

MINISTRY OF THE ENVIRONMENT

PRELIMINARY INVESTIGATIONS OF SHAWNIGAN LAKE
WATER QUALITY 1976

ENVIRONMENTAL AND ENGINEERING SERVICES
WATER INVESTIGATIONS BRANCH

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SUMMARY

A review of environmental information up to 1976 regarding Shawnigan Lake was undertaken for the purpose of identifying areas of insufficient data and attempting to assess the present state of water quality in Shawnigan Lake. Based on the limited amount of information collected to the end of 1976, it appears that water quality is good but insufficient evidence is available to draw firm conclusions. It is intended that deficiencies in data will be corrected by a sampling program to be carried out in 1977.

TABLE OF CONTENTS

	Page
Summary	i
List of Tables	ii
List of Figures	iii
List of Appendix Tables	iv
1. Existing Information	
1.1 General Characteristics and Morphometry	1
1.2 Climate	1
1.3 Soils	1
1.4 Hydrology	3
1.5 Fisheries Biology	3
1.6 Physical and Chemical Limnology	4
1.7 Biology	7
2. Sampling during 1976	
2.1 Water Chemistry	9
2.2 Physical Limnology	11
2.3 Biology	15
2.4 Hydrology	15
3. Overall View of Information to Date	16

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1 General Morphometry of Shawnigan Lake	3
2 Water Quality of Shawnigan Lake 1971-1975	6
3 Fish and Wildlife Branch Survey of Shawnigan Lake 1951	8
4 Water Quality 1976	9
5 Volume of zooplankton collected during 1966	14
6 Bacterial concentrations of water samples in the Shawnigan Lake area	15

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Shawnigan Lake basin outline map	2
2	Thermal conditions in Shawnigan Lake in the summers of 1935 and 1936	5
3	Dissolved oxygen - temperature profiles for Shawnigan Lake May 1969	5
4	Temperature and dissolved oxygen profiles in Shawnigan Lake, Station 01, 1976	12
5	Temperature and dissolved oxygen profiles in Shawnigan Lake, Station 02, 1976	13

LIST OF APPENDIX TABLES

<u>Appendix</u>		<u>Page</u>
1	Shawnigan Lake water levels	18
2	Shawnigan Creek flow data	24
3	Zooplankton Collections 1976	27

PRELIMINARY INVESTIGATIONS OF SHAWNIGAN LAKE WATER QUALITY 1976

1. Existing information

1.1 General Characteristics and Morphometry

Shawnigan Lake is a small lake situated on southern Vancouver Island. Some general characteristics are shown in Table 1. The lake surface temperature approaches 24°C in summer and in winter "occasionally" has ice cover for duration of one week (Carl, 1940). The lake is a highly utilized recreation area with numerous summer cottages and permanent homes.

The lake is composed of one main (north) basin and separated from several sub-basins in the south end by a sill less than 10 metres deep. (Figure 1). A long channel runs west from the main basin and is referred to locally as the "west arm". Main inflow is from a creek at the south end and from a creek midway along the west shore.

1.2 Climate

A meteorological station at Shawnigan Lake indicates a mean daily temperature of 1.6°C (January) and 17.2°C (July), and a mean annual rainfall total of 108 cm.

1.3 Soils

A soil survey (Day, Forstad and Laird, 1959) shows most of the soils surrounding the lake are designated D-Rs indicating soils of the Dashwood group with rough stony texture. Smaller amounts of Shawnigan group and Chemainus group also occur in the drainage basin. A more detailed and up-to-date survey is being prepared at present by the Resource Analysis Branch, Ministry of the Environment.

TABLE 1

General Morphometry of Shawnigan Lake*

altitude above sea level	468 feet ¹	380 feet ²
surface area	1468 acres ³	1327 ¹
watershed area	22 square miles ²	
mean depth	35 feet ³	38.5 feet ¹
maximum depth	154 feet ¹	32 metres ² 128 feet ³
volume	51,155 acre feet ¹	
perimeter	77,000 feet ¹	

* a number of conflicts exist in the table, and until a proper survey of the lake is done, the accuracy of these data is uncertain.

¹Fish and Wildlife Branch Lake Survey data

²Carl (1940)

³Northcote and Larkin (1956)

1.4 Hydrology

An early investigation of power potential of the Koksilah River and Shawnigan Lake was done in the early 1920's (Knewstubb, 1924). A Water Investigations Branch report by MacLean (1953) concerned itself with flooding problems of Shawnigan Lake. Copies of both these reports are in the Water Investigations Branch reports library.* Carl (1940) cites some discharge data for the lake. Lake level monitoring has been carried out by the Water Survey of Canada at Memory Island since 1970 (08HA032) and the flow of Shawnigan Creek has been monitored since 1974 (08HA033) (Appendix Tables 1 and 2).

1.5 Fisheries Biology

Dymond (1936) published a paper on the freshwater fish of B.C. and included some information on Shawnigan Lake. He mentions the Kokanee pop-

* Room 209, 780 Blanshard Street, Victoria, B.C.

ulation of the lake and the fact that Eastern Whitefish (Coregonus clupeaformis) were introduced into Shawnigan Lake (1,125,000 fry) in 1896. The Fish and Wildlife Branch has sampled the lake on a number of occasions (1950, 1956, 1957, 1969) and report Cutthroat (salmo clarki), and Rainbow trout (S. Gairdneri), Kokanee (Oncorhynchus nerka), the sculpin Cottus asper, and the brown bullhead Ameiurus nebulosus being resident in the lake.

Northcote and Larkin (1956) estimated the standing stock of fish to be 3.6 kg per standard gill net set.

1.6 Physical and Chemical Limnology

Very sketchy information from isolated samplings is available on the limnology of the lake. Carl (1940) reported a surface water temperature of 23.3° on August 4, 1936. The bottom temperature was 6.1° and the thermocline was at a depth of 5 to 15 m. Two profiles taken in 1935 and 1936 are shown in Figure 2. One interesting note, which will be discussed in more depth later, is the low oxygen concentrations in bottom waters (43% saturation) in August 1936. Carl recorded the alkalinity as 12-14 ppm.

The Fish and Wildlife Branch did a temperature and oxygen profile on May 10, 1969 which is shown in Figure 3.

Sampling of water quality was carried out by the Pollution Control Branch between 1971 and 1975 at Station 0131140, "private dock east side of lake, north end", and consists of surface samples only. A summary of the data is shown in Table 2 below.

Figure 2

THERMAL CONDITIONS IN SHAWNIGAN LAKE
SUMMERS OF 1935 AND 1936
FROM CARL (1940)

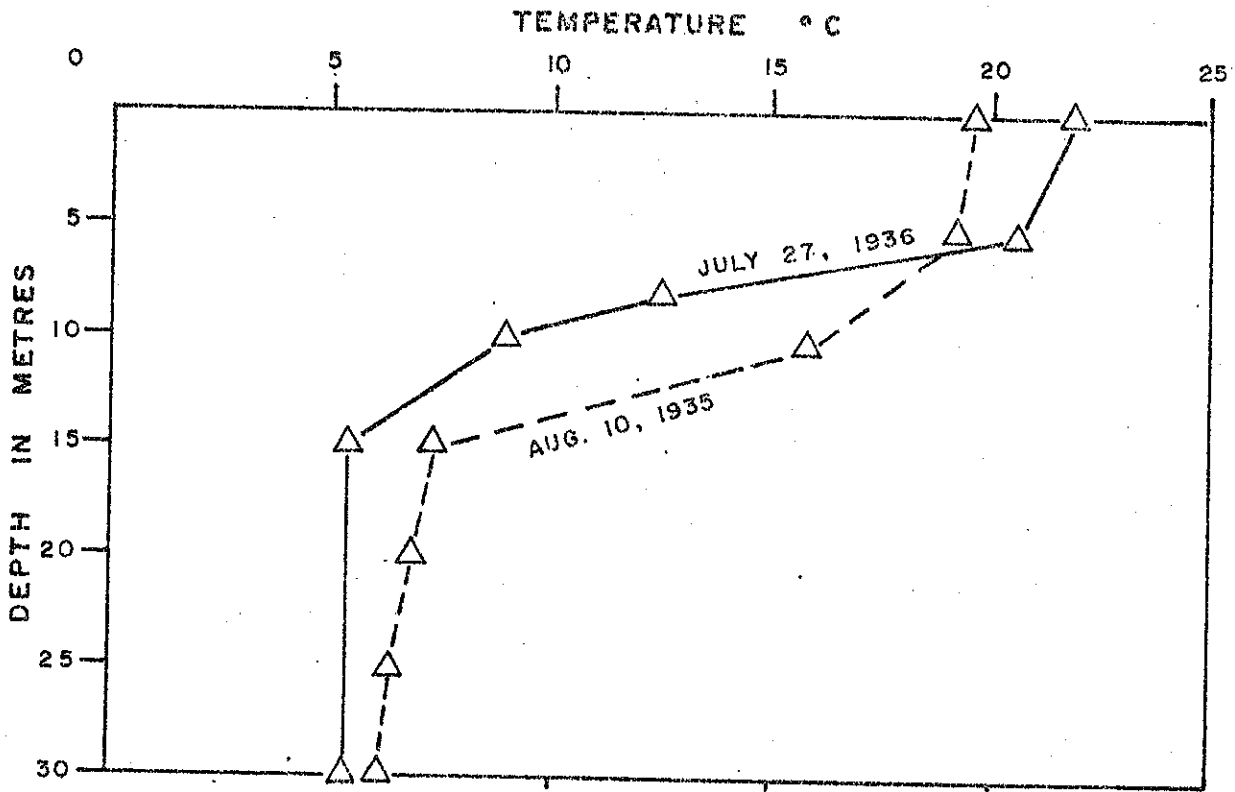
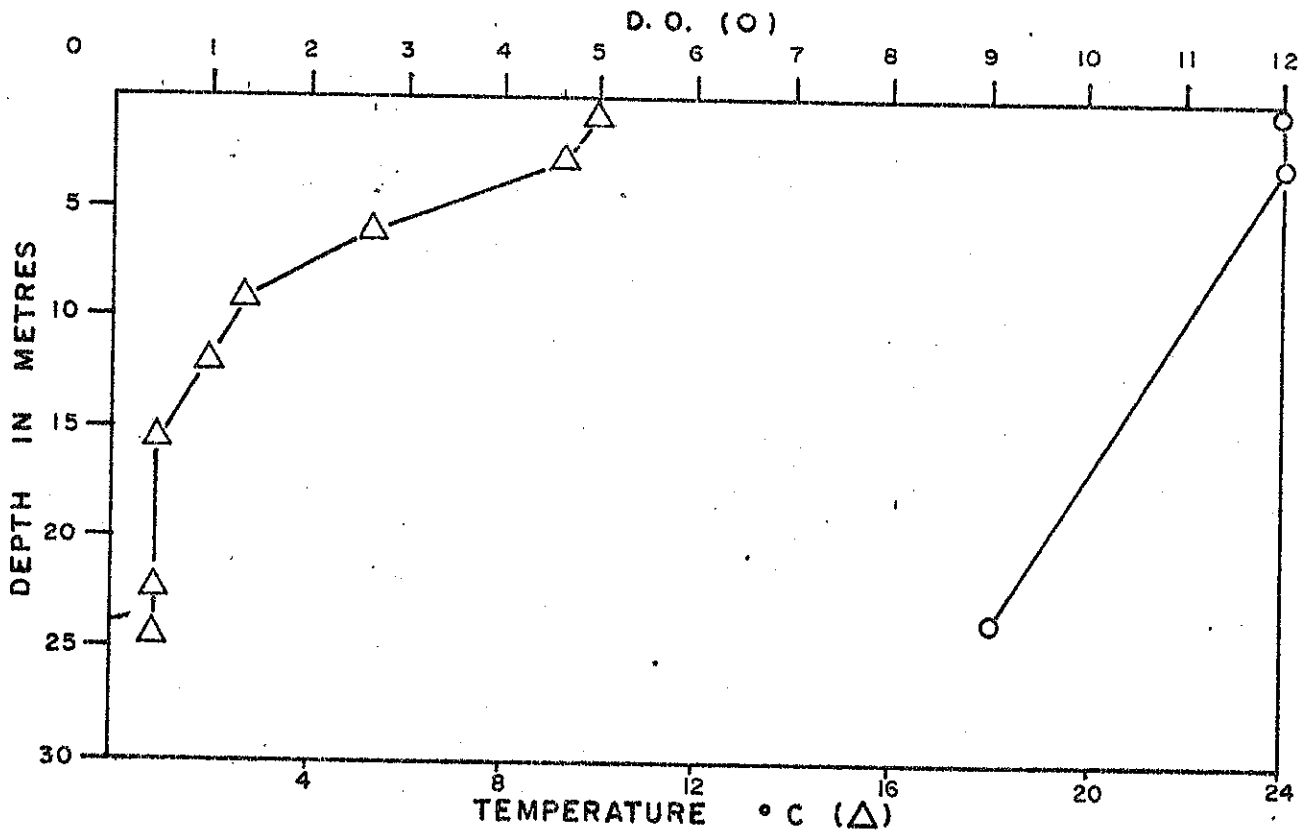


Figure 3

DISSOLVED OXYGEN - TEMPERATURE PROFILES
FOR SHAWNIGAN LAKE.



Fish and Wildlife Branch, Date 10, May, 1969

TABLE 2

Water Quality of Shawnigan Lake 1971-1975

All values mg/l unless noted.	No. of samples	min	max	mean
Colour (True)	13	5	15	7.3
(TAC)	1			6.0
pH	12	6.8	7.5	7.28
Total Residue 105 ^o	14	26	42	35.7
Residue filt 105 ^o	10	23	42	34.6
Residue non-filt 105 ^o	8	<1	8.0	2.13
turbidity (JTU)	14	.20	.90	.57
alkalinity	3	14.5	15.0	
hardness	14	11.2	20.6	16.7
ammonia nitrogen	2	0.005	.009	
NO ₃ nitrogen	14	<0.20	.130	.051
Organic nitrogen	2	0.90	.140	
Kjeldahl nitrogen	3	.100	.330	
Total nitrogen	3	.100	.330	
Dissolved phosphorus	6			all less than (.003)
Total phosphorus	13	<.003		.005
surfactants	8			all below detectable limits
cadmium	3			all less than .0005
chromium	2			both less than .005
copper	2			both less than .010
iron, total	12			all below detection limit
lead, total	10			most below detection limit (0.001) but one .025
mercury (µg/l)	7			5 values <.05, one .08, one .12
coliforms fecal (MPN)	8			7 are less than 2 MPN one samples of 5
total (MPN)	7	8	79	26.7

A number of conclusions might be drawn from this preliminary sampling. The parameters measuring dissolved materials in the water (residue, specific conductance alkalinity, hardness) indicate very soft water. The water is generally low in colour and turbidity. Nutrients appear to be present at very low concentrations, and there appears to be little evidence of human contamination (surfactants, metals, coliform bacteria).

1.7 Biology

Carl (1940) lists the copepods and cladocerans of Shawnigan Lake although he gives no relative quantities. Sida crystallina, Daphnia longispina, Scapholeberis mucronata, Bosmina obtusirostris, Polyphemus pediculus, Leptodora kindtii, Epischura nevadensis, Cyclops bicuspidatus are listed.

The Fish and Wildlife Branch sampled the lake on July 26, 1951 and part of the results are contained in the report by Northcote and Larkin (1956). It gives a settled plankton volume of 1.8 cc (vertical haul #10 plankton net) and the benthos as being "sparse" (0-10 organisms per 81 square inches). The Fish and Wildlife Branch survey sheet is attached as Table 3.

Another Fish and Wildlife Branch survey was done in 1969 but only the benthos results are given. Chironomids were found at 27 m, molluscs at 6 m and flatworms at 2 m. A plankton haul was done but no results given.

TABLE 3

Fish and Wildlife Branch
Survey of Shawnigan Lake, 1951
Plankton and Invertebrates

A. MACROFLORA POTEMOGETON AMPLIFOLIUS
 POTEMOGETON ROBBINSII

B. PLANKTON

Date, station	T.V. 10	T.V. 20	S.T. 10
July 24, 1951	30M. 1.8 ml. Tabellaria Asterionella Fragilaria Surirella Microspora (Trib- onema?) Rivularia Eremosphaera Ceratium Anuraea Notholca Polyarthra Cyclops D. Longispina Nauplii	30M. 1.5 ml. Tabellaria Asterionella Fragilaria Surirella Microspora (Trib- onema?) Rivularia Eremosphaera Ceratium Anuraea Polyarthra Cyclops D. Longispina Nauplii	4.1 cc. 3 min. Asterionella sp. Tabellaria Surirella sp. Microspora (Tribonema?) Rivularia Ceratium Notholca Anuraea D. Longispina Cyclops Diaptomus Nauplii

C. BOTTOM FAUNA

Date	Depth	Substrata	Organisms
July 24, 1951	2M.	All dredgings taken in Northern portion - soft, oozy mud. - Many gravel beaches probably 1/4 of shoreline comp. solid rock.	Nostoc Chironomus
	8M.		Nostoc Chironomus
	16M.		Chironomus
	24M.		Pisidium, Chironomus

2. Sampling during 1976

Sampling was carried out with the intention of relating current information to the past data. Trips were made to the lake on June 29, September 9, October 20, and November 25 and sampling was carried at three stations. One station was located in the main (north) basin (1199901), one station in the major of the shallower south basins (1199902) and one station at the end of the west arm (1199903).

The following is a summary of the parameters considered:

2.1 Water Chemistry

TABLE 4

Water Quality 1976

mg/l unless noted	no. of samples	min.	max.	mean
Station 01 pH	18	6.6	7.5	7.09
alkalinity	8	14.7	15.8	15.3
secchi depth (ft.)			9 Sept.	6.7 metres
			20 Oct.	6.7 m
			25 Nov.	5 m
colour (TAC units)	13	3	9	5.5
organic carbon	18	2.0	40	3.3
ammonia nitrogen	14	.006	.012	.008
NO ₂ /NO ₃ nitrogen	18	most values <.020, some higher values at depth.		
total nitrogen	14	.020	.230	.132
kjeldahl nitrogen	18	.020	.170	.103
ortho phosphorous	18	all <.003		
total phosphorus	18	<.003	.008	.0055
silica	14	4.1	6.3	5.02
inorganic carbon	8	1	4	2.5

TABLE 4 con'd

mg/l unless noted	no. of samples	min.	max.	mean
total coliform (MPN)	2		<2	
fecal coliform (MPN)	2		<2	
Station 02 pH	13	6.5	7.6	7.11
alkalinity	7	13.5	15.8	14.9
secchi depth (ft)	29 June			4 metres
	9 Sept	760909	20	6.7
	20 Oct	761020	20	6.7
	25 Nov	761125	13	4.3
colour	2			5
total organic carbon	13	3	5	3.3
ammonia nitrogen	9	<.005	.119(56')	
		all surface values <.010		
NO ₂ /NO ₃ nitrogen	13	<.02	.040	
Kjeldahl nitrogen	13	.090	.300	.148
total nitrogen	9	.100	.220	.133
ortho phosphorous	13	all values <.003		
total phosphorous	13	<.003	.010	.0058
silica	9	4.1	6.4	4.7
inorganic carbon	7	4	1	2.14
Station 03 pH	4	7.2	7.4	7.3
alkalinity	2			15.75
colour	3	3	4	3.6
T.O.C.	3	3	4	3.3
ammonia	3	.007	.009	.008
NO ₂ /NO ₃	4	<.020	.020	
Kjel nitrogen	4	.030	.160	.107
total nitrogen	3	.030	.120	.090
ortho phosphorous	4	all <.003		
total phosphorous	4	<.003	.007	.0045
coliform total (MPN)	2	6	11	8.5
fecal (MPN)	2	<2	4	3

In general two points can be made. As was evident in earlier sampling, the water is of high transparency, low colour, low turbidity and nutrient levels are low. These characteristics indicate good water quality. Station 03 was selected in an area of high residential and cottage development, and because of limited water exchange would be expected to show some evidence of human influence, however it shows few differences from the main-lake stations.

2.2 Physical Limnology

Profiles of dissolved oxygen and temperature give information on several important aspects of the lake. These profiles are shown as figures 4 and 5. In June the surface temperature was 18.8°C and the thermocline was 3-7 m deep with the hypolimnion temperature 7-8°. The dissolved oxygen was similar from the surface to 20 m and would be expected to be the same to the bottom. By early September the thermocline was 6-12 m from the surface and the surface temperature was 19°. The oxygen concentration in the hypolimnion was noticeably lower.

By October the surface temperature had decreased to 13.8° and the thermocline was very strongly established at 10-12 m. A noticeable oxygen deficit was present in the hypolimnion.

In November, the surface water was further cooled in response to the cooler air temperatures and the thermocline was at 12-16 m. There was little evidence in the temperature data of stratification but the oxygen data indicated that the hypolimnion was less than 60 percent saturated.

There are two points to be taken from these data. The stratification pattern displayed during 1976 appears to be very typical. The surface water temperature appears to be lower than normal, due to the uncommonly cool summer temperatures. The second point is the surprising oxygen depletion which would not be expected if viewed in the light of the relatively unproductive nature of the lake. However, this unusual oxygen depression was noted also by Carl (1940) and it is doubtful if the present condition is indicative of any recent deterioration in water quality.

Figure 4

TEMPERATURE AND DISSOLVED OXYGEN PROFILES
IN SHAWNIGAN LAKE, STATION 01, 1976.

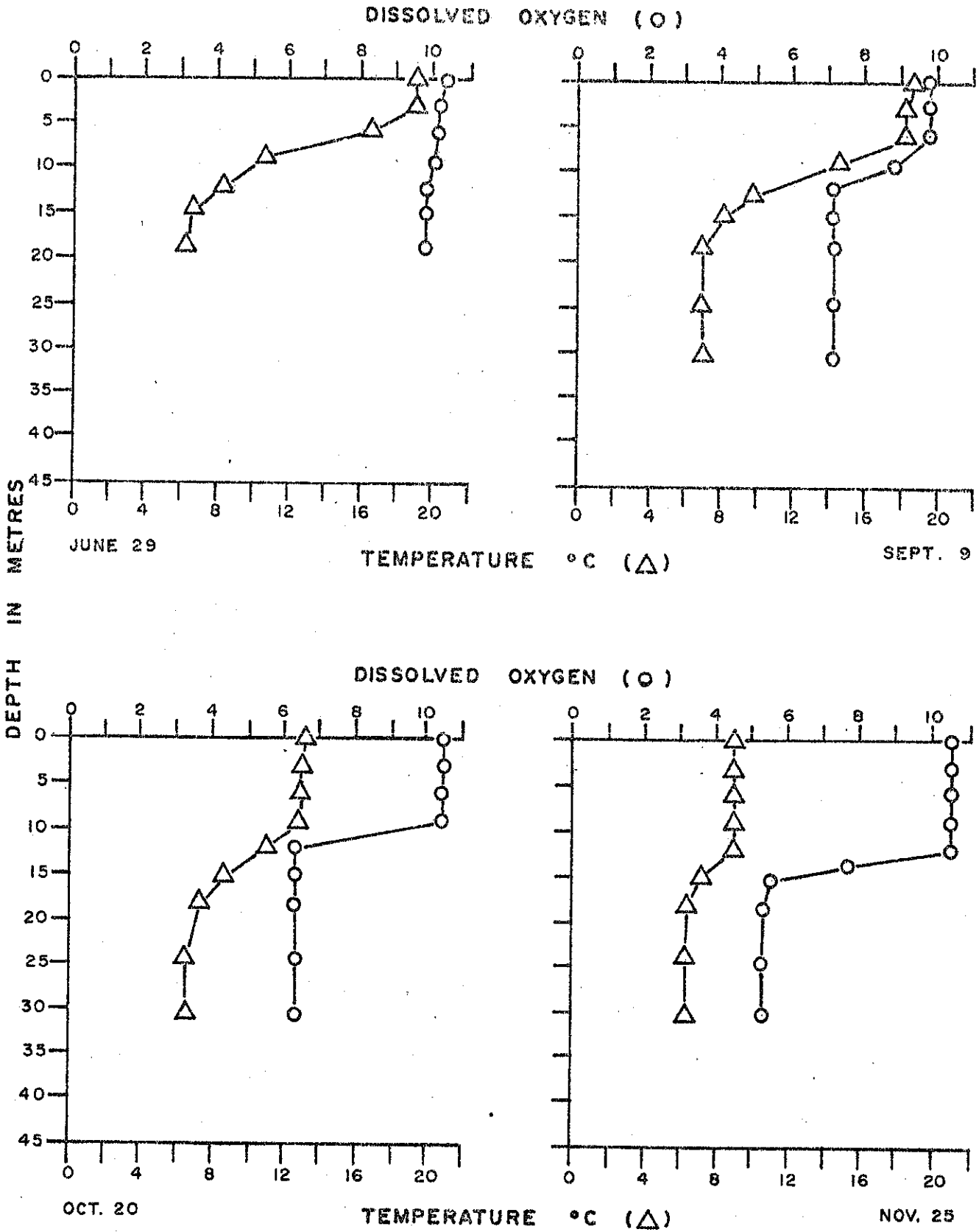
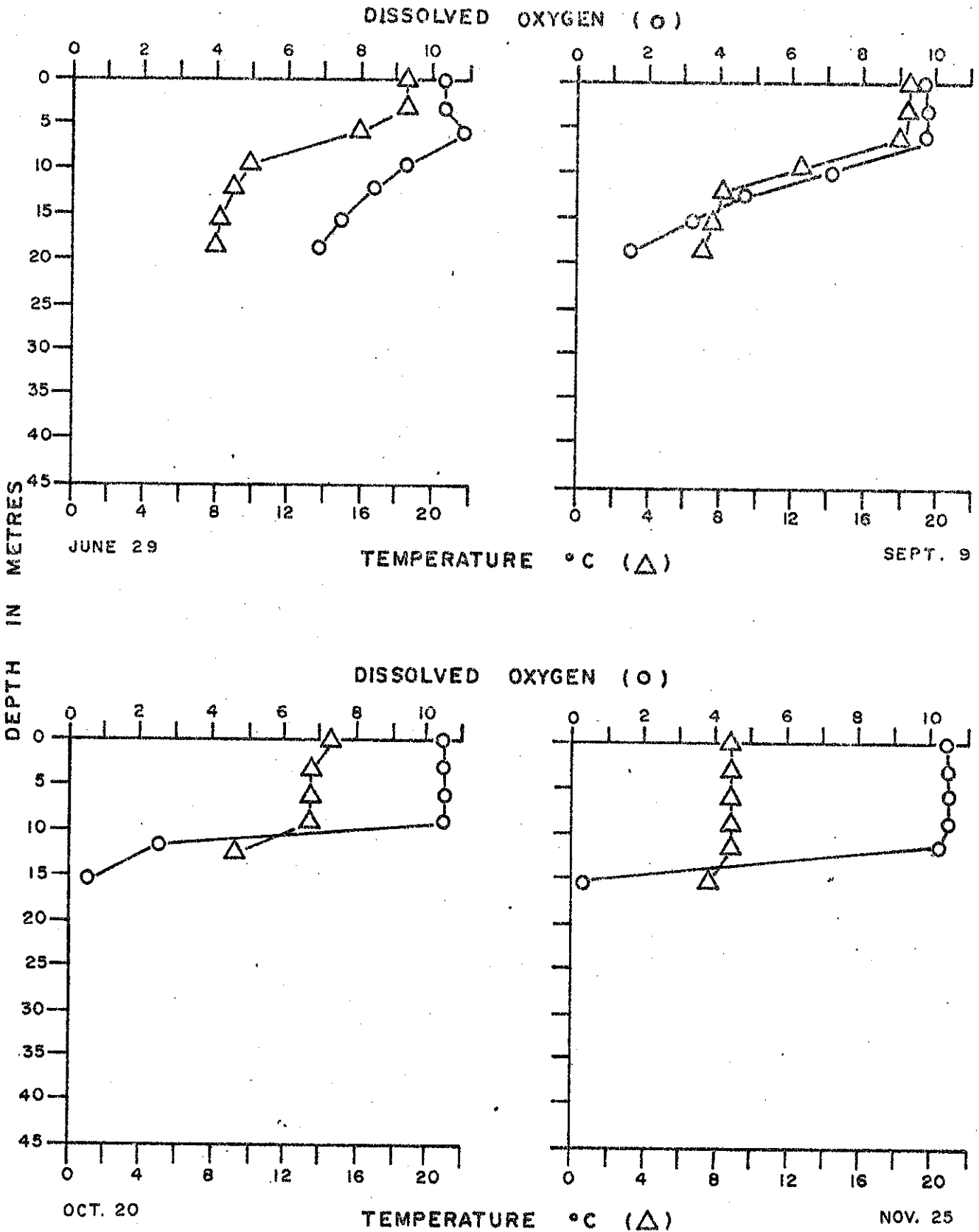


Figure 5

TEMPERATURE AND DISSOLVED OXYGEN PROFILES
IN SHAWNIGAN LAKE, STATION 02, 1976.



2.3 Biology

The sampling of biological parameters in 1976 was limited to zooplankton and phytoplankton. The phytoplankton has not been analysed at present. Two observations of very minor algal blooms were made. One on September 9 was dominated by the blue-green alga Gloeotrichia and the other bloom on November 8 was predominantly Anabaena.

The zooplankton was collected with the intention of comparison to data collected previously by the Fish and Wildlife Branch. The data for stations 01 and 02 are summarized in Table 5. The zooplankton counts and identifications indicate little evidence of species change since the 1930's. A list of the zooplankton and counts are attached as Appendix 3. An explanation of the species listed and the differences are given with the listings.

The zooplankton data indicate that the density and composition of this facet of the lake biota has not become more abundant in the last 20 years and the species composition has changed little, if at all, in 40 years.

TABLE 5

Volume of zooplankton (ml) collected during 1976

Station 01	<u>date</u>	<u>settled volume (ml)</u>
	29/6/76	1.4
	9/4/76	0.6
	20/10/76	1.0
	25/11/76	0.4
		mean .86
Station 02	29/6/76	.60
	9/9/76	.30
	20/10/76	.67
		mean .52

Northcote and Larkin (1956) list a settled zooplankton volume of 1.8 for Shawnigan Lake. For comparison, productive lakes have settled plankton volume in the order of 14.0 (St. Mary's Lake), 710 (Charlie Lake) and relatively unproductive lakes 1.8 (Kootenay) and 3.6 (Kalamalka Lake).

The conclusions which might be drawn from the biological information gathered are that the algal blooms which were observed were minor and of little consequence. This year (1977) with low flushing rates expected and if normal or above-normal sunshine is experienced, should be more telling of conditions and such algal blooms might be more noticeable and/or long lasting.

Sampling for bacterial contamination was done in selected areas coincident with lake sampling in an attempt to establish the level of bacterial contamination. The results are shown below as Table 6.

TABLE 6
Bacterial concentrations of water samples
in the Shawnigan Lake Area

Site	Date	MPN	
		Total	Fecal
boat launch site, west side off Carlson Road	29 June	350	
public beach, north end, off dock	29 June	17	
Shawnigan Creek at lake exit	20 Oct	220	130
Shawnigan Creek at lake exit	25 Nov	49	33

A report by Stonehouse (1969) of a survey carried out in July and August of 1969 indicates similar findings. The levels of bacterial contamination were below Health Branch Standards for bathing, swimming, and recreation (i.e. median values less than an MPN of 1000) but above raw drinking water standards (i.e. no more than 10% of samples showing presence of coliform bacteria).

2.4 Hydrology

The estimated mean annual outflow for Shawnigan Lake is 55,000 acre feet (Hydrology Division, Water Investigations Branch) and the estimated volume of the lake is 51,155 acre feet (Fish and Wildlife Branch). The theoretical water exchange time (flushing rate) would be slightly more than once-per year (1.07 times per year). Water Survey of Canada gives a total

discharge figure for 1975 of 81,200 acre feet. This indicates a fairly wide range of variability of water exchange time according to the particular rainfall pattern for that year.

3. Overall view of information to date

There appears to be insufficient evidence to draw definite conclusions. There is poor information in a number of areas. Water quality appears to be good but the only serious sampling was done during a year of a typically cold summer and a typically dry winter. The relatively high water exchange rate may be a large contributor to keeping the water quality high. The sources and quantification of nutrients is also an area where little information exists.

A number of these deficiencies will be remedied in the proposed sampling for 1977.



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APPENDIX TABLE 1

Shawnigan Lake Levels 1970-1975

DAILY GAUGE HEIGHTS

Station Name SHAWNIGAN LAKE OPPOSITE MEMURY ISLAND Station No. 8HA-32

Daily Elevations or Gauge Heights in Feet for the Year 1975

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1						1.55	1.24	0.89	1.00				1
2					1.88	1.54	1.23	0.87	0.99				2
3								0.86					3
4		2.89			1.87			0.84					4
5							1.23						5
6						1.49			0.98				6
7									0.97		4.43		7
8						1.47			0.96		4.63		8
9			3.18						0.95	1.02	4.83		9
10										1.05			10
11	3.74									1.05			11
12				2.30					0.93	1.06			12
13							1.12		0.93	1.07	4.20		13
14						1.46			0.92				14
15					1.79			0.73					15
16			2.75		1.78			0.74					16
17													17
18							1.09	0.75		1.74			18
19					1.75		1.08	0.74		1.85			19
20					1.73		1.06	0.73		2.01			20
21				2.15	1.71	1.33	1.05	0.74					21
22						1.31		0.73					22
23						1.30		0.73			4.1		23
24					1.66			0.91					24
25								0.91					25
26					1.63		0.98	0.90					26
27							0.97	0.89	0.84				27
28				1.90		1.28	0.95	0.93	0.84				28
29									0.87				29
30						1.26		0.99			3.62		30
31						1.26		1.00					31
								1.00					

Summary For the Year For the Period (to)	Maximum instantaneous elevation, daily gauge height,	ft	on	Checked by Date
	Minimum instantaneous elevation, daily gauge height,	ft	on	

MAY 26 1976

SHAWNIGAN LAKE OPPOSITE MEMORY ISLAND - STATION NO. 02NAG02

DAILY WATER LEVEL IN FEET FOR 1973

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	---	---	---	---	---	---	---	---	---	---	---	---	1
2	---	---	---	---	---	---	1.29	0.95	---	---	---	---	2
3	---	---	---	---	---	---	---	---	0.53	---	---	---	3
4	---	---	---	---	---	---	---	---	0.58	---	---	---	4
5	---	---	---	---	1.62	---	---	0.80	---	---	---	---	5
6	---	---	---	---	---	---	---	0.89	---	---	---	---	6
7	---	---	---	---	---	---	---	---	---	0.38	---	---	7
8	---	---	---	---	---	1.06	1.26	0.87	---	---	---	---	8
9	---	---	---	---	---	---	---	0.85	---	---	---	4.31	9
10	---	---	---	---	---	---	---	---	0.49	---	0.99	---	10
11	---	---	---	---	---	---	---	0.83	---	---	1.05	---	11
12	---	---	---	---	---	---	---	---	---	---	---	---	12
13	---	---	---	---	---	---	---	---	---	0.93	---	---	13
14	---	---	---	1.88	---	---	1.20	---	---	---	---	---	14
15	---	---	---	---	---	---	1.19	---	---	---	---	---	15
16	---	---	2.20	---	---	---	---	---	---	---	---	---	16
17	---	---	---	---	---	---	---	---	---	---	---	---	17
18	4.55	---	---	---	---	---	---	---	---	---	---	---	18
19	---	---	---	---	1.59	---	1.15	0.72	---	---	---	---	19
20	---	---	---	---	---	---	---	0.69	---	---	---	---	20
21	---	---	---	1.78	---	---	1.08	---	---	---	---	---	21
22	---	---	---	---	---	---	---	---	---	---	---	---	22
23	---	---	---	---	---	1.37	---	---	---	---	---	---	23
24	---	---	---	---	---	---	---	---	---	---	2.85	---	24
25	---	---	---	---	---	---	1.04	---	---	---	---	---	25
26	---	---	---	---	---	---	---	0.61	---	---	---	---	26
27	---	---	---	---	---	---	1.03	0.59	---	---	---	---	27
28	---	---	---	---	---	1.31	---	---	---	---	---	---	28
29	---	---	---	---	---	---	1.01	---	---	---	---	---	29
30	---	---	---	---	---	---	0.99	---	0.41	---	---	---	30
31	---	---	---	---	---	---	---	0.57	---	---	---	---	31

DAILY WATER LEVEL IN FEET FOR 1978

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	---	---	---	---	---	1.76	1.41	---	0.93	---	---	---	1
2	---	---	---	---	---	1.76	---	---	0.92	---	---	---	2
3	---	---	---	2.75	---	---	---	1.28	0.90	---	0.55	---	3
4	---	---	---	---	1.91	---	1.39	1.26	---	---	---	---	4
5	---	---	---	---	1.89	---	---	1.24	---	0.64	---	---	5
6	---	---	---	---	---	---	---	1.22	---	---	---	---	6
7	---	---	---	2.74	---	---	---	1.21	---	---	---	---	7
8	---	---	---	---	---	1.84	1.38	---	---	---	---	---	8
9	---	---	3.05	---	---	---	---	1.17	0.85	---	0.61	---	9
10	---	---	---	---	---	---	---	1.16	---	---	0.66	---	10
11	---	---	---	---	1.85	---	---	1.14	---	0.63	0.81	2.90	11
12	---	---	---	2.60	1.85	---	1.39	1.12	---	---	---	---	12
13	2.70	---	3.65	2.54	---	---	1.39	1.12	---	0.63	---	---	13
14	---	---	---	2.51	---	---	1.38	1.11	0.82	---	---	---	14
15	---	---	---	2.44	---	---	---	1.09	---	---	1.05	---	15
16	---	3.70	---	---	---	1.70	---	1.08	---	---	1.86	---	16
17	---	---	---	---	1.82	---	---	1.07	---	---	---	---	17
18	---	---	---	---	1.81	---	---	1.05	---	---	---	---	18
19	---	---	---	---	---	---	---	1.05	---	0.59	---	---	19
20	---	---	---	2.24	---	---	1.44	1.03	---	0.59	---	---	20
21	---	---	---	---	2.19	1.74	1.60	1.02	0.77	---	---	---	21
22	---	---	---	---	---	---	---	1.01	0.76	---	---	---	22
23	---	---	---	---	---	1.55	---	1.01	0.75	---	---	---	23
24	---	3.29	---	---	---	---	---	1.00	---	---	2.86	---	24
25	4.68	---	---	---	1.80	---	---	0.99	---	---	---	---	25
26	---	---	---	---	1.81	---	---	---	---	---	---	---	26
27	---	---	---	2.08	---	---	1.36	---	0.70	---	---	---	27
28	---	---	---	2.06	---	---	1.35	---	---	---	---	---	28
29	---	---	---	2.04	---	---	1.35	---	---	---	---	---	29
30	---	---	---	---	---	1.45	---	---	---	---	2.76	---	30
31	---	---	---	---	---	---	1.31	0.94	---	---	---	---	31

TYPE OF GAUGE - MANUAL
 LOCATION - LAT 48 36 32 N
 LONG 123 38 25 W

NATURAL FLOW

WATER LEVELS ARE REFERRED TO ASSUMED DATUM

DAILY GAUGE HEIGHTS

Station Name SHAWINIGAN LAKE OPPOSITE MEMORY ISLAND Station No. 08HA032

Daily ~~Elevation~~ Gauge Heights in Feet for the Year 19 70

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1													1
2													2
3													3
4													4
5													5
6									0.61				6
7									0.59				7
8													8
9													9
10													10
11													11
12													12
13													13
14													14
15													15
16													16
17													17
18													18
19													19
20													20
21													21
22													22
23													23
24										0.63			24
25													25
26									0.60				26
27													27
28													28
29													29
30													30
31													31

Summary For the Year For the Period (<u>SEPT 5</u> to <u>DEC 20</u>)	Maximum daily instantaneous elevation gauge height,	4.11 ft ab	on <u>DEC. 20</u>	Computed by <u>D.L. 197</u> Date <u>12.13.70</u>	Checked by <u>AW</u> Date <u>Dec 6/73</u>
	Minimum daily instantaneous elevation gauge height,	0.59 ft ab	on <u>SEPT. 6</u>		

DAILY GAUGE HEIGHTS

Station Name SHAWINIGAN LAKE OPPOSITE MEMORY ISLAND Station No. 03HA032

Daily Gauge Heights in Feet for the Year 19 71

Day	January	February	March	April	May	June	July	August	September	October	November	December
1												
2												
3												
4												
5												
6							1.42					
7												
8					1.70	1.34		1.15				
9												
10							1.43			0.79		
11									0.90			
12												
13												
14								1.06				
15												
16				2.61								
17			4.11				1.40					
18									0.84			
19												
20												
21					1.55							3.59
22												
23												
24												
25						1.45						
26												
27												
28											2.45	
29												
30					1.45							
31							1.23					
Summary For the Year (1971)												
Maximum instantaneous elevation, gauge height, <u>4.20</u> ft at <u>JAN 31</u> on <u>JAN 31</u> Minimum instantaneous elevation, gauge height, <u>0.79</u> ft at <u>DEC 19</u> on <u>DEC 19</u>												
										Computed by <u>P. J. [Signature]</u> Date <u>11.13.73</u>		
										Checked by <u>SW</u> Date <u>Dec 6/73</u>		

DAILY GAUGE HEIGHTS

Station Name

SHANNIGAN LAKE OPPOSITE MEMORY ISLAND

Station No.

08MA032

Daily Gauge Heights in Feet for the Year 19 72

Day	January	February	March	April	May	June	July	August	September	October	November	December	Day
1													1
2													2
3				2.59					0.85			1.50	3
4						1.45							4
5					1.95								5
6								1.05		0.87			6
7													7
8						1.40			0.50				8
9													9
10						1.41							10
11							1.40	0.98					11
12													12
13													13
14		3.34											14
15													15
16						1.39							16
17													17
18													18
19					1.65			0.99					19
20	4.15												20
21							1.31						21
22									0.92				22
23				2.97		1.33							23
24													24
25													25
26								0.93				8.73	26
27			3.06										27
28					1.55			0.92					28
29						1.29							29
30							1.18						30
31								0.89					31

Summary
For the Year
For the Period
(1971 to DEC 26)

Maximum
instantaneous elevation,
daily gauge height,
Minimum
instantaneous elevation,
daily gauge height,

8.73
feet
0.80
feet

DEC 26
on
SEP 8
on

Computed by
Date
12.13.72

Checked by
Date
Dec 6/73

APPENDIX TABLE 2

Shawnigan Creek Flows 1974-1975

ALTER SURVEY OF CANADA
APR 22 1976 PAGE 21
VANCOUVER, B.C.

SHANNIGAN CREEK NEAR MILL BAY
(MANUAL GAUGE)

STATION NO. 287-033

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 1975

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	225	170	178	100	30.2	9.7	2.3	0.35 E	1.8	0.05 E	238	382	1
2	217	162	184	98.4	30.2	9.2	2.3	0.35 E	1.6	0.85 E	251	402	2
3	254	150	200	96.8	30.2	9.2	1.8	0.35 E	1.6	1.00	272	416	3
4	266	140	215	98.4	29.4	8.8	1.8	0.35 E	1.5	2.1	285	425	4
5	277	128	215	92.0	29.4	8.3	1.8	0.35 E	1.3	5.7	290	500	5
6	250	121	226	87.5	28.6	8.3	1.8	0.35 E	1.2	4.6	295	450	6
7	263	115	194	84.5	27.0	7.9	1.8	0.35 E	0.95 E	4.6	315	452	7
8	266	108	154	78.5	25.4	6.5	2.0	0.35 E	0.95 E	5.7	368	359	8
9	260	102	172	75.5	23.8	6.1	2.0	0.35 E	0.90 E	6.5	368	362	9
10	234	119	164	72.5	23.3	5.7	1.6	0.35 E	0.90 E	7.9	337	342	10
11	234	140	162	69.5	23.0	5.3	1.5	0.35 E	0.90 E	7.9	310	314	11
12	234	168	144	65.0	22.4	4.9	1.8	0.35 E	0.90 E	6.5	285	292	12
13	222	217	135	62.0	21.8	4.6	1.6	0.35 E	0.85 E	5.2	287	276	13
14	222	231	131	59.6	21.2	4.6	1.5	0.30 E	0.80 E	6.1	287	252	14
15	214	231	126	57.2	21.2	4.6	1.5	0.30 E	0.75 E	7.9	404	252	15
16	219	217	142	53.6	20.6	4.6	1.5	0.35 E	0.75 E	8.8	404	240	16
17	228	208	139	51.2	20.0	3.8	1.2	0.40 E	0.90 E	47.0	374	227	17
18	251	204	164	50.0	18.8	3.4	0.95 E	0.45 E	0.90 E	48.0	370	216	18
19	274	211	174	49.0	17.6	2.6	0.85 E	0.50 E	0.90 E	49.0	364	201	19
20	277	217	186	48.0	17.6	2.4	0.75 E	0.55 E	0.85 E	69.5	342	187	20
21	285	206	196	47.0	17.0	2.3	0.70 E	0.70 E	0.85 E	80.0	322	179	21
22	272	206	196	44.0	16.4	2.3	0.70 E	1.00	0.85 E	80.0	304	173	22
23	261	211	192	41.0	16.4	3.4	0.70 E	5.7	0.80 E	80.0	304	176	23
24	261	208	186	43.0	15.2	4.4	0.65 E	2.4	0.80 E	84.5	300	182	24
25	254	194	174	42.0	14.0	3.4	0.50 E	2.4	0.80 E	91.6	294	205	25
26	251	182	164	39.1	14.0	2.6	0.45 E	2.3	0.75 E	108	236	239	26
27	228	174	150	37.3	13.4	2.6	0.45 E	2.1	0.75 E	117	232	325	27
28	215	164	131	34.6	12.8	2.6	0.45 E	2.1	0.75 E	128	278	344	28
29	208	121	121	33.7	11.0	2.6	0.45 E	1.8	0.75 E	174	294	364	29
30	196	122	122	32.8	10.6	2.6	0.40 E	1.8	0.75 E	215	296	342	30
31	178	108	108	10.1	10.1	0.35 E	0.35 E	1.6	0.75 E	224	334	334	31
TOTAL	7508	4904	5185	1843.7	633.1	150.0	38.15	31.50	29.05	1679.90	9406	9462	TOTAL
MEAN	242	175	167	61.5	20.4	5.0	1.2	1.0	0.97	54.2	314	305	MEAN
AC-FT	14900	9730	10300	3660	1260	298	75.7	62.5	57.6	3300	1800	1800	AC-FT
MAX	285	231	226	100	30.2	9.7	2.3	5.7	1.8	224	494	500	MAX
MIN	178	102	108	32.8	10.1	2.3	0.35	0.30	0.75	0.65	238	173	MIN
SUMMARY FOR THE YEAR 1975													
MEAN DISCHARGE, 112 CFS													
TOTAL DISCHARGE, 81200 AC-FT													
MAXIMUM DAILY DISCHARGE, 500 CFS ON DEC 5													
MINIMUM DAILY DISCHARGE, 0.30 CFS ON AUG 14													
E-ESTIMATED													

DISCHARGES BELOW 1.0 CFS ARE ESTIMATED

Total #1 Jan. 1 - 20
Total #2 Jan. 21 - Nov. 14
Total #3 Nov 15 - Dec 31

Station
May 5, 1976
Rupert
1975

SHANNIGAN CREEK NEAR HILL BAY - STATION NO. 08HA033
 DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 1974

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1					40.2	23.0	6.8	2.2	0.26 E	0.26 E	0.34 E	99.6	1
2					38.2	21.2	6.1	2.2	0.27 E	0.34 E	0.34 E	98.4	2
3					37.3	23.0	5.7	2.0	0.17 E	0.34 E	0.34 E	98.4	3
4					35.4	32.7	5.4	2.0	0.17 E	0.34 E	0.34 E	96.0	4
5					33.6	32.7	4.2	1.7	0.15 E	0.34 E	0.34 E	92.4	5
6					31.9	31.9	3.3	1.3	0.17 E	0.34 E	0.34 E	101	6
7					32.7	31.0	3.3	1.2	0.17 E	0.34 E	0.34 E	101	7
8					30.1	20.1	2.4	1.2	0.17 E	0.34 E	0.34 E	101	8
9					29.2	26.5	2.8	1.1	0.17 E	0.34 E	0.34 E	102	9
10					28.3	23.8	3.3	1.0	0.17 E	0.34 E	0.34 E	113	10
11					26.3	22.0	3.3	1.0	0.17 E	0.34 E	0.34 E	128	11
12					27.7	22.1	2.1	0.96 E	0.34 E	0.34 E	0.34 E	146	12
13					27.7	20.9	2.8	0.88 E	0.34 E	0.34 E	0.34 E	126	13
14					31.9	18.3	2.8	0.88 E	0.34 E	0.34 E	0.34 E	126	14
15					30.1	17.9	2.4	0.71 E	0.34 E	0.34 E	0.34 E	168	15
16					30.1	15.9	2.6	0.63 E	0.34 E	0.34 E	0.34 E	170	16
17					30.1	15.3	2.6	0.46 E	0.34 E	0.34 E	0.34 E	170	17
18					26.5	12.0	5.4	0.38 E	0.34 E	0.34 E	0.34 E	188	18
19					25.5	12.0	3.9	0.54 E	0.34 E	0.34 E	0.34 E	188	19
20					24.7	12.0	3.1	0.54 E	0.34 E	0.34 E	0.34 E	198	20
21					23.0	11.5	2.9	0.46 E	0.34 E	0.34 E	0.34 E	219	21
22					23.0	10.1	2.8	0.46 E	0.34 E	0.34 E	0.34 E	235	22
23					23.0	10.1	2.6	0.38 E	0.34 E	0.34 E	0.34 E	235	23
24					23.0	10.1	2.4	0.38 E	0.34 E	0.34 E	0.34 E	250	24
25					23.0	8.6	2.4	0.34 E	0.34 E	0.34 E	0.34 E	283	25
26					28.3	10.1	3.4	0.34 E	0.34 E	0.34 E	0.34 E	265	26
27					26.5	9.1	2.7	0.17 E	0.34 E	0.34 E	0.34 E	277	27
28					25.6	8.2	2.2	0.17 E	0.34 E	0.34 E	0.34 E	275	28
29					24.7	7.2	2.2	0.17 E	0.34 E	0.34 E	0.34 E	254	29
30					23.8	6.8	2.2	0.26 E	0.34 E	0.34 E	0.34 E	264	30
31					23.0	6.8	2.2	0.26 E	0.34 E	0.34 E	0.34 E	287	31
TOTAL					916.1	528.9	102.3	76.36	9.71	10.60	1238.11	5771.8	TOTAL
MEAN					29.6	18.0	3.3	0.85	0.32	0.34	41.3	186	MEAN
AC-FT					1820	1070	203	52.2	15.3	21.0	2460	11400	AC-FT
MAX					40.2	32.7	6.8	2.2	0.54	0.54	127	350	MAX
MIN					23.0	6.8	2.2	0.13	0.13	0.17	0.36	52.4	MIN

SUMMARY FOR THE YEAR 1974

MINIMUM DAILY DISCHARGE, 0.13 CFS ON AUG 27
 TYPE OF GAUGE - MANUAL
 LOCATION - LAT 48 19 29 N
 LONG 123 14 08 W
 DRAINAGE AREA 2.8 SQ MILES

E-ESTIMATED
 NATURAL FLOW

APPENDIX TABLE 3

Zooplankton Collections 1976

Zooplankton sampled in Shawnigan Lake 1976 - Station 01

Cladocera*	29 June	9 Sept	20 Oct	25 Nov
<u>Daphnia rosea</u>	300	165	544	43
<u>D. longiremus</u>	81	14	94	9
<u>Bosmina longirostris</u>	40		89	72
<u>Sida crystallina</u>	1	4		
<u>Chydorus sphaericus</u>	1			
<u>Leptodora kindtii</u>	3			
<u>Diaphanosoma leuchtenbergianum</u>				1
<u>Ceriodaphnia reticulata</u>				1
immature	16	11	3	1
Copepoda*				
<u>Cyclops bicuspidatus</u>	633	504	2507	1570
<u>Epischura nevadensis</u>	46	14	42	4
<u>Diaptomus oregonensis</u>	1			32
nauplii	835	487	1607	138
Rotifera**				
<u>Keratella cochlearis</u>	+	+	+	+
<u>K. quadrata</u>	+		+	+
<u>Kellicottia longispina</u>	+	+	+	+
<u>Polyarthra vulgaris</u>	+	+	+	
<u>Asplanchna sp.</u>				

* number of organisms per sample (30 m vertical tow with #10 net of 11.75 cm mouth size)

** presence or absence only

Zooplankton sampled in Shawnigan Lake 1976 Station 02

Cladocera	29 June	9 Sept	20 Oct	25 Nov.
<u>Daphnia rosea</u>	182	27	168	
<u>D. longiremus</u>	35	8	74	
<u>Bosmina longirostris</u>	4	15	34	
<u>Sida crystallina</u>		2	1	
<u>Chydorus sphaericus</u>		1		
<u>Leptodora kindtii</u>			3	
<u>Diaphanosoma leuchtenbergianum</u>				
<u>Ceriodaphnia reticulata</u>				
immature	6		20	
Copepoda				
<u>Cyclops bicuspidatus</u>	883	180	1078	
<u>Epischura nevadensis</u>	33	5	7	
<u>Diaptomus oregonensis</u>				
nauplii	576	66	849	
Rotifera				
<u>Keratella cochlearis</u>	+	+	++	
<u>K. quadrata</u>			++	
<u>Kellicottia longispina</u>	+	+	++	
<u>Polyarthra vulgaris</u>	+	+	++	
<u>Asplanchna sp.</u>			+	

Note to accompany Appendix Table 3*

Carl's (1940) citation of Daphnia longispina is equivalent taxonomically to the modern D. rosea. Also Carl lists Bosmina obtusirostrus, the present synonym is Eubosmina lagmanii, however the animal present is Bosmina longirostrus and since Carl does not specify what key was used, the answer to this small problem is not readily available. Carl also notes that Epishura occurs in Shawnigan Lake but Diaptomus does not. However, Diantomus was found during this year's sampling. The reason may be that Carl's sampling may not have been very comprehensive. This may be the result of the lack of specimens in his samples.

* Identifications, counts and comments on zooplankton are a result of the efforts of Daphne Stancil