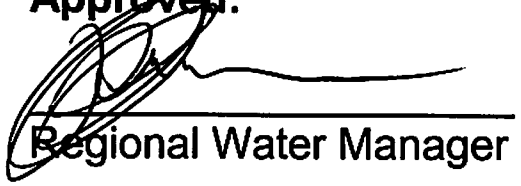
PROVINCE OF BRITISH COLUMBIA

Ministry of Environment
Water Stewardship Division
Vancouver Island Region

SHAWNIGAN-GOLDSTREAM

WATER ALLOCATION PLAN

Approved:



Regional Water Manager

Date:

February 20, 2006

Forward

The main body of the Shawnigan – Goldstream Water Allocation Plan was prepared as a draft in May 2000 by Crystal Campbell and Bruno Blecic, Regional Water Management, Ministry of the Environment, Lands and Parks and due to organizational changes was never signed. The existing report has been updated to include recent reports completed for the Shawnigan Lake watershed.

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1.0 INTRODUCTION

The Water Stewardship's vision is a sustained and healthy water resource that is valued by all uses. Water Allocation Plans are a means of anticipating and planning for water uses, identifying water demands and ensuring that water use is compatible with the goals of a sustainable environment. The advantages are:

1. Water Stewardship's position on water allocation decisions is available to applicants and public.
2. Response time is reduced.
3. Eliminates the need for individual studies and reports on each application.
4. Consistency of decisions is improved.
5. Specific allocation directions and decisions are defined.
6. Plans are more comprehensive.
7. Eliminates the need for referrals on individual applications.

The Vancouver Island Region developed the following policy to provide water allocation direction:

Regional Policy:

> **The region shall be subdivided into watershed areas and a water allocation plan shall be prepared for each watershed area. Water licence decisions will be made in accordance with approved plans.**

Assessments undertaken as part of the water allocation planning process include identifying the surface water resources available, the instream requirements for fish, the existing and potential licensable water demands and providing direction regarding further water licence allocations.

2.0 GENERAL WATERSHED INFORMATION

2.1 Geography and Morphology

The Shawnigan-Goldstream Water Allocation Plan area is located on Vancouver Island (Figure 1). The area lies to the west of Saanich Inlet and northwest of Greater Victoria. The plan area includes the communities of Cowichan Bay, Shawnigan, Mill Bay, Cobble Hill, Malahat, Goldstream and part of Langford. To the south, the plan area is bounded by Mount Wells (elev. 340 m), Mount McDonald (elev. 433 m) and Mount Braden (elev. 471 m). To the west and north, the plan area is divided from the Sooke River and Koksilah River watersheds by a mountainous ridge (maximum elev. 640 m). To the east, the plan area is bounded by Satellite Channel, Saanich Inlet and the Mill Stream watershed. The elevation of the land decreases toward the coast where drainages empty into the sea. The size of the allocation plan area is approximately 254 square kilometres (see Figure 1).

Butchart Lake, Lubbe Lake, Goldstream Lake, Mavis Lake, Jack Lake and Langford Lake are significant lakes in the Goldstream drainage area. Wrigglesworth Lake flows into Arbutus Creek and Spectacle Lake flows into Spectacle Creek in the small drainage areas north of the Goldstream River. Oliphant Lake is in the headwaters of both Johns Creek and Spectacle Creek and water is released in both directions from dams constructed on both creeks. Shawnigan Lake, which flows into Shawnigan Creek, is the largest lake in the plan area.

2.2 Climate

Warm, relatively dry summers and mild wet winters characterize the climate in the Shawnigan-Goldstream Water Allocation Plan area. Frosts are common in winter, but snow cover at lower elevations is rare. Climatic normals, using information from Environment Canada's Atmospheric Environment Service (AES) stations at Shawnigan Lake and at Langford Lake for the years 1951-1980 (Appendix A) indicate that the warmest month is July with an average temperature of 17.1°C and the coolest month is January at 1.8°C. The mean temperature for the year is 9.3°C and is one of the mildest in Canada.

2.3 Geology and Groundwater

The geology of the southern part of Vancouver Island has been modified by glaciation during the Pleistocene epoch as a result of structural, erosional, and depositional processes. Erosion surface remnants and landforms of mountain glaciation (both alpine and overridden types) constitute much of the Vancouver Island landscape. Deposition is composed mostly of unconsolidated sands, gravels, and tills (boulder clays) within the area. Brunisolic and Podzolic soils formed on glacial drift and glaciomarine deposits dominate.

The most significant aquifer within the plan area is the Cherry Point aquifer. The Cherry Point aquifer extends from the south side of Cowichan Bay, through Cobble Hill, to Mill Bay. It extends under a land area of 39 km^2. The average well yield from the Cherry Point aquifer is 1.12 litres/second with a well density of approximately 17 wells per km^2. This aquifer is used for irrigation, commercial, municipal and domestic water supply.

Both the Cobble Hill Waterworks District and the Mill Bay Waterworks District, in part, use groundwater to supply the communities at Cobble Hill and Mill Bay. In the community of Mill Bay, licensed surface water is used to supplement the limited groundwater sources. There are also other private water utilities between Mill Bay and Cowichan Bay supplying groundwater for community water supplies. However surface water is the main source of water supply within the plan area.

2.4 History

The first people to inhabit the southern coast of Vancouver Island were the Coast Salish. The Hul'qumi'num people caught Coho, spring, and chum salmon in the area using fish weirs along the rivers and collected clams along the pebble beaches. With the establishment of a Hudson's Bay Company fort in Victoria, immigration and settlement of Europeans followed around the mid 19th century. The main industry was logging and fishing. Tourism, recreation and residential development are now the main industries in the Shawnigan-Goldstream plan area.

Since the 1890's, Victorians have used Shawnigan Lake as a recreation retreat; access in the early days was by train. Today, the residential population of the Shawnigan Lake area is 7,200 people and the lake is a prime location for swimming, water sports, and walking trails.

The southern end of Goldstream River runs through Goldstream Provincial Park. The Greater Victoria Water District donated the Park to the people of British Columbia on June 26, 1958. The park is well known for its annual chum salmon spawning and many hiking trails through a 600-year-old forest of Douglas fir and western red cedar.

2.5 Significant Drainage Areas

The significant drainage areas within the Shawnigan-Goldstream Water Allocation Plan area were determined using 1:50 000 NTS maps. The following table and Figure 2 illustrate these drainage areas.

Table 1 Shawnigan-Goldstream Water Allocation Plan Significant Drainage Areas	
Drainage	**Area (km^2)**
Garnet Creek	5.8
Manley Creek	3.4
Shawnigan Creek	108
Johns Creek	7.0
Spectacle Creek	11.1
Bamber Creek	4.2
Irving Creek	1.9
Arbutus Creek	3.8
Goldstream River	61.7

2.6 Water Quality – Shawnigan Lake

In July 2004 a report entitled, Shawnigan Lake Water Quality Assessment 1976 - 2004, was released which reviewed the water quality in Shawnigan Lake over a number of years. The report was prepared by K. Rieberger, D. Epps and J. Wilson of the Ministry of Water, Land and Air Protection. The report stated that " The nutrient results indicate that Shawnigan Lake continues to be oligotrophic, which is desirable from a recreational and drinking water supply water quality perspective. The monitoring results of other water chemistry parameters showed that the water quality of Shawnigan Lake has been consistently good over the period of study, despite significant changes within the watershed"[1]

In addition there are several recommendations which include continued water quality monitoring by the Ministry and the BC Lake Stewardship Society, review and formalization of water quality objectives and proposed methods to protect Shawnigan Lake for water uses

[1] K. Rieberger. Shawnigan Lake Water Quality Assessment 1976-2004. p 38.

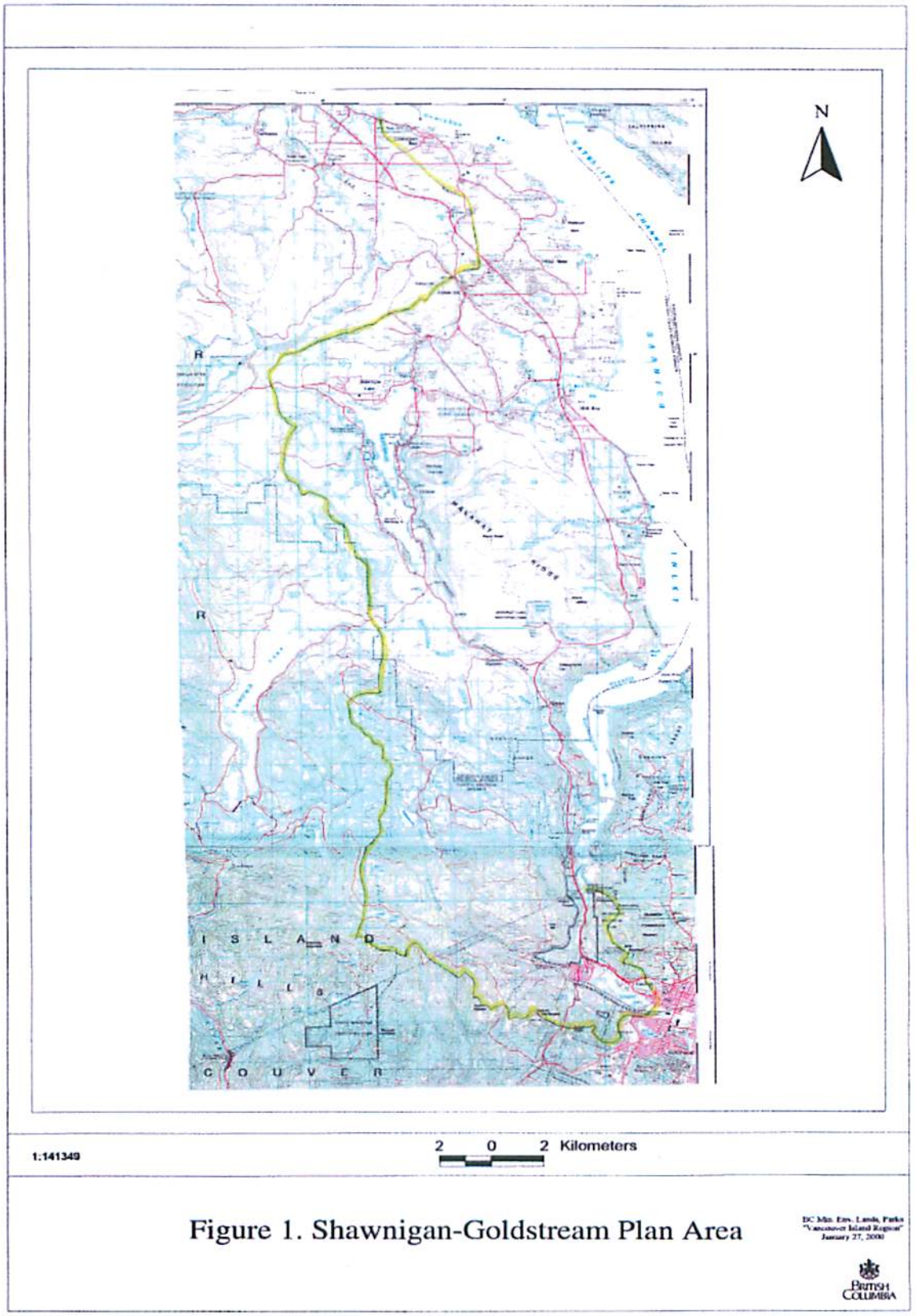


Figure 1. Shawnigan-Goldstream Plan Area

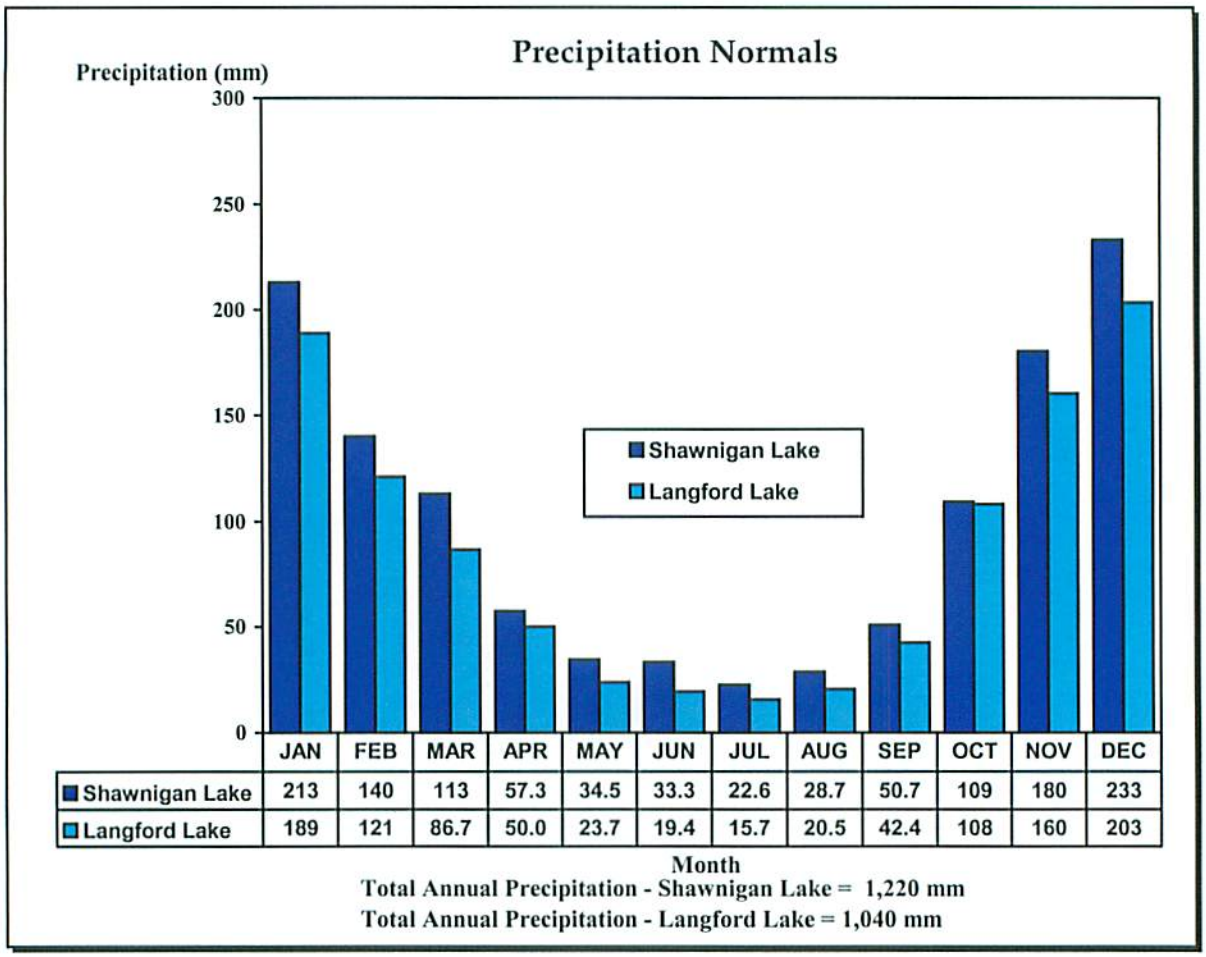
Figure 2. Significant Drainage Areas

Figure 2. Significant Drainage Areas

3.0 HYDROLOGY

3.1 Precipitation

For comparison purposes the monthly precipitation normals from 1951 to 1980 for the Shawnigan Lake and Langford Lake Atmospheric Environmental Service (AES) stations are illustrated below (see Appendix A). Since this period, many climate stations including Langford Lake have been discontinued.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Shawnigan Lake	213	140	113	57.3	34.5	33.3	22.6	28.7	50.7	109	180	233
Langford Lake	189	121	86.7	50.0	23.7	19.4	15.7	20.5	42.4	108	160	203

Figure 3. Precipitation Normals

The measured total annual precipitation in the plan area ranges between 1,040 mm and 1,220 mm. As illustrated in Figure 3, precipitation levels are low during the summer months and higher throughout the winter months. The minimum mean monthly precipitation is 15.7 mm in July. The maximum mean monthly precipitation is 233 mm in December. The average number of days with measurable precipitation is 158 days.

3.2 Hydrometric Information

There are three Water Survey Canada (WSC) hydrometric stations within the Shawnigan-Goldstream Water Allocation Plan area as listed in the following table.

Table 2 Shawnigan-Goldstream Water Survey of Canada Stations				
Station Number	Station Name	Period Of Record	Drainage Area (km^2)	Mean Annual Discharge (m^3/sec)
08HA039	Goldstream River in Goldstream Provincial Park	1976-78	57.0	0.52
08HA004	Shawnigan Creek below Shawnigan Lake	1914-17 1976-79 1984-89	68.8	1.51
08HA033	Shawnigan Creek near Mill Bay	1974-03	91.9	2.22

The discharge records of the above WSC hydrometric stations within the plan area are summarized in Appendix B. The locations of these hydrometric stations and the Shawnigan Lake and Langford Lake AES climatic stations are illustrated in Figure 4.

There are approximately two years of flow records, from 1976 to 1978, at Goldstream River in Goldstream Provincial Park (08HA039). Dams and flow controls at Butchart Lake, Lubbe Lake, Goldstream Lake, Mavis Lake, Jack Lake, Cabin Pond, Japan Gulch Reservoir and Humpback Reservoir have regulated the flow in Goldstream River since the mid 1890's.

There are approximately 12 years of flow records, from 1914 to 1917, 1976 to 1979 and 1984 to 1989, at Shawnigan Creek below Shawnigan Lake (08HA004). There are approximately 28 years of flow records, from 1974 to 2003, at Shawnigan Creek near Mill Bay (08HA033). A dam was constructed on Shawnigan Creek below Shawnigan Lake and the flow in Shawnigan Creek has been regulated since 1983. A new dam is proposed downstream of the existing structure as authorized by storage licences issued in 2003.[2]

The flow in Shawnigan Creek prior to 1983 is unregulated. Therefore, the flow records on Shawnigan Creek prior to 1983 were used to estimate the natural mean monthly discharge and mean annual discharge of all the significant drainage areas within the plan area. The discharge per square kilometre prior to 1983 for each hydrometric station on Shawnigan Creek and the average discharge per square kilometre are listed in the following table.

Table 3 Discharge per Square Kilometre – Prior to 1983 (l/sec/km2)													
Hydrometric Station	J	F	M	A	M	J	J	A	S	O	N	D	MAD
Shawnigan Creek at Shawnigan Lake 08HB004	41	53	58	23	8	3	1	0	0	1	21	69	24
Shawnigan Creek at Mill Bay 08HA033	63	61	48	18	7	3	1	0	0	4	29	81	26
Average	52	57	53	21	7	3	1	0	0	2	25	75	25
% MAD	207	226	210	82	29	11	4	1	1	8	100	298	100

[2] G. Bryden and L. Barr. Shawnigan Lake Community Water Supply Report.

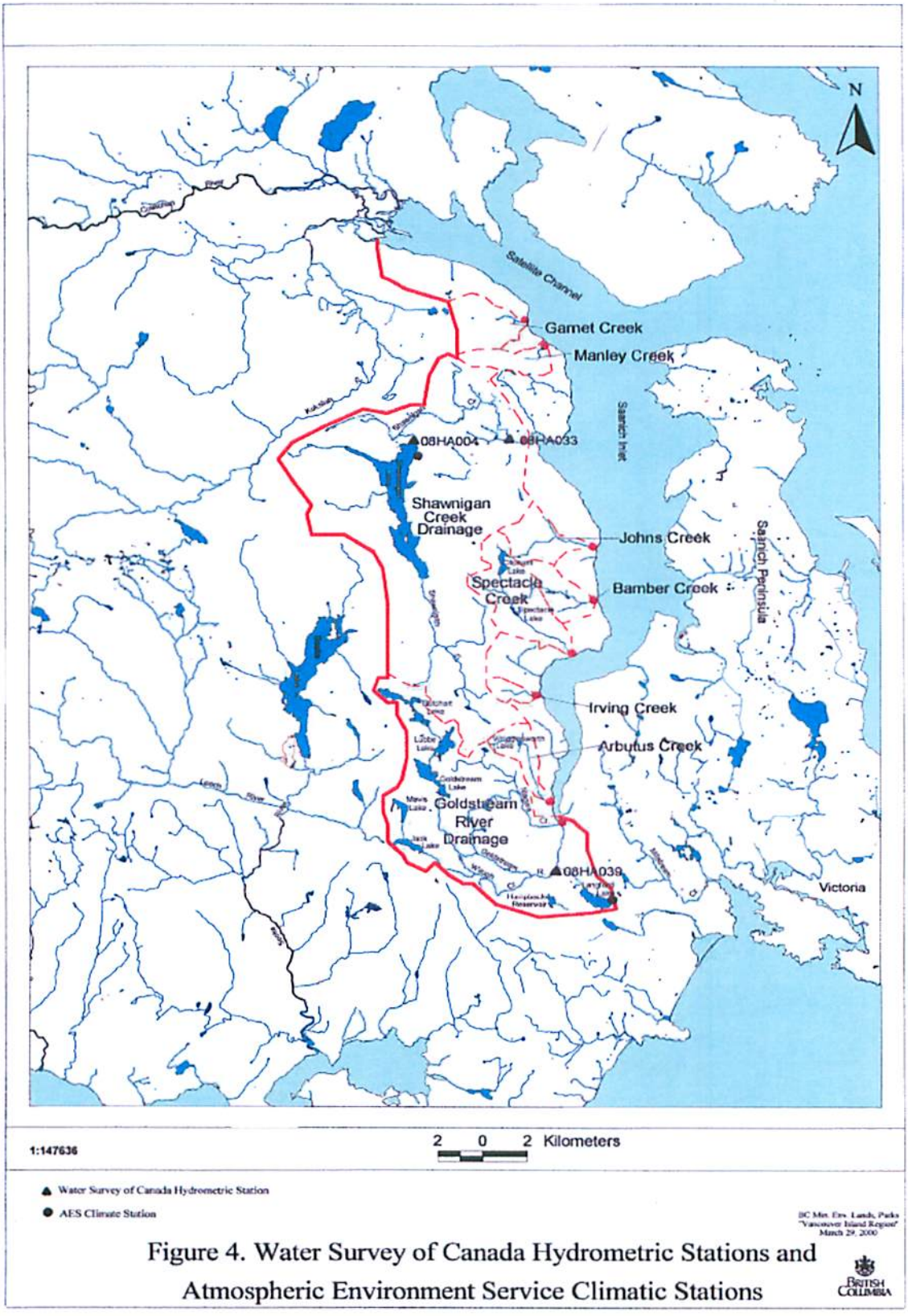


Figure 4. WSC Hydrometric Stations and AES Climatic Stations

For each identified significant watershed, the average discharge per square kilometre noted above was multiplied by the drainage area to obtain an estimate of the mean monthly discharges (MMD) and the mean annual discharge (MAD).

3.2.1 Garnet Creek Drainage

The estimated drainage area of Garnet Creek where it flows into salt water (Satellite Channel) at the mouth is 5.8 km^2.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 4 Garnet Creek Mean Monthly and Mean Annual Discharge (litres/sec)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
302	331	307	116	46	17	6	2	1	17	145	435	145

3.2.2 Manley Creek Drainage

The estimated drainage area of Manley Creek where it flows into salt water (Satellite Channel) at the mouth is 3.4 km^2.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 5 Manley Creek Mean Monthly and Mean Annual Discharge (litres/sec)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
177	194	180	68	27	10	3	0	0	10	85	255	85

3.2.3 Shawnigan Creek Drainage

The estimated drainage area of Shawnigan Creek where it flows into salt water (Mill Bay) at the mouth is 108 km^2. The Shawnigan Creek drainage is the largest drainage area in the plan area. Handysen Creek, Hollings Creek, and Van Horne Creek are significant tributaries to Shawnigan Creek in the Shawnigan Creek drainage area. McGee Creek is a significant tributary to Shawnigan Lake.

Hutchinson Lake and Shawnigan Lake are significant lakes in the Shawnigan Creek drainage. Shawnigan Lake, with a surface area of 537 hectares and a volume of 62,800 dam^3, is the largest lake in the plan area.

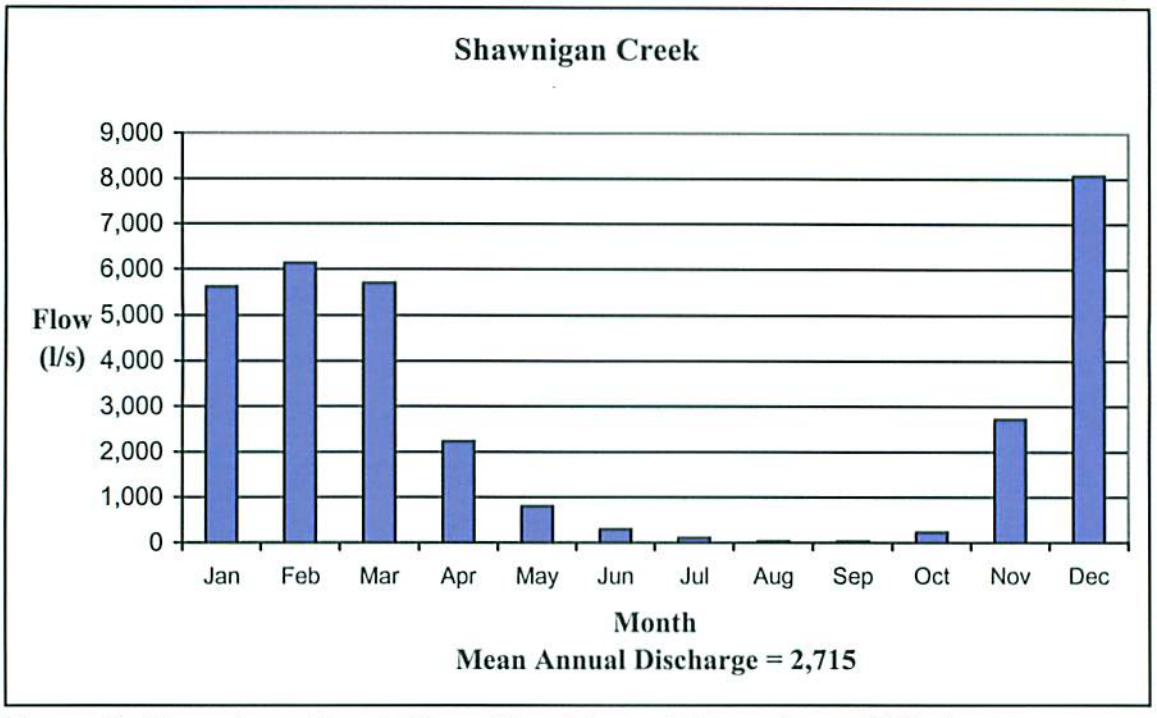


Figure 5. Shawnigan Creek Mean Monthly and Mean Annual Discharge

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 6 Shawnigan Creek Mean Monthly and Mean Annual Discharge (litres/second)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
5,620	6,140	5,700	2,240	797	291	104	35	27	230	2,720	8,080	2,720

3.2.4 Johns Creek Drainage

The estimated drainage area of Johns Creek at the mouth where it flows into salt water (Saanich Inlet) is 7.0 km^2. Oliphant Lake is in the headwaters of both Johns Creek and Spectacle Creek and supplies water to both streams.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 7 Johns Creek Mean Monthly and Mean Annual Discharge (litres/second)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
364	398	370	145	52	19	7	2	2	15	176	524	176

3.2.5 Spectacle Creek Drainage

The estimated drainage area of Spectacle Creek at the mouth where it flows into salt water (Saanich Inlet) is 11.1 km^2. Oliphant Lake is in the headwaters of both Spectacle Creek and Johns Creek and supplies water to both streams.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 8 Spectacle Creek Mean Monthly and Mean Annual Discharge (litres/second)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
578	631	586	230	82	30	11	4	3	24	279	831	279

3.2.6 Bamber Creek Drainage

The estimated drainage area of Bamber Creek at the mouth where it flows into salt water in Saanich Inlet is 4.2 km^2.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 9 Bamber Creek Mean Monthly and Mean Annual Discharge (litres/second)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
219	239	222	87	31	11	4	1	1	9	106	314	106

3.2.7 Irving Creek Drainage

The estimated drainage area of Irving Creek at the mouth where it flows into salt water into Finlayson Arm is 1.9 km^2.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 10 Irving Creek Mean Monthly and Mean Annual Discharge (litres/second)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
99	108	100	39	14	5	2	1	0	4	48	142	48

3.2.8 Arbutus Creek Drainage

The estimated drainage area of Arbutus Creek where it flows into salt water (Finlayson Arm) near the mouth is 3.8 km^2.

The mean monthly and mean annual discharge flow estimates are in the following table.

Table 11 Arbutus Creek Mean Monthly and Mean Annual Discharge (litres/second)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
198	216	201	79	28	10	4	1	1	8	96	284	96

3.2.9 Goldstream River Drainage

The estimated drainage area of the Goldstream River is 61.7 km^2. The Goldstream River drainage is the second largest drainage area in the plan area. Waugh Creek and Niagara Creek are significant tributaries to the Goldstream River.

Butchart Lake, Lubbe Lake, Goldstream Lake, Mavis Lake, Jack Lake and Langford Lake are significant lakes in the Goldstream River drainage. Japan Gulch Reservoir and Humpback Reservoir are also tributary to the Goldstream River.

The Goldstream River in Goldstream Provincial Park hydrometric station (08HA039) has a drainage area of 28.5 km^2. This drainage area does not include Waugh Creek and Niagara Creek that flow into Goldstream River downstream of the hydrometric station.

There is only 2 years of flow recorded in 1976 to 1978 and the flow was regulated during this period. Therefore, the unregulated flow in Shawnigan Creek prior to 1983 was used to estimate the natural flow in the Goldstream River.

The following table and figure summarize the mean monthly and mean annual discharges.

Table 12 Goldstream River Mean Monthly and Mean Annual Discharge (litres/second)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
3,210	3,510	3,260	1,280	456	166	59	20	15	131	1,550	4,620	1,550

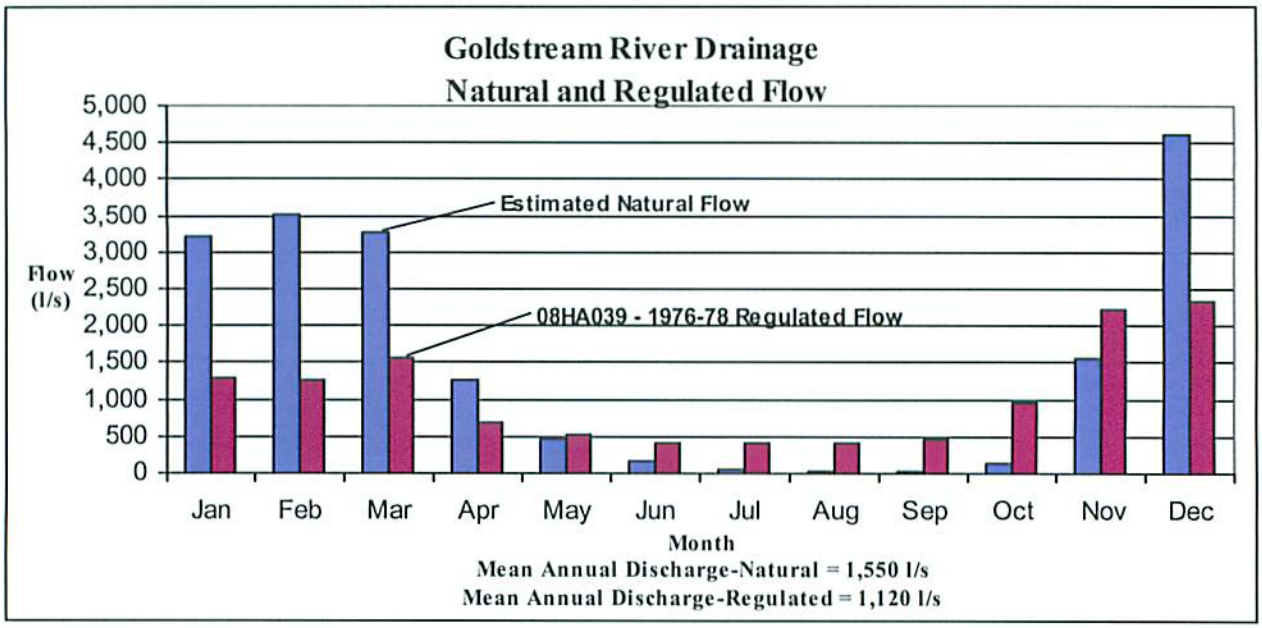


Figure 6. Goldstream River Mean Monthly and Mean Annual Discharge

3.2.10 Other Drainages

Flow in other drainages not identified above, may be calculated from the average discharge runoff per square kilometre, noted above, and then multiplied by the drainage area.

3.3 Lakes

The following table summarizes the information available for lakes located in the Shawnigan-Goldstream Water Allocation Plan area. This information is from the BC Ministry of Fisheries Lake Surveys.

Table 13 Significant Lakes

Lake	Surface Area (ha)	Maximum Depth (m)	Mean Depth (m)	Volume (dam^3)
Shawnigan	537	47.0	11.7	62,800
Oliphant	23.7	8.0	2.8	664
Spectacle	4.13	6.1	2.0	82.6
Butchart	23.5	38.1	11.6	2,730
Lubbe	42.4	20.7	6.5	2,760
Wrigglesworth	4.21	14.5	6.5	274
Goldstream	75.0	27.1	9.6	7,200
Mavis	21.0	14.6	6.6	1,390
Jack	17.8	17.7	7.0	1,250
Langford	59.9	17.1	6.4	3,830

The lake evaporation is estimated to be approximately 0.3 m (1 ft) of water over the surface of a water body.

4.0 INSTREAM FLOW REQUIREMENTS

Maintaining the natural stream environment and instream uses are important for present and future generations. Maintaining flows for the fisheries resource also maintains instream flows for water quality, wildlife, recreational, aesthetic and cultural values.

The Ministry of Environment policy is:

> **In situations where a water allocation decision will significantly impact instream uses of water, the comptroller or regional water manager may refuse the application or include water licence conditions to protect the instream use.**

Instream fisheries flow requirements are based on a Provincially modified version of the Tennant (Montana) Method. The following table outlines the modified version used within the Shawnigan-Goldstream Water Allocation Plan area.

Table 14 Modified Tennant (Montana) Method Instream Flow Requirements

Flows	Description
30-60% MAD	Excellent spawning/rearing
20-30% MAD	Good spawning/rearing
10-20% MAD	Fair spawning/rearing
5-10% MAD	Poor spawning/rearing
< 5% MAD	Severely degraded spawning/rearing

In drainages where fish are present the minimum flow required to sustain the fisheries resource for fair spawning and rearing habitat is 10% of the Mean Annual Discharge (MAD).

The Regional policies to implement Provincial policy are:

The minimum flow required to sustain the fisheries resources for spawning and rearing is 10% of the Mean Annual Discharge (MAD) unless a more rigorous analysis indicates a different minimum flow requirement.

For streams where the natural mean monthly flow falls below 10% of the MAD, extractive licenced demands should only be allowed for the period of months when the mean monthly flow is above 60% of the MAD.

Withdrawals from natural water bodies (lakes, ponds, swamps and marshes) supporting natural fisheries resources shall not reduce the shoal area more than 10%.

Figure 7 identifies the streams with known fish presence within the Shawnigan-Goldstream Water Allocation Plan area

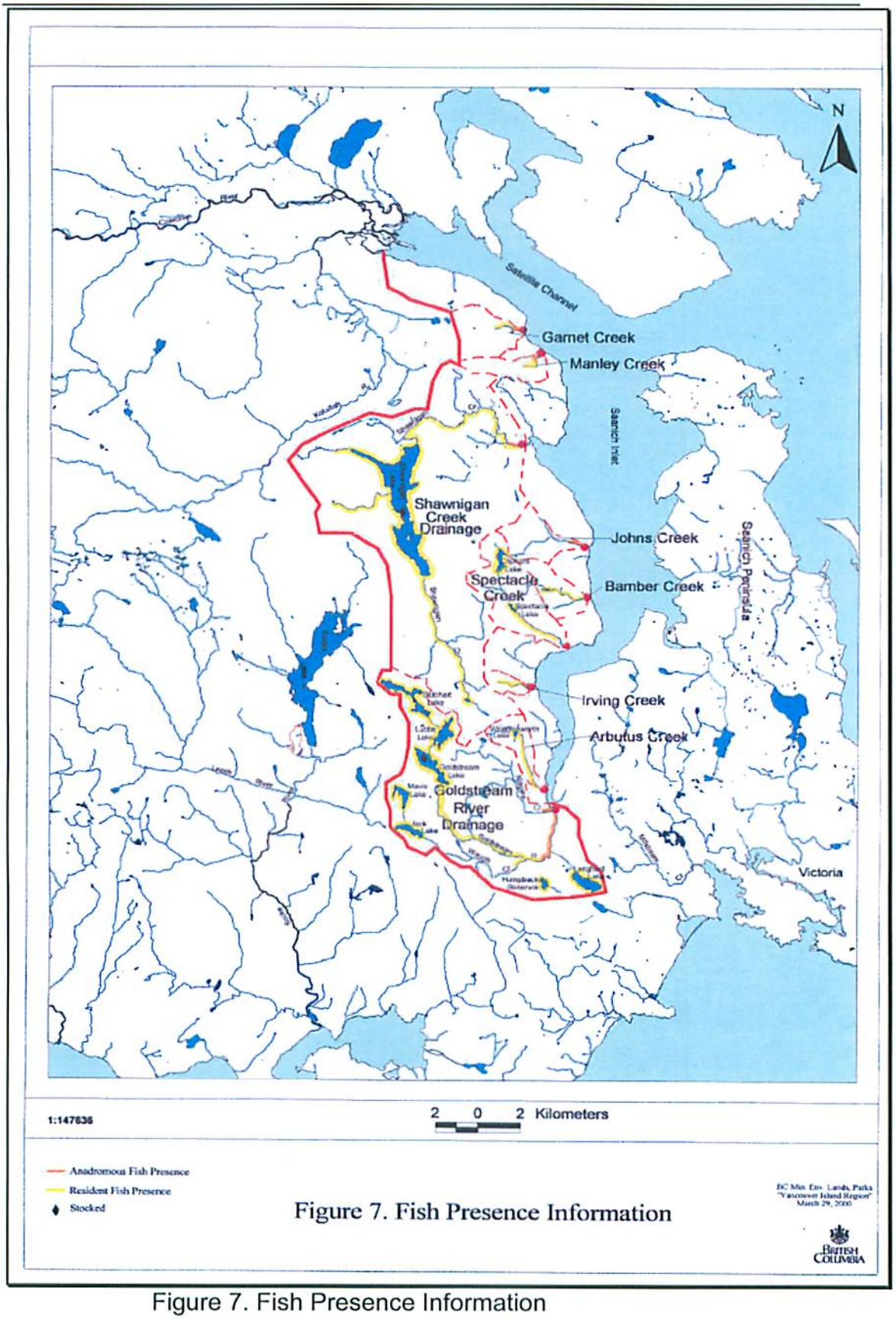


Figure 7. Fish Presence Information

Figure 7. Fish Presence Information

4.1 Garnet Creek Instream Requirements

Anadromous and resident fish have been observed in Garnet Creek by Provincial fish habitat staff.

Figure 8 illustrates that the estimated mean monthly flows in Garnet Creek falls below 10% MAD (14.6 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (87.6 l/s).

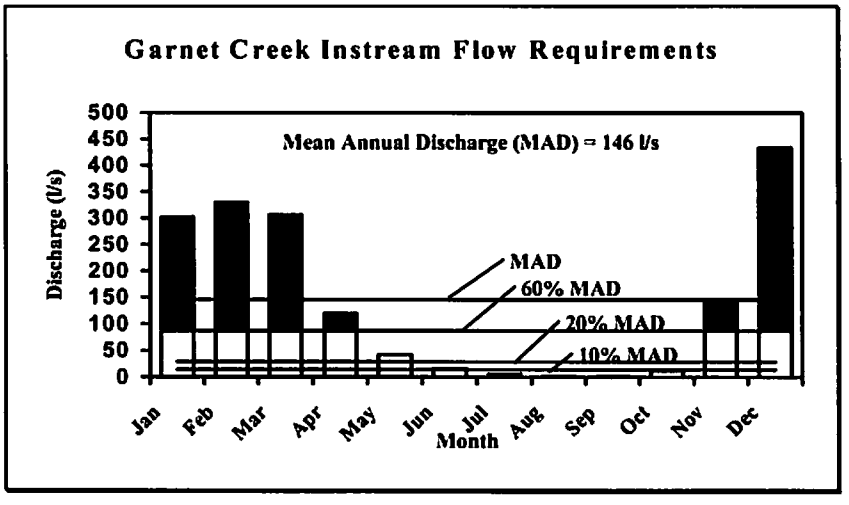


Figure 8. Garnet Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Garnet Creek during the months of November through April. The estimated volume of water available for this period is 2,883 dam^3.

4.2 Manley Creek Instream Requirements

Anadromous and resident fish have been observed in Manley Creek by Provincial fish habitat staff.

Figure 9 illustrates that the estimated mean monthly flows in Manley Creek falls below 10% MAD (8.5 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (51.0 l/s)

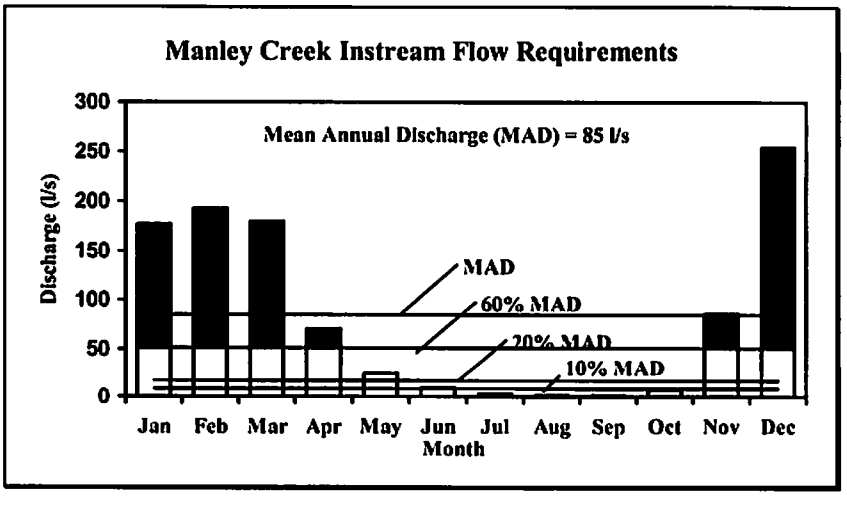


Figure 9. Manley Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Manley Creek during the months of November through April. The estimated volume of water available for this period is 1,700 dam^3.

4.3 Shawnigan Creek Instream Requirements

A waterfall impassable to anadromous fish is located close to the mouth of Shawnigan Creek. However there are resident fish species such as cutthroat trout, rainbow trout and small mouth bass in Shawnigan Lake and in the creeks above the falls. Also coho have been introduced upstream above the falls

Figure 10 illustrates that the estimated mean monthly flows in Shawnigan Creek falls below 10% MAD (272 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (1 630 l/s).

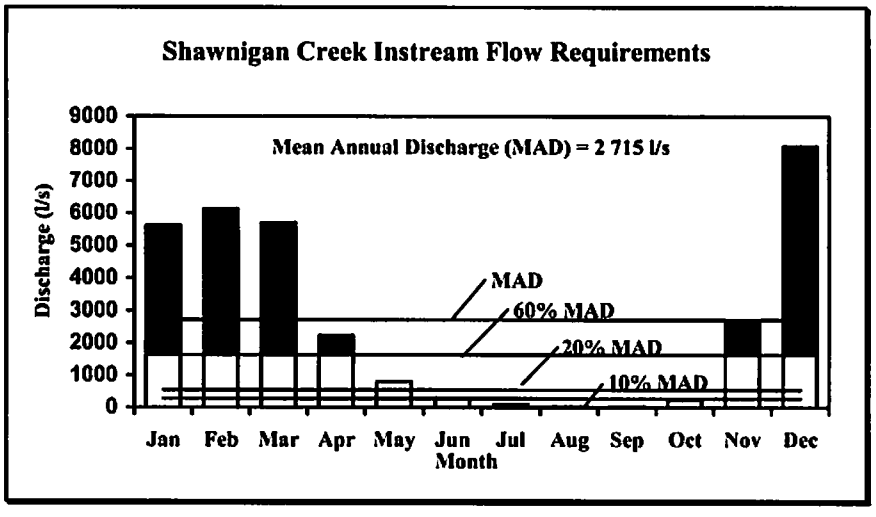


Figure 10. Shawnigan Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Shawnigan Creek during the months of November through April. The estimated volume of water available for this period is 53,700 dam^3.

4.4 Johns Creek Instream Requirements

There are anadromous fish near the mouth in Johns Creek.

Figure 11 illustrates that the estimated mean monthly flows in Johns Creek falls below 10% MAD (17.6 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (106 l/s).

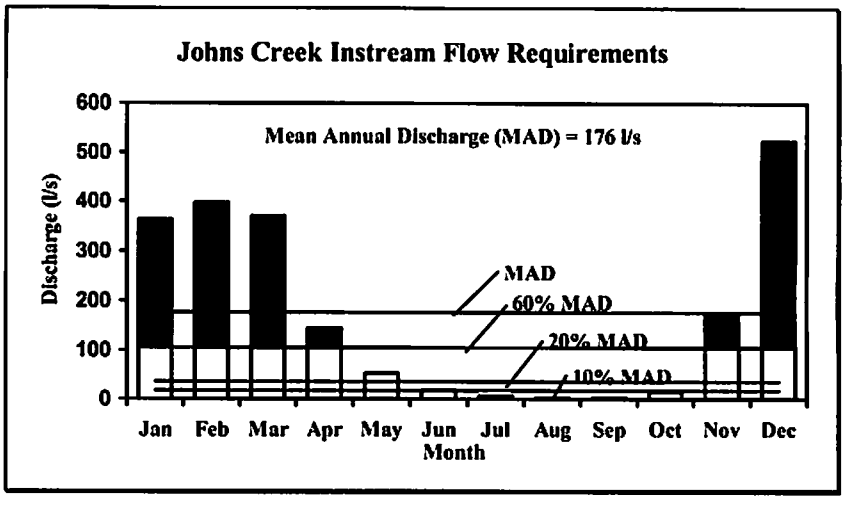


Figure 11. Johns Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Johns Creek during the months of November through April. The estimated volume of water available for this period is 3,480 dam³.

4.5 Spectacle Creek Instream Requirements

There are resident fish present in Spectacle Creek, Spectacle Lake and Oliphant Lake.

Figure 12 illustrates that the estimated mean monthly flows in Spectacle Creek falls below 10% MAD (27.9 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (167 l/s).

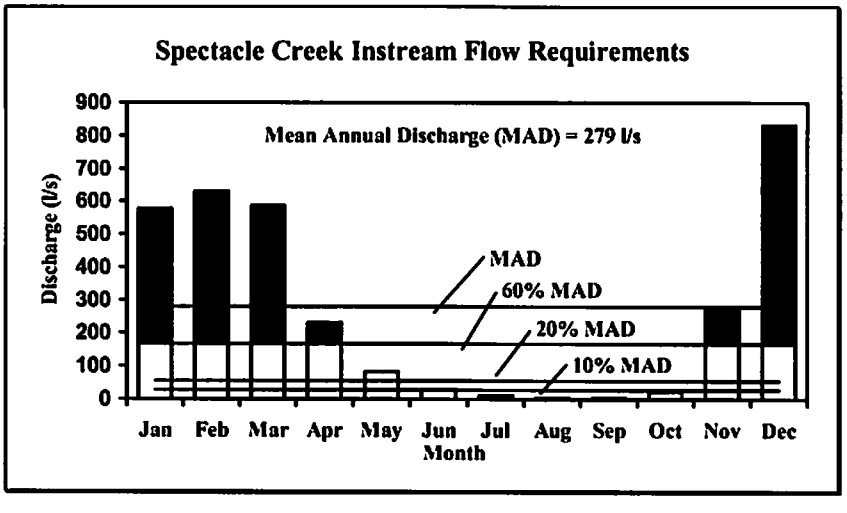


Figure 12. Spectacle Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water

is only available from Spectacle Creek during the months of November through April. The estimated volume of water available for this period is 5,520 dam³.

4.5 Bamber Creek Instream Requirements

There are resident fish present in Bamber Creek.

Figure 13 illustrates that the estimated mean monthly flows in Bamber Creek falls below 10% MAD (10.6 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (63.6 l/s).

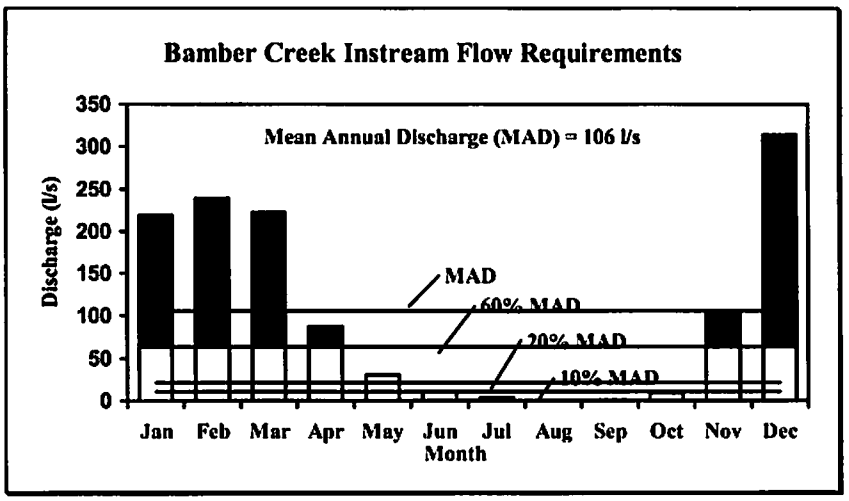


Figure 13. Bamber Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Bamber Creek during the months of November through April. The estimated volume of water available for this period is 2,088 dam³.

4.6 Irving Creek Instream Requirements

There are resident fish present in the Irving Creek.

Figure 14 illustrates that the estimated mean monthly flows in Irving Creek falls below 10% MAD (4.8 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (28.8 l/s).

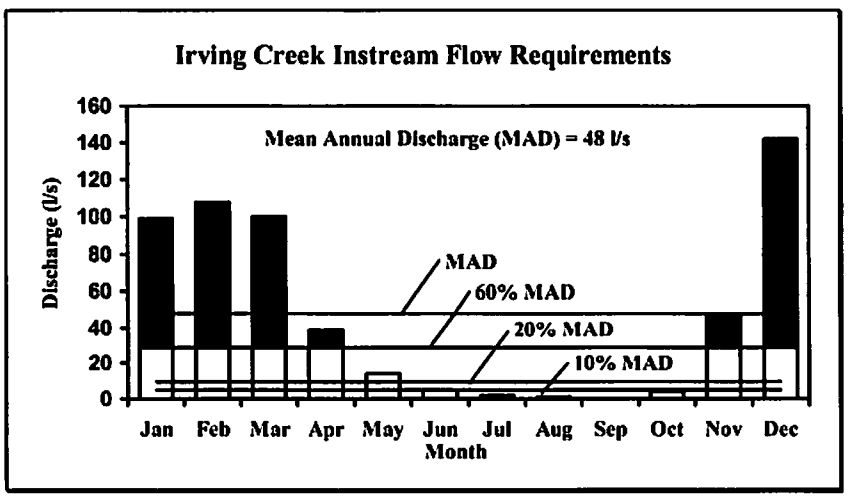


Figure 14. Irving Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Irving Creek during the months of November through April. The estimated volume of water available for this period is 941 dam^3.

4.7 Arbutus Creek Instream Requirements

There are resident fish present in the Arbutus Creek and Wrigglesworth Lake.

Figure 15 illustrates that the estimated mean monthly flows in Arbutus Creek falls below 10% MAD (9.6 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (57.6 l/s).

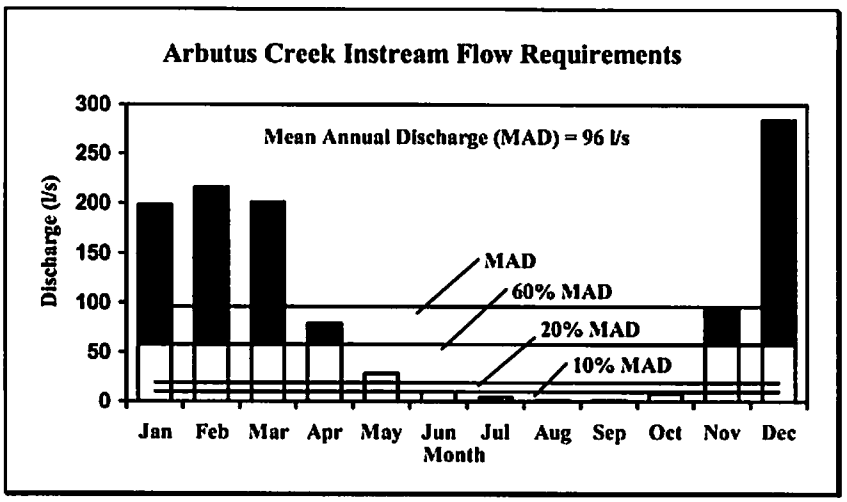


Figure 15. Arbutus Creek Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from Arbutus Creek during the months of November through April. The estimated volume of water available for this period is 1,890 dam^3.

4.8 Goldstream River Instream Requirements

Goldstream River has the best salmon-spawning habitat within this plan area. Also Goldstream River, Butchart Lake, Lubbe Lake, Goldstream Lake, Mavis Lake, Jack Lake, Japan Gulch Reservoir and Humpback Reservoir have resident fish. These fish stocks have been enhanced by flow releases by the Capital Regional District from storage originally developed as a water supply for the City of Victoria. Water from Butchart Lake, Lubbe Lake, Goldstream Lake, Mavis Lake, Jack Lake, Japan Gulch Reservoir and Humpback Reservoir are controlled to enhance the fisheries resources as well as providing a backup supply of water for Victoria.

Figure 16 illustrates that the estimated mean monthly flows in the Goldstream River falls below 10% MAD (155 l/s) during the months July, August, September and October. Water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD (931 l/s).

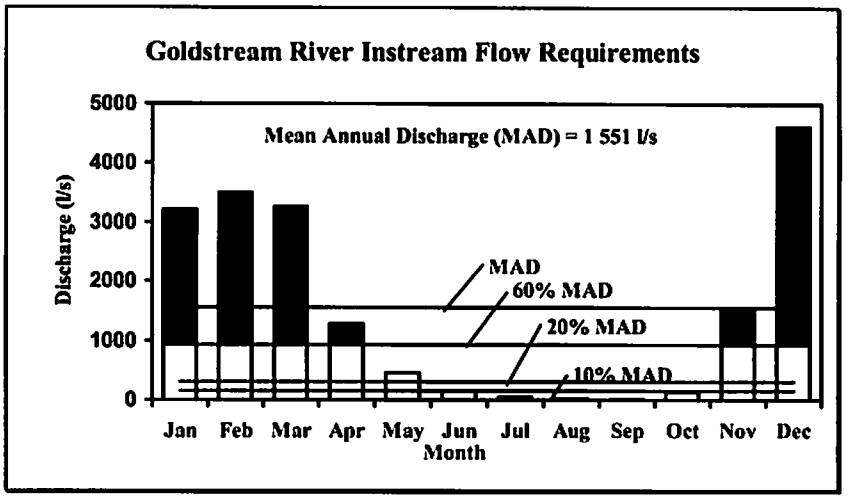


Figure 16. Goldstream River Instream Flow Requirements

May through October have mean monthly flows less than 60% MAD and, it during this low flow period when water is not available for extraction. Thus, water is only available from the Goldstream River during the months of November through April. The estimated volume of water available for this period is 30 700 dam^3

4.9 Other Drainages

In watersheds were fish are identified, water will only be available from those drainages during the period when the mean monthly flow is greater than 60% MAD. Estimated flows and 60% MAD can be determined using procedures identified above.

5.0 WATER DEMAND

5.1 Licenced Demand

The Ministry of Environment, Vancouver Island Region's policy is:

> **Water allocations shall not be committed beyond the resources capability to replenish itself and maintain the natural amenities for present and future generations. Water allocations must be based upon reasonable expectations that water will be available for the period required without significantly impacting existing allocations or instream flow requirements.**

There are 463 water licences currently (June 2005) within the Shawnigan-Goldstream Water Allocation Plan area. Figure 17 illustrates the number of water licences issued for each purpose within the plan area. The largest number of water licences (307 water licences) are for domestic purpose that support rural residential demands.

There are 66 water licences for irrigation purpose that authorize water for the growth of agriculture crops on farms. All licenced irrigation demands are small (less than 50 acre-feet) and from small local creeks that run through the farm lands.

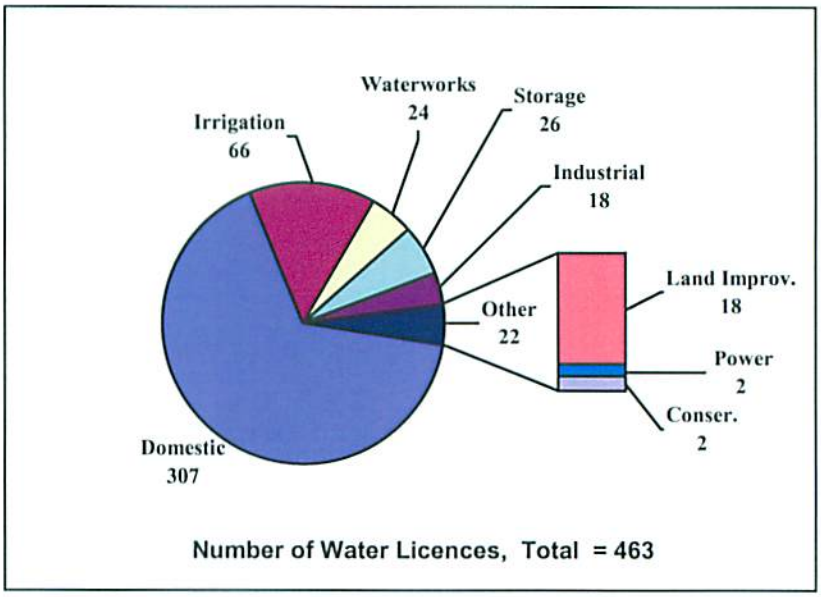


Figure 17. Number of Water Licences

There are 24 water licences for waterworks purpose that supply surface water to communities within the plan area and to Victoria. The Goldstream River was developed as a water supply source for the Greater Victoria area. It is now a secondary source of water supply for the Greater Victoria area to the Sooke Lake source.

The 26 water licences for storage purpose store water from the high flow period to supply water demands and increased flow during the low flow period. The largest quantity of storage is on the Goldstream River and on Shawnigan Lake. The stored water is primarily used to support community water supply (waterworks) demands and also provides enhanced low flow releases to support the fish resources. Smaller quantities of storage have been developed to support some of the licenced irrigation and industrial demands.

The 18 water licences for industrial purposes are primarily water supply for small rural commercial developments. These include 5 water licences for industrial (enterprise) purpose for the water demands of resorts, inns, restaurants and similar enterprises. There are 4 water licences for industrial (fire protection) that permit the construction of intake works or dugouts for the access and storage of water for fire fighting. There are 3 water licences for industrial (processing) purpose for the manufacture of Portland cement at Bamberton. There are 2 water licences for industrial (institutions) purpose for the supply of water demands of a school and a lodge. There are 2 water licences for industrial (stockwatering) purpose for agricultural demands of water for cattle. There is 1 water licence for industrial (ponds) purpose for the development of fish ponds for a commercial enterprise. Finally there is 1 water licence for industrial (residential lawn/garden) watering.

There are 18 water licences for land improvement purpose. These water licences for land improvement purpose authorize the construction and diversion into aesthetic ponds, the construction of storm detention ponds on stream and the maintenance and relocation of streams for drainage improvements.

There are 2 water licences for power (residential) that permit the diversion and use of water in a small turbine to generate power for a rural residence.

There are 2 water licences for conservation purpose that authorize the construction of a small pond for fish enhancement.

Of greater significance is the estimated average annual licenced water demand and low flow water demand. The total estimated average annual licenced water demand for the plan area is 42,092 dam^3. Figure 18 illustrates the estimated average annual licenced water demand for each water licence purpose within the plan area.

Storage is the largest water demand (49%) in the plan area. Storage supports all of the significant community waterworks demands and most of the irrigation and industrial demands and provides enhanced low flows for the fisheries resource.

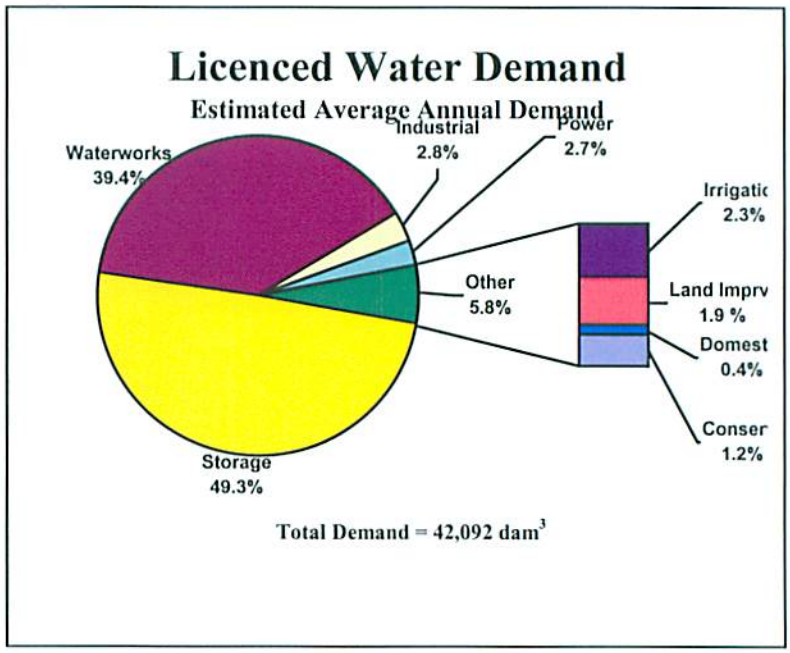


Figure 18. Licenced Water Demand

The second largest annual water demand is waterworks (39%), followed by industrial demands (2.8%), residential power (2.7%), irrigation (2.3%) and land improvement (1.9%), domestic (0.4%), and conservation (1.2%).

Annual licenced water demands within the Shawnigan-Goldstream Water Allocation Plan area are detailed in Appendix C and summarized in the following table.

Table 15 Estimated Average Annual Licenced Water Demand

Purpose	Number of Licences	Quantity Licenced	Annual Demand (dam^3)*
Waterworks (Community)	24	10,540,000 gpd	**16,585**
Domestic (Rural Residential)	307	199,500 gpd	**165**
Industrial (Commercial)			
Enterprise	5	35,000 gpd	58
Fire Protection	7	10,000 gpd 5.58 acft	23
Institution	2	61,000 gpd	101
Ponds	1	2.1 acft	3
Processing	3	595,000 gpd	988
Lawn/Garden Watering	1	0.33 acft	0.41
Stockwatering	2	2,200 gpd	3.65
Total Industrial	18		**1,178**
Irrigation	66	776 acft	**957**
Land Improvement (Aesthetic Ponds, Storm Detention Ponds and Drainage Works)	18	15,500gpd 92.2 acft 0.75 cfs	**810**
Power (Residential)	2	1.25 cfs	**1,117**
Conservation (Fish Enhancement)	2	50 acft 0.5 cfs	**508**
Storage	26	16,839 acft	**20,771**
Total	**463**	-	**42,092**

* Assumes that domestic and waterworks are the authorized maximum daily licenced amount divided by 2 to estimate the average daily demand, then multiplied by 365 days to determine the annual demand. Industrial, storage, conservation, and irrigation represent total annual licenced volumes.

The low flow licenced maximum consumptive water demand within significant drainage areas may be critical between competing water uses and instream flow requirements. The estimated low flow licenced demand for each identified drainage area and for other drainages in the Shawnigan-Goldstream Water Allocation Plan area is summarized in Appendix D and the following table.

Table 16 Low Flow Licenced Maximum Consumptive Water Demand Within Significant Drainage Areas		
Significant Drainage Area	**Low Flow Licenced Maximum Consumptive Water Demand**	
	Maximum Day (litres/second)	**90 Day Volume (dam^3)**
Garnet Creek	8.4	65.6
Manley Creek	15.8	123
Shawnigan Creek	-297	-2312
Johns Creek	0.26	2.05
Spectacle Creek	-64.7	-503
Bamber Creek	-0.36	-2.8
Irving Creek	0.16	1.2
Arbutus Creek	0.32	2.5
Goldstream River	-1,148	-8,930
Other Drainage Areas	57.9	450
Total Consumption All Watersheds	**-1,428**	**-11,104**

The total consumptive low flow water demand is fully supported by storage and there is additional water in storage. Flow releases from reservoirs on Butchart Lake, Lubbe Lake, Goldstream Lake, Mavis Lake, Jack Lake, Japan Gulch and Humpback Reservoir enhance the flow in the Goldstream River for the fisheries resource. Likewise, flow releases from the Shawnigan Lake reservoir enhance the low flow in Shawnigan Creek for the fisheries resource. Flow is released from Oliphant Lake storage into both Johns Creek and Spectacle Creek primarily to enhance the fisheries resources in these small creeks.

5.2 Projected Demand

There are 2 water licence applications pending as of January 2006. The potential annual water demand and the purposes of these existing applications are detailed in Appendix E and summarized in the following table.

Table 17 Water Licence Applications			
Purpose	**Number of Licences**	**Quantity Licenced**	**Annual Demand (dam^3)***
Domestic	1	2,000 gpd	2.1
Land Improvement	1	162 acft	200
Total	**2**	**-**	**202**

* Assumes that domestic and waterworks are the authorized maximum daily licenced amount divided by 2 to estimate the average daily demand, then multiplied by 365.25 days to determine the annual demand. Industrial, storage, power, and conservation represent total annual licenced volumes.

Future water demands are anticipated to be similar to existing licenced water demands. Waterworks, domestic, industrial, irrigation, and land improvement

licences will increase in number as the population of the plan area expands. Conservation purpose demands will increase as conservation groups and fish agencies attempt to preserve and protect fish and wildlife habitat.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The hydrometric stations on Shawnigan Creek were used to calculate natural flow estimates for all significant drainages within the Shawnigan-Goldstream Water Allocation Plan area.

The drainages within the plan area have a natural low flow period with the mean monthly flows falling below 10% MAD during the months of July to September. As per Section 4.0 Instream Flow Requirements, when the natural mean monthly flow falls below 10% MAD, extractive licenced demands should only be allowed during the period when mean monthly flow are above 60% MAD which is from November to April. Water is not available for extractive use during the low flow period of May to October. There is however considerable flow available during November to April to develop supporting storage for water demands during this low flow period.

Most significant drainage areas within the plan area support the spawning and rearing of anadromous fish such as salmon and sea-run Cutthroat trout. As well, there are resident fish such as Rainbow and Cutthroat trout in many of the streams and lakes within the plan area. Therefore, water extraction from these drainages during the low flow period may limit instream fish habitat and fish production. The high flow periods, when water is greater than 60% MAD, have considerable amounts of water available for storage. In turn, stored water can be used to support licenced demands during the low flow period.

The licenced water demand within the Shawnigan-Goldstream Water Allocation Plan area consists of waterworks, domestic, industrial, irrigation, land improvement, power, conservation and storage purpose licences. The majority of the water licences within the area are for domestic purpose; however, these demands do not significantly impact other instream fisheries resource and water use interests. The largest water demands are for storage and community waterworks purposes.

The following table summarizes the water available for the identified significant drainage areas, exclusive of existing licenced water demand.

Table 18 Shawnigan-Goldstream Water Allocation Plan - Water Availability			
Drainages	Drainage Area (km^2)	Water Volume Available (dam^3)	
		High Flow Period*	Low Flow Period**
Garnet Creek	5.8	2,730	0
Manley Creek	3.4	1,600	0
Shawnigan Creek	108	50,500	0
Johns Creek	7.0	3,290	0
Spectacle Creek	11.1	5,210	0
Bamber Creek	4.2	1,950	0
Irving Creek	1.9	889	0
Arbutus Creek	3.8	1,790	0
Goldstream River	61.7	30,700	0

*High Flow Period is the total volume of water available for storage and use above 60% MAD during the period from November through April.
**Low Flow Period is when the mean monthly discharge falls below 60% MAD during the period from May through October.

Fish and debris screens are part of good intake design and may be required on intake or diversion works within identified fish habitat areas. Fish passage provisions for both juvenile and adult fish may be required on storage dams or diversion works constructed on sources frequented by fish. Appendix F contains information on fish screening requirements. Instream works are to be constructed only during a period that minimizes impacts on the fish resources.

6.1 Domestic

A domestic water licence shall be 2,300 litres/day (500 gpd) for each rural dwelling as indicated on the plan attached to the water licence application. This amount will allow for the maintenance of 0.10 hectares (0.25 acres) of garden area associated with the dwelling. It is not appropriate, where the primary source of domestic water supply is insufficient, to issue additional water licences for the maintenance of green lawns and gardens.

Domestic water licences shall not be issued to provide evidence to subdivision approval authorities of an "adequate potable water supply" for subdivision development. Residential land subdivisions within community water supply areas shall be required to connect to existing community water supply systems for residential water supply.

To ensure an adequate domestic water supply for household uses from springs, small creeks and brooks, applicants may need to develop storage or to use naturally stored water from lakes or marshes. On stream sources that go dry for a four month period (June - September; 122 days) the average daily demand of 1,150 litres/day (250 gpd) will require a stored water volume of 0.139 dam^3 (4

900 ft^3). This storage volume requires a reservoir or dugout approximately 8 m (26 ft) long by 5.5 m (18 ft) wide, with an average depth of 3.5 m (11.5 ft), allowing 0.3 m (1 ft) for evaporation loss over the surface of the reservoir.

Springs, brooks or creeks may not require supporting storage if they can supply at least 2,300 litres/day (500 gpd) through the months of May to September. The applicant shall provide adequate pump tests or flow measurements during this period to determine the safe flow yield. Multiple domestic water licences on a spring, brook or creek will only be allowed if the applicant can provide assurances that adequate water is available by determining the safe flow yield near the end of the low flow period (i.e. in August or September) and by satisfying any written concerns and objections of any existing water licensees.

A water licence for domestic use shall not be issued to a residence within a community water supply area unless written leave to do so is obtained from the community water supply agency.

Measuring or regulating (i.e. metering) is not usually necessary with domestic water usage. An adequate screen shall be installed on the intake to prevent fish or debris from entering the works.

6.2 Waterworks

Waterworks purpose in the Water Act is the carriage or supply of water by a municipality, improvement district, regional district or private utility for the purpose of providing water to a residential area.

As the Shawnigan and Goldstream areas are further developed and the population expands, the demand for waterworks purpose water supplies will increase.

Applicants for a waterworks licence shall be required to assess the supply for a ten year projected demand and provide evidence that the projected demand is not excessive in comparison with adjoining community demands, that water conservation is being promoted (i.e. residential meters, pricing practices, education), and that adequate system balancing storage (i.e. volume difference between maximum hour and maximum daily demands) will be constructed or is available for peak hour demands.

Water utilities, pursuant to the Water Utilities Act, will also have to provide evidence that the appropriate requirements for a Certificate of Public Convenience and Necessity (CPCN) have been met and a CPCN will be obtained.

Licenced allocations will be limited to a 10 year projected demand except where the applicant can provide satisfactory evidence that a longer projection period is required (i.e. because the cost of construction of works must be amortized over a longer period).

The licensee shall be required to meter and record the water diverted from the source stream.

The licensee shall be required to treat the water supply in accordance with the Ministry of Health requirements.

All waterworks licences will require storage to support demand.

Storage and diversion structures must be capable of maintaining or improving existing low flows during the low flow period and maintaining fish passage where required.

6.3 Irrigation

The soil type, crop rooting depth, and climatic characteristics determine the water requirements for irrigation. The irrigation demands for different crops and their rooting depths along with the water availability coefficient are classified into two categories, shallow (0.5 m) and deep (1.0 m) effective rooting depths. The available water storage capacity (AWSC) can be estimated for shallow and deep root zone depth for the soil types present within the plan area.

Figure 19 indicates the annual irrigation water requirements for various soil groups within the plan area.

If the applicant for a water licence can provide more specific soil assessment and irrigation requirement information for a given area, that soil assessment and irrigation requirement may be used to assess irrigation demands.

Irrigation gun or flood irrigation systems may require greater irrigation quantities and should be discouraged. In the case where irrigation gun or flood irrigation practices are to be used suitable meters shall be installed and water withdrawals limited to the equivalent annual irrigation requirements for sprinkler systems. As the equivalent annual irrigation water requirements for sprinkler systems may not be adequate to sustain crops using these less efficient methods of irrigation, the applicant may be required to reduce crops, limit the acreage irrigated or convert to a more efficient irrigation system. Trickle irrigation can reduce water requirements by 35% and should be encouraged where practical.

Irrigation water demands must be supported by off-stream storage development. Storage required to support irrigation demands is the total required amount as per crop and soils, plus an additional allowance for evaporation and other losses from the storage reservoir. Diversion into storage will be authorized for the period that the mean monthly flows are above 60% MAD.

The maximum allowable rate of withdrawal shall not exceed 47.2 litres per minute per hectare (4.2 imperial gallons per minute per acre) of land to be

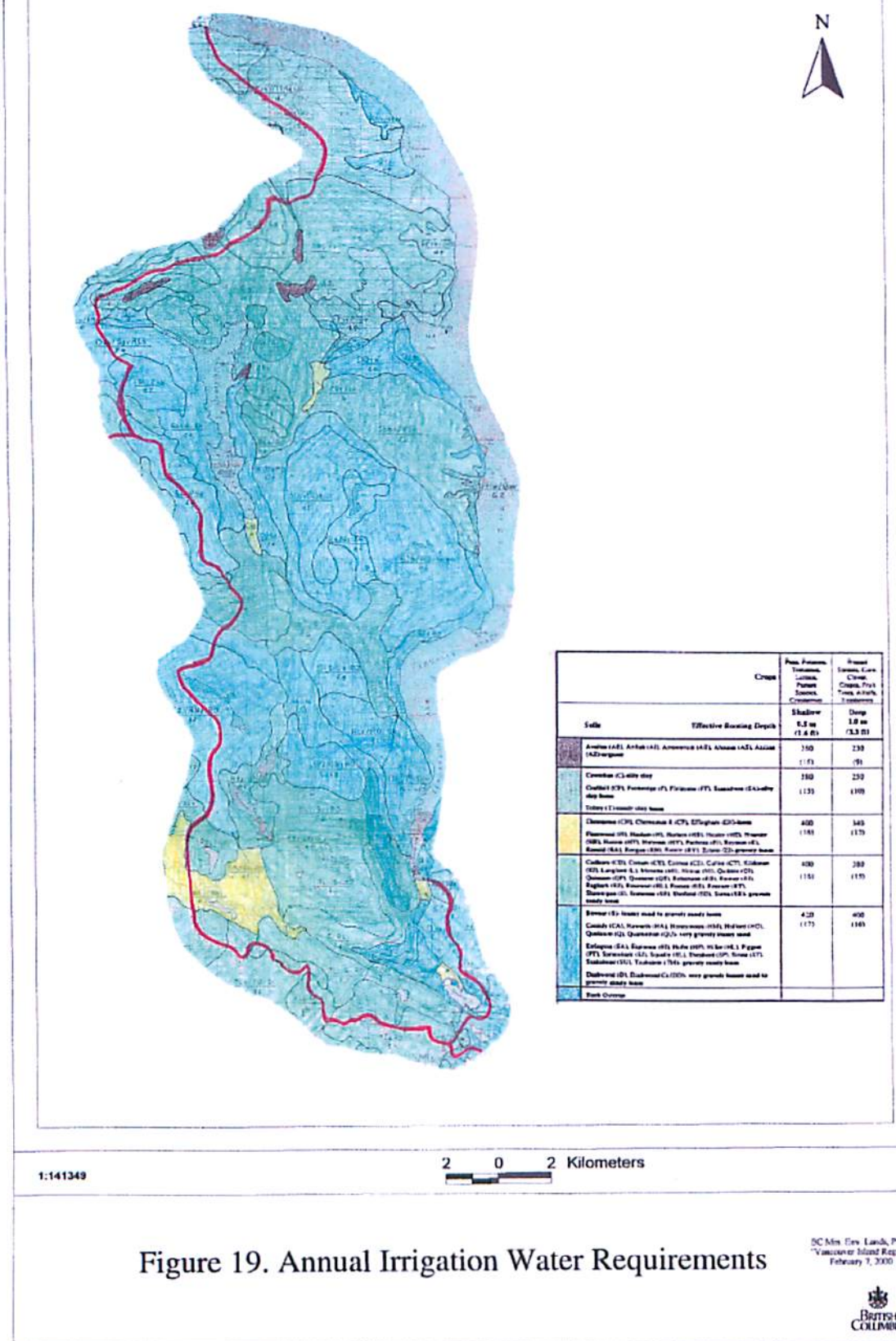


Figure 19. Annual Irrigation Water Requirements

irrigated. Irrigators are encouraged to employ good agricultural practices (field size, system selection and farm management) to conserve water. The authorized period of use for irrigation shall be from April 1 to September 30.

As noted above, all intake works in fish bearing waters shall be screened to prevent fish and debris from entering the intake.

6.4 Industrial

Industrial water licences and water licence applications within the plan area are demands associated with enterprise, fire protection, institutions, ponds, processing, residential lawn/garden, and stockwatering.

Commercial fish hatcheries and/or rearing purposes shall require an industrial water licence. Use of water by government and non-profit organizations will be licenced as conservation purpose. Information on fish species and size, water temperature requirements, and operating methods will be required in support of an application for water licence. Fish Farm and Waste Management Permits will also be required. Offstream storage is required for fish ponds associated with commercial fish farming.

Golf course watering is essentially an irrigation water demand except that the watering is not limited to the irrigation period of April to September. The quantity of water required should be determined as previously stated in the irrigation section. Except for the period of water withdrawal, which shall be the whole year, the same requirements and conditions as irrigation demands shall apply. Water demands will require offstream storage. Diversion into storage will be authorized for the period that the mean monthly flows are above 60% MAD.

Cattle or livestock watering requiring more than 450 litres/day (100 gpd) are to be considered an Industrial (Agricultural/Stockwatering) demand. Cattle or livestock requiring 450 litres/day (100 gpd) or less will be considered a Domestic (Livestock) demand. Estimated amounts of water required for livestock watering demands are listed in the following table.

Table 19 Recommended Livestock Water Requirements

Livestock	Water Requirements	
	litres/day	gallons/day
Cattle (beef) per animal	45	10
Cattle (dairy) per animal	132	29
Chickens per 100 animals	27	6
Turkeys per 100 animals	55	12

Industrial demands related to commercial and resort development should be handled similar to multiple domestic demands with the same requirements; except that supporting storage will be required.

6.5 Storage

Storage purpose is the impoundment of water, either instream or offstream in a dugout or behind a dam. In the event that a large storage development to support a major water demand (i.e. hydro power, pulp and paper, community works) is proposed a more specific supply versus demand and environmental impact assessment will be required.

The storage quantity required to support the smaller water demands of domestic, industrial and irrigation uses shall be the low flow period volume of the water demand plus an additional allowance of 0.3 m (1 ft) depth over the surface area of the storage reservoir for evaporation and other losses. Offstream storage in a dugout will be required for these demands in most cases. Storage in swamps or natural depressions may be considered where fish and wildlife are not adversely impacted or where the natural habitat is enhanced.

The water licence applicant will be required to complete an adequate report form entitled "Schedule 2 - Dam & Reservoir Information". If the required report is not provided the application may be refused.

Diversion of water into off-stream storage will be during the high flow period. Provision to maintain flows during the low flow period shall be required for instream storage reservoirs.

The applicant must obtain written agreement, a right of way or an easement for works or flooding of other lands.

Fish passage may be required, for both juvenile and adult fish, at all dams in fish bearing streams. The owner of a storage dam may be required to provide a fish ladder for fish to pass around the dam and may be required to provide adequate flow releases to maintain fish passage. Loss of spawning areas and modification of fish habitat due to storage development may require mitigation work in the affected stream.

Design plans must be submitted and accepted in writing before construction commences on any proposed dam over 3 m (10 ft) in height or on storage 12 dam^3 (10 acft) or more in volume or as directed by the engineer under the Water Act.

All water licensees for storage greater than 100 dam^3 (80 acft) shall be required to record and report the water level of the reservoir and flows from the reservoir as directed by the "Engineer" under the Water Act of BC.

6.6 Land Improvement

Land improvement purpose is the diversion of water to improve drainage, to protect from flooding, to prevent erosion, or to divert and use water for aesthetic purposes. No significant water quantity is removed from the stream. Land improvement water demands are non-consumptive uses of the water resources.

Water used to facilitate the development of a park is usually maintained in a dammed lake for recreation (i.e. boating, fishing, swimming, golf course water traps) and aesthetics. The dammed lake is usually filled during the high flow period and the water levels maintained or gradually lowered during the low flow period. Golf courses also require water licences to construct and maintain dugouts or to control the volume of water in small ponds for water traps and aesthetics. Property owners may acquire a water licence to construct and maintain dugouts or to control the volume of small ponds for aesthetics. These water demands are essentially storage developments that do not support an extractive use. Therefore, all the requirements noted for storage development shall be required for land improvement development where applicable. The water quantity required to facilitate the development of a park or to create an aesthetic pond shall be the volume of the impoundment.

Constructing ditches to drain swamps or marshes, confining or straightening the meandering of stream channels, and relocating a stream channel adjacent to a property line is sometimes proposed to accommodate subdivision or building development. Streams should be maintained as near as possible to pre-development flow conditions. The development of land improvement detention dugouts or the control of water in natural ponds, swamps, and marshes to reduce flood flow and increase low flow releases will be encouraged. Proposed construction of works on streams that drain swamps or marshes or increase high flow conditions and reduce low flow conditions will be discouraged.

6.7 Conservation

Conservation purpose is the use and storage of water or the construction of works in and about a stream for the enhancement of fish or wildlife for non-profit purposes.

Salmon enhancement proposals that would significantly increase fish stocks in stream channels may require the development of supporting storage to maintain required flows for the enhancement.

6.8 Power

The water licence applicant will be required to complete "Schedule 2-Dam & Reservoir Information" and "Schedule 3-Power Information" reports. If the required reports are not provided the application may be refused.

In the event that a large power development is proposed a more specific supply versus demand and environmental impact assessment will be required. For a small power development the following assessments shall be used to determine the required water demand.

Flow requirements for power:

$$Q = \frac{P}{h \times e \times k}$$

Q = volume rate of flow (m^3/s)
P = power required at the generator (kW)
h = gross head from the pipeline intake to the tailwater (m)
e = total efficiency of the plant considering head loss in the penstock, pipeline, turbine and generator expressed by a decimal (use 0.65 for pumps, 0.70 for turbines)
k = specific gravity constant (9.81 m/s^2)

Table 20 Electric Load Requirements

Type of Establishment	Maximum Electrical Demand per Residence (kW)
Cabin	4
Single Family Residence: Lighting and appliances Lighting, appliances, and water heating Lighting, appliances, water, and space heating	 6 10 26
Hotel or Motel	0.16 per m^2
Camp: Combined space heating electric and propane All electric space heating	 1.5 2

Water returned to the stream after generation of hydro power may be licenced for subsequent compatible water demands. Hydro power use that diverts water away from subsequent use shall be discouraged.

Fish passage is required, for both juvenile and adult fish, at all power diversion works in fish bearing streams. Fish and debris screens may be required at both intake and outlet works to ensure that fish are not lost due to operation of the power plant. Loss of spawning areas and modification of fish habitat due to power development may require mitigation work in the affected stream.

6.9 Allocation Plan Revision

The Shawnigan-Goldstream Water Allocation Plan should be reviewed and updated on or before January 1, 2010.

APPENDIX A
Canadian Climatic Normals 1951 -1980 Data
Atmospheric Environment Service Environment Canada

SHAWNIGAN LAKE - AES station 1951 - 1980 (48° 39'N 123°37'W, 137m)													
Precipitation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	174.80	125.20	102.10	56.90	34.50	33.30	22.60	28.70	50.70	109.40	175.50	205.60	1119.30
Snowfall (cm)	38.50	13.80	11.10	0.30	0.00	0.00	0.00	0.00	0.00	0.00	4.40	27.10	95.20
Total Precipitation (mm)	213.30	139.50	113.20	57.30	34.50	33.30	22.60	28.70	50.70	109.40	179.90	232.90	1215.30
Extreme Daily Rainfall (mm)	90.40	68.60	55.60	52.10	53.10	36.80	23.10	63.50	63.00	68.10	82.00	91.00	91.00
Extreme Daily Snowfall (cm)	55.90	53.30	41.90	5.10		0.00	0.00	0.00	0.00	5.10	48.30	66.00	66.00
Number of Days with:													
Measurable Rainfall	16	15	15	12	10	9	6	7	9	14	17	19	149
Measurable Snowfall	5	2	2		0	0	0	0	0	0	1	3	13
Measurable Precipitation	19	16	17	12	10	9	6	7	9	14	18	21	158

LANGFORD LAKE - AES station 1951 - 1980 (48° 27'N 123° 31'W, 76m)													
Precipitation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	170.60	114.40	81.20	50.00	23.70	19.40	15.70	20.50	42.40	107.70	157.90	191.50	995.00
Snowfall (cm)	20.40	5.30	6.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	10.90	44.60
Total Precipitation (mm)	188.90	121.10	86.70	50.00	23.70	19.40	15.70	20.50	42.40	107.70	160.00	202.60	1038.10
Extreme Daily Rainfall (mm)	67.6	91.7	46.2	44.7	28.2	22.9	15.5	27.4	57.4	66.5	134.1	130	134.1
Extreme Daily Snowfall (cm)	31.8	18.8	19.3	0.3	0		0	0	0	0	7.6	33	33
Number of Days with:													
Measurable Rainfall	18	16	17	12	9	7	5	6	9	15	19	20	153
Measurable Snowfall	4	2	1	0	0	0	0	0	0	0	0	3	10
Measurable Precipitation	20	17	17	13	9	8	5	6	8	15	19	21	158

APPENDIX B

Water Survey of Canada Data

MEAN MONTHLY AND MEAN ANNUAL DISCHARGES

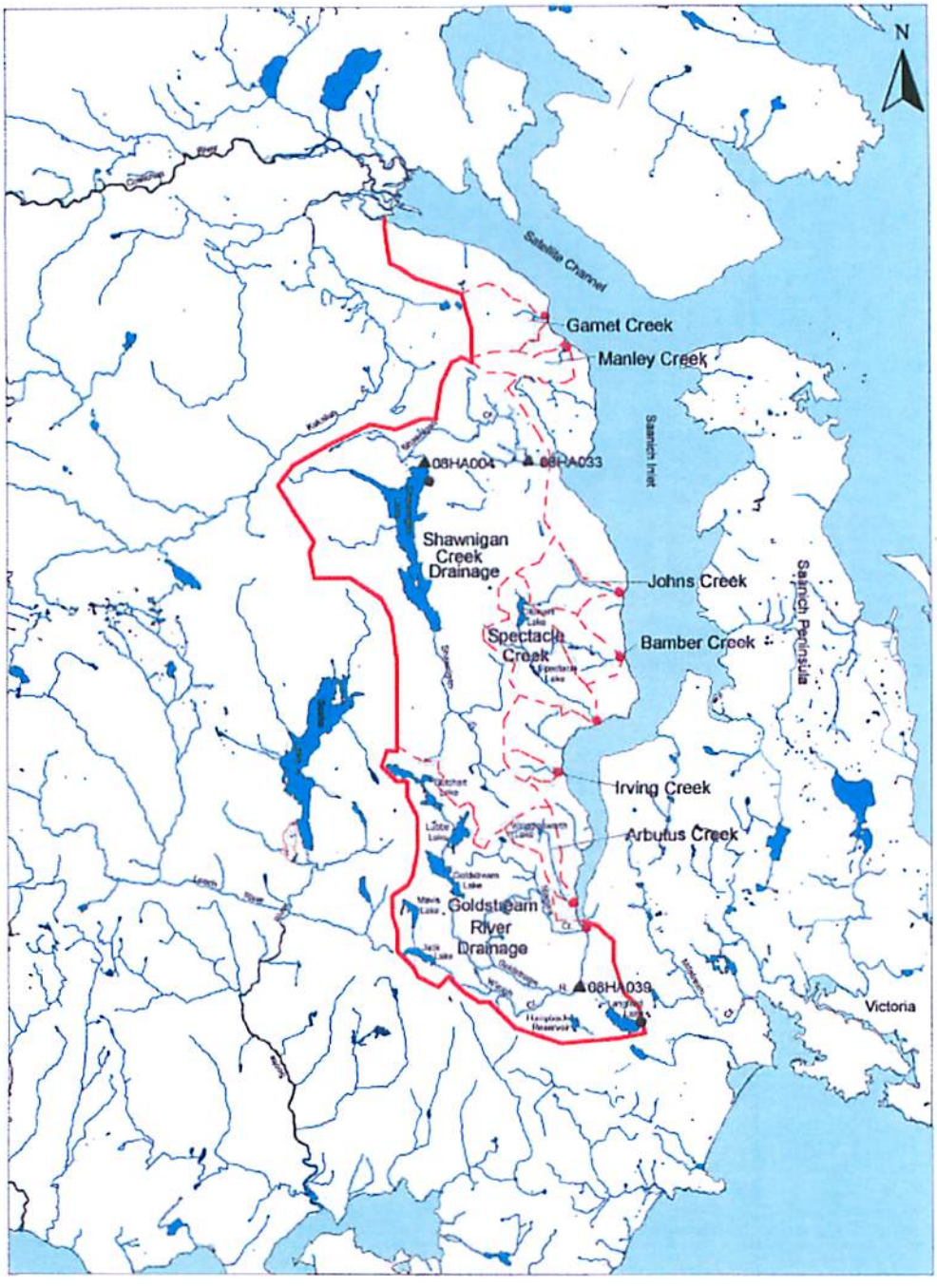


Figure 4. Water Survey of Canada Hydrometric Stations and Atmospheric Environment Service Climatic Stations

	Station Name:			SHAWNIGAN CREEK NEAR MILL BAY										
	Station Number:			08HA033										
	Natural or Regulated:			N										
	Drainage Area (sq.km.):			91.9			Degrees	Minutes	Seconds					
	Location (Decimal):		Latitude	48.65806		Latitude	48	39	29					
			Longitude	123.56889		Longitude	123	34	8					
STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MN ANN
08HA033	1974	M	M	M	M	0.837	0.509	0.093	0.024	0.009	0.01	1.17	5.27	M
08HA033	1975	6.86	4.96	4.74	1.74	0.578	0.142	0.035	0.029	0.027	1.53	8.35	7.67	3.04
08HA033	1976	8.44	6.34	4.97	2.69	0.675	0.211	0.084	0.035	0.018	M	M	M	M
08HA033	1977	M	3	6.08	1.38	0.343	0.161	0.037	0.006	0.031	0.063	3.26	7.5	M
08HA033	1978	5.08	3.58	2.07	1.45	0.513	0.139	0.013	0.001	0.034	0.052	0.103	1.84	1.23
08HA033	1979	1.59	5.34	5.32	1.18	0.409	0.047	0.012	0.002	0.009	0.044	0.186	11.8	2.16
08HA033	1980	5.64	6.11	5.13	1.64	0.45	0.426	0.315	0.109	0.109	0.127	2.99	9.86	2.74
08HA033	1981	4.93	6.87	2.47	2.2	1.17	0.653	0.281	0.069	0.055	0.842	5.03	9.19	2.79
08HA033	1982	8.05	8.43	4.24	1.2	0.554	0.031	0.043	0.061	0.075	0.082	0.491	6.37	2.44
08HA033	1983	7.78	7.6	5.71	1.56	0.075	0.062	0.491	0.165	0.13	0.398	6.38	5.34	2.95
08HA033	1984	4.9	2.93	3.62	2.06	2	1.14	0.164	0.026	0.032	0.152	6.34	6.57	2.49
08HA033	1985	2.2	2.47	1.23	1.4	0.692	0.316	0.048	0.006	0.02	0.163	1.34	1.38	0.929
08HA033	1986	6.46	6.26	5.13	1.57	0.84	0.5	0.08	0.003	0.007	0.013	1.49	4.02	2.18
08HA033	1987	5.39	4.71	3.81	0.87	0.273	0.066	0.016	0.009	0.005	0.005	0.088	3.82	1.58
08HA033	1988	4.66	2.46	2.42	3.87	0.399	0.28	0.092	0.005	0.01	0.209	2.82	3.62	1.73
08HA033	1989	8.6	2.56	4.88	3.34	0.266	0.053	0.032	0.049	0.004	0.007	0.906	2.75	1.96
08HA033	1990	4.95	8.03	3.62	0.763	0.208	0.575	0.297	0.013	0.014	0.459	7.29	9.11	2.91
08HA033	1991	5.14	6.49	3.47	3.24	0.423	0.125	0.04	0.054	0.074	0.113	2.37	4.94	2.18
08HA033	1992	5.82	7.91	2.39	0.43	0.484	0.077	0.02	0.007	0.004	0.018	0.725	2.5	1.68
08HA033	1993	3.11	3	2.53	2.21	1.43	0.624	0.313	0.073	0.011	0.015	0.138	1.75	1.26
08HA033	1994	3.07	3.63	6.16	2.71	0.38	0.063	0.01	0.008	0.019	0.073	1.26	7.58	2.08
08HA033	1995	6.79	5.46	2.52	0.672	0.244	0.023	0.016	0.027	0.035	0.113	5.21	10	2.58
08HA033	1996	6.83	5.66	2.61	2.27	1.73	0.434	0.133	0.048	0.013	0.157	1.6	6.44	2.32
08HA033	1997	11.3	5.77	7.42	4.24	2.61	0.261	0.899	0.279	0.19	1.92	3.43	4.98	3.61
08HA033	1998	7.25	4.79	3.02	1.21	0.101	0.055	0.052	0.021	0.019	0.09	4.4	8.87	2.48
08HA033	1999	8.78	11.2	7.11	0.543	0.186	0.141	0.261	0.066	0.013	0.234	3.37	7.14	3.21

STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MN ANN
08HA033	2000	4.48	3.40	2.73	1.10	0.280	0.201	0.020	0.018	0.146	0.341	0.494	2.19	1.28
08HA033	2001	3.89	2.15	1.46	0.62	0.248	0.283	0.253	0.160	0.065	0.113	1.35	8.33	1.58
08HA033	2002	5.87	5.41	5.24	2.53	0.638	0.185	0.141	0.052	0.005	0.013	0.10	1.61	1.80
08HA033	2003	6.81	3.88	4.70	2.96	0.686	0.069	0.018	0.009	0.010	4.95	4.28	5.98	2.87
08HA033	2004	4.13	4.65	2.00	0.36	0.518	0.122	0.022	0.029	0.072	0.486	2.37	6.01	1.73
MEAN		**5.85**	**5.23**	**3.96**	**1.80**	**0.65**	**0.26**	**0.14**	**0.05**	**0.04**	**0.43**	**2.64**	**5.81**	2.21
% of MAD		265%	237%	179%	82%	30%	12%	6%	2%	2%	19%	120%	263%	100%

	Station Name:			SHAWNIGAN CREEK BELOW SHAWNIGAN LAKE										
	Station Number:			08HA004										
	Natural or Regulated:			N										
	Drainage Area (sq.km.):			68.8			Degrees	Minutes	Seconds					
	Location (Decimal):		Latitude	48.66		Latitude	48	39	34					
			Longitude	123.63		Longitude	123	37	48					
STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MN ANN
08HA004	1914	M	M	M	M	M	0.207	0.086	0.006	0	0.184	5.02	3.13	M
08HA004	1915	2.99	2.06	1.31	1.3	0.543	0.259	0.092	0.029	0	0.012	2.13	8.29	1.59
08HA004	1916	3.03	6.02	8.56	3.03	1.03	0.292	0.123	0.064	0.02	0.001	0.189	2.76	2.09
08HA004	1917	3.99	3.07	2.52	M	M	M	M	M	M	M	M	M	M
08HA004	1976	M	M	M	M	M	M	M	M	M	M	0.028	0.355	M
08HA004	1977	1.56	2.34	4.9	1.21	0.371	0.136	0.013	0.001	0.001	0.005	2.67	7.05	1.69
08HA004	1978	4.29	3.25	1.69	1.29	0.419	0.125	0.013	0	0.002	0.004	0.022	1.22	1.02
08HA004	1979	1.07	5.11	4.96	1.1	0.417	0.051	0.011	0	0.001	0.009	0.054	10.3	1.92
08HA004	1984	4.09	2.29	2.76	1.64	1.48	1.01	0.154	0.015	0.011	0.106	4.87	5.88	2.03
08HA004	1985	1.94	2.09	1.06	1.27	0.512	0.264	0.055	0.02	0.018	0.069	0.928	1.04	0.763
08HA004	1986	4.85	4.57	3.51	1.09	0.626	0.378	0.091	0.015	0.011	0.01	1.08	2.78	1.57
08HA004	1987	3.86	3.38	2.79	0.591	0.187	0.083	0.022	0.016	0.012	0.013	0.014	3.04	1.16
08HA004	1988	3.2	1.88	1.84	3.11	0.219	0.184	0.055	0.018	0.012	0.111	1.95	2.8	1.28
08HA004	1989	M	M	M	2.87	0.158	0.063	0.045	0.056	0.013	0.013	0.365	2.28	M
MEAN		**3.17**	**3.28**	**3.26**	**1.68**	**0.542**	**0.254**	**0.063**	**0.020**	**0.008**	**0.045**	**1.49**	**3.92**	1.51
% of MAD		210%	217%	216%	111%	36%	17%	4%	1%	1%	3%	98%	259%	

	Station Name:			GOLDSTREAM RIVER IN GOLDSTREAM PROVINCIAL PARK										
	Station Number:			08HA039										
	Natural or Regulated:			N										
	Drainage Area (sq.km.):			30.9			Degrees	Minutes	Seconds					
	Location (Decimal):		Latitude	48.46111		Latitude	48	27	40					
			Longitude	123.55250		Longitude	123	33	9					
STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MN ANN
08HA039	1976	M	M	M	M	M	M	M	M	M	M	0.705	0.58	M
08HA039	1977	0.327	0.473	1.01	0.264	0.215	0.187	0.192	0.191	0.195	0.412	1.3	1.59	0.531
08HA039	1978	0.864	0.694	0.434	0.369	0.275	0.187	0.19	0.189	0.231	0.468	1.07	1.07	0.502
MEAN		**0.596**	**0.584**	**0.722**	**0.317**	**0.245**	**0.187**	**0.191**	**0.190**	**0.213**	**0.440**	**1.03**	**1.08**	0.517
% of MAD		115%	113%	140%	61%	47%	36%	37%	37%	41%	85%	198%	209%	100%

APPENDIX C

Licenced Water Demand by Purpose

Existing Licenced Water Demand

Conservation Purpose			Number of Licences = 2		
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
1000391	C061427	Bamber Creek	50	acft	61.7
1002403	C119748	Shawnigan Creek	0.5	cfs	447
		Total =	**50**	**acft**	**508**
			0.5	**cfs**	

Domestic Purpose			Number of Licences = 307		
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0028321	F017026	Hamsterley Creek	1,500	gpd	1.2
0067534	F014706	Rogers Brook	1,000	gpd	0.8
0067534	F014707	Rogers Brook	1,000	gpd	0.8
0067950	F007935	Wilkin Creek	500	gpd	0.4
0068002	C048189	Leggatts Spring	1,000	gpd	0.8
0081828	F017204	Bird Creek	500	gpd	0.4
0086529	F017579	Sylvan Creek	1,000	gpd	0.8
0098373	F008809	Camsusa Creek	500	gpd	0.4
0099889	F011021	Oliphant Lake	0	gpd	0.0
0113913	F012351	Wilkin Creek	1,000	gpd	0.8
0114985	F011218	Wilkin Creek	500	gpd	0.4
0125305	F009777	Silvene Spring	1,000	gpd	0.8
0126618	F011025	Arbutus Creek	2,000	gpd	1.7
0145298	F013063	Wilkin Creek	500	gpd	0.4
0147534	F012112	Sylvan Brook	1,000	gpd	0.8
0147686	F012731	Longmynd Spring	1,000	gpd	0.8
0148044	C015490	Meredith Spring	1,000	gpd	0.8
0148086	F014455	May Spring	1,000	gpd	0.8
0151249	C061445	Masonos Spring	1,000	gpd	0.8
0151361	F015428	Hornsby Spring	500	gpd	0.4
0152458	F015401	Service Creek	500	gpd	0.4
0152990	F014249	Johns Creek	1,000	gpd	0.8
0152990	F016245	Johns Creek	250	gpd	0.2
0153788	C016232	Irving Creek & Sirhenry Spring	1,000	gpd	0.8
0154090	C016231	Givens Spring	1,000	gpd	0.8
0156112	C017044	Silvene Spring & Wrigglesworth Brook	1,000	gpd	0.8
0157708	F012732	Eddy Spring	1,000	gpd	0.8
0158430	F013442	Shawnigan Creek	500	gpd	0.4
0159218	C017043	Silvene Spring & Wrigglesworth Brook	1,000	gpd	0.8
0159322	C017042	Silvene Spring & Wrigglesworth Brook	1,000	gpd	0.8

0160149	C017235	Jep Brook	1,000	gpd	0.8
0167645	C120157	Langford Lake	500	gpd	0.4
0169016	F014954	Shawnigan Creek	1,000	gpd	0.8
0173336	F055408	Irving Creek	500	gpd	0.4
0175370	F014946	Shawnigan Creek	1,000	gpd	0.8
0184485	C019636	Isabelle Brook	3,000	gpd	2.5
0185447	F015415	Benko Spring	100	gpd	0.1
0190546	F044139	Burnham Creek	500	gpd	0.4
0194156	F014698	Camsusa Creek	500	gpd	0.4
0195538	F120750	Wilkin Creek	500	gpd	0.4
0198025	F016192	Theik Spring	500	gpd	0.4
0198108	F016110	Cresswell Spring	500	gpd	0.4
0198109	C021348	Janet Spring	1000	gpd	0.8
0201857	F017537	Wilkin Creek	500	gpd	0.4
0203166	F021186	Parkdale Creek	500	gpd	0.4
0207385	C108349	Shawnigan Creek	500	gpd	0.4
0207742	F017485	Manley Creek	500	gpd	0.4
0208494	F017781	Shawnigan Creek	500	gpd	0.4
0209541	F021258	Schnoter Swamp	1,000	gpd	0.8
0209542	F021191	Schnoter Swamp	1,000	gpd	0.8
0212201	F018335	Taggart Creek	1,000	gpd	0.8
0212230	F018481	Rodger Spring	1,000	gpd	0.8
0215156	F018024	Leslie Swamp	1,500	gpd	1.2
0215420	C023888	Cedar Chines Spring	1,500	gpd	1.2
0216223	C023745	Hook Creek	4,000	gpd	3.3
0216634	C112964	Waterfront Spring	500	gpd	0.4
0220613	F018336	Ordano Brook	500	gpd	0.4
0221005	C024415	Ordano Brook	1,000	gpd	0.8
0221595	F017797	Shawnigan Creek	500	gpd	0.4
0221798	C117964	Shawnigan Lake	500	gpd	0.4
0222048	C117967	Shawnigan Lake	500	gpd	0.4
0222049	C117951	Shawnigan Lake	500	gpd	0.4
0225424	F017780	Wilkin Creek	500	gpd	0.4
0227967	F018815	Shearing Creek	1,000	gpd	0.8
0235487	F018265	Shawnigan Lake	500	gpd	0.4
0241184	F005917	Wace Creek	1,500	gpd	1.2
0241187	F006282	Frayne Creek	500	gpd	0.4
0242667	C027381	Shawnigan Creek	1,000	gpd	0.8
0243616	F019171	Shawnigan Creek	500	gpd	0.4
0244237	F106053	Wood Spring	500	gpd	0.4
0246708	C027735	Shawnigan Creek	1,000	gpd	0.8
0247228	F019966	Shawnigan Creek	500	gpd	0.4
0247229	F019172	Shawnigan Creek	500	gpd	0.4
0249295	F021153	White Brook	500	gpd	0.4
0249744	F019173	Shawnigan Lake	500	gpd	0.4
0251101	F019278	Wass Spring	500	gpd	0.4
0255147	C117812	Shawnigan Creek	500	gpd	0.4
0259029	F021473	Hearn Spring	1,000	gpd	0.8

0259641	C029833	Lind Spring	2,000	gpd	1.7
0262012	F047769	Joyce Spring	100	gpd	0.1
0264397	F047412	Sylvan Brook	1,500	gpd	1.2
0265160	F003752	Achilles Creek	500	gpd	0.4
0265175	F003765	Hook Creek	1,000	gpd	0.8
0265447	F003260	Hincks Spring	2,500	gpd	2.1
0265511	F003739	Arbutus Creek	1,000	gpd	0.8
0268273	F048405	Lenfesty Brook	500	gpd	0.4
0268672	C031373	Lenfesty Brook	1,000	gpd	0.8
0269120	F021306	Shawnigan Lake	500	gpd	0.4
0270264	F040263	Shawnigan Lake	500	gpd	0.4
0270292	F021307	Shawnigan Lake	500	gpd	0.4
0273025	C033373	Lionel Ponds	1,000	gpd	0.8
0273198	C114797	Galvin Spring	250	gpd	0.2
0273252	C113827	Burnham Creek	500	gpd	0.4
0273488	C032557	Galvin Spring	250	gpd	0.2
0273528	F120288	Johns Creek	500	gpd	0.4
0277817	C034164	Lenfesty Brook	500	gpd	0.4
0281017	F021457	Zimmerli Spring	500	gpd	0.4
0281251	C118023	Shawnigan Lake	500	gpd	0.4
0285032	F053420	Thomson Spring	500	gpd	0.4
0285036	C034603	Irving Creek	500	gpd	0.4
0285327	C058370	Gravelle Slough	1,000	gpd	0.8
0285352	F021088	Service Creek	500	gpd	0.4
0290253	C035661	Kelly Springs	1,000	gpd	0.8
0290505	C110081	Wace Creek	333	gpd	0.3
0296176	C036106	Colpman Creek	500	gpd	0.4
0296196	F021255	Johns Creek	750	gpd	0.6
0296600	F120322	Shawnigan Lake	500	gpd	0.4
0296944	F043001	Shawnigan Lake	500	gpd	0.4
0300130	F043000	Ernest Spring	500	gpd	0.4
0300296	C037062	Shawnigan Lake	500	gpd	0.4
0300672	C037406	Burt Brook	500	gpd	0.4
0305198	C041345	Lionel Creek	250	gpd	0.2
0305298	F043002	Shawnigan Lake	500	gpd	0.4
0305466	C041396	McCurdy Springs	1,000	gpd	0.8
0305662	C038665	Burt Brook	500	gpd	0.4
0305867	C038664	Burt Brook	500	gpd	0.4
0309356	F043005	Shawnigan Lake	700	gpd	0.6
0309573	C039337	Shawnigan Lake	1,000	gpd	0.8
0309649	F043184	Shawnigan Lake	500	gpd	0.4
0309659	C070333	Shawnigan Lake	500	gpd	0.4
0309660	F047040	Shawnigan Lake	500	gpd	0.4
0309677	F043644	Shawnigan Lake	500	gpd	0.4
0309813	F042998	Shawnigan Lake	500	gpd	0.4
0309847	F043947	Shawnigan Lake	500	gpd	0.4
0309875	F053153	Shawnigan Lake	500	gpd	0.4
0309937	C039719	Shawnigan Lake	500	gpd	0.4
0309945	F045506	Shawnigan Lake	500	gpd	0.4

0309986	C040162	Shawnigan Lake	1,500	gpd	1.2
0310005	C040179	Masi Spring	500	gpd	0.4
0310046	F120289	Shawnigan Lake	500	gpd	0.4
0310100	F053155	Shawnigan Lake	500	gpd	0.4
0310328	F053154	Shawnigan Lake	500	gpd	0.4
0310376	F049268	Shawnigan Lake	500	gpd	0.4
0310493	C040167	Shawnigan Lake	500	gpd	0.4
0310581	C040847	Shawnigan Lake	500	gpd	0.4
0310878	C041107	Shearing Creek	1,000	gpd	0.8
0310903	F047123	Shawnigan Lake	500	gpd	0.4
0316018	F050919	Shawnigan Lake	500	gpd	0.4
0316093	F045507	Shawnigan Lake	500	gpd	0.4
0316148	F045857	Shawnigan Lake	500	gpd	0.4
0316170	F043004	Shawnigan Lake	2,000	gpd	1.7
0316711	F045503	Shawnigan Lake	500	gpd	0.4
0316944	C049839	Hollings Creek	250	gpd	0.2
0316973	C042493	Fuller Spring	500	gpd	0.4
0316975	F046773	Carlos Spring	1,000	gpd	0.8
0316993	F051930	Shawnigan Lake	500	gpd	0.4
0317412	F045501	Shawnigan Lake	500	gpd	0.4
0317693	C043128	Shawnigan Lake	500	gpd	0.4
0317740	F047413	Shawnigan Lake	500	gpd	0.4
0322042	F051140	Shawnigan Creek	500	gpd	0.4
0322638	C054298	Shawnigan Lake	500	gpd	0.4
0322795	C043281	Shawnigan Creek	500	gpd	0.4
0322962	C043381	Wilkin Creek	500	gpd	0.4
0323332	C043726	Shawnigan Lake	500	gpd	0.4
0323475	C046264	Shawnigan Lake	500	gpd	0.4
0323476	C043931	Shawnigan Lake	500	gpd	0.4
0323859	F044865	Shawnigan Creek	500	gpd	0.4
0328050	C044823	Wilkin Creek	500	gpd	0.4
0328069	F045500	Shawnigan Lake	500	gpd	0.4
0328104	F045499	Shawnigan Lake	500	gpd	0.4
0328450	C045292	Shawnigan Creek	500	gpd	0.4
0328474	C114800	Shawnigan Lake	500	gpd	0.4
0328773	F045508	Shawnigan Lake	500	gpd	0.4
0328986	C045742	Palmer Creek	500	gpd	0.4
0329053	F045505	Shawnigan Lake	500	gpd	0.4
0329060	F044866	Shawnigan Creek	500	gpd	0.4
0329161	C045743	Shawnigan Lake	500	gpd	0.4
0329210	F045504	Shawnigan Lake	500	gpd	0.4
0329618	C046480	Shawnigan Lake	1,000	gpd	0.8
0329653	C047719	McGee Creek	1,000	gpd	0.8
0329660	C055114	Girtin Pond	1,000	gpd	0.8
0329666	C046713	Hancock Spring	500	gpd	0.4
0329758	C047547	Shawnigan Lake	500	gpd	0.4
0329759	C047546	Shawnigan Lake	500	gpd	0.4
0330674	C047346	Shawnigan Lake	500	gpd	0.4
0330856	C048369	Shawnigan Lake	500	gpd	0.4

0340129	C048686	Bayley Spring	500	gpd	0.4
0340148	C048371	Shawnigan Lake	500	gpd	0.4
0340176	C058202	Shawnigan Lake	500	gpd	0.4
0340253	C048368	Shawnigan Lake	500	gpd	0.4
0340625	C048372	Shawnigan Lake	750	gpd	0.6
0340741	C052278	Nott Creek	500	gpd	0.4
0340854	C049678	Shawnigan Lake	500	gpd	0.4
0340944	C050001	Shawnigan Lake	500	gpd	0.4
0341046	F053418	Shawnigan Lake	500	gpd	0.4
0341295	F051351	Shawnigan Lake	500	gpd	0.4
0341369	F053419	Shawnigan Lake	500	gpd	0.4
0341536	C048190	Leggatts Spring	500	gpd	0.4
0341984	C049675	Gillett Spring	500	gpd	0.4
0342091	F050188	Shawnigan Lake	500	gpd	0.4
0342092	F050189	Shawnigan Lake	500	gpd	0.4
0342095	F050190	Shawnigan Lake	500	gpd	0.4
0342198	C050893	Shawnigan Lake	500	gpd	0.4
0342450	C056799	Alfalfa Spring	2,500	gpd	2.1
0346768	C109190	Shawnigan Lake	500	gpd	0.4
0355084	C053455	Shawnigan Lake	500	gpd	0.4
0355118	C053814	Shawnigan Lake	500	gpd	0.4
0355180	C055887	Shawnigan Lake	500	gpd	0.4
0355223	C053458	Shawnigan Lake	500	gpd	0.4
0355291	C054157	Shawnigan Lake	500	gpd	0.4
0355873	C054303	Shawnigan Lake	500	gpd	0.4
0364336	F052311	Shawnigan Lake	500	gpd	0.4
0364337	F052404	Shawnigan Lake	500	gpd	0.4
0364338	F052565	Shawnigan Lake	500	gpd	0.4
0364339	F052312	Shawnigan Lake	500	gpd	0.4
0364768	C052853	Irving Creek	500	gpd	0.4
0365198	C052831	Shawnigan Lake	500	gpd	0.4
0365338	C052802	Shawnigan Lake	500	gpd	0.4
0365352	C052803	Shawnigan Lake	500	gpd	0.4
0365381	C058761	Handysen Creek	1,000	gpd	0.8
0365455	C052981	Shawnigan Lake	500	gpd	0.4
0365781	C053849	Shawnigan Lake	3,200	gpd	2.7
0365979	C053457	Shawnigan Lake	500	gpd	0.4
0366539	C055042	Shawnigan Lake	500	gpd	0.4
0366820	C055043	Shawnigan Lake	500	gpd	0.4
0366924	C055330	Shawnigan Lake	500	gpd	0.4
0366937	C055329	Shawnigan Lake	500	gpd	0.4
0366971	C055331	Shawnigan Lake	500	gpd	0.4
0367085	C055332	Shawnigan Lake	500	gpd	0.4
0367092	C056800	North Squally Creek	500	gpd	0.4
0367140	C056332	Squally Creek	500	gpd	0.4
0367166	C056797	Shawnigan Lake	500	gpd	0.4
0367283	C056649	Shawnigan Lake	500	gpd	0.4
0367757	C056796	Shawnigan Lake	500	gpd	0.4
0368381	C058648	Shawnigan Lake	500	gpd	0.4

0368535	C058647	Shawnigan Lake	500	gpd	0.4
0368612	C057658	Shawnigan Lake	500	gpd	0.4
0368954	C059015	Shawnigan Lake	500	gpd	0.4
0369101	C059296	Singh Spring	600	gpd	0.5
0369107	C057411	Shawnigan Lake	500	gpd	0.4
0369341	C119225	Nineteen Mile Spring	500	gpd	0.4
0369456	C057293	Shawnigan Lake	500	gpd	0.4
1000019	C058477	Chandler Creek	200	gpd	0.2
1000024	C058475	Landblom Spring	1,000	gpd	0.8
1000043	C059074	Shawnigan Lake	500	gpd	0.4
1000045	C059073	Shawnigan Lake	500	gpd	0.4
1000057	C059013	Shawnigan Lake	500	gpd	0.4
1000067	C059012	Shawnigan Lake	500	gpd	0.4
1000068	C059088	Shawnigan Lake	500	gpd	0.4
1000075	C058758	Shawnigan Lake	500	gpd	0.4
1000089	C059014	Shawnigan Lake	500	gpd	0.4
1000128	C061251	Shawnigan Lake	500	gpd	0.4
1000155	C061287	Shawnigan Lake	500	gpd	0.4
1000181	C117881	Shawnigan Lake	500	gpd	0.4
1000209	C061286	Shawnigan Lake	500	gpd	0.4
1000229	C059669	Shawnigan Lake	500	gpd	0.4
1000257	C059705	Shawnigan Lake	500	gpd	0.4
1000260	C059706	Palmer Creek	500	gpd	0.4
1000273	C103280	Shawnigan Lake	500	gpd	0.4
1000304	F111727	Wilkin Creek	500	gpd	0.4
1000348	C070356	Shawnigan Lake	500	gpd	0.4
1000349	C070357	Shawnigan Lake	500	gpd	0.4
1000390	C061346	Shawnigan Lake	500	gpd	0.4
1000391	C061425	Bamber Creek	1,500	gpd	1.2
1000420	C063915	Service Creek	500	gpd	0.4
1000479	C061492	Shawnigan Lake	500	gpd	0.4
1000568	C063944	Shawnigan Lake	1,000	gpd	0.8
1000670	C065703	Charl Spring & Wilkin Creek	500	gpd	0.4
1000679	C064095	Shawnigan Lake	500	gpd	0.4
1000736	C065775	Shawnigan Lake	500	gpd	0.4
1000780	C065766	Shawnigan Lake	500	gpd	0.4
1000847	C065788	Shawnigan Lake	500	gpd	0.4
1000848	C065814	Shawnigan Lake	500	gpd	0.4
1001043	C065831	Shawnigan Lake	500	gpd	0.4
1001073	C070380	Shawnigan Lake	500	gpd	0.4
1001250	C101076	Shawnigan Lake	500	gpd	0.4
1001345	C101091	Shawnigan Lake	500	gpd	0.4
1001391	C101673	Shawnigan Lake	500	gpd	0.4
1001420	C101355	Shawnigan Lake	500	gpd	0.4
1001444	C101575	Shawnigan Lake	500	gpd	0.4
1001449	C101982	Shawnigan Lake	500	gpd	0.4
1001474	C102535	Shawnigan Lake	500	gpd	0.4
1001557	C104442	Shawnigan Lake	500	gpd	0.4
1001601	C105197	Waterfront Spring	500	gpd	0.4

1001608	C105302	Shawnigan Lake	500	gpd	0.4
1001632	C105607	Shawnigan Lake	500	gpd	0.4
1001654	C106031	Shawnigan Lake	500	gpd	0.4
1001660	C106159	Shawnigan Lake	500	gpd	0.4
1001663	C106160	Shawnigan Lake	500	gpd	0.4
1001674	C106663	Shawnigan Lake	500	gpd	0.4
1001705	C106851	Shawnigan Lake	500	gpd	0.4
1001713	C106954	Shawnigan Lake	500	gpd	0.4
1001765	C107847	Shawnigan Lake	500	gpd	0.4
1001774	C108029	Shawnigan Lake	500	gpd	0.4
1001801	C108641	Shawnigan Lake	500	gpd	0.4
1001806	C108980	Shawnigan Lake	500	gpd	0.4
1001810	C109079	Shawnigan Lake	500	gpd	0.4
1001830	C109467	Shawnigan Lake	500	gpd	0.4
1001850	C109722	Shawnigan Lake	500	gpd	0.4
1001873	C110070	Shawnigan Lake	500	gpd	0.4
1001950	C111409	Shawnigan Lake	500	gpd	0.4
1002002	C112685	Shawnigan Lake	500	gpd	0.4
1002035	C113543	Shawnigan Lake	500	gpd	0.4
1002036	C113542	Shawnigan Lake	500	gpd	0.4
1002039	C118058	Shawnigan Lake	500	gpd	0.4
1002068	C117846	Shawnigan Lake	500	gpd	0.4
1002069	C117843	Shawnigan Lake	500	gpd	0.4
1002193	C117882	Shawnigan Lake	1000	gpd	0.8
1002198	C116433	Shawnigan Lake	500	gpd	0.4
1002212	C116512	Shawnigan Lake	500	gpd	0.4
1002213	C116511	Shawnigan Lake	500	gpd	0.4
1002214	C116557	Shawnigan Lake	500	gpd	0.4
1002215	C116556	Shawnigan Lake	500	gpd	0.4
1002297	C118173	Shawnigan Lake	500	gpd	0.4
1002325	C120158	Langford Lake	500	gpd	0.4
1002351	C118278	Shawnigan Lake	500	gpd	0.4
0328450	C121157	Shawnigan Lake	500	gpd	0.4
		Total =	**199,500**	**gpd**	**165**

Industrial Purpose (Enterprise)					**Number of Licences = 5**
FILE NUMBER	**LICENCE NUMBER**	**SOURCE**	**QUANTITY/UNITS**		**DEMAND (dam^3/year)**
0309818	C040614	Shawnigan Lake	7000	gpd	11.6
0317902	C042815	Shawnigan Lake	1000	gpd	1.7
0340944	C050001	Shawnigan Lake	1000	gpd	1.7
0131658	C043577	Cobble Spring	1000	gpd	1.7
1002424	C120414	Shawnigan Lake	25000	gpd	41.5
		Total =	**35,000**	**gpd**	**58**

Industrial Purpose (Fire Protection)					Number of Licences = 4
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0322197	C042816	Shawnigan Creek	10000	gpd	16.6
0368895	C058582	Denise Brook	5.5	acft	6.8
1000672	C065710	Loken Brook	0.04	acft	0.0
1002401	C119692	Massie Swamp	0.04	acft	0.0
		Total =	**10,000**	**gpd**	
		+	**5.58**	**acft**	**23**

Industrial Purpose (Institutions)					Number of Licences = 2
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0317421	C117969	Shawnigan Lake	60000	gpd	99.6
1001044	C120231	Shawnigan Lake	1000	gpd	1.7
		Total =	**61,000**	**gpd**	**101**

Industrial Purpose (Ponds)					Number of Licences = 1
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
1001411	C101300	Eddy Creek	2.2	acft	2.7
		Total =	**2.2**	**acft**	**2.7**

Industrial Purpose (Processing)					Number of Licences = 3
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0099889	F011021	Oliphant Lake	100000	gpd	166.0
0239899	C027301	Spectacle Creek	370000	gpd	614.4
0277868	C034307	Spectacle Creek	125000	gpd	207.6
		Total =	**595,000**	**gpd**	**988**

Industrial Purpose (Residential Lawn/Garden)					Number of Licences = 1
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0281242	C106059	Nightingale Spring	0.33	acft	0.4
		Total =	**0.33**	**acft**	**0**

Industrial Purpose (Stockwatering) Number of Licences = 2					
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0207385	C108349	Shawnigan Creek	2000	gpd	3.3
1000391	C061425	Bamber Creek	200	gpd	0.3
		Total =	**2,200**	**gpd**	**4**

Total for all Industrial Purposes	**1,178**

Irrigation Purpose		Number of Licences = 66			
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0004740	C054728	Wace Creek	0.12	acft	0.1
0150659	F015383	Wace Creek	10	acft	12.3
0152947	C054729	Wace Creek	0.12	acft	0.1
0166032	F014349	Taggart Creek	1	acft	1.2
0172164	C056139	Garnett Creek	0.67	acft	0.8
0189965	C044624	Taggart Creek	11.62	acft	14.3
0193566	F015377	Wace Creek	20	acft	24.7
0194694	C114858	Shawnigan Creek	15	acft	18.5
0195994	C116445	Shawnigan Creek	0.6	acft	0.7
0198170	F017192	Turner Lake	37	acft	45.6
0201940	C054730	Wace Creek	0.12	acft	0.1
0206255	F020380	Granfield Spring	10	acft	12.3
0206256	C118048	Manley Creek	20	acft	24.7
0206334	C022450	Cedar Chines Spring	5	acft	6.2
0214196	C056004	Shawnigan Creek	0.67	acft	0.8
0215420	C023888	Cedar Chines Spring	10	acft	12.3
0216223	C023745	Hook Creek	50	acft	61.7
0227967	F018815	Shearing Creek	20	acft	24.7
0234658	C026596	Hook Creek	85	acft	104.8
0234659	C026598	Hook Creek	70	acft	86.3
0235999	C026786	Hollings Creek	10	acft	12.3
0250001	C028612	Langford Lake	0.25	acft	0.3
0254694	F018482	Ordano Brook	3	acft	3.7
0259641	C029833	Lind Spring	10	acft	12.3
0261278	F018920	Shearing Creek	20	acft	24.7
0264397	F047412	Sylvan Brook	2.1	acft	2.6
0270002	F043006	Knight Brook	11	acft	13.6
0270481	C031765	Rose Spring	10	acft	12.3
0273114	C032802	North Taggart Creek	40	acft	49.3
0273972	C118049	Manley Creek	47	acft	58.0
0273975	F020402	Manley Creek	37	acft	45.6
0277837	C117674	Nisbet Springs	10.6	acft	13.1
0277851	F047767	Manley Creek	0.3	acft	0.4

0285327	C058370	Gravelle Slough	20	acft	24.7
0290122	C036620	Taggart Creek	50	acft	61.7
0290853	C036101	Kilmalu Creek	0.43	acft	0.5
0296856	C036633	Langford Lake	0.25	acft	0.3
0300672	C037406	Burt Brook	1	acft	1.2
0305640	F047414	Bamford Brook	0.4	acft	0.5
0310199	C040169	Wace Creek	0.25	acft	0.3
0310581	C040847	Shawnigan Lake	0.5	acft	0.6
0310878	C041107	Shearing Creek	50	acft	61.7
0317693	C043128	Shawnigan Lake	0.5	acft	0.6
0328591	C056141	Taggart Creek	1.45	acft	1.8
0329653	C047719	McGee Creek	10	acft	12.3
0329659	C046479	Hughes Spring	0.25	acft	0.3
0329660	C055114	Girtin Pond	1.5	acft	1.9
0340714	C053047	Manley Creek	0.6	acft	0.7
0340741	C052278	Nott Creek	0.25	acft	0.3
0340764	C052936	Manley Creek	0.4	acft	0.5
0364176	C108757	Ericson Creek	5	acft	6.2
0365381	C058761	Handysen Creek	5	acft	6.2
0367552	C054731	Wace Creek	0.12	acft	0.1
0367553	C054732	Wace Creek	0.12	acft	0.1
0367554	C054733	Wace Creek	0.12	acft	0.1
0367555	C054734	Wace Creek	0.12	acft	0.1
0369101	C059296	Singh Spring	1.25	acft	1.5
1000276	C117675	Nisbet Springs	1.4	acft	1.7
1000326	C112965	Waterfront Spring	0.5	acft	0.6
1000342	C116444	Shawnigan Creek	2	acft	2.5
1000391	C061425	Bamber Creek	20	acft	24.7
1000675	C065714	Wheelbarrow Creek	0.5	acft	0.6
1000723	C065762	Gauvin Brook	0.5	acft	0.6
1001396	C101655	Stevenson Brook	12	acft	14.8
1002059	C114281	Avery Brook	20	acft	24.7
1002104	C114994	Law Spring	1.3	acft	1.6
		Total =	**775.9**	**acft**	**957**

Land Improvement Purpose					Number of Licences = 18
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
100227	C117634	Adams and Osborn Creek	47.9	acft	59.1
1001661	C106189	Aspen Brook	20	acft	24.7
1001890	C110404	Brayshaw Creek	1.3	acft	1.6
0290393	C037600	Burt Brook	0	total flow	0.0
0309228	C039526	Filleul Brook	0.25	acft	0.3
1002280	C117635	Foote Creek	1.3	acft	1.6
0322791	C043382	Friker Creek	0	total flow	0.0
1000723	C116488	Gauvin Brook	0.5	acft	0.6
1001980	C112238	Goodhope Creek	7	acft	8.6
0273289	C114976	Langford Creek	0.75	ft^3/sec	670
0305467	C041344	Lionel Creek	500	gpd	0.8
0273025	C033373	Lionel Ponds	3000	gpd	5.0
0316104	C041149	Merilees Lake	12000	gpd	19.9
0329037	C120042	Parkdale Creek	2.03	acft	2.5
1001856	C109875	Service Creek	0.9	acft	1.1
1000870	C065794	Shawnigan Creek	0.2	acft	0.2
1002075	C114550	Silver Mines and ZZ Lakes	10	acft	12.3
1001833	C109504	Timothy Brook	0.9	acft	1.1
		Total =	**15,500**	**gpd**	
		+	**92.28**	**acft**	
		+	**0.75**	**ft^3/sec**	**810**

Residential Power Purpose					Number of Licences = 2
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0126618	F011025	Arbutus Creek	0.25	ft^3/sec	223.4
0367092	C056801	North Squally Creek	1.00	ft^3/sec	893.6
		Total =	**1.25**	**ft^3/sec**	**1,117**

Storage Purpose			Number of Licences = 26		
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0099889	F011022	Spectacle Creek	450	acft	555
0227967	F018816	Shearing Creek	20	acft	25
0234658	C026597	Hook Creek	20	acft	25
0234659	C026599	Hook Creek	20	acft	25
0235999	C026787	Hollings Creek	10	acft	12
0246700	C117976	Shawnigan Creek	592	acft	730
0261278	F018921	Shearing Creek	20	acft	25
0273114	C032803	North Taggart Creek	40	acft	49
0273973	C118051	Manley Creek	30	acft	37
0273975	F020403	Manley Creek	13	acft	16
0277837	C117674	Nisbet Springs	10.6	acft	13
0277868	C034308	Spectacle Creek	165	acft	204
0281721	F021631	Goldstream River	13,600	acft	16,776
0290122	C036621	Taggart Creek	30	acft	37
0329666	C046714	Hancock Spring	1	acft	1
0342400	C052935	Hook Creek	5	acft	6
0364176	C108757	Ericson Creek	5	acft	6
0365381	C058762	Handysen Creek	5	acft	6
1000276	C117675	Nisbet Springs	1.4	acft	2
1000391	C061426	Bamber Creek	23.3	acft	29
1001396	C101655	Stevenson Brook	12	acft	15
1001641	C106569	Shawnigan Lake	1032	acft	1,273
1002059	C114281	Avery Brook	20	acft	25
1002104	C114994	Law Spring	1.3	acft	2
1002145	C116151	Shawnigan Lake	696	acft	859
1002424	C120414	Shawnigan Lake	16.5	acft	20
		Total =	**16,839**	**acft**	**20,771**

Waterworks Purpose					Number of Licences = 24
FILE NUMBER	LICENCE NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
0112410	F017565	Wheelbarrow Springs	1,000	gpd	0.8
0116023	F018814	Wheelbarrow Springs	50,000	gpd	41.5
0141535	F015036	Shawnigan Lake	10,000	gpd	8.3
0232966	F017566	Wheelbarrow Springs	1,000	gpd	0.8
0233314	C026400	Squally Creek	4,000	gpd	3.3
0239899	C027301	Spectacle Creek/Oliphant Lake	30,000	gpd	24.9
0244265	C028078	Shawnigan Lake	25,000	gpd	20.7
0246700	C027947	Shawnigan Creek	250,000	gpd	207.4
0277648	F020604	Johns Creek	2,500	gpd	2.1
0277686	C040373	Shawnigan Lake	37,000	gpd	30.7
0277686	C064057	Shawnigan Lake	15,000	gpd	12.4
0281721	F021630	Goldstream River	3,500,000,000	gal/year	15,908
0285684	C034841	Malahat Creek	20,000	gpd	16.6
0290766	C041661	Shawnigan Lake	32,500	gpd	27.0
0310193	C042494	Shawnigan Lake	11,000	gpd	9.1
0322392	C046042	Shawnigan Lake	26,000	gpd	21.6
0328239	C045744	Shawnigan Lake	35,000	gpd	29.0
0330867	C051620	Shawnigan Lake	11,500	gpd	9.5
0342823	C053345	Shawnigan Lake	22,750	gpd	18.9
0365013	C057106	Shawnigan Lake	4,500	gpd	3.7
0365382	C057107	Shawnigan Lake	126,000	gpd	104.5
1000744	C072271	Wheelbarrow Springs	18,500,000	gal/year	84.1
1001641	C106569	Shawnigan Lake	31,210,000	gal/year	141.9
1002145	C116151	Shawnigan Lake	36,500,000	gal/year	165.9
		Total =	**714,750**	**gpd**	
		+	**3,586,210,000**	**gal/year**	**16,585**
				Total Licenced Annual Demand	**42,092**

Waterworks and Domestic annual water demand was estimated assuming that the licensed maximum daily demand is divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand.

Water Use Purpose	Number of Licences	Annual Demand	Percent of Total
Total for all Waterworks Purposes	24	16,585	39%
Total for all Domestic Purposes	307	165	0.4%
Industrial Purpose by use:			
Industrial Purpose (Enterprise)	5	58	0.1%
Industrial Purpose (Fire Protection)	4	23	0.1%
Industrial Purpose (Institutions)	2	101	0.2%
Industrial Purpose (Ponds)	1	3	0.0%
Industrial Purpose (Residential Lawn/Garden)	1	0	0.0%
Industrial Purpose (Processing)	3	988	2.4%
Industrial Purpose (Stockwatering)	2	4	0.0%
Total for all Irrigation Purposes	66	957	2.3%
Total for all Land Improvement Purposes	18	810	1.9%
Total for all Residential Power Purposes	2	1,117	2.7%
Total for all Conservation Purposes	2	508	1.2%
Total for all Storage Purposes	26	20,771	49%
Total for All Water Licences	463	42,092	100%

APPENDIX D

Low Flow Licenced Water Demand by Drainage Area

Low Flow Licenced Maximum Consumptive Water Demand Within Significant Drainage Areas

DRAINAGE AREA	PURPOSE	LICENCED QUANTITY/UNITS		LOW FLOW LICENCED MAXIMUM CONSUMPTIVE WATER DEMAND	
				MAXIMUM DAY (litres/second)	90 DAY VOLUME (dam^3)
Garnett Creek	Domestic	3,000	gpd	0.2	1.2
	Irrigation	104	acft	16.5	128.5
	Storage	52	acft	-8.2	-64.1
			Total Consumption	**5.19**	**40.3**
Manley Creek	Domestic	500	gpd	0.0	0.2
	Irrigation	142.3	acft	22.6	175.5
	Storage	43	acft	-6.8	-53.0
			Total Consumption	**15.8**	**122.7**
Shawnigan Creek	Domestic	114,500	gpd	6.0	46.8
	Industrial	107,000	gpd	5.6	43.8
	Irrigation	175.49	acft	27.8	216.5
	Land Improvement	10.15	acft	**non-consumptive**	
	Waterworks	606,250	gpd	31.9	248.0
		67,710,000	gal/year	19.5	151.8
	Conservation	0.5	cfs	**non-consumptive**	
	Storage	2,448	acft	-388.2	-3019.-
			Total Consumption	**-297**	**-2312.1**
Johns Creek	Domestic	2,500	gpd	0.1	1.0
	Waterworks	2,500	gpd	0.1	1.0
			Total Consumption	**0.26**	**2.05**
Spectacle Creek	Industrial	595,000	gpd	31.3	243.4
	Waterworks	30,000	gpd	1.6	12.3
	Storage	615	acft	-97.6	-758.6
			Total Consumption	**-64.7**	**-503**
Bamber Creek	Conservation	50	acft	**non-consumptive**	
	Domestic	3000	gpd	0.2	1.2
	Industrial	200	gpd	0.0	0.1
	Irrigation	20	acft	3.2	24.7
	Storage	23.3	acft	-3.7	-28.7
			Total Consumption	**-0.36**	**-2.8**

Low Flow Licenced Maximum Consumptive Water Demand Within Significant Drainage Areas (continued)

DRAINAGE AREA	PURPOSE	LICENCED QUANTITY/UNITS		LOW FLOW LICENCED MAXIMUM CONSUMPTIVE WATER DEMAND	
				MAXIMUM DAY (litres/second)	90 DAY VOLUME (dam^3)
Irving Creek	Domestic	3000	gpd	0.2	1.2
			Total Consumption	**0.16**	**1.2**
Arbutus Creek	Domestic	6000	gpd	0.3	2.5
	Residential Power	0.25	cfs	**non-consumptive**	
			Total Consumption	**0.32**	**2.5**
Goldstream River	Land Improvement	1.30	acft	**non-consumptive**	
	Waterworks	3,500,000,000	gpy	1008.9	7845.3
	Storage	13,600	acft	-2157.3	-16775.5
			Total Consumption	**-1148**	**-8930**
Other Areas	Domestic	66,983	gpd	3.5	27.4
	Industrial	1,000	gpd	0.1	0.4
		8.11	acft	1.3	10.0
	Irrigation	333.89	acft	53.0	411.9
	Land Improvement	80.10	acft	**non-consumptive**	
	Residential Power	1	cfs	**non-consumptive**	
	Waterworks	76,000	gpd	4.0	31.1
		18,500,000	gpy	5.3	41.5
	Storage	57	acft	-9.0	-70.1
			Total Consumption	**57.9**	**450.3**
			Total Consumption All Watersheds	**-1,428**	**-11,104**

The low flow licenced maximum day water demand for waterworks, domestic and industrial purpose was the maximum day specified in the licence. For irrigation and storage the low flow licenced maximum day water demand was assumed to be used over a 90 day period.
The low flow licenced maximum 90 day volume water demand for waterworks, domestic and industrial purpose was the maximum day specified in the licence multiplied by the 90 day period. For irrigation and storage the low flow licenced maximum 90 day volume water demand was assumed to be used over a 90 day period
Licenced storage water demand is assumed to be water captured during the high flow period for release during the low flow period. Therefore licenced storage water demand is a negative water demand (or an additional water supply) during the low flow period.
Conservation, land improvement and residential power purpose water licences are assumed to be non-consumptive water demands.

APPENDIX E

Pending Water Licence Applications

Existing Application for a Water Licence Demand

Domestic Purpose					Number of Applications = 1
FILE NUMBER	APPLICATION NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
1002488	Z121315	Shawnigan Lake	2,000	gpd	2.1
		Total =	**2,000**	**gpd**	**2.1**

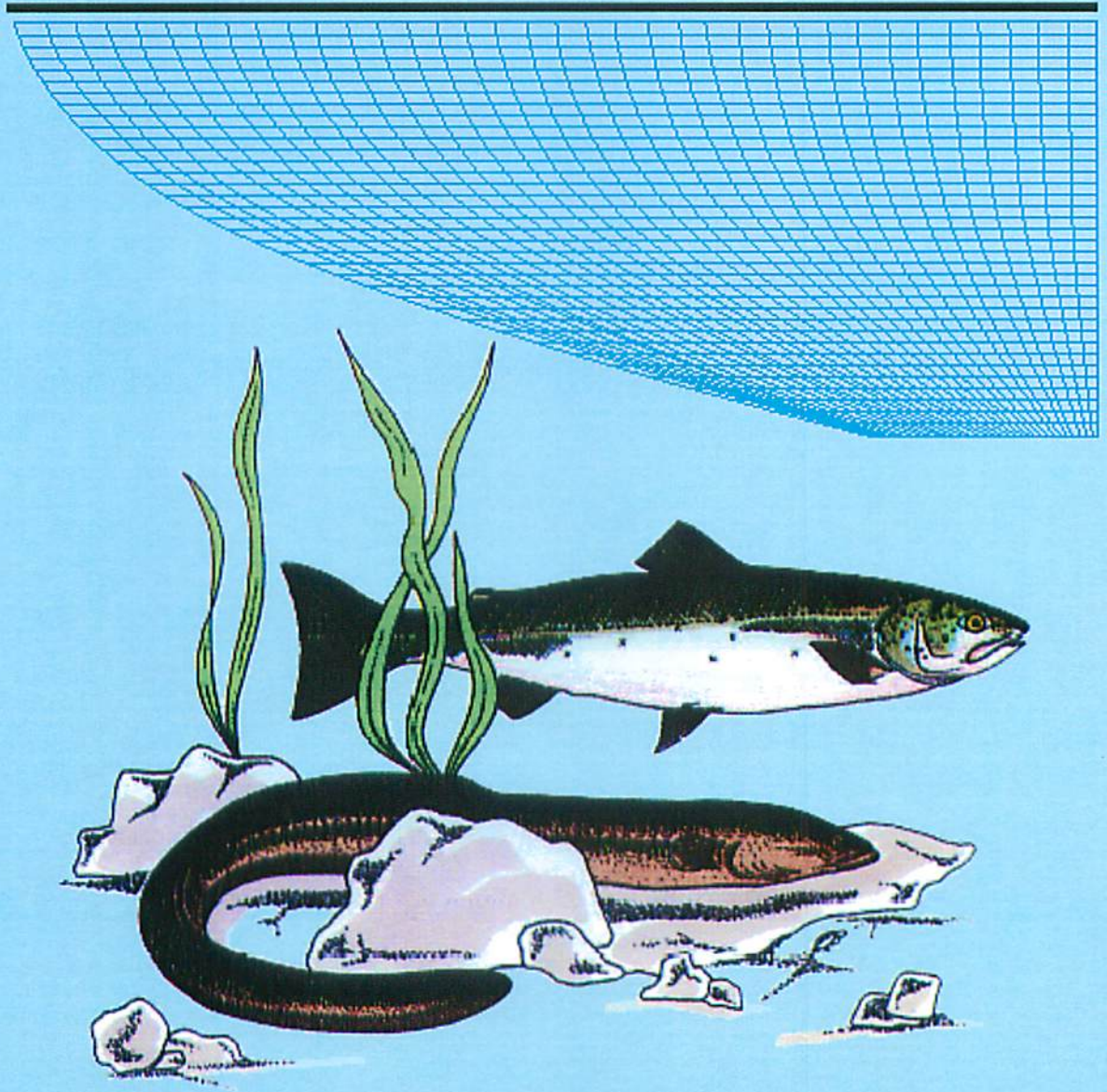
Land Improvement Purpose					Number of Applications = 1
FILE NUMBER	APPLICATION NUMBER	SOURCE	QUANTITY/UNITS		DEMAND (dam^3/year)
1002425	Z120469	Oasis Brook	162	acft	200
		Total =	**162**	**acft**	**200**

APPENDIX F

Fish Screen Requirements

Department of Fisheries and Oceans

Freshwater Intake End-of-Pipe Fish Screen Guideline



Fisheries and Oceans Pêches et Océans

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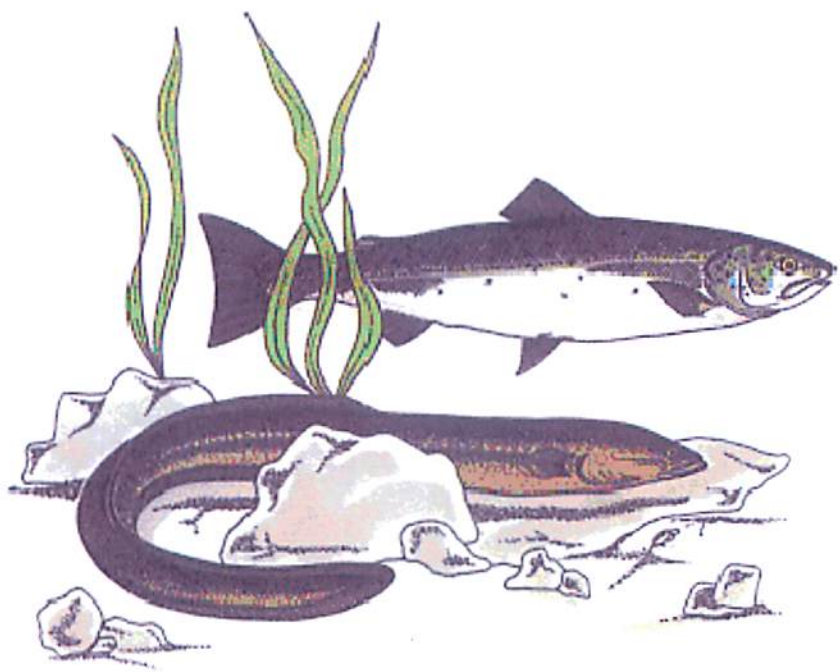
Department of Fisheries and Oceans

Freshwater Intake End-of-Pipe Fish Screen Guideline



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1.0 Introduction

The Department of Fisheries and Oceans (DFO) has prepared the **Freshwater Intake End-of-Pipe Fish Screen Guideline** to assist proponents in the design and installation of fish screens for the protection of anadromous and resident fish where freshwater is extracted from fish-bearing waters. This guideline will also assist regulatory agencies in the review of fish screen proposals.

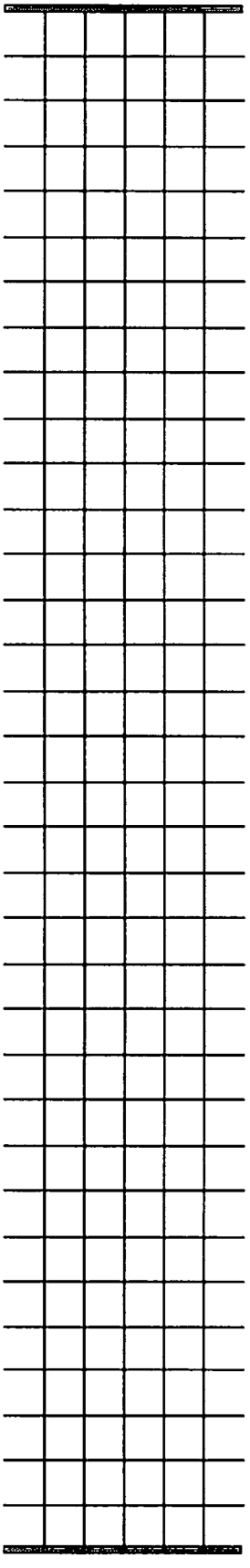
A requirement for fish screening is stated under Section 30 of the *Fisheries Act*, where every water intake, ditch, channel, or canal in Canada constructed or adapted for conducting water from any Canadian fisheries waters must provide for a fish guard or a screen, covering, or netting over the entrance or intake so as to prevent the passage of fish into such water intake, ditch, channel or canal. Other sections of the *Fisheries Act*, or other Federal, Provincial, or Municipal Legislation and Policy may also apply to associated water extraction activities. Proponents are advised to contact the appropriate regulatory agencies regarding approvals or permits.

2.0 Guideline Objective

The objective of the guideline is to provide a National standard-of-practice and guidance for end-of-pipe fish screens at freshwater intakes to prevent potential losses of fish due to entrainment or impingement. Entrainment occurs when a fish is drawn into a water intake and cannot escape. Impingement occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself. The severity of the impact on the fisheries resource and habitat depends on the abundance, distribution, size, swimming ability, and behaviour of the organisms in the vicinity of the intake, as well as, water velocity, flow and depth, intake design, screen mesh size, installation and construction procedures and other physical factors.

The **Freshwater Intake End-of-Pipe Fish Screen Guideline** deals exclusively with the sizing and design of fixed screens that are often placed at the end of a pipe used to extract water up to 0.125 m³/s, or 125 litres per second (L/s) (i.e., 2000 US gallons per minute (US gpm)). The guideline is intended for use in addressing fish screens for small permanent and temporary withdrawals for irrigation, construction, small municipal and

private water supplies, etc. It is *not* intended for application to hydroelectric or canal screen designs; however, such proposals can be considered by regulatory agencies on a site-specific basis. The guideline focuses on the technical aspects of intake screens and the protection of fish rather than on policy, legislation, or environmental assessment processes and their application. This guideline has been developed to provide protection of freshwater fish with a minimum fork length of 25 mm (approximately 1 inch) since most eggs and fish larvae remain in bottom substrates until they reach the fry stage (i.e., 25 mm fork length). Other designs, in addition to intake screens, may be appropiate to address fish and fish habitat protection associated with water withdrawals. Such proposed designs should be addressed with the appropriate regulatory agencies on a site-specific basis.



3.0 Information Requirements for Evaluation of Intake Screens

Information that should be provided to facilitate evaluation of an end-of-pipe intake screen design intended for fish protection during a freshwater withdrawal is highlighted below. Types of information requirements that may also be applicable to the water intake project as a whole are identified in Appendix A.

- fish presence, species, and possible fish size or fish habitat conditions at the project site
- rate or ranges of rates of withdrawal from the watercourse
- screen open and effective areas
- physical screen open parameters with respect to the intake and the watercourse
- screen material, method of installation and supporting structures
- screen maintenance, cleaning, or other special requirements

4.0 Design, Installation, & Maintenance of Freshwater Intake End-of-Pipe Fish Sereens

The appropriate design of a fish screen is largely dependent upon the species and the size of fish requiring protection. Appropriate installation and maintenance/cleaning of the screen are also important in keeping approach velocities low and ensuring satisfactory operation of the screen. For the purposes of this guideline, emphasis is placed on the protection of freshwater fish with a minimum fork length of 25 mm from entrainment and impingement due to water extraction activities. Depending upon site-specific circumstances, a case may be made whereby the minimum fork length size of fish to be protected is greater than 25 mm. In this instance, the fish screen criteria for open screen area (Table 2 and Figure 1) and screen mesh size (2.54 mm) presented here do not apply. Fish screen criteria and guidance for the protection of fish larger than 25 mm is provided by Katopodis (1992).

The following sections address the appropriate design of fixed freshwater intake end-of-pipe fish screens for the protection of fish with a minimum fork length of 25 mm. Guidance on

installation, cleaning, and maintenance is provided. Common types of intake screens and associated intakes are also presented. Appendix B presents a sample calculation utilizing the guideline to determine the appropriate end-of-pipe intake screen size for the protection of freshwater fish.

4. 1 Fish Screen Criteria

To protect fish from impingement or entrainment, the approach velocity (i.e., the water velocity into, or perpendicular to, the face of an intake screen) should not exceed certain values based on the swimming mode (i.e., subcarangiform or anguilliform) of the fish present in the watercourse. The subcarangiform group includes fish that swim like a trout or salmon, and move through the water by undulating the posterior third to half of their bodies. The anguilliform group includes fish that swim like an eel, and move through the water by undulating most or all of their body. Table 1 presents the swimming modes of most common fish species in Canada. Contact DFO or provincial fisheries agencies regarding fish species that are not included in Table 1.

Envelope curves for approach velocities were developed for each swimming mode corresponding to a minimum fork length of 25 mm and a maximum endurance time of 10 minutes (the time the fish is in front of the face of the screen before it can elude it). To satisfy approach velocities of approximately 0.11 m/s and 0.038 m/s for the subcarangiform and anguilliform groups respectively, curves indicating the required open screen areas, based on fish swimming performance data, including fish species and size (Katopodis, 1990) and related to flows/extractions, were developed. Table 2 presents the required open screen area, in both metric and non-metric units, for end-of-pipe intake screens with a capacity up to 125 L/s (2000 US gpm). The open screen area is the area of all open spaces on the screen available for the free flow of water. The same information is presented graphically in Figure 1.

Table 1
Summary of Common Fish Species and Swimming Modes

SUBCARANGIFORM SWIMMING MODE

Common Name	Scientific Name
Alewife (Gaspereau)	*Alosa pseudoharengus*
Arctic Char	*Salvelinus alpinus*
Arctic Grayling	*Thymallus arcticus*
Atlantic Salmon	*Salmo salar*
Broad Whitefish	*Coregonus nasus*
Brook Trout	*Salvelinus fontinalis*
Brown Trout	*Salmo trutta*
Carp	*Cyprinus carpio*
Channel Catfish	*Ictalurus punctatus*
Chinook Salmon	*Oncorhynchus tshawytscha*
Chum Salmon	*Oncorhynchus keta*
Cisco	*Coregonus artedii*
Coho Salmon	*Oncorhynchus kisutch*
Cutthroat Trout	*Oncorhynchus clarki clarki*
Dolly Varden	*Salvelinus malma*
Goldeye	*Hiodon alosoides*
Green Sturgeon	*Acipenser medirostris*
Inconnu	*Stenodus leucichthys*
Kokanee	*Oncorhynchus nerka*
Lake Sturgeon	*Acipenser fulvescens*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Largemouth Bass	*Micropterus salmoides*
Longnose Sucker	*Catostomus catostomus*
Mooneye	*Hiodon tergisus*
Mountain Whitefish	*Prosopium williamsoni*
Ouananiche	*Salmo salar ouananiche*
Pink Salmon	*Oncorhynchus gorbuscha*
Rainbow Smelt	*Osmerus mordax*
Rainbow Trout	*Oncorhynchus mykiss*
Sauger	*Stizostedion canadense*
Smallmouth Bass	*Micropterus dolomieui*
Sockeye Salmon	*Oncorhynchus nerka*
Walleye	*Stizostedio vitreum*
White Bass	*Morone chrysops*
White Perch	*Morone americana*
White Sturgeon	*Acipenser transmontanus*
White Sucker	*Catostomus commersoni*
Yellow Perch	*Perca flavescens*

ANGUILLIFORM SWIMMING MODE

Common Name	Scientific Name
American Eel	*Anguilla rostrata*
Burbot	*Lota lota*
Sea Lamprey	*Petromyzon marinus*

Note: The few data points available for Northern Pike ***(Esox lucius)*** are close to the anguilliform group.

4.2 Design of Fixed End-of-Pipe Fish Screens

Once the required open area has been found from Table 2 or Figure 1, the effective screen area must be calculated. It is the area occupied by the open spaces (i.e., open screen area) and the screen material available for the free flow of water. The effective screen area should be provided at the intake location and is determined as follows:

$$\text{Effective Screen Area } (m^2 \text{ or } ft^2) = \frac{\text{Open Screen Area (Table 2)}}{\left(\frac{\text{\% Open Area (Table 3)}}{100}\right)}$$

It should be noted that if the percent (%) open screen area is maximized, then the effective screen area required for a given flow is minimized. The narrowest dimension of any opening on the screen is referred to as the design opening, regardless of opening shape. The maximum design opening for a fish of 25 mm fork length is estimated at 2.54 mm (0.10 inches). Guidance on screen openings and materials is presented below.

- The screen openings may be round, square, rectangular, or any combination thereof, but should not have any protrusions that could injure fish.
- Screen materials may include brass, bronze, aluminum, monel metal, galvanized or stainless steel, and plastics. The screen material should be resistant to corrosion and UV light.
- Note: clogging due to corrosion is minimized with the use of stainless steel.
- Welded wedge wire screens offer reduced debris clogging and increased open area and screen stiffness, in comparison to round wire mesh and punch plate.

Table 3 presents several common types of screening material that meet the requirements of wire diameter, clear opening width and percent open area,

The dimensions of the fish screen can be calculated after the correct shape, configuration, location, and method of installation have been determined. This will usually be determined after a site investigation and a review of these guidelines. Included in Figure 2 are common screen shapes and the associated

Table 2
Open Screen Area Required for End-of-Pipe Water Intakes

Metric Units			Non-Metric Units		
Flow (L/s)	Subcarangiform (m^2)	Anguilliform (m^2)	Flow (US gpm)	Subcarangiform (ft^2)	Anguilliform (ft^2)
1	0.01	0.03	10	0.1	0.2
5	0.05	0.13	50	0.3	0.9
6	0.06	0.16	100	0.6	1.8
8	0.07	0.21	150	0.9	2.7
10	0.09	0.26	200	1.3	3.6
12	0.11	0.31	250	1.6	4.5
14	0.13	0.37	300	1.9	5.4
15	0.14	0.39	350	2.2	6.2
16	0.15	0.42	400	2.5	7.1
18	0.17	0.47	450	2.8	8.0
20	0.18	0.52	500	3.2	8.9
22	0.20	0.58	550	3.5	9.8
24	0.22	0.63	600	3.8	10.7
25	0.23	0.65	650	4.1	11.6
26	0.24	0.68	700	4.4	12.5
28	0.26	0.73	750	4.7	13.4
30	0.28	0.79	800	5.0	14.3
32	0.30	0.84	850	5.4	15.2
34	0.31	0.89	900	5.7	16.0
35	0.32	0.92	950	6.0	16.9
36	0.33	0.94	1000	6.3	17.8
38	0.35	0.99	1050	6.6	18.7
40	0.37	1.05	1100	6.9	19.6
45	0.42	1.18	1150	7.2	20.5
50	0.46	1.31	1200	7.6	21.4
55	0.51	1.44	1250	7.9	22.3
60	0.55	1.57	1300	8.2	23.2
65	0.60	1.70	1350	8.5	24.1
70	0.65	1.83	1400	8.8	25.0
75	0.69	1.96	1450	9.1	25.8
80	0.74	2.09	1500	9.4	26.7
85	0.78	2.23	1550	9.8	27.6
90	0.83	2.36	1600	10.1	28.5
95	0.88	2.49	1650	10.4	29.4
100	0.92	2.62	1700	10.7	30.3
110	1.02	2.88	1750	11.0	31.2
120	1.11	3.14	1800	11.3	32.1
125	1.16	3.30	1850	11.6	33.0
			1900	12.0	33.9
			1950	12.3	34.8
			2000	12.6	35.7

Table 3
Examples of Sereen Material

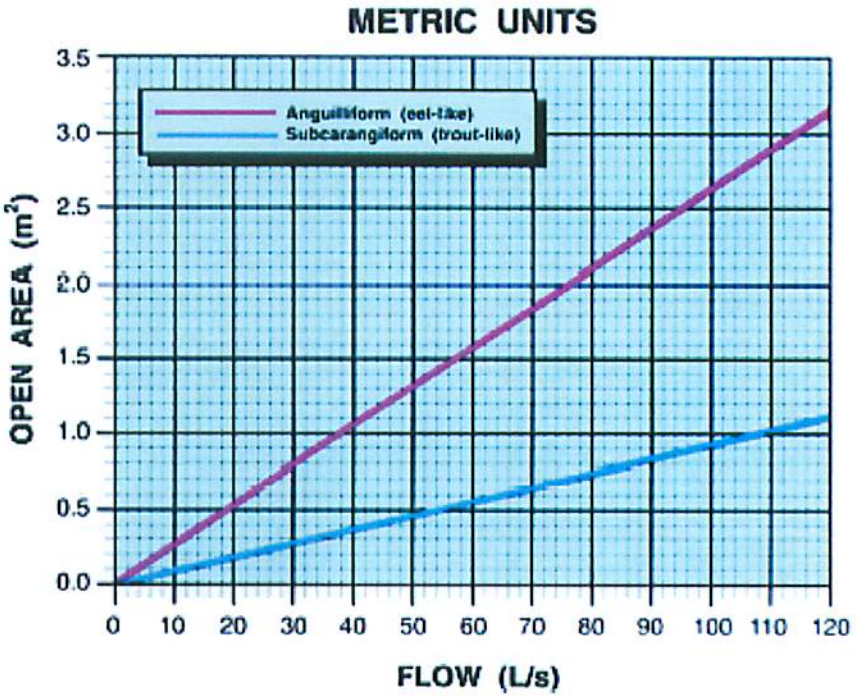
Material	Wire Thickness	Opening Width	% Open Area
8x8 Stainless Steel Alloy Mesh	0.711 mm (0.028")	2.44 mm (0.096")	60
#7 Mesh Wire Cloth	1.025mm (0.041")	2.54 mm (0.100")	51
#8 Mesh Wire Cloth	0.875 mm (0.035")	2.25 mm (0.089")	52
#8 Mesh Wire Cloth	0.700mm (0.028")	2.54 mm (0.100")	62
#60 Wedge Wire Screen	1.50mm (0.059")	2.54 mm (0.100")	63
#45Wedge Wire Screen	1.10mm (0.080")	2.54 mm (0.100")	69

dimensions and area formulae. These are just examples of the many shapes and sizes in which fish screens can be fabricated. Screens are instream structures and, as such, should have sufficient strength and durability, and be capable of withstanding any potential large forces and impacts. Figure 3, 4, and 5 illustrate some of the various configurations, applications, and screen material types of end-of-pipe fish screens.

4.3 Installation

- Screens should be located in areas and depths of water with low concentrations of fish throughout the year.
- Screens should be located away from natural or man-made structures that may attract fish that are migrating, spawning, or in rearing habitat.
- The screen face should be oriented in the same direction as the flow.
- Ensure openings in the guides and seals are less than the opening criteria to make "fish tight".
- Screens should be located a minimum of 300 mm (12 in.) above the bottom of the watercourse to prevent entrainment of sediment and aquatic organisms associated with the bottom area.
- Structural support should be provided to the screen panels to prevent sagging and collapse of the screen.
- Large cylindrical and box-type screens should have a manifold installed in them to ensure even water velocity distribution across the screen surface. The ends of the structure should be made out of solid materials and the end of the manifold capped.
- Heavier cages or trash racks can be fabricated out of bar or grating to protect the finer fish screen, especially where there is debris loading (woody material, leaves, algae mats, etc.). A 150 mm (6 in.) spacing between bars is typical.

Figure 1
Open Screen Area for End-of-Pipe Water Intake Flow



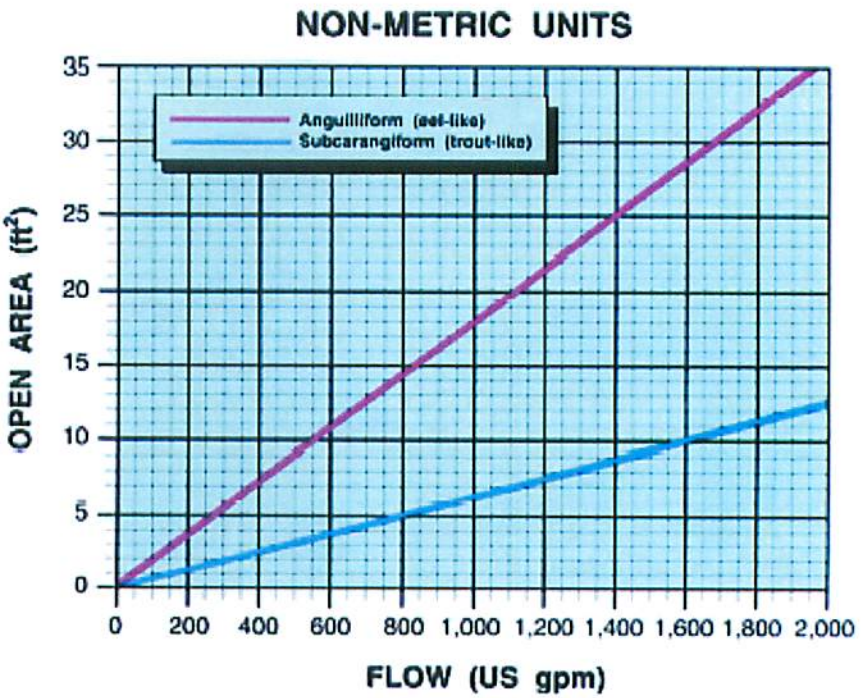
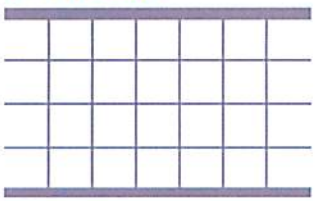
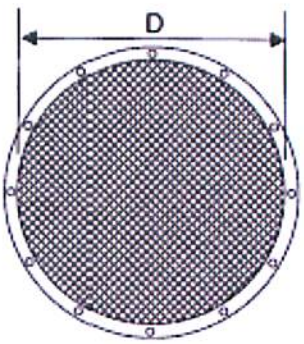


Figure 2
Common Screen Shapes and Area Formulae

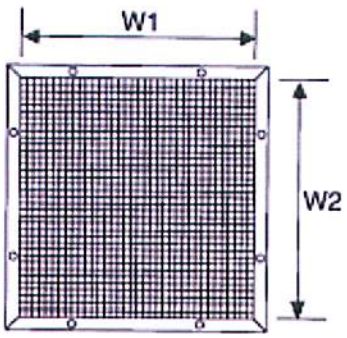


CIRCULAR SCREEN



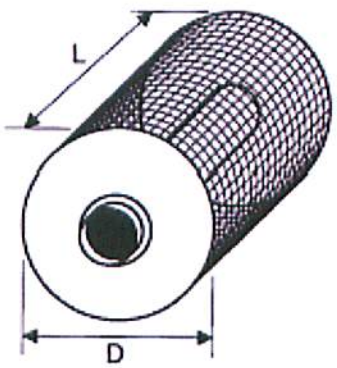
Area = $\frac{\pi}{4} D^2$

SQUARE SCREEN



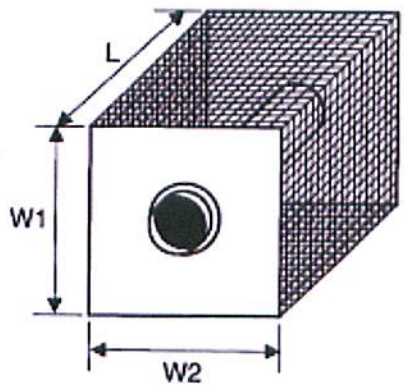
Area = W1 x W2

CYLINDRICAL SCREEN



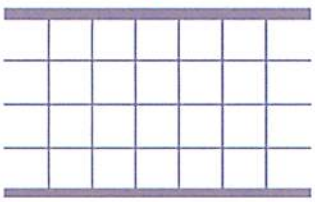
Area = πDL

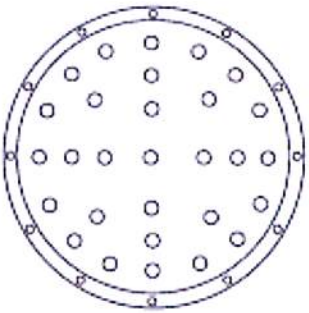
BOX SCREEN



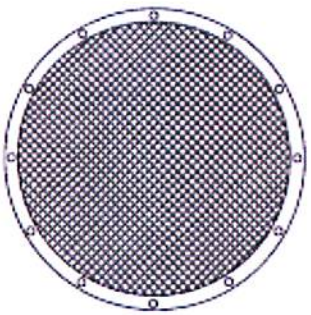
Area = 2L(W1 + W2)

Figure 3
Typical Applications and Features of End-of-Pipe Screens

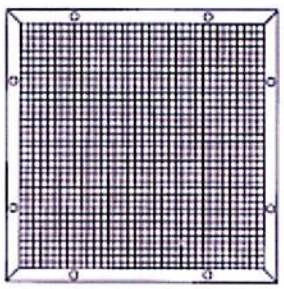




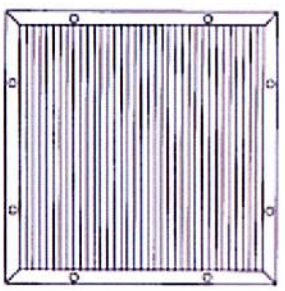
PERFORATED PLATE (PUNCHED)



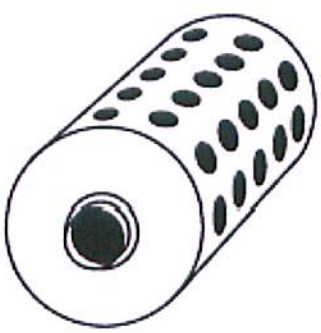
CIRCULAR MESH SCREEN



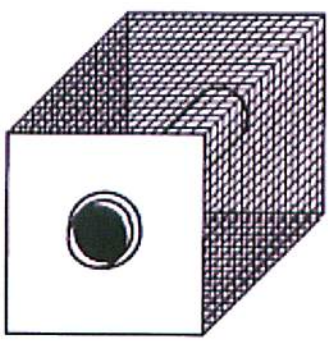
SQUARE MESH SCREEN



SQUARE WEDGE WIRE SCREEN

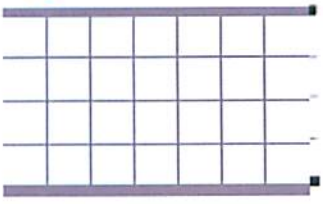


DRUM OR CYLINDER WITH PERFORATED PIPE

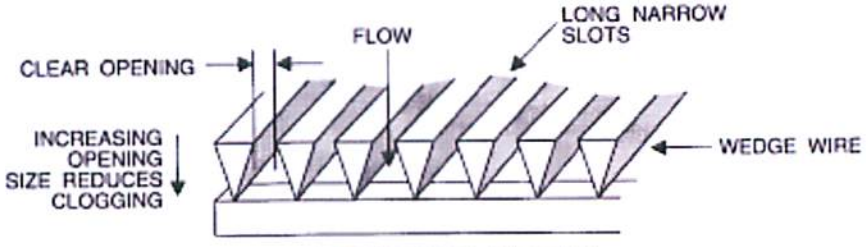


BOX-TYPE WITH MESH SCREEN

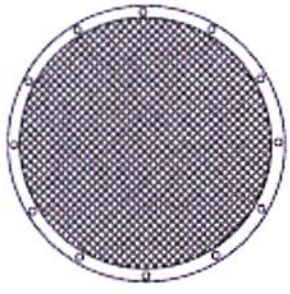
Figure 4
Examples of Typical Screen and Material Types



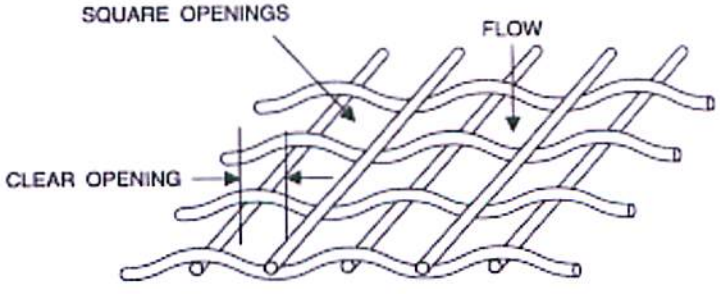
SQUARE WEDGE WIRE SCREEN



WEDGE WIRE PROFILE

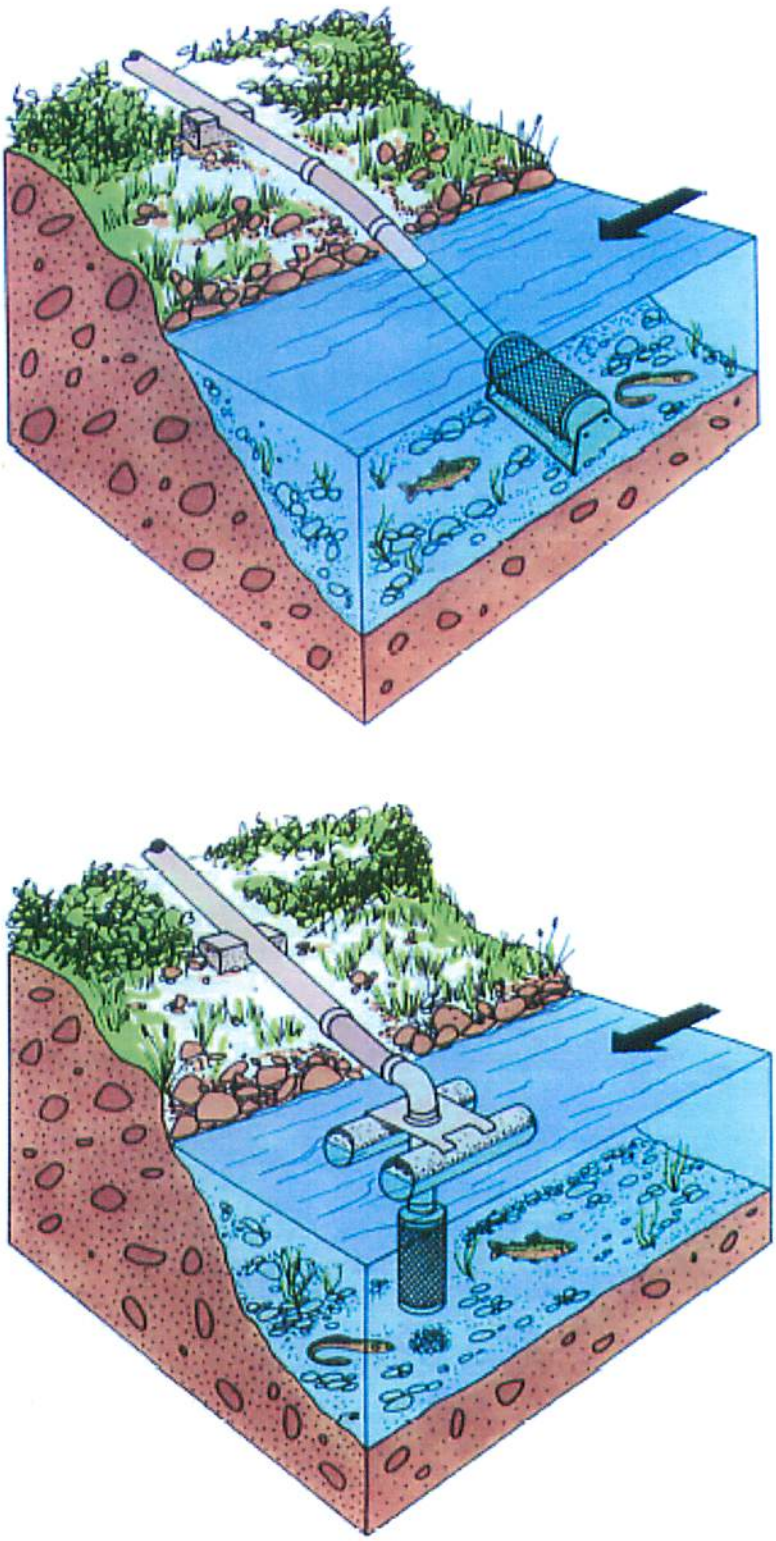


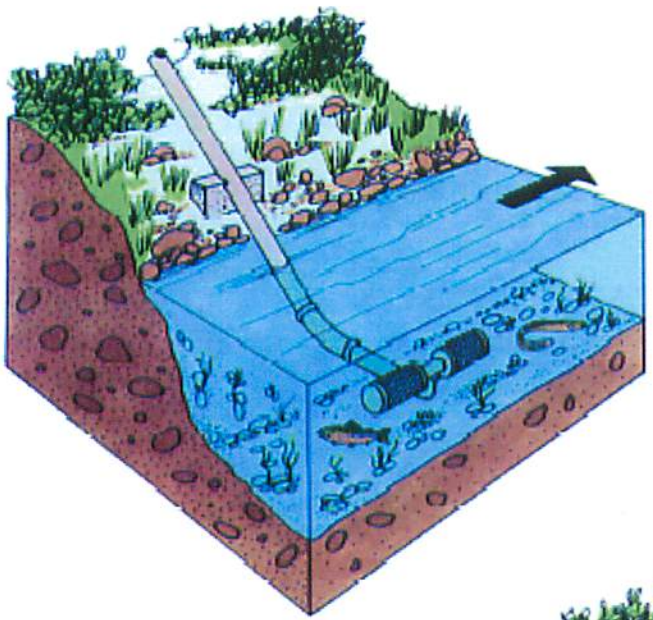
CIRCULAR MESH SCREEN

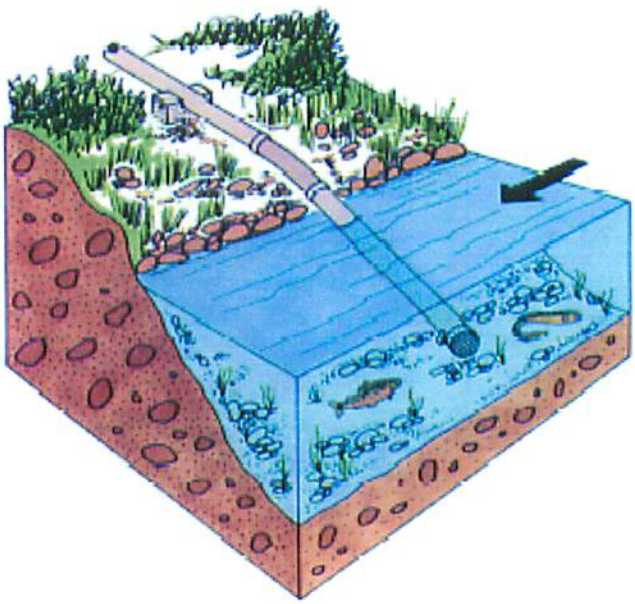


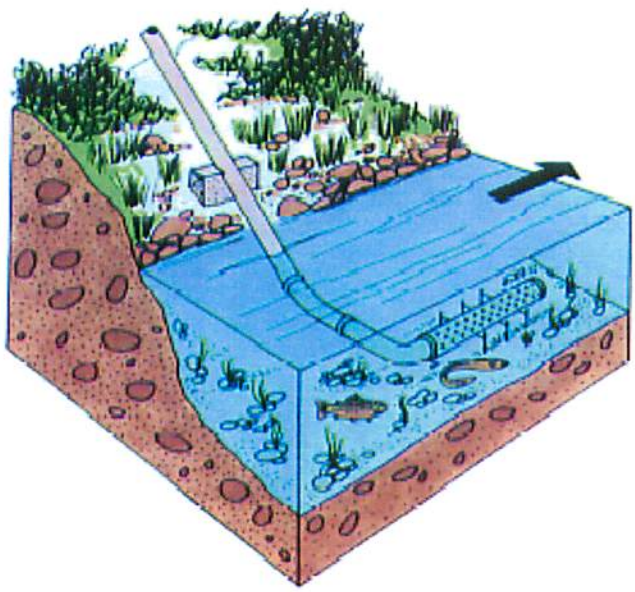
WOVEN WIRE MESH PROFILE

Figure 5
Examples of Typical Installations of End-of-Pipe Screen









4.4 Cleaning and Maintenance

- Provision should be made for the removal, inspection, and cleaning of screens.
- Ensure regular maintenance and repair of cleaning apparatus, seals, and screens is carried out to prevent debris-fouling and impingement of fish.
- Pumps should be shut down when fish screens are removed for inspection and cleaning.
- Screens may be cleaned by methods such as air or water, backwashing, removal and pressure washing or scrubbing.
- Under certain site-specific winter conditions, it may be appropriate to remove screens to prevent screen damage.
- Flexible suction pipe may be used instead of solid, fixed piping for ease of screen removal and cleaning.
- Pump suction pressure can be measured to assess the need for screen cleaning.

To facilitate intake screen cleaning/maintenance, design and installation features such as orientation of the screen (e.g., in a cove) or variation in mesh shape (i.e., square wire/bars versus round wire/bars), etc. may be considered for regularly cleaned screens. For screens that will not be cleaned regularly, provision of considerably more open screen area (e.g., four times more) than determined from Table 2/Figure 1 may be considered. Such design/installation features should be addressed with the appropriate regulatory agencies on a site-specific basis.

Appendix C presents a list of units of conversion.

For more information on the appropriate design of freshwater intake end-of-pipe fish screens, contact the nearest DFO office. In addition, a list of DFO Regional contacts is presented in Appendix D. Other appropriate regulatory agencies should also be contacted.

References

Fish Screening Directive. 1990. Department of Fisheries and Oceans, Ottawa, Ontario.

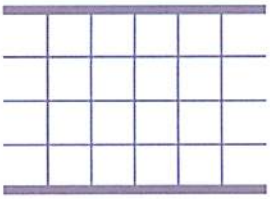
Katopodis, C. 1990. *Advancing the art of engineering fishways for upstream migrants.* Proceedings of International Symposium on Fishways '90, Oct. 8-10, 1990, Gifu, Japan, p. 19-28.

Katopodis, C. 1992. *Fish screening guide for water intakes.* Working Document, Freshwater Institute, Winnipeg, Manitoba.

Katopodis, C, 1994. *Analysis of ichthyomechanical data for fish passage or exclusion system design.* Proc. International Fish Physiology Symposium, July 16-21, 1994, Vancouver, B.C. American Fisheries Society and Fish Physiology Association.

Katopodis, C. and R. Gervais, 1991. *Icthyomechanics*, Working Document, Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, Manitoba.

Glossary



Anadromous: Fish species that migrate from the sea to freshwater systems in order to spawn.

Anguilliform: The type of swimming mode for fish that swim like an eel, and move through the water by undulating most or all of their body.

Effective Screen Area: The area occupied by the open spaces (i.e., open screen area) and screen material available for the free flow of water.

Entrainment: Occurs when a fish is drawn into a water intake and cannot escape.

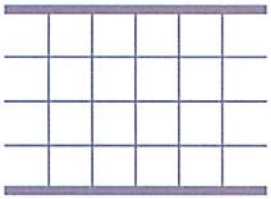
Fork Length: The straight line distance measured from the tip of the nose to the fork of the tail of a fish.

Impingement: Occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself.

Open Screen Area: The area of all open spaces on the screen available for the free flow of water.

Subcarangiform: The type of swimming mode for fish that swim like trout or salmon, and move through the water by undulating the posterior third to half of their body.

Appendix A Information Requirements



Appendix A Information Requirements

Types of information requirements that may be applicable to a freshwater intake proposal are highlighted below. While this listing is not intended to be all inclusive, it indicates information that may be necessary to enable regulatory agencies to review a water intake and fish screen proposal. The information highlighted below considers Section 30 and other sections of the *Fisheries Act* .These information requirements may also address other Federal, Provincial, and Municipal legislation and policies.

General and Site Information

- gazette or common name of the watercourse
- location of the watercourse
- type of watercourse (e.g., pond or stream)
- type of water intake
- other activities associated with the development or construction of the intake/screen structure

Biophysical Information

- fish presence, species, and possible fish size or fish habitat conditions at the protect site
- physical description of the watercourse at the intake site, including channel width and depth, direction and velocity of water currents, variations in wafer levels, sediment transport processes, lateral or channel grade movement, debris loading, etc.
- location and position of the intake within the watercourse, including dimensions, alignment, depth in the water column, wetted area, etc.
- description of the site features and characteristics, including site access

Water Use Information

- purpose of water withdrawal

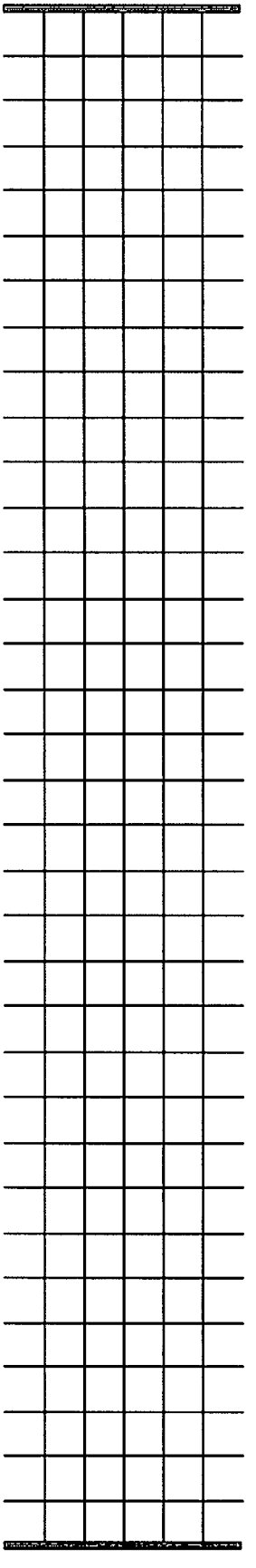
- average rate, or ranges of rates, of withdrawal from the watercourse
- duration and time of withdrawal
- estimates of ranges of flow (i.e., daily, weekly, monthly) in the watercourse during times of withdrawal with dates and times of year (with particular consideration to periods of low flow)
- expected effects of withdrawal on existing watercourse (e.g., drawdown, downstream dewatering, etc)
- description of structures or activities associated with the development of the intake
- whether the application is for a new intake, or re-development or upgrading of an existing structure

Other Information

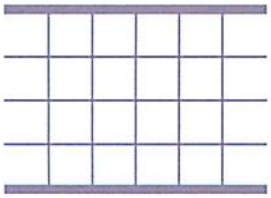
- site plans/sketches indicating intake site and location (detailed on 1:50,000 topographic map)
- photographs/video of the site are often useful

Fish Screen Information

- screen open and effective areas
- physical screen parameters with respect to the intake and the watercourse
- screen material, method of installation and supporting structures
- screen maintenance, cleaning or other special requirements



Appendix B
Sample Calculation



A proponent wishes to withdraw water at a rate of 0.075 m^3/s from a nearby pond. The pond supports populations of brown trout, brook trout, and American eel. The intake is proposed to be cylindrical with the ends solid and #60 wedge wire screen around the cylinder.

What size must the intake screen be to satisfy the guideline requirements?

There are 4 steps to finding the answer:

1. Determine the fish swimming mode.
2. Determine the open screen area.
3. Determine the effective screen area.
4. Determine the dimensions necessary to produce the effective screen area.

1. Fish Swimming Mode

The fish swimming mode is found from Table 1. Brook trout and brown trout are listed as subcarangiform swimmers, while the American eel is an anguilliform swimmer.

2. Open Screen Area

Table 2 lists the required open screen area for both subcarangiform and anguilliform swimmers under flows up to 125 L/s (2000 US gpm). To use the table, if is necessary first to convert the flow from cubic metres per second to litres per second.

$$0.075 \frac{m^3}{s} \times \frac{1000\ L}{1\ m^3} = 75 \frac{L}{s}$$

For a flow of 75 L/s, Table 2 indicates that the open screen area must be:

- 0.69 m^2 for subcarangiform swimmers, and
- 1.96 m^2 for anguilliform swimmers.

The higher number (1.96 m^2) is the more stringent requirement, therefore, it is used in the calculation of effective screen area,

3. Effective Screen Area

The screen material in this case is # 60 Wedge Wire. A review of Table 3 indicates that the % Open Area for this material is 63%. With this value and the previously determined area from Step 2, the following formula is used to determine the Effective Screen Area.

$$\text{Effective Screen Area} = \frac{\text{Open Screen Area}}{\left(\frac{\text{\% Open Area}}{100}\right)}$$

$$= \frac{1.96\ \text{m}^2}{\left(\frac{63}{100}\right)}$$

$$= 3.111\ \text{m}^2$$

4. Dimensions of Intake Screen

Figure 2 lists several common screen shapes and their respective area formulae. For a cylindrical screen where the ends are solid and screening is around the cylinder, the following formula applies:

$$\text{Area} = \pi DL$$

The unknown dimensions are diameter (D) and length (L). These dimensions are determined by choosing a value for one and solving the equation for the other.

If the diameter is 0.600 m, then the length follows as:

$$\text{Area} = \pi DL$$

$$3.111\ \text{m}^2 = (0.600\ \text{m})L$$

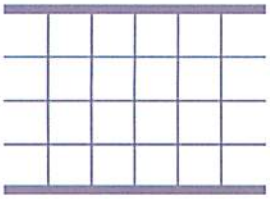
$$3.111\ \text{m}^2 = (1.885\ \text{m})L$$

$$L = \frac{3.111\ \text{m}^2}{1.885\ \text{m}}$$

$$L = 1.65\ \text{m}$$

A 0.600 m diameter, 1.65 m long cylindrical screen would meet the design requirements. It should be noted that the dimensions given are representative of the screening area only; they do not include any screen that may be blocked by framing, etc. By comparison, if the pond only supported trout (subcarangiform), a 0.600 m diameter, 0.58 m long cylindrical screen would meet the design requirements.

Appendix C
Units of Conversion



To Convert	Into	Multiply By
cubic feet per second	cubic metres per second	0.0283
cubic feet per second	litres per second	28.3
cubic feet per second	US gallons per minute	448.9
cubic metres per second	cubic feet per second	35.3
cubic metres per second	US gallons per minute	15850
litres per second	cubic feet per second	0.0353
litres per second	cubic feet per minute	2.12
litres per second	cubic metres per second	0.001
litres per second	US gallons per minute	15.85
square metre	square foot	10.76
square metre	square inch	1550
square foot	square metre	0.0929
US gallons per minute	litres per second	0.0631
US gallons per minute	cubic feet per second	0.00223
US gallons per minute	Imperial gallons per minute	0.833
Imperial gallons per minute	litres per second	0.0758

Appendix D
DFO Regional Contacts

NEWFOUNDLAND REGION	Habitat Management Division P.O. Box 5667 St. John's NF A1C 5X1 Tel: 709-772-6157 Fax: 709-772-5562
GULF REGION	Habitat Management Division P.O. Box 5030 Moncton NB E1C 9B6 Tel: 506-851-6252 Fax: 506-851-6579
SCOTIA-FUNDY REGION	Habitat Management Division P.O. Box 550 Halifax NS B3J 2S7 Tel: 902-426-6027 Fax: 902-426-1489
QUEBEC REGION	Fish Habitat Management P.O. Box 15550 Quebec QC G1K 7Y7 Tel: 418-648-4092 Fax: 418-648-7777
CENTRAL & ARCTIC REGION	Habitat Management 501 University Crescent Winnipeg MB R3T 2N6 Tel: 204-983-5181 Fax: 204-984-2404
PACIFIC REGION	Habitat Management 555 W. Hastings St. Vancouver BC V6B 5G3 Tel: 604-666-6566 Fax: 604-666-7907

Local DFO offices should be contacted. Other appropriate regulatory agencies should also be contacted.

References

1. Bryden, George and Larry Barr. Land and Water BC Inc. Ministry of Sustainable Resource Management. Province of British Columbia. Shawnigan Lake Community Water Supply. December 2002. 42 pages.

2. Rieberger, Kevin. Ministry of Water, Land and Air Protection. Province of British Columbia. Water Quality Assessments and Objectives For Shawnigan Lake 1976-2004. Draft. July 2005. 90 pages