Province of British Columbia
Ministry of the Environment

Water Investigations Branch

CONTRIBUTION TO THOMPSON RIVER BASIN PREPLANNING STUDY

WATER QUALITY

Victoria, B.C.
File 0273896-19
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Shuswap - Thompson Basin

Water Quality Report

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February 26, 1980

WATER QUALITY REPORT

1.0 INTRODUCTION

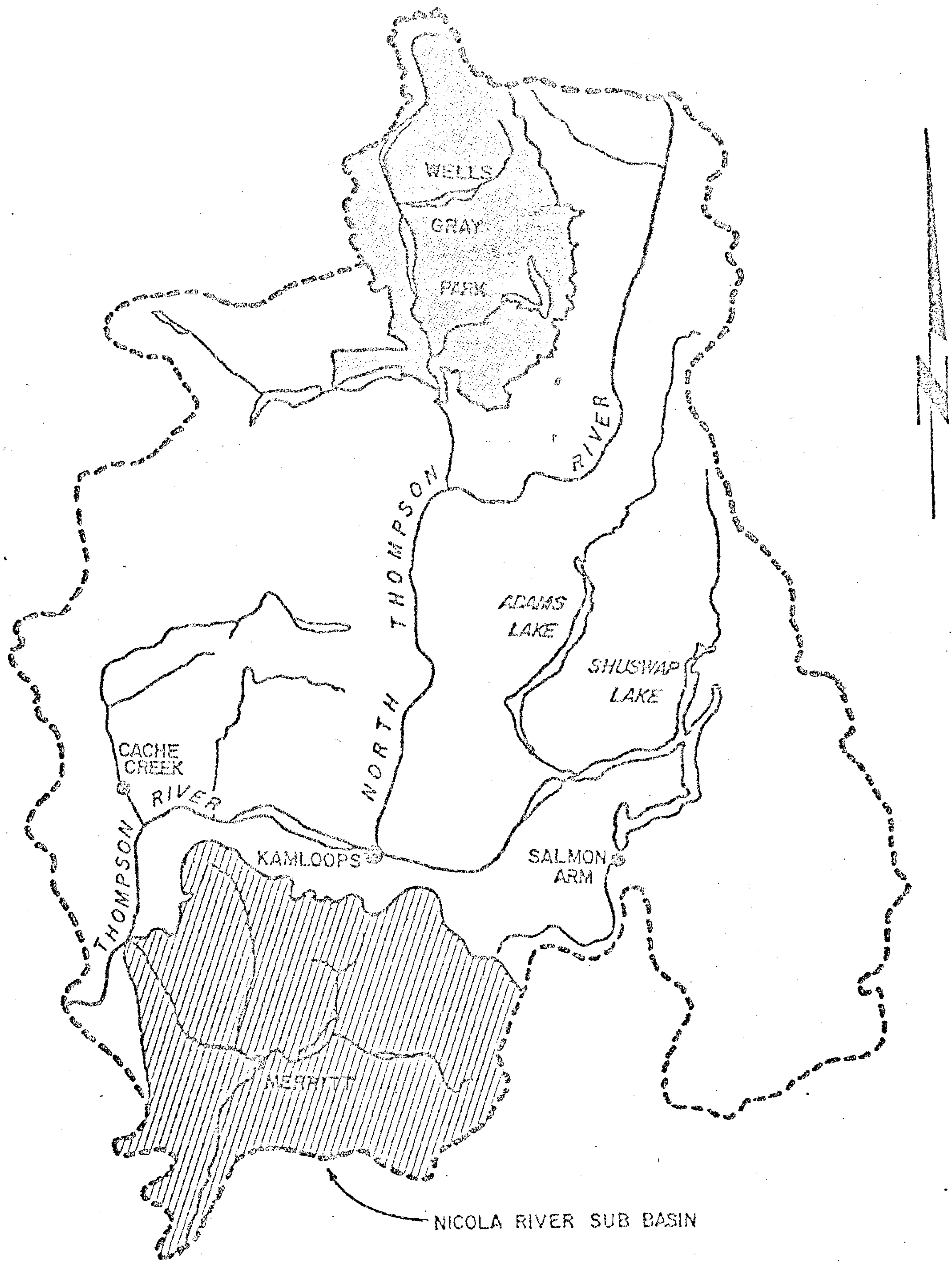
This chapter discussed available data on water quality in the basin's rivers and lakes and identifies the problem areas. This is followed by the discussion of various land use activities, notably human settlements, industry, agriculture and recreation, as they affect water quality. The effluent and run-off sources are subdivided into point and non-point sources, the latter including also erosion and sedimentation. The impact of existing water quality and other aquatic habitat characteristics on fisheries, wildlife and waterfowl is analysed in sections on fisheries and wildlife - Water Users Chapter. Finally, the potential problems associated with Eurasian water milfoil in the basin are discussed.

To simplify the presentation the Shuswap-Thompson Basin has been subdivided into three parts;

1. Thompson Sub-basin
2. North Thompson Sub-basin
3. South Thompson - Shuswap Sub-basin

as shown in Figures 1, 2 and 3. Some subjects listed in the Introduction are discussed separately for each sub-basin, others deal with the entire region.

The first part of this report discusses the point discharges to the rivers and the corresponding water quality problems. The second part discusses limnology and lake water qualitv. The third part discusses non-point water quality concerns and the fourth and final part deals with the potential problem of Eurasian water milfoil in the basin.



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THOMPSON RIVER DRAINAGE BASIN

PART ONE

Thompson River Basin Pre-Planning Study

Water Quality Analysis

prepared by

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Water Investigations Branch

Part One

Shuswap - Thompson Basin
Water Quality Report

Quality of Receiving Waters and Point Discharge Sources

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PART ONE

1.1 Thompson Sub-Basin

This sub-basin as shown in Figure 1 encompasses the Thompson River from Kamloops through Kamloops Lake to Lytton. The Thompson River Watershed to the north covers relatively undisturbed country. Two major tributaries of the Thompson River are Bonaparte River and Deadman River.

1.1.1 Quality of Receiving Waters

There are four water quality sampling stations on the Thompson River and an extensive sampling network on the Bonaparte River and its tributaries; Clinton Creek, Cache Creek, Hat Creek and Loon Creek. These stations are shown in Figure 4.

a) Thompson River

There are four sampling stations on the Thompson River; located at Savona (Site 0600004), Wallachin (Site 0600163), Ashcroft (Site 0600325) and Spences Bridge (Site 0600005). The stations are operated by the Kamloops Regional Office - Waste Management. In 1978, the Savona Station was taken over by the Weyerhaeuser Mill.

The water quality of the Thompson River downstream from Kamloops has been the subject of public concern since the early 1970's. In the spring of 1973, and ad hoc Federal-Provincial Committee was formed to carry out an immediate short-term study of the North and South Thompson Rivers, Kamloops Lake and the Thompson River. Based on its findings a joint Federal-Provincial Task Force was formed in the fall of 1973. The Task Force report was published in December 1975, dealing primarily with Kamloops Lake and the Thompson River. The conclusions of the Federal-Provincial Task Force are presented in Appendix 1. Its conclusions appear to be as applicable now as they were in 1975. The water quality sampling results presented in Tables 1, 2, 3 and 4 generally show no significant changes in the levels of different parameters over the years.

Slight increases in suspended solids and sulphate are noted at Savona - Table 1, and the alkali, colour, hardness, dissolved solids and sulphate increased at Wallachin - Table 2.

Another interesting observation is that there was very little difference in several parameters of water quality between the sampling stations from Savona to Spences Bridge, particularly colour, dissolved oxygen and dissolved phosphorus.

The major problems related to water quality of the Thompson River are:

- Nutrients - the major one is phosphorous - causing benthic algae growth in the lower Thompson River.
- Fish tainting - whitefish and rainbow trout have consistent taste characteristics typical of kraft pulp mill effluent exposure.
- Colour - the Lower Thompson River has a darker appearance than either the South or North Thompson Rivers upstream of Kamloops. See also Appendix 1.

b) Bonaparte River and Tributaries

This sampling network has been set up by the Former Pollution Control Branch - Kamloops Region and is presently operated by its successor the Waste Management Branch. The results from the four stations on the Bonaparte River presented in Tables 5 to 8 (St. 0600017, above Clinton Creek - Table 5; St. 0600506, above Cache Creek STP - Table 6; St. 0600508, below Cache Creek STP - Table 7; St. 0600329, at mouth - Table 8). The results from the main tributaries of the Bonaparte River are presented in Tables 9 to 12 (St. 0600009, Clinton Creek near mouth - Table 9; St. 0600336, Loon Creek, at mouth - Table 10; St. 0600073, Hat Creek, at mouth - Table 11; St. 0600074, Cache Creek, near mouth - Table 12). The water quality of the Bonaparte River, based on the mean results, is decreasing downstream. Above the confluence with Clinton Creek it reflects influence of agricultural activity by its slightly elevated coliform and nutrients levels. Downstream of Clinton Creek, the discharge of municipal effluent from the Village of Clinton causes both coliforms and nutrients to increase sharply. Further downstream, below Cache Creek and the village outfall another sharp increase takes place. Near its mouth, coliforms decrease somewhat but the nutrient levels are maintained. The sampling results of its tributaries indicate the lowest water quality in Clinton Creek (high coliforms and nitrogen nutrients) followed by Loon Creek (high coliforms and nitrogen nutrients), Hat Creek (high nitrogen nutrients) and Cache Creek (high coliforms, nitrogen and phosphorus nutrients). In summary, both the agriculture (cattle industry) and the municipal effluents from the villages of Clinton and Cache Creek, combined with low seasonal flow contribute to the deteriorated condition of the Bonaparte River.

1.1.2 Point Sources

There are two major effluent sources in the sub-basin, both in Kamloops; the Weyerhaeuser Pulp Mill and the City of Kamloops. In addition there are several small municipalities and small industrial plants.

a) Weyerhaeuser Pulp Mill

The Kraft pulp mill is located on the Thompson River just west of Kamloops. Its normal output is 1260 air-dried metric tonnes of unbleached pulp per day. The operation is covered by Pollution Control Permit PE-1199, issued February 4, 1972, and amended several times. The last amendment was dated March 20, 1978.

Summary of Permit Conditions

Quality of effluent	- 182,000 m^3/day average 273,000 m^3/day maximum
pH	- 6.5 - 8.0
Temperature	- 35^o C maximum
T.S.S.	- 8510 kg/day
D.O.	- 2.0 mg/L
Toxicity	- TL_m 96-50% survival at 90% effluent concentration

Treatment works: clarifier, two settling basins, emergency dump pond, 5-day aeration basin, two submerged outfalls and diffusers.

A summary of the mill effluent monitoring is presented in Table 13. Since 1975, a slight reduction in dissolved phosphorus has occurred. No reduction of colour has been achieved so far. The Regional Office of the Waste Management in Kamloops advises that the mill housekeeping and the spill prevention procedures have improved in recent years and only the colour remains a major unresolved problem.

b) City of Kamloops Sewage Treatment Works

In 1978 the city population was estimated at just over sixty thousand inhabitants; 35,000 on a central sewage collection system and 25,000 on septic tanks.

The sewage works consist of four (4) sewage lagoons, a chlorine contact chamber, a phosphorus removal facility on cell no. 4 and an outfall. The installation is covered by Pollution Control Permit PE-399, issued April 23, 1971, which specifies the following requirements:

Volume: 17,048 m^3/day max.
T.S.S.: 65 ppm. ave.
B.O.D.: 50 ppm. ave.
Chlorination required if coliform count over 5000 MPN/100 ml. during the winter period.

The effluent monitoring results are presented in Table 14. A significant decrease of phosphorus in the effluent is evident and recent levels are quite low.

In September 1977, the City applied for an amendment to its permit to cover the future rate of discharge projected from available land use plans. This request was rejected by the Pollution Control Branch on May 12, 1978.

In June 1978, the City approved funding for a wastewater management study. Preliminary reports were submitted to the City by Associated Engineering Services Ltd. in August 1978 and Stanley Associates Engineering Ltd. in March, 1979. These reports discuss various options for sewage collection and disposal, including continuation of the present river discharge in the existing lagoons and various schemes for land disposal through spray irrigation.

In August 1979, a Federal-Provincial Committee, struck specifically for this purpose, reviewed the Stanley report, but no recommendation was made regarding the selection of the most feasible scheme. As of this date, the Kamloops Waste Management Plan is under continuing study by various levels of government.

Other point discharges to the Thompson River are very small compared to the two in Kamloops and are spaced far apart. They are briefly discussed below in order proceeding downstream from Kamloops.

c) Tranquille School Outfall - N. Shore Kamloops Lake

This discharge is covered by Pollution Control Permit PE-1643, which was issued May 9, 1973, with the following permit conditions:

Volume	=	545 m^3/day
$B.O.D._5$	=	45 mg/L
T.S.S.	=	60 mg/L

on the discharge from the treatment system consisting of an aerated lagoon, stabilization pond and chlorination chamber. During the summer months the effluent is sprayed on a 24 ha. area. Monitoring results show effluent quality within the permit requirements.

d) Westcoast Transmission - Savona Station

The station covered by Pollution Control Permit PE-1758, issued June 12, 1973, and amended May 12, 1976, discharges only compressor cooling water to the Thompson River;

volume: 10,910 m^3/day

The monitoring records show that the effluent is of a better quality that the intake river water (because of the treatment it receives).

e) Savona Timber Co. Ltd.

This firm discharges 66 m^3/day of compressor cooling water to Kamloops Lake. It is covered by Pollution Control Permit PE-429-P, which was issued August 30, 1971.

f) Village of Ashcroft

This discharge is covered by Pollution Control Permit PE-420, issued July 16, 1971, and amended December 24, 1975. This permit has following conditions:

Volume: 2273 m^3/day
BOD_5 : 45 mg/L
T.S.S.: 60 mg/L
Works : Secondary treatment plant, sludge handling facilities and outfall.

The effluent monitoring results are presented in Table 15. A substantial improvement in the overall effluent quality was evident in 1977 when the secondary sewage treatment plant began regular operation.

g) Village of Cache Creek

This discharge is covered by the Pollution Control Permit PE-264, issued March 3, 1969, amended April 6, 1972, with the following permit conditions:

Volume: 1455 m^3/day to Bonaparte and Thompson River
BOD_5 : 30 mg/L
T.S.S.: 60 mg/L
pH : 6.5 - 7.5
Works : Secondary treatment plant, chlorination chamber, sludge drying beds and outfall. In 1975 the treatment was converted to two parallel modules with common sludge thickener, storage and drying beds. Monitoring results presented in Table 16 indicate generally satisfactory operation with some room for improvement in biological control (coliforms).

h) Loon Creek Trout Hatchery, Hatchery Creek

The hatchery effluent is discharged to Loon Creek via Hatchery Creek, Bonaparte River and the Thompson River. Pollution Control Permit PE-2388, issued in September 6, 1974 specifies intermittent discharge; February 15 - May 30 and September 9 - September 30, with a maximum volume of 3582 m^3/day.

BOD_5 = 10 mg/L
T.S.S. = 5 mg/L

The Regional Office of the Waste Management Branch advises there have been no detrimental effects on the receiving waters based on several years of operation.
1974-1979 effluent sampling results show long terms means;

Diss. Oxygen = 7.85 mg/L
BOD_5 = 10 mg/L
T.S.S. = 3.3 mg/L

i) Village of Clinton

This discharge is covered by Pollution Control Permit PE-170, issued December 13, 1966, amended February 24, 1972 and July 20, 1974. This permit has the following conditions:

Volume: 455 m^3/day
BOD_5 : 20 mg/L
T.S.S.: 30 mg/L
Works : two anaerobic cells, two lagoons and an outfall to Clinton Cr.

Monitoring results presented in Table 17 show fairly typical effluent characteristics for an Interior sewage treatment facility. The problem is that the flow of the creek drops sharply during the winter months resulting in an unacceptable effluent dilution factor. The situation is being assessed currently by the Waste Management Branch.

1.2 North Thompson Sub-Basin

This sub-basin as shown in Figure 2 encompasses the North Thompson watershed extending from Kamloops in its south extremity to Wells Gray Park to the North and Quesnel Highlands to the West. The only major tributary of the North Thompson River is the Clearwater River.

1.2.1 Quality of Receiving Waters

There are two permanent water quality sampling stations on the North Thompson River located at Kamloops (Site 0600164) and at McLure (Site 0600002). operated by the Kamloops Regional Office - Waste Management Branch. In 1978 the Kamloops station was taken over by the Weyerhaeuser Mill. A station at Bird Island (Kamloops) was operated between May 1972 and August 1976 (Site 0600025), and the station on the Clearwater River was operated between May 1972, and May 1978 (Site 0600031). The monitoring results from these stations are presented in Tables 18 to 21, respectively. Generally the results are uniform regardless of the station location and show no definite trends in changes of water quality. Exceptions are noted in the tables. Generally the quality is acceptable and consistent with the values recommended for freshwater streams.

1.2.2 Point Discharges

There are only four small discharge point sources in the North Thompson sub-basin and their impact on the overall water quality is negligible, although some of them may pose local problems.

a) Village of 100 Mile House

This discharge is covered by Pollution Control Permit PE-236, issued June 28, 1965, amended October 22, 1971 and June 22, 1976. This permit has the following conditions:

Volume: 910 m^3/day to Bridge Cr., Clearwater R., N. Thompson R.

BOD_5 : 30 mg/l

T.S.S.: 40 mg/l

Works : mechanically aerated lagoon, two stabilization lagoons, outfall. The aeration lagoon was installed in late 1977. The monitoring results presented in Table 22 most likely do not reflect these changes. The Waste Management Branch is concerned with the very low dilution rates during the periods of low flow and this discharge is now under review.

b) Village of Clearwater

This discharge is covered by Pollution Control Permit PE-330, which was issued April 2, 1970. The permit has the following conditions:

Volume: 136 m^3/day to North Thompson River

BOD_5 : 45 mg/L

T.S.S.: 60 mg/L

Works : Stabilization pond (retention time 91 days), chlorination facilities and outfall.

There are no monitoring results available, but the dilution ratio at low flow of the North Thompson River is 1:2000.

c) Noranda Mines Ltd. - Boss Mountain Camp

This discharge is from the permanent mining camp at Hendrix Lake in the Northwest corner of the sub-basin. It is covered by Pollution Control Permit PE-088, which was issued May 7, 1964, with following permit conditions:

Volume: 91 m^3/day to Hendrix Lake

BOD_5 : 50 mg/L

T.S.S.: 100 mg/L

Total coliforms: 40,000 MPN/100 ml

Works : Packaged secondary sewage plant improved in the early seventies.

The available effluent monitoring results presented in Table 23 show generally acceptable effluent characteristics.

d) Noranda Mines - Boss Mt. Division - Tailings

This discharge is covered by Pollution Control Permit PE-3439, which was issued April 10, 1978 and amended April 9, 1979. The permit has the following conditions:

Volume	:	3900 m^3/day to Ryan Creek, Boss Creek, Canim Lake
T.S.S.	:	50 mg/L
pH	:	6.5 - 8.5
diss.Fe	:	1.0 mg/L
diss.Mo	:	3.0 mg/L
diss.Pb	:	0.05 mg/L
diss.Cu	:	0.05 mg/L
cyanide	:	0.1 mg/L
toxicity	:	LC 50 (96 hr.) = 100%
Works	:	Tailings pond, settling pond, flocculant addition system, outfall.

The monitoring results presented in Table 24 show the cyanide and copper levels well above permit conditions. The main problem is the cyanide, where the long term mean is 0.3 mg/L. The maximum level approved on the permit is 0.1 mg/L. The company is engaged in bench scale tests to reduce this level.

1.3 South Thompson-Shuswap Sub-basin

This sub-basin as shown in Figure 3 encompasses the South Thompson watershed from Kamloops eastward including the extensive lakes system, from Adams Lake in the north to Sugar Lake in the southeast. The major tributaries are the Adams, Salmon and Shuswap Rivers.

1.3.1 Quality of Receiving Waters

There is an extensive sampling network on the South Thompson River, Adams River, Salmon River and Shuswap River consisting of several permanent and temporary sites as shown in Figure 8. These sites were established by the former Pollution Control Branch and are operated by its successor the Waste Management Branch - Kamloops Region.

a) South Thompson River

There are four sampling stations established on the South Thompson River at: Squilax (Site 0500077), Chase (Site 0600136), Pritchard (Site 0600001) and Pioneer Park in Kamloops (Site 0600135). The stations at Squilax and Pritchard are temporary only. The water quality sampling results presented in Tables 25, 26, 27 and 28 indicate relatively uniform water quality between Shuswap Lake and Kamloops, with low coliform, nutrient, suspended solids, hardness, colour and turbidity values, indicating an overall healthy condition of the river.

b) Adams River

There is one permanent sampling station at Celista Road Bridge near the mouth of Adams River (Site: 0500001). In 1974 the river was briefly sampled at several locations between its mouth and Adams Lake. The monitoring results presented in Table 29 show good water quality, with low nutrients, coliforms and suspended solids, consistent with values desired for healthy freshwater streams.

c) Salmon River

There are two permanent sampling stations, one approximately midway between Salmon Arm and Glenemma - Salmon Valley #1 (Site 1130003) and one at Highway #1 Bridge near the mouth of Salmon River (Site 0500062). The monitoring results presented in Tables 30 and 31 show the rapid deterioration of the water quality in the lower run of Salmon River. At both sites the nutrient levels, alkali, hardness and sulphate are uniformly high but near the mouth the coliform levels nearly double, indicating the effects of feedlot and agricultural runoff. There are no point discharges to the Salmon River. Seven more temporary sampling stations were maintained between 1973 and 1975 for varying periods of time, from one to three seasons, on the Salmon River. Their results show water quality gradually deteriorating downstream.

d) Shuswap River

There are five permanent sampling stations on the Shuswap River between its mouth and Mabel Lake. Two stations located further upstream operated, one from 1970 and the other from 1972, until the summer of 1978. To illustrate the changes in water quality, the results from three stations are presented in Tables 32, 33 and 34;

Table 32 upstream of Sugar Lake (Site 0500072)

Table 33 downstream of Enderby (Site 0500498)

Table 34 at Mara Bridge - near mouth (Site 0500069)

A study by the Water Investigations Branch in 1977, initiated by complaints of deteriorating water quality by water users on the Shuswap River downstream of Enderby, indicated that:

1. the major source of suspended sediment is from natural slide areas along Kingfisher Creek (a tributary to the Shuswap River near Mabel Lake),
2. high concentrations of nutrients and coliform bacteria contamination came from Fortune Creek (a tributary to the Shuswap River draining predominantly agricultural land near Enderby), and
3. in general the concentrations increased gradually as one progressed downstream indicating most of the pollution to be from non-point sources.

e) Bessette Creek

This creek flows by the village of Lumby and flows into the Shuswap River south of Mabel Lake.

The Environmental Protection Branch - Pacific Region carried out a water quality and biological study of the creek during the summer of 1975. (Reference 3). The study concluded that the water quality was consistent with values desired for healthy freshwater streams. Macroinvertebrate diversity was also indicative of a clean water stream.

1.3.2 Point Discharges

There are three major municipal sewage outfalls in the Shuswap-Salmon Arm area and one industrial discharge to the South Thompson River, just upstream of Kamloops. In addition there are several small discharges in Salmon Arm and Lumby.

a) Lafarge Cement, Kamloops

This discharge is covered by Pollution Control Permit PE-365 P, issued October 7, 1970, with the following permit conditions:

Volume	1728 m^3/day to South Thompson River
Characteristics:	cooling water
Temp. gradient :	20^{o}F

The monitoring results show good discharge quality water, well within the permit limits.

b) Village of Lumby

The village sewage outfall is covered by Pollution Control Permit PE-173, issued March 13, 1967, and amended on January 4, 1973, and June 21, 1976. The permit has the following conditions:

Volume:	1640 m^3/day between April 15 - June 14 each year and 455 m^3/day between October 3 and April 14 each year to Bessette Creek
BOD_5 :	45 mg/L
T.S.S.:	60 mg/L
Works :	One aerated lagoon, two polishing lagoons, chlorination facilities and outfall, completed in late 1976.

There are no recent monitoring results. The Pollution Control Branch stated in 1976 that after 13 months of operation of the plant, no negative effects were observed on Bessette Creek.

The village arena outfall - cooling water only, is covered by Pollution Control Permit PE-1662, issued September 21, 1972.

Volume: 182 m^3/day, October to March each year

c) Town of Enderby

The town municipal effluent discharge is covered by the Pollution Control Permit PE-203, issued October 4, 1967, with the following permit conditions:

Volume:	1137 m^3/day to Shuswap River
BOD_5 :	20 mg/L
T.S.S.:	50 mg/L
pH :	6.5 - 7.5
Temp.range:	45 - 55° F
Fecal Coliforms:	10,000 MPN/100 ml.
Works :	Oxidation ditch, secondary clarifier, chlorinator, flow meter and outfall

The sludge is collected from the clarifier and stored in the sludge beds before being trucked out to cultivated areas.

The effluent monitoring results are presented in Table 35. The results are in compliance with the permit conditions. A small increase is noted in the nutrients level. The coliform numbers have decreased sharply in recent years.

d) District of Salmon Arm

The municipal sewage works are covered by Pollution Control Permit PE-1251, issued July 4, 1972, and amended on June 17, 1976. The permit has following conditions:

Volume:	2840 m^3/day to Shuswap Lake
BOD_5 :	30 mg/L
T.S.S.:	40 mg/L
Works :	Activated sludge plant with ancillary works and lake outfall

A sludge land disposal scheme is currently under consideration by the municipality but suitable land has not been located yet.

The plant discharge to the lake, augmented by the storm sewer discharge and effluent from different small industries located in Salmon Arm, is of concern to both the federal and provincial environmental agencies - see file PE-1251. The monitoring results (sampled in early 1977) presented in Table 36 indicate high coliform numbers.

1.4 Main Concerns

Based on the preliminary review of the point discharge sources and the corresponding water quality data, the following problem areas are identified:

1.4.1 Thompson Sub-basin

a) Thompson River water quality downstream of Kamloops including colour, fish tainting substances, phosphorus nutrients and the corresponding algae problems downstream of Kamloops Lake, all related to the discharges from the Kamloops area.

b) The water quality of the Bonaparte River and its tributaries related to the point discharges from the villages of Clinton and Cache Creek and the agricultural runoff.

1.4.2 South Thompson-Shuswap Sub-basin

a) Salmon River water quality in the Salmon Valley area and the nutrient input into Salmon Arm. Problems related to agricultural runoff and the District of Salmon Arm municipal effluent.

b) Shuswap River between Mabel and Mara Lake - deteriorating water quality as one proceeds downstream from no particularly identifiable source.

Further problem areas are identified in the subsequent parts of this report.

LIST OF REFERENCES

1. Waste Management Study - Volume 1, prepared by Stanley Associates Engineering Ltd. for the City of Kamloops - Engineering Department - March 1979.

2. City of Kamloops - Review of Wastewater Management, B.C. Ministry of Environment- Report No. 79-7, August 1979.

3. Summary Report on Sources and Effects of Algal Growth, Colour, Foaming and Fish Tainting in the Thompson River System, by Federal-Provincial Thompson River Task Force - December 1975.

4. Review of Sampling Data From South Thompson River at Chase, 1977/78 and 1978/79. By:D.W. Holmes, Pollution Control Branch - South Central, September 1979.

5. Water Quality in the Shuswap River between Mabel and Mara Lakes, 1977 By: R.N. Nordin, Ph.D. Water Investigations Branch.

6. Water Quality and Macroinvertebrate Community Structure of Bessette Creek, British Columbia. Regional Program Report No. 79 - Draft Copy. By: G. Derksen, Environmental Protection Service, Vancouver, May 1979.

7. Determination of Nitrogen and Phosphorus in Periphyton and/or Algae Project No. 90010, Environmental Laboratory, Vancouver, 1979.

Appendix 1

Summary Report on Sources and Effects of Algal Growth, Colour, Foaming and Fish Tainting in the Thompson River System Federal-Provincial Thomspon River Task Force. December 1975

CONCLUSIONS

(1) Discharge of phosphorus from Weyerhaeuser Canada Ltd. and the City of Kamloops should be reduced significantly. A treatment system should be adopted which will reduce as much phosphorus addition to the river as is technologically possible during most of the year. Phosphorus releases from settlements, feedlots, etc., should also be minimized. The option of a variable schedule for wastewater phosphorus release that is related to the physical dynamics of Kamloops Lake is recommended for consideration in the Canada Centre for Inland Waters Technical Report.

(2) Colour in the Weyerhaeuser Canada Ltd. pulp mill effluent should be reduced to cause publically acceptable aesthetic improvement.

(3) Studies should be initiated to identify and remove fish tainting agents from the major point source discharges (Weyerhaeuser Canada Ltd. and City of Kamloops) to the Thompson River system.

(4) The Thompson River system should be monitored chemically and biologically on a continuing basis. Monitoring programs should include requirements established by the Task Force in order to detect changes in water quality leading to shifts in species composition and biomass in algal and invertebrate populations.

Monitoring results by permittees and regulatory agencies should be evaluated and reported by a federal-provincial committee after a five-year period.

(5) New developments that result in nutrient discharges into the Thompson River basin (e.g., industry, logging, feedlots, urbanization) should be controlled to ensure that individual and cumulative effects of such discharges does not impair water quality in the system.

(6) A social, economic, and technical study should be initiated to determine the feasibility of elimination of discharges detrimental to the Thompson River system. This could include total recycle, land disposal, joint effluent treatment.

(7) The following research should be encouraged:

(i) A research program should be undertaken on the physiology and nutrient energetics of benthic algal communities typical to British Columbia rivers.

Because of insufficient knowledge in this area, accurate predictions of the changes in algal biomass to be expected in the lower Thompson River as a result of phosphorus control are not possible. There is no interpretable record of the algal communities that existed prior to recent reported changes. Hence it is impossible to deduce objectively the condition of the lower Thompson prior to recent reported degradation.

(ii) An investigation of the effluent of the Weyerhaeuser Canada mill should be undertaken to isolate and identify toxic substances which may adversely affect the biota of Kamloops Lake or the lower Thompson River. Any such substances should subsequently be removed from the effluent.

(iii) The effect of altered algal and invertebrate community structures on the feeding ecology of salmonids should be investigated.

TABLE 1

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Thompson

Site: 0600004 at Savona

Sampling Period

Nov. 71 - June 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	44.8	26.7	35.1	79	
Coliforms fecal	MPN/100 ml	17	2	3.73	11	
Coliforms total	MPN/100 ml	17	2	5	5	
Colour T.A.C.		16	1	7.6	81	
Copper, dissolved	mg/L	0.06	0.001	0.0061	31	
total	mg/L	0.02	0.001	0.0037	21	
Dissolved oxygen	mg/L	13.4	4.8	10.15	58	
Hardness	mg/L	47.6	30.0	38.13	76	
Iron, dissolved	mg/L	0.1	0.02	0.092	29	
total	mg/L	0.3	0.1	0.1667	6	
Lead, dissolved	mg/L	0.003	0.001	0.00146	13	
total	mg/L	0.006	0.001	0.0019	21	
Mercury, dissolved	mg/L	0.05	0.05	0.05	1	
total	mg/L	0.25	0.02	0.0548	27	
Nitrogen, Ammonia	mg/L	0.03	0.005	0.00824	25	
Nitrate	mg/L	0.22	0.02	0.083	59	
Nitrite	mg/L	0.005	0.005	0.005	56	
Organic	mg/L	0.15	0.01	0.0832	25	
pH		8.61	6.1	7.56	177	
Phosphorus, dissolved	mg/L	0.009	0.003	0.00315	53	
total	mg/L	0.021	0.003	0.0063	177	
Solids, dissolved	mg/L	80.0	38.0	58.48	85	
suspended	mg/L	8.9	0.5	2.55	14	inc. noted 77/79 period
Sulphate	mg/L	10	5	7.25	72	some inc. in 78/79 peric
Turbidity, J.T.U.		8.5	0.2	1.5	82	
Zinc, dissolved	mg/L	0.12	0.005	0.002	12	
total	mg/L	0.016	0.005	0.0057	22	

TABLE 2

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Thompson

Site: 0600163 at Walachin

Sampling Period

Aug. 75 - Nov. 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	42.9	28.3	34.8	42	Inc. noted starting 77
Coliforms fecal	MPN/100 ml	8	2	2.6	10	
Coliforms total	MPN/100 ml	2	2	2	4	
Colour T.A.C.		13	2	7.4	5.7	Inc. noted starting 76
Copper, dissolved	mg/L	0.004	0.001	0.0016	10	
total	mg/L	0.009	0.001	0.0031	7	
Dissolved oxygen	mg/L	13.4	8.1	10.66	44	
Hardness	mg/L	47.4	30.0	38.1	41	Inc. noted starting 77
Iron, dissolved	mg/L	0.1	0.1	0.1	10	
total	mg/L	0.3	0.1	0.133	6	
Lead, dissolved	mg/L	0.001	0.001	0.001	2	
total	mg/L	0.001	0.001	0.001	9	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	7	
Nitrogen, Ammonia	mg/L	0.011	0.005	0.006	19	
Nitrate	mg/L	0.13	0.02	0.071	28	
Nitrite	mg/L	0.005	0.005	0.005	25	
Organic	mg/L	0.24	0.01	0.112	19	
pH		8.0	2.6	7.5	98	
Phosphorus, dissolved	mg/L	0.003	0.003	0.003	37	
total	mg/L	0.068	0.003	0.0072	119	
Solids, dissolved	mg/L	74.0	40.0	59.68	51	Inc. starting in 1977
suspended	mg/L	6.0	2.0	2.5	8	
Sulphate	mg/L	9.5	5	7.36	44	Inc. noted in 1978
Turbidity, J.T.U.		4.4	0.5	1.4	42	
Zinc, dissolved	mg/L	0.005	0.005	0.005	2	
total	mg/L	0.005	0.005	0.005	10	

TABLE 3

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Thompson

Site: 0600326 at Ashcroft

Sampling Period

Nov. 73 - April 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	41.2	33	38.65	6	No significant changes over the years in all parameters
Coliforms fecal	MPN/100 ml	--	--	0	--	
Coliforms total	MPN/100 ml	5	2	3.5	2	
Colour T.A.C.		15	1	7.82	29	
Copper, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Dissolved oxygen	mg/L	16.3	5.6	11.25	9	
Hardness	mg/L	44.3	39.9	42.26	5	
Iron, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.01	0.005	0.006	14	
Nitrate	mg/L	0.13	0.03	0.083	15	
Nitrite	mg/L	0.005	0.005	0.005	15	
Organic	mg/L	0.41	0.01	0.118	14	
pH		8.5	4.0	7.53	34	
Phosphorus, dissolved	mg/L	0.003	0.003	0.003	14	
total	mg/L	0.043	0.001	0.008	59	
Solids, dissolved	mg/L	86	56	68.85	14	
suspended	mg/L	--	--	--	--	
Sulphate	mg/L	10.1	7.2	8.78	14	
Turbidity, J.T.U.		3.2	0.5	1.25	11	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	

TABLE 4

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Thompson

Site: 0600005, at Spences Bridge

Sampling Period

Aug. 66 - Dec. 76

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	51.9	27.6	38.17	117	
Coliforms fecal	MPN/100 ml	--	--	--	--	
Coliforms total	MPN/100 ml	--	--	--	--	
Colour T.A.C.		14	1	7.62	21	
Copper, dissolved	mg/L	0.38	0.001	0.016	37	
total	mg/L	0.01	0.001	0.0039	25	
Dissolved oxygen	mg/L	13.2	5.7	9.15	21	
Hardness	mg/L	55.3	32.0	43.17	98	
Iron, dissolved	mg/L	0.1	0.001	0.047	49	
total	mg/L	0.25	0.036	0.127	8	
Lead, dissolved	mg/L	0.05	0.001	0.01	34	
total	mg/L	0.01	0.001	0.0028	23	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.02	0.043	9	
Nitrogen, Ammonia	mg/L	0.2	0.003	0.084	23	
Nitrate	mg/L	0.13	0.04	0.082	31	
Nitrite	mg/L	0.005	0.005	0.005	31	
Organic	mg/L	0.2	0.2	0.2	1	
pH		8.8	6.7	7.67	144	
Phosphorus, dissolved	mg/L	0.03	0.002	0.0036	38	
total	mg/L	0.049	0.001	0.009	96	
Solids, dissolved	mg/L	80.0	1.0	61.0	44	
suspended	mg/L	36.0	0.7	11.84	16	
Sulphate	mg/L	27.3	4.1	8.76	104	
Turbidity, J.T.U.		47	0.1	2.48	116	
Zinc, dissolved	mg/L	0.08	0.001	0.01	33	
total	mg/L	0.01	0.001	0.004	25	

TABLE 5

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Bonaparte River

Site: 0600017 above Clinton Cr.

Sampling Period

May 72 - Feb. 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	211.	70.8	118.98	20	All values fairly steady, no trend
Coliforms fecal	MPN/100 ml	110.	2.	36.78	18	
Coliforms total	MPN/100 ml	240.	22.	64.67	15	
Colour T.A.C.		21.	8.	13.14	7	
Copper, dissolved	mg/L	0.005	<0.001	0.0024	7	
total	mg/L	0.02	<0.001	0.0044	12	
Dissolved oxygen	mg/L	14.	6.5	10.32	25	
Hardness	mg/L	163.	65.	99.37	16	
Iron, dissolved	mg/L	0.1	<0.1	0.1	7	
total	mg/L	0.9	0.1	0.4	3	
Lead, dissolved	mg/L	0.002	<0.001	0.0012	5	
total	mg/L	0.029	<0.001	0.0072	10	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	<0.05	<0.05	0.05	1	
Nitrogen, Ammonia	mg/L	0.051	<0.005	0.0148	18	
Nitrate	mg/L	0.09	<0.02	0.03	26	
Nitrite	mg/L	<0.005	0.005	0.005	26	
Organic	mg/L	0.45	0.1	0.258		
pH		8.8	7.8	8.16	49	
Phosphorus, dissolved	mg/L	0.01	<0.003	0.0044	7	
total	mg/L	0.103	0.003	0.0148	58	
Solids, dissolved	mg/L	244.	90.	150.39	36	
suspended	mg/L	20.	4.	10.75	4	
Sulphate	mg/L	7.6	<5.	5.27	14	
Turbidity, J.T.U.		9.1	0.5	1.97	21	
Zinc, dissolved	mg/L	0.006	0.006	0.006	1	
total	mg/L	0.03	<0.005	0.0091	12	

TABLE 6

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Bonaparte River

Site: 0600506, above Cache Cr. S.T.P.

Sampling Period

April 74 - March 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	230.	110.	182.13	15	
Coliforms fecal	MPN/100 ml	920.	8.	108.53	30	
Coliforms total	MPN/100 ml	G 2400.	9.	333.47	19	
Colour T.A.C.		27.	3.	10.16	6	
Copper, dissolved	mg/L	0.004	0.004	0.004	1	
total	mg/L	--	--	--	--	
Dissolved oxygen	mg/L	14.6	5.38	10.57	29	
Hardness	mg/L	238.	106.	180.33	15	
Iron, dissolved	mg/L	<0.1	<0.1	0.1	1	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	<0.001	<0.001	0.001	1	
total	mg/L	--	--	--	--	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.09	<0.005	0.022	24	
Nitrate	mg/L	0.19	<0.02	0.043	26	
Nitrite	mg/L	<0.005	0.005	0.005	26	
Organic	mg/L	0.97	0.13	0.278	22	
pH		8.75	6.3	8.22	45	
Phosphorus, dissolved	mg/L	0.057	0.003	0.018	10	
total	mg/L	0.403	0.01	0.037	51	
Solids, dissolved	mg/L	326.	164.	254.2	30	
suspended	mg/L	14	14	14	1	
Sulphate	mg/L	37.4	37.4	37.4	1	
Turbidity, J.T.U.		54.	0.7	9.15	11	
Zinc, dissolved	mg/L	0.08	0.08	0.08	1	
total	mg/L	--	--	--	--	

TABLE 7

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Bonaparte River

Site: 0600508 below Cache Cr. S.T.P.

Sampling Period

April 74 - March 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	228.	108.	172.93	14	
Coliforms fecal	MPN/100 ml	5400.	2.	480.	29	
Coliforms total	MPN/100 ml	9200.	8.	1287.	19	
Colour T.A.C.		27.	6.	10.86	7	
Copper, dissolved	mg/L	<0.001	<0.001	0.001	1	
total	mg/L	--	--	--	--	
Dissolved oxygen	mg/L	14.2	5.1	10.46	27	
Hardness	mg/L	239.	102.	171.92	13	
Iron, dissolved	mg/L	<0.1	<0.1	0.1	1	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	<0.001	<0.001	0.001	1	
total	mg/L	--	--	--	--	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.15	<0.005	0.046	25	
Nitrate	mg/L	0.24	<0.02	0.057	27	
Nitrite	mg/L	0.027	<0.005	0.0061	27	
Organic	mg/L	1.06	0.15	0.30	23	
pH		8.75	7.4	8.26	46	
Phosphorus, dissolved	mg/L	0.157	0.012	0.048	12	
total	mg/L	0.405	0.019	0.065	54	
Solids, dissolved	mg/L	330.	160.	248.	30	
suspended	mg/L	13.	13.	13.	1	
Sulphate	mg/L	37.4	37.4	37.4	1	
Turbidity, J.T.U.		50.	1.	9.78	12	
Zinc, dissolved	mg/L	0.006	0.006	0.006	1	
total	mg/L	--	--	--	--	

TABLE 8

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Bonaparte River

Site: 0600329, at mouth

Sampling Period

Feb. 78 - March 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	222.	189.	210.67	3	
Coliforms fecal	MPN/100 ml	920.	8.	94.76	17	
Coliforms total	MPN/100 ml	1600.	33.	366.94	16	
Colour T.A.C.		--	--	--	--	
Copper, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Dissolved oxygen	mg/L	14.8	4.7	10.55	15	
Hardness	mg/L	221.	195.	210.	4	
Iron, dissolved	mg/L					
total	mg/L					
Lead, dissolved	mg/L					
total	mg/L					
Mercury, dissolved	mg/L					
total	mg/L					
Nitrogen, Ammonia	mg/L	0.061	<0.005	0.018	17	
Nitrate	mg/L	0.23	<0.02	0.065	17	
Nitrite	mg/L	0.005	0.005	0.005	17	
Organic	mg/L	1.07	0.14	0.305	17	
pH		8.8	8.2	8.42	18	
Phosphorus, dissolved	mg/L	0.04	0.04	0.04	1	
total	mg/L	0.437	0.016	0.060	33	
Solids, dissolved	mg/L	338.	180.	263.22	18	
suspended	mg/L	--	--	--	--	
Sulphate	mg/L	34.2	34.2	34.2	1	
Turbidity, J.T.U.		42.	42.	42.	1	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	

TABLE 9

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Clinton Creek

Site: 0600009, near mouth

Sampling Period

May 72 - Feb. 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	386.	261.	326.92	24	
Coliforms fecal	MPN/100 ml	2400.	7	331.37	24	
Coliforms total	MPN/100 ml	5420.	14	940.9	30	
Colour T.A.C.		42.	4	12.14	7	
Copper, dissolved	mg/L	0.004	<0.001	0.0024	7	
total	mg/L	0.02	<0.001	0.0054	11	
Dissolved oxygen	mg/L	13.9	6.1	10.72	29	
Hardness	mg/L	405.	288.	341.75	12	
Iron, dissolved	mg/L	0.1	<0.1	0.1	7	
total	mg/L	0.4	<0.1	0.266	3	
Lead, dissolved	mg/L	0.002	<0.001	0.0011	6	
total	mg/L	0.029	<0.001	0.006	8	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.4	<0.005	0.096	19	
Nitrate	mg/L	0.76	<0.02	0.20	28	
Nitrite	mg/L	0.016	<0.005	0.0066	28	
Organic	mg/L	2.	<0.01	0.448	19	
pH		9.	7.8	8.49	54	
Phosphorus, dissolved	mg/L	0.122	0.023	0.0646	5	
total	mg/L	0.214	0.024	0.077	63	
Solids, dissolved	mg/L	468.	312.	403.03	39	
suspended	mg/L	22.	3.	8.1	5	
Sulphate	mg/L	57.3	27.5	40.6	20	
Turbidity, J.T.U.		16.	1.2	3.48	21	
Zinc, dissolved	mg/L	0.009	<0.005	0.0062	5	
total	mg/L	0.03	<0.005	0.012	12	

TABLE 10

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Loon Creek

Site: 0600336, at mouth

Sampling Period

April 79 - Oct. 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	--	--	--	--	
Coliforms fecal	MPN/100 ml	240.	4.	87.5	6	
Coliforms total	MPN/100 ml	1600.	17.	479.5	6	
Colour T.A.C.		--	--	--	--	
Copper, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Dissolved oxygen	mg/L	14.8	10.1	11.74	5	
Hardness	mg/L	--	--	--	--	
Iron, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.04	0.008	0.018	8	
Nitrate	mg/L	0.15	0.04	0.098	7	
Nitrite	mg/L	<0.005	<0.005	0.005	7	
Organic	mg/L	1.06	0.24	0.46	8	
pH		8.7	8.2	8.49	9	
Phosphorus, dissolved	mg/L	0.065	0.065	0.065	1	
total	mg/L	0.121	0.06	0.09	18	
Solids, dissolved	mg/L	284.	226.	265.5	4	
suspended	mg/L	32.	3.	13.4	5	
Sulphate	mg/L	16.	7.8	11.83	3	
Turbidity, J.T.U.		--	--	--	--	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	

TABLE 11

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Hat Creek

Site: 0600073, at mouth

Sampling Period

Nov. 72 - Feb. 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	275.	142.	245.05	20	
Coliforms fecal	MPN/100 ml	130.	2.	26.17	18	
Coliforms total	MPN/100 ml	240.	6.	60.36	14	
Colour T.A.C.		27.	1.	11.8	10	
Copper, dissolved	mg/L	0.003	<0.001	0.0015	8	
total	mg/L	0.005	<0.001	0.0021	13	
Dissolved oxygen	mg/L	14.5	6.3	10.54	22	
Hardness	mg/L	288.	137.	249.89	18	
Iron, dissolved	mg/L	<0.1	<0.1	0.1	7	
total	mg/L	2.2	0.1	0.51	7	
Lead, dissolved	mg/L	0.002	<0.001	0.0011	8	
total	mg/L	0.005	<0.001	0.0017	13	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	<0.05	0.05	8	
Nitrogen, Ammonia	mg/L	0.028	<0.005	0.126	17	
Nitrate	mg/L	0.09	<0.02	0.030	28	
Nitrite	mg/L	<0.005	<0.005	0.005	28	
Organic	mg/L	1.97	0.08	0.341	16	
pH		9.	7.9	8.46	4	
Phosphorus, dissolved	mg/L	0.02	0.006	0.0113	9	
total	mg/L	0.865	0.007	0.037	57	
Solids, dissolved	mg/L	428.	176.	338.88	34	
suspended	mg/L	4.	1.0	2.5	4	
Sulphate	mg/L	71.	24.2	51.16	15	
Turbidity, J.T.U.		29.	0.6	8.25	15	
Zinc, dissolved	mg/L	<0.005	<0.005	0.005	1	
total	mg/L	0.02	<0.005	0.0065	10	

TABLE 12

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Cache Creek

Site: 0600074, near mouth

Sampling Period

Nov. 72 - Feb. 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	268.	47.4	205.03	15	
Coliforms fecal	MPN/100 ml	170.	2.	49.93	16	
Coliforms total	MPN/100 ml	920.	5.	213.62	13	
Colour T.A.C.		44.	1.	13.71	7	
Copper, dissolved	mg/L	0.004	<0.001	0.0026	5	
total	mg/L	0.09	<0.001	0.013	8	
Dissolved oxygen	mg/L	14.2	5.8	10.05	24	
Hardness	mg/L	265.	47.4	186.43	15	
Iron, dissolved	mg/L	1.8	<0.1	0.44	5	
total	mg/L	0.3	0.2	0.25	2	
Lead, dissolved	mg/L	0.004	<0.001	0.00225	4	
total	mg/L	--	--	--		
Mercury, dissolved	mg/L	--	--	--		
total	mg/L	--	--	--		
Nitrogen, Ammonia	mg/L	0.133	<0.005	0.016	17	
Nitrate	mg/L	0.3	<0.02	0.054	27	
Nitrite	mg/L	0.026	<0.005	0.0058	27	
Organic	mg/L	0.37	0.06	0.172	17	
pH		9.	7.5	8.36	45	
Phosphorus, dissolved	mg/L	0.196	0.091	0.12	7	
total	mg/L	1.46	0.069	0.154	53	
Solids, dissolved	mg/L	412.	150.	289.27	30	
suspended	mg/L	6.	5.	5.5	2	
Sulphate	mg/L	55.7	17.5	36.87	8	
Turbidity, J.T.U.		670.	0.4	52.58	14	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	0.2	<0.005	0.031	8	

TABLE 13

EFFLUENT MONITORING RESULTS

Plant: Weyerhauser Pulp Mill, Kamloops

Sampling Period
Jan. 1965 - July 1979

Parameter		Max.	Min.	Mean	No. of Values	Comments
Bioassay	%	100	100	100	4	Fairly steady over year No definite trend
B.O.D.$_5$	Kg/day	16,018.	113	5331.9	628	
Carbon Org.	mg/L	346	64	154.94	66	Slight inc. 78/79 mean 167 mg/L
Chloride	mg/L	646	131	450.33	63	Fairly steady over last few years
Colour	T.A.C.	1900	220	1364	97	Slight inc. lately, 78/7 mean: 1401
Flow	m^3/d	462,943	38,720	182,210	1923	
Mercaptans	mg/L	9.6	0.0	0.3283	106	No sampling after mid 7 Definite inc. in 77
Nitrogen Kjel.	mg/L	29.	1.	4.31	49	Fairly steady since 75 no trend
NO_2/NO_3		0.03	0.02	0.025	2	
Oil & Grease	mg/L	53.6	0.2	9.75	61	
Oxygen Diss.	mg/L	11.0	0.1	3.48	1732	Fairly steady
pH		9.6	5.8	7.29	2007	
Phenol	mg/L	1.78	0.012	0.087	58	
Phosph. Total	mg/L	3.0	0.004	0.529	393	Slight inc. in 78/79
Phosph. Diss.	mg/L	2.2	0.003	0.197	57	Decrease in recent yrs. 78/79 mean 0.134
Product	tonnes/d	6119.9	34.1	956.07	637	Slight inc of prod. noted in 78/79
Solids Susp.	mg/L	130	1.4	39.42	134	Inc. 78/79 mean 63.58 19 values
Solids Diss.	mg/L	1954	960	1512	37	Inc. 78/79 mean 1761, 19 values
Spec. Cond.	UMHO/cm	3500	900	2055.2	134	Fairly steady over yrs.
Sulphate	mg/L	304	<8	158.88	66	Fairly steady over yrs.
Tan. & Lignin	mg/L	200	20	62.22	58	Fairly steady over yrs.
Temp.	°C	35	7.5	26.74	1749	
T.S.S.	Kg/d	19,360	1.5	10,069	87	Exceeds permit conditi fairly steady over the last two years

TABLE 14

SEWAGE EFFLUENT MONITORING RESULTS

Town: Kamloops

Sampling Period
Aug. 73 - April 79

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	80.	<10.	29.35	59	Fairly steady
Calcium, total	mg/L	21.8	15.3	18.57	7	Fairly steady, no trend
Chloride	mg/L	29.5	23.1	26.25	28	Steady over the year
Coliforms, Total	MPN/100 ml	920,000	80	80,184	48	
Coliforms, Fecal	MPN/100 ml	1,600,000	20	71,175	52	
Colour, T.A.C.		88.	16	56.5	26	Decrease in 1977
Flow	m^3/day	14,547	1,818	6,364	6	Well below Permit specified maximum
Nitrogen Ammonia	mg/L	24.7	2.18	16.3	43	Fairly steady, no trend
NO_2/NO_3		10	<0.02	2.46	34	Decrease in recent year
Nitrogen, Organic	mg/L	7.7	0.3	3.62	39	Fairly steady, no trend
Nitrogen, Total	mg/L	29.02	11.08	20.18	60	Steady, no trend
Oxygen, Diss.	mg/L	11.9	0.4	4.7	42	Inc. since early 1978
pH		8.1	6.4	7.37	104	
Phosphorus, Diss.	mg/L	5.46	0.012	3.05	49	Steady dec. starting 77
Phosphorus, Total	mg/L	6.85	0.064	2.79	129	Dec. strongly in 77, low since
Sodium, Diss.	mg/L	43.2	40.2	41.46	3	
Solids, Diss.	mg/L	300.	248.	269.61	31	Steady in recent years
Solids, Susp.	mg/L	125	5.	31.42	72	Slight red. starting 78
Spec. Cond.	UMHO/cm	620	411	512.93	104	Steady over the years

TABLE 15

SEWAGE EFFLUENT MONITORING RESULTS

Town: Ashcroft

Sampling Period

April 73 - Jan 79

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	281	<10	69.76	27	Drastic dec. starting May 77, mean: 27.51
Calcium, total	mg/L	21.1	16.0	18.93	9	Steady, no trend
Chloride	mg/L	35.6	11.7	22.37	23	Steady, no trend
Coliforms, Total	MPN/100 ml	2.8×10^6	49,000	1.4×10^6	13	Steady
Coliforms, Fecal	MPN/100 ml	9.2×10^6	700	1.37×10^6	17	Definite reduction Start. May 77:mean 130,427
Colour, T.A.C.		232	10	66.14	21	Steady, no trend
Flow	m^3/day	868	868	868	1	
Nitrogen Ammonia	mg/L	16.6	0.145	9.2	11	Highly erratic readings
NO_2/NO_3		21.2	<0.02	6.49	15	Highly erratic readings some drop in 78
Nitrogen, Organic	mg/L	17.6	1.0	8.9	8	Decrease since 77
Nitrogen, Total	mg/L	59.1	11.3	23.34	28	Decrease since 77
Oxygen, Diss.	mg/L	6.5	0.3	3.43	14	
pH		9.8	4.7	7.31	41	
Phosphorus, Diss.	mg/L	8.55	1.48	4.12	20	No change over years
Phosphorus, Total	mg/L	17	0.396	5.28	49	No change over years
Sodium, Diss.	mg/L	52	34.1	41.76	10	Steady, no trend
Solids, Diss.	mg/L	492	160	270.67	27	Steady, no trend
Solids, Susp.	mg/L	218	6	70.96	25	Definite reduction start 77, mean 23.85
Spec. Cond.	UMHO/cm	604	184	396.86	42	Steady, no trend

TABLE 16

SEWAGE EFFLUENT MONITORING RESULTS

Town: Cache Creek

Sampling Period

July 71 - March 79

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	207	<10	37.41	60	Fairly steady over yrs.
Calcium, total	mg/L	--	--	--	--	
Chloride	mg/L	67	0.3	36.5	46	Steady, no trend
Coliforms, Total	MPN/100 ml	2.4×10^6	170	303,830	38	Extremely variable res.
Coliforms, Fecal	MPN/100 ml	350,000	70	40,965	35	" " "
Colour, T.A.C.		78	16	38.55	20	No sampling since 78
Flow	m^3/day	937	455	677	362	
Nitrogen Ammonia	mg/L	29.8	0.144	11.49	36	Definite dec. starting summer 78, May 78-Feb [illegible] mean: 3.91
NO_2/NO_3		20.5	0.02	6.61	32	
Nitrogen, Organic	mg/L	37.9	1.5	4.85	35	
Nitrogen, Total	mg/L	52.34	9.41	22.1		
Oxygen, Diss.	mg/L	4.5	0.9	2.5	37	Steady, no trend
pH		8.3	6.4	7.6	83	
Phosphorus, Diss.	mg/L	8.1	2.1	4.81	17	Steady over years
Phosphorus, Total	mg/L	17.3	0.129	5.88	95	Steady over years
Sodium, Diss.	mg/L	67	60.2	63.6	2	
Solids, Diss.	mg/L	694	415	520	40	
Solids, Susp.	mg/L	120	5	31	76	Def. dec. started in [illegible] 77-79 mean: 18.36 mg/L
Spec. Cond.	UMHO/cm	1200	675	909	87	Fairly steady

TABLE 17

SEWAGE EFFLUENT MONITORING RESULTS

Town: Clinton Creek

Sampling Period

Oct. 71 - Feb. 79

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	60	L 10	21.22	49	Fairly consistent with reg inc. during winter
Calcium, total	mg/L	--	--	--	--	
Chloride	mg/L	29.5	2.8	19.17	17	Fairly steady
Coliforms, Total	MPN/100 ml	1.1×10^6	<20	117,070	36	
Coliforms, Fecal	MPN/100 ml	1.1×10^6	<20	104,860	37	
Colour, T.A.C.		76	22	39.25	12	Fairly steady
Flow	m^3/day	3146	0.34	474	17	
Nitrogen Ammonia	mg/L	19.4	0.043	4.95	35	Fairly steady
NO_2/NO_3		0.71	0.019	0.086	34	Steady over the years
Nitrogen, Organic	mg/L	6.95	0.6	3.43	31	Fairly steady
Nitrogen, Total	mg/L	23	2.08	8.87	51	Fairly steady
Oxygen, Diss.	mg/L	G 20	0.7	6.2	38	Results erratic but mean steady
pH		10	6.1	8.38	71	Steady over years
Phosphorus, Diss.	mg/L	4.55	1.31	2.53	20	Fairly steady
Phosphorus, Total	mg/L	7.55	0.082	2.73	84	Fairly steady
Sodium, Diss.	mg/L	--	--	--	--	
Solids, Diss.	mg/L	888.	62.	574.35	31	
Solids, Susp.	mg/L	104	4	24.92	48	Fairly steady over years
Spec. Cond.	UMHO/cm	1280	130	923.65	72	Fairly steady over years

TABLE 18

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: N. Thompson R.

Site: 0600164, at Kamloops

Sampling Period

Jan 65 - June 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	54.2	21.1	34.77	99	Most parameters gen. steady over years with a few exceptions noted below
Coliforms fecal	MPN/100 ml	13	2	3.57	7	
Coliforms total	MPN/100 ml	5	5	5	2	
Colour T.A.C.		17	2	5.49	41	
Copper, dissolved	mg/L	0.01	0.001	0.005	25	
total	mg/L	0.02	0.001	0.004	21	
Dissolved oxygen	mg/L	13.2	8.2	10.78	41	
Hardness	mg/L	60.8	23.2	38.93	89	
Iron, dissolved	mg/L	0.1	0.001	0.03	38	
total	mg/L	3.8	0.003	0.56	19	
Lead, dissolved	mg/L	0.05	0.001	0.027	13	
total	mg/L	0.011	0.001	0.0027	23	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	12	
Nitrogen, Ammonia	mg/L	0.2	0.002	0.069	33	Pronounced drop since 7
Nitrate	mg/L	0.1355	0.02	0.085	27	
Nitrite	mg/L	0.00	0.005	0.005	22	Slight inc. since 76
Organic	mg/L	0.45	0.03	0.141	7	
pH		8.3	4.4	7.52	150	
Phosphorus, dissolved	mg/L	0.0213	0.002	0.0036	37	
total	mg/L	0.218	0.002	0.0115	129	Slight drop since 77
Solids, dissolved	mg/L	86.0	38.0	58.0	55	
suspended	mg/L	30.0	4.0	10.3	13	
Sulphate	mg/L	12.5	3.8	7.15	91	
Turbidity, J.T.U.		26.0	0.1	2.64	100	
Zinc, dissolved	mg/L	0.27	0.001	0.024	17	
total	mg/L	0.022	0.001	0.005	24	

TABLE 19

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: N. Thompson

Site: 0600025 at Birch Island

Sampling Period
May 72 - Aug. 76

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	241	11.8	35.36	20	All parameters fairly steady over the sampling period
Coliforms fecal	MPN/100 ml	--	--	--	--	
Coliforms total	MPN/100 ml	--	--	--	--	
Colour T.A.C.		22	1	6.91	12	
Copper, dissolved	mg/L	0.004	0.001	0.0018	12	
total	mg/L	0.01	0.001	0.0043	7	
Dissolved oxygen	mg/L	11.8	5.4	9.45	8	
Hardness	mg/L	216	14	42.67	16	
Iron, dissolved	mg/L	0.1	0.1	0.1	12	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	0.001	0.001	0.001	10	
total	mg/L	0.05	0.001	0.0126	7	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.01	0.01	0.01	1	
Nitrate	mg/L	0.22	0.05	0.13	14	
Nitrite	mg/L	0.005	0.005	0.005	14	
Organic	mg/L	0.08	0.08	0.08	1	
pH		8.7	6.7	7.36	36	
Phosphorus, dissolved	mg/L	0.003	0.003	0.003	7	
total	mg/L	0.062	0.003	0.014	30	
Solids, dissolved	mg/L	284	22	59.3	20	
suspended	mg/L	40	40	40	1	
Sulphate	mg/L	13.5	5.0	7.97	12	
Turbidity, J.T.U.		27	0.6	8.19	21	
Zinc, dissolved	mg/L	0.019	0.005	0.0077	9	
total	mg/L	0.022	0.005	0.0116	7	

TABLE 20

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: N. Thompson

Site: 0600002 at McLure

Sampling Period

August 66 - April 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	60.8	17.4	36.33	146	Increase noted since 1977
Coliforms fecal	MPN/100 ml	5	2	2.75	4	
Coliforms total	MPN/100 ml	--	--	--	--	
Colour T.A.C.		19	1	5.93	30	
Copper, dissolved	mg/L	0.05	0.001	0.0063	42	
total	mg/L	0.02	0.001	0.0052	36	
Dissolved oxygen	mg/L	13.6	6.0	10.31	25	
Hardness	mg/L	66.1	19.2	40.56	142	
Iron, dissolved	mg/L	0.12	0.001	0.049	56	
total	mg/L	1.0	0.1	0.345	9	
Lead, dissolved	mg/L	0.05	0.001	0.0136	36	
total	mg/L	0.064	0.001	0.0056	32	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	9	
Nitrogen, Ammonia	mg/L	0.2	0.003	0.068	39	Pronounced decrease since 1977
Nitrate	mg/L	0.22	0.07	0.107	33	
Nitrite	mg/L	0.005	0.005	0.005	33	
Organic	mg/L	0.25	0.04	0.089	13	
pH		8.78	6.6	7.59	176	
Phosphorus, dissolved	mg/L	0.006	0.002	0.0028	52	
total	mg/L	0.051	0.001	0.0083	125	
Solids, dissolved	mg/L	90	1	59.46	52	Slight decrease since 1977
suspended	mg/L	190	1	29.57	23	
Sulphate	mg/L	17	3.7	7.45	136	
Turbidity, J.T.U.		26	0.2	4.08	146	
Zinc, dissolved	mg/L	0.05	0.001	0.0084	37	
total	mg/L	0.03	0.001	0.0076	34	

Note: Most parameters fairly steady over the years with a few exceptions as marked.

TABLE 21

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Clearwater River

Site: 0600031at Clearwater

Sampling Period

May 72 - May 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	41.5	25.7	33.74	14	All parameters fairly steady over the years. No trends.
Coliforms fecal	MPN/100 ml	2.0	2.0	2.0	2	
Coliforms total	MPN/100 ml	7.0	7.0	7.0	1	
Colour T.A.C.		35	5	13.67	6	
Copper, dissolved	mg/L	--	--	--	--	
total	mg/L	0.001	0.001	0.0037	9	
Dissolved oxygen	mg/L	13.5	6.0	10.19	8	
Hardness	mg/L	42.4	25.4	34.77	13	
Iron, dissolved	mg/L	--	--	--	--	
total	mg/L	0.5	0.2	0.35	2	
Lead, dissolved	mg/L	--	--	--	--	
total	mg/L	0.1	0.001	0.0159	9	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.01	0.007	0.0085	2	
Nitrate	mg/L	0.1	0.08	0.091	7	
Nitrite	mg/L	0.005	0.005	0.005	7	
Total	mg/L	0.44	0.09	0.185	16	Organic was not sampled
pH		8.8	6.8	7.55	23	
Phosphorus, dissolved	mg/L	0.003	0.003	0.003	5	
total	mg/L	0.019	0.003	0.0073	21	
Solids, dissolved	mg/L	58	40	51	15	
suspended	mg/L	11.8	3.0	6.36	5	
Sulphate	mg/L	6.8	5.0	5.67	7	
Turbidity, J.T.U.		3.8	0.4	1.43	14	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	0.016	0.005	0.0077	8	

TABLE 22

SEWAGE EFFLUENT MONITORING RESULTS

Town: 100 Mile House

Sampling Period

Aug. 78 - Feb. 78

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	129	13	55.58	31	Erratic readings but mean steady
Calcium, total	mg/L	--	--	--	--	
Chloride	mg/L	66.2	28.5	50.85	27	Steady
Coliforms, Total	MPN/100 ml	1.6×10^6	130	418,690	21	Slight inc. starting 77
Coliforms, Fecal	MPN/100 ml	920,000	20	185,930	16	Slight inc. starting 77
Colour, T.A.C.		108	29	71.3	17	Steady
Flow	m^3/day	--	--	--	--	
Nitrogen Ammonia	mg/L	33.2	10	24.7	16	Fairly steady, no trend
NO_2/NO_3		0.427	<0.02	0.06	15	Very low since 1976
Nitrogen, Organic	mg/L	12	3.8	6.54	15	Steady
Nitrogen, Total	mg/L	39	17	27.51	26	Fairly steady
Oxygen, Diss.	mg/L	10	1.2	3.67	27	Fairly steady
pH		9.2	6.8	7.81	72	Steady
Phosphorus, Diss.	mg/L	8.96	2.9	7.04	15	Steady
Phosphorus, Total	mg/L	13.95	3.04	7.95	35	Steady
Sodium, Diss.	mg/L	150	74	120.36	25	Fairly steady
Solids, Diss.	mg/L	730	448	608.14	28	Steady
Solids, Susp.	mg/L	146	80	113	2	
Spec. Cond.	UMHO/cm	1475	240	1008.6	74	Some inc. noted starting in 77

TABLE 23

SEWAGE EFFLUENT MONITORING RESULTS

Town: Noranda Mine Camp

Sampling Period

Jan. 74

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	65	L 10	23.75	4	
Calcium, total	mg/L	--	--	--	-	
Chloride	mg/L	14.1	4.6	8.86	3	
Coliforms, Total	MPN/100 ml	200	200	200	1	
Coliforms, Fecal	MPN/100 ml	--	--	--	-	
Colour, T.A.C.		--	--	--	-	
Flow	m^3/day	--	--	--	-	
Nitrogen Ammonia	mg/L	--	--	--	-	
NO_2/NO_3		0.540	0.540	0.540	1	
Nitrogen, Organic	mg/L	1.48	1.48	1.48	1	
Nitrogen, Total	mg/L	5.54	1.89	3.71	2	
Oxygen, Diss.	mg/L	--	--	--	-	
pH		--	--	--	-	
Phosphorus, Diss.	mg/L	--	--	--	-	
Phosphorus, Total	mg/L	1.120	1.120	1.120	1	
Sodium, Diss.	mg/L	--	--	--	-	
Solids, Diss.	mg/L	493	90	202	4	
Solids, Susp.	mg/L	88	88	88	1	
Spec. Cond.	UMHO/cm	176	102	137.33	3	

TABLE 24

EFFLUENT MONITORING RESULTS

Plant: Noranda Mines, Boss Mt. Div.
Hendrix Lake, B.C.

Sampling Period
May 74 - July 79

PARAMETER		MAX	MIN	$\overline{X}$	NO. OF VALUES	COMMENTS
Chloride	mg/L	540	1.6	15.51	49	Act. mn. much lower~5 with 1 except. high
Colour, T.A.C.		1600	6	52	49	Steady, av. high due to single maximum
Copper, diss.	mg/L	1.53	0.006	0.39	57	Inc. lately 78/79 mean 0.59 mg/L
Cyanide	mg/L	2.3	<0.01	0.31	58	Err. res. val. above 1 mg/L from tm to tm
Iron, diss.	mg/L	1.0	<0.1	0.296	51	
Lead, diss.	mg/L	0.002	<0.001	0.00108	12	
Molybdenium dis	mg/L	3.2	0.00563	1.69	57	
Nitrite	mg/L	0.525	0.009	0.24	52	Fairly steady
Oxygen diss.	mg/L	11.2	5.9	8.64	53	
pH		8.6	6.0	7.34	141	Steady over years
Solids, diss.	mg/L	1610	96	244.18	34	Steady, max. could be result of mistake
Solids, susp.	mg/L	396	5	61.57	36	Dec. started 78, 79 avg was 18.44 mg/L
Spec. Cond.	UMHO/cm	2120	46	341	141	Steady over yrs. Single max-mistake or spill
Turbidity	J.T.U.	425	4.4	62.65	58	Act. mean~15, except fr isolated peaks

TABLE 25

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: S. Thompson

Site: 0500077, at Squilax

Sampling Period

May 70 - June 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	42.2	16.5	33.04	39	
Coliforms fecal	MPN/100 ml	79.0	2.0	14.83	6	
Coliforms total	MPN/100 ml	1609	2.0	361.6	5	Quite high and varied
Colour T.A.C.		19	19	19	1	
Copper, dissolved	mg/L	0.41	0.0	0.36	26	
total	mg/L	0.001	0.001	0.001	6	
Dissolved oxygen	mg/L	13.4	0.9	11.44	27	
Hardness	mg/L	44.0	29.2	36.83	34	
Iron, dissolved	mg/L	0.12	0.0	0.047	28	
total	mg/L	0.3	0.04	0.14	8	
Lead, dissolved	mg/L	0.041	0.001	0.006	26	
total	mg/L	0.004	0.001	0.016	5	
Mercury, dissolved	mg/L	0.02	0.02	0.02	6	
total	mg/L	0.26	0.02	0.059	16	
Nitrogen, Ammonia	mg/L	13.58	0.0	0.41	34	1976- 78 mean 0.006 mg/L
Nitrate	mg/L	0.1	0.02	0.05	31	
Nitrite	mg/L	0.005	0.005	0.005	22	
Organic	mg/L	9.28	0.01	0.36	34	1975-78 mean 0.006 mg/L
pH		9.2	6.6	7.54	52	
Phosphorus, dissolved	mg/L	11.0	0.0	0.35	32	1975-77 mean 0.003 mg/
total	mg/L	11.85	0.0	0.33	37	1975-78 mn. 0.0053 mg/
Solids, dissolved	mg/L	60.0	44.0	53.25	8	
suspended	mg/L	18.0	1.0	3.19	21	
Sulphate	mg/L	27.0	5.0	6.72	25	1974-77 mean 5.32 mg/L
Turbidity, J.T.U.		3.3	0.2	0.79	14	
Zinc, dissolved	mg/L	1.0	0.005	0.083	26	
total	mg/L	0.006	0.005	0.0052	5	

TABLE 26

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: S. Thompson

Site: 0600136, at Chase

Sampling Period

Oct. 73 - April 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	54.1	29.3	38.24	18	
Coliforms fecal	MPN/100 ml	170	2.0	38.5	6	
Coliforms total	MPN/100 ml	26.0	26.0	26.0	1	
Colour T.A.C.		18.0	1.0	3.88	63	
Copper, dissolved	mg/L	0.011	0.001	0.0028	7	
total	mg/L	0.014	0.001	0.004	6	
Dissolved oxygen	mg/L	15.0	5.0	10.66	24	
Hardness	mg/L	62.6	32.6	40.84	17	Increase in 77 - no further sampling
Iron, dissolved	mg/L	0.1	0.1	0.1	6	
total	mg/L	1.7	0.1	0.62	5	
Lead, dissolved	mg/L	0.003	0.001	0.002	2	
total	mg/L	0.003	0.001	0.0015	7	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	6	
Nitrogen, Ammonia	mg/L	0.021	0.005	0.0072	21	
Nitrate	mg/L	0.08	0.02	0.047	23	
Nitrite	mg/L	0.005	0.005	0.005	23	
Organic	mg/L	0.19	0.01	0.087	21	
pH		9.2	4.7	7.63	91	
Phosphorus, dissolved	mg/L	0.007	0.003	0.0032	29	
total	mg/L	0.121	0.003	0.0096	131	
Solids, dissolved	mg/L	90.0	44.0	64.0	32	
suspended	mg/L	45.0	2.0	14.2	5	
Sulphate	mg/L	9.2	5.0	6.96	27	
Turbidity, J.T.U.		21.0	0.3	2.21	38	
Zinc, dissolved	mg/L	0.027	0.005	0.013	3	
total	mg/L	0.04	0.005	0.009	9	

TABLE 27

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: S. Thompson

Site: 0600001, at Pritchard

Sampling Period

Nov. 71 - Feb. 75

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	54.5	30.2	35.0	31	No sampling since 75 (why?).
Coliforms fecal	MPN/100 ml	--	--	--	--	
Coliforms total	MPN/100 ml	--	--	--	--	
Colour T.A.C.		8.0	1.0	3.0	15	
Copper, dissolved	mg/L	0.08	0.001	0.0013	15	
total	mg/L	0.02	0.001	0.0034	18	
Dissolved oxygen	mg/L	12.2	5.9	7.7	8	
Hardness	mg/L	61.8	31.0	36.96	30	
Iron, dissolved	mg/L	0.1	0.01	0.082	14	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	0.006	0.001	0.002	12	
total	mg/L	0.105	0.001	0.0199	18	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Nitrogen, Ammonia	mg/L	0.05	0.01	0.022	4	
Nitrate	mg/L	0.09	0.02	0.051	28	
Nitrite	mg/L	0.005	0.005	0.005	28	
Organic	mg/L	0.14	0.02	0.082	4	
pH		9.2	6.8	7.65	50	
Phosphorus, dissolved	mg/L	0.017	0.003	0.0039	15	
total	mg/L	0.078	0.003	0.01	48	
Solids, dissolved	mg/L	96.0	46.0	54.05	14	
suspended	mg/L	16.5	0.5	3.8	19	
Sulphate	mg/L	8.5	5.0	6.26	25	
Turbidity, J.T.U.		6.7	0.5	1.59	29	
Zinc, dissolved	mg/L	0.06	0.005	0.016	9	
total	mg/L	0.02	0.005	0.0086	18	

TABLE 28

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: S. Thompson

Site: 0600135, at Pioneer Pk.

Sampling Period

Oct. 73 - June 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	44.7	30.8	34.4	40	
Coliforms fecal	MPN/100 ml	130.0	2.0	26.83	6	
Coliforms total	MPN/100 ml	--	--	--	--	
Colour T.A.C.		7.0	1.0	3.3	66	
Copper, dissolved	mg/L	0.007	0.001	0.0016	13	
total	mg/L	0.011	0.001	0.0031	7	
Dissolved oxygen	mg/L	15.0	4.6	10.4	48	
Hardness	mg/L	58.6	32.3	37.18	38	
Iron, dissolved	mg/L	0.1	0.1	0.1	12	
total	mg/L	0.7	0.1	0.38	6	
Lead, dissolved	mg/L	0.001	0.001	0.001	2	
total	mg/L	0.003	0.001	0.0013	8	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	7	
Nitrogen, Ammonia	mg/L	0.021	0.009	0.0147	7	
Nitrate	mg/L	0.09	0.02	0.04	48	
Nitrite	mg/L	0.005	0.005	0.005	45	
Organic	mg/L	0.23	0.03	0.116	7	Inc. noted starting 76
pH		8.6	4.4	7.56	125	
Phosphorus, dissolved	mg/L	0.004	0.003	0.003	29	
total	mg/L	0.033	0.003	0.0087	138	
Solids, dissolved	mg/L	80.0	46.0	53.74	39	
suspended	mg/L	13.0	2.0	3.53	8	
Sulphate	mg/L	20.1	5.0	6.6	33	
Turbidity, J.T.U.		6.0	0.8	2.2	51	
Zinc, dissolved	mg/L	0.005	0.005	0.005	3	
total	mg/L	0.007	0.055	0.0052	10	

TABLE 29

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Adams R.

Site: 0500001 at Celista Rd. Bridge

Sampling Period

May 70 - May 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	32.0	22.1	26.26	47	
Coliforms fecal	MPN/100 ml	23.0	<2.0	7.0	9	
Coliforms total	MPN/100 ml	1600.0	<2.0	240.33	9	
Colour T.A.C.		3.0	1.0	2.0	3	
Copper, dissolved	mg/L	0.17	0.0	0.0135	26	
total	mg/L	0.002	<0.001	0.00114	7	
Dissolved oxygen	mg/L	15.0	9.4	11.87	32	
Hardness	mg/L	39.6	23.3	29.1	43	
Iron, dissolved	mg/L	0.17	0.0	0.064	29	
total	mg/L	0.8	<0.02	0.272	8	
Lead, dissolved	mg/L	0.023	<0.001	0.005	24	
total	mg/L	0.005	<0.001	0.002	5	
Mercury, dissolved	mg/L	<0.02	<0.02	0.02	3	
total	mg/L	0.05	<0.02	0.04	14	
Nitrogen, Ammonia	mg/L	0.06	0.0	0.018	42	
Nitrate	mg/L	0.14	0.04	0.085	29	
Nitrite	mg/L	<0.005	<0.005	0.005	21	
Organic	mg/L	0.27	<0.01	0.1	43	
pH		8.8	6.6	7.53	66	
Phosphorus, dissolved	mg/L	<0.01	<0.003	0.0038	30	
total	mg/L	0.053	<0.003	0.0073	55	
Solids, dissolved	mg/L	52.0	32.0	42.35	17	
suspended	mg/L	85.0	<1.0	7.67	31	
Sulphate	mg/L	10.5	<5.0	5.94	26	
Turbidity, J.T.U.		2.8	0.2	0.72	21	
Zinc, dissolved	mg/L	0.8	<0.005	0.054	25	
total	mg/L	0.01	<0.005	0.006	5	

TABLE 30

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Salmon R.

Sampling Period

Site: 1130003, Salmon R. Valley #1

Oct. 73 - March 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	188.0	48.4	134.26	64	
Coliforms fecal	MPN/100 ml	2400.0	33.0	862.44	18	
Coliforms total	MPN/100 ml	2400.0	49.0	1069.3	20	
Colour T.A.C.		10.0	10.0	10.0	1	
Copper, dissolved	mg/L	--	--	--	--	
total	mg/L	0.006	0.001	0.002	7	
Dissolved oxygen	mg/L	--	--	--	--	
Hardness	mg/L	206.0	49.0	146.72	83	
Iron, dissolved	mg/L	--	--	--	--	
total	mg/L	0.9	0.3	0.51	7	
Lead, dissolved	mg/L	--	--	--	--	
total	mg/L	0.002	0.001	0.001	7	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	7	
Nitrogen, Ammonia	mg/L	0.09	0.007	0.033	28	
Nitrate	mg/L	0.12	0.05	0.085	2	
Nitrite	mg/L	0.005	0.005	0.005	2	
Organic	mg/L	0.99	0.04	0.286	28	
pH		9.2	7.2	8.14	108	
Phosphorus, dissolved	mg/L	0.106	0.021	0.05	56	
total	mg/L	0.83	0.024	0.1	167	
Solids, dissolved	mg/L	286.0	78.0	243.0	24	
suspended	mg/L	388.0	2.0	59.2	83	
Sulphate	mg/L	46.5	6.1	30.04	64	
Turbidity, J.T.U.		92.0	1.1	14.57	83	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	0.006	0.005	0.0054	7	

TABLE 31

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Salmon R.

Site: 0500062, at Hwy. 1 Bridge

Sampling Period

May 70 - Oct. 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	187.0	46.0	134.09	38	
Coliforms fecal	MPN/100 ml	7900.0	80.0	1205.9	10	
Coliforms total	MPN/100 ml	13000.	130.0	2296.9	20	
Colour T.A.C.		37.0	4.0	13.25	4	
Copper, dissolved	mg/L	0.16	0.001	0.022	23	
total	mg/L	0.005	0.001	0.0024	5	
Dissolved oxygen	mg/L	14.3	9.6	12.1	16	
Hardness	mg/L	214.0	49.0	143.24	36	
Iron, dissolved	mg/L	--	--	--	--	
total	mg/L	3.8	0.12	1.08	7	
Lead, dissolved	mg/L	0.021	0.001	0.0052	24	
total	mg/L	0.006	0.001	0.0026	3	
Mercury, dissolved	mg/L	0.04	0.02	0.025	4	
total	mg/L	0.18	0.02	0.0572	11	
Nitrogen, Ammonia	mg/L	0.33	0.0	0.035	37	
Nitrate	mg/L	0.46	0.02	0.108	27	
Nitrite	mg/L	0.005	0.005	0.005	19	
Organic	mg/L	1.0	0.03	0.279	37	
pH		8.7	7.2	8.03	52	
Phosphorus, dissolved	mg/L	0.1	0.0	0.045	29	mean of 7 May CONC. 0.0336 mg/L
total	mg/L	0.398	0.042	0.103	43	mean of 9 May CONC. 0.218 mg/L
Solids, dissolved	mg/L	256.0	109.0	211.46	13	
suspended	mg/L	300.0	2.7	50.24	28	
Sulphate	mg/L	47.6	8.3	31.01	34	
Turbidity, J.T.U.		82.0	0.8	10.87	17	
Zinc, dissolved	mg/L	0.74	0.005	0.007	24	
total	mg/L	0.016	0.005	0.01	3	

TABLE 32

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Shuswap R.

Site: 0500072, U/S Sugar Lake

Sampling Period

Aug. 72 - Aug. 78

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	38.6	16.8	27.36	10	
Coliforms fecal	MPN/100 ml	5.0	2.0	2.75	4	
Coliforms total	MPN/100 ml	280.0	2.0	73.75	4	
Colour T.A.C.		--	--	--	--	
Copper, dissolved	mg/L	0.001	0.001	0.001	2	
total	mg/L	0.002	0.002	0.002	1	
Dissolved oxygen	mg/L	13.2	8.4	10.68	5	
Hardness	mg/L	40.4	18.5	29.76	8	
Iron, dissolved	mg/L	0.1	0.02	0.06	4	
total	mg/L	0.2	0.1	0.15	2	
Lead, dissolved	mg/L	0.003	0.001	0.002	2	
total	mg/L	0.001	0.001	0.001	1	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.07	0.05	0.055	4	
Nitrogen, Ammonia	mg/L	0.01	0.005	0.0068	10	
Nitrate	mg/L	0.21	0.02	0.112	5	
Nitrite	mg/L	0.005	0.005	0.005	5	
Organic	mg/L	0.17	0.01	0.084	10	
pH		8.4	7.0	7.5	14	
Phosphorus, dissolved	mg/L	0.1	0.003	0.0042	6	
total	mg/L	0.024	0.003	0.0052	16	
Solids, dissolved	mg/L	40.0	32.0	37.0	4	
suspended	mg/L	24.0	0.8	5.1	8	
Sulphate	mg/L	5.8	5.0	5.1	11	
Turbidity, J.T.U.		4.1	0.4	1.35	9	
Zinc, dissolved	mg/L	0.015	0.005	0.01	2	
total	mg/L	0.005	0.005	0.005	1	

TABLE 33

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Shuswap R.

Site: 0500498, D/S Enderby

Sampling Period

Oct. 76 - June 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	49.6	37.6	42.43	7	
Coliforms fecal	MPN/100 ml	130.0	2.0	29.76	29	
Coliforms total	MPN/100 ml	540.0	8.0	144.21	29	
Colour T.A.C.		20.0	1.0	5.3	23	
Copper, dissolved	mg/L	--	--	--	--	
total	mg/L	0.005	0.005	0.005	1	
Dissolved oxygen	mg/L	13.6	8.6	10.3	4	
Hardness	mg/L	53.6	39.1	44.68	6	
Iron, dissolved	mg/L	--	--	--	--	
total	mg/L	--	--	--	--	
Lead, dissolved	mg/L	--	--	--	--	
total	mg/L	0.001	0.001	0.001	1	
Mercury, dissolved	mg/L	--	--	--	--	
total	mg/L	0.05	0.05	0.05	1	
Nitrogen, Ammonia	mg/L	0.071	0.005	0.0127	33	
Nitrate	mg/L	0.09	0.02	0.035	30	
Nitrite	mg/L	0.005	0.005	0.005	30	
Organic	mg/L	0.26	0.01	0.096	32	
pH		8.1	7.4	7.78	35	
Phosphorus, dissolved	mg/L	0.008	0.003	0.0032	28	
total	mg/L	0.035	0.003	0.0076	56	
Solids, dissolved	mg/L	76.0	48.0	62.35	23	
suspended	mg/L	25.0	1.0	5.95	20	
Sulphate	mg/L	7.7	5.2	6.33	11	
Turbidity, J.T.U.		6.4	0.4	1.79	22	
Zinc, dissolved	mg/L	--	--	--	--	
total	mg/L	0.006	0.006	0.006	1	

TABLE 34

WATER QUALITY DATA
COLLECTED BY THE PROVINCE

River: Shuswap River

Site: 0500069, at Mara Bridge

Sampling Period

March 71 - May 79

Parameter		Max.	Min.	Mean	No. of Values	Comments
Alkali T	mg/L	58.1	34.0	43.18	28	
Coliforms fecal	MPN/100 ml	110.0	17.0	39.57	7	
Coliforms total	MPN/100 ml	1600.0	7.0	195.23	26	
Colour T.A.C.		9.0	1.0	4.72	29	
Copper, dissolved	mg/L	0.16	0.001	0.016	18	
total	mg/L	0.002	0.001	0.00125	4	
Dissolved oxygen	mg/L	15.6	7.3	11.38	22	
Hardness	mg/L	62.6	38.3	47.35	29	
Iron, dissolved	mg/L	0.14	0.0	0.069	22	
total	mg/L	0.1	0.1	0.1	2	
Lead, dissolved	mg/L	0.06	0.001	0.0073	18	
total	mg/L	0.001	0.001	0.001	2	
Mercury, dissolved	mg/L	0.02	0.02	0.02	2	
total	mg/L	0.05	0.02	0.044	11	
Nitrogen, Ammonia	mg/L	0.38	0.0	0.02	52	
Nitrate	mg/L	0.1	0.02	0.042	46	
Nitrite	mg/L	0.006	0.005	0.0050	45	
Organic	mg/L	0.3	0.02	0.116	52	
pH		8.7	7.0	7.74	67	
Phosphorus, dissolved	mg/L	0.012	0.003	0.0035	47	
total	mg/L	0.036	0.003	0.0098	87	
Solids, dissolved	mg/L	88.0	52.0	63.69	39	
suspended	mg/L	24.0	1.0	7.73	33	
Sulphate	mg/L	12.9	5.0	7.81	29	
Turbidity, J.T.U.		11.0	0.4	2.68	41	
Zinc, dissolved	mg/L	0.87	0.005	0.082	18	
total	mg/L	0.005	0.005	0.005	2	

TABLE 35

SEWAGE EFFLUENT MONITORING RESULTS

Town: Enderby

Sampling Period

Dec. 70 - June 79

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	144	10	27.12	50	
Calcium, total	mg/L	31.1	31.1	31.1	1	
Chloride	mg/L	41.9	0.5	28.13	29	
Coliforms, Total	MPN/100 ml	350,000	6	29,495	41	Dec. in recent yrs. 1976-79 mean 7168
Coliforms, Fecal	MPN/100 ml	160,000	L 2	10,916	36	Dec. in recent yrs 1976-79 mean 2433
Colour, T.A.C.		59	21	43.25	4	
Flow	m^3/day	1362	28	512	1353	
Nitrogen Ammonia	mg/L	25	0.05	15.32	36	Inc. since 77, 77-79 mean 20.48 mg/L
NO_2/NO_3		0.67	0.04	0.1567	12	1977-79 mean 0.115 mg/L
Nitrogen, Organic	mg/L	22	0.3	4.73	32	Slight inc. 1977-79 mean 5.17 mg/L
Nitrogen, Total	mg/L	37.7	1.91	21.48	39	Inc. since 77, 77-79 mean 26.09 mg/L
Oxygen, Diss.	mg/L	7.4	2.5	4.87	31	
pH		7.9	6.6	7.4	64	
Phosphorus, Diss.	mg/L	5.8	1.6	3.77	28	Slight inc. 77-79 mean 4.09 mg/L
Phosphorus, Total	mg/L	10.6	0.516	4.48	42	Fairly steady
Sodium, Diss.	mg/L	47.6	29.4	40.66	9	Fairly steady
Solids, Diss.	mg/L	613	259	375.88	17	
Solids, Susp.	mg/L	345	2	44.3	49	Some inc. noted in 77
Spec. Cond.	UMHO/cm	667	536	598.25	4	

TABLE 36

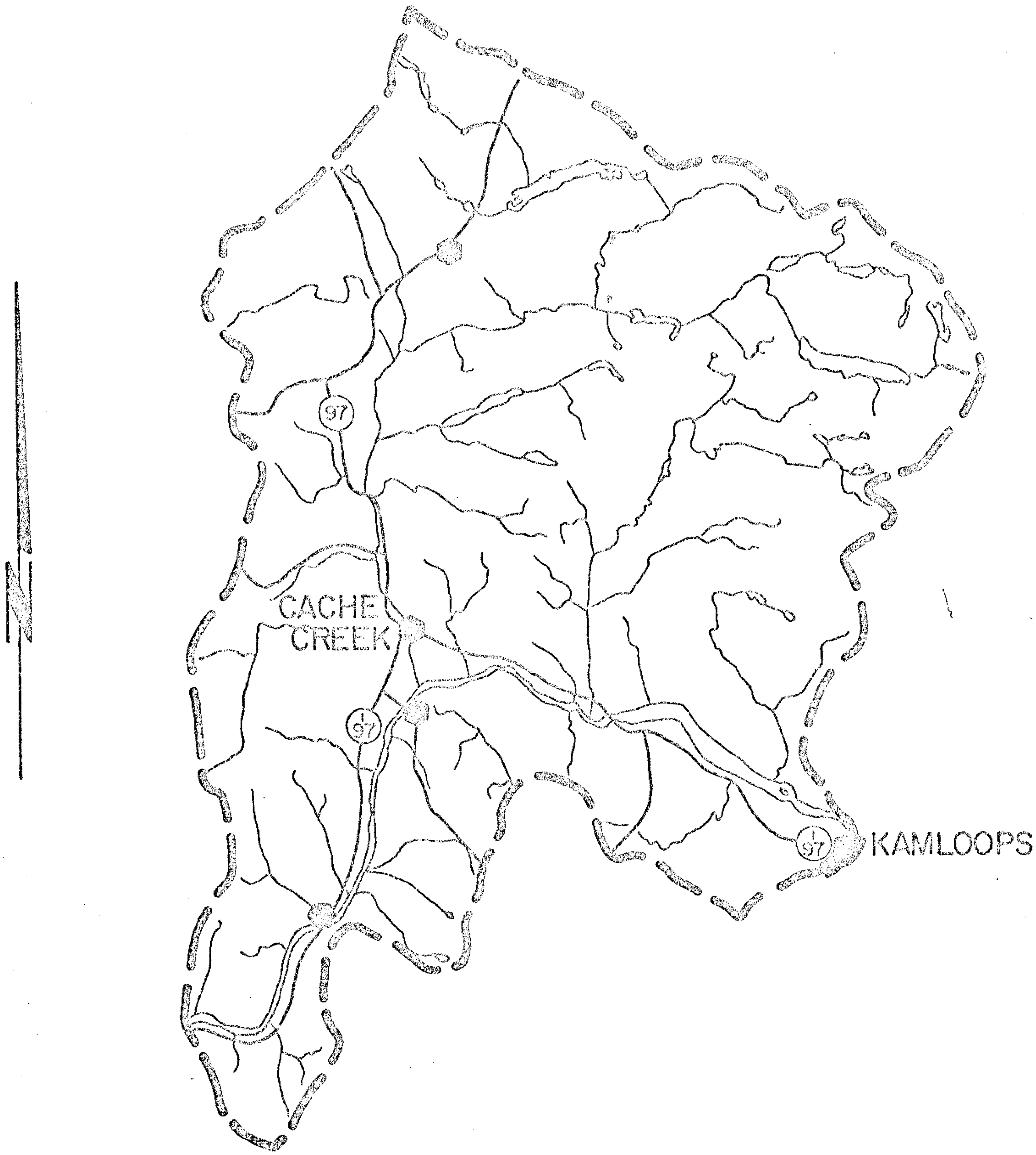
SEWAGE EFFLUENT MONITORING RESULTS

Town: Salmon Arm

Sampling Period

Sept. 69 - Oct. 79

		Max.	Min.	Mean	No. of Values	Comments
BOD_5	mg/L	905	<10	124.79		
Calcium, total	mg/L	--	--	--		
Chloride	mg/L	313	0.5	47.31	29	
Coliforms, Total	MPN/100 ml	$24x10^6$	24,000	$3.63x10^6$	33	
Coliforms, Fecal	MPN/100 ml	$16x10^6$	< 1	$1.21x10^6$	28	
Colour, T.A.C.		71	36	53.5	4	
Flow	m^3/day	2265	6.54	1548	125	
Nitrogen Ammonia	mg/L	50.4	0.139	12.34	36	
NO_2/NO_3		15.2	<0.02	3.036	17	
Nitrogen, Organic	mg/L	54	0.37	9.21	36	
Nitrogen, Total	mg/L	56.38	0.965	20.564	40	
Oxygen, Diss.	mg/L	--	--	--	--	
pH		8.3	6.0	7.48	56	
Phosphorus, Diss.	mg/L	60.8	0.0	6.53	31	
Phosphorus, Total	mg/L	106	0.1	10.48	47	
Sodium, Diss.	mg/L	60.6	37	46.27	7	Erratic Results
Solids, Diss.	mg/L	4128	288	883.1	10	Err. res. mean inf. by [illegible] single high mean 500mg/[illegible]
Solids, Susp.	mg/L	1933	1.0	168.89	51	Err. res. 3 highs above 1000 in 72,77-79 mn=41
Spec. Cond.	UMHO/cm	2600	6.37	789.01	51	High readings until 75 77-79 mean=592



LEGEND

DRAINAGE BASIN BOUNDARY

HIGHWAYS

1 inch = 15.3 MILES

THOMPSON SUB-BASIN

FIGURE 1

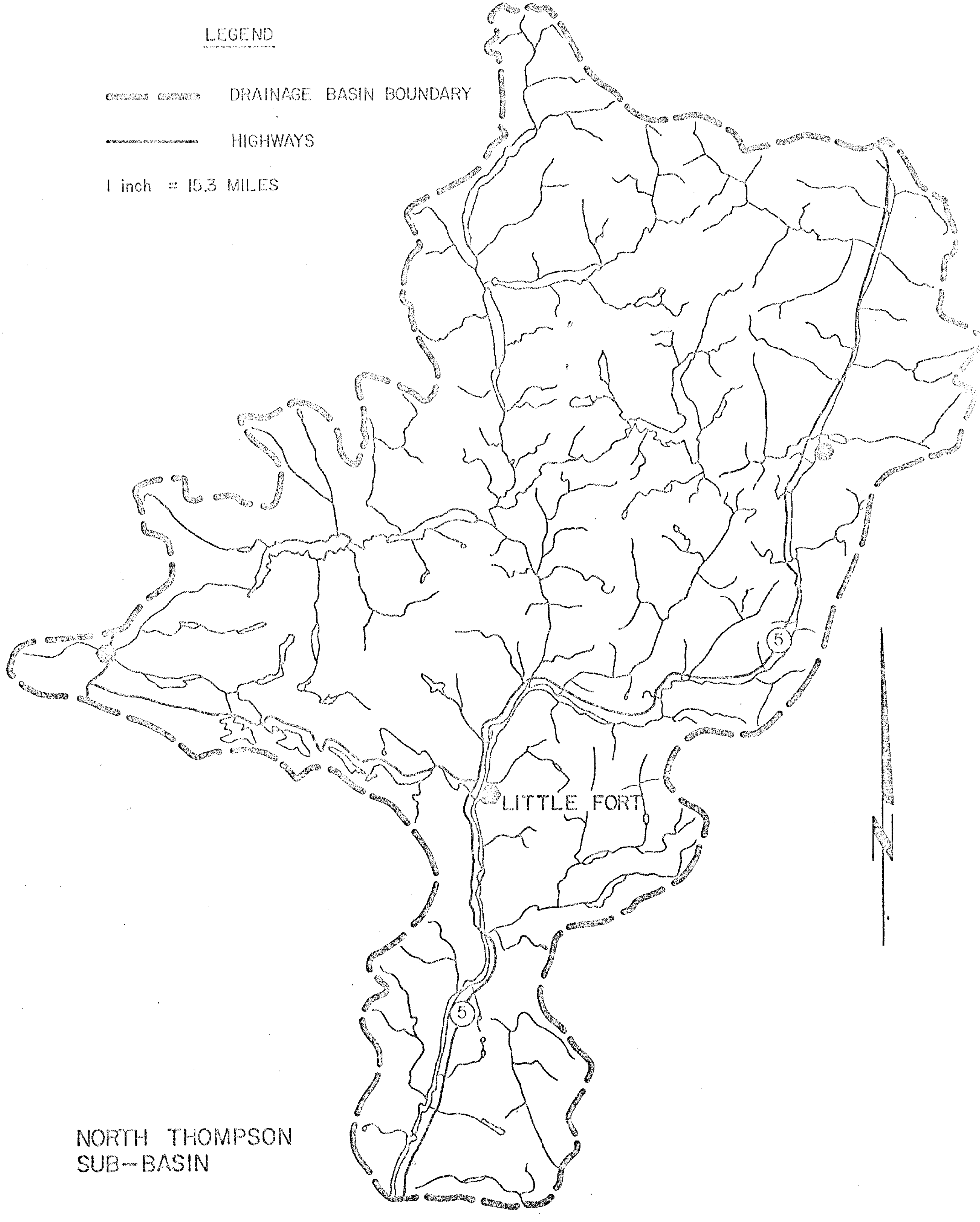
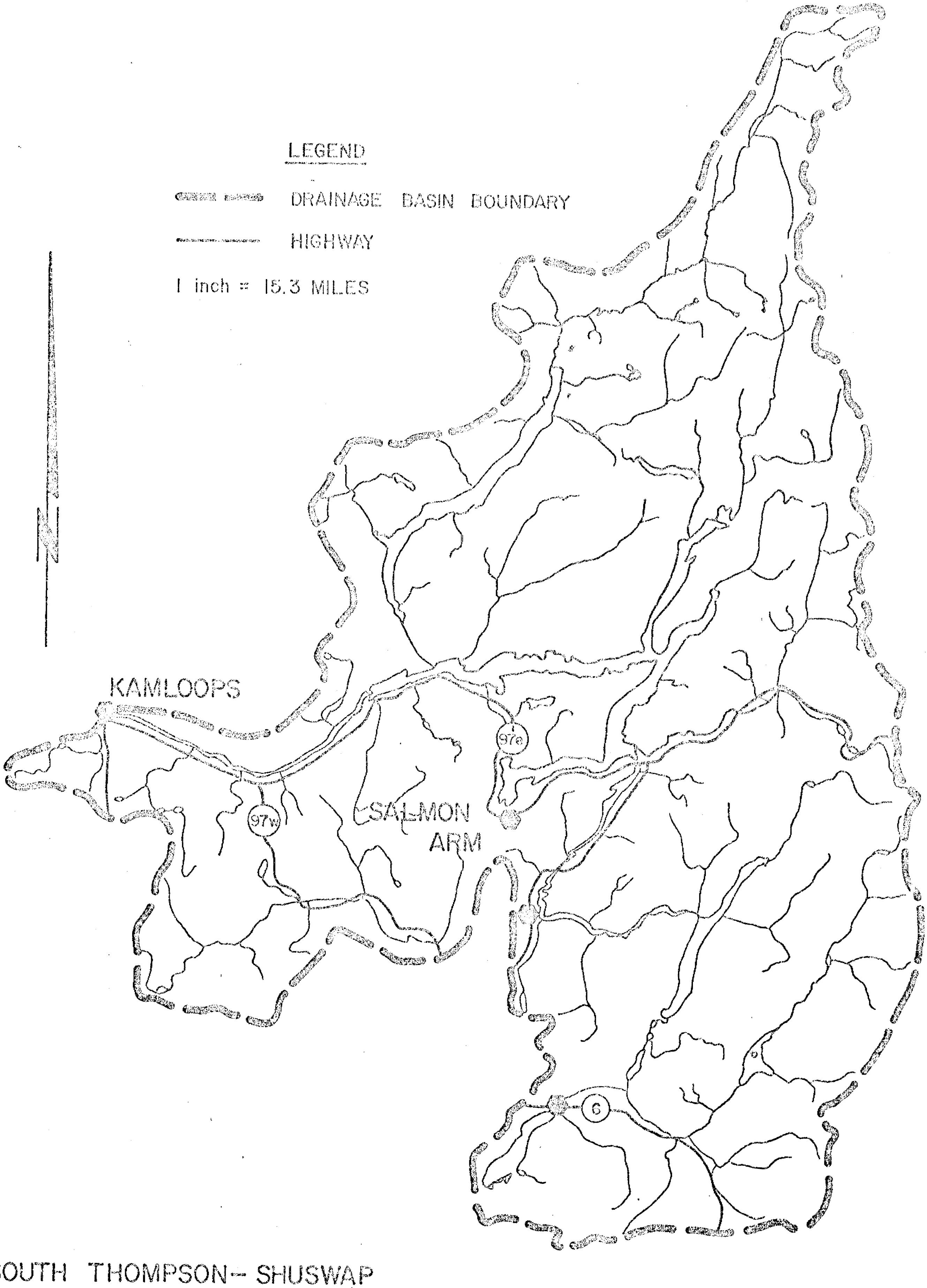
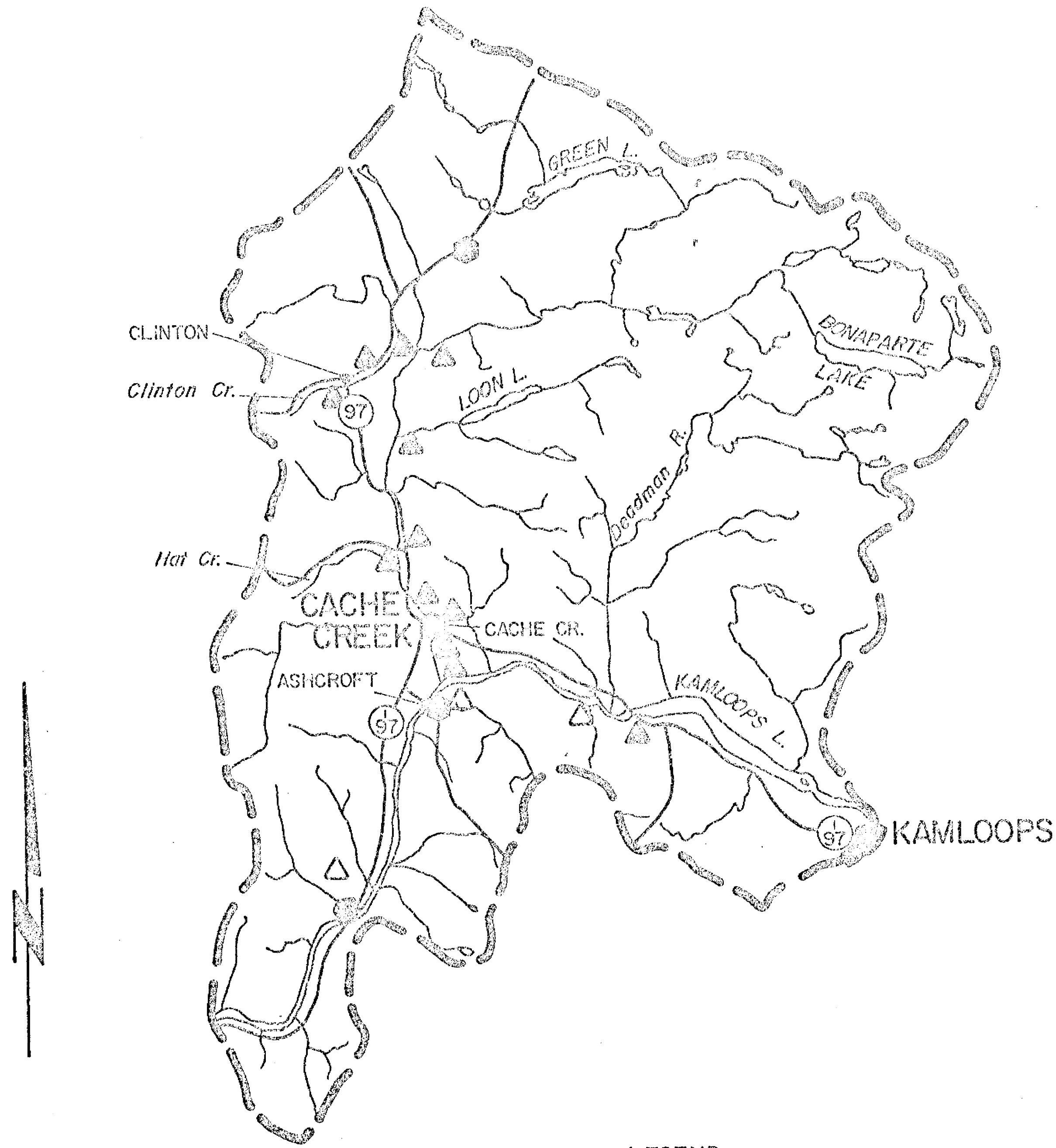

LEGEND
DRAINAGE BASIN BOUNDARY
HIGHWAYS
1 inch = 15.3 MILES
LITTLE FORT
5
5
N
NORTH THOMPSON
SUB-BASIN

FIGURE 2



SOUTH THOMPSON– SHUSWAP
SUB-BASIN

FIGURE 3



LEGEND

DRAINAGE BASIN BOUNDARY

HIGHWAYS

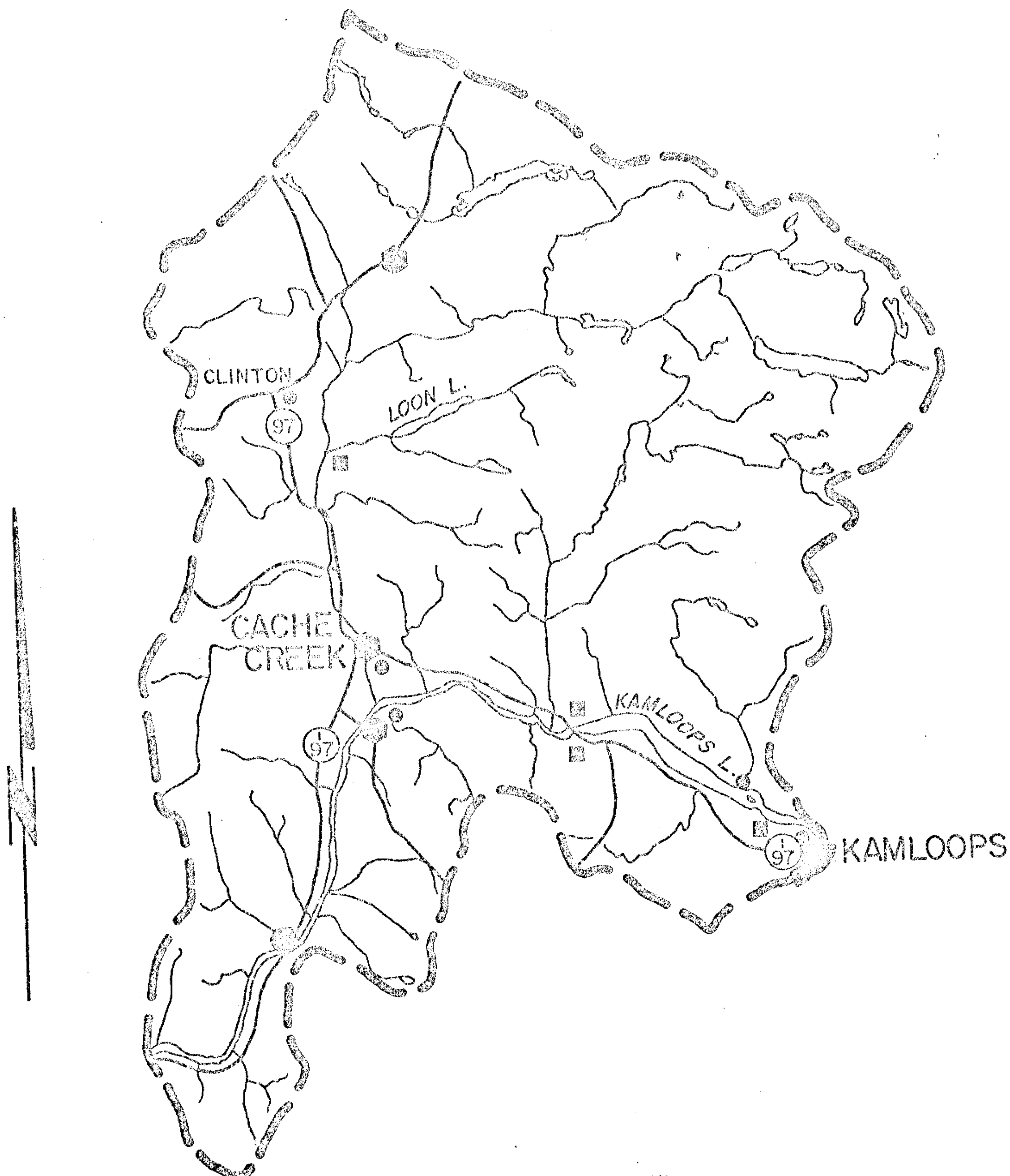
1 inch = 15.3 MILES

△ TEMPORARY SAMPLING STATION

▲ PERMANENT SAMPLING STATION

THOMPSON SUB-BASIN
WATER QUALITY SAMPLING STATIONS

FIGURE 4



LEGEND

DRAINAGE BASIN BOUNDARY

HIGHWAYS

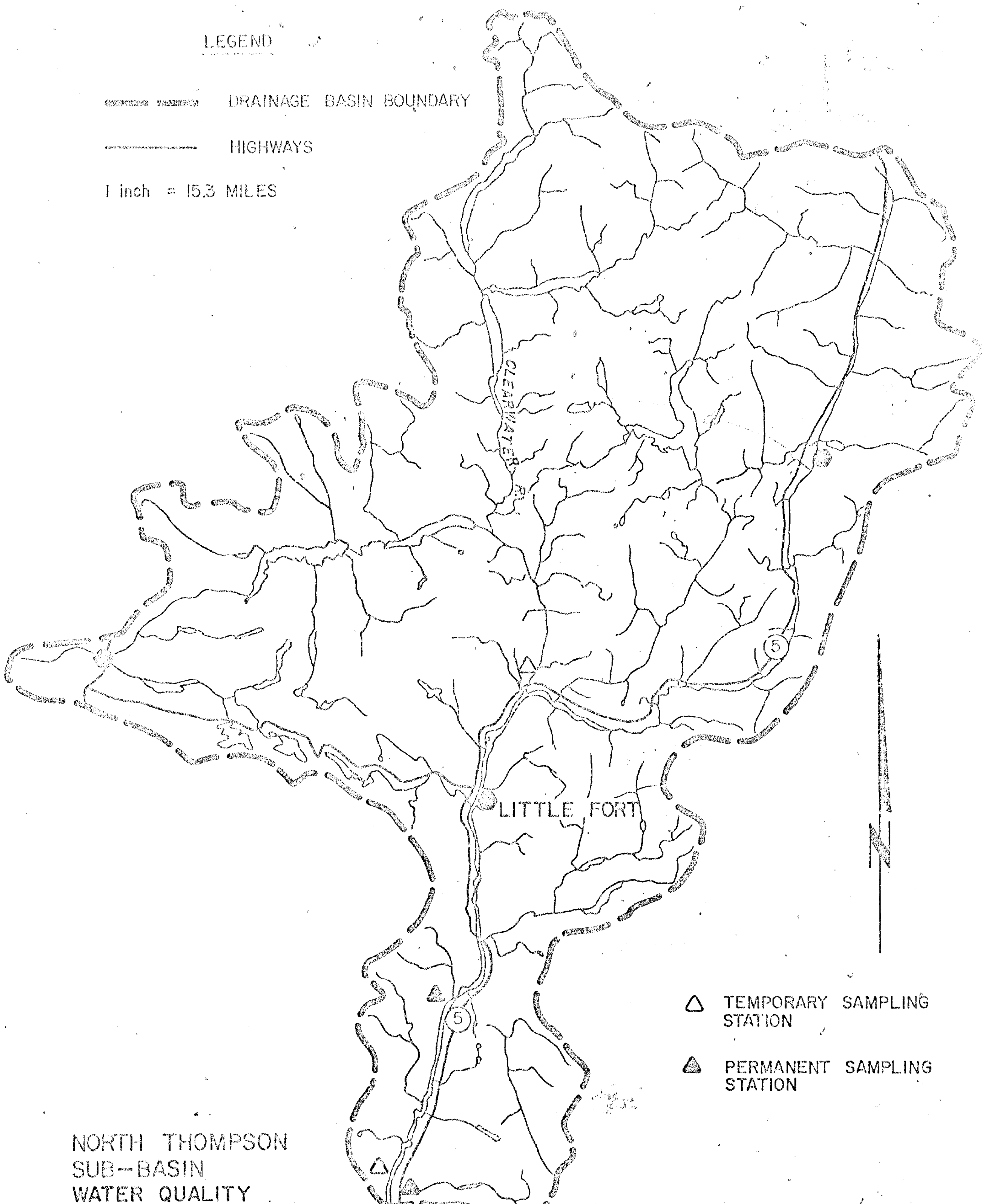
1 inch = 15.3 MILES

MUNICIPAL DISCHARGE

INDUSTRIAL DISCHARGE

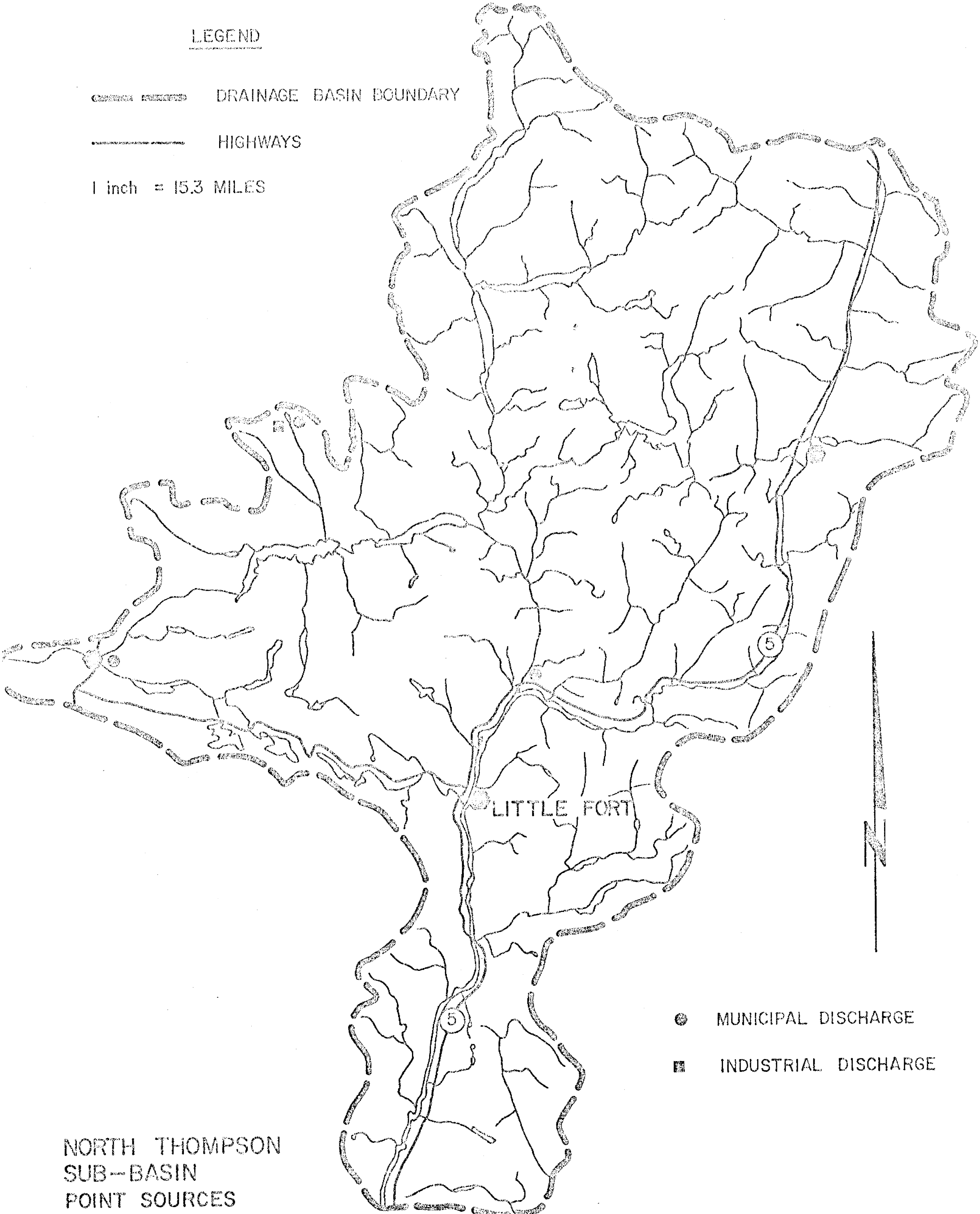
THOMPSON SUB-BASIN
POINT SOURCE LOCATIONS

FIGURE 5



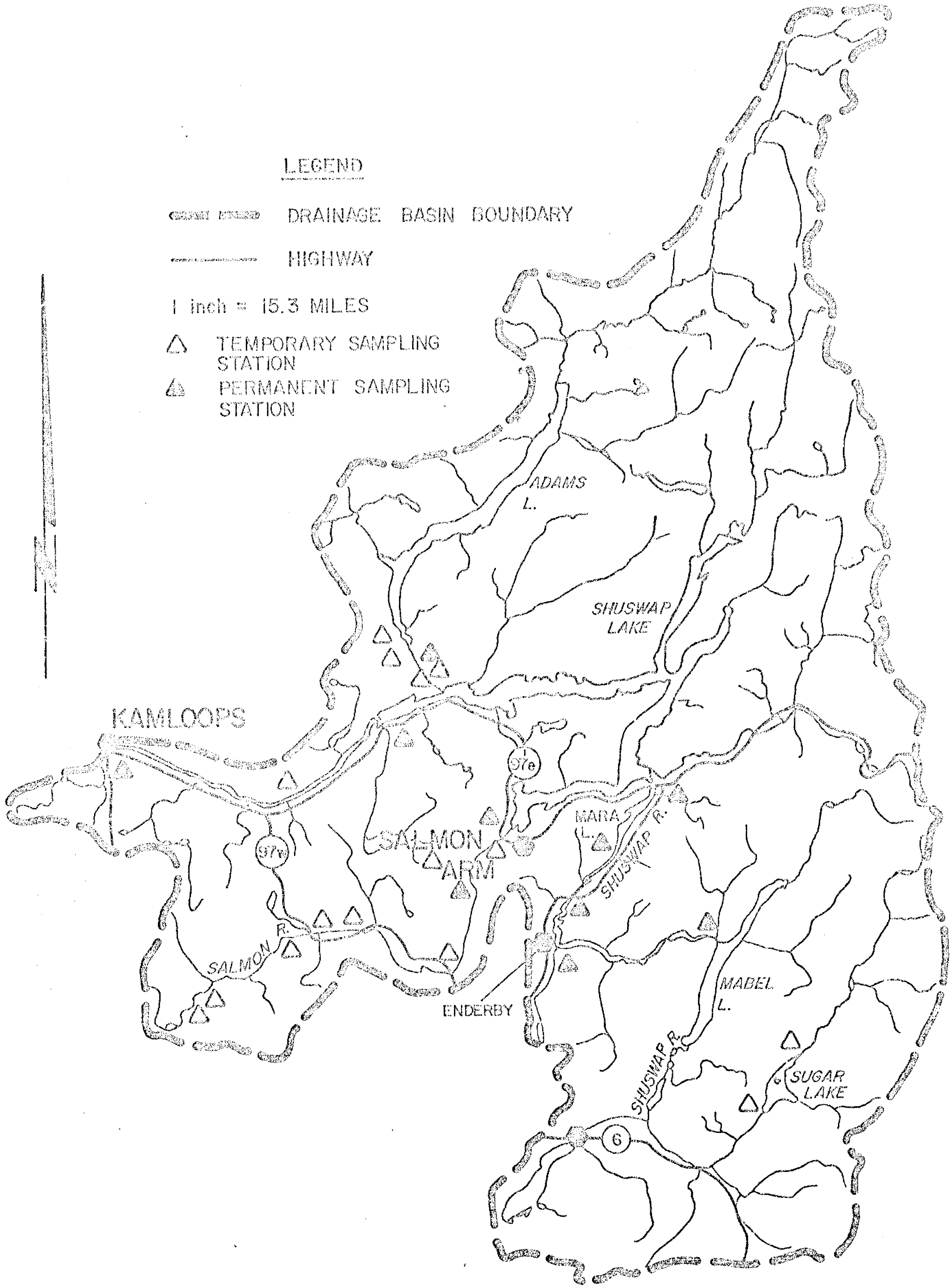
NORTH THOMPSON SUB-BASIN
WATER QUALITY SAMPLING STATIONS

FIGURE 6



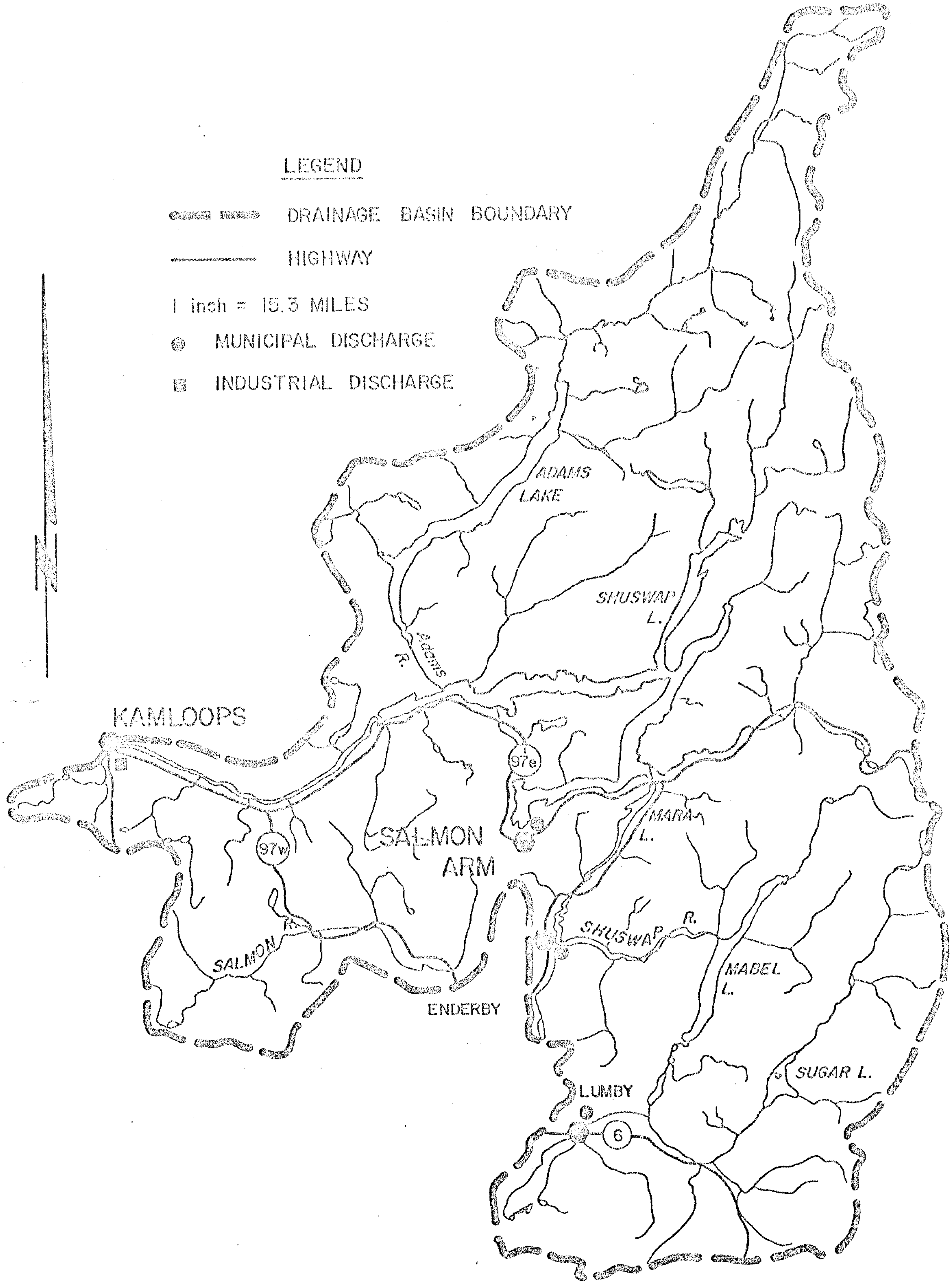
NORTH THOMPSON
SUB-BASIN
POINT SOURCES
LOCATIONS

FIGURE 7



SOUTH THOMPSON– SHUSWAP
SUB-BASIN
WATER QUALITY SAMPLING STATIONS

FIGURE 8



SOUTH THOMPSON— SHUSWAP
SUB-BASIN
POINT SOURCES LOCATIONS

FIGURE 9

PART TWO

Limnology and Lake Water Quality

Thompson River Basin Preplanning Study

prepared by

R. N. Nordin, Ph.D.

Water Investigations Branch

December 1979

Thompson River Basin Pre Planning
Water Quality - Item 4

1.2 Limnology and Lake Water Quality

There are a large number of lakes in the Thompson Basin, and they form an important role in many aspects of life in the watershed. The majority of lakes have never been sampled to document their physical/chemical/biological characteristics. What is intended here is to review those data which exist and to indicate those lakes in which a problem or problems exist and those lakes which some additional data collection might be made in order to more clearly identify problems or provide information on which to base water use or watershed management decisions.

The data are considered in three separate sub basins as was recommended by the Working Committee.

Limnology and Lake Water Quality

Summary

Listed below are some of the concerns which appear to be the most important. Other concerns are noted in the overall text. Accompanying these major concerns are suggestions for either remedial action or for further sampling which might be carried out under the basin study, if one is forthcoming.

1. Shuswap Lake, particularly Tappen Bay of Salmon Arm, is subject to two major discharges, the Salmon River and the Salmon Arm Sewage Treatment Plant. Evaluation should be made of what the effects of these discharges on the Bay are, and effects of reducing or modifying the discharges.
   On Shuswap Lake in general, the effect of changes in land use (residential development, logging, agriculture) on lake water quality.

2. Residential development guidelines for small lakes should be drawn up to assist planning agencies (perhaps on an individual site basis) in insuring that water quality deterioration does not take place as a consequence of cottage or residential development.

3. Adoption of a monitoring program for lakes which have little or no water chemistry information recorded for them, particularly for lakes as important as Adams Lake.

A. North Thompson Sub Basin

In terms of the overall Thompson Basin, the majority of the lakes are in the North Thompson Sub Basin. Particularly notable are the number of large lakes in and near Wells Gray Park in the Clearwater River drainage. These lakes include Hobson, Azure, Clearwater, Murtle, Mahood, and Canim. These lakes have surfaces areas greater than 25 km^2 and depths (from those measured) greater than 150 metres (Table 1). The two lakes which have been sampled (Mahood and Canim) show similar water chemistry (Table 2). Both are low in nutrients, moderately alkaline pH (7.8 - 7.9) with moderate dissolved solids (75-100) and alkalinity (55-76). Because of their montane setting (minimal littoral area) and low nutrients, the group of lakes would be regarded as "pristine" in layman's terms. This group of lakes and some smaller lakes (Horse, Coldscaur, Bowers) by virtue of their size and their protected (park) status would be unlikely to undergo any changes in water quality from man's activity. However, there are a number of smaller lakes in the sub basin which are more succeptable to disturbance and likely to suffer from the influence of development. Some of these small lakes displayed signs of problems with regard to water quality - either natural or man-mediated which have the potential of impairing human use of the water. Some limited sampling has been done at Hendrix Lake with regard to the discharge of domestic wastes from the village into the lake. North Barriere Lake has been sampled to determine water chemistry characteristics in the event that B.C.Hydro's Hat Creek Thermal Generating plant goes into service and causes some acidification of rain in the area. North Barriere Lake has very low dissolved ions and alkalinity (both parameters are less than 20 mg/L)(Table 1). Many other lakes and streams have been examined in the Thompson Basin (Newcombe, 1977) and potential acid rain problems are being addressed in another pre-planning submission by Don Holmes. Other lakes in the North Thompson which have been sampled include Paul Lake near Kamloops which is heavily utilized and an important sport fishing lake and the subject of a large number of fishery reports. Paul Lake is also one of a number of lakes being used as examples for development planning in trying to establish what loading of nutrients is acceptable in a lake basin before algal growth becomes objectionable. This water chemistry/nutrient/chlorophyll sampling was carried out by Waste Management Branch (ex PCB) in order to assist the Thompson Nicola Regional District with regard to planning guidelines around lakes (T.N.R.D., 1979). Several other lakes have been sampled in this regard in the other sub basins.

Other lakes with site specific problems include Horse Lake (near 100 Mile House) where sampling was initiated by complaints regarding drinking water quality. Dutch Lake has also been the subject of some concern with regard to the effect of watershed development on water quality. The lake has a very long water residence time as no inlet or outlet streams exist and so its succeptability to eutrophication appears very high. McGillivary Lake is sampled to monitor a ski development project and as one of the lakes in the acid rain background reports.

B. South Thompson - Shuswap Sub Basin

This area is dominated by two large lakes, Adams and Shuswap. Adams Lake is notable for the lack of data which has been collected. Despite its size (132 km^2, 475 metres deep) and importance, no water quality data of any kind have been collected.

Shuswap Lake on the other hand has been sampled at scattered intervals over the past 45 years by a number of agencies because of its importance as fishery habitat. It is also a highly favoured recreational area partially because of its excellent water quality. The first sampling was carried out by Clemens, et al. (1937). The longest sampling record has been compiled by the International Pacific Salmon Fisheries Commission. Their routine lake monitoring program has been directed toward salmon productivity and has consisted of temperature and conductivity profiles, some light penetration data, zooplankton biomass and (since 1974) identifications. Specific projects (ie., Ward, 1957) provided details on zooplankton populations. The Provincial Waste Management Branch has collected the vast majority of water chemistry information on the lake. Since 1971, a variety of parameters have been monitored at stations throughout the lake in an attempt to describe the basic limnology of the lake and to determine the sources of any contamination to the lake. Most recently the Environmental Protection Service of

Environment Canada has carried out sampling on the lake, particularly Salmon Arm (Kelso, 1979). Kelso (1979) as well as Truscott (1973) and Bryan (unpublished)have noted the significantly higher phytoplankton and nutrient levels in Tappen Arm than the rest of the lake.

From the collected data there appear to be identified a number of problems or potential problems. First is the supply of nutrients into Salmon Arm (Tappen Bay) and its effect on the water quality of that relatively isolated section of the lake. The nutrients originate from both the Salmon River, a highly agriculturalized valley, and the City of Salmon Arm, particularly the sewage treatment plant. The second concern with regard to Shuswap Lake is the general development pressure in the watershed. Large areas of land are being subdivided and developed and concern has been expressed that this activity would end in degradation of lake water quality. There are also concerns that forestry and agricultural activities could effect lake water quality. Concern for sewage contamination from houseboat discharges has also been noted.

Other lakes in the sub basin which have been examined include Sugar, Mabel and Mara Lakes (water quality summaries in Table 2). Sugar Lake serves as a control for other lakes in the area as it is relatively undisturbed. Mabel Lake is the next in the chain and it also is relatively undisturbed at present except for some farming activity at the inlet and the influences of discharges from the town of Lumby. There is some potential for large scale development if roads are upgraded and access improved.

Mara Lake is subject to change from two major sources. The first is the input from the Shuswap River of high concentrations of nutrients derived primarily from diffuse agricultural sources in farming areas around and downstream of Enderby. The second concern noted is from septic tank discharges near the lake in the Secamous area. As in Shuswap Lake, regulation of houseboat discharges is also a concern.

Nutrient discharges are also a concern for Three Valley Lake, but apparently because of a high water exchange rate the lake has not shown noticeable signs of deterioration. High water exchange also plays a large role in the water quality of Little Shuswap Lake, as the mean residence time appears to be about 0.03 years.

The other lake where sampling was carried out is at Tum Tum Lake (upper Adams River) as part of an acid rain monitoring program.

C. Lower Thompson Sub Basin

This sub basin has a smaller number of lakes than the other two basins but has the major centre of population and as such many of the lakes have very high utilization and are subject to the disadvantages of such utilization. These can be housing development or industrial development (mining). As well, some lakes are, in their natural state, very productive which limit their use to some degree.

The largest lake (by far) in the sub basin is Kamloops Lake. It has been the subject of a number of studies (Ward 1964, Kussat and Olan, 1975, Kelso and Derksen, 1976) the latter were of a Federal-Provincial Study which was undertaken to answer concerns about colour, foaming and fish tainting in the river. The limnology of the lake was superbly described (St. John, et al., 1976) during 1974 and 1975. The main concerns with regard to the lake are the discharges from the Weyernaeuser pulp mill and the city of Kamloops, however, because of the lake characteristics, the problems have been manifested in the Thompson River downstream of the lake.

Of the smaller lakes, several have received attention. Look Lake receives nutrients through its inlet stream from ranching operations upstream. It also has residential development which contributes nutrients to the lake. Fish and Wildlife Branch undertook a comprehensive study on the lake, and a report is in preparation.

Most of the other lakes have been sampled in response to three basic needs. The first is fisheries management Rawson, 1934, Johannes and Larkin, 1961, MacLeod, 1957) or by the Fish and Wildlife Branch in an attempt to improve winter kill lakes (i.e., Edith Lake).

The second need was to monitor the effect of Afton Mines smelter emissions on lake water chemistry, sediment chemistry and metal accumulations in fish tissues. These lakes (there are others in the Nicola Basin) include Six Mile, Pass, Duffy and Jocko.

The third group which are sampled are those monitored as baseline monitoring for possible acid rain effects. These lakes include Venables, Red and Phinetta lakes.

Water quality monitoring (for bacterial contamination) has been carried out by the South Central Health Unit at highly utilized beaches, ie., on Kamloops Lake, Barnes, Eleanor, Green, Loon and Paul lakes.

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TABLE 1

LAKE MORPHOMETRIC DATA - THOMPSON RIVER BASIN

NAME	ALT (meters)	SA (Km^2)	Z max (meters)	VOL. (decameters)	DRAINAGE (km^2) AREA	(YEARS) RET. TIME	(Km^2) AREA EPILIM	(DECAMETERS) VOL. EPILIM
GREEN	1,096	27.6	36	283,000			1.68	137,800
DUNN	451	3.7	84	204,860			25' 0.36	25' 27,123
N. BARRIERE	634	5.14	54	181,373	486	0.588		
E. BARRIERE	640	10.4	92	1,311,242	205	15		
JOHNSON	1,067	4.02	59	70,032	64		25' 0.59	25' 18,168
SUGAR	598	20.8	83	731,754	1,114	0.59	25' 5.25	25' 110,413
PINANTAN	853	0.65	18.9	6,553	58	[illegible]		
LITTLE SHUSWAP	347	18.1	59	260,633	15,974	0.029		
NISKONLITH	513	37	37	69,076	128	8	25' 0.66	25' 25,666
MONTE	684	1.77	36	38,184	60	0.73		
BARNES	636	0.56	12.8	3,685	115		15' 0.43	15' 1,920
DUTCH	305	0.34	40.8	8,908			25' 0.26	
AZURE	680	32.1	<150	3,343,658	1,088	1.98		
MURTLE	1,128	73.3	<60					
CANIM	772	56.2	208	4,794,890		8.4	20' 4.4	20' 328,848
MURPHY	792	10.1	23					
HENDRIX	1,067	0.9	9.4	4,247			20' 0.58	20' 620
HORSE	991	11.6	34	177,130	901	2.89		
RED	947	1.1	10	6,217			20' 0.48	20' 5,365
CLEARWATER	756	57.8	186					
SALMON	936	1.2	12	7,148				

TABLE 2

WATER QUALITY SUMMARIES FOR THOMPSON BASIN LAKES

	SUGAR LAKE	PHINETTA LAKE	DUNN LAKE	DUTCH LAKE	COLDSCAUR LAKE	HENDRIX LAKE	HORSE LAKE	RED LAKE	NED ROBERTS LAKE	LITTLE SHUSWAP LAKE	TUM TUM LAKE	McGILLIVRAY LAKE
Alkalinity:LAB	26	98	25.6		60			301	208	31	12	11
Arsenic:Total		<0.005	<0.005		<0.005			0.005	0.006		<0.005	0.0075
Cadium:Total	<0.0005	<0.0005	<0.0005		<0.0005			<0.0005	<0.0005		<0.0005	<0.0005
Calcium:Total	9.5	28	7		16			36			5	3.3
Calcium:Dissolved				23					44	11		
Carbon:Total Organic	1.75			9		9				2.6		
Carbon:Total Inorganic	6.25			27						6		
Chloride:Diss.	<0.5	1.0	<0.5		<0.5	<0.5		22			<0.5	<0.5
Chlorophyll a	1.2						1.14					
Colour:True	5								TAC 18			
Copper;Total	<0.001	0.002	<0.001		<0.001			0.0025	0.002		0.0015	0.0035
Hardness	28.5			92					206	34		
Iron:Total	0.1	0.1	<0.1		0.1			0.3	0.23		0.2	0.15
Lead:Total	<0.001	0.0015			<0.001			0.0025	0.002		0.0015	0.002
Magnesium:Total	0.9	5.3	1.6		3.85			37	24		0.33	0.53
Magnesium:Dissolved				8.4						1.6		
Manganese:Total	<0.02	<0.02	<0.02		<0.02			<0.02	0.05		0.03	<0.02
Mercury:Total	<0.05	<0.05	<0.05		<0.05			<0.05			<0.05	<0.05
Molybedenum:Total	<0.0005	0.0009	0.0013		<0.0005			0.00195			<0.0005	<0.0005
Nickel:Total	<0.01	<0.01		<0.01	<0.01			<0.01			<0.01	<0.01
Nitrogen:NH_4	0.009	0.094	0.005		0.007	0.027	0.019	0.12			0.048	0.0185
Nitrogen:NO_2-NO_3	0.09	0.055	<0.02	0.03	<0.02	<0.02	<0.02	0.13	<0.02	0.03	0.175	<0.02
Nitrogen:Organic	0.07					0.22	0.42					
Nitrogen:Total	0.15			1.5		0.25	0.44		0.475	0.11		
Phosphorus:Diss. Inorganic	<0.003					0.005	<0.003		<0.003	<0.003		
Phosphorus:Total Diss.	<0.003			0.009		0.011	0.005	0.088	0.006			
Phosphorus:Total	0.005	0.019	0.008	0.030	0.008	0.02	0.016	0.131	0.009	0.0056	0.0075	0.0085
Potassium:Diss.	0.7	1.3		0.2	0.6						0.4	
Residue:T.Inorganics	33.3											
Residue:T.Dissolved	42	125	33	155	74			340	266	49	26	41
Residue:T.Suspended						5						
Residue:Total Solids	44	127	35		81	58		360	269	55	34	44
Secchi Disc Depth feet	21.7					5	25					
Silica:Reactive	5.9	4.8	4.9		8.35			17.6			4	4.6
Sodium:Dissolved	0.8	4.3		1.25	2			25			0.8	0.95
Specific Conductance	60	190	54	204	115	48.5	277	500	415	73	33	25
Sulphate	5	5.2	<5		<5			<5	17.2		<5	<5
Turbidity	0.88					1.5			1.5			
Zinc:Total		0.0075		<0.005	<0.005			<0.005	0.005		<0.005	0.0055
pH	7.3	8.0	7.6	7.9	8.2	7.35	8.35	8.8	8.1	7.5	7.4	7.2

TABLE 2

WATER QUALITY SUMMARIES FOR THOMPSON BASIN LAKES (Continued)

	MARA LAKE	JOCKO LAKE	MABEL LAKE	NORTH BARRIERE LAKE	CANIM LAKE	THREE VALLEY LAKE	VENABLES LAKE	SIX MILE LAKE	OEMERS LAKE	McCONNEL LAKE	DUFFY LAKE
Alkalinity:LAB	43	240	40	17.2	76	23	485	335	160	144	430
Arsenic:Total		<0.005		<0.005			0.006	<0.005		<0.005	<0.005
Cadmium:Total		<0.005	<0.0005	<0.0005			<0.005	<0.0005		<0.0005	<0.005
Calcium:Total	16		15	4.75	18.45	8.5	40				
Calcium:Dissolved	15.8	57				8		31	60	34	29
Carbon:Total Organic	2.4		1.9		8.45	1.6			6.1	8	13.5
Carbon:Total Inorganic	11		9.6		16.8	4			45	39	107
Chloride:Diss.	0.5		<0.5	<0.5	0.5	0.8	4.8		0.6		
Chromium:Total	<0.005			<0.005			0.009				
Colour:True	7.5	TAC 10.5			17			TAC 9	TAC 7.7	TAC 2	TAC 7.3
Chlorophyll a	1.2		1.11			1.8					
Copper:Total		0.0005	<0.001	<0.001	DISSOLVED 0.0015		0.002	0.002		0.002	0.16
Hardness	48	270	44		71	27.5		315	177	133	575
Iron:Total	0.125	0.1	<0.1	0.1	<0.1		0.2	0.1	0.15	0.1	0.1
Lead:Total	<0.001	<0.001	<0.1	<0.001	0.0003		0.004	0.001	0.0005	0.001	<0.001
Magnesium:Total	2		1.7	0.53		1	216				
Magnesium:Dissolved		35.8			6.1			60	6.6	11.9	123
Manganese:Total	<0.02		<0.02	<0.02	<0.01		0.055				
Mercury:Total		0.2	<0.05	<0.05			<0.05	0.09		0.05	0.05
Molybedenum:Total			0.0007	0.001	DISSOLVED 0.0053		0.003				
Nickel:Total	<0.01		<0.01	0.01			<0.01				
Nitrogen:NH_4	0.0125	0.045	0.0115	0.005	0.018	0.011	0.07		0.57		0.17
Nitrogen:NO_2-NO_3	0.09	0.02	0.0675	0.02	0.035	0.14	<0.02	<0.02	0.02	0.04	0.04
Nitrogen:Organic	0.10	1.03	0.20		0.225	0.114			0.41		1.16
Nitrogen:Total	0.185	1.065	0.24		0.27	0.260		0.76	0.89	0.64	1.45
Phosphorus:Diss. Inorganic		0.0375	<0.003		<0.003			<0.003	0.003	<0.003	<0.003
Phosphorus:Total Diss.	0.0045	0.034	0.0035			0.003		0.008	0.006	0.007	0.009
Phosphorus:Total	0.0085	0.068	0.003	0.007	0.008	0.006	0.110	0.018	0.026	0.013	0.019
Potassium:Diss.	0.9		0.7	0.4	1.1	0.86					
Residue:T.Inorganics	53		49		82.8						
Residue:T.Dissolved	68	455	62.5	16	101.4	41	1460	438	214	194	768
Residue:T.Suspended									9		
Residue:Total Solids	68	459	63.5	18	107		1491	446	221	197	780
Secchi Disc Depth (feet)	15.5		16.4			14		14.7		14.7	16.4
Silica:Reactive	7.2		6.75	3.9	7.45	5.9	34				
Sodium:Dissolved	1.5		1.2	0.8		1.35	60				
Specific Conductance	108	658	94	34	152	62	1610	633	347	299	984
Sulphate	7.5	121	6.35	<5	<5	7	621	40	23.6	13.4	183
Turbidity	1.37	1.7	0.65		0.48	2.2		4.4	1.56	0.8	1
Zinc:Total	0.009	<0.005		<0.005	<0.005		0.008	<0.005		<0.005	0.005
pH	7.67	8.2	7.7	7.7	7.9	7.35	8.5	8.7	7.7	8.1	8.6

TABLE 2

WATER QUALITY SUMMARIES FOR THOMPSON BASIN LAKES (Continued)

	MAHOOD LAKE	LOON LAKE	PAUL LAKE
Alkalinity:LAB	55	295	156
Calcium:Dissolved	14	23	37
Carbon:Total Organic	5	5.3	7.7
Carbon:Total Inorganic	12.5	72	39
Chloride:Diss.		2.3	1.2
Chlorophyll a		5.2	1.6
Colour:T.A.C.;True	TAC 10.5		15
Copper:Total	DISS 0.0015		
Hardness	54	214	167
Iron:Total	DISS. <0.1		
Lead:Total	DISS <0.001		
Magnesium:Dissolved	4.25	37	17.6
Molybedenum:Total	0.004		
Nitrogen:NH_4		0.032	0.016
Nitrogen:NO_2-NO_3	<0.02	0.10	<0.02
Nitrogen: Organic		0.5	
Nitrogen:Total	0.145	0.63	0.34
Phosphorus:Diss. Inorganic	<0.003	0.041	0.003
Phosphorus:Total Diss.		0.050	
Phosphorus:Total	0.006	0.058	0.0085
Potassium:Diss.		6.6	2.5
Residue:T. Dissolved	75	325	215
Residue:Total Solids	77	328	217
Secchi Disc. Depth feet			16
Silica:Reactive			9.3
Sodium:Dissolved		37.5	7.5
Specific Conductance	113	517	340
Sulphate	<5	<5	26.4
Turbidity		0.78	0.58
pH	7.8	8.6	8.3

Part Three

NON-POINT SOURCE WATER QUALITY CONCERNS IN THE THOMPSON-SHUSWAP BASIN

Background report for the
Thompson-Shuswap Pre-planning Study

Prepared by J.H. Wiens, Ph.D., P.Ag.

Water Investigations Branch

December, 1979

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1. INTRODUCTION

Tributary stream inflows, direct waste discharges (e.g. sewage treatment plants) precipitation, natural groundwater inflows, and diffuse leachate and runoff from various land use activities in a watershed all affect quality of receiving waters. Lake, stream, and river monitoring provides a composite measure of the impacts of all of these sources. To direct effective management at causes of degraded water quality, information on sources of impaired quality inflows is needed.

This report will deal with non-point or diffuse sources of water enriching nutrients or other potential contaminants. Erosion and sedimentation, agricultural activities, on-site land disposal of sewage, urban storm water runoff, and several miscellaneous sources are topics discussed.

Non-point sources, by their nature, are difficult to characterize or even detect. Data is therefore sparse. This report will identify some concerns which have been raised, indicate data which is available, present limited data on potential nutrient loadings from agricultural sources, and make recommendations for consideration by the working committee.

2. EROSION AND SEDIMENTATION - FORESTLAND

Forest harvesting practices have been blamed in the press, in briefs to government, and in questionnaire responses, for various problems including unsightly clearcut areas on mountain slopes, logging debris in streams and lakes, low summer stream flows, and sediment in spawning beds and water (high turbidity and residue). Sediment is a concern from both a water quality and a fish habitat point of view. Eroding areas whether forested, agricultural or other, should therefore be termed non-point sources.

Mass movement, sheet, rill or gully erosion processes are natural but may be accelerated by man's activities. Natural and accelerated rates are affected by factors such as steepness of slope, nature of soil and geologic materials etc. A particular situation of very high sediment loads in August 1976 (Kingfisher Creek - tributary to the Shuswap River) was alleged to be due to forest harvesting. On investigation, slumps were shown to have occurred primarily in undisturbed heavy timbered areas. This same creek continued to supply the major sediment load to the Shuswap River below Mabel Lake even in 1977 (Nordin, 1976). Undoubtedly forest operations have been the cause of high sediment loads in other cases.

The nature and extent of erosion and sedimentation in forested areas in the Thompson-Shuswap Basin is not well documented (Mitchell, 1979). Forest Service, Fish and Wildlife Management Branch, timber company, and various other agency personnel and local residents likely have knowledge of general high erosion rates in some areas, and times and locations of specific events. Agency files likely also contain reports.

Recommendation 1 is presented.

3. AGRICULTURAL ACTIVITIES

Concentrations of agricultural activities occur in various river valleys of the Thompson-Shuswap Basin. Extensive grazing occurs on range-lands of benches and plateaus etc. often further from river and stream valleys. Most prominent river valley concentrations include those of the Shuswap River (including Fortune Creek), Salmon River, White Creek, South Thompson River, North Thompson (various reaches), lower Barriere River, Louis Creek, Thompson River between Kamloops and Ashcroft, Deadman Creek, and the Bonaparte River. Primary intensive activities include overwintering and feeding of cattle, feedlot feeding of cattle, poultry and egg production, swine production, irrigated alfalfa and other hay production, sweet and silage corn production, small grain, and other miscellaneous crop production.

Feedlots, particularly proposed feedlots, are a public concern in relation to water quality. The Inland Feeders proposed feedlot near the Lafarge cement plant in E. Kamloops was strongly opposed by some members of the public and press, and by the Thompson-Nicola Regional District to the point of court proceedings. In the case of that proposal, site inspections by a soils specialist, arrangements for leachate movement monitoring, and arrangements for runoff collection and land spreading of manure on cropland had all been made. The project has now been set aside by the proponents. A proposed 100,000 head feedlot at Wahlachin on the Thompson River has recently generated controversy. Details of this proposal are not available. Water quality is not the only concern in the case of feedlot proposals but it certainly is a major concern.

Feedlots presently in the areas are outlined in Table 1. It can be seen that proposed feedlot capacity far exceeds present capacity. A trend to increased beef production and finishing in B.C. is expected. Confrontations occurring on proposals for new feedlots must be minimized and investiations should be undertaken. Future approval or rejection decisions should be made with greater direct knowledge of impacts.

It is not known whether existing feedlots are a source of nutrients to waterways. At present this does not appear to be a concern but a potential does exist.

Recommendations 2a, 2b and 2c are made relative to feedlots.

Overwintering and concentrated area feeding adjacent to streams and rivers can be the cause of various problems. Nutrient and B.O.D. loading to streams by washoff of accumulated winter manure or direct cattle entry to streams are perhaps the greatest concerns. However, careless disposal of pesticides containers, erosion and sedimentation etc. have also been reported. Louis and Campbell Creeks are particularly prominent examples of such activities in the Kamloops area. However, complaints have been registered through the Agricultural Environmental Control (A.E.C.) office for activities near Knouff and Heffley Creeks as well. Convenience of stock watering by direct access to streams, and required ice removal for watering in feeding areas, often dictate locations and concentrations of cattle.

TABLE 1: CATTLE FEEDLOTS IN THE THOMPSON-SHUSWAP BASIN[1]

Name	Location	Maximum head/yr or estimated capacity (approx.)[2]	
Present:			
Ashcroft Estates	Ashcroft	1000	
Prairie Ranch	Cache Creek	800	
Junction Feedlots	Kamloops IR#1	2500	
Purity Feedlot	Kamloops (N. Thom. R., West side)	800	
Wayne Everett Feedlot	Monte Creek	600	
Harper Ranch	Kamloops (near Lafarge Plant)	3000	
			8700
Proposed:			
Inland Feeders	Kamloops (near Lafarge Plant)	5000	
-	Walhachin	100,000	
			105,000

[1]Information largely from Mr. J. Ryder, District Agriculturist, B.C. Ministry of Agriculture, Kamloops.
[2]Mr. J. Ryder emphasized that several of the lots are used for only a portion of the year.

Only limited documentation of the magnitude of water quality impacts of overwintering or feeding near streams is available (e.g. Tautz, 1979). Local Ministry of Agriculture, Environment, and Health personnel are aware of other problem situations. Improvements in some of these situations could be prescribed based on experience and good judgement. The A.E.C. program has been set up and has dealt with some situations as complaints are received. Further authority beyond this voluntary program lies with the Pollution Control Act. However, diffuse sources and particularly traditional agricultural practices present a difficulty for enforcement.

Recommendations 3a, 3b, 3c and 3d are offered.

Other alleged agricultural impacts on water quality include flooding of feeding, grazing, and cropped areas during spring high water and resultant washoff of manure and sediment (Shuswap River between Enderby and Mara Lake), surface runoff of manure and sediment from dairy farm barnyards and cultivated fields immediately adjacent to streams (Salmon River, White Creek), and possible runoff from miscellaneous hobby farms and swine operations (Tappen Creek, middle Shuswap River). In addition to observed direct stream entry of cattle and washing of manure into creeks, increased periphytic algae growth has been observed (McDonald, 1979). Other evidence includes reports on water quality monitoring on the Salmon and Shuswap Rivers (Bryan, 1976; Nordin, 1978). Circumstantial evidence is provided in a water quality report by the Environmental Protection Service (Ferguson, 1978). In many cases problem situations and desirable management improvements are known to local Ministry of Agriculture, Environment, and Health personnel.

No documentation is available on commercial fertilizer nutrient use in the Thompson-Shuswap Basin and certainly not on inflows to receiving waters. The same is the case for animal manures. In an attempt to assess nutrient use and production, Census of Agriculture statistics were compiled and estimates made for livestock and fertilizer nutrient loading to the land by sub-basin. This information is presented in Tables 2 and 3. By far the largest amounts of nutrients in livestock manures are produced in the S. Thompson and Thompson sub-basins. Cattle account for the largest amounts in all sub-basins, but amounts due to horses in all sub-basins, sheep and turkeys in the N. Thompson, and pigs and layers in the S. Thompson sub-basins should be recognized. Highest use of nutrients from commercial fertilizers is in the S. Thompson sub-basin (Table 3). This is likely due to the intensity of farming operations in the Shuswap and Salmon River valleys where both croplands and pastures are fertilized.

It must be emphasized that data presented in Tables 2 and 3 are only loadings to land. No estimates of loadings to receiving waters have been made. These would be very small fractions of loadings to land. Attenuation in nutrient pathways from land to water would have to be accounted for in making inferences on loadings to water.

Recommendations 4a and 4b are offered.

TABLE 2: ESTIMATED NUTRIENTS FROM LIVESTOCK AND POULTRY MANURES BY SUB-BASINS (KG/YR.)

Livestock Type / Sub-basins	N. Thompson		S. Thompson		Thompson	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Cattle	878,313	186,246	1,964,666	413,471	2,055,283	446,255
Pigs	5,259	1,663	22,224	7,409	5,566	1,855
Sheep	35,884	5,263	13,109	1,922	5,577	817
Horses	71,629	12,204	103,850	17,694	141,113	24,041
Layer Hens	2,104	818	99,856	38,834	8,698	3,380
Broilers	5,207	1,167	9,940	2,209	1,286	288
Turkeys	127,333	28,540	2,024	454	269	60
Geese	1,406	316	2,148	482	449	101
Ducks	565	1,068	1,095	245	255	57
TOTAL	1,127,700	237,285	2,218,912	482,720	2,218,496	476,854
Percent of Basin	20.3	19.8	39.8	40.3	39.8	39.8

Notes:

1. Statistical data on livestock numbers extracted from 1976 Canada Census of Agriculture, computer printouts of data by census sub-divisions courtesy of Mr. Hugh Bryce, Statistician, B.C. Ministry of Agriculture.
2. Census subdivision data on livestock numbers aggregated for sub-basins statistics as follows

Regional District / Sub-basins	N. Thompson	S. Thompson	Thompson
Cariboo	Subdivision A(10%)	--	- -
Columbia-Shuswap	- -	Subdivision C(100%)	- -
North Okanagan	- -	Subdivision A, IR(100%)	- -
Thompson-Nicola	Subdivision A(100%)	Subdivision E(100%)	Subdivision B(100%), D(56%)

TABLE 2 (Continued)

3. Nutrient production coefficients (kg/day/1000 kg liveweight) used were as follows:

Nutrient Animal	Total Nitrogen	Total Phosphorus
Dairy cow	0.41	0.073
Beef feeder	0.34	0.11
Swine feeder	0.45	0.15
Sheep feeder	0.45	0.066
Layer hen	0.72	0.28
Broiler	1.16	0.26
Horse	0.27	0.046

4. Actual cattle numbers and liveweight used for various classes of livestock are available on request.

TABLE 3: ESTIMATED NUTRIENTS FROM COMMERCIAL FERTILIZERS USED IN THE THOMPSON-SHUSWAP BASIN (KG/YR.)

Fertilized Land Type / Sub-basin	N. Thompson		S. Thompson		Thompson	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Field crops including hay	19,424	34,805	130,259	153,398	19,124	39,629
Vegetables	211	110	2,855	1,305	1,007	471
Tree and Small Fruits	--	--	931	728	76	34
Pasture	4,200	1,838	35,336	22,475	5,768	2,524
TOTAL	43,835	36,753	169,381	188,905	25,975	42,658
Percent of Basin	18.3	13.7	70.8	70.4	10.9	15.9

Notes:

1. Basic data on areas of fertilized land types by Regional District taken from the 1971 Census of Agriculture
2. Regional District fertilized land type areas were pro-rated for census subdivisions using 1976 proportions of Regional District subdivision areas in various crop types.
3. Census subdivision data aggregated for sub-basin statistics as follows:

Regional District / Sub-basin	N. Thompson	S. Thompson	Thompson
Cariboo	Subdivision A (10%)	- -	- -
Columbia-Shuswap	- -	Subdivision C (100%)	- -
North Okanagan	- -	Subdivision A, IR (100%)	- -
Thompson-Nicola	Subdivision A (100%)	Subdivision E (100%)	Subdivision B (100%), E (56%)

4. Fertilizer application rates taken from: "Fertilizier Guide for Boundry, Okanagan and Kamloops" and "Fertilizer Guide for Kootenay Region and Southeastern B.C." both by B.C. Ministry of Agriculture.
5. Actual areas of fertilized land types, proportions by census subdivision, and application rates are available on request.

4. ON-SITE SEWAGE DISPOSAL

Septic tanks with associated drainfield areas (ST/DF) are the most common method of on-site domestic sewage disposal in rural and low density residential areas. Modifications of this conventional system (e.g. raised beds, leaching beds) exist and are used to a limited extent in B.C. Both conventional and modified systems are highly effective in sewage renovation given suitable construction, and soil, climatic, and other site conditions. Under poor conditions ST/DF systems can contribute to ground or surface water quality deterioration.

In the Thompson-Shuswap Basin area ST/DF systems are widely used. In Kamloops alone, a minimum of 22 percent of the population (i.e., Heffley Creek, Rayleigh, Westsyde, Dallas, Barnhartvale) is serviced by such systems (Stanley Associates Engineering Ltd. 1979). Many smaller centres such as Savona, Cache Creek, Grindrod, Sicamous etc. are entirely serviced by such systems.

The possibility of impact on water quality of several of these established centres (e.g. Savona) has been expressed, as has a concern for other low density areas (Shuswap River Valley, various Shuswap Lake shoreline areas). In a public opinion survey of foreshore use of Shuswap Lake, permanent residents ranked septic tank effluent entering the lake as the problem with highest severity rating (Regional District of Columbia-Shuswap, 1977). Greatest concern has been expressed for large new subdivisions on or near Shuswap Lake (e.g. Cedar Heights Estates, Shuswap Lake Estates, Anglemont). Thousands of lots are involved. Concern is for both receiving water quality due to sewage leachates, and land based problems such as sewage surfacing and instability of sloping land.

The Blind Bay-Sorento area where subdivision activity is high has received particular mention (Kirk, 1979a; Regional District of Columbia-Shuswap, 1977). A report describing soil characteristics and suitability for various urban related uses (Luttmerding, 1978) has been prepared.

Although indicating generally suitable soil conditions for sewage renovation in much of the area, concern is expressed for increased erosion, instability, and sewage problems with increased road building, vegetation removal and alteration to water courses.

The Ministry of Health (both North Okanagan and South Central Health Units) have emphasized that ST/DF systems are generally effective treatment systems and are having negligible effects on receiving water quality in the Thompson Shuswap Basin, especially when compared to other sources. This includes the Shuswap Lake system. However, the desirability of further study of several areas in the Shuswap Lakes area is allowed (Kirk, 1979 b).

Evidence for actual sewage entry from ST/DF to receiving waters is limited. Likewise, deterioration of receiving water or aquatic habitat due to leachate has not been documented. Several uses of dye tracers in on-going inspections in the Kamloops area have confirmed drainfield sources of ditch-bank seepage (Keenan, 1979). A study of ST/DF systems has identified a number of malfunctioning systems in the Barnhartvale Community (South Central Health Unit, 1978). An estimate of nitrogen loading to the North and South Thompson Rivers from septic tank sources in the Kamloops area gave values of 20,566 kg/yr. and 11,805 kg/yr., or 1.72 and 2.86 percent of present river nitrogen, respectively. Phosphorus loading was considered to be very small (Stanley Assoc. Engineering Ltd. 1979). Water quality monitoring and observed trends (e.g. Nordin, 1978) were complicated by multiple stream-side land uses in the Shuswap River Basin. Observations of increased periphytic algae growth below suspected drainfield leachate entry (McDonald, 1979) is similarly circumstantial and complicated by mixed land uses.

Methodologies for distinguishing between diffuse sources, in particular ST/DF leachate and agricultural runoff are not well developed and not available for routine use and interpretation. Some evidence indicates ratios of fecal coliform to fecal streptococci may distinguish between human and animal sources (Geldreich and Kenner, 1969) and the method has been discussed and used by Hall et al (1974). Other ratios of indicator organisms or chemicals may be used as well. If sources must be distinguished to aid decisions on improvements, one or more particular problem areas may need to be chosen for a pilot investigation.

Recommendations 5a and 5b relate to on-site sewage disposal problems.

5. URBAN STORMWATER

From studies in North American cities, primarily over the last ten years, it has become evident that urban stormwater is not as pure as was once thought. Many potential pollutants can be constituents of urban run-off. Table 4 presents a typical list. It will be recognized that air pollution fallout, automobile fuels and oils, road ice control chemicals, animal feces, as well as fertilizers and pesticides used on lawns, gardens, and parks can all be sources of pollutants.

TABLE 4 POLLUTANT CHARACTERISTICS OF URBAN RUNOFF

1. Colour causing materials
2. Turbidity
3. Foam causing materials
4. Floating materials
5. Street litter debris
6. Material from street or pavement surface
7. Debris from vacant lands
8. Ice control chemicals
9. Pest control chemicals
10. Fertilizers
11. Droppings from animals or birds
12. Lawn or garden litter
13. Household or commercial refuse
14. Air-deposited materials from precipitation
15. Twigs and leaves
16. Paper
17. Plastic materials
18. Tire and vehicular exhaust residue
19. Heavy metals
20. Hazardous material spills

Urban areas typically have large proportions of hard surfaces. Rainfall and snowmelt quickly washes accumulated constituents into sewers and other stormwater channels. Pollutant concentrations vary greatly with time, but typically, higher pollutant concentrations may be expected in early stages of a storm (first flush).

As with other B.C. areas, data on stormwater quality in the Thompson-Shuswap area is sparse. Three sources of data have been identified.

An Environmental Protection Service (EPS) study (Sidhu, 1975) in Kamloops in 1973 provided data on eleven quality parameters including dissolved and extracted heavy metals, BOD_5, COD, solids, pH, temperature and toxicity to salmonids. Ten storm sewers and 30 grab samples were involved. Sampling was done between July 31 and November 6. At that time Kamloops had about 45 storm sewer outfalls. Reported concentrations of BOD_5 are similar to those of other North American cities; of non-filterable residue they are lower; of total residue they are somewhat higher; and of COD they are similar (see Ferguson, 1979). Four of thirty samples exhibited acute toxicity to juvenile coho salmonids. No estimates of loadings were made. Table 5, taken from the EPS report, describes sampling locations.

The Pollution Control Branch (P.C.B.) has sampled storm drains at five locations at various times in the last three years. In addition, two creeks serving as stormwater receiving channels (Guerin Cr. and Patterson Cr.) have been sampled for a number of years (Table 6). Parameters for which analysis have been done have varied with date and location but have included measurements of oil and grease, residue, major cations and anions, nutrients, trace metals, and coliforms. Cursory examination of data in relation to the EPS data shows generally higher residue values. When compared to reported data for other North American cities (Ferguson, 1979) residue and nutrient values appear to be as high or higher than other cities. No estimates of loadings with the P.C.B. data have been attempted. Many of the stormwater samples were taken in the January to March period. Therefore, whereas the EPS data give an indication of summer and fall conditions, the P.C.B. data provide information on winter and spring runoff conditions.

TABLE 5: EPS STORM SEWER SAMPLING STATIONS (KAMLOOPS)

Sample Station	Description*
2	Beside trailer court in Mission Flats Road. Discharge is primarily from residential area. Continuously flowing.
6	Same general location as Hasler's Ready Mix. Discharge is primarily runoff from residential and possibly includes industrial yeard drainage. Usually flowing.
8	Foot of MacKintosh Street. Discharge primarily runoff from residential areas. Occasionally flowing.
14	Foot of 8th Street at Thompson River. Discharge is primarily runoff from residential areas. Occasionally flowing.
16	Same general location as the veterinary clinic. Discharge primarily runoff from residential areas. Occasionally flowing.
18	Foot of 13th Avenue beside water intake plant. Discharge and runoff from both residential and commercial areas. Continuously flowing.
23	West of new bridge. Discharge primarily runoff from residential areas. Continuously flowing.
29	Foot of Kenora Street. Discharge is primarily runoff from residential area. Occasionally flowing.
38	Foot of Sidney Street. Discharge is runoff from residential and commercial areas. Usually flowing.
45	Foot of Kingston Street. Discharge is primarily runoff from residential areas and includes some runoff from commercial areas. Occasionally flowing.

Note: Due to variability in weather conditions which affected flows of storm sewers, flow volumes were not estimated.

* Information from personal communication (EPS) with City of Kamloops, Engineering Department.

TABLE 6: PCB STORM SEWER SAMPLING STATIONS (KAMLOOPS)

Sampling Station (EQUIS #)	Description
XE 0602201	Storm drain on West Lake Road
XE 0602301	8th Street to South Thompson
XE 0601901	3rd Avenue East at River
XE 0601601	Sydney Avenue storm drain
XE 0601501	Tranquille Road storm drain
0600056	Guerin Creek at Dufferin
0600055	Peterson Creek at mouth
0600168	Peterson Creek below Jocko Lake

A further study providing stormwater quality data for the Thompson-Shuswap area, was done by EPS in 1977 (Ferguson, 1978). Two storm drains to Tappen Bay of Shuswap Lake from Salmon Arm were sampled along with other streamflows. Sampling was done over a three day period in August. Both storm drains showed high concentrations of total phosphate, nitrate, and ammonia relative to other streamflows.

In summary little information is available on urban stormwater flow and quality in the Thompson-Shuswap Basin. No estimates of loading or relative significance of stormflows have been made. The dry climatic regime of much of this area relative to coastal areas, and the runoff regime must be recognized when considering the impact of stormwater flows on receiving waters.

Recommendation 6a is presented for consideration.

6. MISCELLANEOUS NON-POINT SOURCES

The significance of precipitation and dry atmospheric fallout (e.g., dustfall) directly to water, as sources of nutrients and contaminants is unkown. It must be minor, however, when considering receiving water to receiving land areas, and the magnitudes of loadings of other sources. In some specific locations or lakes this may not be true. Review of dustfall and precipitation chemistry data may allow some inferences. Nearest CANSAP (Canadian Network for Sampling Precipitation) stations are in Kelowna and Prince George.

Possible acidification effects on water in the basin due to emissions from the proposed Hat Creek thermal power plant will be dealt with in another report.

Flushing of sewage or dumping of storage tanks by houseboat and cruisers has been raised as a concern by the public (Regional District of Columbia-Shuswap, 1977) as well as other management agencies (Thompson-Okanagan Regional Resource Management Committee, 1976). On recommendations of the Ministries of Health and Environment, the Environment and Land Use Technical Committee (ELUTC) recommended further public information efforts but no further regulatory actions. It has been emphasized that possible problems are confined to several local areas (e.g., Blind Bay, Mud Bay-Seymour Arm, marinas and launching area) where shelter is sought during rough water on the lake (Kirk, 1979 a).

Irrigation return-flow water quality (primarily salinity) and impact on receiving water has not been as significant a concern in B.C. as in western states of the U.S. It has not been identified as a problem within the Thompson-Shuswap Basin and no complaints have been recorded. Areas of saline, or saline and alkali soils do exist in the basin and if efforts are made to reclaim by leaching, local deteriorated water quality problems are a possiblity.

7. RECOMMENDATIONS

7.1 Erosion and Sedimentation - Forestland

1. A basin-wide review should be made of the known recent (e.g., 10-15 yr) occurrences of high stream sediment loads and high erosion rates (particularly mass movements) on forested lands in the Thompson-Shuswap Basin. Efforts should be made to relate these to conditions of geology, soils, precipitation patterns or storm events and forestry operations. Methods of review might include: a) a review of Forest Service files for Engineering, District Ranger, or special investigation reports of occurrences of slides or other heavy erosion; b) a review of Fish and Wildlife Branch or other Ministry of Environment files for reports of occurrences, special investigations, or public complaints about erosion and possible fisheries impacts; and c) meeting(s) of regional representatives of the Forest Service, Fish and Wildlife Branch, Water Management Branch, Fisheries and Oceans Canada etc. to discuss and record observed occurrences which are known to personnel of these agencies but have not been documented.

Patterns of occurrence should influence future forest operations planning and perhaps result in further pilot or problem areas investigations of spawning channel impacts, and effective management alternatives.

7.2 Beef Cattle Feedlots

Feedlot and other intensive housing/feeding of beef cattle is being promoted and is likely to increase in the Thompson-Shuswap Basin. Serious concerns for receiving water quality are being expressed by resource management agencies and the public, yet no systematic effort is being made to research the literature or investigate local conditions to allow informed decisions in the future. Therefore:

2a. Pending decisions on feedlots should be made with maximum possible precautions for water quality (e.g., maximum available distances to watercourses, interception and diversion of clean drainage waters away from feedlots, collection and treatment of feedlot surface runoff, good manure management) and provision for ground and surface water monitoring.

2b. Extensive studies already done (primarily in the U.S.) should be reviewed and the information presented to and discussed with regulatory and resource management agencies. Ministry of Agriculture and Environment personnel should cooperate in this review.

2c. A monitoring program of ground and surface water below one or more existing feedlots should be undertaken to allow assessment of processes, pathways, and effects under local climatic conditions.

7.3 Overwintering of Cattle and Other High Livestock Concentrations

3a. Continued and increased efforts should be made by the Ministries of Agriculture and Environment to increase the awareness of producers of the impact of the cattle industry on water quality.

3b. Problem situations known to Ministry of Agriculture, Environment or Health personnel should be reported to the Agricultural Environmental Control Program immediately if this has not already been done. This would allow procedures under AEC to be set in motion for possible early improvement actions.

3c. Recognizing that both management and economic issues are involved, and most effective improvements would often involve considerable expense (e.g., fencing buffer strips; providing alternative stock watering facilities, purchasing stream buffer strip easements), selected problem areas should be chosen and alternative long term improvement schemes designed and costs estimated. This should involve personnel from the Ministry of Agriculture, Environment and perhaps other agencies (e.g., local government). As part of the design, technical alternatives and regulatory and funding options should be considered. A pilot project to carry out actual improvements should be undertaken as soon as possible.

3d. Further monitoring projects or extensions of those already done should be undertaken on some priority basis. These would be designed to assess nutrient loadings and other water quality impacts of livestock operations. Ideally they would be linked to actual improvements made as suggested in 3c above, and allow assessment of effectiveness.

7.4 Other Agricultural Effects on Water Quality

Agricultural impacts on water quality in several valleys (Salmon, Shuswap Rivers) have been noted and monitoring has been done.

4a. Further site specific monitoring, preferably tied particularly to storm events, or more generally to runoff and non-runoff periods might be undertaken. This would give evidence for processes of movement of potential pollutants to water courses. Further monitoring and flow measurement could give better estimates of loading from agriculture to receiving water and information on the significance of agriculture relative to other sources.

4b. A systematic reach by reach review of land use of priority streams (e.g., Salmon and/or Shuswap Rivers) might be considered as an initial step in designing improvement schemes to reduce potential pollutant runoff from agricultural land.

7.5 On-site Sewage Disposal

5a. Investigations should be designed in several priority areas (e.g., Savona, Sarento-Blind Bay, Mara Lake, Shuswap River - see also Appendix I) to determine whether effluent leachates are of significance and affecting surface or ground water quality. Results from such studies and further associated studies of soil and geologic conditions should aid local governments in development planning and Ministry of Health officials in regulation of on-site sewage disposal.

5b. In areas where agriculture and on-site sewage disposal are both believed to be contributing to deteriorated water quality (e.g., Shuswap River and Fortune Creek) some effort to identify sources may be desired. A small pilot project may investigate several methods for subsequent application to a larger study area.

7.6 Stormwater

6a. A detailed review of available data, particularly with reference to sampling dates and times should be made. This should give direction to design of a further study to estimate loadings of selected potential pollutants from stormflow in urban centres of the Thompson-Shuswap Basin. Particular recognition should be given to the climatic regime and receiving water flows. Decisions on further investigations of stormwater management could then be made.

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APPENDIX I

Province of
British Columbia

Ministry of
Health

PUBLIC HEALTH
PROGRAMS

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November 27, 1979

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Dear Sir:

Re: Proposed Shuswap Lake Study

As promised at our brief meeting in Kamloops, B. C., November 15, 1979, the following comments or opinions are the philosophy of the North Okanagan Health Unit as related to the proposed study of Shuswap Lake.

It would seem from your initial comments that the prime purpose of the study would relate to Shuswap Lake. I am of the opinion that any study involving such waters must include other portions of the Shuswap Chain. Except for a possible two (2) specific areas on the main Shuswap Lake, one would have some difficulty in classifying the Shuswap Lake as critical by reason of the limited development adjacent to its shores and the number of annual lake "turn overs" or volume of flow. Probably of greater importance would be the Shuswap River between Ashton Creek and Mara Lake, Mara Lake and the Narrows at Sicamous, B. C.

The magnitude of any study on the Shuswap Chain would appear to dictate that certain assumptions must be made. Initially assuming that the main Shuswap Lake is not critical, thus any study involved should be limited to establishing a 1980 base line. One must then determine what areas can be termed critical at the present time or could be so affected in the future as to become critical. The existing causative agent or agents and potential causative agent or agents would have to be assumed and placed on an assumed priority list depending upon the causative agent. Such agents may be classified as agricultural wastes, on-site sewage disposal, municipal wastes, perhaps on water waste disposal (house boats and launches) and industrial wastes (sawmills, log storage) etc.

Based on the above philosophy, I submit areas that are critical or have such a future potential.

(1) Blind Bay

Apparently present condition of waters in the Bay are acceptable. By reason of the location of the Bay, the turnover of water will not be as frequent as the main lake, thus any possibility of nutrient escapement into the Bay from on-site sewage disposal from the large residential development surrounding Blind Bay could be drastic.

(2) Mud Bay, Seymour Arm (Frequently referred to as "Soap Bay")

Residential development at Seymour Arm probably of little consequence at the present time. Currently the problem rests with the practise of house boats congregating in the Bay when the main lake is rough. It is possible that future residential development served via private sewage disposal could have an affect on the Seymour River, the Salmon run and the lake immediately adjacent to the river.

(3) Salmon Arm Bay

Probably the most critical area in the total Shuswap Chain. A shallow body of water with a low rate of exchange. Has been subjected to the discharge of septic tank effluent via a collection system for many years and is still subject to nutrient flows from the municipal sewage plant, the Salmon River, a slaughterhouse and waste waters from a cheese operation.

(4) Sicamous Narrows

An area immediately adjacent to a high density residential-commercial area. All premises being served via individual septic tank systems. Subsoil conditions tend to primarily sands with an intermix of sands and gravels. Evident at various depth are thin layers of clay. If, as many believe septic tanks are a hazard to a body of water, the Sicamous area should warrant attention.

(5) Mara Lake

Subject to a flow of water high in silts during spring run-off and subject to high agricultural inflows. A lake with fewer annual turn overs than the Main Shuswap. It is my opinion that because of the inflow characteristics of the Shuswap River certain base line characteristics of Mara Lake should be established in the immediate future.

(6) Shuswap River

(Mara Lake to Ashton Creek influence). Because of agricultural wastes from lands adjacent to the Shuswap River, inflows from such drainage as Fortune Creek, municipal waste from the City of Enderby, septic tank wastes on a gravel fan adjacent to Brash Creek, it is believed that studies should be undertaken on the river.

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In closing I gather that you are aware that the Columbia-Shuswap Regional District is in the process of negotiating with four (4) Engineering Firms as related to Water and Sewage, 6 Mile area, Mara Lake and to Sicamous proper. The final proposal for both areas from the firm selected to undertake such studies may be of interest to you. Mr. T. Pellett would probably supply the final report.

Yours truly,

H. W. Kirk, C.P.H.I.(C)
Chief Public Health Inspector

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Part Four

Aquatic Plants

Prepared by R.A. Nijman

Documentation and Prevention Coordinator

1. Reason for Concern: Eurasian Water Milfoil

The nuisance aquatic plant Eurasian water milfoil (*Myriophyllum spicatum* L.) was first recorded in British Columbia from Okanagan Lake in 1971. By 1976 six out of seven mainstem lakes in the Okanagan Valley were infested to some degree. Aquatic plant surveys to locate Eurasian water milfoil in British Columbia outside of the Okanagan Valley have been intensified since 1977, with the identification of 40 additional infested water bodies confined to the lower Fraser Valley region. To date, there are more than 1000 ha of Eurasian water milfoil infested area in British Columbia.

The geographic restriction of Eurasian water milfoil in British Columbia strongly suggests recent introduction. However, there is evidence suggesting that the distribution of Eurasian water milfoil is on the increase:

1) 1978 Boat Quarantine Project. This project indicated that boating traffic from infested water bodies could transport Eurasian water milfoil to non-infested areas.

2) Waterfowl transport. Waterfowl have long been implicated in the wide distribution of many aquatic plant species. Eurasian water milfoil is a non-native species; the source of introduction to many of the infested areas in the lower Fraser Valley could only be explained on the basis of waterfowl transport.

Some nuisance aspects of Eurasian water milfoil include aesthetic nuisance or direct interference with water-based recreational activities, reduction in usefullness of recreational facilities (marinas, boat docks and launching ramps), reduction in the value of lakefront property, and interference with the supply or quality of domestic or irrigation water. More than $500,000 was spent to alleviate the nuisance conditions caused by Eurasian water milfoil populations in infested areas of British Columbia in the fiscal year 1979-80.

2. Requests for Assistance

Due to the proximity of Shuswap Lake to the Okanagan Valley area of infestation, together with its value as a water resource, the Water Investigations Branch began aquatic plant surveys in 1975 to locate possible pioneering infestations of Eurasian water milfoil. Since that date, surveys of both Shuswap Lake and other water bodies within the Thompson River Basin have been intensified, in part due to requests encouraging the provincial government to prevent the spread of Eurasian water milfoil into the area. Requests for assistance have come from the Regional District of Columbia Shuswap, the Shuswap-Thompson River Association as well as various chambers of commerce.

3. Survey Efforts

Although qualitative information on aquatic plant species diversity has been collected by the Water Investigations Branch from numerous lakes within the Thompson River Basin since 1977, the greatest volume of quantitative data has been collected for Shuswap (including Mara and Little Shuswap) and Mabel lakes, both frequented by boaters from the Okanagan Valley. Shuswap Lake was selected because of the potential serious negative impacts of Eurasian water milfoil infestations, whereas Mabel Lake was selected because infestation would quickly result in fragment drift into the Shuswap system via the Shuswap River. Data were collected to evaluate the potential impact of

Eurasian water milfoil in the selected lakes; these data included species diversity and abundance, physical characteristics of the lakes including sediments and size of the littoral shelf, together with water quality and water-use information. Data related to fisheries interests have also been collected.

The most important result of the aquatic plant surveys was that no Eurasian water milfoil has been yet identified in any of the lakes surveyed within the Thompson River Basin. However, data collected from the Shuswap Lake system indicate a potential for survival and propogation of a pioneering infestation of Eurasian water milfoil. The growth characteristics of Eurasian water milfoil suggest it would displace native aquatic plant species, resulting in decreased diversity. Seasonal drawdown would have some effect in controlling Eurasian water milfoil infestation in some areas. The maximum recorded seasonal variation in water level was 4.9 m (1972) although levels have varied considerably less (2.3 m in 1926) from one year to the next. The abundance of native aquatic plant species together with the clarity of the water in the Shuswap Lake system, however, suggest that Eurasian water milfoil could establish itself to nuisance proportions, particularly in areas where there are now populations of native species.

Some of the largest populations of native aquatic plants were noted to be a nuisance in areas of the Shuswap Lake system, including Blind Bay, Crystal Sands Beach and the Sicamous Narrows; all these areas have marinas, resorts or summer cottage development. The extent of nuisance populations of native plants as well as future populations of Eurasian water milfoil (if introduced) could well be encouraged if future shoreline developments (e.g., groins or piers) interfered with normal shore currents or effected increased sedimentation and nutrient input.

4. Efforts to Prevent the Spread of Eurasian Water Milfoil into the Thompson River Basin

To date, feasibility studies have been conducted by the Water Investigations Branch on the quarantine of Eurasian water milfoil within British Columbia. These studies have indicated the potential for Eurasian water milfoil to be transported by boaters. Also, road-side check stations for boaters leaving infested areas have been evaluated, to prevent transport of this aquatic plant and to distribute public education materials. A highway check station was manned in 1979 by Water Investigations Branch staff on Highway 97, north of Vernon, to intercept boaters travelling toward the Shuswap Lake area.

Other activities directed at preventing the spread of Eurasian water milfoil through the Thompson River Basin have included intensive field surveys to provide an early warning of introduction. The public and government agencies were encouraged to assist with this objective. Signs instructing the boating public to remove all aquatic plant material from their boating equipment were posted at all public boat launches in the Shuswap Lake system, as well as other selected locations in the Thompson River Basin. A Eurasian water milfoil display was set up in various regions of British Columbia to further the public education requirement involved with preventing the spread of Eurasian water milfoil.

Regardless of the intensity of these types of efforts, neither public education nor quarantine of infested areas may be totally effective in the long term in preventing the spread of Eurasian water milfoil. The lack of full public cooperation must be taken into account, together with the probability that waterfowl will contribute to its spread.

5. Contingency Plans for the Removal of New Eurasian Water Milfoil Infestations

If Eurasian water milfoil is identified within the Thompson River Basin, and intensive survey of the water body would be implemented to determine the nature of the infestation. With this information, the Water Investigations Branch would be in the position to recommend the appropriate methods of control or attempted eradication to local authorities. If the infestation was sufficiently small and if local agencies gave encouragement and support, the Water Investigations Branch could attempt a management project using either of the following methods:

a) mechanical - a diver operated dredge has been placed on standby, or

b) herbicide - application would be made to the Pesticide Control Branch for permits to use the herbicide 2,4-D in the following year (there would be delays in obtaining a herbicide permit after a new infestation was found).

If the size of the infestation was so large that attempted eradication was not feasible, a program of cosmetic control would be appropriate. Regional agencies would be encouraged to develop a management program that suited their needs, with technical advice from the Province.

6. Conclusion

Based on observations of aquatic plants in the Okanagan Basin, there is a high probability that Eurasian water milfoil may be introduced to some high use lakes in the Thompson River Basin. Eradication measures might be attempted but have a low probability of success. It is possible that some lakes may require cosmetic aquatic weed treatments to maintain water-based recreational activities to an acceptable standard following Eurasian water milfoil introduction. Even if Eurasian water milfoil is not introduced, some native species might be a nuisance in localized areas and be stimulated be shoreline developments.

Additional information is desirable to:

a) evaluate the degree to which native populations and potential infestations of Eurasian water milfoil might be encouraged by shoreline developments,

b) evaluate the potential for greater use of drawdown to control both native and introduced populations of aquatic plants.