	0.4300
NITRATE+NITRITE	PPM	8	1.350	1.312	1.700	0.7000
PHOSPHORUS-TOTAL	PPM	8	0.099	0.094	0.128	0.0680
PHOSPHORUS-DISS	PPM	8	0.056	0.059	0.096	0.0400
CARBON						
TOT ORG CARBON	PPM	6	6.500	8.167	14.000	3.0000
TOT INORG CARBON	PPM	6	40.000	37.667	45.000	29.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500197 KELOWNA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	13.000	12.500	18.000	6.5000
DISSOLVED 02	PPM	5	7.000	6.840	7.300	6.3000
PH	PH UNITS	7	8.400	8.366	8.600	8.1000
COLOUR	HAZEN	7	15.000	17.857	40.000	10.0000
TURBIDITY	JACKSON	7	2.300	2.743	4.000	2.1000
CONDUCTIVITY	M-MHOS	6	520.000	526.667	575.000	480.00
HARDNESS - TOTAL	PPM	7	215.000	217.714	253.000	148.00
SOLIDS						
TOTAL	PPM	7	342.000	334.000	384.000	234.00
FIXED	PPM	7	222.000	220.000	262.000	144.00
SUSPENDED	PPM	7	322.000	314.000	366.000	170.00
GENERAL IONS						
CALCIUM	PPM	7	66.700	61.314	70.500	40.0000
CHLORIDE	PPM	7	8.600	8.314	10.000	5.6000
METALS						
IRON - DISSOLVED	PPM	7	0.180	0.247	0.510	0.0600
NUTRIENTS						
N-KJELDHAL	PPM	6	0.550	0.605	0.920	0.4800
NITRATE+NITRITE	PPM	7	1.850	1.864	2.250	1.2500
PHOSPHORUS-TOTAL	PPM	7	0.059	0.064	0.083	0.0550
PHOSPHORUS-DISS	PPM	7	0.037	0.040	0.056	0.0300
CARBON						
TOT ORG CARBON	PPM	6	8.500	7.500	10.000	4.0000
TOT INORG CARBON	PPM	6	30.000	32.000	45.000	23.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500198 KELOWNA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	13.500	12.143	17.000	6.0000
DISSOLVED 02	PPM	5	6.800	6.920	7.600	6.1000
PH	PH UNITS	7	8.400	8.343	8.600	8.0000
COLOUR	HAZEN	7	15.000	19.286	40.000	15.0000
TURBIDITY	JACKSON	7	4.100	4.114	4.800	3.4000
CONDUCTIVITY	M-MHOS	7	501.000	490.286	526.000	380.00
HARDNESS - TOTAL	PPM	7	229.000	215.143	233.000	130.00
SOLIDS						
TOTAL	PPM	7	340.000	327.714	348.000	248.00
FIXED	PPM	7	232.000	221.714	238.000	162.00
SUSPENDED	PPM	7	332.000	312.000	336.000	196.00
GENERAL IONS						
CALCIUM	PPM	7	67.100	62.657	71.000	36.7000
CHLORIDE	PPM	7	3.200	3.029	3.700	1.9000
METALS						
IRON - DISSOLVED	PPM	7	0.120	0.181	0.480	0.0600
NUTRIENTS						
N-KJELDHAL	PPM	6	0.490	0.507	0.660	0.3700
NITRATE+NITRITE	PPM	7	0.300	0.324	0.440	0.2000
PHOSPHORUS-TOTAL	PPM	7	0.100	0.097	0.110	0.0750
PHOSPHORUS-DISS	PPM	7	0.075	0.071	0.100	0.0460
CARBON						
TOT ORG CARBON	PPM	7	9.000	9.143	13.000	6.0000
TOT INORG CARBON	PPM	7	30.000	32.429	44.000	25.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500199 KELOWNA CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	8	11.500	10.063	15.000	4.0000
DISSOLVED O2	PPM	5	7.300	7.280	7.700	6.9000
PH	PH UNITS	8	8.200	8.212	8.500	8.0000
COLOUR	HAZEN	8	10.000	16.250	50.000	5.0000
TURBIDITY	JACKSON	8	2.000	2.150	3.200	1.6000
CONDUCTIVITY	M-MHOS	8	357.000	344.625	401.000	200.00
HARDNESS - TOTAL	PPM	8	171.000	161.525	192.000	78.2000
SOLIDS						
TOTAL	PPM	6	241.000	241.667	262.000	226.00
FIXED	PPM	6	165.000	161.000	184.000	128.00
SUSPENDED	PPM	6	229.000	235.000	260.000	220.00
GENERAL IONS						
CALCIUM	PPM	8	53.200	49.262	57.100	23.7000
CHLORIDE	PPM	8	2.150	2.050	2.600	1.0000
METALS						
IRON - DISSOLVED	PPM	8	0.175	0.171	0.340	0.0600
NUTRIENTS						
N-KJELDHAL	PPM	8	0.395	0.375	0.540	0.1500
NITRATE+NITRITE	PPM	8	0.105	0.117	0.170	0.0700
PHOSPHORUS-TOTAL	PPM	8	0.057	0.067	0.101	0.0400
PHOSPHORUS-DISS	PPM	8	0.040	0.039	0.063	0.0130
CARBON						
TOT ORG CARBON	PPM	8	6.500	7.875	13.000	4.0000
TOT INORG CARBON	PPM	8	25.500	25.375	34.000	16.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500201 KELOWNA CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	6	11.500	12.000	16.000	9.0000
DISSOLVED O2	PPM	4	6.250	6.175	6.700	5.5000
PH	PH UNITS	7	7.600	7.500	8.100	6.8000
COLOUR	HAZEN	7	60.000	63.571	75.000	50.0000
TURBIDITY	JACKSON	7	1.000	1.270	2.900	0.1400
CONDUCTIVITY	M-MHOS	7	34.000	48.143	134.000	32.0000
HARDNESS - TOTAL	PPM	7	16.200	19.757	36.500	14.2000
SOLIDS						
TOTAL	PPM	7	58.000	58.286	64.000	56.0000
FIXED	PPM	6	22.000	28.000	48.000	20.0000
SUSPENDED	PPM	7	54.000	54.000	60.000	48.0000
GENERAL IONS						
CALCIUM	PPM	7	4.950	6.046	9.880	4.3800
CHLORIDE	PPM	5	0.500	0.620	1.100	0.4000
METALS						
IRON - DISSOLVED	PPM	4	0.335	0.347	0.570	0.1500
NUTRIENTS						
N-KJELDHAL	PPM	4	0.500	0.517	0.610	0.4600
NITRATE+NITRITE	PPM	7	0.010	0.014	0.030	0.0100
PHOSPHORUS-TOTAL	PPM	7	0.019	0.026	0.052	0.0140
PHOSPHORUS-DISS	PPM	7	0.007	0.009	0.024	0.0030
CARBON						
TOT ORG CARBON	PPM	5	14.000	14.200	16.000	12.0000
TOT INORG CARBON	PPM	5	2.000	2.200	3.000	2.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500202 KELOWNA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	10.000	9.857	15.000	4.5000
DISSOLVED 02	PPM	4	8.100	7.875	8.500	6.8000
PH	PH UNITS	8	8.050	8.012	8.400	7.1000
COLOUR	HAZEN	8	12.500	21.875	50.000	10.0000
TURBIDITY	JACKSON	8	1.500	1.592	2.600	0.8000
CONDUCTIVITY	M-MHOS	8	230.500	234.500	280.000	220.00
HARDNESS - TOTAL	PPM	8	102.000	101.400	112.000	88.3000
SOLIDS						
TOTAL	PPM	7	170.000	169.143	184.000	148.00
FIXED	PPM	7	104.000	111.714	148.000	86.0000
SUSPENDED	PPM	7	162.000	159.429	172.000	132.00
GENERAL ICNS						
CALCIUM	PPM	8	29.050	28.950	32.600	23.9000
CHLORIDE	PPM	8	2.250	2.112	2.700	1.1000
METALS						
IRON - DISSOLVED	PPM	8	0.230	0.282	0.780	0.1200
NUTRIENTS						
N-KJELDHAL	PPM	7	0.440	0.416	0.610	0.2100
NITRATE+NITRITE	PPM	8	0.435	0.382	0.620	0.0800
PHOSPHORUS-TOTAL	PPM	8	0.054	0.065	0.132	0.0340
PHOSPHORUS-DISS	PPM	8	0.029	0.035	0.056	0.0180
CARBON						
TOT ORG CARBON	PPM	8	7.500	9.625	19.000	5.0000
TOT INORG CARBON	PPM	8	17.000	17.125	21.000	14.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500203 KELOWNA CREEK TRIBUTARY

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	7	13.000	12.429	19.000	5.5000
DISSOLVED 02	PPM	4	8.500	8.450	9.000	7.8000
PH	PH UNITS	8	8.150	8.187	8.500	7.9000
COLOUR	HAZEN	8	50.000	50.000	80.000	30.0000
TURBIDITY	JACKSON	8	1.300	1.159	1.900	0.5700
CONDUCTIVITY	M-MHOS	8	117.500	124.375	160.000	100.00
HARDNESS - TOTAL	PPM	8	51.250	54.362	68.200	46.1000
SOLIDS						
TOTAL	PPM	7	104.000	105.429	116.000	96.0000
FIXED	PPM	7	54.000	58.000	78.000	50.0000
SUSPENDED	PPM	7	94.000	99.429	114.000	94.0000
GENERAL ICNS						
CALCIUM	PPM	8	16.300	16.662	19.100	15.2000
CHLORIDE	PPM	8	0.450	0.487	0.700	0.4000
METALS						
IRON - DISSOLVED	PPM	8	0.245	0.307	0.620	0.1200
NUTRIENTS						
N-KJELDHAL	PPM	8	0.380	0.420	0.590	0.2900
NITRATE+NITRITE	PPM	8	0.010	0.015	0.030	0.0100
PHOSPHORUS-TOTAL	PPM	8	0.024	0.024	0.036	0.0140
PHOSPHORUS-DISS	PPM	8	0.012	0.012	0.017	0.0060
CARBON						
TOT ORG CARBON	PPM	8	12.500	12.625	18.000	8.0000
TOT INORG CARBON	PPM	8	8.500	9.250	14.000	7.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500205 COSENS CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	2	7.250	7.250	11.500	3.0000
DISSOLVED 02	PPM	2	10.450	10.450	11.200	9.7000
PH	PH UNITS	1	8.500	8.500	8.500	8.5000
COLOUR	HAZEN	2	52.500	52.500	60.000	45.0000
TURBIDITY	JACKSON	2	1.150	1.150	1.200	1.1000
CONDUCTIVITY	M-MHOS	2	130.000	130.000	160.000	100.00
HARDNESS - TOTAL	PPM	2	51.450	51.450	61.000	41.9000
TANNIN & LIGNIN	PPM	1	1.000	1.000	1.000	1.0000
SOLIDS						
TOTAL	PPM	2	121.000	121.000	138.000	104.00
FIXED	PPM	2	78.000	78.000	92.000	64.0000
SUSPENDED	PPM	2	3.000	3.000	4.500	1.5000
GENERAL IONS						
CALCIUM	PPM	2	12.650	12.650	14.800	10.5000
MAGNESIUM	PPM	2	4.400	4.400	5.000	3.8000
SODIUM	PPM	2	4.450	4.450	4.900	4.0000
POTASSIUM	PPM	2	2.300	2.300	2.700	1.9000
SULPHATE	PPM	2	13.750	13.750	17.000	10.5000
CHLORIDE	PPM	2	0.750	0.750	0.800	0.7000
FLUORIDE	PPM	1	0.120	0.120	0.120	0.1200
METALS						
IRON - DISSOLVED	PPM	2	0.110	0.110	0.120	0.1000
MANGANESE - DISS	PPM	1	0.010	0.010	L 0.010	L 0.0100
COPPER	PPM	1	0.002	0.002	0.002	0.0020
ZINC	PPM	1	0.009	0.009	0.009	0.0090
LEAD	PPM	1	0.003	0.003	0.003	0.0030
MERCURY - UNFILT	PPM	1	0.050	0.050	L 0.050	L 0.0500
CHROMIUM	PPM	1	0.005	0.005	L 0.005	L 0.0050
CADMIUM	PPM	1	0.000	0.000	0.000	0.0002
NUTRIENTS						
AMMONIA AS NH3	PPM	1	0.010	0.010	L 0.010	L 0.0100
N-KJELDHAL	PPM	1	0.470	0.470	0.470	0.4700
NITRATE	PPM	1	0.020	0.020	L 0.020	L 0.0200
NITRITE	PPM	1	0.005	0.005	L 0.005	L 0.0050
NITRATE+NITRITE	PPM	1	0.020	0.020	0.020	0.0200
TOTAL N	PPM	2	0.395	0.395	0.490	0.3000
PHOSPHORUS-TOTAL	PPM	2	0.022	0.022	0.033	0.0120
PHOSPHORUS-DISS	PPM	1	0.005	0.005	0.005	0.0050
SILICATE	PPM	2	20.250	20.250	25.000	15.5000
ORGANIC N	PPM	1	0.300	0.300	0.300	0.3000
CARBON						
ALK - TOTAL	PPM	2	47.050	47.050	53.000	41.1000
TOT ORG CARBON	PPM	1	17.000	17.000	17.000	17.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

O K A N A G A N B A S I N S T U D Y
STREAM DATA FROM 1 APRIL 1972

0500215 GARBAGE CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
TEMPERATURE	DEG CENT	2	6.000	6.000	9.000	3.0000
DISSOLVED 02	PPM	2	8.300	8.300	9.400	7.2000
PH	PH UNITS	1	8.000	8.000	8.000	8.0000
COLOUR	HAZEN	2	17.500	17.500	20.000	15.0000
TURBIDITY	JACKSON	2	8.050	8.050	10.000	6.1000
CONDUCTIVITY	M-MHOS	2	350.000	350.000	360.000	340.00
HARDNESS - TOTAL	PPM	2	143.000	143.000	153.000	133.00
SOLIDS						
TOTAL	PPM	2	247.000	247.000	270.000	224.00
FIXED	PPM	2	168.000	168.000	174.000	162.00
SUSPENDED	PPM	2	11.850	11.850	12.400	11.3000
GENERAL IONS						
CALCIUM	PPM	2	33.250	33.250	36.500	30.0000
MAGNESIUM	PPM	2	14.500	14.500	15.000	14.0000
SODIUM	PPM	2	21.500	21.500	22.000	21.0000
POTASSIUM	PPM	2	3.550	3.550	4.000	3.1000
SULPHATE	PPM	2	6.650	6.650	6.800	6.5000
CHLORIDE	PPM	2	3.250	3.250	4.200	2.3000
METALS						
IRON - DISSOLVED	PPM	1	0.130	0.130	0.130	0.1300
NUTRIENTS						
N-KJELDHAL	PPM	2	0.985	0.985	1.200	0.7700
NITRATE+NITRITE	PPM	2	0.050	0.050	0.060	0.0400
TOTAL N	PPM	2	1.035	1.035	1.260	0.8100
PHOSPHORUS-TOTAL	PPM	2	0.200	0.200	0.247	0.1530
SILICATE	PPM	2	28.000	28.000	28.500	27.5000
CARBON						
ALK - TOTAL	PPM	2	187.500	187.500	202.000	173.00
TOT ORG CARBON	PPM	2	9.500	9.500	13.000	6.0000

NOTE: THE STATISTICS ARE CALCULATED OVER ALL AVAILABLE RESULTS REGARDLESS OF SAMPLE PREPARATION OR TEST METHOD

APPENDIX I

SUMMARY OF WATER QUALITY OF MAIN VALLEY AND HEADWATER LAKES

1969-1971

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 1 OSOYOOS LAKE - MIDDLE THREAD OF LOWER LAKE AT BORDER

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	17	10.000	9.706	10.000	5.000
TEMPERATURE	DEG CENT	13	17.000	13.423	24.000	1.000
DISSOLVED O2	PPM	1	9.000	9.000	9.000	9.000
PH	PH UNITS	14	8.150	8.286	8.900	8.000
COLOUR	HAZEN	10	5.000	3.400	7.000	0.0
TURBIDITY	JACKSON	10	1.000	1.190	2.500	0.700
CONDUCTIVITY	M-MHOS	14	273.500	255.500	326.000	130.000
HARDNESS - TOTAL	PPM	10	127.000	124.600	149.000	104.000
SOLIDS						
DISSOLVED	PPM	2	201.500	201.500	212.000	191.000
GENERAL IONS						
CALCIUM	PPM	11	35.000	31.591	39.200	1.000
MAGNESIUM	PPM	10	8.750	9.240	12.400	8.000
SODIUM	PPM	9	10.900	10.644	12.500	8.900
POTASSIUM	PPM	10	2.400	2.360	2.800	2.000
SULPHATE	PPM	10	31.350	30.350	41.900	24.700
CHLORIDE	PPM	10	1.550	1.600	2.000	1.300
FLUORIDE	PPM	3	0.190	0.193	0.210	0.180
METALS						
IRON - DISSOLVED	PPM	3	0.010	0.010	L 0.010	L 0.010
MANGANESE - DISS	PPM	10	0.002	0.005	L 0.010	0.001
HEAVY METALS						
COPPER	PPM	10	0.009	0.013	0.031	L 0.001
ZINC	PPM	10	0.003	0.006	0.028	0.0
LEAD	PPM	10	0.001	0.004	L 0.010	0.0
NUTRIENTS						
PHOS - ORTHO	PPM	1	0.010	0.010	L 0.010	L 0.010
SILICATE	PPM	10	3.300	3.250	5.300	1.300
CARBON						
ALK - TOTAL	PPM	10	116.500	112.900	128.000	94.000
TOT ORG CARBON	PPM	8	5.000	5.000	7.000	2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 2 OSOYOOS LAKE - MIDDLE THREAD, ONE MILE NORTH OF MICA CREEK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	9	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	6	17.750	15.667	21.000	8.000
DISSOLVED O2	PPM	2	8.250	8.250	8.500	8.000
PH	PH UNITS	7	8.100	8.200	8.800	7.800
TURBIDITY	JACKSON	1	1.400	1.400	1.400	1.400
CONDUCTIVITY	M-MHOS	7	201.000	214.286	285.000	120.000
HARDNESS - TOTAL	PPM	3	125.000	125.667	128.000	124.000
SOLIDS						
DISSOLVED	PPM	4	87.000	89.000	180.000	2.000
GENERAL IONS						
CALCIUM	PPM	3	34.200	34.567	35.400	34.100
MAGNESIUM	PPM	3	9.700	9.900	10.500	9.500
SODIUM	PPM	3	0.008	3.172	9.500	0.007
POTASSIUM	PPM	3	2.400	2.433	2.700	2.200
SULPHATE	PPM	2	29.600	29.600	30.400	28.800
CHLORIDE	PPM	2	1.250	1.250	1.500	1.000
FLUORIDE	PPM	1	0.240	0.240	0.240	0.240
METALS						
IRON - TOTAL	PPM	1	0.060	0.060	0.060	0.060
MANGANESE - DISS	PPM	7	0.005	0.016	0.050	L 0.001
HEAVY METALS						
COPPER	PPM	8	0.012	0.013	0.030	0.001
ZINC	PPM	9	0.015	0.029	0.100	0.004
LEAD	PPM	7	0.010	0.015	0.032	L 0.010
NUTRIENTS						
AMMONIA AS NH3	PPM	3	0.020	0.037	0.080	0.010
NITRATE	PPM	3	0.040	0.027	0.040	L 0.002
NITRITE	PPM	1	0.007	0.007	0.007	0.007
TOTAL N	PPM	2	0.150	0.150	0.180	0.120
PHOS - ORTHO	PPM	3	0.010	0.083	0.230	L 0.010
PHOS - TOTAL	PPM	3	0.050	0.207	0.530	0.040
SILICATE	PPM	3	1.060	2.687	6.500	0.500
CARBON						
ALK - TOTAL	PPM	3	112.000	113.000	116.000	111.000
TOT ORG CARBON	PPM	6	3.000	4.170	11.000	L 0.010

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 3 SKAHA LAKE - MIDDLE THREAD, ONE MILE NORTH OF OKANAGAN FALLS

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	6	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	2	19.000	19.000	21.000	17.000
PH	PH UNITS	4	8.700	8.625	8.900	8.200
CONDUCTIVITY	M-MHOS	4	161.500	158.750	187.000	125.000
METALS						
MANGANESE - DISS	PPM	6	0.001	0.002	0.008	0.001
HEAVY METALS						
COPPER	PPM	6	0.020	0.019	0.024	0.012
ZINC	PPM	6	0.007	0.012	0.026	0.004
LEAD	PPM	6	0.010	0.010	L 0.010	L 0.010
CARBON						
TOT ORG CARBON	PPM	5	4.000	4.200	7.000	L 2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 4 SKAHA LAKE - MIDDLE THREAD OF LAKE OPPOSITE KALEDEN

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	12	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	9	20.000	16.444	22.500	7.000
DISSOLVED O2	PPM	2	8.850	8.850	9.200	8.500
PH	PH UNITS	9	8.000	8.144	8.800	7.600
COLOUR	HAZEN	1	5.000	5.000	5.000	5.000
TURBIDITY	JACKSON	1	0.900	0.900	0.900	0.900
CONDUCTIVITY	M-MHOS	10	264.000	225.700	300.000	120.000
HARDNESS - TOTAL	PPM	5	118.000	118.000	120.000	116.000
SOLIDS						
DISSOLVED	PPM	2	165.000	165.000	171.000	159.000
GENERAL IONS						
CALCIUM	PPM	5	32.600	32.560	33.000	31.900
MAGNESIUM	PPM	6	8.800	8.900	9.300	8.600
SODIUM	PPM	2	5.280	5.280	10.500	0.060
POTASSIUM	PPM	6	2.350	2.250	2.600	1.700
SULPHATE	PPM	3	29.600	33.267	41.000	29.200
CHLORIDE	PPM	3	1.500	1.400	1.700	1.000
FLUORIDE	PPM	1	0.119	0.119	0.119	0.119
METALS						
IRON - TOTAL	PPM	2	0.020	0.020	0.020	L 0.020
IRON - DISSOLVED	PPM	2	0.080	0.080	0.100	0.060
MANGANESE - DISS	PPM	13	0.008	0.006	0.020	L 0.001
HEAVY METALS						
COPPER	PPM	12	0.018	0.018	0.040	0.0
ZINC	PPM	13	0.020	0.081	0.800	0.002
LEAD	PPM	12	0.010	0.033	0.170	0.005
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.040	0.050	0.130	0.010
NITRATE	PPM	5	0.020	0.032	0.060	0.020
NITRITE	PPM	1	0.006	0.006	0.006	0.006
TOTAL N	PPM	4	0.245	0.250	0.430	0.080
PHOS - ORTHO	PPM	5	0.030	0.026	0.050	L 0.010
PHOS - TOTAL	PPM	4	0.060	0.052	0.060	0.030
SILICATE	PPM	4	1.500	1.925	4.200	L 0.500
CARBON						
ALK - TOTAL	PPM	6	105.500	105.167	109.000	101.000
TOT ORG CARBON	PPM	6	5.000	5.833	13.000	3.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 5 OKANAGAN LAKE - MIDDLE THREAD OF LAKE OPPOSITE SUMMERLAND

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	12	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	8	15.500	14.187	21.000	5.500
DISSOLVED O2	PPM	2	8.600	8.600	9.100	8.100
PH	PH UNITS	10	7.900	8.060	8.700	7.400
COLOUR	HAZEN	1	10.000	10.000	10.000	10.000
TURBIDITY	JACKSON	1	0.400	0.400	0.400	0.400
CONDUCTIVITY	M-MHOS	8	227.000	210.875	290.000	110.000
HARDNESS - TOTAL	PPM	4	118.500	118.500	119.000	118.000
SOLIDS						
DISSOLVED	PPM	2	151.500	151.500	158.000	145.000
GENERAL IONS						
CALCIUM	PPM	4	32.600	32.800	33.700	32.300
MAGNESIUM	PPM	4	8.900	8.875	9.100	8.600
SODIUM	PPM	1	9.500	9.500	9.500	9.500
POTASSIUM	PPM	4	2.200	2.225	2.600	1.900
SULPHATE	PPM	1	38.000	38.000	38.000	38.000
CHLORIDE	PPM	1	1.000	1.000	1.000	1.000
FLUORIDE	PPM	1	0.200	0.200	0.200	0.200
METALS						
IRON - TOTAL	PPM	3	0.020	0.020	0.040	0.0
IRON - DISSOLVED	PPM	3	0.0	0.013	0.040	0.0
MANGANESE - DISS	PPM	10	0.001	0.004	L 0.010	0.0
HEAVY METALS						
COPPER	PPM	10	0.007	0.011	0.026	0.0
ZINC	PPM	10	0.012	0.032	0.140	0.001
LEAD	PPM	10	0.010	0.017	0.031	L 0.010
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.010	0.015	0.040	0.0
NITRATE	PPM	4	0.025	0.030	0.050	L 0.020
NITRITE	PPM	1	0.005	0.005	L 0.005	L 0.005
TOTAL N	PPM	3	0.010	0.060	0.160	0.010
PHOS - ORTHO	PPM	4	0.010	0.015	0.030	L 0.010
PHOS - TOTAL	PPM	4	0.030	0.030	0.040	0.020
SILICATE	PPM	4	4.600	4.175	5.000	2.500
CARBON						
ALK - TOTAL	PPM	4	106.000	105.750	107.000	104.000
TOT ORG CARBON	PPM	5	3.000	3.600	7.000	L 2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 6 OKANAGAN LAKE - MIDDLE THREAD OF LAKE OPPOSITE WESTBANK

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	10	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	9	15.000	14.444	21.000	6.500
DISSOLVED O2	PPM	2	9.550	9.550	9.800	9.300
PH	PH UNITS	9	8.000	8.144	8.800	7.800
COLOUR	HAZEN	1	5.000	5.000	5.000	5.000
TURBIDITY	JACKSON	1	0.700	0.700	0.700	0.700
CONDUCTIVITY	M-MHOS	9	265.000	217.778	280.000	110.000
HARDNESS - TOTAL	PPM	5	118.000	118.000	119.000	117.000
SOLIDS						
TOTAL	PPM	2	162.000	162.000	164.000	160.000
FIXED	PPM	2	104.500	104.500	105.000	104.000
DISSOLVED	PPM	2	159.000	159.000	160.000	158.000
GENERAL IONS						
CALCIUM	PPM	4	33.100	33.050	33.700	32.300
MAGNESIUM	PPM	5	8.600	8.580	8.800	8.200
SODIUM	PPM	1	8.800	8.800	8.800	8.800
POTASSIUM	PPM	5	2.300	2.440	3.300	2.000
SULPHATE	PPM	3	30.400	31.733	35.600	29.200
CHLORIDE	PPM	1	1.200	1.200	1.200	1.200
FLUORIDE	PPM	1	0.220	0.220	0.220	0.220
METALS						
IRON - TOTAL	PPM	3	0.040	0.027	0.040	0.0
IRON - DISSOLVED	PPM	5	0.020	0.016	0.040	0.0
MANGANESE - DISS	PPM	9	0.004	0.005	L 0.010	0.0
HEAVY METALS						
COPPER	PPM	9	0.020	0.022	0.048	0.0
ZINC	PPM	9	0.030	0.027	0.060	0.004
LEAD	PPM	9	0.013	0.023	0.060	L 0.010
NUTRIENTS						
AMMONIA AS NH3	PPM	5	0.0	0.012	0.050	0.0
NITRATE	PPM	5	0.020	0.036	0.100	0.010
NITRITE	PPM	1	0.005	0.005	L 0.005	L 0.005
TOTAL N	PPM	4	0.190	0.205	0.360	0.080
PHOS - ORTHO	PPM	4	0.010	0.032	0.110	0.0
PHOS - TOTAL	PPM	3	0.050	0.083	0.170	0.030
SILICATE	PPM	4	5.250	5.000	5.500	4.000
CARBON						
ALK - PHENOL	PPM	2	1.250	1.250	2.500	0.0
ALK - TOTAL	PPM	5	105.000	105.400	107.000	104.000
TOT ORG CARBON	PPM	4	5.000	4.500	6.000	2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 7 OKANAGAN LAKE - MIDDLE THREAD OF LAKE AT KELOWNA BRIDGE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	6	10.000	8.833	10.000	3.000
TEMPERATURE	DEG CENT	4	19.750	17.775	20.600	11.000
DISSOLVED O2	PPM	2	8.500	8.500	8.500	8.500
PH	PH UNITS	3	8.400	8.533	8.900	8.300
COLOUR	HAZEN	1	0.0	0.0	0.0	0.0
TURBIDITY	JACKSON	1	0.600	0.600	0.600	0.600
CONDUCTIVITY	M-MHOS	4	189.000	195.750	275.000	130.000
HARDNESS - TOTAL	PPM	1	117.000	117.000	117.000	117.000
GENERAL IONS						
CALCIUM	PPM	1	33.300	33.300	33.300	33.300
SODIUM	PPM	1	8.600	8.600	8.600	8.600
POTASSIUM	PPM	1	2.000	2.000	2.000	2.000
SULPHATE	PPM	1	26.500	26.500	26.500	26.500
CHLORIDE	PPM	1	1.100	1.100	1.100	1.100
FLUORIDE	PPM	1	0.160	0.160	0.160	0.160
METALS						
MANGANESE - DISS	PPM	5	0.001	0.004	0.014	L 0.001
HEAVY METALS						
COPPER	PPM	5	0.017	0.014	0.024	0.002
ZINC	PPM	5	0.005	0.005	0.011	0.002
LEAD	PPM	5	0.010	0.010	L 0.010	L 0.010
NUTRIENTS						
NITRATE	PPM	1	0.010	0.010	L 0.010	L 0.010
PHOS - ORTHO	PPM	1	0.010	0.010	L 0.010	L 0.010
PHOS - TOTAL	PPM	1	0.020	0.020	0.020	0.020
SILICATE	PPM	1	4.000	4.000	4.000	4.000
CARBON						
ALK - PHENOL	PPM	1	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	1	106.000	106.000	106.000	106.000
TOT ORG CARBON	PPM	5	3.000	4.600	8.000	2.000
TOT INORG CARBON	PPM	1	24.000	24.000	24.000	24.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 8 OKANAGAN LAKE - MIDDLE OF LAKE OPPOSITE OKANAGAN CENTRE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	5	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	5	10.500	14.100	22.500	7.000
PH	PH UNITS	5	7.900	7.860	8.000	7.700
COLOUR	HAZEN	1	5.000	5.000	5.000	5.000
TURBIDITY	JACKSON	1	0.400	0.400	0.400	0.400
CONDUCTIVITY	M-MHOS	5	268.000	269.800	280.000	265.000
HARDNESS - TOTAL	PPM	4	120.000	119.500	120.000	118.000
SOLIDS						
TOTAL	PPM	2	167.000	167.000	171.000	163.000
FIXED	PPM	2	105.000	105.000	107.000	103.000
DISSOLVED	PPM	2	155.500	155.500	159.000	152.000
GENERAL IONS						
CALCIUM	PPM	3	33.100	32.933	33.100	32.600
MAGNESIUM	PPM	5	8.900	8.900	9.300	8.600
SODIUM	PPM	1	9.100	9.100	9.100	9.100
POTASSIUM	PPM	5	2.500	2.400	2.600	2.100
SULPHATE	PPM	3	30.800	30.000	32.400	26.800
FLUORIDE	PPM	1	0.220	0.220	0.220	0.220
METALS						
IRON - TOTAL	PPM	4	0.010	0.020	0.060	0.0
IRON - DISSOLVED	PPM	4	0.020	0.020	0.040	0.0
MANGANESE - DISS	PPM	4	0.005	0.005	L 0.010	0.0
HEAVY METALS						
COPPER	PPM	5	0.020	0.018	0.050	0.0
ZINC	PPM	5	0.100	0.086	0.120	0.040
LEAD	PPM	5	0.022	0.043	0.125	L 0.020
NUTRIENTS						
AMMONIA AS NH3	PPM	5	0.010	0.042	0.160	0.0
NITRATE	PPM	5	0.020	0.056	0.190	L 0.020
NITRITE	PPM	1	0.005	0.005	L 0.005	L 0.005
TOTAL N	PPM	4	0.295	0.297	0.470	0.130
PHOS - ORTHO	PPM	4	0.010	0.007	L 0.010	0.0
PHOS - TOTAL	PPM	4	0.035	0.037	L 0.050	0.030
SILICATE	PPM	4	5.000	5.150	5.800	4.800
CARBON						
ALK - PHENOL	PPM	2	1.250	1.250	2.500	0.0
ALK - TOTAL	PPM	5	106.000	105.600	107.000	104.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L 9 OKANAGAN LAKE - MID THREAD, 3 MILES SOUTH OF OKANAGAN LANDING

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	6	10.000	8.333	10.000	0.0
TEMPERATURE	DEG CENT	6	12.500	14.000	21.500	6.000
PH	PH UNITS	6	7.800	7.833	8.100	7.700
COLOUR	HAZEN	1	5.000	5.000	5.000	5.000
TURBIDITY	JACKSON	1	0.600	0.600	0.600	0.600
CONDUCTIVITY	M-MHOS	6	269.000	270.167	280.000	265.000
HARDNESS - TOTAL	PPM	5	119.000	118.600	120.000	117.000
SOLIDS						
TOTAL	PPM	3	167.000	166.333	169.000	163.000
FIXED	PPM	3	107.000	112.333	124.000	106.000
DISSOLVED	PPM	4	159.500	161.250	168.000	158.000
GENERAL IONS						
CALCIUM	PPM	5	33.000	32.980	33.500	32.600
MAGNESIUM	PPM	6	8.800	8.833	9.400	8.300
SODIUM	PPM	1	9.000	9.000	9.000	9.000
POTASSIUM	PPM	6	2.400	2.417	2.700	2.200
SULPHATE	PPM	4	27.800	28.700	34.000	25.200
CHLORIDE	PPM	1	0.800	0.800	0.800	0.800
FLUORIDE	PPM	1	0.210	0.210	0.210	0.210
METALS						
IRON - TOTAL	PPM	3	0.0	0.0	0.0	0.0
IRON - DISSOLVED	PPM	6	0.0	0.047	0.260	0.0
MANGANESE - DISS	PPM	6	0.005	0.005 L	0.010	0.0
HEAVY METALS						
COPPER	PPM	5	0.020	0.024	0.060	0.0
ZINC	PPM	5	0.080	0.120	0.330	0.030
LEAD	PPM	4	0.154	0.269	0.740	0.030
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.010	0.008	0.020	0.0
NITRATE	PPM	6	0.025	0.030	0.060 L	0.020
NITRITE	PPM	1	0.005	0.005 L	0.005 L	0.005
TOTAL N	PPM	5	0.100	0.186	0.340	0.070
PHOS - ORTHO	PPM	6	0.010	0.032 L	0.100 L	0.010
PHOS - TOTAL	PPM	6	0.030	0.033	0.050	0.020
SILICATE	PPM	6	5.050	5.167	5.800	4.700
CARBON						
ALK - PHENOL	PPM	3	0.0	1.000	3.000	0.0
ALK - TOTAL	PPM	6	107.000	106.833	109.000	105.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L10 OKANAGAN LAKE - MID THREAD, EAST ARM OPP OKANAGAN LANDING

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	7	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	5	19.000	17.600	20.000	11.000
DISSOLVED 02	PPM	3	9.900	10.267	11.000	9.900
PH	PH UNITS	4	8.800	8.725	8.800	8.500
CONDUCTIVITY	M-MHOS	5	140.000	160.200	200.000	140.000
METALS						
MANGANESE - DISS	PPM	7	0.001	0.003	0.007 L	0.001
HEAVY METALS						
COPPER	PPM	7	0.019	0.019	0.040 L	0.001
ZINC	PPM	7	0.006	0.006	0.013	0.001
LEAD	PPM	7	0.010	0.010 L	0.010 L	0.010
CARBON						
TOT ORG CARBON	PPM	5	5.000	5.000	7.000 L	2.000

OKANAGAN BASIN STUDY

TASK 102 - LAKE WATER QUALITY

L11 WOODS LAKE - MIDDLE THREAD OF LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	12	10.000	9.583	10.000	5.000
TEMPERATURE	DEG CENT	8	16.500	15.875	23.000	8.000
PH	PH UNITS	8	8.100	8.287	9.100	7.900
COLOUR	HAZEN	1	5.000	5.000	L 5.000	L 5.000
TURBIDITY	JACKSON	1	2.100	2.100	2.100	2.100
CONDUCTIVITY	M-MHOS	9	337.000	320.778	380.000	231.000
HARDNESS - TOTAL	PPM	7	142.000	142.000	149.000	134.000
SOLIDS						
TOTAL	PPM	3	199.000	203.000	213.000	197.000
FIXED	PPM	3	120.000	122.000	132.000	114.000
DISSOLVED	PPM	4	216.000	215.500	223.000	207.000
SUSPENDED	PPM	2	6.800	6.800	10.600	3.000
GENERAL IONS						
CALCIUM	PPM	4	26.850	26.500	28.900	23.400
MAGNESIUM	PPM	7	18.800	18.671	19.200	17.500
SODIUM	PPM	2	18.250	18.250	18.500	18.000
POTASSIUM	PPM	7	4.400	4.314	4.800	3.600
SULPHATE	PPM	4	28.900	29.450	32.000	28.000
CHLORIDE	PPM	2	2.650	2.650	2.800	2.500
FLUORIDE	PPM	2	0.340	0.340	0.350	0.330
METALS						
IRON - TOTAL	PPM	3	0.020	0.013	0.020	0.0
IRON - DISSOLVED	PPM	6	0.0	0.007	0.020	0.0
MANGANESE - DISS	PPM	12	0.006	0.008	0.020	0.0
HEAVY METALS						
COPPER	PPM	12	0.008	0.016	0.080	0.0
ZINC	PPM	12	0.015	0.029	0.080	0.0
LEAD	PPM	11	0.010	0.019	0.080	L 0.003
OXYGEN						
BOD	PPM	1	10.000	10.000	L 10.000	L 10.000
NUTRIENTS						
AMMONIA AS NH3	PPM	7	0.0	0.011	0.060	0.0
NITRATE	PPM	7	0.020	0.024	0.030	L 0.020
NITRITE	PPM	2	0.007	0.007	0.009	L 0.005
TOTAL N	PPM	6	0.180	0.387	0.910	0.100
PHOS - ORTHO	PPM	7	0.080	0.063	0.140	L 0.003
PHOS - TOTAL	PPM	7	0.130	0.134	0.230	0.050
SILICATE	PPM	7	3.500	3.800	5.600	2.300
COLIFORM						
TOTAL	MPN100ML	1	2.000	2.000	L 2.000	L 2.000
FAECAL	MPN100ML	1	2.000	2.000	L 2.000	L 2.000
CARBON						
ALK - PHENOL	PPM	7	6.000	7.214	18.500	0.0
ALK - TOTAL	PPM	7	142.000	146.857	156.000	138.000
TOT ORG CARBON	PPM	4	11.500	11.750	17.000	7.000

OKANAGAN BASIN STUDY

TASK 102 - LAKE WATER QUALITY

L12 KALAMALKA LAKE - MID THREAD, OPPOSITE RATTLESNAKE POINT

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	13	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	10	17.250	15.580	22.000	5.000
DISSOLVED O2	PPM	2	8.900	8.900	9.200	8.600
PH	PH UNITS	9	7.900	8.156	8.700	7.800
COLOUR	HAZEN	1	10.000	10.000	10.000	10.000
TURBIDITY	JACKSON	1	1.000	1.000	1.000	1.000
CONDUCTIVITY	M-MHOS	11	385.000	322.000	430.000	165.000
HARDNESS - TOTAL	PPM	6	168.500	168.333	171.000	166.000
SOLIDS						
DISSOLVED	PPM	3	217.000	227.333	250.000	215.000
GENERAL IONS						
CALCIUM	PPM	4	37.100	37.025	37.800	36.100
MAGNESIUM	PPM	6	18.350	18.367	18.700	18.000
SODIUM	PPM	1	16.500	16.500	16.500	16.500
POTASSIUM	PPM	6	4.700	4.733	4.900	4.500
SULPHATE	PPM	4	56.800	56.400	58.000	54.000
CHLORIDE	PPM	1	1.500	1.500	1.500	1.500
FLUORIDE	PPM	1	0.330	0.330	0.330	0.330
METALS						
IRON - TOTAL	PPM	3	0.0	0.007	L 0.020	0.0
IRON - DISSOLVED	PPM	6	0.010	0.047	0.240	0.0
MANGANESE - TOT	PPM	1	0.0	0.0	0.0	0.0
MANGANESE - DISS	PPM	12	0.001	0.003	L 0.010	0.0
HEAVY METALS						
COPPER	PPM	12	0.007	0.015	0.060	0.0
ZINC	PPM	12	0.017	0.027	0.100	0.001
LEAD	PPM	12	0.011	0.047	0.330	L 0.010
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.0	0.008	0.040	0.0
NITRATE	PPM	6	0.020	0.048	0.180	L 0.020
NITRITE	PPM	1	0.005	0.005	L 0.005	L 0.005
TOTAL N	PPM	5	0.130	0.204	0.470	0.040
PHOS - ORTHO	PPM	6	0.010	0.008	L 0.010	0.0
PHOS - TOTAL	PPM	6	0.015	0.022	0.060	L 0.010
SILICATE	PPM	6	10.600	10.867	12.500	10.000
CARBON						
ALK - PHENOL	PPM	6	0.0	0.500	1.500	0.0
ALK - TOTAL	PPM	6	143.500	143.500	148.000	139.000
TOT ORG CARBON	PPM	5	5.000	5.200	10.000	2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L13 KALAMALKA LAKE - MIDDLE THREAD OF LAKE OPPOSITE COLDSTREAM

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	6	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	6	13.500	14.417	23.000	5.000
PH	PH UNITS	6	7.800	7.867	8.100	7.800
COLOUR	HAZEN	1	5.000	5.000	5.000	5.000
TURBIDITY	JACKSON	1	1.000	1.000	1.000	1.000
CONDUCTIVITY	M-MHOS	6	390.000	386.500	392.000	372.000
HARDNESS - TOTAL	PPM	6	169.000	168.500	171.000	165.000
SOLIDS						
DISSOLVED	PPM	3	236.000	234.667	246.000	222.000
GENERAL IONS						
CALCIUM	PPM	5	37.600	37.420	37.800	36.300
MAGNESIUM	PPM	6	18.300	18.217	18.500	17.700
SODIUM	PPM	1	15.000	15.000	15.000	15.000
POTASSIUM	PPM	6	4.800	4.767	5.000	4.500
SULPHATE	PPM	4	53.750	53.375	55.600	50.400
CHLORIDE	PPM	1	5.900	5.900	5.900	5.900
FLUORIDE	PPM	1	0.330	0.330	0.330	0.330
METALS						
IRON - TOTAL	PPM	3	0.020	0.060	0.160	0.0
IRON - DISSOLVED	PPM	5	0.020	0.052	0.140	0.0
MANGANESE - DISS	PPM	6	0.010	0.007	0.010	0.0
HEAVY METALS						
COPPER	PPM	6	0.025	0.023	0.050	0.0
ZINC	PPM	6	0.045	0.047	0.070	L 0.020
LEAD	PPM	6	0.042	0.049	0.090	0.025
NUTRIENTS						
AMMONIA AS NH3	PPM	6	0.005	0.012	0.050	0.0
NITRATE	PPM	6	0.020	0.028	0.050	L 0.020
NITRITE	PPM	1	0.006	0.006	0.006	0.006
TOTAL N	PPM	5	0.200	0.188	0.320	0.080
PHOS - ORTHO	PPM	6	0.010	0.017	L 0.050	L 0.010
PHOS - TOTAL	PPM	6	0.020	0.027	L 0.050	0.020
SILICATE	PPM	6	11.100	11.233	13.000	10.200
CARBON						
ALK - PHENOL	PPM	6	0.0	0.333	2.000	0.0
ALK - TOTAL	PPM	6	143.500	142.833	148.000	137.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L14 AUGUR LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	1.750	7.000	0.0
TEMPERATURE	DEG CENT	4	23.500	23.650	25.200	22.400
PH	PH UNITS	4	8.200	8.200	8.300	8.100
TURBIDITY	JACKSON	1	1.200	1.200	1.200	1.200
CONDUCTIVITY	M-MHOS	4	463.000	455.000	485.000	409.000
HARDNESS - TOTAL	PPM	1	131.000	131.000	131.000	131.000
SOLIDS						
DISSOLVED	PPM	2	247.000	247.000	262.000	232.000
SUSPENDED	PPM	1	225.000	225.000	225.000	225.000
GENERAL IONS						
CALCIUM	PPM	1	21.600	21.600	21.600	21.600
MAGNESIUM	PPM	1	18.700	18.700	18.700	18.700
SODIUM	PPM	1	29.200	29.200	29.200	29.200
POTASSIUM	PPM	1	10.400	10.400	10.400	10.400
SULPHATE	PPM	1	2.800	2.800	2.800	2.800
CHLORIDE	PPM	1	2.600	2.600	2.600	2.600
METALS						
MANGANESE - DISS	PPM	1	0.008	0.008	L 0.008	L 0.008
NUTRIENTS						
N-KJELDHAL	PPM	4	1.515	1.412	1.670	0.950
NITRATE	PPM	4	0.030	0.092	0.300	L 0.010
PHOS - ORTHO	PPM	4	0.010	0.010	L 0.010	L 0.010
PHOS - TOTAL	PPM	4	0.035	0.037	0.050	0.030
SILICATE	PPM	3	6.500	6.733	7.300	6.400
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	201.000	200.750	211.000	190.000
TOT ORG CARBON	PPM	4	21.500	21.500	23.000	20.000
TOT INORG CARBON	PPM	4	42.500	42.250	43.000	41.000
SOL ORG CARBON	PPM	4	20.500	20.750	23.000	19.000
SOL INORG CARBON	PPM	4	43.000	42.750	43.000	42.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L15 MONRO LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	2.800	11.200	0.0
TEMPERATURE	DEG CENT	3	23.300	23.267	23.300	23.200
PH	PH UNITS	4	7.300	7.350	7.900	6.900
COLOUR	HAZEN	1	20.000	20.000	20.000	20.000
CONDUCTIVITY	M-MHOS	4	88.500	86.500	97.000	72.000
SOLIDS						
DISSOLVED	PPM	1	82.000	82.000	82.000	82.000
SUSPENDED	PPM	2	83.000	83.000	84.000	82.000
GENERAL IONS						
CALCIUM	PPM	1	13.300	13.300	13.300	13.300
MAGNESIUM	PPM	1	1.600	1.600	1.600	1.600
SODIUM	PPM	1	1.900	1.900	1.900	1.900
POTASSIUM	PPM	1	1.000	1.000	1.000	1.000
SULPHATE	PPM	1	7.200	7.200	7.200	7.200
CHLORIDE	PPM	1	0.400	0.400	0.400	0.400
NUTRIENTS						
N-KJELDHAL	PPM	4	0.750	0.780	1.230	0.390
NITRATE	PPM	4	0.010	0.050	0.170	L 0.010
PHOS - ORTHO	PPM	4	0.010	0.035	0.110	L 0.010
PHOS - TOTAL	PPM	4	0.035	0.102	0.310	0.030
SILICATE	PPM	4	9.650	10.050	12.400	8.500
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	36.900	36.375	37.700	34.000
TOT INORG CARBON	PPM	4	7.500	7.250	8.000	6.000
SOL ORG CARBON	PPM	4	14.500	18.750	34.000	12.000
SOL INORG CARBON	PPM	4	7.500	7.250	8.000	6.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L16 HYDRAULIC LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	1.500	6.000	0.0
TEMPERATURE	DEG CENT	4	23.000	20.950	23.800	14.000
DISSOLVED O2	PPM	1	8.300	8.300	8.300	8.300
PH	PH UNITS	4	6.750	6.700	6.900	6.400
COLOUR	HAZEN	1	65.000	65.000	65.000	65.000
CONDUCTIVITY	M-MHOS	4	42.500	44.750	63.000	31.000
HARDNESS - TOTAL	PPM	1	11.700	11.700	11.700	11.700
SOLIDS						
DISSOLVED	PPM	3	71.000	69.333	85.000	52.000
SUSPENDED	PPM	1	60.000	60.000	60.000	60.000
GENERAL IONS						
CALCIUM	PPM	1	3.600	3.600	3.600	3.600
MAGNESIUM	PPM	1	0.700	0.700	0.700	0.700
SODIUM	PPM	1	1.100	1.100	1.100	1.100
POTASSIUM	PPM	1	0.400	0.400	0.400	0.400
SULPHATE	PPM	1	1.800	1.800	1.800	1.800
CHLORIDE	PPM	1	0.600	0.600	0.600	0.600
METALS						
MANGANESE - DISS	PPM	1	0.008	0.008	L 0.008	L 0.008
NUTRIENTS						
AMMONIA AS NH3	PPM	2	0.010	0.010	L 0.010	L 0.010
N-KJELDHAL	PPM	4	0.420	0.480	0.820	0.260
NITRATE	PPM	4	0.010	0.017	0.040	L 0.010
PHOS - ORTHO	PPM	4	0.015	0.017	0.030	L 0.010
PHOS - TOTAL	PPM	4	0.085	0.087	0.120	0.060
SILICATE	PPM	4	5.550	5.025	7.900	1.100
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	12.200	10.625	12.800	5.300
TOT ORG CARBON	PPM	2	14.000	14.000	14.000	14.000
TOT INORG CARBON	PPM	2	2.000	2.000	2.000	2.000
SOL ORG CARBON	PPM	2	12.000	12.000	12.000	12.000
SOL INORG CARBON	PPM	2	2.000	2.000	2.000	L 2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L17 HEADWATER #1

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	1.875	7.500	0.0
TEMPERATURE	DEG CENT	3	24.400	24.867	26.000	24.200
PH	PH UNITS	4	7.250	7.250	7.500	7.000
COLOUR	HAZEN	1	30.000	30.000	30.000	30.000
TURBIDITY	JACKSON	1	2.800	2.800	2.800	2.800
CONDUCTIVITY	M-MHOS	4	93.750	99.125	127.000	82.000
HARDNESS - TOTAL	PPM	3	126.000	104.767	147.000	41.300
SOLIDS						
DISSOLVED	PPM	2	95.000	95.000	102.000	88.000
SUSPENDED	PPM	1	8.700	8.700	8.700	8.700
GENERAL IONS						
CALCIUM	PPM	1	14.200	14.200	14.200	14.200
MAGNESIUM	PPM	2	0.705	0.705	1.400	0.010
SODIUM	PPM	1	1.800	1.800	1.800	1.800
POTASSIUM	PPM	1	0.900	0.900	0.900	0.900
SULPHATE	PPM	1	5.200	5.200	5.200	5.200
CHLORIDE	PPM	1	0.500	0.500	0.500	0.500
NUTRIENTS						
N-KJELDHAL	PPM	4	0.170	0.217	0.520	L 0.010
NITRATE	PPM	4	0.010	0.020	0.050	L 0.010
PHOS - ORTHO	PPM	4	0.010	0.010	0.010	L 0.010
PHOS - TOTAL	PPM	4	0.045	0.047	0.060	0.040
SILICATE	PPM	3	12.700	12.867	13.600	12.300
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	40.250	40.850	44.300	38.600
TOT ORG CARBON	PPM	4	11.500	11.500	14.000	9.000
TOT INORG CARBON	PPM	4	8.000	8.250	10.000	7.000
SOL ORG CARBON	PPM	3	10.000	10.000	11.000	9.000
SOL INORG CARBON	PPM	3	9.000	8.667	9.000	8.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L18 JACKPINE LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	1.875	7.500	0.0
TEMPERATURE	DEG CENT	4	23.000	20.725	24.800	12.100
DISSOLVED O2	PPM	1	8.000	8.000	8.000	8.000
PH	PH UNITS	4	7.000	6.950	7.100	6.700
COLOUR	HAZEN	1	50.000	50.000	50.000	50.000
TURBIDITY	JACKSON	1	1.100	1.100	1.100	1.100
CONDUCTIVITY	M-MHOS	4	60.500	62.500	74.000	55.000
HARDNESS - TOTAL	PPM	1	23.000	23.000	23.000	23.000
SOLIDS						
DISSOLVED	PPM	3	90.000	83.000	97.000	62.000
SUSPENDED	PPM	1	0.720	0.720	0.720	0.720
GENERAL IONS						
CALCIUM	PPM	1	7.100	7.100	7.100	7.100
MAGNESIUM	PPM	1	1.300	1.300	1.300	1.300
SODIUM	PPM	3	1.800	1.700	1.800	1.500
POTASSIUM	PPM	3	0.900	0.867	0.900	0.800
SULPHATE	PPM	1	17.400	17.400	17.400	17.400
CHLORIDE	PPM	1	0.400	0.400	0.400	0.400
METALS						
MANGANESE - DISS	PPM	1	0.008	0.008	L 0.008	L 0.008
NUTRIENTS						
N-KJELDHAL	PPM	4	0.805	0.777	1.110	0.390
NITRATE	PPM	4	0.010	0.020	0.050	L 0.010
PHOS - ORTHO	PPM	4	0.015	0.115	0.420	0.010
PHOS - TOTAL	PPM	4	0.065	0.215	0.680	0.050
SILICATE	PPM	3	7.400	7.900	9.100	7.200
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	24.650	23.725	24.800	20.800
TOT ORG CARBON	PPM	2	15.000	15.000	16.000	14.000
TOT INORG CARBON	PPM	2	5.000	5.000	6.000	4.000
SOL ORG CARBON	PPM	4	14.500	14.250	17.000	11.000
SOL INORG CARBON	PPM	4	7.500	8.500	14.000	5.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L19 LAMBY LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	2.125	8.500	0.0
TEMPERATURE	DEG CENT	4	23.100	20.450	24.500	11.100
DISSOLVED 02	PPM	1	9.300	9.300	9.300	9.300
PH	PH UNITS	4	7.100	7.100	7.200	7.000
COLOUR	HAZEN	1	65.000	65.000	65.000	65.000
TURBIDITY	JACKSON	1	5.600	5.600	5.600	5.600
CONDUCTIVITY	M-MHOS	4	82.500	80.250	92.000	64.000
HARDNESS - TOTAL	PPM	3	93.000	78.500	114.000	28.500
SOLIDS						
DISSOLVED	PPM	3	103.000	97.333	103.000	86.000
SUSPENDED	PPM	1	0.830	0.830	0.830	0.830
GENERAL IONS						
CALCIUM	PPM	1	8.900	8.900	8.900	8.900
MAGNESIUM	PPM	1	1.500	1.500	1.500	1.500
SODIUM	PPM	1	1.900	1.900	1.900	1.900
POTASSIUM	PPM	1	1.000	1.000	1.000	1.000
SULPHATE	PPM	1	13.000	13.000	13.000	13.000
CHLORIDE	PPM	1	0.500	0.500	0.500	0.500
METALS						
MANGANESE - DISS	PPM	1	0.008	0.008	L 0.008	L 0.008
NUTRIENTS						
N-KJELDHAL	PPM	4	0.600	0.787	1.670	0.280
NITRATE	PPM	4	0.015	0.020	0.040	L 0.010
PHOS - ORTHO	PPM	4	0.070	0.077	0.150	0.020
PHOS - TOTAL	PPM	4	0.180	0.205	0.410	0.050
SILICATE	PPM	3	17.700	17.733	18.500	17.000
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	28.950	29.375	37.900	21.700
TOT ORG CARBON	PPM	2	14.500	14.500	17.000	12.000
TOT INORG CARBON	PPM	2	9.500	9.500	14.000	5.000
SOL ORG CARBON	PPM	4	14.500	14.750	16.000	14.000
SOL INORG CARBON	PPM	4	6.500	6.500	8.000	5.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L20 ELLISON LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	5	10.000	10.000	10.000	10.000
TEMPERATURE	DEG CENT	5	19.000	16.600	22.000	8.500
DISSOLVED 02	PPM	1	1.400	1.400	1.400	1.400
PH	PH UNITS	5	7.300	7.640	9.000	7.100
COLOUR	HAZEN	1	20.000	20.000	20.000	20.000
TURBIDITY	JACKSON	1	14.000	14.000	14.000	14.000
CONDUCTIVITY	M-MHOS	4	111.500	113.750	124.000	108.000
HARDNESS - TOTAL	PPM	4	50.100	50.425	56.000	45.500
SOLIDS						
TOTAL	PPM	1	145.000	145.000	145.000	145.000
FIXED	PPM	1	98.000	98.000	98.000	98.000
DISSOLVED	PPM	3	103.000	106.000	115.000	100.000
SUSPENDED	PPM	1	25.000	25.000	25.000	25.000
GENERAL IONS						
CALCIUM	PPM	3	11.700	12.433	14.000	11.600
MAGNESIUM	PPM	4	4.900	4.825	5.500	4.000
SODIUM	PPM	1	5.700	5.700	5.700	5.700
POTASSIUM	PPM	4	1.700	1.675	1.900	1.400
SULPHATE	PPM	2	10.250	10.250	12.000	8.500
CHLORIDE	PPM	1	0.900	0.900	0.900	0.900
FLUORIDE	PPM	1	0.130	0.130	0.130	0.130
METALS						
IRON - TOTAL	PPM	2	4.400	4.400	5.000	3.800
IRON - DISSOLVED	PPM	4	0.750	0.790	1.540	0.120
MANGANESE - DISS	PPM	4	0.075	0.067	0.080	0.040
HEAVY METALS						
COPPER	PPM	4	0.020	0.015	0.020	0.0
ZINC	PPM	4	0.055	0.050	0.060	0.030
LEAD	PPM	4	0.021	0.024	0.050	L 0.003
OXYGEN						
BOD	PPM	1	10.000	10.000	L 10.000	L 10.000
NUTRIENTS						
AMMONIA AS NH3	PPM	4	0.045	0.070	0.170	0.020
NITRATE	PPM	4	0.065	0.062	0.100	L 0.020
NITRITE	PPM	1	0.005	0.005	L 0.005	L 0.005
TOTAL N	PPM	4	0.525	0.597	1.050	0.290
PHOS - ORTHO	PPM	4	0.014	0.035	L 0.100	L 0.010
PHOS - TOTAL	PPM	4	0.245	0.235	0.340	0.109
SILICATE	PPM	4	20.400	20.825	26.800	15.700
COLIFORM						
TOTAL	MPN100ML	1	17.000	17.000	17.000	17.000
FAECAL	MPN100ML	1	2.000	2.000	L 2.000	L 2.000
CARBON						
ALK - PHENOL	PPM	1	1.000	1.000	1.000	1.000
ALK - TOTAL	PPM	4	48.250	50.125	57.000	47.000
TOT ORG CARBON	PPM	1	16.000	16.000	16.000	16.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L21 FISH HAWK LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	3	0.0	2.000	6.000	0.0
TEMPERATURE	DEG CENT	3	23.000	23.267	23.800	23.000
PH	PH UNITS	3	6.900	6.900	7.100	6.700
COLOUR	HAZEN	1	25.000	25.000	25.000	25.000
CONDUCTIVITY	M-MHOS	3	21.000	20.667	24.000	17.000
HARDNESS - TOTAL	PPM	1	5.200	5.200	5.200	5.200
SOLIDS						
DISSOLVED	PPM	3	48.000	42.333	57.000	22.000
GENERAL IONS						
CALCIUM	PPM	2	1.850	1.850	2.100	1.600
SODIUM	PPM	2	0.900	0.900	1.000	0.800
POTASSIUM	PPM	2	0.200	0.200	0.200	0.200
SULPHATE	PPM	2	1.900	1.900	2.100	1.700
CHLORIDE	PPM	1	0.200	0.200	0.200	0.200
NUTRIENTS						
N-KJELDHAL	PPM	3	0.100	0.430	1.160	0.030
NITRATE	PPM	3	0.020	0.020	0.030 L	0.010
PHOS - ORTHO	PPM	3	0.010	0.010	0.010 L	0.010
PHOS - TOTAL	PPM	3	0.060	0.090	0.170	0.040
SILICATE	PPM	3	3.200	3.233	3.900	2.600
CARBON						
ALK - PHENOL	PPM	3	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	3	4.600	4.667	5.100	4.300
TOT ORG CARBON	PPM	1	8.000	8.000	8.000	8.000
TOT INORG CARBON	PPM	1	2.000	2.000	2.000	2.000
SOL ORG CARBON	PPM	3	8.000	7.667	8.000	7.000
SOL INORG CARBON	PPM	3	2.000	2.000 L	2.000 L	2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L22 SWALWELL LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	3	0.0	9.500	28.500	0.0
TEMPERATURE	DEG CENT	3	23.000	23.333	24.000	23.000
PH	PH UNITS	3	7.400	7.300	7.400	7.100
COLOUR	HAZEN	1	30.000	30.000	30.000	30.000
CONDUCTIVITY	M-MHOS	3	53.000	50.667	55.000	44.000
HARDNESS - TOTAL	PPM	1	23.500	23.500	23.500	23.500
SOLIDS						
DISSOLVED	PPM	2	59.000	59.000	63.000	55.000
GENERAL IONS						
CALCIUM	PPM	1	6.800	6.800	6.800	6.800
SODIUM	PPM	1	2.000	2.000	2.000	2.000
POTASSIUM	PPM	1	0.800	0.800	0.800	0.800
SULPHATE	PPM	1	3.500	3.500	3.500	3.500
CHLORIDE	PPM	1	0.400	0.400	0.400	0.400
NUTRIENTS						
N-KJELDHAL	PPM	3	0.900	0.803	1.150	0.360
NITRATE	PPM	3	0.040	0.130	0.320	0.030
PHOS - ORTHO	PPM	3	0.010	0.013	0.020 L	0.010
PHOS - TOTAL	PPM	3	0.050	0.050	0.070	0.030
SILICATE	PPM	3	4.700	5.533	7.700	4.200
CARBON						
ALK - PHENOL	PPM	3	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	3	21.000	20.467	21.300	19.100
TOT ORG CARBON	PPM	1	10.000	10.000	10.000	10.000
TOT INORG CARBON	PPM	1	6.000	6.000	6.000	6.000
SOL ORG CARBON	PPM	3	12.000	11.333	12.000	10.000
SOL INORG CARBON	PPM	3	3.000	3.333	4.000	3.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L23 ALEX LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	2.200	8.800	0.0
TEMPERATURE	DEG CENT	3	23.000	23.333	24.000	23.000
PH	PH UNITS	1	7.000	7.000	7.000	7.000
COLOUR	HAZEN	1	60.000	60.000	60.000	60.000
CONDUCTIVITY	M-MHOS	4	40.300	38.150	48.000	24.000
HARDNESS - TOTAL	PPM	1	14.700	14.700	14.700	14.700
SOLIDS						
DISSOLVED	PPM	2	56.500	56.500	60.000	53.000
SUSPENDED	PPM	1	44.000	44.000	44.000	44.000
GENERAL IONS						
CALCIUM	PPM	1	3.700	3.700	3.700	3.700
MAGNESIUM	PPM	1	1.300	1.300	1.300	1.300
SODIUM	PPM	1	1.300	1.300	1.300	1.300
POTASSIUM	PPM	1	0.500	0.500	0.500	0.500
SULPHATE	PPM	1	2.600	2.600	2.600	2.600
CHLORIDE	PPM	1	0.600	0.600	0.600	0.600
NUTRIENTS						
N-KJELDHAL	PPM	4	0.960	0.860	1.260	0.260
PHOS - ORTHO	PPM	4	0.010	0.017	0.040 L	0.010
PHOS - TOTAL	PPM	4	0.045	0.065	0.140	0.030
SILICATE	PPM	3	7.300	8.633	12.000	6.600
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	9.750	10.075	12.100	8.700
TOT ORG CARBON	PPM	2	15.000	15.000	15.000	15.000
TOT INORG CARBON	PPM	2	3.000	3.000	3.000	3.000
SOL ORG CARBON	PPM	4	17.000	17.500	22.000	14.000
SOL INORG CARBON	PPM	4	2.000	2.250	3.000 L	2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 - LAKE WATER QUALITY

L24 OYMA LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	2.200	8.800	0.0
TEMPERATURE	DEG CENT	4	20.800	21.600	24.200	20.600
DISSOLVED 02	PPM	1	8.600	8.600	8.600	8.600
PH	PH UNITS	4	7.100	7.150	7.300	7.100
COLOUR	HAZEN	1	30.000	30.000	30.000	30.000
CONDUCTIVITY	M-MHOS	4	51.000	52.000	57.000	49.000
HARDNESS - TOTAL	PPM	1	16.200	16.200	16.200	16.200
SOLIDS						
DISSOLVED	PPM	2	53.000	53.000	54.000	52.000
SUSPENDED	PPM	1	42.000	42.000	42.000	42.000
GENERAL IONS						
CALCIUM	PPM	1	4.200	4.200	4.200	4.200
MAGNESIUM	PPM	1	1.400	1.400	1.400	1.400
SODIUM	PPM	1	1.700	1.700	1.700	1.700
POTASSIUM	PPM	1	0.600	0.600	0.600	0.600
SULPHATE	PPM	1	2.600	2.600	2.600	2.600
CHLORIDE	PPM	1	0.400	0.400	0.400	0.400
METALS						
MANGANESE - DISS	PPM	1	0.008	0.008 L	0.008 L	0.008
NUTRIENTS						
AMMONIA AS NH3	PPM	1	0.010	0.010 L	0.010 L	0.010
N-KJELDHAL	PPM	4	0.320	0.332	0.560	0.130
NITRATE	PPM	4	0.010	0.047	0.160 L	0.010
PHOS - ORTHO	PPM	4	0.020	0.055	0.170	0.010
PHOS - TOTAL	PPM	4	0.075	0.160	0.440	0.050
SILICATE	PPM	4	4.800	4.300	5.900	1.700
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	16.150	16.025	17.400	14.400
TOT ORG CARBON	PPM	2	7.000	7.000	11.000	3.000
TOT INORG CARBON	PPM	2	7.500	7.500	11.000	4.000
SOL ORG CARBON	PPM	4	11.500	11.500	13.000	10.000
SOL INORG CARBON	PPM	4	3.000	3.250	5.000	2.000

O K A N A G A N B A S I N S T U D Y

TASK 102 – LAKE WATER QUALITY

L25 PINAUS LAKE

		#VALS	MEDIAN	MEAN	MAXIMUM	MINIMUM
DEPTH	FEET	4	0.0	1.425	5.700	0.0
TEMPERATURE	DEG CENT	3	22.800	23.533	25.000	22.800
PH	PH UNITS	4	7.650	7.650	8.100	7.200
COLOUR	HAZEN	1	5.000	5.000	5.000	5.000
CONDUCTIVITY	M-MHOS	4	129.500	140.500	181.000	122.000
SOLIDS						
DISSOLVED	PPM	2	123.500	123.500	125.000	122.000
GENERAL IONS						
CALCIUM	PPM	1	16.200	16.200	16.200	16.200
MAGNESIUM	PPM	1	6.600	6.600	6.600	6.600
SODIUM	PPM	2	8.650	8.650	8.800	8.500
POTASSIUM	PPM	2	1.900	1.900	2.200	1.600
CHLORIDE	PPM	2	0.750	0.750	1.100	0.400
NUTRIENTS						
N-KJELDHAL	PPM	4	0.590	0.612	1.070	0.200
NITRATE	PPM	3	0.140	0.180	0.280	0.120
PHOS - ORTHO	PPM	3	0.170	0.213	0.450	0.020
PHOS - TOTAL	PPM	3	0.240	0.307	0.620	0.060
SILICATE	PPM	4	19.700	17.525	22.000	8.700
CARBON						
ALK - PHENOL	PPM	4	0.0	0.0	0.0	0.0
ALK - TOTAL	PPM	4	84.400	83.775	85.600	80.700
TOT ORG CARBON	PPM	4	12.000	11.750	13.000	10.000
TOT INORG CARBON	PPM	4	16.500	15.750	17.000	13.000
SOL ORG CARBON	PPM	4	13.000	13.250	17.000	10.000
SOL INORG CARBON	PPM	4	14.000	13.750	17.000	10.000

APPENDIX J

KELOWNA AND LAMBLY CREEKS

J.1 - Median, Mean, Maximum and Minimum Values of Chemical and Physical Parameters.

J.2 - Mean Differences Between Loadings at Water Quality Stations

APPENDIX J.1

KELOWNA AND LAMBLY CREEKS

Median, Mean, Maximum and
Minimum Values of Chemical and
Physical Parameters. Samples
Taken bi-weekly July to October, 1972

NITRATE-NITRITE (NITROGEN), mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	1.45	1.26	2.01	.02
197	1.85	1.86	2.25	1.25
196	1.35	1.31	1.70	.7
198	.30	.32	.44	.20
038	.17	.28	1.0	.1
199	.11	.12	.17	.07
173	.080	.081	.130	.03
201	.01	.01	.03	.01
202	.44	.38	.62	.08
203	.010	.015	.03	.01
LAMBLY CREEK				
041	.01	.01	.01	.01
170	.01	.01	.01	.01
190	.01	.012	.03	.01
191	.01	.01	.01	.01
192	.01	.011	.02	.01
194	.01	.01	.01	.01
193	.01	.01	.01	.01
195	.01	.01	.01	.01

TOTAL PHOSPHORUS (P), mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	.083	.096	.189	.054
197	.059	.064	.083	.055
196	.099	.094	.128	.068
198	.100	.097	.11	.075
038	.07	.09	.22	.049
199	.06	.07	.10	.04
173	.038	.035	.049	.014
201	.019	.026	.052	.014
202	.05	.07	.13	.034
203	.024	.024	.036	.014
LAMBLY CREEK				
041	.025	.021	.03	.01
170	.021	.037	.15	.01
190	.009	.013	.025	.007
191	.017	.027	.11	.005
192	.014	.012	.02	.006
194	.019	.02	.025	.013
193	.014	.012	.018	.004
195	.01	.009	.016	.003

ORTHO-PHOSPHORUS (P), mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	.038	.041	.058	.029
197	.037	.04	.056	.03
196	.056	.059	.096	.04
198	.075	.071	.10	.046
038	.047	.048	.068	.036
199	.040	.039	.063	.013
173	.016	.015	.023	.009
201	.007	.009	.024	.003
202	.029	.035	.056	.018
203	.012	.012	.017	.006
LAMBLY CREEK				
041	.013	.013	.024	.005
170	.007	.008	.013	.003
190	.005	.006	.009	.003
191	.004	.004	.007	.003
192	.005	.005	.006	.003
194	.012	.012	.017	.006
193	.003	.003	.003	.003
195	.003	.003	.005	.003

CALCIUM, mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	52.8	50.2	65.5	26.0
197	66.7	61.3	70.5	40.0
196	69.3	66.6	76.8	40.8
198	67.1	62.7	71.0	36.7
038	62.3	59.5	68.2	34.2
199	53.2	49.3	57.1	23.7
173	8.8	10.6	22.1	4.8
201	49.	6.0	9.9	4.4
202	29.	29.	32.6	23.9
203	16.3	16.7	19.1	15.2
LAMBLY CREEK				
041	36.3	33.9	41.6	22.6
170	29.0	27.4	34.5	18.0
190	29.	27.0	39.	4.2
191	31.2	28.9	34.9	19.6
192	40.4	37.3	41.9	15.7
194	20.2	19.8	23.1	17.4
193	9.1	8.8	9.5	6.9
195	4.8	6.4	16.9	4.3

TOTAL INORGANIC CARBON, mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	30.5	32.3	47.0	24.0
197	30.0	32.0	45.0	23.0
196	40.0	37.7	45.0	29.0
198	30.0	32.43	44.0	25.0
038	30.5	30.8	40.0	23.0
199	25.5	25.4	34.0	16.0
173	5.0	6.9	13.0	4.0
201	2.0	2.2	3.0	2.0
202	17.	17.	21.	14.
203	8.5	9.3	14.0	7.0
LAMBLY CREEK				
041	18.0	17.3	23.0	12.0
170	17.0	17.0	19.0	15.0
190	12.0	13.1	19.0	9.0
191	15.5	15.5	19.0	12.0
192	18.0	18.0	22.0	13.0
194	12.0	12.4	15.0	10.0
193	5.5	5.5	7.0	3.0
195	3.0	2.6	3.0	2.0

TOTAL ORGANIC CARBON, mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	6.0	7.9	17.0	2.0
197	8.5	7.5	10.0	4.0
196	6.5	8.2	14.0	3.0
198	9.0	9.14	13.0	6.0
038	10.0	9.25	15.00	5.0
199	6.5	7.88	13.0	4.0
173	14.5	13.8	18.0	9.0
201	14.0	14.2	16.0	12.0
202	7.5	9.6	19.	5.
203	12.5	12.6	18.	8.
LAMBLY CREEK				
041	7.0	7.3	11.0	5.0
170	8.0	7.8	9.0	7.0
190	8.0	8.0	11.0	6.0
191	6.5	6.7	8.0	5.0
192	9.0	9.7	18.0	5.0
194	9.	8.8	10.0	7.0
193	7.0	7.7	12.0	5.0
195	9.0	8.0	10.0	6.0

APPENDIX J.1(cont'd)

CHLORIDE, mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	8.8	8.6	10.8	5.9
197	8.6	8.3	10.0	5.6
196	6.5	6.3	7.9	3.6
198	3.2	3.0	3.7	1.9
038	2.10	2.14	2.80	1.40
199	2.15	2.05	2.6	1.0
173	.6	1.63	9.1	.5
201	.5	.6	1.1	.4
202	2.3	2.1	2.7	1.1
203	.45	.49	.7	.4
LAMBLY CREEK				
041	.6	.6	.7	.4
170	.45	.47	.60	.30
190	.4	.4	.5	.3
191	.4	.4	.5	.3
192	.40	.4	.5	.3
194	.5	.5	.7	.3
193	.4	.4	.8	.2
195	.3	.33	.5	.2

DISSOLVED OXYGEN, mg/l				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	7.3	8.6	13.8	6.1
197	7.0	6.8	7.3	6.3
196	7.6	7.7	8.4	7.2
198	6.8	6.9	7.6	6.1
038	7.2	7.3	8.2	6.6
199	7.3	7.3	7.7	6.9
173	8.7	9.5	13.8	8.2
201	6.3	6.2	6.7	5.5
202	8.1	7.9	8.5	6.8
203	8.5	8.5	9.0	7.8
LAMBLY CREEK				
041	8.7	8.7	12.0	5.9
170	7.4	8.6	12.7	5.8
190	8.5	24.7	74.0	8.0
191	8.2	8.1	8.6	7.4
192	7.7	7.6	7.9	6.9
194	8.5	8.4	8.8	7.8
193	9.1	8.6	9.6	6.5
195	6.6	4.1	7.6	0

TURBIDITY, (JTU's)				
STATION	MEDIAN	MEAN	MAXIMUM	MINIMUM
KELOWNA CREEK				
039	5.6	10.7	43.0	1.8
197	2.3	2.7	4.0	2.1
196	2.9	4.4	14.0	1.8
198	4.1	4.1	4.8	3.4
038	4.05	10.2	54.0	2.71
199	2.0	2.2	3.2	1.6
173	2.6	2.2	2.9	.68
201	1.0	1.3	2.9	.14
202	1.5	1.6	2.6	.8
203	1.3	1.2	1.9	.6
LAMBLY CREEK				
041	.99	1.1	2.0	.26
170	.57	.71	1.40	.29
190	.38	.37	.49	.22
191	.53	.69	1.9	.26
192	.60	.67	1.70	.25
194	.41	.47	1.1	.16
193	.71	.82	1.2	.4
195	.48	.81	1.7	.37

APPENDIX J.2

At each station, the loading in the stream was calculated for each parameter and date. For the station pairs designated in the difference loadings for each date and parameter was then calculated. Then for each parameter the mean over all the dates of the differences in loadings between the stations in each pair was calculated. These means are presented in Appendix C. Loadings at some individual stations in the headwaters are also presented.

APPENDIX J.2

MEAN DIFFERENCES BETWEEN LOADINGS AT WATER QUALITY STATIONS
KELOWNA AND LAMBLY CREEKS (lbs. x 10^{-6}/ sec)

	CALCIUM	CHLORIDE	IRON	TOTAL RESIDUE	TOTAL FIXED RESIDUE	FILTERABLE RESIDUE	NITROGEN (KJELDAHL)	NITRATE-NITRITE	TOTAL PHOS-PHORUS	ORTHO-PHOS-PHORUS	TOTAL ORGANIC CARBON	TOTAL INORGANIC CARBON	HARDNESS
LAMBLY													
070 - 401	9,526	154.3	-5.7	10,170	-4,919	38,270	8.7	1.27	2.02	5.56	1,694	-538	31,540
190 - 170	7,420	75.2	-48.0	47,380	45,030	16,260	47.6	-5.89	9.80	2.62	621	2,748	24,860
192 - 191	11,840	116.8	57.6	54,150	39,590	50,900	105.0	4.64	8.12	2.04	3,362	6,605	39,130
193 - 194	4,345	87.9	30.1	47,350	16,400	19,360	72.3	1.61	4.02	2.85	1,674	3,150	13,340
195 - 193	106	8.1	11.5	4,676	4,094	2,390	1.5	0.43	0.89	0.14	530	344	353
KELOWNA													
197 - 039	-3,073	189.	-23.7	-2,320	4,000	-8,100	-14.1	-94.3	6.08	-2.03	-457	-597	-7,063
196 - 197	-410	1,509.	23.1	-15,400	--14,300	-13,900	50.5	367	-12.16	-8.89	542	-1,240	-5,005
198 - 196	10,220	2,262.	36.0	69,800	35,200	60,900	91.1	578	8.89	1.56	-155	6,725	42,370
038 - 198	3,940	503.	-20.9	15,700	12,500	29,200	-8.8	85.3	13.80	12.28	746	2,182	13,110
199 - 038	4,370	62.	17.2	37,600	35,700	25,700	97.7	55.1	0.078	3.34	569	2,567	19,650
173 + 202* - 199	11,490	288.	-73.8	40,200	29,700	40,100	-43.5	-33.5	5.52	5.10	-1,860	5,333	35,180
201 - 173	6,240	241.	339.9	65,400	41,900	57,400	271.	69.6	27.12	10.07	6,996	4,770	25,510
203 - 202	4,120	349.	15.1	22,030	15,000	20,300	49.7	63.5	15.58	7.96	653	2,595	15,107
Above 203*	7,060	235.	136.2	46,900	24,900	43,600	173	6.3	11.71	5.41	6,117	3,762	24,440
Above 038*	32,460	1,418.	529.3	219,300	151,000	192,000	731	165.	67.66	33.90	17,985	18,250	116,030
038 - 197	13,900	4,274.	39.4	70,200	33,500	76,300	133	1,031.	10.52	4.95	1,134	7,667	50,480

* Effects of diversions considered.