PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT, LANDS, AND PARKS
VANCOUVER ISLAND REGION

GABRIOLA, VALDES, THETIS, AND KUPER ISLANDS

WATER ALLOCATION PLAN

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1.0 INTRODUCTION

The Water Management Program's goals are to sustain a healthy water resource through anticipating and planning for water uses. Water Allocation Plans are a means of identifying water demands and ensuring that water use is compatible with the goals of a sustainable environment. The many advantages of preparing an allocation plan include:

1. Providing the public with our position on water allocation in advance of water applications (pro-active management, information available to applicants and the public);

2. Reducing response time by having plans in place prior to receiving applications;

3. Eliminating individual studies and reports on each application;

4. Improving the consistency of our approach and decision making;

5. Replacing or reducing most Water Licence Application Reports by pre-defining specific allocation directions and decisions;

6. Being more comprehensive in the plan than in present reports;

7. And eliminating the need for many referrals.

The following regional policy was developed to provide 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 fisheries requirements, existing and potential licensable water demands in order to provide direction for further water licence allocations.

The Gabriola, Valdes, Thetis, and Kuper Islands Water Allocation Plan is one of a series of allocation plans under development. Completion of this plan will significantly expedite the adjudication of water licence applications.

Input may be sought from other agencies. Referrals go to Federal & Provincial Fisheries agencies and to Water Management in Victoria.

2.0 GENERAL WATERSHED INFORMATION

The Gabriola, Valdes, Thetis, and Kuper Islands Water Allocation Plan area (Figure 1) is located approximately 3 kilometres off the East coast of Vancouver Island adjacent to the City of Nanaimo and Town of Ladysmith. The area, approximately 105.5 km^2, encompasses the whole of Gabriola, Valdes, Thetis, and Kuper Islands and the surrounding minor islands. Ferry service links Nanaimo to Gabriola Island and Chemanius to Thetis and Kuper Islands, providing passenger and vehicle access.

Table 1 Gabriola, Valdes, Thetis and Kuper Islands Water Allocation Plan Area

Islands	Size (km^2)	% Area
Gabriola	52.3	49.6
Mudge	2.2	2.1
Link	0.2	0.2
De Courcy	1.8	1.7
Ruxton	1.0	0.9
Pylades	0.5	0.5
Breakwater	0.3	0.3
Valdes	24.3	23.0
Thetis	11.1	10.5
Kuper	9.3	8.9
Reid	1.0	0.9
Other Islands	1.5	1.4
TOTAL AREA	**105.5**	**100.0**

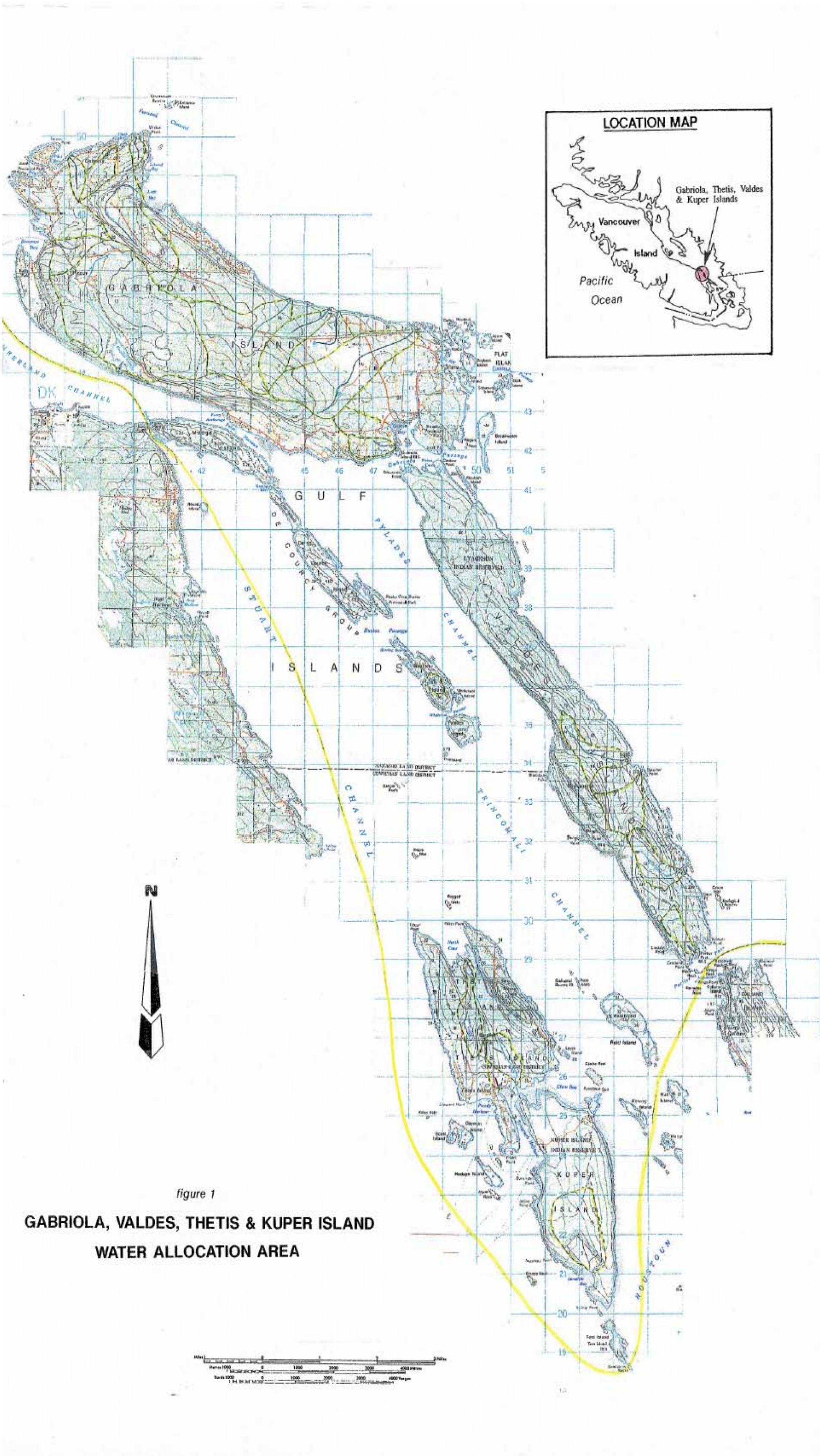


figure 1

GABRIOLA, VALDES, THETIS & KUPER ISLAND WATER ALLOCATION AREA

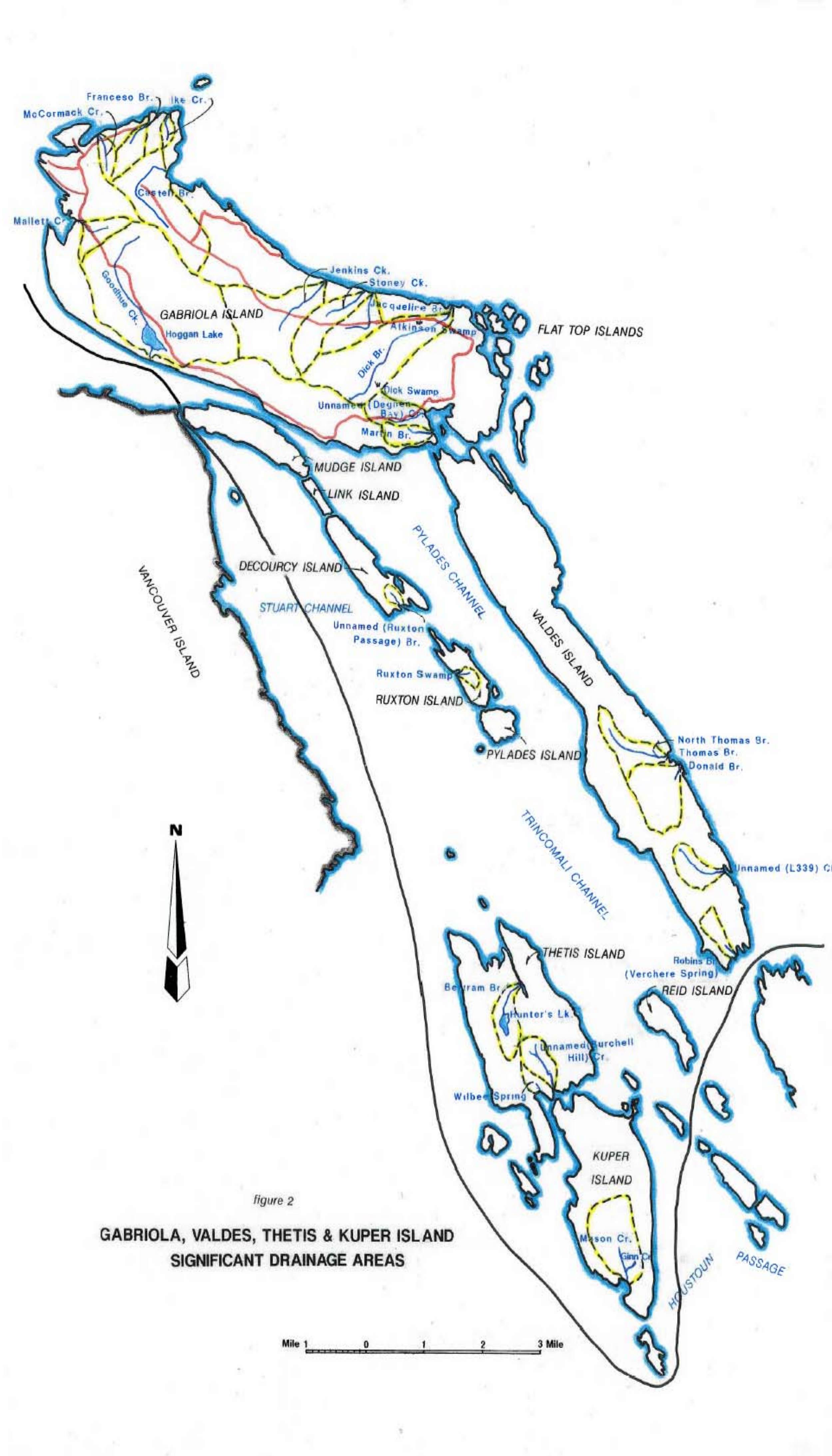
For the purpose of assessing water supplies for allocation demands, the significant drainage areas of the Islands in the following table are identified and illustrated in Table 2 and Figure 2.

Table 2 Significant Drainage Areas

Significant Drainages	Area (km2)
Gabriola Island	
Goodhue Creek	10.5
Mallett Creek	0.7
McCormack Creek	0.2
Francesco Brook	0.6
Ike Brook	0.3
Castell Brook	3.3
Jenkins Creek	3.7
Stoney Creek	1.7
Jacqueline Brook	1.2
Dick Brook	4.4
Martin Brook	0.6
Unnamed (Degnen Bay) Brook	0.9
Other Areas	24.2
Valdes Island	
Thomas Brook	1.5
Donald Brook	1.9
Unnamed (L339) Creek	0.5
Verchere Spring	0.6
Other Areas	19.8

Significant Drainages	Area (km2)
Thetis Island	
Bertram Brook	1.0
Unnamed (Burchell Hill) Brook	0.9
Wilbee Spring	0.3
Other Areas	8.9
Kuper Island	
Mason/Ginn Brook	2.4
Other Areas	6.9
Ruxton Island	
Ruxton Swamp	0.2
Other Areas	0.8
DeCourcy Island	
Unnamed (Ruxton Passage) Brook	0.1
Other Areas	1.7
Other Islands	0.2

Figure 2 Significant Drainage Areas



2.1 Topography and Climate

The climate of the Islands and adjacent areas are characterized by wet mild winters and warm dry summers. Mean daily temperatures recorded 19km to the northwest at Departure Bay vary over the year between 3^oC and 19^oC (Senewelets). Mean annual precipitation figures range between 24.7mm and 148.1mm for the period 1967 to 1990. The average annual precipitation is approximately 850mm with the majority falling in the October to March period (Canadian Climate Normals).

The physical environment is underlain by sandstones and shales of Upper Cretaceous age. Pleistocene glaciation with concomitant erosion and deposition of glacial and glacio-fluvial materials has had a major impact in land surface formation (Senewelets;p.10).
As the soil cover of the Islands averages less than 1.8 metres, the topography reflects the underlying bedrock structure (Geohydrological Study of Gabriola Island;p.3).

2.2 History and Growth

The majority of the water and Islands were named by the British Surveyor, Captain Richards, during 1858-1859; however a few of the island names originate from the Spanish explorers of 1790-1792.

The Coast Salish Indians used the areas as fishing and shellfish gathering grounds. The first European settlers arrived on Gabriola Island in the mid 1800s. These settlers were primarily homesteaders and farmers supplying the local island needs as well as selling products to the Vancouver Island markets. Today the economy of the area is based on fishing, tourism, home businesses, retirement income and local services.(Gabriola Island Official Community Plan).

The following tables highlight the population growth for Gabriola and Thetis Island over the past 25 years:

Table 3 Population Growth of Gabriola Island

Year	1966	1971	1976	1981	1986	1991
Population	407	680	1188	1627	2066	2579
Increase		273	508	439	439	513
Percent Increase		67%	75%	37%	37%	25%
Source:Island Specific Census Data						

Table 4 Population Growth of Thetis Island

Year	1966	1971	1976	1981	1986	1991
Population	109	144	173	217	235	236
Increase		35	29	44	18	1
Percent Increase		32%	20%	25%	8%	0.4%
Source: Island Specific Census Data						

The remaining areas within the allocation area have no demographic information available.

3.0 HYDROLOGY

3.1 STREAMFLOW OBSERVATIONS AND MEASUREMENTS

3.1.1 Goodhue Creek (Gabriola Island)

Goodhue Creek originates at 95 metre elevation and flows in a south-westerly direction through Hoggan Lake south to Northumberland Channel (Ocean). The total watershed area is 10.5 km^2 of which 6.48km^2 is located upstream of Hoggan Lake. Goodhue Creek is seasonal with no flow during summer and early fall (June-November). A Parshall Flume was installed (location of flume not recorded) with the following readings recorded:

Table 5 Goodhue Creek Parshall Flume Measurements

Date	Measure (cms)	Comments
April 26, 1989	0.0024	
May 3, 1989	0.0010	Sunny
May 4, 1989	0.0009	Sunny
May 15, 1989	0.0	Sunny
May 28, 1989	0.0011	After heavy rain
June 18,1989	0.0	Sunny
June 25, 1989	0.0	
July 5, 1989	0.0028	Rain
July 14,20,31, 1989	0.0	

Date	Measure (cms)	Comments
August 12,21,31, 1989	0.0	
September 1989	0.0	
October 6,25, 1989	0.0	
November 4, 1989	0.0038	Rain
November 9, 1989	0.0041	Rain
November 17, 1989	0.0056	Rain
November 26, 1989	0.0179	Rain
December 4,16, 1989	overflowing	
January 23, 1990	0.0044	

The flume measurements indicate there is zero flow from approximately mid-May to November except after heavy rainfall. On October 31, 1980 zero flow was recorded.

Hoggan Lake flows south and enters the Northumberland Channel (Ocean). Hoggan Lake has a surface area approximately 25.1 hectares. The lake is fed by two creeks: Goodhue Creek enters the northern most end of the lake from the northwest direction and the South Road Creek enters the east side of the lake from the northeast direction.

A Water Survey of Canada hydrometric station Hoggan Creek at Outlet of Hoggan Lake (08HB046) was operational during the years 1972 to 1978 inclusive. The Low Flow Period discharges are shown in Table 6 (see Appendix A).

Table 6 Low Flow Period at Hoggan Creek

Hoggan Creek at Outlet of Hoggan Lake-Station No.08HB046							
Low Flow Period (m^3/s)							
Year	Apr	May	June	July	Aug	Sept	Oct
1974	0.156	0.029	0.007	0.001	0	0	0
1975	0.037	0.016	.. 0.001	0	0	0	0.001
1976	0.119	0.021	0.009	0.002	0	0	0.001
1977	0.024	0.005	0.001	0	0	0	0
1978	0.135	-	-	-	-	-	-

The station recorded zero flow for the months of August to October for the years 1972 to 1978. In addition, the lake dropped 0.2 metres between August and October on an average for the years 1972 to 1978 (this is a combination of water extraction and evaporation). Parshall flume readings on the upper reaches of Goodhue on Lot 1, Plan 27281 for the years 1989 and 1990 indicate zero flow for the months of July to October.

The mean flow at the outlet of Hoggan Lake for the high flow period, November to March, is 0.348 cms based on 1975 and 1976 records. The maximum monthly mean is 18.9 cfs for 1975 and 1976 which are average years. Monthly mean flows of zero have been recorded for the months in July 1975 and 1977, and October 1974, 1976, 1977 and 1978.

Eppler Spring is tributary to Hoggan Lake. The water licence file 1000513 recorded a zero flow August 14, 1987. The spring flows seasonally and during flooding.

3.1.2 Mallett Creek (Gabriola Island)

Mallett Creek flows in a westerly direction into Descanso Bay, (Ocean) from a maximum elevation of 80 metres. The total watershed area is 0.7 km^2 as planimetered from a 1:50,000 topographic map with a median elevation of 65 metres. On February 25, 1985, a streamflow of 0.014 cms was recorded on this creek at Taylor Bay road culvert (method not recorded). Fiddlehead Spring and Ingeberg Swamp are tributary to the Mallett Creek watershed.

Ingeberg Swamp has no observed outlet channel, but most likely drains in a north west direction underground into the shale rock just below the swamp (water licence file 1001078). There are no flow measurements on file for Ingeberg Swamp and Fiddlehead Spring.

3.1.3 McCormack Creek (Gabriola Island)

McCormack Creek flows north into Pilot Bay (Strait of Georgia, Ocean). The total watershed area is 0.2 km^2 as planimetered from a 1:50,000 topographic map. The median elevation is 40 metres with the highest elevation at 80 metres. The water licence file 310651 recorded McCormack Creek dry in September 1991 and November 21, 1992.

3.1.4 Francesco Brook (Gabriola Island)

Francesco Brook flows in a north-easterly direction into Clark Bay, (Strait of Georgia, Ocean). The total watershed area is 0.6 km^2 as planimetered from a 1:50,000 topographic map. There are no flow measurements on file.

Harold Spring is tributary to the Francesco Brook watershed. There are no flow measurements on file.

3.1.5 Ike Brook (Gabriola Island)

Ike Brook flows north into the Strait of Georgia from a maximum elevation of 80 metres. The total watershed area is 0.3 km^2 with a median elevation of 40 metres. Water licence file 1000748 recorded a zero flow August 14, 1987 and notes that the brook runs during rain storms and is dry approximately 11 months of the year.

Pam Brook, Pam Spring, Darling Spring and McCall Spring are tributaries to Ike Brook. There are no flow measurements on file for Pam Brook, Pam Spring or McCall Spring.

Darling Spring flows into the ground. A pumping test was carried out May 27, 1980 which revealed that Darling Spring has an estimated capacity of 3,000 gpd.

3.1.6 Castell Brook (Gabriola Island)

Castell Brook flows in a north-westerly direction to Lock Bay Lagoon, (Strait of Georgia, Ocean) with a maximum elevation of 80 metres. The total watershed area is 3.3 km^2 as planimetered from a 1:50,000 topographic map. The water licence files 285242 and 366092 recorded a zero flow for September 19, 1969 and October 31, 1980. This source is seasonal with zero flow from approximately May to November. McClay Creek is tributary to Castell Brook.

McClay Creek flows north-westerly direction into Lock Bay Lagoon, with a maximum elevation of 70 metres. The water licence file 1001040 recorded the creek dry on July 26, 1990 and zero flow during the summer months.

3.1.7 Jenkins Creek (Gabriola Island)

Jenkins Creek has a drainage area of 3.7 km^2 and flows in a north-easterly direction into the Strait of Georgia. There are no flow measurements on file.

3.1.8 Stoney Creek (Gabriola Island)

Stoney Creek flows in a north-easterly direction to the Strait of Georgia, (Ocean). The total watershed area is 1.7 km^2 as planimetered from a 1:50,000 topographic map with a median elevation of 70 metres. A flow measurement of 0.042 cms on April 13, 1989 was observed (water licence file 1000756, method not recorded).

3.1.9 Jacqueline Brook (Gabriola Island)

Jacqueline Brook flows from an average elevation of 50 metres in a north-easterly direction to the Strait of Georgia, (Ocean). The total drainage area is 1.2 km^2 as planimetered from a 1:50,000 topographic map.

Windecker Spring, tributary to the Jacqueline Brook watershed, flows steady year round and dissipates into the ground. On April 13, 1989, a flow measurement of 90 to 115 litres per minute was observed (water licence file 1000966, method not recorded).

3.1.10 Dick Brook (Gabriola Island)

Dick Brook flows in a north-easterly direction into the Strait of Georgia, (Ocean). The median elevation of the basin is 40 metres with the highest elevation at 95 metres. The total watershed area is 4.4 km^2 as planimetered from a 1;50,000 topographic map. Dick Brook (water licence file 1000671) had zero flow on July 9, 1982 and August 14, 1987 with only pools of water which indicated that there may be some flow through the stream bed. The brook flows seasonally and through the months October to March.

3.1.11 Martin Brook (Gabriola Island)

Martin Brook flows in an easterly direction from a maximum elevation of 30 metres to Degnen Bay in the Strait of Georgia, (Ocean). The total watershed area is 0.6 km^2 as planimetered from a 1:50,000 topographic map. The water licence file 0328720 recorded a zero flow on July 21, 1975 and indicated that the brook flows seasonally and during the winter months.

3.1.12 Thomas Brook (Valdes Island)

Thomas Brook flows south-east and discharges into Starvation Bay, Strait of Georgia. The total watershed area is 1.5 km^2 as planimetered from 1:50,000 topographic map. Water licence file 364561 recorded a flow of 0.7cfs, (method not recorded), January 20, 1982, and zero flow in late August and September.

North Thomas Brook is a tributary to Thomas Brook watershed. The brook has zero flow during late August and September and on February 8, 1982, a flow of 2,000,000 lpd or 0.028 cms was recorded (method not recorded).

3.1.13 Verchere Spring (Valdes Island)

Verchere Spring flows south into Porlier Pass and is tributary to the Robin Brook watershed. The total watershed area planimetered from a 1:50,000 topographic map is 0.6 km^2. There are no flow measurements on file.

3.1.14 Bertram Brook (Thetis Island)

Bertram Brook flows in a northerly direction into Hunter's Lagoon, (Ocean). The total watershed is 1.0 km^2 as planimetered from a 1:50,000 topographic map. There are no flow measurements on file.

3.1.15 Wilbee Spring (Thetis Island)

Wilbee Spring flows in a south-east direction into Telegraph Harbour. The total watershed area is 0.3 km^2 as planimetered from a 1:50,000 topographic map. The water licence file 1000815 recorded a flow measurement of 4 litres/ 6 seconds (using a bucket and stopwatch) on October 30, 1989. The spring flows from November to mid April.

3.1.16 Ruxton Swamp (Ruxton Island)

Ruxton Swamp flows west and discharges into Staurt Channel, (Ocean). The total watershed area is 0.2 km^2 as planimetered from a 1:50,000 topographic map. On February 26, 1985, the volume of Ruxton Swamp was estimated to be 25 acre feet with a flow measurement of 3.8 lpm in the outlet creek on Lot 81, Plan 17982 (method not recorded). The water licence file 1000362 recorded a flow measurement of 0.0002 cms (using Haslam Creek 7-day flow data).

3.1.17 Other Small Watersheds

Farrow Spring (Gabriola Island) flows south-easterly into Pylades Channel, (Ocean).

Claude Spring (Gabriola Island) flows south into False Narrows, (Ocean). The water licence file 170761 recorded zero flow in the late summer of 1986 and 1987.

Toadeye Swamp (Gabriola Island) flows in a north-easterly direction into Silva Bay, (Ocean). The swamp flows seasonal and dries in the summer months (water licence file 1000111).

Easthom Spring (Gabriola Island) flows in a north-easterly direction into Descano Bay, (Ocean). The water licence file 290354 recorded zero flow on November 6, 1969.

Vicki Spring (Gabriola Island) There are no flow measurements on file.

Lobo Spring (Gabriola Island) flows south and discharges into a drainage ditch on the south west side of Gabriola Island. The water licence file 316726 recorded an estimated flow of 75,000 lpd (method not recorded) on January 31, 1974.

Lucas Spring (Gabriola Island) flows west and discharges into Descano Bay, (Ocean). The watershed area of the source is approximately 21 acres. The spring has a seasonal flow and flows 3 to 4 months during the winter on the surface then subsurfaces for remainder of the year, (1100 lpd in the summer and 11,000 lpd in the winter, water licence file 1000473, method not recorded).

Rowson Spring (Gabriola Island) flows south and disappears into the ground. The water licence file 316749 reported zero flow August 17,1973.

Chapple Spring (Gabriola Island) flows in a north-westerly direction and discharges into Percy Anchorage, (Ocean). There are no flow measurements on file.

Sewell Spring (Valdes Island) flows in a south-west direction into Trincomali Channel, (Ocean). There are no flow measurements on file.

Unnamed (Ruxton Passage) Brook (DeCourcy Island) Unnamed Swamp (Block F, Sections 10, 23, and 24, DeCourcy Island, Nanaimo District, Plan 41970) flows in a south-east direction into Ruxton Passage, (Ocean). The total watershed area is 0.1 km^2 as planimetered from a 1:50,000 topographic map. There are no flow measurements on file.

Crystal Spring (Thetis Island) flows in an easterly direction and discharges into Cufra Canal (Ocean). On February 26, 1985 a measurement of 0.5 gal/min was recorded (reading taken at culvert crossing approximately 50' below source, method not recorded)

Lawrence Spring (Thetis Island) flows south-westerly direction and discharges into Preedy Harbour. There are no flow measurements on file.

3.2 MEAN ANNUAL DISCHARGE

Within the Plan area, the only long term flow measuring station on an annual basis is located at Hoggan Lake. For this watershed, the Mean Annual Discharge was adjusted to allow for the change in storage, precipitation, and evaporation. For all other watersheds within the Plan Area that have limited or no measurement records, an estimation of the Mean Annual Discharge is utilized.

3.2.1 Goodhue Creek (Hoggan Lake)

From the available WSC, (Hoggan Creek at Outlet of Hoggan Lake-Station #08HB046, see appendix A) streamflow records on Hoggan Lake, the mean monthly and annual discharges are shown in Table 7 and the streamflow hydrograph is shown in Figure 3.

Figure 3 Streamflow Hydrograph of Goodhue Creek

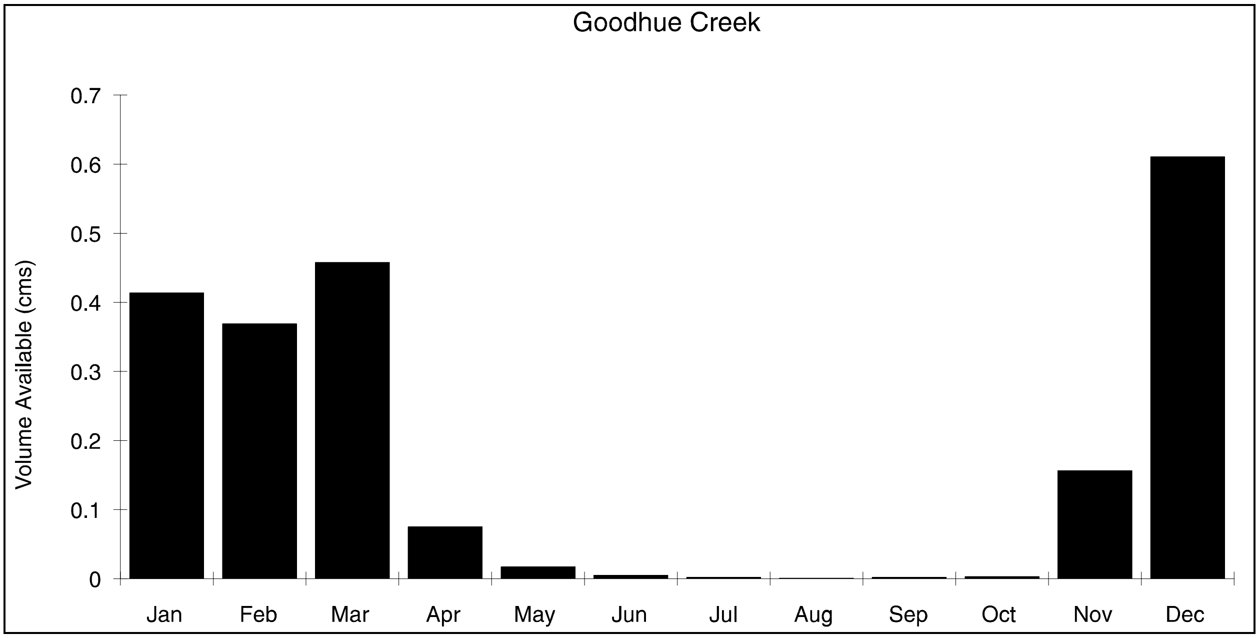


Table 7 Hoggan Lake @ WSC 08HB046

Distribution of Mean Annual Discharge													
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	MAD
% MAD	235	209	260	43	10	3	1	0	1	2	89	347	
m^3s	0.414	0.369	0.458	0.075	0.017	0.005	0.002	0.001	0.002	0.003	0.156	0.611	3.462

The **mean annual discharge was 0.176 m^3**/s at WCS Station 08HB046 located at the Goodhue outlet to Hoggan Lake . The upward drainage area is 6.48 km^2, with a **mean annual runoff of 531 mm** and an **annual yield of 5173 dam^3**.

3.2.2 Estimation of Mean Annual Discharge in Ungauged Basins

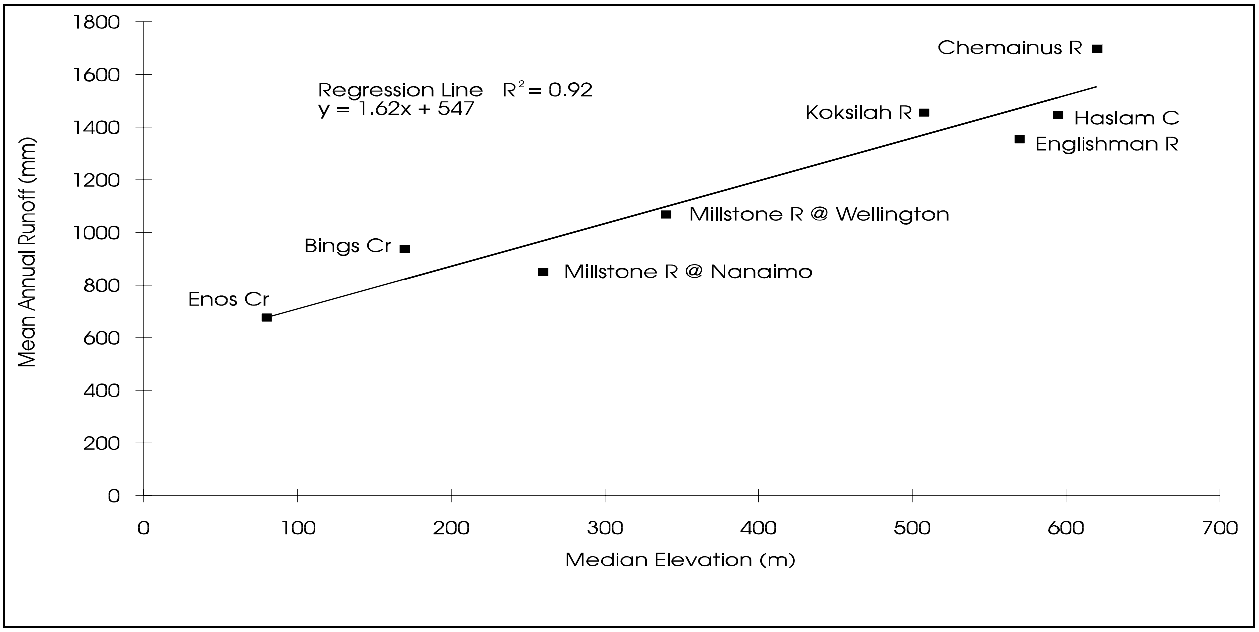
As the other streams within the Allocation Plan area have limited or no streamflow records, the hydrologic characteristics of these watersheds must be inferred from a regional Water Survey of Canada station. The stations used in this analysis are listed in Table 8. The stations are all located in the east coast of Vancouver Island in the same bioclimatic zone.

Table 8 Regionalization of Streamflow

Table 1 - Regional Water Survey of Canada Stations					
Station	Stream	Drainage Area (km^2)	Median Elevation (m)	Mean Discharge (m^3/s)	Mean Annual Runoff (mm)
08HB032	Millstone @ Nanaimo	86.2	260	2.32	849
08HB027	Millstone @ Wellington	46.1	340	1.56	1067
08HA003	Koksilah @ Cowichan Stn	209	508	9.63	1453
08HA001	Chemainus @ Westholme	355	620	19.1	1697
08HB002	Englishman @ Parksville	324	570	13.9	1353
08HA016	Bings @ mouth	15.5	170	0.46	936

Several methods based on median elevation, drainage area and precipitation were compared, with a median elevation - annual runoff relationship being the most efficient. The relationship is shown in Figure 4.

Figure 4 Linear Relationship Mean Annual Runoff-Median Elevation



Therefore, estimation of streamflow in unguaged basins located in the Allocation Plan area is based on the median elevation-mean annual runoff relationship. By using the slope and y-axis intercept form the regression line (R^2=0.92), the following formula derived.

y= 1.62x +547

where y=mean annual runoff (mm)
x=median elevation (m)

The mean annual runoff (mm) can be converted to Mean Annual Discharge ($m^3/3$) by using the watershed area of the ungauged basin. The Mean Annual Runoff and Mean Annual Discharge for ungauged basins within the Plan Area are shown in Table 9.

Table 9 MAD for Ungauged Basins

Drainage	Area km^2	Median Elevation (m)	Annual Runoff (mm)	MAD (cms)
Goodhue Creek	10.45	95.0	531.1	0.176
Mallett Creek	0.72	65.0	652.3	0.015
McCormack Creek	0.24	40.0	611.8	0.005
Fransceco Brook	0.63	34.0	602.1	0.012
Ike Brook	0.25	40.0	611.8	0.005
Castell Brook	3.25	60.0	644.2	0.066
Jenkins Creek	3.67	100.0	709.0	0.083
Stoney Creek	1.66	70.0	660.4	0.035
Jacqueline Brook	1.22	50.0	628.0	0.024
Dick Brook	4.44	40.0	611.8	0.086
Unnamed (Degnen Bay) Creek	0.85	55.0	636.1	0.017
Martin Brook	0.55	30.0	595.6	0.010
Ruxton Swamp	0.21	40.0	611.8	0.004
Thomas Brook	1.53	100.0	709.0	0.034
Donald Brook	1.94	50.0	628.0	0.039
Unnamed (L339) Creek	0.53	80.0	676.6	0.011
Verchere Spring	0.61	50.0	628.0	0.012
Bertram Brook	1.02	40.0	611.8	0.020
Unnamed (Burchell Hill) Stream	0.85	10.0	563.2	0.015
Wilbee Spring	0.25	40.0	611.8	0.005
Mason/Ginn Creek	2.40	30.0	595.6	0.045
Unnamed (Ruxton Passage) Brook	0.12	25.0	587.5	0.002

In order to develop a monthly streamflow hydrograph based on the above estimated MAD, the average of the monthly percentages of MAD for Hoggan Lake was used (this distribution of MAD is shown in Table 7). At this gauged basin, the minimum mean monthly flow was less than 10% of Mean Annual Discharge. The months where mean monthly discharge is greater than 60% are November to April inclusive.

For the major ungauged streams within the Plan area, the estimated distributions of MAD and streamflow hydrographs are shown in Appendix B.

3.3 LAKES

The available data for lakes in the plan area is summarized in Table 10.

Table 10 Lakes-Available Data

Lake	Surface Area (ha)	Volume (dam^3)	Bath Survey	Depths Max/Mean (metres)	Control on Lake	Comments
Hoggan (Gabriola)	24.5	5173	yes	15.25/-	yes	domestic/irrigation/power (residential)
Hunter (Thetis)	12.0	480	no	-	yes	domestic/irrigation
*as measured from NTS 1:50000 maps						

4.0 INSTREAM FLOW REQUIREMENTS

Maintaining the natural stream environment and instream uses is of paramount importance for present and future generations. Maintaining water for the fisheries resource is a key factor in also providing instream flow requirements for water quality, recreational, aesthetic and cultural values. The Provincial 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 modified version of the Tennant (Montana) Method as shown in Table 11.

Table 11 Fisheries Criteria

Modified Tennant (Montana) Method Instream Flow Requirements	
Flows	**Description**
30-60% MAD	Excellent spawning
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). Therefore, the following Regional policies were developed to implement the Provincial directive.

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 licensed demands should only be allowed for the period of months when the mean monthly flow is above 60% of the MAD

For streams where the mean 7-day average low flow falls below 10% of the MAD, extractive demands should only be allowed for the period of months when the mean monthly flow is above 60% of the MAD (Figure #). Where the mean 7-day average low flow remains above 10%, then the 7-day low flow amount above 10% MAD is available.

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

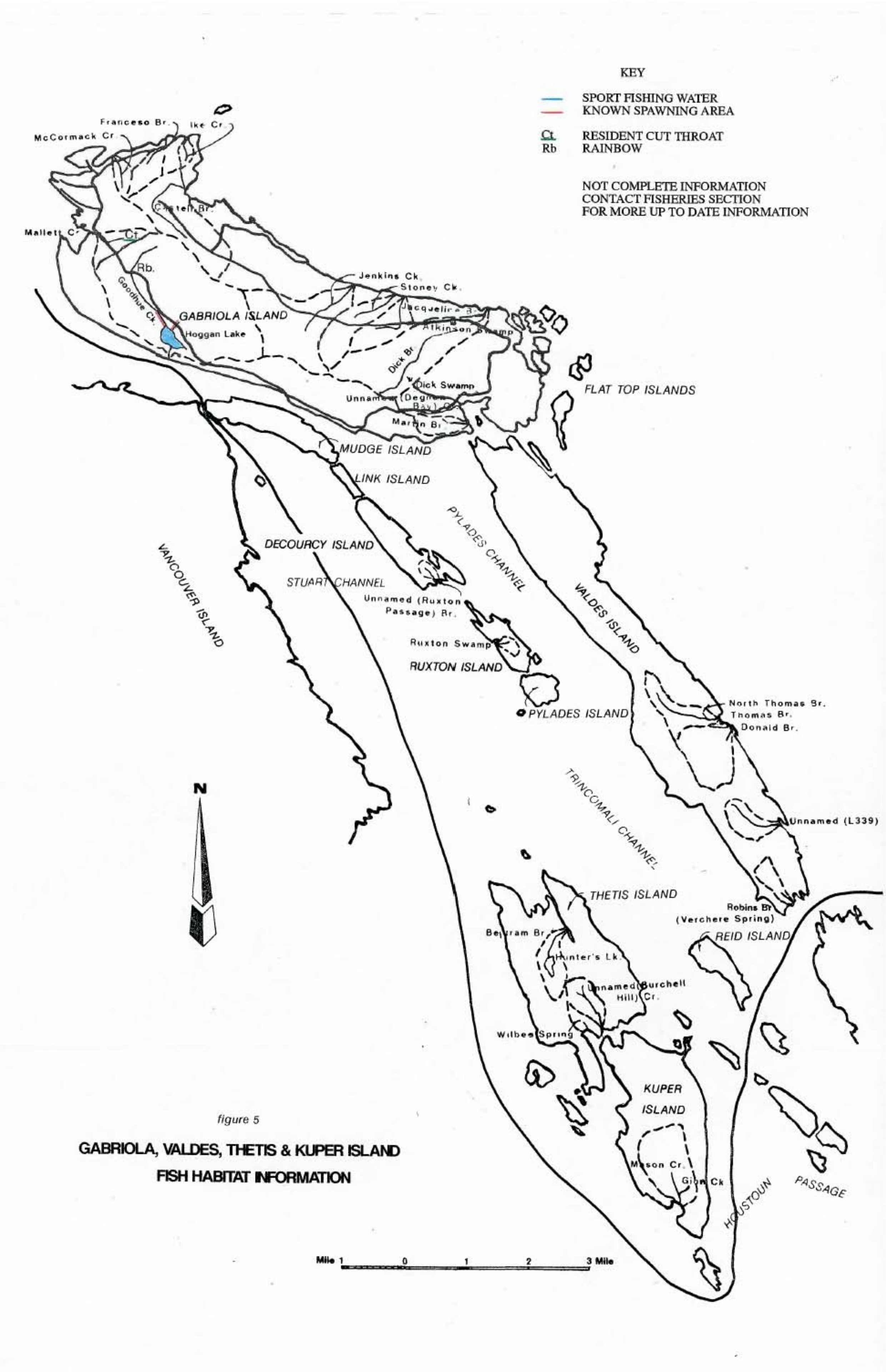


figure 5

GABRIOLA, VALDES, THETIS & KUPER ISLAND FISH HABITAT INFORMATION

4.1 IDENTIFIED FISH VALUES

Fisheries habitat information for streams within the Plan area is shown on Figure 5. Fisheries values are described below for the major streams.

4.1.1 Goodhue Creek

Goodhue Creek inlet channel to Hoggan Lake is a spawning bed for Rainbow Trout.

4.1.2 Mallett Creek

Mallett Creek maintains a stocked population of Cutthroat fish.

5.0 LICENSED WATER DEMAND

5.1 Licensed Demand

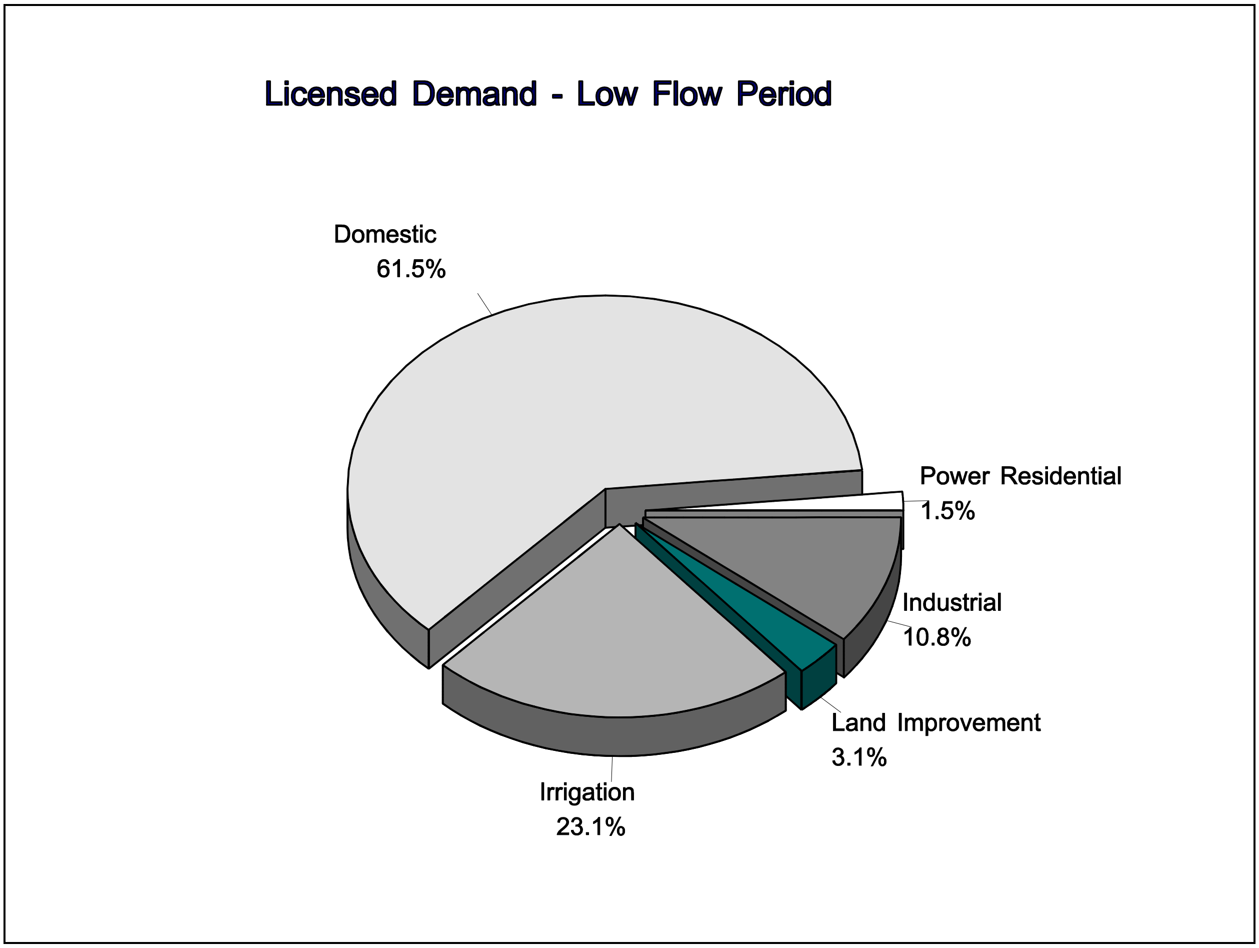
Water licence information is available on the WLIS database. For the Plan area, a list of water licenses within this Plan area shown are in Appendix C. A summary of the existing licensed demand by purpose is shown in Table 12.

Table 12 Licensed Demand Summary

Low Flow Licensed Demand by Purpose			
Purpose	**Quantity/Units**	Equivalent Low Flow & Volume *	
		litres/second	**dam^3**
Domestic	31,450 gpd	1.65	22.2
Irrigation	82.73 acft	13.13	102.1
Industrial Enterprise	171,150 gpd	8.74	77.3
Land Improvements	1.04 acft	0.17	1.3
Power Residential **	13.0 cs	0	0
	Total Extractive Demand	23.69	202.85
Storage	250.5 acft	-20.71	-161.0
	Total Unsupported Demand	2.98	41.85
*Based on 90 day irrigation period			
** The 120 acft of storage to support Power Residential on Hoggan Lake,(non consumptive), is not included in Storage			

Existing licensed water demand is summarized by the percentage each represents of the total water demand during the low flow period in Figure 6.

Figure 6 Licensed Demand-Low Flow Period



5.2 Projected Demand

25 water licenses are pending as of February 1994. A summary of the pending applications by purpose/use is detailed in Appendix D.

Table 13 Licensed Application Summary

Pending Water Licence Applications during Low Flow Demand (by Purpose)			
Purpose	Quantity/Units	Equivalent Demand*	
		litres/sec	dam^3
Domestic	3000 gpd	0.156	2.1
Irrigation	27.5 acft	4.362	34.03
Industrial	451,240 gpd	23.5	182.73
Land Improvement	1.0 gpd	0	0
Conservation	1.0 acft	0.093	1.234
	Total	28.111	220.094
Storage	14.503 acft	-2.301	-18.0
	Unsupported	25.81	202.094
* Based on a 90 day irrigation period demand			

The area residents depend primarily on individual sources of potable water. Fresh water aquifers are finite in capacity and recharged seasonally. (Gabriola Island Official Community Plan). The community water supplies experience problems with meeting the increasing water demand.

The conclusions and recommendations found in the following sections outline the requirements, limitations and acceptance criteria necessary for approval of the applications discussed above.

6.0 CONCLUSIONS

The human population of Gabriola Island is rapidly increasing with large subdivision proposals being planned for the Island with a water supply from wells. Further significant community waterworks demands on Gabriola Island is anticipated.

Streamflow in the study area during the low flow months of July and August is zero in most years and may be zero for the months of June to October in a low flow year for all creeks.

The water available for storage development for each drainage area and the mean for each Island is listed in Table 14.

Table 14 Estimated Water Available For Storage

Estimated Water Available for Storage	
Drainage Area	dam^3/ha
Goodhue Creek (Hoggan Lake)	3.3
Mallett Creek	3.3
McCormack Creek	3.3
Fransceco Brook	3.0
Ike Brook	3.1
Castell Brook	3.2
Jenkins Creek	3.5
Stoney Creek	3.3
Jacqueline Brook	3.1
Dick Brook	3.0
Unnamed (Degnen Bay) Creek	3.1
Martin Brook	2.8
Mean for Gabriola Island	**3.1**
Ruxton Swamp	3.0
Mean for Ruxton Island	**3.0**
Thomas Brook	3.5
Donald Brook	3.1
Unnamed (L339) Creek	3.2
Verchere Spring	3.1
Mean for Valdes Island	**3.2**
Bertram Brook	3.0
Unnamed (Burchell Hill) Creek	2.6
Wilbee Spring	3.1
Mean for Thetis Island	**2.9**
Mason/Ginn Creek	2.9
Mean for Kuper Island	**2.9**
Unnamed (Ruxton Passage) Brook	2.6
Mean for DeCourcy Island	**2.6**

No significant increase in industrial demand is anticipated for the Islands. Existing industrial demands are primarily commercial ventures associated with resort uses.

Diversion structures must be capable of maintaining existing base flows and provide fish passage where there is fish and fish habitat (Goodhue Creek and Mallett Creek). There is limited information on fish or fish flow requirements for other small streams in the Plan area. These small streams experience "no flow" conditions for approximately six months of the year and is unlikely that they maintain sufficient flows to support any significant fish populations. Therefore, it will be assumed that there are no instream flow requirements on other small streams in the plan area unless further studies indicate otherwise.

Lands available for farming, and thus irrigation demand, are relatively small. Also, there is no soil information readily available to calculate irrigation duties.

There is adequate water available during the high flow period (November through April) for storage purpose to support water use during the low flow period (July through September) demands without adversely affecting instream requirements. A summary of water available from significant drainage areas during the high flow period is shown in Table 15.

Table 15 Water Available during High Flow Period

Water Available during November to April inclusive			
Drainage Area	Size (km^2)	Volume Available	
		dam^3	ac-ft
Goodhue Creek (Hoggan Lake)	10.5	5173	4195
Mallett Creek	0.7	438	355
McCormack Creek	0.2	151	122
Fransceco Brook	0.6	372	302
Ike Brook	0.3	143	116
Castell Brook	3.3	2073	1681
Jenkins Creek	3.7	2608	2115
Stoney Creek	1.7	1094	887
Jacqueline Brook	1.2	744	603
Dick Brook	4.4	2674	2169
Unnamed (Degnen Bay) Creek	0.9	535	434
Martin Brook	0.6	312	253
Ruxton Swamp	0.2	163	132
Thomas Brook	0.5	1420	1152
Donald Brook	1.9	1634	1325
Unnamed (L339) Creek	0.5	462	375
Verchere Spring	0.6	500	405
Bertram Brook	1.0	834	676
Unnamed (Burchell Hill) Creek	0.9	467	379
Wilbee Spring	0.3	202	164
Mason/Ginn Creek	2.4	1759	1427
Unnamed (Ruxton Passage) Swamp	0.1	81	66

7.0 RECOMMENDATIONS

As zero flow occurs during the summer low flow period, future water licences within the Gabriola, Valdes, Thetis, and Kuper Islands Water Allocation Plan area will require adequate supporting storage for the period given between June to October.

7.1 Domestic

A domestic water licence shall be 2273 litres per day (500 gallons per day) for each rural dwelling as indicated on the plan attached to the water licence. This amount will allow for the maintaining of 1000 m^2 (0.25 acre) of garden associated with the dwelling. It is not appropriate, where the primary source of domestic water supply is insufficient, to issue water licences to maintain green lawns and gardens.

Domestic water licence should not be used as evidence of a "adequate water supply" for subdivision development and speculative purposes. Large subdivision of land shall be encouraged to form a community water system.

To ensure an adequate water supply, applicants should be prepared to develop storage or use lake or swamp storage. For the average daily demand of 1135 litres per day (250 gpd) for a five month period (150 days) which is 170 m^3 (6000 ft^3 or 0.14 acre feet) is recommended. This requires a reservoir or dugout approximately 6 metres wide by 9 metres long (20 feet wide by 30 feet long), with an average depth of 3 metres (11 feet) (allowing 0.3 metre (1 foot) for evaporation loss).

Springs shall be licensed for individual domestic water demands provided that it is 30 metres (100 feet) from any existing licensed springs . Multiple water licensing of one spring will be permitted if water is available. The onus is on the applicant to supply flow records or determine flow yields and to satisfy the written concerns and objections of existing water licenses.

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 (ie meters) is not usually required on domestic water use. But screening of intake works shall be required to prevent fish or debris entering the works.

7.2 Waterworks

Waterworks purpose demand 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.

Water required for waterworks licences shall be based upon a ten year projected maximum daily and annual demand; except that a longer projected demand period shall be authorized where the capital cost of construction of works must be amortised over a longer period.

Adequate system balancing storage shall be required to ensure that the rate of withdrawal from the source during short term or maximum hour demand does not exceed the maximum daily demand. Good conservation techniques must be practised at all times and no increase in the amount of water in the existing community waterworks licences shall be allowed unless meters and other conservation measures have been implemented.

All waterworks water licence applications require storage at the source stream except where the water supply is from a lake that has water available within 10% of the shoal area.

7.3 Irrigation

There is no soil information available for the Water Allocation Plan area. Therefore, the irrigation duty for agriculture on the Islands will be 3046 m^3 of water per hectare (1.0 acre foot per acre) of land to be irrigated. The maximum allowable rate of withdrawal will be 47.2 litres per minute per hectare (4.2 Igpm per acre) of land to be irrigated.

The maximum irrigation system demand shall not exceed 19.1 l/sec (4.2 Igpm) per acre in order to encourage employment of good agricultural practices (good design of field size, irrigation system selection and farm management) to conserve water.

Irrigation gun or flood irrigation systems require greater irrigation quantities (as compared to the sprinkler irrigation systems) and should be discouraged. If irrigation gun and flood irrigation practices are to be used then 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 sprinkler irrigation system.

Trickle irrigation can reduce water requirements by 35% and should be encouraged where practical.

All irrigation water demands must be supported by 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.

The authorized period of use for irrigation shall be from April 1 to September 30.

All intake works in fish bearing waters shall be screened as per the Fish Screening Directive found in Appendix E.

7.4 Industrial and Commercial

The tables in Appendix F indicate the quantity of water required for small commercial and industrial purposes.

Commercial fish hatching and/or rearing purposes shall require an industrial water licence. Use of water by government and non-profit organizations will be licensed as conservation purpose. Information on fish species and size, water temperature requirements and operating methods will be required. Fish Farm and Waste Management Permits will be required.

7.5 Land Improvement

Water required for land improvement aesthetic ponds shall be the volume of the pond to be created. All storage requirements will be met.

7.6 Conservation

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

To maintain flows in streams through the June to October period and for fish rearing ponds, storage development will be required. Works in stream/channels and in and around lakes, marshes, and other bodies may be authorized to conserve fish and wildlife without a quantity being specified in the water licence. Timing constraints may apply for the construction of work.

7.7 Storage

Storage purpose is the impoundment of water, either on-stream or off-stream, in a dugout and/or behind a dam. An additional 0.3 metres (1.0 foot) depth over the surface area of the storage reservoir or natural water body is to be allow for evaporation and other losses.

Design plans must be submitted and accepted in writing before construction commences on any proposed dam over 3.2 metres (10 feet) in height or on storage of 12.3 dam^3 (10 acre-feet) or more.

All storage use greater than 30 dam^3 shall require water level recording and the results shall be submitted to the Water Allocation Office once a year.

Off-stream storage is to be encouraged at all times, with off-stream sites that are:
- -outside the high water winter wetted perimeter of any watercourse,
- -not accessible by fish, and
- -do not adversely impact on flows in any watercourse(s) during the dry period.

In stream storage works are to be constructed during the period June to October.

The applicant must obtain separate written agreement, easement or right-of-way for works or flooding affecting other lands.

Diversion of water into storage will be during the period November to April. All instream storage will be required to maintain all natural inflows past the dam during the period May to October.

Total storage (dead and live) will be licensed. Dead storage should be licensed as it will in most cases have some intrinsic value such as providing conservation of water for wildlife or aesthetic value.

7.9 Allocation Plan Revision

The Gabriola, Valdes, Thetis, and Kuper Islands Allocation Plan should be reviewed and updated on or before April 1999.

Appendix A: Hydrometric Records

GABRIOLA ISLAND

49°09'N 123°44'W/O, 46m *1967 to/à 1990*

	Jan janv	Feb févr	Mar mars	Apr avr	May mai	Jun juin	Jul juill	Aug août	Sep sept	Oct oct	Nov nov	Dec déc	Year année
Precipitation / Précipitations													
Rainfall (mm) / Chutes de pluie (mm)	102.3	93.1	87.5	51.1	42.1	34.4	24.7	25.3	47.9	78.4	136.2	133.9	856.9
Snowfall (cm) / Chutes de neige (cm)	16.4	9.1	0.7	0.0T	0.0	0.0	0.0	0.0	0.0	0.0T	4.2	14.2	44.7
Precipitation (mm) / Précipitations (mm)	118.5	103.3	88.3	51.1	42.1	34.4	24.7	25.3	47.9	78.5	140.4	148.1	902.5
Extreme Daily Rainfall (mm) / Extrême quotidien de pluie (mm)	51.4	61.0	36.2	24.9	25.8	31.4	23.2	40.6	37.3	37.0	49.0		46.6
Date / Date	986/17	983/10	983/08	969/03	984/25	984/03	981/28	975/22	971/28	982/21	983/14	979/16	
Extreme Daily Snowfall (cm) / Extrême quotidien de neige (cm)	22.9	30.5	8.1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	29.0		63.5
Date / Date	971/14+	975/11	971/01	990/30+	990/31+	990/30+	990/31+	990/31+	990/30+	984/31	985/26	968/27	
Extreme Daily Pcpn. (mm) / Extrême quotidien de préc. (mm)	51.4	61.0	36.2	24.9	25.8	31.4	23.2	40.6	37.3	37.0	49.0		63.5
Date / Date	986/17	983/10	983/08	969/03	984/25	984/03	981/28	975/22	971/28	982/21	983/14	968/27	
Month-end Snow Cover (cm) / Couver. de neige, fin de mois (cm)	N	N	0	0	0	0	0	0	0	0	0		17
Days with / Journées avec													
Measurable Rainfall / Hauteur de pluie mesurable	14	13	14	12	10	8	6	6	8	12	16	15	133
Measurable Snowfall / Hauteur de neige mesurable	3	1	*	0	0	0	0	0	0	*	*	2	7
Measurable Precipitation / Hauteur de précipitation mesurable	16	13	14	12	10	8	6	6	8	12	16	17	138

Canadian Hydrological Data (c)1997 Environment Canada
Station : 08HB053 HOGGAN LAKE ON GABRIOLA ISLAND Prov-Terr-State : BC
Latitude:49°9'12"N Longitude:123°49'34"W
Region : Vancouver Drainage Area (km^2): --------(G),--------(E) Parameter : Levels (metres)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1972	-------	-------	-------	-------	3.857	-------	-------	-------	3.190	-------	-------	-------	-------
1973	-------	-------	-------	-------	-------	-------	-------	-------	-------	2.940	3.340	4.192	-------
1974	4.009	3.874	4.229	3.463	3.347	3.254	3.190	3.077	2.979	2.942	3.163	3.612	3.427
1975	3.666	-------	3.621	3.356	3.304	3.188	3.095	3.035	3.012	3.087	3.659	3.720	-------
1976	3.675	3.555	3.561	3.436	3.310	3.257	3.197	-------	-------	-------	-------	-------	-------
1977	3.444	3.438	3.789	3.313	3.262	3.230	3.048	2.960	2.923	2.953	3.222	4.143	3.311
1978	4.413	3.762	3.466	3.445	-------	-------	3.383	3.268	-------	-------	3.326	3.490	-------
Mean	3.841	3.657	3.733	3.403	3.416	3.232	3.183	3.085	3.026	2.980	3.342	3.831	3.369
Maximum	4.413	3.874	4.229	3.463	3.857	3.257	3.383	3.268	3.190	3.087	3.659	4.192	3.427
Minimum	3.444	3.438	3.466	3.313	3.262	3.188	3.048	2.960	2.923	2.940	3.163	3.490	3.311

A - Manual Gauge
D - Dry
R - Revised within the last two years
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
 - no symbol
d - Complete and Some Dry

Canadian Hydrological Data (c)1997 Environment Canada
Station : 08HB053 HOGGAN LAKE ON GABRIOLA ISLAND Prov-Terr-State : BC
Latitude:49°9'12"N Longitude:123°49'34"W
Region : Vancouver Drainage Area (km^2): --------(G),--------(E) Parameter : Levels

Year	Maximum Instantaneous Water Level	Maximum Daily Water Level		Minimum Daily Water Level	
1974	---------	5.163	Jan 21	2.935	Sep 29
1975	---------	4.331	Dec 28	3.008	Sep 16
1976	---------	3.932	Jan 01	3.100	Sep 22
1977	---------	4.877	Dec 16	2.905	Sep 13
1978	---------	4.831	Jan 17	3.249	Aug 09

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R - Revised within the last two years
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
 - no symbol
d - Complete and Some Dry

Canadian Hydrological Data (c)1997 Environment Canada
Station : 08HB046 HOGGAN CREEK AT OUTLET OF HOGGAN LAKE Prov-Terr-State : BC
Latitude:49°8'57"N Longitude:123°49'38"W
Region : Vancouver Drainage Area (km²): 6.48(G),---------(E) Parameter : Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1972	-------	-------	-------	-------	0.046	0.005	-------	-------	-------	-------	-------	-------	-------
1974	-------	-------	-------	0.156	0.029	0.007	0.001	0.000	0.000	0.000	0.071	0.402	-------
1975	0.506	0.414	0.370	0.037	0.016	0.001	0.000	0.000	0.000	0.001	0.445	0.515	0.191
1976	0.565	0.351	0.312	0.119	0.021	0.009	0.002	0.000	0.000	0.000	0.001	0.033	0.117
1977	0.120	0.112	0.778	0.024	0.005	0.001	0.000	0.000	0.000	0.000	0.035	1.62	0.228
1978	1.92	0.723	0.158	0.135	-------	-------	-------	-------	-------	-------	-------	-------	-------
Mean	0.778	0.400	0.405	0.094	0.023	0.005	0.001	0.000	0.000	0.000	0.138	0.642	0.179
Maximum	1.92	0.723	0.778	0.156	0.046	0.009	0.002	0.000*	0.000*	0.001	0.445	1.62	0.228
Minimum	0.120	0.112	0.158	0.024	0.005	0.001*	0.000*	0.000*	0.000*	0.000*	0.001	0.033	0.117

A - Manual Gauge
D - Dry
R - Revised within the last two years
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
- no symbol
d - Complete and Some Dry

Canadian Hydrological Data (c)1997 Environment Canada
Station : 08HB046 HOGGAN CREEK AT OUTLET OF HOGGAN LAKE Prov-Terr-State : BC
Latitude:49°8'57"N Longitude:123°49'38"W
Region : Vancouver Drainage Area (km²): 6.48(G),---------(E) Parameter : Flow

Year	Maximum Instantaneous Water Discharge	Maximum Daily Water Discharge		Minimum Daily Water Discharge	
1974	---------	---------	---------	0.000	Jul 26
1975	---------	0.974	Nov 19	0.000	Jun 15
1976	---------	1.05	Jan 01	0.000	Jul 17
1977	---------	3.31E	Dec 16	0.000E	Jun 12
1978	---------	2.66E	Jan 10	---------	---------

A - Manual Gauge
D - Dry
R - Revised within the last two years
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
- no symbol
d - Complete and Some Dry

Appendix B: Estimated Distribution of MAD and Volumes Available

Net Inflow to Hoggan Lake Corrected for Change in Storage, Precipitation and Evaporation														
STATION	**YEAR**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JULY**	**AUG**	**SEPT**	**OCT**	**NOV**	**DEC**	**MN ANN**
	1974	0.515	0.581	0.444	0.143	0.025	0.007	0.002	0.000	0.000	0.000	0.100	0.384	0.235
	1975	0.496	0.436	0.331	0.032	0.016	0.002	0.004	0.000	0.007	0.013	0.454	0.478	0.234
	1976	0.531	0.352	0.293	0.103	0.018	0.011	0.001	0.002	0.001	0.000	0.008	0.014	0.194
	1977	0.115	0.106	0.764	0.022	0.007	0.002	0.002	0.001	0.000	0.000	0.062	1.567	0.180
Mean		0.414	0.369	0.458	0.075	0.017	0.005	0.002	0.001	0.002	0.003	0.156	0.611	0.176
days/month		31	28.25	31	30	31	30	31	31	30	31	30	31	
% of MAD		235%	209%	260%	43%	10%	3%	1%	0%	1%	2%	89%	347%	100%
Net Precipitation (m) - used Vancouver UBC Evaporation and Gabriola Island Precipitation														
	1974	174	85	107	-9	-30	-106	-55	-113	-55	-12	174	144	25
	1975	123	101	8	-44	-72	-91	-138	9	-77	189	146	121	23
	1976	121	78	28	-21	-25	-71	-91	-4	-43	39	18	41	6
	1977	67	85	63	-49	-55	-119	-96	-91	30	50	126	113	11
Mean		121	87	52	-31	-45	-97	-95	-50	-36	67	116	105	16
Total Evaporation Losses(mm)			-353											

Gabriola , Valdes, Thetis, and Kuper Islands Water Allocation Plan-Unguaged Streams

Estimated Distribution of Mean Annual Discharge

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
% MAD used for Mean Monthly Flow		235	209	260	43	10	3	1	0	1	2	89	347
Stream	**MAD (cms)**	**MEAN MONTHLY FLOW (m3/s)**											
Goodhue Creek (Hoggan)	0.176	0.414	0.369	0.458	0.075	0.017	0.005	0.002	0.001	0.002	0.003	0.156	0.611
Mallett Creek	0.015	0.035	0.031	0.039	0.006	0.002	0	0	0	0	0	0.013	0.052
McCormack Creek	0.005	0.012	0.010	0.013	0.002	0	0	0	0	0	0	0.004	0.017
Francesco Brook	0.012	0.028	0.025	0.031	0.005	0.001	0	0	0	0	0	0.011	0.042
Ike Brook	0.005	0.012	0.010	0.013	0.002	0	0	0	0	0	0	0.004	0.017
Castell Brook	0.066	0.155	0.138	0.172	0.028	0.007	0.002	0	0	0	0.001	0.059	0.229
Jenkins Creek	0.083	0.195	0.173	0.216	0.036	0.008	0.002	0	0	0	0.002	0.074	0.288
Stoney Creek	0.035	0.082	0.073	0.091	0.015	0.004	0.001	0	0	0	0	0.031	0.121
Jacqueline Brook	0.024	0.056	0.050	0.062	0.010	0.002	0	0	0	0	0	0.021	0.083
Dick Brook	0.086	0.202	0.180	0.224	0.037	0.009	0.003	0	0	0	0.002	0.077	0.298
Unnamed (Degnen Bay) Creek	0.017	0.040	0.036	0.044	0.007	0.002	0	0	0	0	0	0.015	0.059
Martin Brook	0.010	0.024	0.021	0.026	0.004	0.001	0	0	0	0	0	0.009	0.035
Ruxton Swamp	0.004	0.009	0.008	0.010	0.002	0	0	0	0	0	0	0.004	0.014
Thomas Brook	0.034	0.080	0.071	0.088	0.015	0.003	0.001	0	0	0	0	0.030	0.118
Donald Brook	0.039	0.092	0.082	0.101	0.017	0.004	0.001	0	0	0	0	0.035	0.135
Unnamed (L339) Creek	0.011	0.026	0.023	0.029	0.005	0.001	0	0	0	0	0	0.010	0.038
Verchere Spring	0.012	0.028	0.025	0.031	0.005	0.001	0	0	0	0	0	0.011	0.042
Bertram Brook	0.020	0.047	0.042	0.052	0.009	0.002	0	0	0	0	0	0.018	0.069
Unnamed (Burchell Hill) Creek	0.015	0.035	0.031	0.039	0.006	0.002	0	0	0	0	0	0.013	0.052
Wilbee Spring	0.005	0.012	0.010	0.013	0.002	0	0	0	0	0	0	0.004	0.017
Mason/Ginn Creek	0.045	0.106	0.094	0.117	0.019	0.005	0.001	0	0	0	0	0.040	0.156
Unnamed (Ruxton Passage) Brook	0.002	0.005	0.004	0.005	0	0	0	0	0	0	0	0.002	0.007

Estimated Distribution of Mean Annual Discharge and Volumes Available														
Ungauged Drainage Areas within Gabriola-Valdes-Thetis Islands Water Allocation Plan														
Drainage Area		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
														Volume
	%MAD used													**(acft)**
	for distribution	**235**	**209**	**260**	**43**	**10**	**3**	**1**	**0**	**1**	**2**	**89**	**347**	
Goodhue (Hoggan)	Distribution of MAD(cms)	0.414	0.369	0.458	0.075	0.017	0.005	0.002	0.001	0.002	0.003	0.156	0.611	
Creek	Volume Available(acft)	899	724	995	158	37	11	4	2	4	6	328	1327	4495
(0.176cms)														
Mallett Creek	Distribution of MAD(cms)	0.035	0.031	0.039	0.006	0.002	0	0	0	0	0	0.013	0.052	
(0.015cms)	Volume Available(acft)	76	61	85	13	4	0	0	0	0	0	27	113	379
McCormack Creek	Distribution of MAD(cms)	0.012	0.01	0.013	0.002	0	0	0	0	0	0	0.004	0.017	
(0.005cms)	Volume Available(acft)	26	20	28	4	0	0	0	0	0	0	8	37	123
Fransceco Brook	Distribution of MAD(cms)	0.028	0.025	0.031	0.005	0.001	0	0	0	0	0	0.011	0.042	
(0.012cms)	Volume Available(acft)	61	49	67	11	2	0	0	0	0	0	23	91	304
Ike Brook	Distribution of MAD(cms)	0.012	0.01	0.013	0.002	0	0	0	0	0	0	0.004	0.017	
(0.005cms)	Volume Available(acft)	26	20	28	4	0	0	0	0	0	0	8	37	123
Castell Brook	Distribution of MAD(cms)	0.155	0.138	0.172	0.028	0.007	0.002	0	0	0	0.001	0.059	0.229	
(0.066cms)	Volume Available(acft)	337	271	374	59	15	4	0	0	0	2	124	497	1683
Jenkins Creek	Distribution of MAD(cms)	0.195	0.173	0.216	0.036	0.008	0.002	0	0	0	0.002	0.074	0.288	
(0.083cms)	Volume Available(acft)	424	339	469	76	17	4	0	0	0	4	156	626	2115
Stoney Creek	Distribution of MAD(cms)	0.082	0.073	0.091	0.015	0.004	0.001	0	0	0	0	0.031	0.121	
(0.035cms)	Volume Available(acft)	178	143	198	32	9	2	0	0	0	0	65	263	890
Jacqueline Brook	Distribution of MAD(cms)	0.056	0.05	0.062	0.01	0.002	0	0	0	0	0	0.021	0.083	
(0.024cms)	Volume Available(acft)	122	98	135	21	4	0	0	0	0	0	44	180	604

Estimated Distribution of Mean Annual Discharge and Volumes Available

Ungauged Drainage Areas within Gabriola-Valdes-Thetis Islands Water Allocation Plan

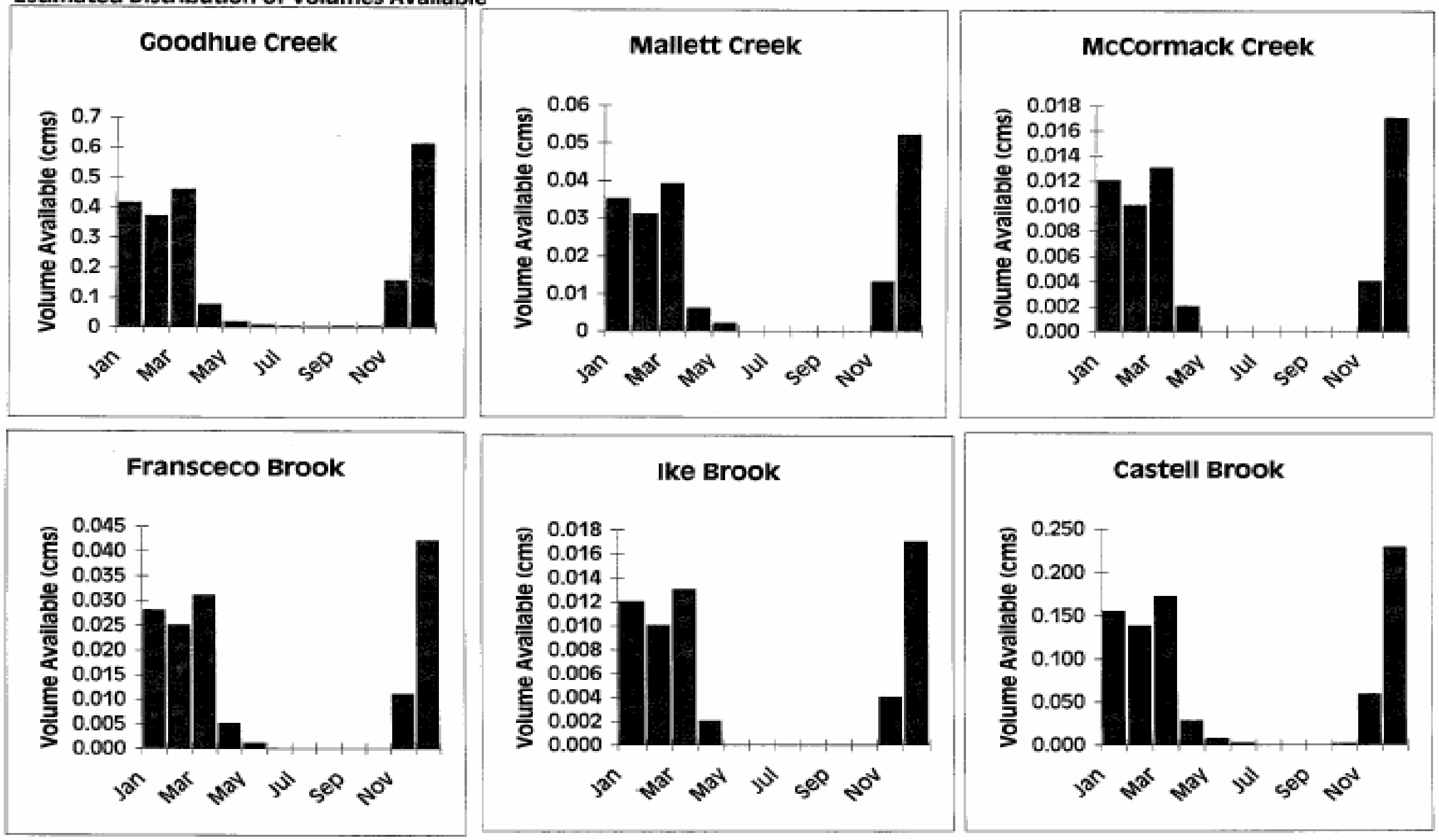
Drainage Area		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Volume (acft)
	%MAD used for distribution	**235**	**209**	**260**	**43**	**10**	**3**	**1**	**0**	**1**	**2**	**89**	**347**	
Dick Brook	Distribution of MAD(cms)	0.202	0.18	0.224	0.037	0.009	0.003	0	0	0	0.002	0.077	0.298	
(0.086cms)	Volume Available(acft)	439	353	487	78	20	6	0	0	0	4	162	647	2196
Unnamed Creek	Distribution of MAD(cms)	0.040	0.036	0.044	0.007	0.002	0.000	0.000	0.000	0.000	0.000	0.015	0.059	
Degnen Bay	Volume Available(acft)	87	71	96	15	4	0	0	0	0	0	33	128	434
(0.017cms)														
Martin Brook	Distribution of MAD(cms)	0.024	0.021	0.026	0.004	0.001	0	0	0	0	0	0.009	0.035	
(0.010cms)	Volume Available(acft)	52	41	56	8	2	0	0	0	0	0	19	76	254
Ruxton Swamp	Distribution of MAD(cms)	0.009	0.008	0.01	0.002	0	0	0	0	0	0	0.004	0.014	
(0.004cms)	Volume Available(acft)	29	16	32	4	0	0	0	0	0	0	8	44	133
Thomas Brook	Distribution of MAD(cms)	0.080	0.071	0.088	0.015	0.003	0.001	0.000	0.000	0.000	0.000	0.030	0.118	
(0.034cms)	Volume Available(acft)	254	139	279	32	10	2	0	0	0	0	63	374	1153
Donald Brook	Distribution of MAD(cms)	0.092	0.082	0.101	0.017	0.004	0.001	0	0	0	0	0.035	0.135	
(0.039cms)	Volume Available(acft)	292	161	320	36	13	2	0	0	0	0	74	428	1326
Unnamed (L339)	Distribution of MAD(cms)	0.026	0.023	0.029	0.005	0.001	0	0	0	0	0	0.01	0.038	
Creek (0.011cms)	Volume Available(acft)	82	45	92	11	3	0	0	0	0	0	21	121	375
Verchere Spring	Distribution of MAD(cms)	0.028	0.025	0.031	0.005	0.001	0	0	0	0	0	0.011	0.042	
(0.012cms)	Volume Available(acft)	89	49	98	11	3	0	0	0	0	0	23	133	406
Bertram Brook	Distribution of MAD(cms)	0.047	0.042	0.052	0.009	0.002	0	0	0	0	0	0.018	0.069	
(0.020cms)	Volume Available(acft)	149	82	165	19	6	0	0	0	0	0	38	219	678

Estimated Distribution of Mean Annual Discharge and Volumes Available

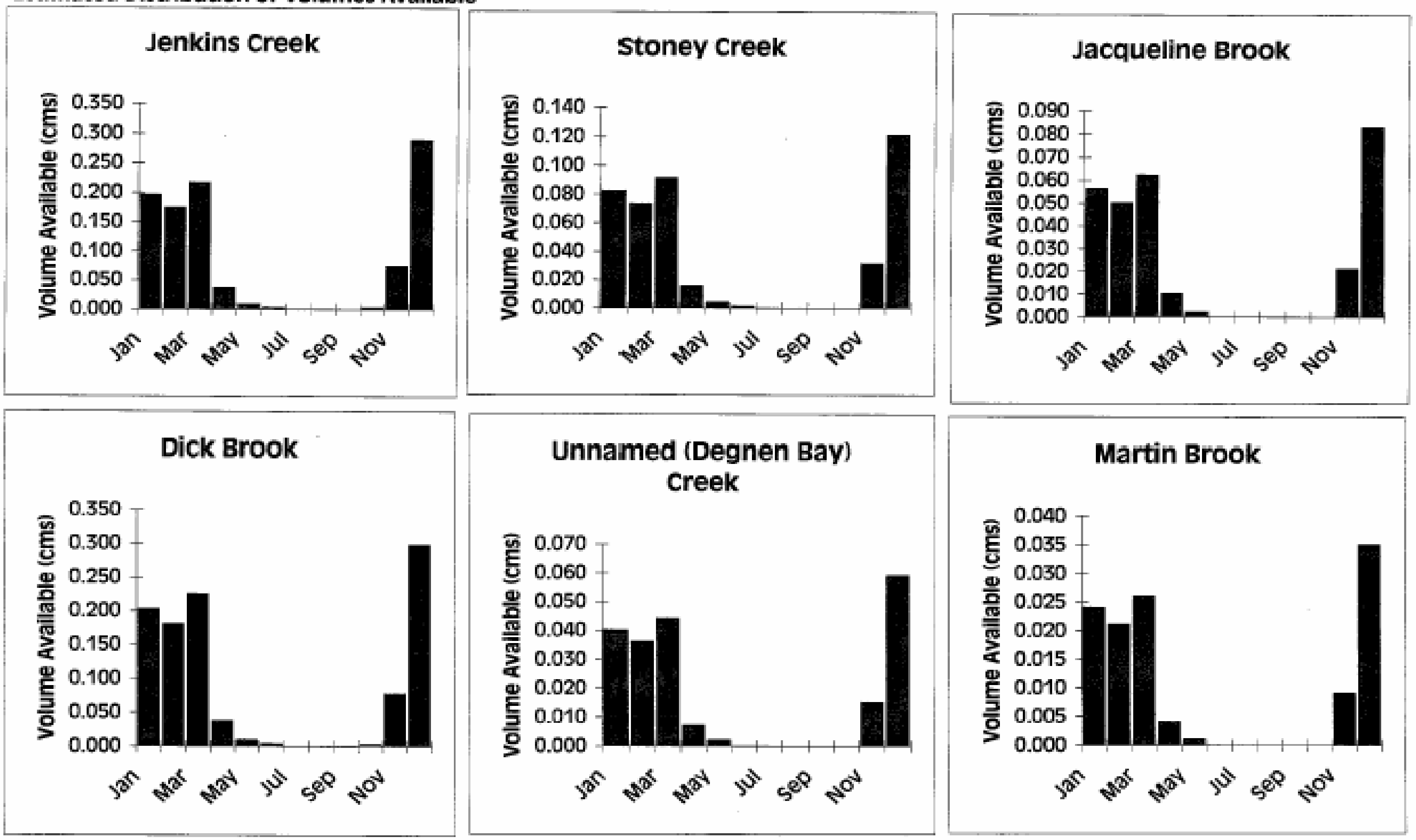
Ungauged Drainage Areas within Gabriola-Valdes-Thetis Islands Water Allocation Plan

Drainage Area		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Unnamed (Burchell Hill) Creek (0.015cms)	Distribution of MAD(cms)	0.035	0.031	0.039	0.006	0.002	0	0	0	0	0	0.013	0.052	
	Volume Available(acft)	76	61	85	13	4	0	0	0	0	0	27	113	379
Wilbee Spring (0.005cms)	Distribution of MAD(cms)	0.012	0.01	0.013	0.002	0	0	0	0	0	0	0.004	0.017	
	Volume Available(acft)	38	20	41	4	0	0	0	0	0	0	8	54	165
Mason/Ginn Creek (0.045cms)	Distribution of MAD(cms)	0.106	0.094	0.117	0.019	0.005	0.001	0	0	0	0	0.04	0.156	
	Volume Available(acft)	336	184	143	40	143	2	0	0	0	0	84	495	1427
Unnamed (Ruxton Passage) Brook (0.002cms)	Distribution of MAD(cms)	0.005	0.004	0.005	0	0	0	0	0	0	0	0.002	0.007	
	Volume Available(acft)	16	8	16	0	0	0	0	0	0	0	4	22	66

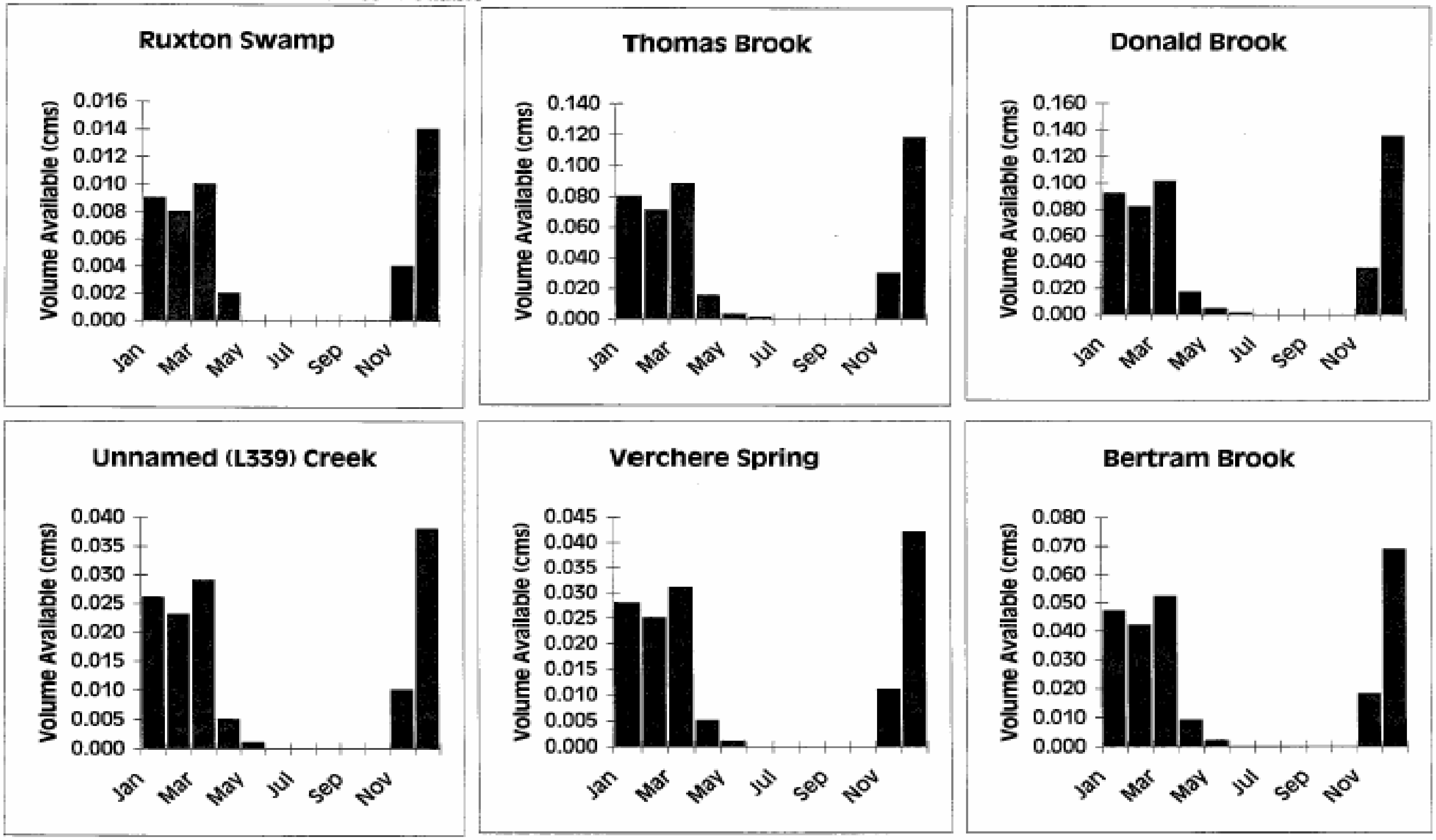
Estimated Distribution of Volumes Available



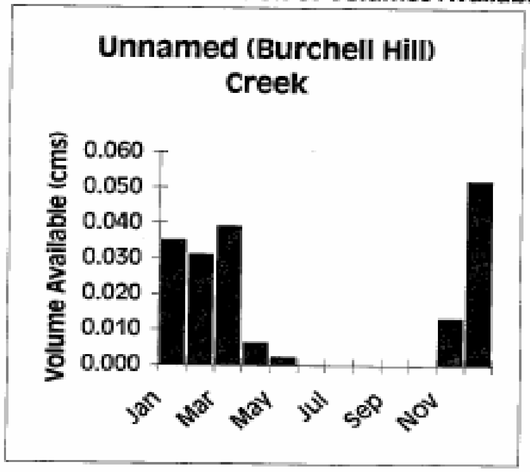
Estimated Distribution of Volumes Available

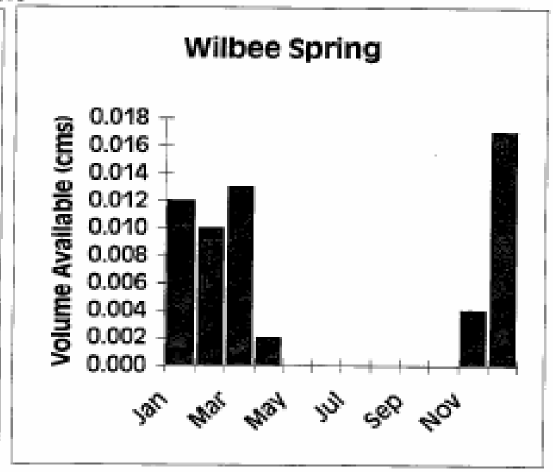


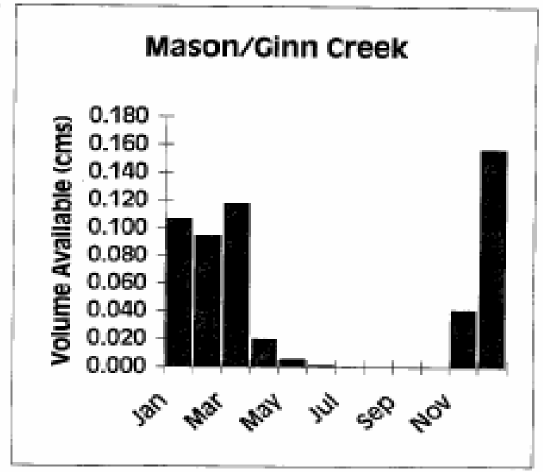
Estimated Distribution of Volumes Available

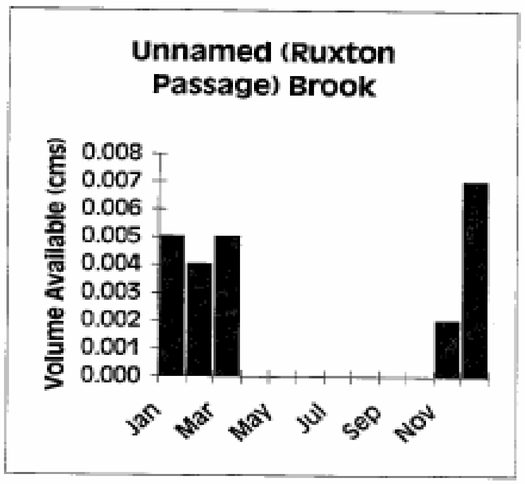


Estimated Distribution of Volumes Available









Appendix C: Licensed Water Demand

LICENCE NUMBER	FILE NUMBER	PRIORITY DATE	TERM START	TERM END	SOURCE NAME	QUANTITY/UNITS	CONVERTED DEMAND: LS	LOW FLOW dam3
DOMESTIC PURPOSE								
C106507	207958	19550525	Jan. 01	Dec. 31	Bertram Brook	2,000.000 GD	0.105	1.415
C069821	1000887	19550525	Jan. 01	Dec. 31	Bertram Brook	1,000.000 GD	0.053	0.714
F041014	285242	19690228	Jan. 01	Dec. 31	Castell Brook	500.000 GD	0.026	0.35
C101155	1001377	19901207	Jan. 01	Dec. 31	Castell Brook	100.000 GD	0.005	0.067
C065820	309898	19720404	Jan. 01	Dec. 31	Chapple Spring	500.000 GD	0.026	0.35
F015263	170761	19471006	Jan. 01	Dec. 31	Claude Spring	1,000.000 GD	0.053	0.714
C061403	1000251	19840106	Jan.01	Dec.31	Crystal Spring	500.000 GD	0.026	0.35
C055523	366726	19800610	Jan. 01	Dec. 31	Darling Spring	500.000 GD	0.026	0.35
C065734	1000671	19861030	Jan. 01	Dec. 31	Dick Brook	500.000 GD	0.026	0.35
C030755	252073	19630906	Jan. 01	Dec. 31	Donald Brook	500.000 GD	0.026	0.35
F040698	290354	19690918	Jan. 01	Dec. 31	Easthom Spring	500.000 GD	0.026	0.35
C055166	366118	19800305	Jan. 01	Dec. 31	Goodhue Creek	500.000 GD	0.026	0.35
C042348	322500	19380801	Jan. 01	Dec. 31	Harold Spring	500.000 GD	0.026	0.35
F042622	131775	19380801	Jan. 01	Dec. 31	Harold Spring	500.000 GD	0.026	0.35
F040699	228629	19591202	Jan. 01	Dec. 31	Harold Spring	500.000 GD	0.026	0.35
F040700	228630	19591202	Jan. 01	Dec. 31	Harold Spring	500.000 GD	0.026	0.35
F040701	229612	19600209	Jan. 01	Dec. 31	Harold Spring	500.000 GD	0.026	0.35
C044729	322386	19740123	Jan. 01	Dec.31	Harold Spring	500.000 GD	0.026	0.35
C063921	1000471	19850515	Jan. 01	Dec. 31	Hoggan Creek	800.000 GD	0.042	0.566
F070362	322337	19740109	Jan. 01	Dec. 31	Hoggan Lake	1,250.000 GD	0.066	0.89
C058279	1000016	19820511	Jan. 01	Dec. 31	Hoggan Lake	1,500.00 GD	0.079	1.065
C063741	77087	19270826	Jan. 01	Dec. 31	Lawrence Spring	2,000.000 GD	0.105	1.415
C061401	1000372	19840509	Jan. 01	Dec. 31	Mallett Creek	500.000 GD	0.026	0.35
C045317	328713	19750428	Jan. 01	Dec. 31	Martin Brook	500.000 GD	0.026	0.35
C045741	328720	19750430	Jan. 01	Dec. 31	Martin Brook	200.000 GD	0.011	0.148
C021930	201643	19530921	Jan. 01	Dec. 31	McCall Spring	500.000 GD	0.026	0.35
C040780	310651	19720810	Jan. 01	Dec. 31	McCormack Creek	500.000 GD	0.026	0.35
C059401	369232	19810910	Jan. 01	Dec. 31	North Thomas	500.000 GD	0.026	0.35
C020280	190336	19510813	Jan. 01	Dec. 31	Pam Brook	1,000.000 GD	0.053	0.714
F015219	169719	19470901	Jan. 01	Dec. 31	Pam Spring	500.000 GD	0.026	0.35
C041870	316749	19730411	Jan. 01	Dec. 31	Rowson Spring	500.000 GD	0.026	0.35

LICENCE NUMBER	FILE NUMBER	PRIORITY DATE	TERM START	TERM END	SOURCE NAME	QUANTITY/UNITS	CONVERTED DEMAND: LS	LOW FLOW dam3
DOMESTIC PURPOSE								
C061389	1000169	19830530	Jan. 01	Dec. 31	Ruxton Swamp	500.000 GD	0.026	0.35
C061390	1000262	19830530	Jan. 01	Dec. 31	Ruxton Swamp	500.000 GD	0.026	0.35
C024623	222045	19580915	Jan. 01	Dec. 31	Sewell Spring	6,000.000 GD	0.316	4.26
C030317	252628	19631009	Jan. 01	Dec. 31	Thomas Brook	500.000 GD	0.026	0.35
C059402	369377	19811021	Jan. 01	Dec. 31	Thomas Brook	500.000 GD	0.026	0.35
C056128	364561	19780822	Jan. 01	Dec. 31	Thomas Brook	500.000 GD	0.026	0.35
C027946	245915	19621206	Jan. 01	Dec. 31	Verchere Spring	500.000 GD	0.026	0.35
C101139	1001354	19901002	Jan. 01	Dec. 31	Vicki Spring	500.000 GD	0.026	0.35
C072634	1000815	19880205	Jan. 01	Dec. 31	Wilbee Spring	500.000 GD	0.026	0.35
C072635	1000966	19881104	Jan. 01	Dec. 31	Windecker Spring	100.000 GD	0.005	0.067
					SUB-TOTAL	**31,450.000 GD**	**1.647**	**22.185**
IRRIGATION PURPOSE								
C055164	366092	19800222	Apr. 01	Sep. 30	Castell Brook	1.000 AF	0.159	1.236
C036091	290303	19690909	Apr. 01	Sep. 30	Dick Brook	27.000 AF	4.283	33.305
C065731	1000513	19850812	Apr. 01	Sep. 30	Eppler Swamp	0.030 AF	0.005	0.039
C070374	1000993	19890103	Apr. 01	Sep. 30	Farrow Spring	1.000 AF	0.159	1.236
C070321	1000795	19871130	Apr. 01	Sep. 30	Goodhue Creek	3.500 AF	0.555	4.316
F062077	309323	19711125	Apr. 01	Sep. 30	Hoggan Lake	6.200 AF	0.984	7.652
C065742	1000748	19870713	Apr. 01	Sep. 30	Ike Brook	5.000 AF	0.793	6.166
C072274	1001078	19890612	Apr. 01	Sep. 30	Ingeberg Swamp	5.000 AF	0.793	6.166
C053058	341032	19770331	Apr. 01	Sep. 30	Jacqueline Brook	1.000 AF	0.159	1.236
C061401	1000372	19840509	Apr. 01	Sep. 30	Mallett Creek	18.000 AF	2.855	22.2
C045741	328720	19750430	Apr. 01	Sep. 30	Martin Brook	1.000 AF	0.159	1.236
C024623	222045	19580915	Apr. 01	Sep. 30	Sewell Spring	10.000 AF	1.586	12.333
C072621	1000756	19870806	Apr. 01	Sep. 30	Stoney Creek	2.000 AF	0.317	2.465
C061943	1000111	19821222	Apr. 01	Sep. 30	Toadeye Swamp	1.000 AF	0.159	1.236
C101139	1001354	19901002	Apr. 01	Sep. 30	Vicki Spring	1.000 AF	0.159	1.236
					SUB-TOTAL	**82.73 AF**	**13.125**	**102.058**

LICENCE NUMBER	FILE NUMBER	PRIORITY DATE	TERM START	TERM END	SOURCE NAME	QUANTITY/UNITS	CONVERTED DEMAND: LS	LOW FLOW dam3
INDUSTRIAL ENTERPRISE PURPOSE								
C062079	309323	19711125	Jan. 01	Dec. 31	Hoggan Lake	4,000.000 GD	0.21	2.83
C043118	322338	19740109	Jan. 01	Dec. 31	Hoggan Lake	20,000.000 GD	1.052	14.179
C062078	309323	19711125	Apr. 01	Sep. 30	Hoggan Lake	48.200 AF/		
						145,000 GD	7.551	58.709
C070343	316726	19730410	Jan. 01	Dec. 31	Lobo Spring	1,000.000 GD	0.053	0.714
C065736	1000473	19850515	Jan. 01	Dec. 31	Lucas Spring	450.000 GD	0.024	0.323
C061401	1000372	19840509	Jan. 01	Dec. 31	Mallett Creek	500.000 GD	0.026	0.35
C072621	1000756	19870806	Jan. 01	Dec. 31	Stoney Creek	200.000 GD	0.011	0.148
					SUB-TOTAL	**171,150.000 GD**	**8.738**	**77.253**
POWER RESIDENTIAL PURPOSE								
C063922	1000469	19850515	Jan. 01	Dec. 31	Hoggan Creek	13.000 CS	368.109	2862.416
					SUB-TOTAL	**13.000 CS**	**368.109**	**2862.416**
LAND IMPROVEMENT PURPOSE								
C107143	341032	19770331	Jan. 01	Dec. 31	Jacqueline Brook	0.740 AF	0.117	0.91
C070378	1001040	19890313	Jan. 01	Dec. 31	McClay Creek	0.300 AF	0.048	0.373
					SUB-TOTAL	**1.040 AF**	**0.165**	**1.283**
STORAGE PURPOSE								
F041015	285242	19690228	Jan. 01	Dec. 31	Castell Brook	0.500 AF	-0.079	-0.614
C055165	366092	19800222	Jan. 01	Dec. 31	Castell Brook	1.000 AF	-0.159	-1.236
C036092	290303	19690909	Jan. 01	Dec. 31	Dick Brook	27.000 AF	-4.283	-33.305
C070374	1000993	19890103	Jan. 01	Dec. 31	Farrow Spring	1.000 AF	-0.159	-1.236
C070321	1000795	19871130	Jan. 01	Dec. 31	Goodhue Creek	3.500 AF	-0.555	-4.316
C063923	1000470	19850515	Jan. 01	Dec. 31	Hoggan Lake	120.000 AF	-19.035	-148.016
F062080	309323	19711125	Jan. 01	Dec. 31	Hoggan Lake	62.000 AF	-9.835	-76.477
C065742	1000748	19870713	Jan. 01	Dec. 31	Ike Brook	5.000 AF	-0.793	-6.166
C072274	1001078	19890612	Jan. 01	Dec. 31	Ingeberg Swamp	5.000 AF	-0.793	-6.166
C053059	341032	19770331	Jan. 01	Dec. 31	Jacqueline Brook	1.000 AF	-0.159	-1.236
C070343	316726	19730410	Jan. 01	Dec. 31	Lobo Spring	0.500 AF	-0.079	-0.614

LICENCE NUMBER	FILE NUMBER	PRIORITY DATE	TERM START	TERM END	SOURCE NAME	QUANTITY/UNITS	CONVERTED DEMAND: LS	LOW FLOW dam3
STORAGE PURPOSE								
C061402	1000372	19840509	Jan. 01	Dec. 31	Mallett Creek	18.000 AF	-2.855	-22.2
C045318	328713	19750428	Jan. 01	Dec. 31	Martin Brook	0.500 AF	-0.079	-0.614
C072621	1000756	19870806	Jan. 01	Dec. 31	Stoney Creek	3.000 AF	-0.476	-3.701
C061944	1000111	19821222	Jan. 01	Dec. 31	Toadeye Swamp	1.000 AF	-0.159	-1.236
C101139	1001354	19901002	Jan. 01	Dec. 31	Vicki Spring	1.500 AF	-0.238	-1.851
					SUB-TOTAL	**250.500 AF**	**-39.736**	**-308.984**
Based on an estimated 90 day irrigation period								
Lowflow is 156 days from June-October								

			CONVERTED DEMAND					
SOURCE NAME	PURPOSE	QUANTITY/UNITS		lowflow	highflow	COMMENTS		
			l/sec *	dam3	dam3			
Goodhue Creek								
Hoggan Lake	DOM	2,750.000 GD	0.145	1.955	2.268			
Goodhue Creek	DOM	500.000 GD	0.026	0.35	0.407			
Hoggan Creek	DOM	800.000 GD	0.042	0.566	0.657			
Hoggan Lake	IRR	6.200 AF	0.984	7.652	0			
Goodhue Creek	IRR	3.500 AF	0.555	4.316	0			
Hoggan Lake	IND	169,000.000 GD	8.813	75.718	137.821			
Hoggan Creek	POWER	13.000 CFS	368.109		non consumptive			
Hoggan Lake	STONP	182.000 AF	-28.87	-224.493	224.49			
Goodhue Creek	STONP	3.500 AF	-0.476	-3.701	3.701			
		TOTAL	349.328	-137.637	369.344			
Mallett Creek								
Mallett Creek	DOM	500.000 GD	0.026	0.35	0.407			
Ingeberg Swamp	IRR	5.000 AF	0.793	6.166	0			
Mallett Creek	IRR	18.000 AF	2.855	22.2	0			
Mallett Creek	IND	500.000 GD	0.026	0.35	0.407			
Ingeberg Swamp	STONP	5.000 AF	-0.793	-6.166	6.166			
Mallett Creek	STONP	18.000 AF	-2.855	-22.2	22.2			
		TOTAL	0.052	0.7	29.587			
McCormack Creek						*based on an estimated 90 irrigation period		
McCormack Creek	DOM	500.000 GD	0.026	0.35	0.407	Lowflow is 156 days from June-October		
						Highflow is 181 days from November-April		

			CONVERTED DEMAND					
SOURCE NAME	**PURPOSE**	**QUANTITY/UNITS**		**lowflow**	**highflow**	**COMMENTS**		
			l/sec *	**dam3**	**dam3**			
Fransceco Brook								
Harold Spring	DOM	3000.000 GD	0.156	2.1	2.44			
Ike Brook								
McCall Spring	DOM	500.000 GD	0.026	0.35	0.407			
Pam Spring	DOM	500.000 GD	0.026	0.35	0.407			
Pam Brook	DOM	1,000.000 GD	0.053	0.714	0.829			
Darling Spring	DOM	500.000 GD	0.026	0.35	0.407			
Ike Brook	IRR	5.000 AF	0.793	6.166	0			
Ike Brook	STONP	5.000 AF	-0.793	-6.166	6.166			
		Total	0.131	1.895	8.216			
Castell Brook								
Castell Brook	DOM	600.000 GD	0.031	0.417	0.485			
Castell Brook	IRR	1.000 AF	0.159	1.236	0			
McClay Creek	LDIMP	0.300 AF	0.048	0.373	0			
Castell Brook	STONP	1.500 AF	-0.238	-1.85	1.85			
		TOTAL	0	0.176	2.335			
Stoney Creek								
Stoney Creek	IRR	2.000 AF	0.317	2.465	0			
Stoney Creek	IND	200.000 GD	0.011	0.148	0.172			
						*based on an estimated 90 irrigation period		
Stoney Creek	STONP	3.000 AF	-0.476	-3.701	3.701	Lowflow is 156 days from June-October		
		TOTAL	-0.148	-1.088	3.873	Highflow is 181 days from November-April		

			CONVERTED DEMAND					
SOURCE NAME	**PURPOSE**	**QUANTITY/UNITS**		**lowflow**	**highflow**	**COMMENTS**		
			l/sec *	**dam3**	**dam3**			
Jacqueline Brook								
Windecker Spring	DOM	100.000 GD	0.005	0.067	0.078			
Jacqueline Brook	IRR	1.000 AF	0.159	1.236	0			
		TOTAL	0.164	1.303	0.078			
Dick Brook								
Dick Brook	DOM	500.000 GD	0.026	0.35	0.407			
Dick Brook	IRR	27.000 AF	4.283	33.305	0			
Dick Brook	STONP	27.000 AF	-4.283	-33.305	33.305			
		TOTAL	0.026	0.35	33.712			
Martin Brook								
Martin Brook	DOM	700.000 GD	0.037	0.498	0.579			
Martin Brook	IRR	1.000 AF	0.159	1.236	0			
Martin Brook	STONP	0.500 AF	-0.079	-0.614	0.614			
		TOTAL	0.117	1.12	1.193			
Ruxton Swamp								
Ruxton Swamp	DOM	1,000.000 GD	0.052	0.7	0.813			
Thomas Brook								
Thomas Brook	DOM	1500.000 GD	0.078	1.05	1.22			
North Thomas	DOM	500.000 GD	0.026	0.35	0.407			
		TOTAL	0.104	1.4	1.627	*based on an estimated 90 irrigation period		
						Lowflow is 156 days from June-October		
						Highflow is 181 days from November-April		

			CONVERTED DEMAND					
SOURCE NAME	**PURPOSE**	**QUANTITY/UNITS**		**lowflow**	**highflow**	**COMMENTS**		
			l/sec *	**dam3**	**dam3**			
Donald Brook								
Donald Brook	DOM	500.000 GD	0.026	0.35	0.407			
Verchere Spring								
Verchere Spring	DOM	500.000 GD	0.026	0.35	0.407			
Bertram Brook								
Bertram Brook	DOM	3,000.000 GD	0.158	2.129	2.471			
Crystal Spring								
Crystal Spring	DOM	500.000 GD	0.026	0.35	0.407			
Wilbee Spring								
Wilbee Spring	DOM	500.000 GD	0.026	0.35	0.407			
Rowson Spring								
Rowson Spring	DOM	500.000 GD	0.026	0.35	0.407			
Farrow Spring								
Farrow Spring	IRR	1.000 AF	0.159	1.236	0			
	STONP	1.000 AF	-0.159	-1.236	1.236			
		TOTAL	0	0	1.643			
Vicki Spring								
Vicki Spring	DOM	500.000 GD	0.026	0.35	0.407			
Vicki Spring	IRR	1.000 AF	0.159	1.236	0			
		TOTAL	0.185	1.586	0.407	*based on an estimated 90 irrigation period		
						Lowflow is 156 days from June-October		
						Highflow is 181 days from November-April		

			CONVERTED DEMAND			COMMENTS		
SOURCE NAME	PURPOSE	QUANTITY/UNITS		lowflow	highflow			
			l/sec *	dam3	dam3			
Chapple Spring								
Chapple Spring	DOM	500.000 GD	0.026	0.35	0.407			
Lobo Spring								
Lobo Spring	IND	1,000.000 GD	0.053	0.714	0			
		TOTAL	-0.026	0.1	1.021			
Eppler Swamp								
Eppler Swamp	IRR	0.300 AF	0.005	0.039	0			
Easthom Spring								
Easthom Spring	DOM	500.000 GD	0.026	0.35	0.407			
Lucas Spring								
Lucas Spring	IND	450.000 GD	0.024	0.323	0.375			
Sewell Spring								
Sewell Spring	DOM	6,000.000 GD	0.316	4.26	4.942			
Sewell Spring	IRR	10.000 AF	1.586	12.333	0			
		TOTAL	1.902	16.593	4.942			
Lawrence Spring								
Lawrence Spring	DOM	2,000.000 GD	0.105	1.415	1.642			
						*based on an estimated 90 irrigation period		
						Lowflow is 156 days from June-October		
						Highflow is 181 days from November-April		

Appendix D: Pending (1994) Water Licensed Applications

LICENCE NUMBER	FILE NUMBER	PRIORITY DATE	TERM START	TERM END	SOURCE NAME	QUANTITY/UNITS	CONVERTED DEMAND: LS	LOW FLOW dam3
DOMESTIC PURPOSE								
Z101145	1001352	19901002	Jan. 01	Dec. 31	Jenkins Creek	500.000 GD	0.026	0.35
Z101149	1001353	19901002	Jan. 01	Dec. 31	Jenkins Creek	500.000 GD	0.026	0.35
Z105804	1001635	19921030	Jan. 01	Dec. 31	ZZ Spring(67048) Gab.	500.000 GD	0.026	0.35
Z107517	1001742	19931221	Jan. 01	Dec. 31	ZZ Spring (68668) Gab.	500.000 GD	0.026	0.35
Z103809	1001527	19911120	Jan. 01	Dec. 31	ZZ Spring (64916) Thetis	500.000 GD	0.026	0.35
Z104218	1001547	19920116	Jan. 01	Dec. 31	ZZ Swamp Gab.	500.000 GD	0.026	0.35
					TOTAL	**3000.000 GD**	**0.156**	**2.1**
IRRIGATION PURPOSE								
Z106297	1001664	19930208	**Jan. 01**	**Dec. 31**	Dick Brook	**5.000 AF**	**0.793**	**6.2**
Z100846	1001031	19890213	Apr. 01	Sep. 30	Jacqueline Brook	0.500 AF	0.079	0.6
Z101149	1001353	19901002	Apr. 01	Sep. 30	Jenkins Creek	4.000 AF	0.635	4.9
Z101145	1001352	19901002	Apr. 01	Sep. 30	Jenkins Creek	1.500 AF	0.238	1.9
Z106792	1001695	19930614	**Jan. 01**	**Dec. 31**	Martin Brook	5.000 AF	0.793	6.2
Z100849	1001151	19891102	Apr. 01	Sep. 30	McCormack Swamp	1.500 AF	0.238	1.9
Z106791	1001686	19930521	**Jan. 01**	**Dec. 31**	ZZ Spring (67937) Gab.	10.000 AF	1.586	12.33
					TOTAL	**27.500 AF**	**4.362**	**34.03**
INDUSTRIAL								
Z100867	1001042	19890317	Jan. 01	Dec. 31	ZZ Pond (22982) Gab.	450,000.000 GD	23.436	182.24
Z103307	1001505	19910923	Jan. 01	Dec. 31	ZZ Spring (64438) Thetis	1,000.000 GD	0.052	0.4
Z103809	1001527	19911120	Jan. 01	Dec. 31	ZZ Spring (64916) Thetis	140.000 GD	0.007	0.05
Z105849	1001643	19921119	Jan. 01	Dec. 31	ZZ Spring (67110) Valdes	100.000 GD	0.005	0.04
					TOTAL	**451,240.000 GD**	**23.5**	**182.73**
LAND IMPROVEMENT								
Z100846	1001031	19890213	Jan. 01	Dec. 31	Jacqueline Brook	1.000 GD	0	0
					TOTAL	**1.000 GD**	**0**	**0**
CONSERVATION								
Z106874	1001706	19930716	Jan. 01	Dec. 31	ZZ Swamp (68045) DeC	1.000 AF	0.093	1.234
					Total	**1.000 AF**	**0.093**	**1.234**

LICENCE NUMBER	FILE NUMBER	PRIORITY DATE	TERM START	TERM END	SOURCE NAME	QUANTITY/UNITS	CONVERTED DEMAND: LS	LOW FLOW dam3
STORAGE PURPOSE								
Z106297	1001664	19930208	Jan. 01	Dec. 31	Dick Brook	2.500 AF	-0.397	-3.1
Z101149	1001353	19901002	Jan. 01	Dec. 31	Jenkins Creek	6.000 AF	-0.952	-7.4
Z101145	1001352	19901002	Jan. 01	Dec. 31	Jenkins Creek	2.000 AF	-0.317	-2.5
Z106792	1001695	19930614	Jan. 01	Dec. 31	Martin Brook	2.500 AF	-0.397	-3.1
Z100849	1001151	19891102	Jan. 01	Dec. 31	McCormack Swamp	1.500 AF	-0.238	-1.9
Z105849	1001643	19921119	Jan. 01	Dec. 31	ZZ Spring (67110) Valdes	0.003 AF	0	0
					TOTAL	**14.503 AF**	**-2.301**	**-18**
Based on an estimated 90 day irrigation period								

Appendix E: Fish Screening Information

FISH SCREENING DIRECTIVE

Government of Canada
Department of Fisheries and Oceans

WATER INTAKE FISH PROTECTION FACILITIES

The Department of Fisheries and Oceans has prepared this document as a guide to assist in the design and installation of water intakes and fish screening in British Columbia and the Yukon Territory to avoid conflicts with anadromous fish. Additional precautions must be taken at marine intake locations where entrainment of fish larvae, such as eulachon and herring larvae, is a possibility. The screening criteria constitutes the Department's policy regarding the design and construction requirements pursuant to Section 28 of the Fisheries Act.

PROVISIONS OF THE FISHERIES ACT - SECTION 28

Every water intake, ditch, channel or canal in Canada constructed or adapted for conducting water from any Canadian fisheries waters for irrigating, manufacturing, power generation, domestic or other purposes, shall, if the Minister deems it neccessary in the public interest, be provided at its entrance or intake with a fish guard or a screen, covering or netting, so fixed as to prevent the passage of fish from any Canadian fisheries waters into such water intake, ditch, channel or canal.

The fish guard, screen, covering or netting shall have meshes or holes of such dimensions as the Minister may prescribe, and shall be built and maintained by the owner or occupier of the water intake, ditch, channel or canal subject to the approval of the Minister or such officer as the Minister may appoint to examine it.

The owner or occupier of the water intake, ditch, channel or canal shall maintain the fish guard, screen, covering or netting in a good and efficient state of repair and shall not permit its removal except for renewal or repair, and during the time such renewal or repair is being effected, the sluice or gate at the intake or entrance of the water intake, ditch, channel or canal shall be closed in order to prevent the passage of fish into the water intake, ditch, channel or canal.

PROCEDURES FOR INSPECTION AND APPROVAL OF INTAKE STRUCTURES

Diversions less than 0.0283 cms (one cubic foot per second): The intake structure shall be constructed in accordance with specifications indicated herein. Upon completion of construction and prior to operation the owner shall contact a local representative of the Department of Fisheries and Oceans to arrange for on-site inspection and approval of the installation. Permanently submerged screens must be inspected prior to installation.

Diversons greater than 0.0283 cms (one cubic foot per second): The owner shall submit to the Department of Fisheries and Oceans 2 sets of detailed plans of the proposed installation for review and approval prior to fabrication. Design drawings are required whenever the diversion quantity exceeds 0.0283 cms (1.0 cfs) or 817,200 L/day (180,000 Igpd) for industrial diversions (calculated on the basis of 8 hours/day) or 123,350 cmy (100 ac.- ft./year) for irrigation diversions (calculated on the basis of 100 days/year and 12 hours/day). The plans shall contain the following information:

1. Intake structure location and dimensions.
2. Maximum discharge capacity of diversion.
3. Screen dimensions.
4. Mesh size.
5. Screen material.
6. Fabrication details.
7. Minimum and maximum water levels at the intake site.
8. Provision for bypassing fish.

The intake structure shall then be constructed in accordance with the approved plans. Upon completion of construction and prior to operation, the owner shall contact the local representative of the Department of Fisheries and Oceans to arrange for on-site inspection and approval of the installation. Permanently submerged screens must be inspected prior to installation.

SPECIFICATIONS FOR INTAKE STRUCTURES WITHOUT PROVISION FOR AUTOMATIC CLEANING

1. Screen Material: The screen material shall be either stainless steel, galvanized steel, aluminum, brass, bronze, or monel metal. Stainless steel is preferred since corrosion is greatly reduced.

2. Screen Mesh Size: Clear openings of the screen (the space between strands) shall not exceed 2.54 mm (0.10 inch). The open screen area shall not be less than 50% of the total screen area. The following square-mesh wire cloth screens are recommended:

   - 7 mesh, 1.025 mm (0.041 inch) wire, 51% open, 2.54 mm (0.10 inch) openings; or
   - 8 mesh, 0.875 mm (0.035 inch) wire, 52% open, 2.25 mm (0.09 inch) openings; or
   - 8 mesh, 0.700 mm (0.028 inch) wire, 60% open, 2.54 mm (0.10 inch) openings.

3. Screen Area: A minimum unobstructed screen area (gross area) of 0.93 square metre (10 square feet) shall be provided for each 0.0283 cms (1cfs) of water entering the intake. The required screen area shall be installed below minimum water level. Screen area lost by framing shall not be included as part of the unobstructed screen area.

4. Screen Support: The screen shall be adequately supported with stiffeners or back-up material to prevent excessive sagging.

5. Screen Protection: The intake structure shall, where necessary, be equipped with a trash rack or similar device to prevent damage to the screen from floating debris, ice, etc.

6. Screen Accessibility: The screen shall be readily accessible for cleaning and inspection. Screen panels or screen assemblies must be removable for cleaning, inspection and repairs.

7. Allowable Openings: The portion of the intake structure which is submerged at maximum water level shall be designed and assembled such that no openings exceed 2.54 mm (0.10 inch) in width.

8. Design and Location: The design and location of the intake structure shall be such that a uniform flow distribution is maintained through the total screen area.

9. Fish Bypass: The intake shall be designed to provide a transverse velocity (the component of the velocity parallel and adjacent to the screen face) to lead fish to a bypass or past the screens before they become fatiqued. In no case should the transverse velocity be less than double the velocity through the screen.

SPECIFICATIONS FOR INTAKE STRUCTURES WITH PROVISIONS FOR AUTOMATIC CLEANING

The specifications are identical to those for intake structures without provisions for automatic cleaning except that the minimum unobstructed screen area (gross area) of 0.23 square metre (2.5 square feet) need only be provided for each 0.0283 cms (1 cfs) of water entering the intake. However, a regular cleaning and maintenance schedule is required to ensure seals and screen panels remain in good repair preventing impingement and entrainment of fish and debris.

For these self-cleaning intake structures, the location, design and juvenile fish avoidance system all affect operating characteristics. The final design, therefore, may incorporate modifications reflecting the best current technology available for minimizing adverse impact upon the fisheries resource.

ALTERNATE FISH PROTECTION FACILITIES

Enquiries concerning the Department's requirements for indirect intakes, such as infiltration galleries and wells, for salt water ocean intakes, and for new methods or devices for screening intake structures should be directed to the Department of Fisheries and Oceans, Senior Habitat Management Biologist.

Conversion Factors:

1 cubic foot per second (cfs) = 449 U.S. gallons per minute (U.S. gpm).
= 374 Imperial gallons per minute (Igpm).
= 1.98 acre feet per day (Ac.-Ft./day).
= 28.3 litres per second (L/sec.).
= 0.0283 cubic metres per second (cms)

0.10 inch = 3/32" (approx.) = 2.54 millimetres

Addresses for Correspondence and Approvals

1. Senior Habitat Management Biologist
   Fraser River, Northern B.C. and Yukon Division
   Department of Fisheries and Oceans
   Room 330, 80 - 6th Street
   New Westminster, B.C. V3L 5B3 — Phone: 666-6479

2. Senior Habitat Management Biologist
   South Coast Division
   Department of Fisheries and Oceans
   3225 Stephenson Point Road
   Nanaimo, B.C. V9T 1K3 — Phone: 756-7270

3. Senior Habitat Management Biologist
   North Coast Division
   Department of Fisheries and Oceans
   Room 109, 417 - 2nd Avenue West
   Prince Rupert, B.C. V6J 1G8 — Phone: 624-9385

Other Federal and Provincial agencies having jurisdiction in water withdrawals and construction pertaining to watercourses in British Columbia include:

1. Transport Canada
   Canadian Coast Guard.

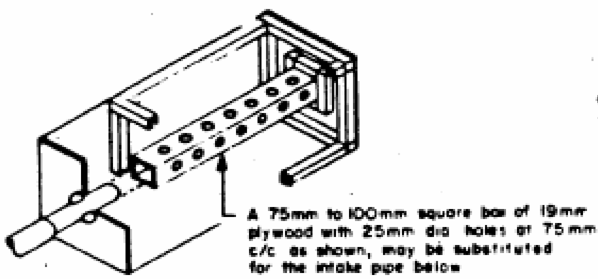
2. B.C. Ministry of Environment
   Fish and Wildlife Management.

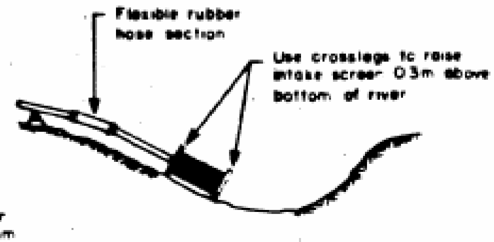
3. B.C. Ministry of Environment
   Water Management.

4. B.C. Ministry of Agriculture and Food.

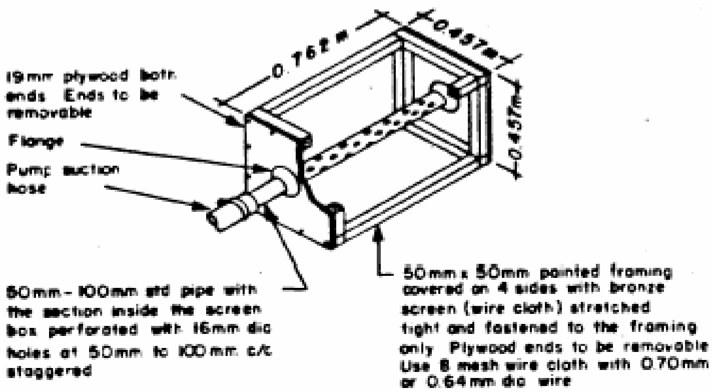
5. B.C. Ministry of Lands, Parks and Housing.

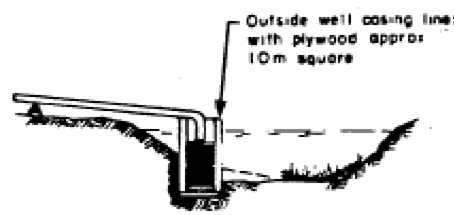
It may be necessary that several or all these agencies also be solicited for approvals prior to the installation of a water intake.



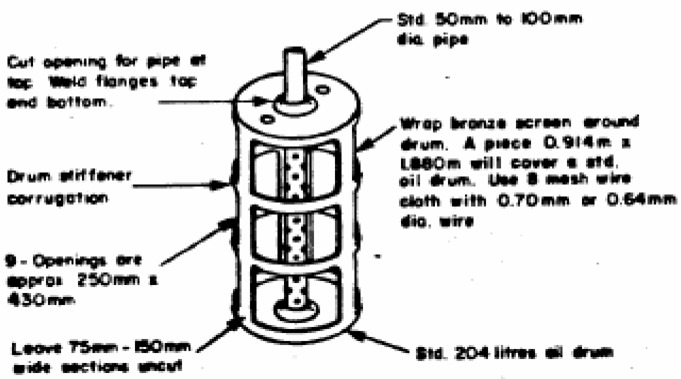


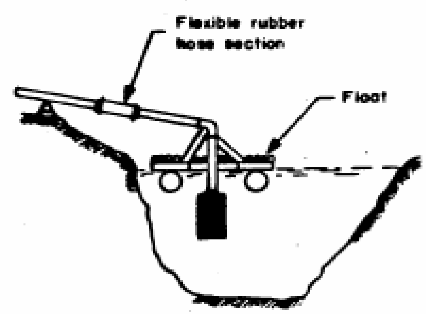
STANDARD INSTALLATION





INSTALLATION IN SHALLOW WATER
MUDDY OVERGROWN BOTTOM





INSTALLATION IN DEEP WATER

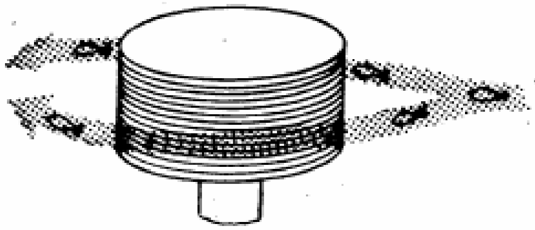
NOTE:

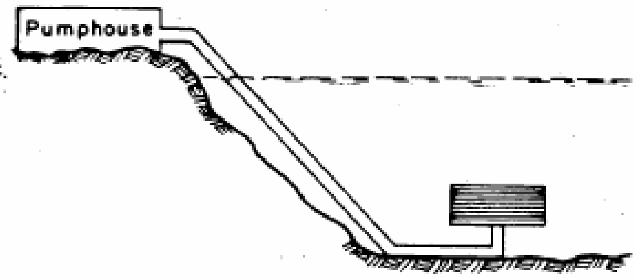
1. Oil drum shall be thoroughly washed out or steam cleaned before cutting openings
2. All loose rust shall be removed and the drum coated with metal primer. Two coats of machinery enamel or expoxy paint shall be applied before covering with wire cloth.

NOTE:
All screens shall be installed below minimum water level, shall be easily accessible for cleaning, and shall be cleared of debris at regular intervals

SMALL STATIONARY WATER INTAKE SCREENS

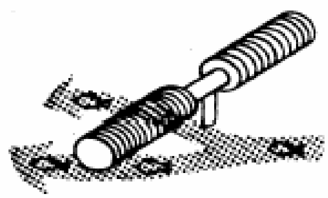
(For pumps of a capacity less than 28.3 L/sec [1cfs, 449 U.S. or 374 Igpm])





DEEP WATER WELL SCREEN

May be installed in lakes and the ocean.



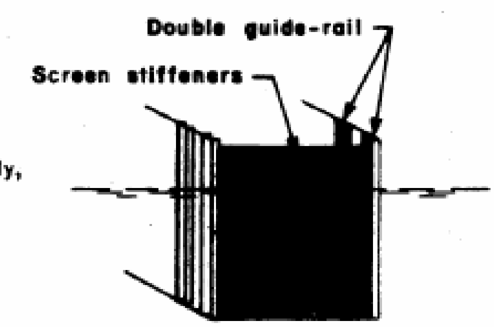
SHALLOW WATER WELL SCREEN

May be installed in lakes, pools, and stable areas in rivers.

Totally submerged cylindrical shaped stainless steel well screens provide for high intake capacity and large percentage of open area permitting water to enter at low velocities. Slot opening shall not exceed 2.54 mm (0.10 inch).

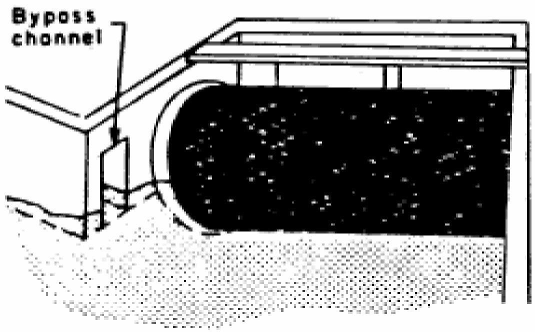
VERTICAL PANEL SCREENS

May be installed in rivers, lakes and the ocean. Generally, requires coarse trashracks, a sluice gate in river installations, double sets of guide-rails, and standby screen panels to allow for cleaning and repairs.



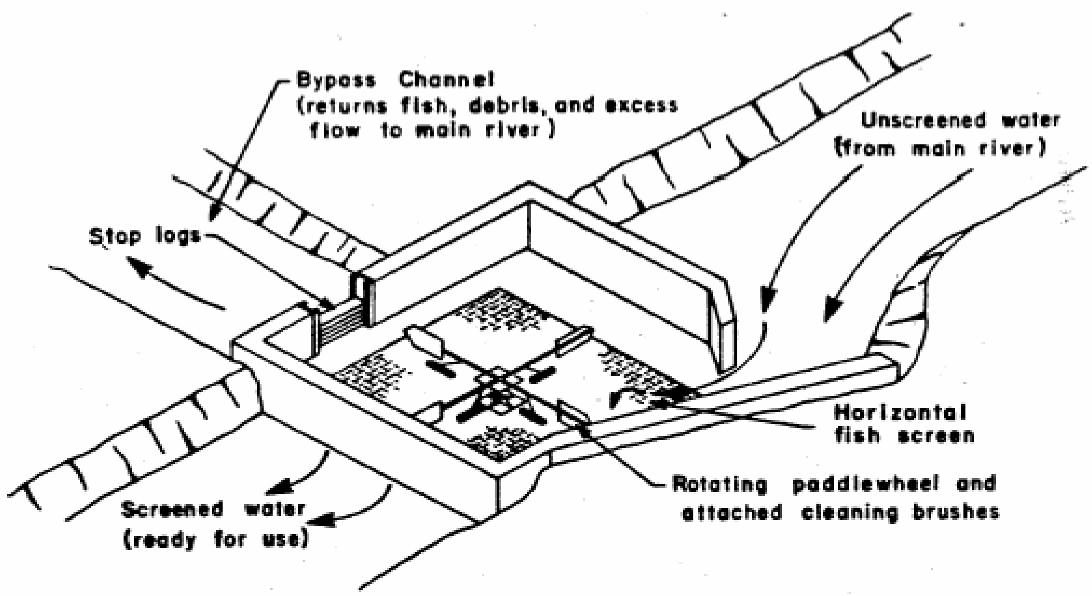
LARGE STATIONARY WATER INTAKE SCREENS

(For pumps of a capacity more than 28.3 L/sec [1 cfs, 449 U.S. or 374 Igpm])



REVOLVING DRUM SCREEN, HORIZONTAL AXIS

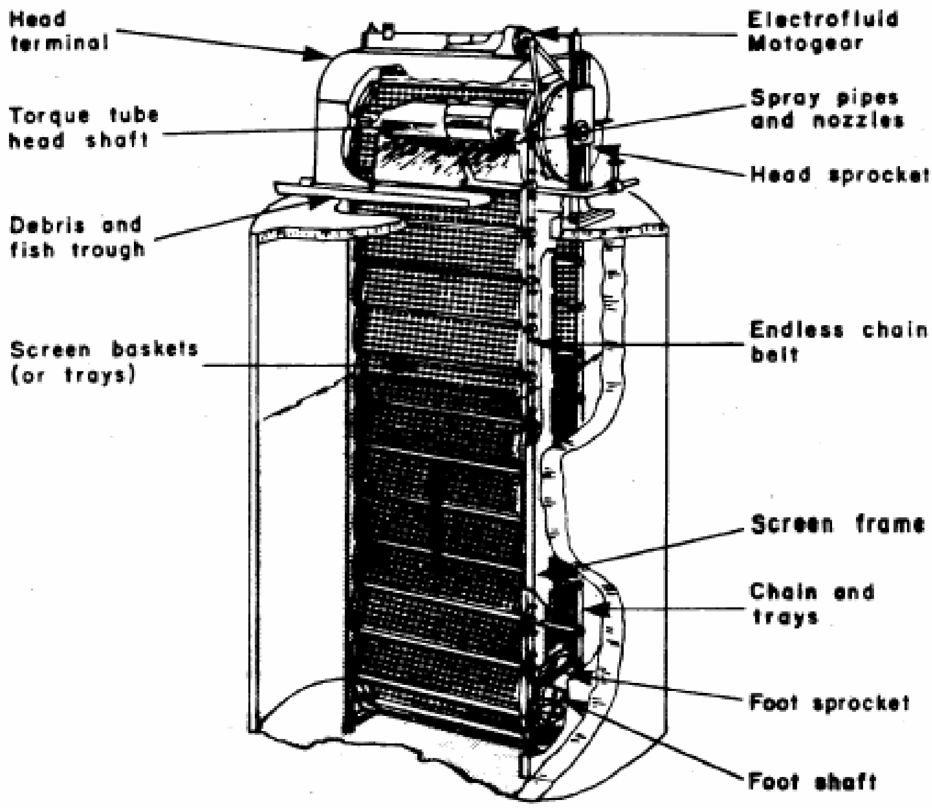
Generally, installed to divert fish from irrigation canals. Can be driven by a small motor or by a paddle wheel. To avoid juvenile fish impingement, a bypass channel is required near the front of the screen. Rubber seals are necessary along the base and sides.



FINNIGAN SCREEN

The horizontal, self-cleaning Finnigan Screen is another concept, generally installed to divert fish from irrigation or enhancement projects. The stationary horizontal screen is kept clean by a set of brushes attached to a revolving paddle wheel powered by the water current entering the structure. A portion of the flow, the suspended debris, and fish are directed to the bypass channel. The remainder of the flow passes through and below the screen for use as required.

IRRIGATION INTAKE SCREENS



CONVENTIONAL VERTICAL TRAVELLING SCREEN

May be installed in rivers, lakes and the ocean. A common screening method utilized by industry, these self-cleaning mechanical screens with modifications can prevent impact upon fish. Mounted flush to the stream bank (shoreline) or as pier intakes within streams and provided with an opening on the downstream end between the intake screens and trashracks, juvenile fish can generally escape entrapment. Rubber panel, side, and boot seals are required to prevent juvenile fish from gaining entry into the pumpwell. A safe bypass system is essential to return juvenile fish with debris back to the watercourse. Automatic controls are also necessary to ensure operation at a specific minimum head differential.

LARGE INDUSTRIAL AND DOMESTIC WATER INTAKE SCREEN

Appendix F: Industrial Water Requirements

Schedule B: Industrial Water Requirements (Metric)

PROCESSING USES

Type of Process	**Water Requirements**
Pulp and Paper Mills	404,558 litres/t
Paper Converting	20,603 litres/t
Saw Mills	6.25 litres/board-metre
Food Processing: Meat Packing Poultry Dressing Dairy Products Canned Fruit & Vegetables Frozen Fruit & Vegetables Malt Beverages	 30 litres/kg. of carcass 44 litres/bird 7 litres/kg. of milk 851 litres/case 24-303 cans 93.3 litres/kg. 5688 litres/barrel of malt
Nitrogenous Fertilizers	88,778 litres/t
Phosphatic Fertilizers	110,879 litres/t
Hydraulic Cement	4,233 litres/t
Steel	195,162 litres/t
Iron and Steel Foundries	38,583 litres/t
Washing Sand and Gravel Initial pond filling Make-up water	 880 litres/t (one time) 130 litres/t/day (8 hrs.)
Primary Copper	441 litres/kg.
Primary Aluminum	411 litres/kg.

Schedule B: Industrial Water Requirements (Metric)

COMMERCIAL USES

Types of Establishment:	**Water Requirements**
Airports	13.65 lpd per passenger
Apartments, multiple family	227.5 lpd per resident
Bath houses	36.4 lpd per bather
Camps: Constr. camps, semi-permanent Day with no meals Luxury Resorts with limited plumbing Tourists with central bath and toilet	 191 lpd per worker 54.6 lpd per camper 387 lpd per camper 191 lpd per camper 132 lpd per camper
Cottages w/seasonal occupancy	191 lpd per resident
Courts, tourist w/individual bath units	191 lpd per person
Clubs: Country Country	 378 lpd per resident 191 lpd per member
Dwellings Boarding houses Luxury dwelling Multiple family apartments Rooming houses Single family	 191 lpd per boarder 378 lpd per person 150 lpd per resident 227.5 lpd per resident 191 lpd per resident
Factories	91 lpd per worker
Hotels: With private bath Without private bath	 227.5 lpd per person 191 lpd per person
Hospitals	1,228 lpd per bed
Institutions other than hospitals	387 lpd per person
Laundries, self service	191 lpd per customer
Motels: With bath and toilet With bath, toilet, and kitchen	 150 lpd per bed 191 lpd per bed
Parks: Overnight with flush toilets	 95.5 lpd per camper

Types of Establishment:	**Water Requirements**
Trailers with individual bath units	191 lpd per camper
Picnic: With toilet With toilet, bath house and showers	 36.4 lpd per picnicker 77 lpd/picnicker
Restaurant: With toilet With toilet, bar and lounge	 36.4 lpd per patron 41 lpd per patron
Schools: Without cafeteria, gym or showers With cafeteria With cafeteria, gym and showers Boarding	 54.6 lpd per pupil 77 lpd per pupil 95.5 lpd per pupil 382 lpd per pupil
Service Stations	36.4 lpd per vehicle
Stores	1,515 lpd per toilet
Swimming Pools	36.4 lpd per swimmer
Theatres: Drive-in Movie and Stage	 18.2 lpd per car space 18.2 lpd per seat
Workers: Construction Office	 191 lpd per worker 54.6 lpd per staff

Schedule B: Industrial Water Requirements (Metric)

AGRICULTURAL USES

Types of Agriculture Activity:	**Gallon/day**
Livestock Drinking: Cattle Dairy cattle (and servicing) Goat Hog Horse Mule Sheep Steer	 45.5 lpd per animal 132 lpd per animal 4.5 lpd per animal 13.6 lpd per animal 45.5 lpd per animal 45.5 lpd per animal 4.5 lpd per animal 45.5 lpd per animal
Poultry: Chicken (per 100) Turkeys (per 100)	 27.3 lpd per 100 54.6 lpd per 100
Flood harvesting (cranberries)	2 dam^3 per hectare
Crop suppression (potatoes)	.2 dam^3 per hectare (from Jan. to Mar.)
Frost protection and tree cooling	2 dam^3 per hectare

Appendix G: References

References

Gabriola Island Official Community Plan, Island Trust, February 19,1993.

Canadian Climate Normals 1951-1980 Temperature and Precipitation, Environment Canada, Atmospheric Environment Service.

Senewelets-Culture History of the Nanaimo Coast, David V.Burley, Ministry of Municipal Affairs, Recreation, and Culture, Victoria, 1989.

Islands Specific Census Data, Island Trust.

Historical Streamflow Summary British Columbia to 1988, Inland Waters Directorate Water Resources Branch, Environment Canada.