Province of British Columbia
Ministry of the Environment
Water Investigations Branch

WATER QUALITY IN THE SHUSWAP RIVER BETWEEN MABEL AND MARA LAKES, 1977

by

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SUMMARY

Sampling was carried out during 1977 to investigate the basis of several complaints with regard to water quality in the segment of the Shuswap River between Mabel and Mara Lakes. The major source of suspended sediments in the system appears to originate from the Kingfisher Creek watershed. High concentrations of nutrients and coliform bacterial contamination were found in Fortune Creek. Along the course of the river there are significant increases in concentrations of suspended and dissolved solids, nitrogen, phosphorus and coliform bacteria, which appear to be due primarily to non point discharges.

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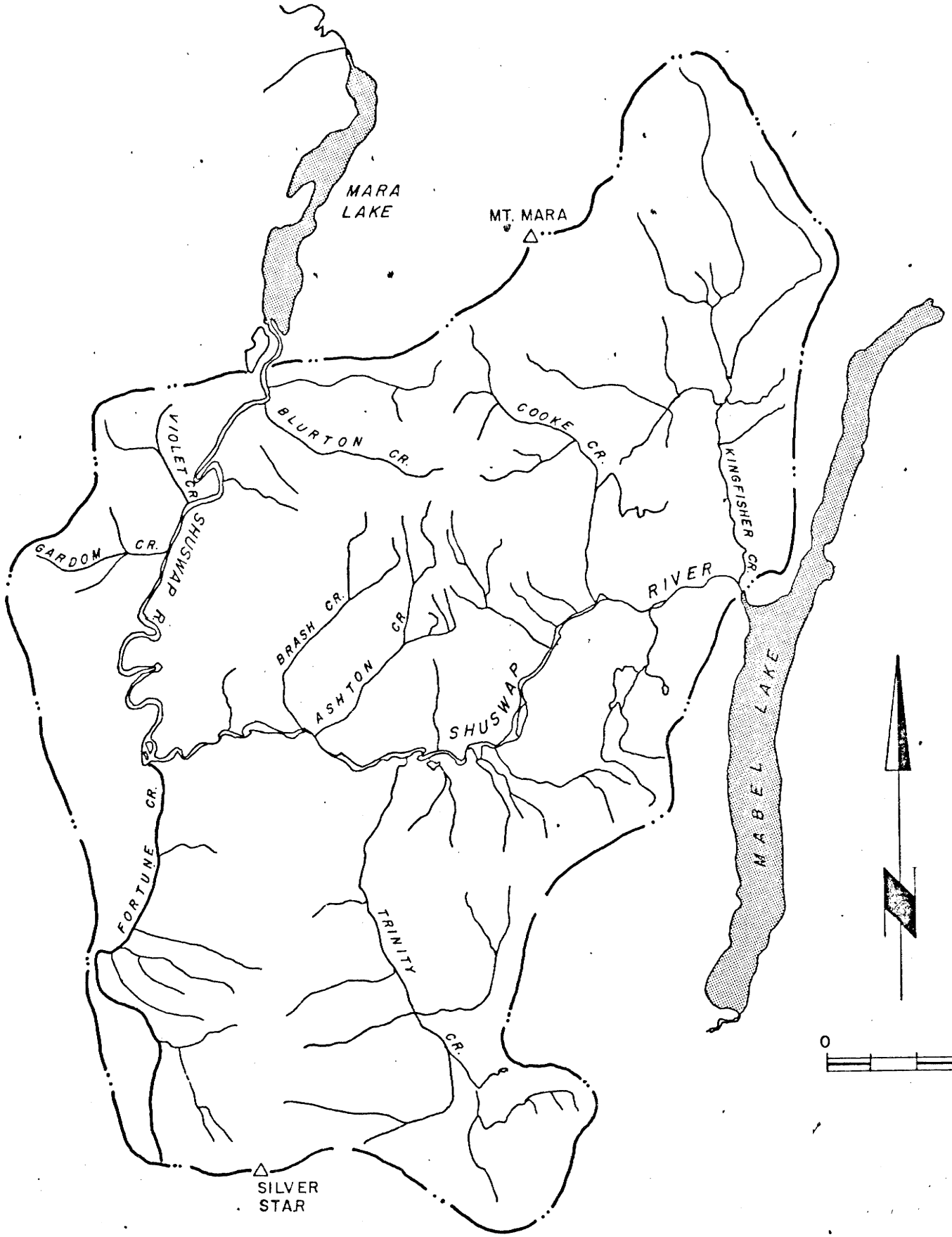
1. Introduction

The study was initiated after concerns were expressed by a number of individuals and organizations in the Enderby area regarding water quality in the Shuswap River. There are a number of letters and correspondance on file (0273896-14) expressing concern regarding the effects of logging, agriculture, residential and industrial development, and recreational use on both water quality and quantity in the Shuswap River. The areas of water quality to which complaints were addressed included siltation of irrigation equipment, bacterial levels in the river, nutrient related problems ("slime"-presumably algal growth) and taste and odour.

The watershed drained by the Shuswap River between Mabel and Mara Lakes comprises approximately 1430 km^2 (Figure 1). The topography ranges from an altitude of 2196 m at Mount Mara on the northern border of the watershed to 1891 m at Silver Star on the southern boundary to 393 m at Mabel Lake and 349 m at Mara Lake. There are no long-term climatological stations located inside the watershed but two established stations at Salmon Arm and Armstrong are just outside the basin. The mean daily maximum temperature at Salmon Arm for January and July are -1.9 C and 27.5 C respectively. Extreme temperatures range between 41.1 C and -35 C. Rainfall in the area varies with altitude and topography but mean precipitation averages 53.1 cm at Salmon Arm and decreases to 44.8 cm at Armstrong (B.C. Ministry of Agriculture).

The vegetation in the area is of four different zones. The river valley is in the Interior Douglas Fir biogeoclimatic area. The southern portion of the Fortune Creek watershed is in the transition area to the Ponderosa Pine-Bunchgrass zone. The upland areas are Subalpine Engelman Spruce-Subalpine Fir (in the western portion of the watershed) or Interior Western Hemlock (in the higher elevations of the eastern portion of the watershed).



SHUSWAP RIVER WATERSHED BETWEEN MABEL AND MARA LAKES

Figure 1

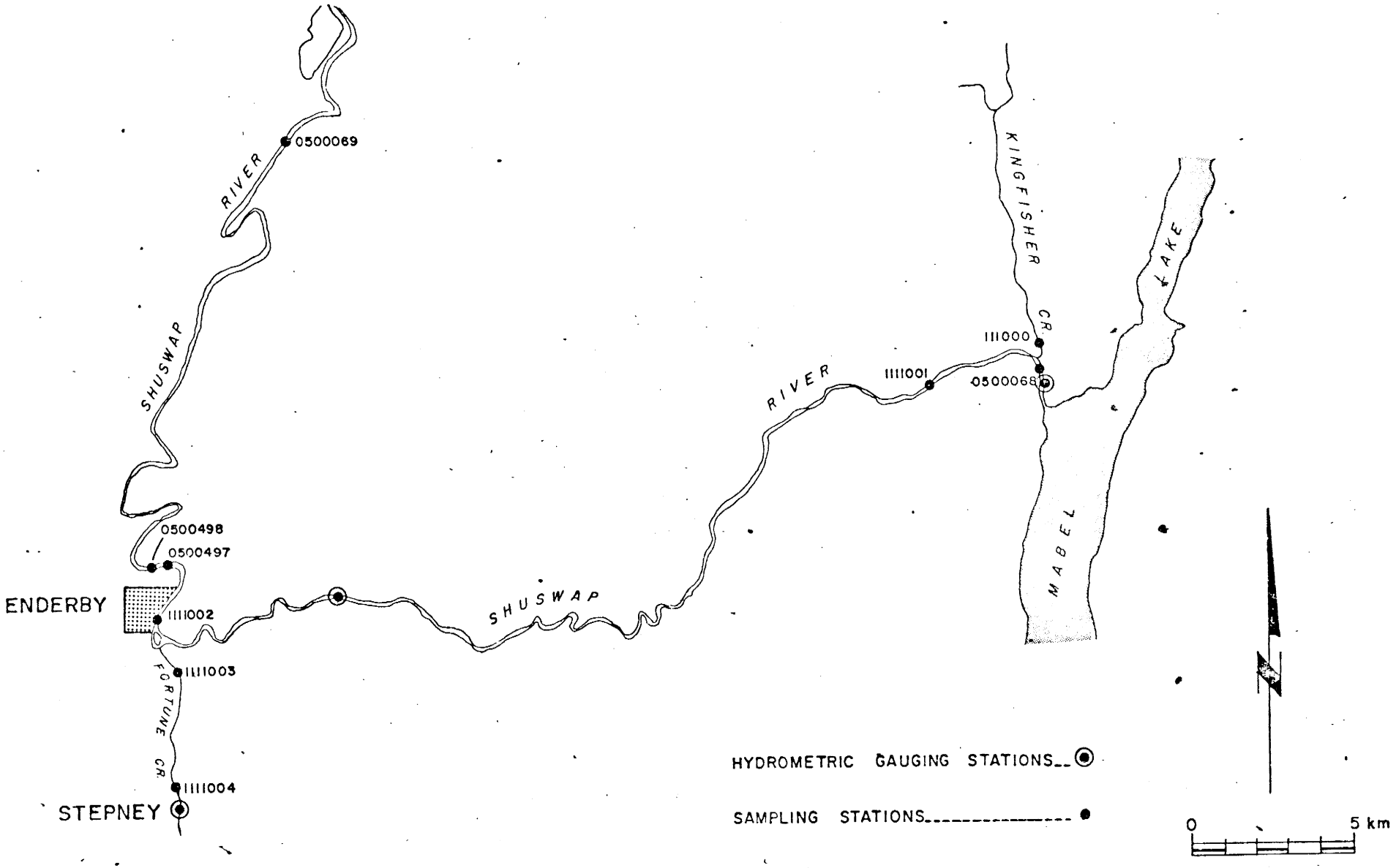
The soils are basically of the podzolic type but differentiated into the complex pattern described in Kelley and Spilsbury (1948).

2. Hydrology

The quantity of water flowing through the system has a direct influence on the concentration of materials at any point in the system and as such is an important aspect of water quality. Flow gauges are maintained or have been maintained at several stations in the area being considered. The Water Survey of Canada presently makes measurements on the Shuswap River at the Outlet of Mabel Lake (station 08LC019) and records exist for 1927-1939 and 1951 to present. A gauge near Enderby (08LC002) has records for 1911-1936 and 1960 to present. Two gauges on Fortune Creek give some partial record of flow, station 08LC035 near Armstrong in 1911-1912 and 1959-1973. A station on Fortune Creek at Stepney (08LC031) gives partial information (summers April through September) for 1950-1959 and for the year 1960. There are also gauges on Violet Creek, Gordon Creek, and Brash Creek. (See Figures 1 and 2)

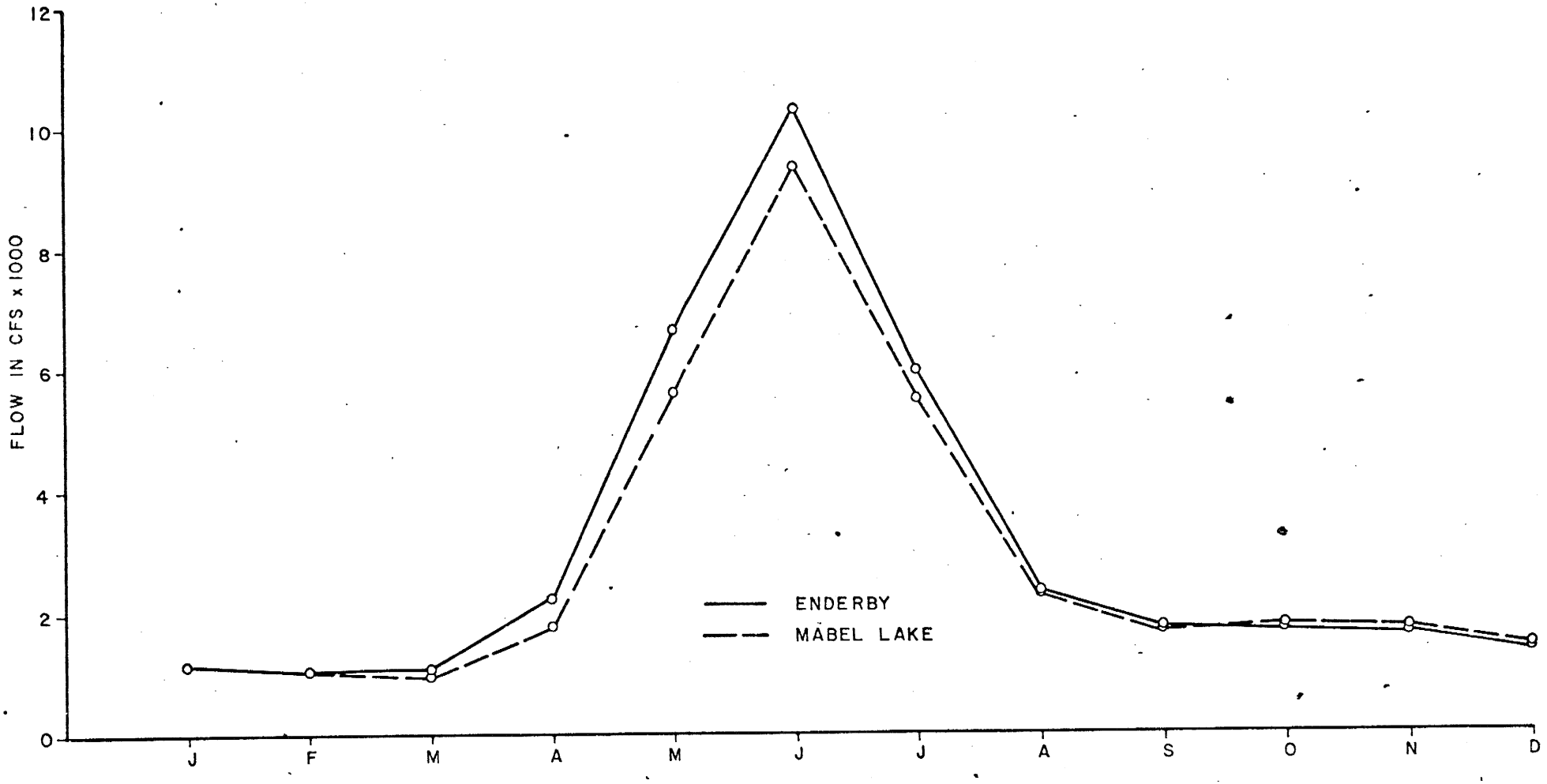
The annual mean pattern of flow (Figure 3) shows the peak of freshet in June in the Shuswap River with low flows in February and March. The amount of water flowing past each station in an average year (2,552,310,000 m^3 - 2,070,000 acre-feet at Mabel Lake, 2,738,493,000 m^3 or 2,221,000 acre-feet at Enderby) incidates a difference of 186,183,000 m^3 or a 7.3% increase between Mable Lake and Enderby. From this is might be infered that the creeks between Mabel Lake and Enderby contribute relatively little to the volume of the river on an annual basis. In the same way, the flow of Fortune Creek, from the records available, would contribute only a small amount of water to the Shuswap system (1960 discharge past Stepney is 32,427,900 m^3). However the quality of this water should also be considered and this is discussed below. A stream flow gauge was requested for the year 1977 for Fortune Creek but was not installed until August and thus the flows in Fortune Creek for the year 1977 have to be estimated (Appendix)

The Water Investigations Branch has carried out mapping of the floodplain and calculated levels of 25, 50, 100 and 200 year floods.



LOCATION OF SAMPLING STATIONS ON SHUSWAP RIVER

Figure 2



MEAN ANNUAL FLOW PATTERN OF THE SHUSWAP RIVER

Figure 3

There are a large number of water licences on the Shuswap River which are primarily for irrigation and domestic use.

3. Fisheries

The fisheries resource is an aspect considered because of some facets of water quality discussed further on, particularly the silt load contributed by Kingfisher Creek and its implications to the fishery.

A report prepared by the Federal Fisheries Service and the International Pacific Salmon Fisheries Commission (Anon. 1969) considered the problems associated with proposed diversion of water from the Shuswap drainage to the Okanagan drainage. Also, the report is a source of information on the status of anadromous and game fisheries in the Shuswap River. The following information is abstracted from this source.

The river downstream of Mabel Lake to the area known as "The Islands" has large areas of streambed suitable for spawning - estimated to be 750,000 square yards, which could support 750,000 spawners. Sockeye escapement in the lower Shuswap, which has a dominant 4 year cycle - 1950, 1954 etc., in the period 1950-1966 ranged from 9,307 to 31,205. The area below the Islands to the mouth of Trinity Creek supports a large population of Kokanee. Estimates up to 337,000 spawners have been recorded. The river also supports runs of Chinook and Coho. The former spawns primarily between Mabel Lake and Kingfisher Creek and has an escapement of 1000 - 10,000 a year, the latter have runs of a few hundreds to 5000 in the lower Shuswap.

4. Water Quality

4.1 Background and Study Design

The study was undertaken to assess the changes in water quality along the length of the lower Shuswap. Previous to 1977, four water quality stations had been established on this portion of the river by the Pollution Control Branch, Okanagan Regional Office in Vernon. However, two of these

stations, above and below the Enderby Sewage Treatment Plant (0500497 and 050048) were only established in January 1976 and very little data had been collected before this study was initiated. The other stations, downstream of Mabel Lake (0500068) was established in February 1972 and at Mara (0500069) established in March 1971. These two stations had the only information of any quantity which existed and were the only basis for judgement on water quality in the system. A preliminary review of these data in June 1976 indicated that significant differences existed in water quality between Mabel Lake and Mara and that noticeable increases in suspended solids, turbidity, nutrients (nitrogen and phosphorous) and bacterial content of the water occurred (Table 1).

Table 1

Comparison of some water quality parameters at two stations on the Shuswap River, June 1976

parameter	A. at Mabel Lake concentration (mg/L)			B. at Mara concentration (mg/L)		
	maximum	minimum	mean	maximum	minimum	mean
suspended solids	2.0	LO.5	1.08	24	L1.0	7.5
turbidity (J.T.U.)			0.49	87	0.4	2.9
total nitrogen	.460	.020	.158	.600	.060	.205
dissolved phosphorus	L.003	L.003	L.003	.012	L.003	.004
total phosphorus	.009	.003	.004	.036	.003	.016
coliform bacteria (MPN/100 ml) total			L2	1600	141	483
fecal			L2	110	17	40

L= Less than detectable limits

These data however were insufficient to make any definite conclusions regarding deteriorating water quality, although it seemed likely; nor did they give any clue to the sources of these apparent increases in materials.

4.2 Selection of sampling stations

The sampling stations were chosen with the purpose of documentation of changes in water quality through the system as well as to attempt to locate the origin of materials entering the river. Stations were chosen incorporating the suggestions of a number of individuals and the North Enderby Residents Association (Anthony 1976). The major stations sampled during the project included the following. The locations are shown in Figure 2.

site 1111000 Kingfisher Creek at mouth
site 1111001 Shuswap River 2km below 111000
site 1111002 Shuswap River at Enderby bridge
site 1111003 Fortune Creek at Fortune Road
site 1111004 Fortune Creek at Stepney
site 1111005 Fortune Creek near Armstrong
site 0500497 Shuswap River upstream Enderby S.T.P.
site 0500498 Shuswap River downstream Enderby S.T.P.
site 0500068 Shuswap River downstream Mabel Lake
site 0500069 Shuswap River at Mara

A number of other locations were sampled at various times to investigate localized problems and/or to obtain baseline information.

4.3 Sampling methodology

Sampling was carried out at one month intervals from May through November, the intention being to sample at high flow periods (May) and summer low flows (August-September). Intensive sampling during each trip was carried out by sampling over a two or three day period. During this period four to eight samples were taken at each station. The purposes of the repetitive sampling were to take into account any diurnal changes in concentration (and flow), to reduce any errors in estimates of concentration by having multiple samples, and to have some estimate of the variability associated with sampling.

4.4 Parameters

The parameters were chosen with the intention of deriving information on the problems and concerns which have been discussed earlier. The parameters are listed in Table 2.

Table 2

Water Quality Parameters for the Study

pH
Residue Total 105C (total solids)
Residue Filterable 105C (dissolved solids)
Residue Non-filterable 105C (suspended solids)
Turbidity
Colour (TAC)
Nitrogen-ammonia
Nitrogen-nitrate
Nitrogen-organic
Nitrogen-total
Phosphorous-ortho
Phosphorous-total
Conductivity (field and laboratory
temperature (field)
total coliform bacteria
fecal coliform bacteria

All of the water chemistry samples were collected and shipped on ice and arrived at the Environmental Laboratory of the B.C. Ministry of the Environment within 48 hours of collection. Coliform samples were analysed by the Water Bacteriology Laboratory, Ministry of Health, Vancouver.

4.5 Results

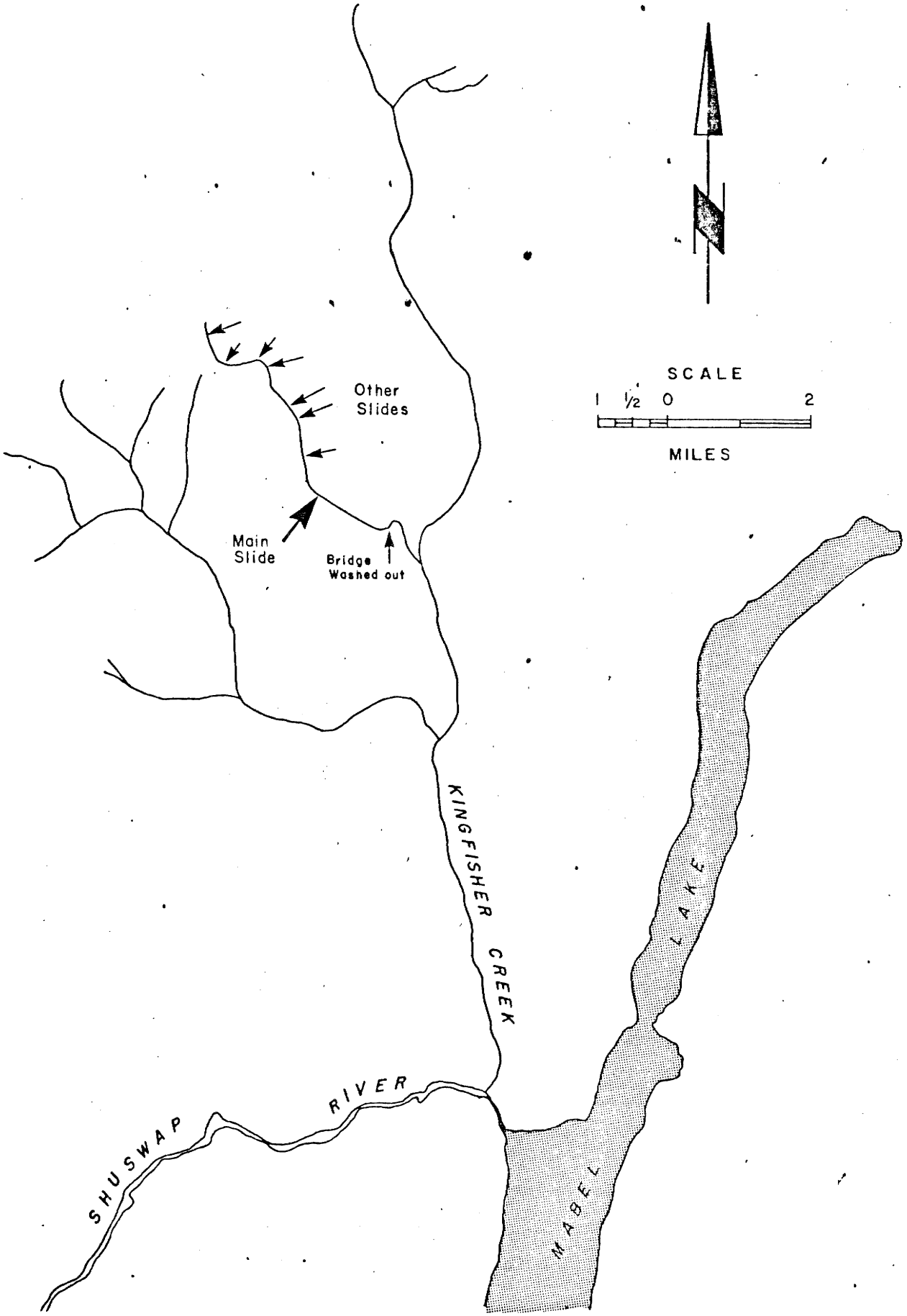
The data can be examined in two different dimensions. The first is comparison between stations progressing downstream and second is changes through the year at each station. The changes between stations is the most important in terms of the origins of different materials in the system. Since the study considers the portion of the Shuswap River between Mabel and Mara Lakes, the water quality as it leaves Mabel Lake can be used as an indication of the background level of concentrations monitored in the

system. A tabular summary of the data is shown in Table 3 and discussed below. The first three parameters are concerned with the amount of materials dissolved and suspended in the water. Dissolved solids concentrations at the outlet of Mabel Lake are 59.8 mg/L (mean) with peak dissolved solids during May and June of 1977 of 66 mg/L. The average dissolved solids from Kingfisher Creek are very similar (52.1 mg/L) but from Fortune Creek are considerably higher (197.9 mg/L). This is probably due to the low flow and high rate of evaporation from surface waters as well as materials leaching from watershed soils which, in a low flow year such as 1977, would be relatively concentrated.

In the river, the concentration of dissolved solids increases progressively downstream, from 59.8 below Mable Lake to 62.8 at Enderby to 63.7 at Mara.

Suspended sediment is a more important problem and has been the subject of a number of complaints particularly in August 1976 when suspended sediments were very evident. A number of complaints during this period prompted the Pollution Control Branch and the B.C. Forest Service to make investigations as to the source of the materials. The origin of the materials was Kingfisher Creek and a survey of the watershed by helicopter revealed that the source of the materials was a large number of slides which had apparently been caused by the unusually heavy rainfall during August. A map prepared by the B.C.F.S. (Figure 4) shows the location of these slides and the memo which reported these findings indicated that the slide areas were not associated with logging areas. The discharge of Kingfisher Creek containing the heavy concentration of suspended materials was visually very evident from one of the photos taken at the time (Figure 5).

The sampling carried out during 1977 confirmed the fact that the majority of suspended sediment in this portion of the Shuswap River originates from Kingfisher Creek. The concentrations of suspended sediment over the period of study (May through November) indicated that the average concentration was an order of magnitude higher at the mouth of Kingfisher Creek (15.3 mg/L) than in the Shuswap River immediately upstream of Kingfisher Creek (1.5 mg/L). A better basis of comparison would be to compare



SLOUGH AREAS IN KINGFISHER CREEK WATERSHED – AUGUST 1976

Figure 4

Figure 5. Confluence of Kingfisher Creek and Shuswap River, August 1976, showing suspended sediment contribution of Kingfisher Creek. Photo courtesy of J. Wanderer, Ministry of Forests, Enderby

spring concentrations which for 3-4 May at Kingfisher Creek was 50.0 mg/L and in the Shuswap River was 3.0 mg/L, both sampling points just upstream of the confluence.

The loading of sediments (using mean monthly concentration and mean monthly flow) indicated that the suspended sediment load would amount to an estimate of 3680 metric tonnes per year.

Fortune Creek also had relatively high concentrations of suspended sediments but because of the low flow, would have little effect on the river. The loading from Fortune Creek is estimated at 161 metric tonnes for 1977. The significance of the concentrations should not be minimized, however, since they do decrease the usefullness of water in the Fortune Creek system itself.

Turbidity is related to suspended sediments and basically reflects the same patterns (Table 3). The effect of Kingfisher Creek is notable in this regard. The annual pattern indicates the dominant influence of the freshet with maximum values in May and June (Table 4).

Colour of the water also was measured throughout the system and the highest values were found in the Fortune Creek system with increasing concentrations with distance downstream (i.e., higher at Stepney than near Armstrong and higher at Fortune Road than Stepney).

The next group of parameters deal with nutrients and were sampled to ascertain the sources of materials which would likely be the cause of any algal growth in the river. Some complaints regarding "slime" in the river had been voiced. This is likely algal growth. Nutrients also give some indication of possible contamination from septic disposal systems which are the predominant waste disposal method in the watershed (excluding the town of Enderby). The summary table (Table 3) indicates that the highest concentrations within the system were at the Fortune Creek stations for both nitrogen and phosphorus, with intermediate concentrations for phosphorus at Kingfisher Creek.

Table 3

Summary of water quality parameters

parameters	Sampling Sites (mean concentrations) Shuswap at Mabel L.	Kingfisher Creek	Fortune at Fortune Rd.	Fortune at Stepney	Fortune at Armstrong	Shuswap at Enderby	Shuswap U/S S.T.P.	Shuswap D/S S.T.P.	Shuswap at Mara
number of values used to determine mean	32-45	22-25	21-24	18	14	26	29-32	21-32	27-54
total solids*	60.8	66.3	206.3	188.9	150.4	70.2	67.9	68.8	71.6
dissolved* solids	59.8	52.1	197.9	170.6	143.6	62.8	61.3	62.2	63.7
suspended* solids	1.5	15.3	8.7	5.8	7.2	7.5	4.8	6.0	7.5
turbidity*	0.5	4.9	6.2	3.3	1.9	2.5	1.6	1.8	2.6
colour	3.2	7.5	18.6	17.3	7.3	5.0	3.8	5.3	4.5
ammonia**	7.9	9.5	17.8	50.4	15.9	13.0	9.0	12.9	21.6
nitrate**	46.6	39.2	all L20	80.9	73.5	34.2	34.0	33.5	42.0
organic nitrogen**	85.5	82.8	312.1	336.7	97.8	108.1	110.0	91.0	114.9
total nitrogen**	142.9	146.8	324.0	425.1	183	135.7	145.1	143.2	178.7
total phosphorous**	3.9	13.7	45.8	44.6	14.1	8.7	8.6	9.9	13.0
ortho phosphorous**	all values L3.0	all values L3.0	22.1	19.9	5.0	all values L.3.0	all values L3.0	3.0	3.5
total dissolved phosphorus	L3.0	4.9	30.9	31.1	5.9	L3.0	L3.0	3.3	3.6

L= less than

* concentrations in milligrams/litre (mg/L)
** concentrations in micrograms/litre (µg/L)

Table 4

Annual Pattern of Concentrations of
Some Parameters in the Shuswap River System

A. Kingfisher Creek

	May	June	July	August	Sept.	Nov.
Suspended Solids*	50.0	22.6	3.0	2.3	2.0	2.0
Nitrate**	103.0	50.0	21.6	55.0	53.3	70.0
Total Nitrogen**	202.5	150.0	66.7	93.3	115.0	100.0
Total Phosphorus**	47.8	23.0	3.6	4.0	3.0	4.0
Flow (est)***	21.2	14.2	2.4	1.4	0.8	1.4

B. Shuswap River downstream Mabel Lake

Suspended Solids	3.0	2.0	2.0	2.0	1.3	1.0
Nitrate	60	40	33.3	26.6	43.3	55.0
Total Nitrogen	130	112	170	116	120	130
Total Phosphorus	4.6	3.4	4.6	4.0	3.0	4.6

C. Fortune Creek at Fortune Road

Total Solids	90.5	110.3	188.8	288.8	288.0	345.0
Total Nitrogen	273	215	272	483	272	295
Total Phosphorus	25.3	27.3	49.2	93.0	30.7	27.5

D. Shuswap River at Mara

Suspended Solids	15.8	9.2	3.3	3.8	43	3.0
Nitrate	64	40	26	<20	<20	35
Total Nitrogen	226	130	196	285	80	106
Total Phosphorus	18.3	11.0	8.5	8.2	7.5	7.0

* concentrations in milligrams/litre (mg/L)

** concentrations in micrograms/litre (µg/L)

*** flow in cubic metres per second

Nitrogen concentrations at the mouth of Kingfisher Creek were relatively low (mean 147 µg/L total Nitrogen) which is a concentration similar to water upstream of the confluence. The most notable characteristic is the increase in concentration with distance downstream in the Shuswap. The contributions of nitrogen in terms of mass (loadings) from Kingfisher and Fortune Creeks are quite different primarily because of flow differences. The estimated mean annual flow for 1977 for Kingfisher Creek is of the order of 4.2 m^3/s (150 c.f.s.) (Appendix), this coupled with a mean concentration for total nitrogen of 146.8 µg/L gives a loading of 19421 kg/year. Fortune Creek on the other hand, has extremely high concentrations (mean 312.1 µg/L) relatively low flows (0.6 m^3/s - 2. c.f.s.) yielding loading estimates of 5781 kg/year. In the overall scope of the river, these contributions appear to be relatively insignificant. For example, the amount of nitrogen contributed by Kingfisher Creek is about 7% of the amount originating from Mable Lake. Fortune Creek is also notable as having much lower nitrate concentrations than any other rivers. The majority of nitrogen at the Fortune Creek stations is in the organic form, and the concentrations are relatively high.

The other nutrient parameter of importance is phosphorus. The trend of increasing concentration with distance downstream is evident also in this case. The major sources in the system again appear to be Fortune and Kingfisher Creeks. A number of the other tributaries to the Shuswap were examined during the course of the study (Cooke, Blurton, Ashton, Brash and Trinity Creeks) but the samples never had extraordinary concentrations of either nutrients, suspended sediments or bacterial contamination. The phosphorus levels were highest in Fortune Creek (mean of 45.8 µg/L) but relatively low flows would mean that the Shuswap River loading from this watershed is proportionately lessened. Kingfisher Creek had lower concentrations (mean 13.7 µg/L) than Fortune but the estimated loadings are higher at Kingfisher (1812 kg/year) than from Fortune Creek (848 kg/year).

The final aspect of water quality for which some concern had been expressed was bacterial content of the Shuswap River. The results of the sampling (Table 5) carried out indicate (as with other parameters) an increase in bacterial levels with distance downstream. The highest levels

Table 5

Coliform Data

Summary -T/F

MPN per 100 ml.

DATE	STN.	Shuswap R. @ Mabel L.	Kingfisher Cr.	Fortune Cr. at Fortune Rd.	Fortune Cr. at Stepney	Fortune Cr. at Armstrong	Shuswap at Enderby	Shuswap at U/S STP	Shuswap R. D/S STP	Shuswap at Mara
	3 May	49/8	22/2	920/920			49/49	130/49	79/79	79/79
			7/4	1600/1600			23/23			540/350
	4 May	17/2	13/2	920/920			49/17	130/49	130/49	920/540
							49/23			350/350
	31 May		49/23	350/240	2400/1600	27/17	23/13	49/17	14/7	170/79
				920/280	350/350	1600/540			46/8.	
					240/240	170/33			13/13	
						920/920			13/8	
	1 June			540/540	350/350	13/13	17/8	19/17	13/8	140/70
									8/5	
									33/13	
	2 June			1600/920	920/920	240/240	46/17	70/70	110/110	
					1600/1600	11/7				
	12 July	46/2	33/13	350/350	540/540	1600/920	17/8	350/110	540/33	130/7
					350/350	240/130	49/49	33/11	110/17	240/33
					1600/1600					
					1600/920					
	13 July			540/540	350/350	220/140	11/7	350/170	130/23	70/49
				920/920	920/920		31/11	240/33	350/22	94/18
					2400/2400					
	14 July			540/540	1600/1600		46/31	79/79	49/17	130/11
							220/94	49/23	350/14	130/79
	9 August	17/2	31/8	220/220	1600/920	540/540	46/31	240/240	170/33	220/70
		33/13	240/14	170/170	1600/1600	540/240	49/22	350/79	70/23	7/4
	10 August	79/5	49/13	130/49	350/240	130/49	170/27	130/8	240/49	170/23
		110/4	920/240	70/33	220/170	2400/170	350/17	540/49	140/33	
									130/130	
	11 August	23/2	49/11	1600/31	540/130	920/350	350/49	350/49	17/5	79/33
				70/70	70/49	2400/1600	540/49	170/49	540/79	170/46
	11 September		79/5	350/22	920/920		33/5	33/17	210/8	79/17
				49/2	540/540		8/2	79/13	79/2	23/2
	12 September			130/22	2400/2400	-	31/11	130/22	49/5	27/14
	8 November	31/8	9/2	170/49	350/350	540/350	79/4	49/13	49/23	13/5
				33/33	31/31	540/170	79/2	49/23	70/5	23/23

of contamination are evident in the samples from Fortune Creek. This appears to be a consequence of the Fortune Creek watershed being the most populous and the most heavily agriculturalized. The bacterial levels in the water are certainly worth noting since they would preclude any use as a drinking water supply (if that were to be considered) and approach the minimum standards for body contact. The B.C. Ministry of Health (1969) cites bacterial standards (total coliform MPN) for receiving waters used for bathing, swimming and recreation. The coliform levels according to these standards should have a median value of less than an MPN of 1000 with 20% of samples not to exceed an MPN of 2400. The mean values for total coliforms at Stepney over the year 1977 was 954 with 12% of values 2400 or greater.

The sewage treatment plant at Enderby must be considered since it services the largest concentration of population in this portion of the watershed and represents a potential source of contaminants to the Shuswap River. The treatment plant was constructed in 1970. Previous to this period, septic tank overflow was discharged to storm sewers and thus the river contained high concentrations of coliform bacteria in the river (Pollution Control Branch file PE-203). The plant is licenced to discharge $946m^3$ (250,000 gallons) of effluent per day, however average discharge has been about 475 m^3 per day (.0065 m^3/s). This discharge is relatively small in comparison to even the lowest flow recorded for the river (10.6 m^3/s), however the concentrations of some materials are relatively high (Table 6).

The mean concentration of total nitrogen discharged from the plant is 21.1 mg/L and combined with the mean flow from the plant indicates that the plant contributes about 4340 kg of nitrogen per year to the river. This appears to be significant but in the context of the amount of nitrogen carried by the Shuswap River at this point, (calculated using mean flow of 87.8 m^3/s and the 1977 mean concentration of nitrogen upstream of the treatment plant yields a river load of 375,751 kg/year) the amount is just over 1%.

Table 6

Discharge Characteristics of the Enderby Sewage Treatment Plant, December 1970 to November 1977

Parameter	Number of samples	Concentration		
		maximum	minimum	mean
total solids (mg/L)	47	754	278	426.1
suspended solids (mg/L)	46	345	2	43.3
flow m^3/day	1172	1361	28	475
ammonia (mg/L)	32	25.0	.05	3.37
organic nitrogen (mg/L)	28	22.0	0.3	4.8
total nitrogen (mg/L)	35	37.7	1.9	21.1
ortho phosphorus (µg/L)	25	5.8	1.6	3.8
total phosphorus (µg/L)	36	10.6	0.5	4.5
coliforms - fecal MPN/100 mL	32	160,000	L2	12087
coliforms - total MPN/100 mL	37	350,000	6	31892

The average concentration of phosphorus discharged from the treatment plant is 4.5 mg/L (4500 µg/L). Thus compares with a mean concentration in the river above the plant of 8.6 µg/L. The calculated loading to the river of total phosphorus would be approximately 913 kg/year. Again this is relatively small considering that approximately 24,000 kg of phosphorus flow past the plant each year.

The coliform concentrations below the sewage treatment plant show a general increase downstream as they do elsewhere in the system, however no sharp increase was evident. There should be some note made of the coliform levels in the area below Enderby in light of the number of water licences, many for domestic purposes. The B.C. Ministry of Health (1969) bacteriological standards for drinking water state that samples should not have more than 10% of any one month's samples showing presence of coliform bacteria. All samples taken between Enderby and Mara showed presence of coliform bacteria (Table 5).

Although sampling was done upstream and downstream of the sewage treatment plant, it is felt that this sampling was not entirely successful. The effluent pipe discharges at the river bottom and the effluent flows along the bottom without mixing for some distance downstream. The results between the upstream and downstream stations show only marginal differences between the two. Because of these sampling problems, the upstream/downstream results may not accurately reflect the real concentrations.

Of concern to fisheries is chlorine residual from the plant which has been measured from greater than 3 mg/L to less than 0.01 mg/L with a mean (n=36) of 0.76 mg/L. A number of the values would appear to be at levels normally considered toxic to fish.

5. Discussion

As a result of the sampling program carried out in 1977 and the sampling done by the Pollution Control Branch, a number of problems can be identified (Figure 6).

ANNUAL MEAN CONCENTRATIONS FOR SOME PARAMETERS IN THE SHUSWAP BASIN

Figure 6

The major source of suspended materials appears to originate in the Kingfisher Creek watershed. The silt originates from slide areas and appears to be of natural origin rather than being caused by any activity by man. There are several effects of these elevated levels of suspended materials. The materials could decrease the usefulness of the water by adversly affecting irrigation pumping equipment operation and siltation of water lines. The suspended sediments also have the potential of decreasing the useability of the salmon spawning areas below Kingfisher Creek. However no evidence is presently available whether siltation of the grounds has resulted from the discharges from Kingfisher Creek. The effect of a large discharge of sediments on the visual appearance of the river cannot be discounted either. Since this source of suspended sediment is natural it can be expected that this loading will decrease over time as the slough areas stabilize.

Nutrients present some problems by decreasing the water quality by encouraging the growth of algae and aquatic plants in the river. The main sources of nutrients were found to be from Fortune Creek and the Enderby sewage treatment plant. The nutrients from the Fortune Creek watershed (which is predominantly agricultural), appear to be related to either leaching of fertilizers from farmland or runoff from cattle operations. On numerous occasions cattle were observed drinking water directly from Fortune Creek. The amount of phosphorous discharged from Fortune Creek is similar to the amount discharged from the Enderby sewage treatment plant. If the cattle were prevented from entering the creek or the adjacent banks some of this nutrient contamination would, in all likelihood be prevented.

The nutrients added to the river have consequences not only for the river itself but for Mara Lake downstream. An increased loading of nutrients to the lake is likely to result in increased phytoplankton growth and consequently decreased water clarity. The calculated volume of Mara Lake is 357,570,000 m^3 and the mean annual inflow is 2,724,930,000 m^3 (measured at Enderby) indicating a very high flushing rate (7.7 times per year). The phosphorus loading to the lake is also relatively high

(1.0 gm/m^2/year) but protection appears to be afforded by the high flushing rate.

Bacterial levels in the Fortune Creek watershed when of sufficiently high levels during the period of the study to be of concern. The other section of the watershed where some notice should be made is downstream of Enderby due, it would appear, to the discharge of both Fortune Creek and the Enderby S.T.P. The concentration of bacteria along this river reach discourages the domestic use of the water without some sort of treatment and users of the water for this purpose should be aware of this.

The sources of contamination in the section of the Shuswap River between Mabel and Mara Lakes appear, for the large part, to be diffuse and hard to control. Any improvement in the situation would appear to be very difficult to carry out.

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7. Appendix

Calculation of Flows in Fortune Creek for 1977

Plans were made, before the study began, to measure flow in Fortune Creek. Unfortunately the gauge was not established until August 1977 and it was established near Armstron (8LC035). Flow records are available from August thru December. The Hydrology division has estimated mean monthly flows for Fortune Creek for the year 1977 at Stepney (8LC035) and for 8LC035 for the period up to August.

Fortune Creek-Monthly Mean Discharge

m^3/s

1977	8LC035	8LC031
January	0.11	0.16
February	0.13	0.19
March	0.15	0.21
April	0.59	0.82
May	2.68	3.96
June	0.98	1.36
July	0.23	0.26
August	0.045	0.037
September	0.031	0.017
October	0.042	0.062
November	0.028	0.042
December	0.020	0.031

The watershed area of 8LC035 is 15.9 square miles and the watershed area of 8LC031 is 51.0 square miles. Between 8LC031 and the mouth of Fortune Creek is an area of 19 square miles, however no major tributaries enter Fortune Creek below Stepney, so flows at Stepney were used to calculate loadings to the Shuswap River. The loadings thus probably quite conservative and may be underestimated by as much as one-third.

Calculation of Flows in Kingfisher Creek for 1977

Kingfisher Creek has no gauge but estimates of flow were made at each sampling. Using these values, data for the months not sampled were approximated so that loads could be calculated. The mean monthly flows for 1977 which were used are as follows: January 1.4 $m^3/s.$, February 1.4, March 2.1, April 2.8, May 21.5, June 14.2, July 2.4, August 1.4, September 0.8, October 1.1, November 1.4, December 1.4.

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