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

Comox / Black Creek

WATER ALLOCATION PLAN

June 10, 1997

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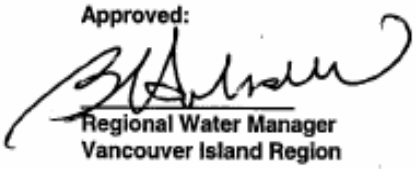

Regional Water Manager
Vancouver Island Region

Date:

13 June 1997

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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 advantages are:

- Water Management's position on water allocation decisions is available to applicants and public.
- A significant reduction in response time.
- The Elimination of the need for individual studies and reports on each application.
- Consistency of decisions are improved.
- Specific allocation directions and decisions are defined.
- Plans are more comprehensive.
- Elimination of the need for referrals on individual applications.

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

> **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.

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 Comox / Black Creek region is illustrated in *Figure 1.* It is an area located north of Courtenay and south of Campbell River on the east coast of Vancouver Island with a total area of 186.5 km^2. The predominant drainage divide for the plan area is located between the Tsolum River watershed to the south and the Oyster River watershed to the north. With the exception of Brooklyn Creek and Queens Ditch, flow in the plan area is generally in a west to east direction into the Strait of Georgia.

For the purpose of assessing water supplies for allocation demands, watershed and drainage areas were identified and defined on 1:50,000 NTS maps. The following table lists the significant drainage areas as illustrated in *Figure 2*.

Significant Drainage Areas	
Drainage Location	**Area (km^2)**
Black Creek	80.8
Kitty Coleman Creek	14.2
Little River	19.3
Queens Ditch	10
Brooklyn Creek	6.7

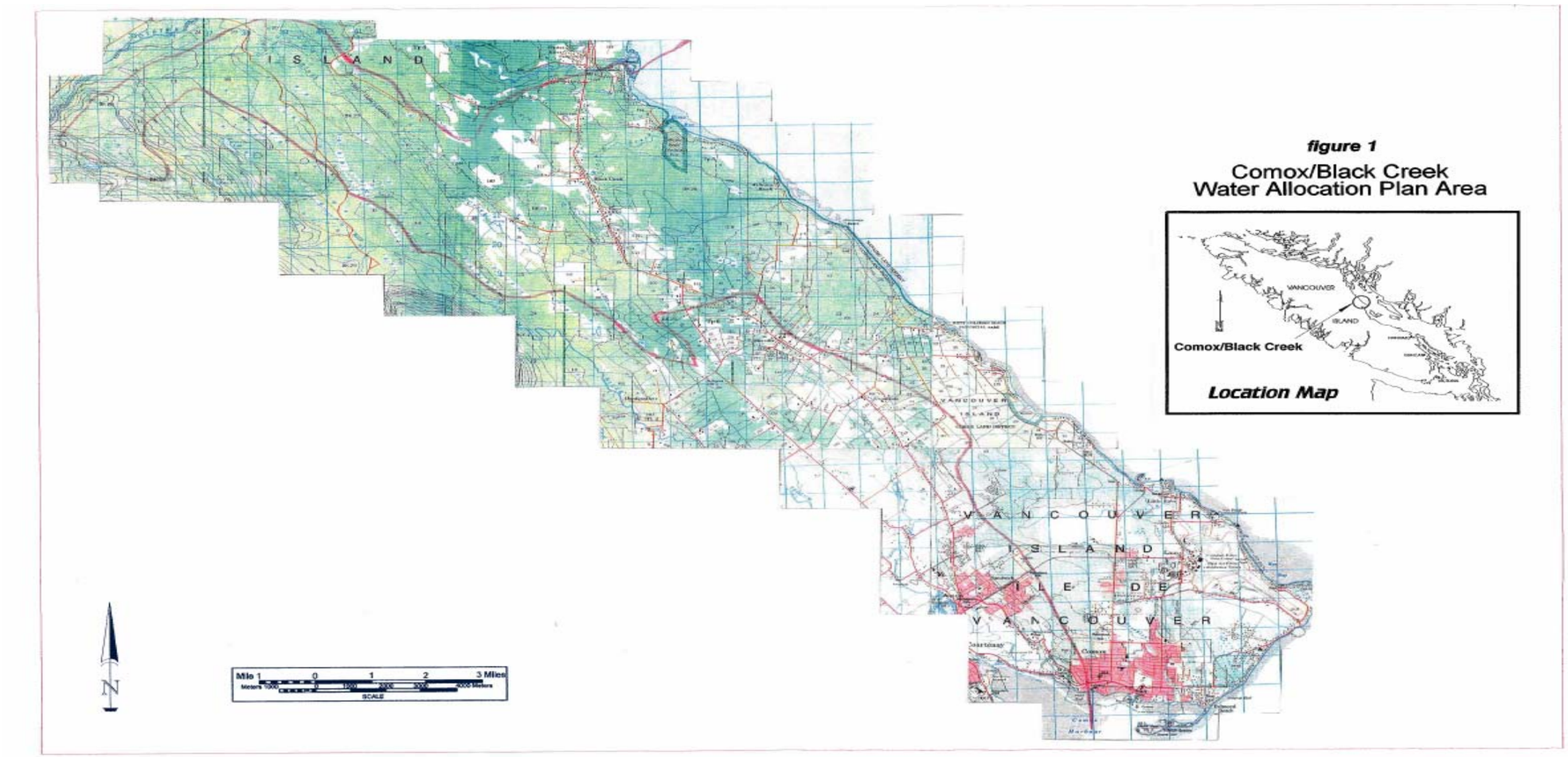


Figure 1: Comox/Black Creek Water Allocation Plan Area

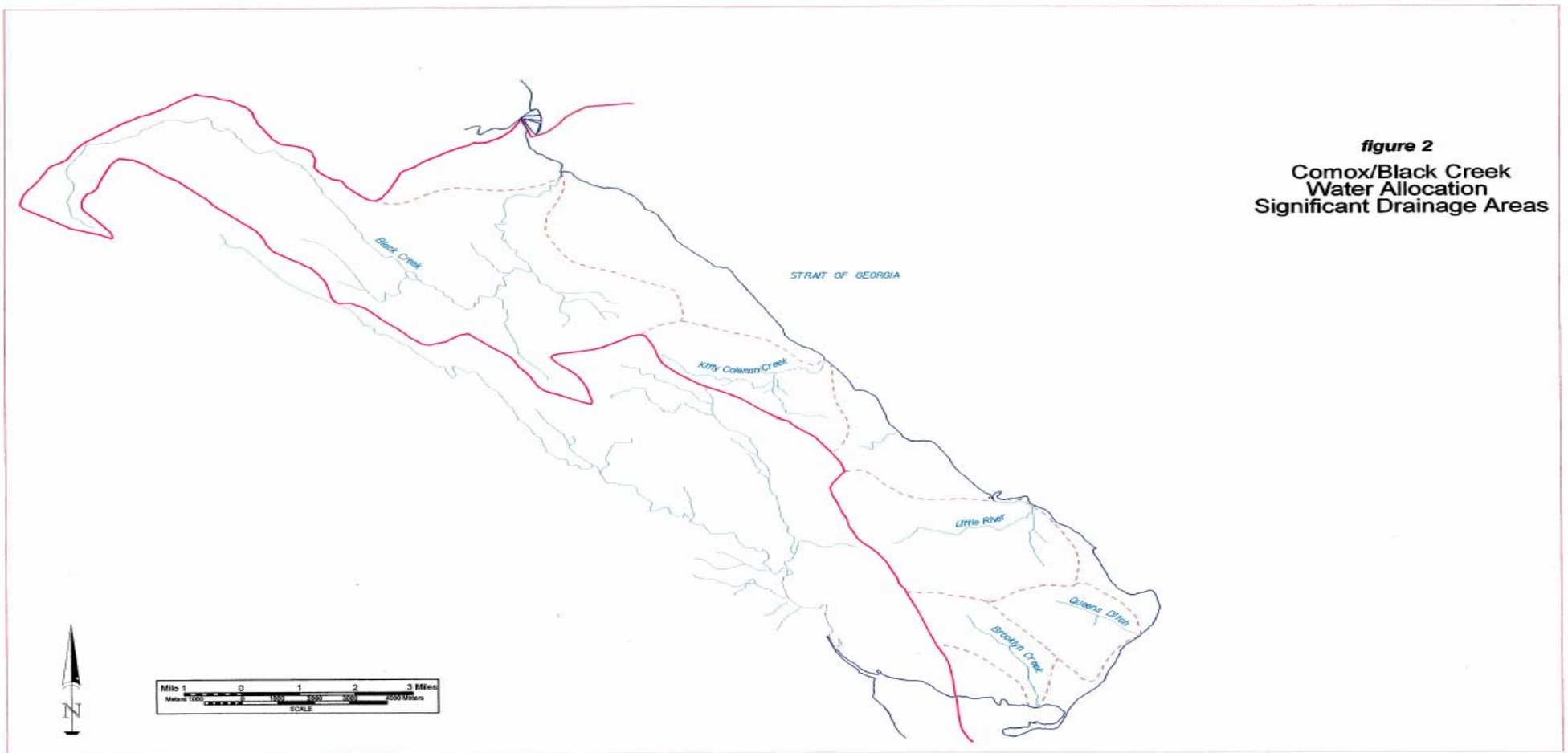


Figure 2: Significant Drainage Areas

3.0 HYDROLOGY

3.1 Precipitation

There are two Atmospheric Environment Service (AES) stations in the Comox/Black Creek Water Allocation Plan area that record atmospheric data. Monthly precipitation normals from both locations were used to construct the following bar graph (see Appendix A for the AES Canadian Climatic Normals).

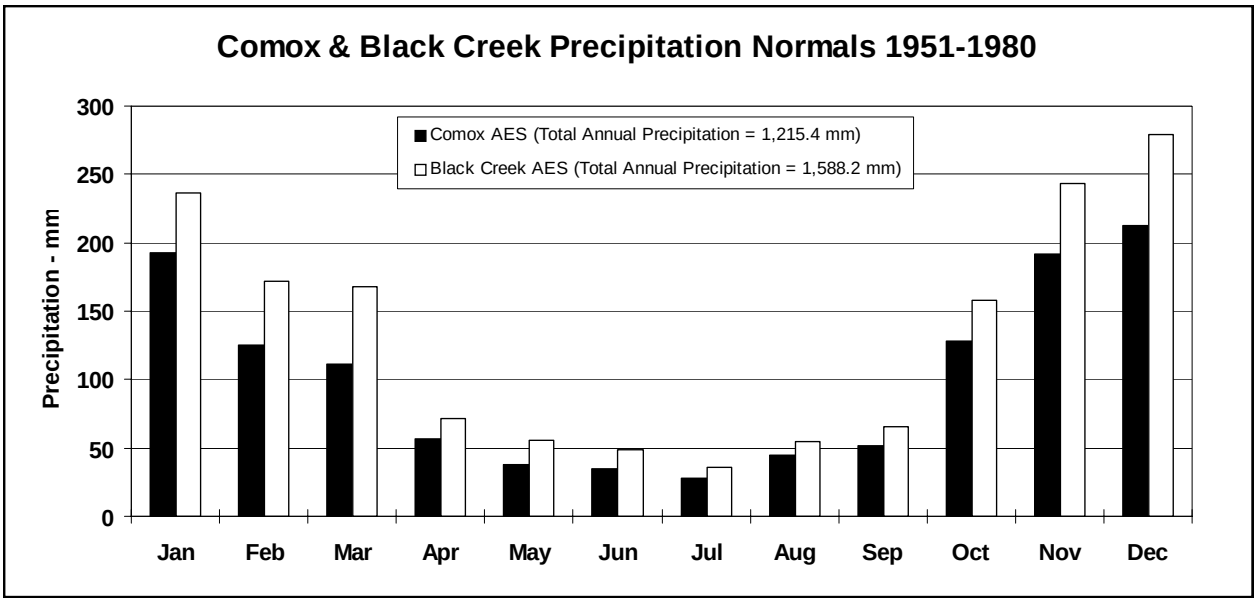


Figure 3: Comox & Black Creek Precipitation Normals 1951-1980

The mean total annual precipitation at the Comox AES station is 1,215.4 mm. The minimum mean monthly precipitation of 27.8 mm occurs in July and the maximum mean precipitation of 212.7 mm occurs in December. The mean number of days with measurable precipitation is 195; with 188 days of measurable rainfall and 16 days of measurable snowfall.

The mean total annual precipitation at the Black Creek AES station is 1,588.2 mm. The minimum mean monthly precipitation of 35.6 mm occurs in July and the maximum mean precipitation of 278.7 mm occurs in December. The mean number of days with measurable precipitation is 154; with 146 days of measurable rainfall and 12 days of measurable snowfall.

The high precipitation in the winter months and low precipitation in the summer months is typical of the east coast of Vancouver Island.

3.2 Hydrometric Information

There are two Water Survey of Canada (WSC) hydrometric stations within the Comox/Black Creek Water Allocation Plan area; Black Creek near Miracle Beach (08HD008) and Black Creek at Sturgess Road (08HD014). There are three months of flow records in 1968 for Black Creek near Miracle Beach (08HD008) and 10 years of flow records from April to September for Black Creek at Sturgess Road (08HD014).

Water Survey of Canada Hydrometric Stations Within the Plan Area

Station Number	Station Name	Period of Record	Drainage Area (km^2)	MAD (m^3/sec)
08HD008	Black Creek near Miracle Beach Park	1968 Jul-Sept	80.8	-
08HD014	Black Creek at Sturgess Road	1980-89 Apr-Sept	45	-

There is also a Provincial hydrometric station on Little River at Wilkinson Road (08HBB11). There are 6 years of flow records.

Provincial Hydrometric Station

Station Number	Station Name	Period of Record	Drainage Area (km^2)	MAD (m^3/sec)
08HBB11	Little River at Wilkinson Road	1987 - 92	18.6	0.332

There are also miscellaneous flow measurements as follows:

Black Creek (at Dzini Road) ..... Jul - Sept 1977
Millar Brook (trib to Black Creek)..... Jul 29, Aug 27 & Oct 3, 1980
Little River (upstream of Scales Creek) ..... Jul - Sept 1977
Scales Creek (trib to Little River)..... Jul - Sept 1977 & Aug 27, Sept 16 & 17 & Oct 3, 1980
Queens Ditch..... Oct 21, 1987
Hilton Springs Ditch (trib to Queens Ditch) ..... Jun 15 - Jul 15, 1982 & Oct 21, 1987
Brooklyn Creek..... Aug 14, 1985

Due to the limiting data noted above, two additional WSC Hydrometric stations located outside of the plan area were used to estimate mean annual discharge and the October

through March mean monthly discharge. Data from Tsolum River near Courtenay (08HB011) and Dove Creek near the Mouth (08HB075) were used to estimate the October through March mean monthly flow and the mean annual discharge (MAD).

Water Survey of Canada Hydrometric Stations Outside of the Plan Area				
Station Number	**Station Name**	**Period of Record**	**Drainage Area (km^2)**	**MAD (m^3/sec)**
08HB011	Tsolum River near Courtenay	1914 - 17 1955 - 57 1964 - 93	235	10.3
08HB075	Dove Creek near the mouth	1985-93	41.1	1.59

Figure 4, on the following page, shows the locations of the hydrometric stations and climatic stations. See Appendix B for a summary of the hydrometric data.

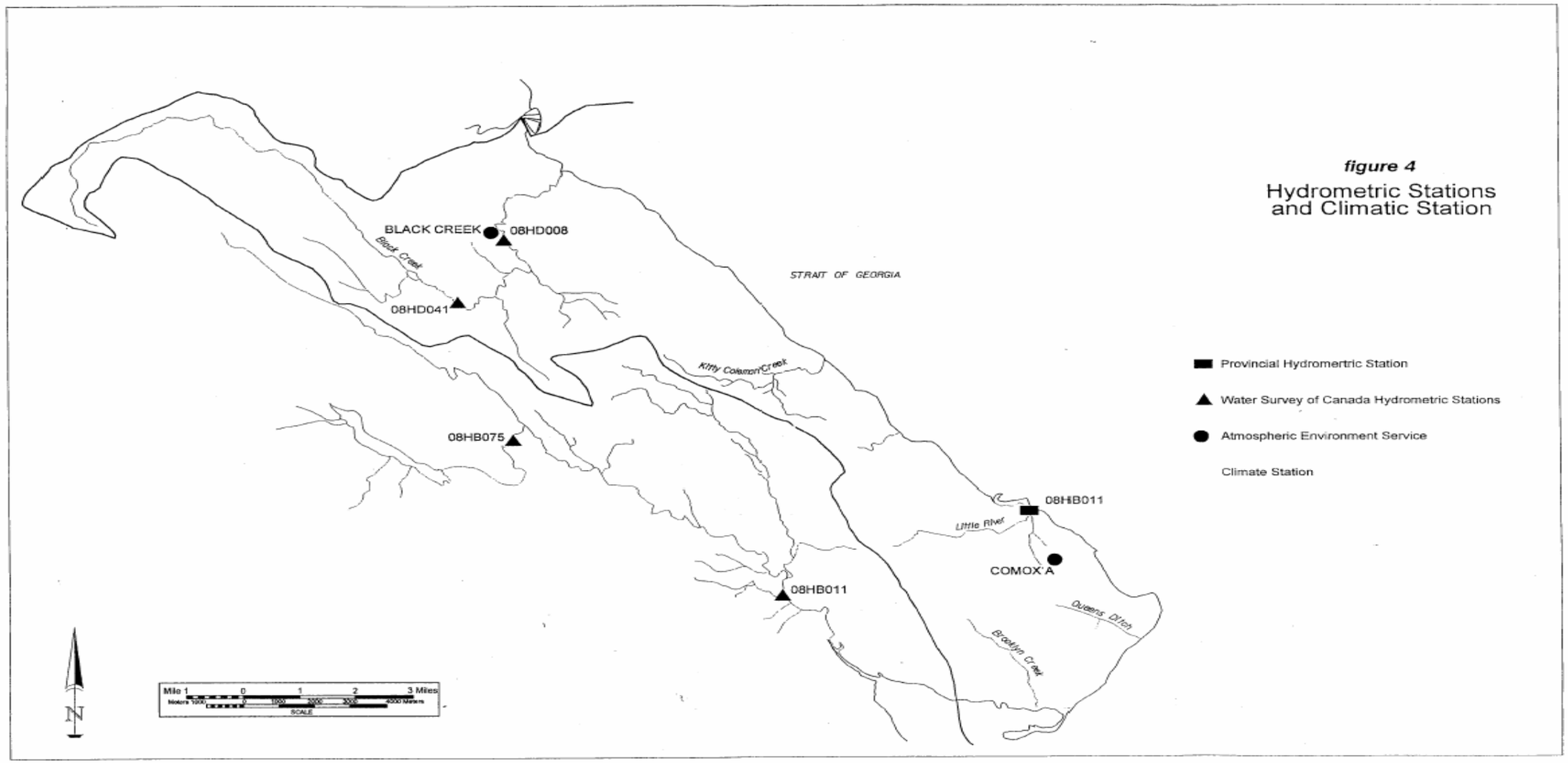


Figure 4: Hydrometric Stations and Climatic Stations

3.3 Streamflow Estimates

The following adjusted average discharge runoff per square kilometre was used to estimate the mean monthly and mean annual discharge for Black Creek and for Kitty Coleman Creek.

Black Creek and Kitty Coleman Creek Runoff per Square Kilometer litres/sec/km²													
	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
08HD008							0.1	0.0	0.1				
08HD014				17.5	6.9	1.7	1.7	0.2	0.1				
08HB075	87	73	61	50	21	14	4	3	2	21	67	88	40
08HB011	66	65	60	43	28	16	7	4	6	29	70	81	40
Adjusted Average	88	80	72	17	7	2	2	0.2	0.1	35	80	97	40

The following Little River at Wilkinson Road (08HBB11) discharge runoff per square kilometre was used to estimate the mean monthly and mean annual discharge for Little River, Queens Ditch and Brooklyn Creek.

Little River Runoff per Square Kilometer litres/sec/km²													
	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
08HBB11	41	36	22	16	5.6	5.5	2.3	1.4	4.4	8	33	32	17.2

3.3.1 Black Creek Drainage

The estimated drainage area of Black Creek is 80.8 km² The mean watershed elevation of Black Creek is approximately 75 metres (250 ft) above sea level (ASL). Black Creek drains easterly from a watershed divide at elevation 430 metres (1,404 ft) east of Blue Grouse Lake and west of the Duncan Bay Main Road. Black Creek and its tributaries flow from and through numerous swamps and small lakes, through Miracle Beach Provincial Park, into the Strait of Georgia (ocean). The drainage of swamp lands for agricultural development and urban land development have increased flood flows (November - February) and decreased low flows (June - September). Millar Creek, Sayers Creek, Ployart Creek and Williams Creek are significant tributaries to Black Creek.

The above adjusted average runoff per square kilometre was used to estimate the mean monthly discharge and mean annual discharge for Black Creek. The following table and graph illustrate the mean monthly flows and mean annual discharge for Black

Creek.

Black Creek Discharge & Percent MAD litres/sec												
JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	MAD
7,100	6,500	5,800	1,400	560	140	140	16	9	2,800	6,500	7,800	3,217
221%	202%	180%	44%	17%	4%	4%	0%	0%	87%	202%	242%	100%

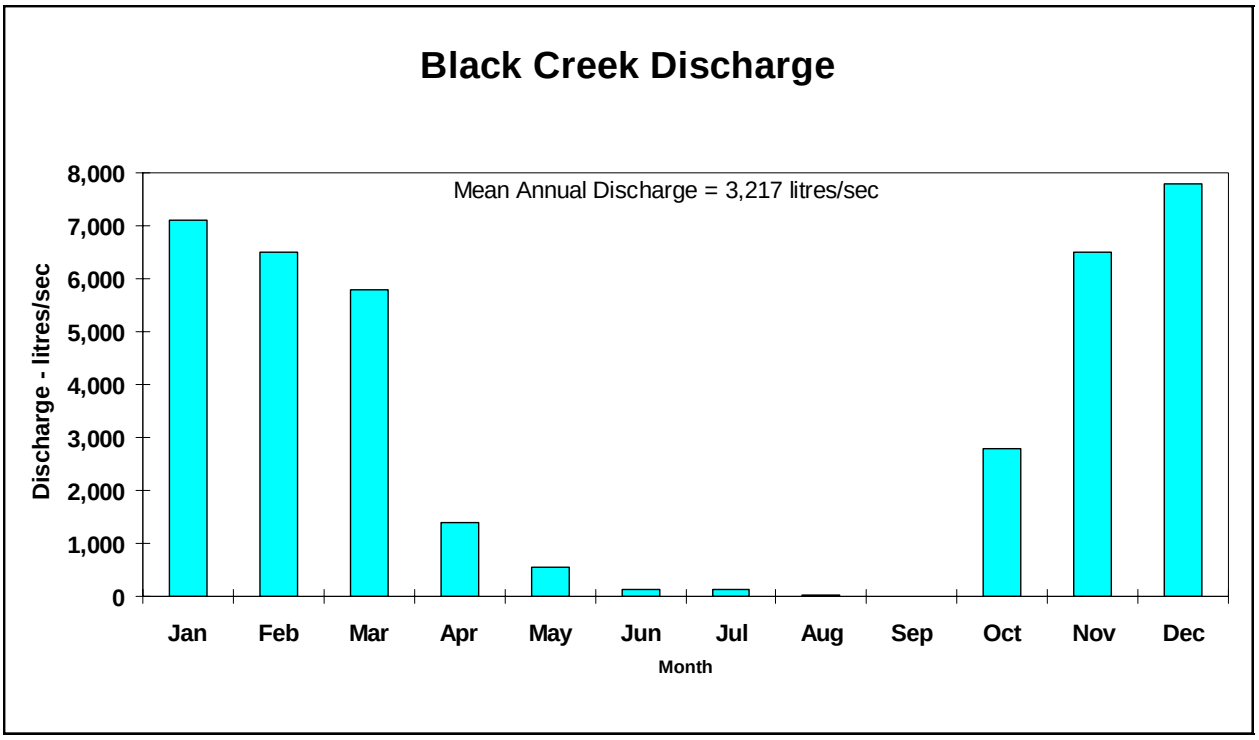


Figure 5: Black Creek Discharge

3.3.2 Kitty Coleman Creek Drainage

The total drainage area of Kitty Coleman Creek is 14.2 km². The mean watershed elevation of Kitty Coleman Creek is approximately 50 metres (150 ft) above sea level (ASL). Kitty Coleman Creek drains easterly from the Island Highway, through Kitty Coleman Beach Provincial Park, into the Strait of Georgia (ocean).

The above adjusted average discharge runoff per square kilometre was used to estimate the mean monthly and mean annual discharge for Kitty Coleman Creek. The following table and graph illustrate the mean monthly and mean annual flows for Kitty Coleman Creek.

Kitty Coleman Creek Discharge & Percent MAD litres/sec												
JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	MAD
1,248	1,142	1,019	246	98	25	25	3	2	492	1,142	1,371	565
221%	202%	180%	44%	17%	4%	4%	0%	0%	87%	202%	242%	100%

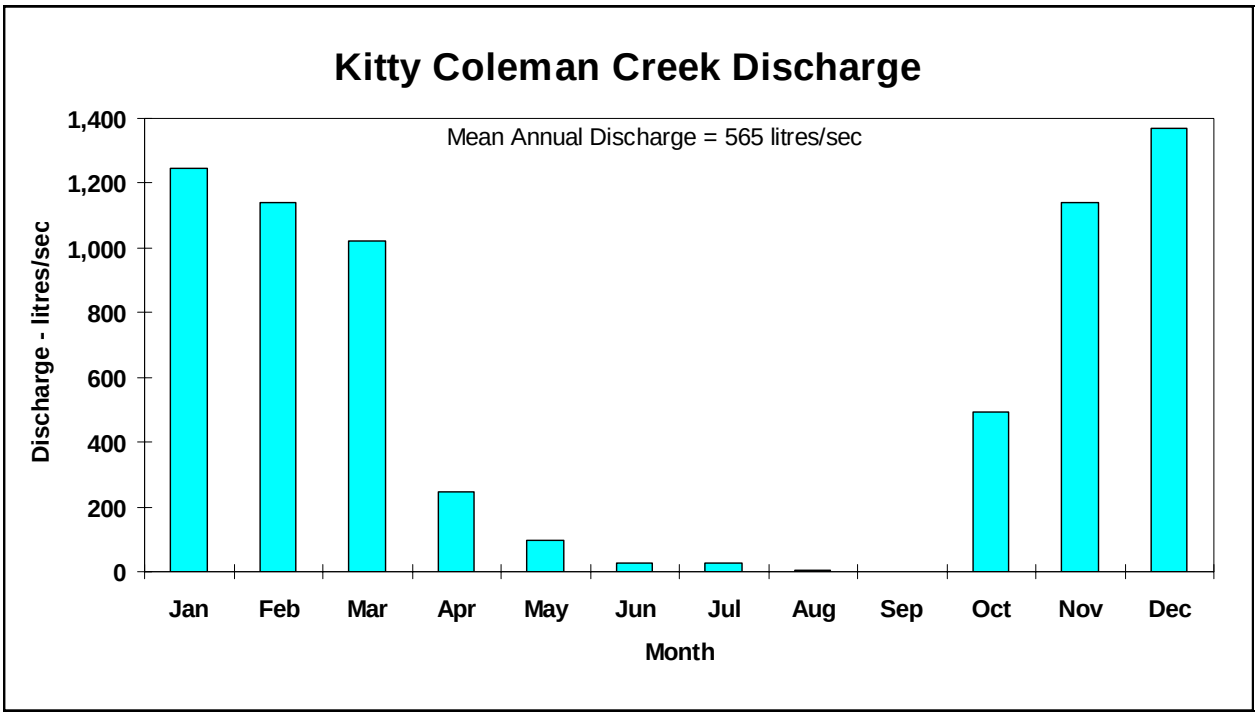


Figure 6: Kitty Coleman Creek Discharge

3.3.3 Little River Drainage

Little River is located north of Comox and has a total drainage area of 19.3 km². The Little River drainage area is flat to gently rolling. The mean watershed elevation of Little River is approximately 30 metres (100 ft) above sea level (ASL). Little River drains easterly into the Straight of Georgia (ocean). Residential development and the drainage of swamp lands for agricultural development have increased flood flows (November - February) and decreased low flows (July - September). Springs in the headwaters may offset some of the drainage affects during low flow periods. Scales Creek is a significant tributary to the Little River upstream of Wilkinson Road.

The Little River at Wilkinson Road (08HBB11) runoff per square kilometre was used to estimate the mean monthly and mean annual discharge for Little River. The following graph and table illustrate mean monthly and mean annual flows for Little River.

Little River Discharge & Percent MAD litres/sec												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAD
788	692	429	307	108	106	43.8	27.2	84.3	159	640	621	332
237%	209%	129%	93%	33%	32%	13%	8%	25%	48%	193%	187%	100%

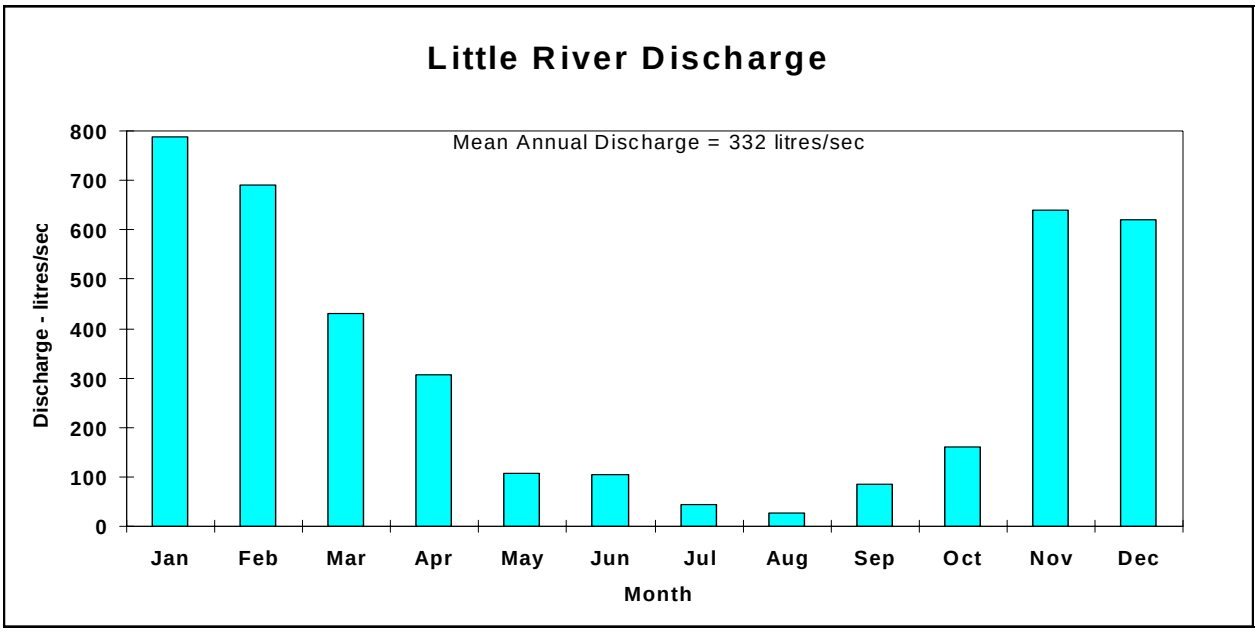


Figure 7: Little River Discharge

3.3.4 Queens Ditch Drainage

The total drainage area of Queens Ditch is 10.0 km². The mean watershed elevation of Queens Ditch is approximately 10 metres (30 ft) above sea level (ASL). Queens Ditch drains south-easterly into the Straight of Georgia (ocean). Queens Ditch was originally constructed by the Federal Government to drain the airfield at Canadian Forces Base Comox. The ditch was dug through swamp lands south of Knight Road. Agriculture has developed on the lands drained by Queens Ditch. The drainage of these swamp lands have increased flood flows and decreased low flows. Part of the drainage from Canadian Forces Base Comox has been diverted into the City of Comox storm drains to reduce potential flooding. This reduction of flow in Queens Ditch has also reduced the flow available for irrigation water supply for agriculture. Hilton Springs is a significant tributary to Queens Ditch and an improved ditch from the spring may have offset some of the reduced flows during the low flow periods.

The Federal Government has a right-of-way for Queens Ditch. Authorisation to access through the right-of-way to obtain water from the ditch must be obtained from the Federal Government.

The Little River at Wilkinson Road (08HBB11) runoff per square kilometre was used to estimate the mean monthly and mean annual discharge for Queens Ditch. The following graph and table illustrate mean monthly and mean annual flows for Queens Ditch.

Queens Ditch Discharge & Percent MAD litres/sec												
JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	MAD
408	358	222	159	56	55	23	14	44	83	332	322	172
237%	209%	129%	93%	33%	32%	13%	8%	25%	48%	193%	187%	100%

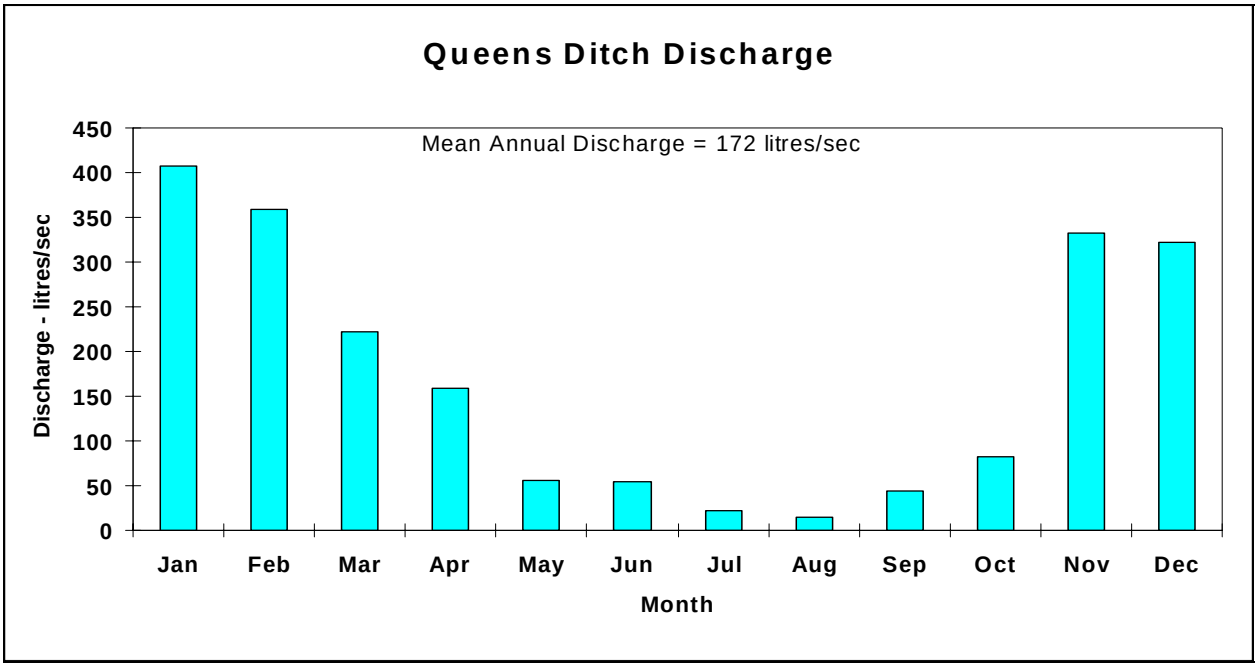


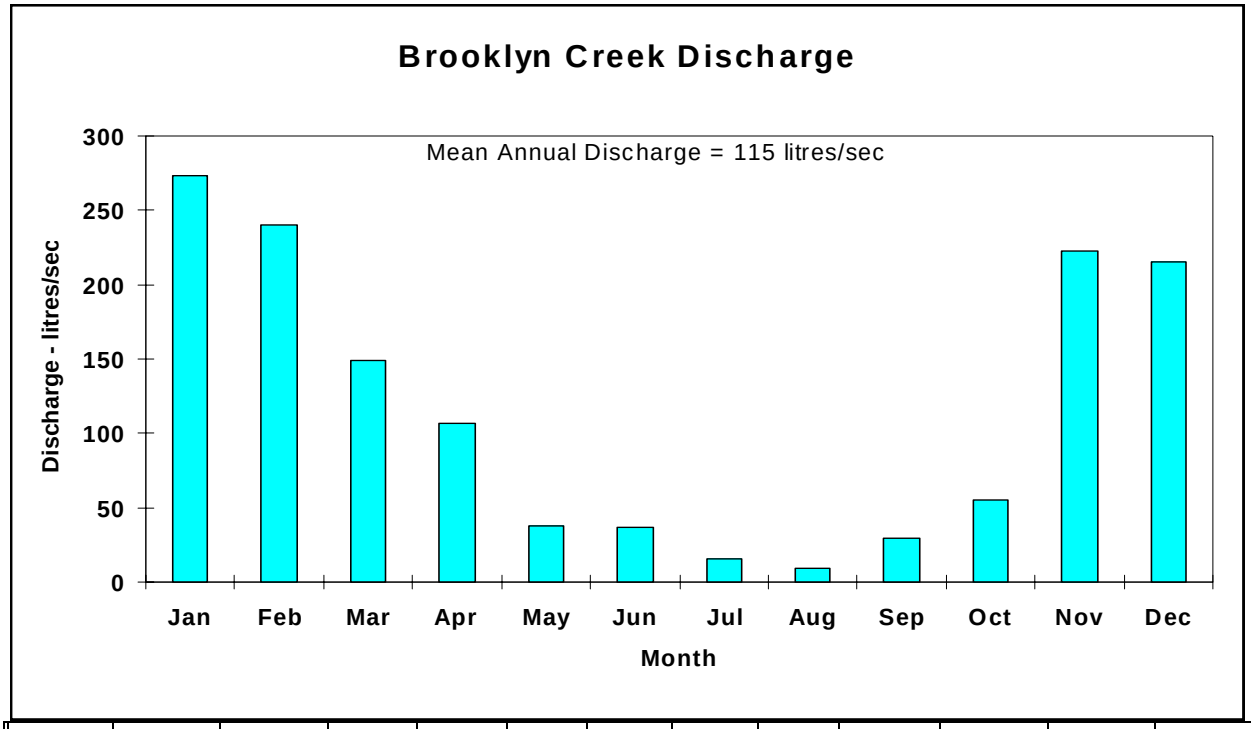
Figure 8: Queens Ditch Discharge

3.3.5 Brooklyn Creek Drainage

Brooklyn Creek has a total drainage area of 6.7 km². The mean watershed elevation of Brooklyn Creek is approximately 50 metres (150 ft) above sea level (ASL). The creek drains in a southerly direction, through the City of Comox and discharges into Comox Harbour (ocean). The drainage of land for residential and agricultural development have increased flood flows (November - February) and decreased low flows (July - September).

The Little River at Wilkinson Road (08HBB11) runoff per square kilometre was used to estimate the mean monthly and mean annual discharge for Brooklyn Creek. The following graph and table illustrate mean monthly and mean annual flows for Brooklyn Creek.

Brooklyn Creek Discharge & Percent MAD litres/sec												
JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	MAD
273	240	149	107	37	37	15	9	29	55	222	215	115



237%	209%	129%	93%	33%	32%	13%	8%	25%	48%	193%	187%	100%

Figure 9: Brooklyn Creek Discharge

3.4 Low Flows

Within the plan area minimum monthly flows occur in August and September. The following table summarizes Mean Annual Discharges and Minimum Mean Monthly Discharges for each significant drainage area.

Mean Annual Discharge and Minimum Mean Monthly Discharge litres/sec		
Drainage	**Mean Annual Discharge**	**Minimum Mean Monthly Discharge**
Black Creek	3,217	9 (September)
Kitty Coleman Creek	565	2 (September)
Little River	332	27.2 (August)
Queens Ditch	172	14 (August)
Brooklyn Creek	115	9 (August)

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 maintaining instream flow requirements for water quality recreational, aesthetic and cultural values. The Ministry of Environment **Provincial 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.

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). Therefore, the **Regional policies** to implement the 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 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. 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%.

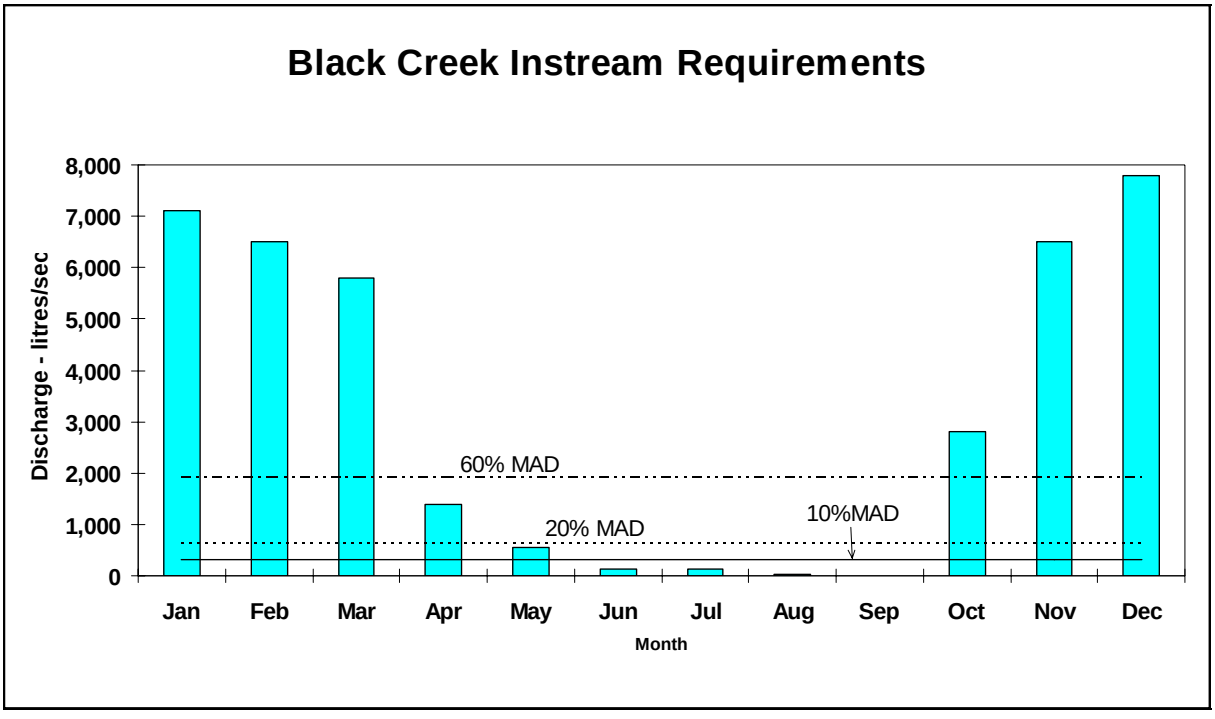
Figure 10 illustrates the location of fish habitat within the plan area.

4.1 Black Creek Instream Requirements

Black Creek supports Coho, Steelhead and resident Cut-throat trout.

The following graph illustrates that the June, July, August and September mean monthly discharges for Black Creek are below 10 % of the mean annual discharge (MAD).

Figure 10: Black Creek Instream Requirements



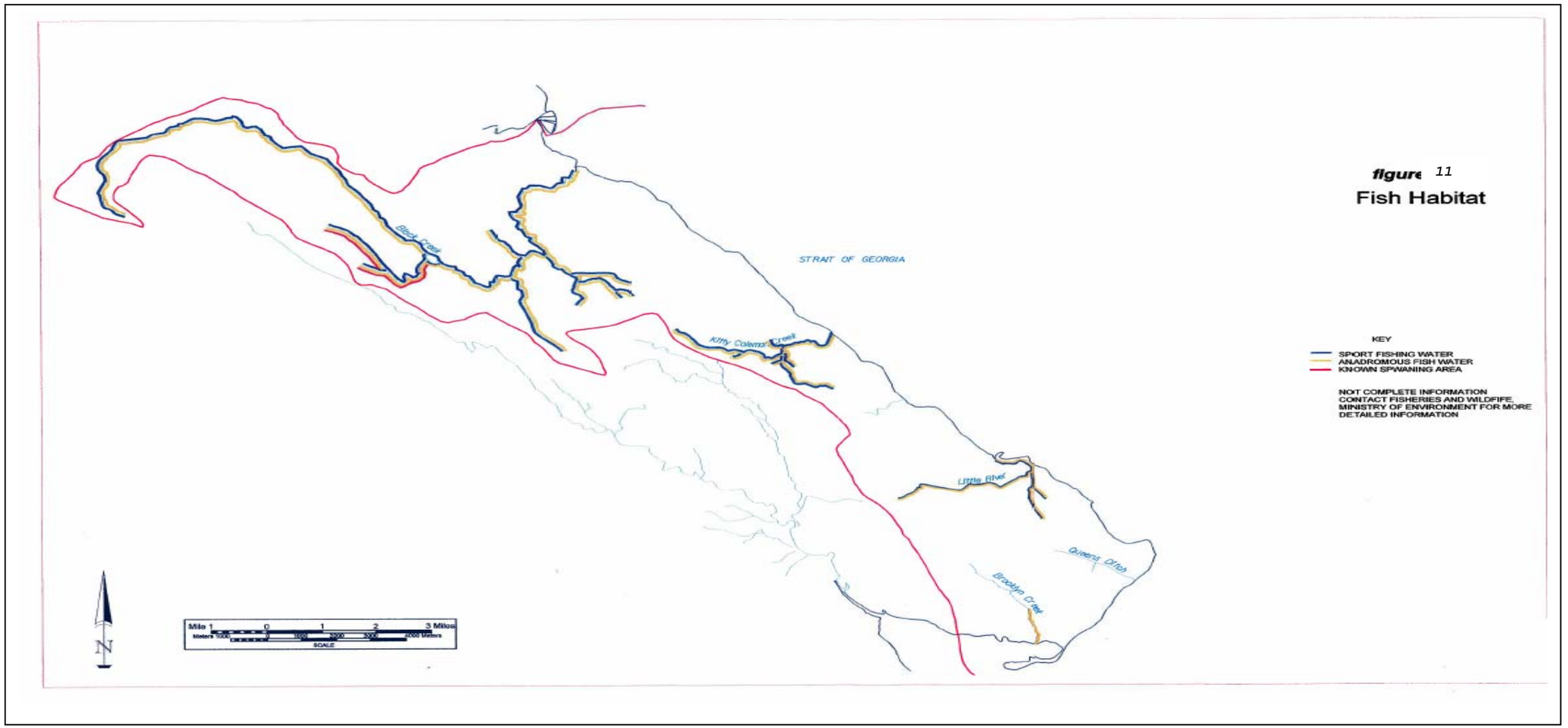


Figure 11: Fish Habitat

Therefore water is only available for extractive demands from October through March when the mean monthly flow is above 60% MAD. The estimated water available for winter storage to support summer extractive water demands is 65,262 dam³ (52,908 acft)

4.2 Kitty Coleman Creek Instream Requirements

Kitty Coleman Creek supports Coho, Steelhead and resident Cut-throat trout.

The following graph illustrates that the June, July, August and September mean monthly discharges for Kitty Coleman Creek are below 10 % of the mean annual discharge (MAD).

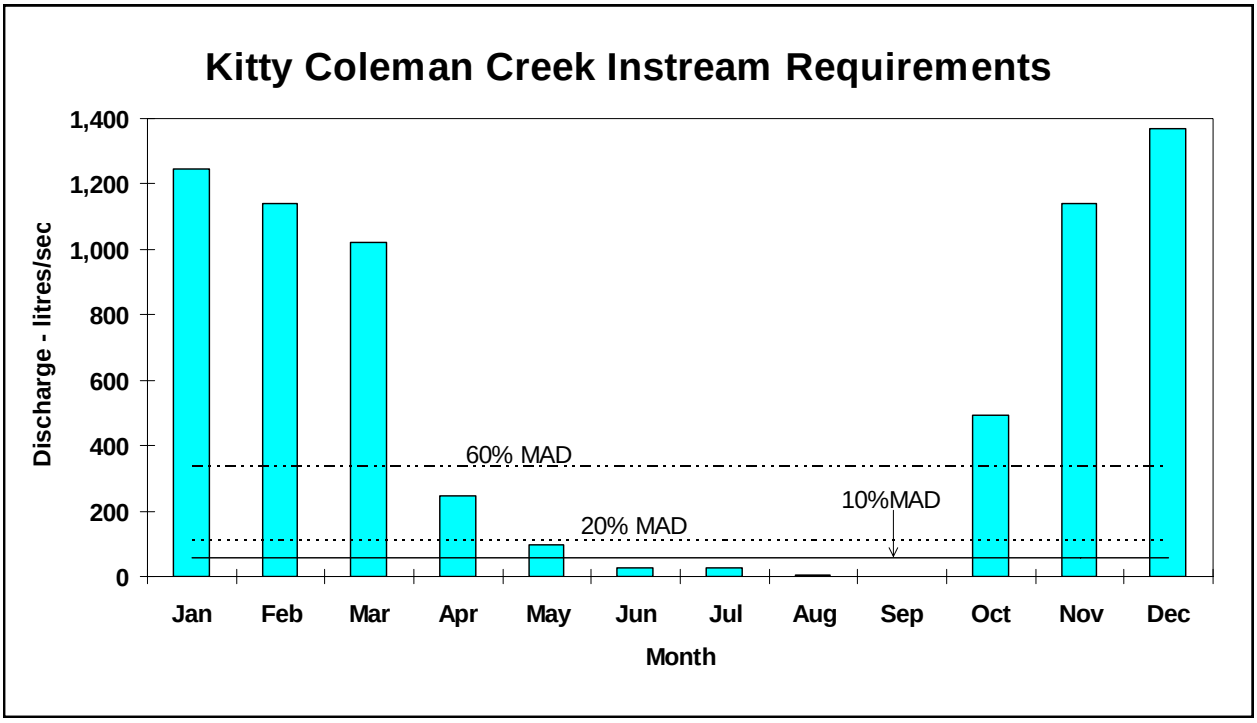


Figure 12: Kitty Coleman Creek Instream Requirements

Therefore water is only available for extractive demands from October through March when the mean monthly flow is above 60% MAD. The estimated water available for winter storage to support summer extractive water demands is 11,469 dam³ (9,298 acft)

4.3 Little River Instream Requirements

Little River supports Coho, Steelhead and resident Cut-throat trout.

The following graph illustrates that the August mean monthly discharge for Little River is below 10 % of the mean annual discharge (MAD).

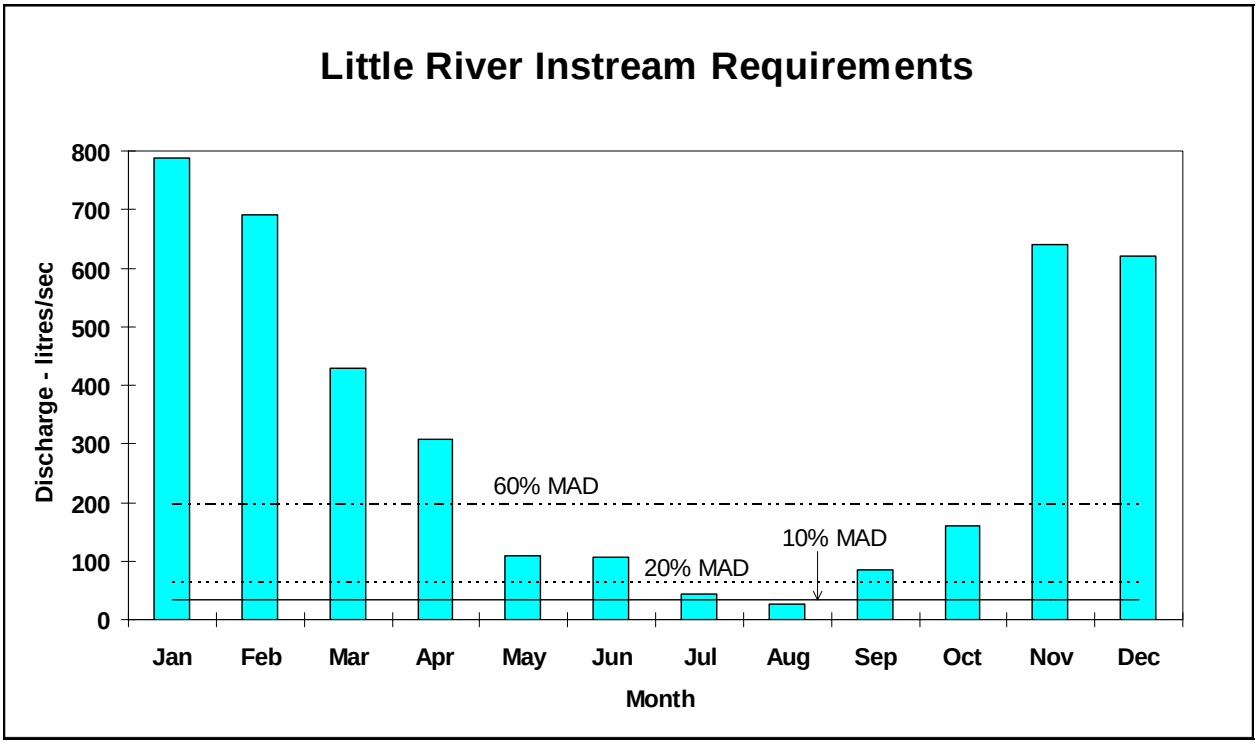


Figure 13: Little River Instream Requirements

Therefore water is only available for extractive demands from November through April when the mean monthly flow is above 60% MAD. The estimated water available for winter storage to support summer extractive water demands is 5,960 dam³ (4,832 acft)

4.4 Queens Ditch Instream Requirements

There is no evidence that Queens Ditch supports fish. There are no instream flow requirements for Queens Ditch. Therefore the total flow of water is available for water allocation.

Therefore water is available for extractive demands throughout the year. Water available directly from the stream without supporting storage is the minimum monthly flow for August of 14 litres/sec (0.5 cfs or 270,000gpd) for the low flow months of May through October. For a three month irrigation period this flow will support an irrigation demand of 113 dam³ (92 acft). Existing unsupported low flow licenced consumptive water demand is 210 dam³ (170 acft) as noted in the following chapter.

The estimated water available for the winter storage period of November through April to support summer extractive water demands is 4,154 dam³ (3,368 acft)

4.5 Brooklyn Creek Instream Requirements

Brooklyn Creek supports Coho for approximately 2.5 km upstream from the mouth.

The following graph illustrates that the August mean monthly discharge for Brooklyn Creek is below 10 % of the mean annual discharge (MAD).

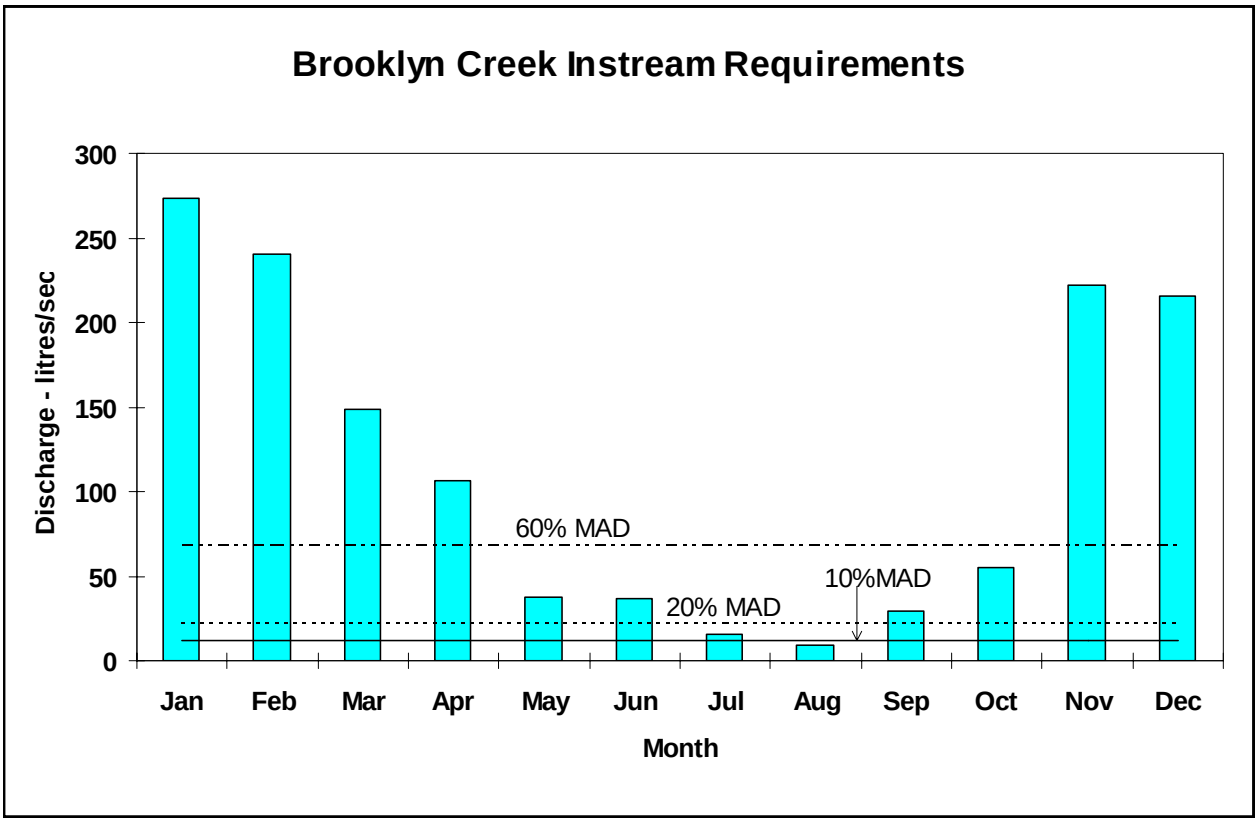


Figure 14: Brooklyn Creek Instream Requirements

Therefore water is only available for extractive demands from November through April when the mean monthly flow is above 60% MAD. The estimated water available for winter storage to support summer extractive water demands is 2,069 dam³ (1,677 acft)

4.6 Other Drainages

Various other drainages not identified above may support fish populations. Where fish are identified water will only be available from these drainages during the period when the mean monthly flow is greater than 60% MAD. Estimated flows and 60% MAD can be determined using the procedures identified above.

5.0 WATER DEMAND

5.1 Licensed Demand

More than half of the water licenses in the plan area are for domestic purpose (33). In addition to domestic purpose, water licences in the plan area are for irrigation(18), storage (6), industrial (3), land improvement (2), waterworks (1) and conservation (1) purposes.

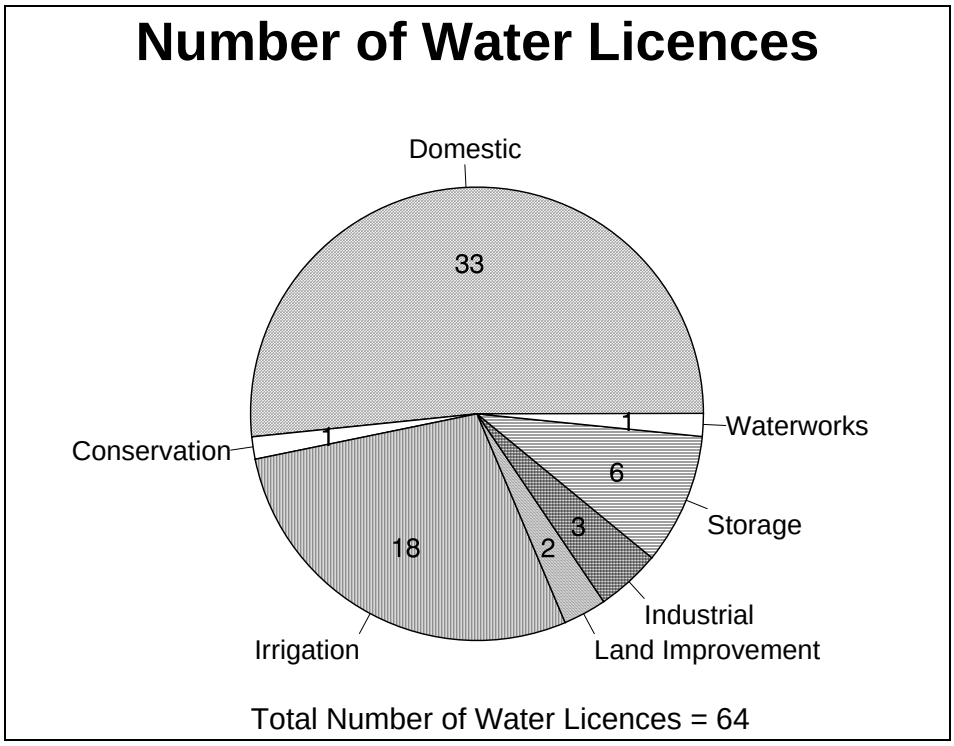


Figure 15: Number of Water Licences

Of great significance to water allocation is the estimated average annual licensed water demand and low flow water demand in each significant drainage.

The total estimated average annual licensed water demand for the plan area is 1,421 dam^3. The following graph and table illustrates the estimated average annual licensed water demand for each purpose for the plan area.

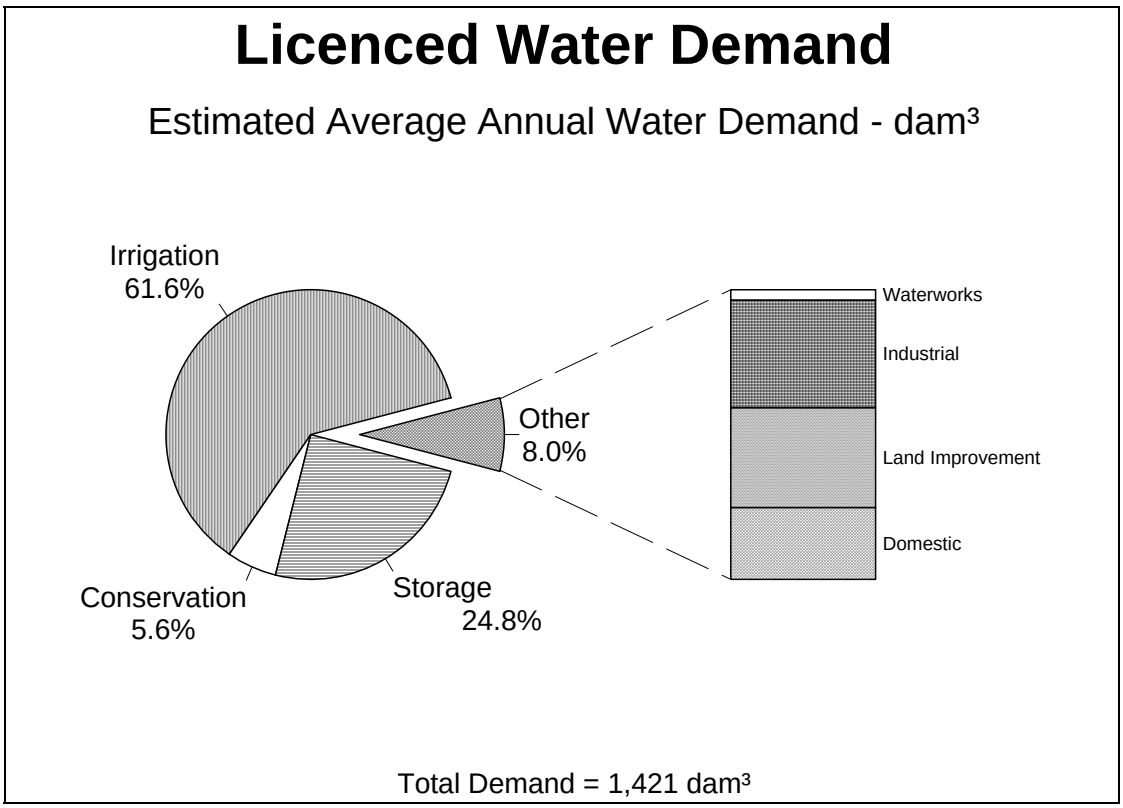


Figure 16: Licenced Water Demand

Annual Licenced Water Demand			
Purpose	**Quantity / Units**	**Annual Demand dam³**	**%**
Irrigation Purpose	709.76 acft	875	62%
Storage Purpose	286 acft	353	25%
Conservation Purpose	65 acft	80	6%
Industrial Purpose	1100 gpd 33 acft	42	3%
Land Improvement Purpose	32 acft	39	3%
Domestic Purpose	33000 gpd	27	2%
Waterworks Purpose	5000 gpd	4	0%
	Total	1,421	100%

The largest water demand in the plan area is irrigation water demand (62%). Three farms; Northy Lake Farm (275 acft) in the Black Creek drainage, Beaver Meadows Farm (140 acft) in the Little River drainage and Woodrow's Farm (150 acft) in the Queens Ditch drainage have the largest water licence irrigation demands in the plan area.

The second largest annual water demand is storage (25%). Nearly all the storage developed is used to support irrigation demand. Storage developed in Keddy Swamp (160 acft), in partial support of the Northy Lake Farm irrigation demand in the Black Creek drainage area, accounts for more than half of the total storage in the plan area. Storage developments on Huband Swamp (30 acft), outside the identified significant drainages, and Beaver Springs (33 acft), in the Little River drainage, supply water to support the irrigation, frost protection and flood harvesting of cranberries. Storage does not totally support the irrigation demand in any of the significant drainage areas.

Conservation is the third largest annual water demand (6%). The single water licence for conservation purpose (65 acft) authorizes the construction of a dam to maintain water levels on Lazo Marsh for wild fowl habitat.

Industrial demands (3%) include stockwatering (1,100 gpd) and frost protection and flood harvesting of cranberries (33 acft). Land improvement (3 %) demand is for aesthetic ponds and drainage of farm land. Domestic demand (2%) is for rural residential use and stockwatering use. Waterworks demand (0%) is the supply from Park Spring to Miracle Beach Provincial Park.

The low flow period is the period when the flow is below 60% MAD. The low flow period is from April through September for Black Creek and Kitty Coleman Creek and from May through October for Little River, Queens Ditch and Brooklyn Creek.

Water diverted from a stream during the low flow period that is not supported by releases from storage will reduce the natural flow in the stream. This unsupported low flow licenced consumptive water demand reduces the water available for competing water uses and the instream flow requirements to maintain the fish resources. The estimated low flow licenced demand for each identified drainage area and for the areas outside of the identified drainage areas are summarized below. Further information on licence water demand may be found in Appendix C.

Low Flow Licenced Consumptive Water Demand		
Significant Drainage Area	**Unsupported Low Flow Water Demand***	
	litres/second	**dam³**
Black Creek	23.0	175
Kitty Coleman Creek	0.6	5
Little River	23.5	182
Queens Ditch	27	210
Brooklyn Creek	0	0
Other Areas	5.5	42

*Based on an estimated licenced water demand assuming that: irrigation and industrial demands are totally withdrawn over a 90 day period; domestic and waterworks demands are the authorized licenced maximum daily amount for 90 days; authorized storage balances demand and results in a negative demand over 90 days; conservation and power is non-consumptive and, therefore, has no extractive demand.

Unsupported low flow water demands in this plan area are predominately irrigation demands that are not supported by storage. These demands significantly reduce the low flows particularly during the low flow months of June, July, August and September when irrigation water use will be the highest.

5.2 Projected Demand

There are 10 water license applications with 12 water licence demands pending in the Comox/Black Creek Water Allocation Plan area at the beginning of 1997. These water licence application demands are listed in the following table and are summarized in Appendix D.

Water Licence Applications			
Purpose	**Quantity / Units**	**Annual Demand dam³**	**%**
Irrigation	419 acft	517	67%
Conservation	188.46 acft	232	30%
Industrial	1200 gpd	2	0%
	17 acft	21	3%
Land Improvement	1 acft	1	0%
	Total	**772**	100%

The potential annual water demand of these applications totals 772 dam^3 (626 acft).

The largest potential water demand is 517 dam^3 (419 acft) for irrigation purpose. These potential demands occur in the Little River drainage area (230 acft), Black Creek drainage area (123 acft) and Queens Ditch drainage area. (54 acft). No storage is proposed to support these potential irrigation demands.

The second largest potential water demand is 232 dam^3 (188.5 acft) for conservation purpose. The largest water licence application for conservation purpose (186.46 acft) is for the construction of a flow control structure near the headwaters of Sayer Creek to maintain water levels on a potato farm to inhibit volunteer potatoes and for wild fowl habitat.

Potential industrial demands include frost protection and flood harvesting of cranberries (12 acft), fish farming (5 acft) and livestock watering (1,200 gpd). The single land improvement water licence application is for ditch maintenance for farm drainage.

Future water demands for the area are anticipated to be similar to existing licensed demands. The number of domestic, irrigation and land improvement licenses will increase as the agricultural community grows. Conservation purpose demands will likely increase as groups and agencies take measures to preserve and protect fish and wildlife habitat from urban encroachment. Therefore; storage of winter high flows will be required to support water demands during the summer low flow period in most locations within the plan area.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The minimum mean monthly flow for Black Creek and Kitty Coleman Creek drainage areas occur in September. Zero flow has been recorded for over 90 days through the months of June, July and August in Black Creek. The minimum mean monthly flow for Little River, Queens Ditch and Brooklyn Creek drainage areas occur in August. Zero flow has been recorded for up to 16 days in July and August in Little River.

The high flow period, when flow is above 60% MAD, is from October to March for Black Creek and Kitty Coleman Creek and is from November through April for Little River, Queens Ditch and Brooklyn Creek.

The low flow period, when the flow is below 60% MAD, is from April through September for Black Creek and Kitty Coleman Creek and from May through October for Little River, Queens Ditch and Brooklyn Creek.

Black Creek, Kitty Coleman Creek, Little River and Brooklyn Creek support an important fish resource that is naturally limited by low flows. Water withdrawals during the low flow months will further limit the fish resource in these streams. There is a considerable quantity of water available for extractive demands in these streams during the high flow period that is excessive to fish flow needs and that is available for storage development. The water available is summarized in the following table.

Water Available			
Significant Drainage Area	**Drainage Area km²**	**Low Flow Period litres/sec**	**High Flow Period dam³ (acft)**
Black Creek	80.8	0	65,262 (52,908)
Kitty Coleman Creek	14.2	0	11,469 (9,298)
Little River	19.3	0	5,960 (4,832)
Queens Ditch	10.0	0	4,154 (3,368)
Brooklyn Creek	6.7	0	2,069 (1,677)

The largest existing and potential water demand in the plan area is irrigation water demand. The unsupported low flow licenced consumptive water demand reduces the water available for competing water uses and the instream flow requirements to maintain the fish resources.

Any further low flow licenced consumptive water demand in the Comox/Black Creek Water Allocation plan area requires supporting storage. Storage of high flows for release and water use during the low flow months will help maintain water

supplies for licenced water use and instream fish habitat. Off-stream dugout storage is preferred over in-stream dammed storage in locations where fish passage or fish habitat may be negatively impacted. Fish passage provisions for both juvenile and adult fish shall be required on all storage dams or diversion works constructed on sources frequented by fish.

Fish and debris screens shall be required on all intake or diversion works in Black Creek, Kitty Coleman Creek, Little River, Brooklyn Creek and their tributaries and any other streams that have identified fish resources. Fish and debris screens are part of a good intake design and should be encouraged on all intakes or diversion works.

Instream works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resources. Instream work will normally only be allowed during the low flow period or when the stream is naturally dry.

6.1 Domestic

A domestic water license shall be 2,270 litres/day (500 gpd) for each rural dwelling as indicated on the plan attached to the water license application. This amount will allow for the maintenance of 0.10 hectares (0.25 acres) of garden associated with the dwelling. It is not appropriate, where the primary source of domestic water supply is insufficient, to issue additional water licenses for the maintenance of green lawns and gardens.

Domestic water licenses shall not be issued to provide evidence to subdivision approval authorities of an “adequate potable water supply” for subdivision development. Residential land subdivisions shall be encouraged to connect to existing community water supply systems.

To ensure an adequate domestic water supply for household uses, applicants shall be encouraged to develop storage or use naturally stored water from lakes or marshes. For the average daily demand of 1,136 litres/day (250 gpd) for a three month period (92 days) a volume of 0.1 dam^3 (4,000 ft^3) is required. This requires a reservoir or dugout approximately 7 meters (23 feet) long by 5 meters (16 feet) wide, with an average depth of 3.5 meters (12 feet); allowing 0.3 meters (1 foot) for evaporation loss.

A spring shall be licensed for an individual domestic water demand provided that there is no surface flow from the spring during the low flow period and it is 30 meters away from any existing licensed points of diversion. Multiple domestic water licenses on a spring 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. pump test in August or September) and by satisfying any written concerns and objections of any existing water licensees.

A water license 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 required 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.

The present waterworks demand is related to a demand in a provincial park. It is anticipated that there will be no further municipal waterwork demand from the streams in the Comox/Black Creek Water Allocation Plan Area.

6.3 Irrigation

The crop rooting depth, soil type and climatic characteristics determine the water requirements for irrigation. In order to estimate the irrigation demands the effective rooting depths for different crops were classified into shallow (< 0.5 metres) and deep (> 1.0 metres) categories. The available water storage capacity (AWSC) was estimated for shallow and deep root zone depth for the soil type present within the plan area. Where composites of two or three soil associations are intermixed or occupy such a small area that they cannot be separated at the scale of the mapping, only the predominate soil association was considered. Soil and rock areas that are not suitable for agriculture are not colour coded on the following figure and were assumed to have no potential irrigation demand. The following table and figure indicate the annual irrigation water requirements for various crops and soil groups in the plan area.

Annual Irrigation Water Requirements millimetres (inches)		
Crops	**Peas, Potatoes, Tomatoes, Lettuce, Pasture Species, Cranberries**	**Brussels Sprouts, Corn, Clover, Grapes, Fruit Trees, Alfalfa, Raspberries**
Effective Rooting Depth	**Shallow 0.5 m (1.6 feet)**	**Deep 1.0 m(3.3 ft)**
Arrowsmith (Ar)	28 (11)	No Irrigation Required
Fairbridge (F)	33 (13)	28 (11)
Tolmie (T), Cowichan (C), Royston (R), Chemainus (Ch), Sandwick (Sk)	41 (16)	28 (11)
Parksville (Pa), Puntledge (Pu), Shawnigan (S), Bowser (B), Merville (M)	51 (20)	28 (11)
Kye (Ky), Dashwood (D), Lazo (La)	69(27)	41 (16)
Qualicum (Q)	69(27)	51 (20)

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

It should be noted that these annual irrigation water requirements are for sprinkler irrigation systems only. Irrigation gun or flood irrigation systems require greater irrigation quantities and should be discouraged. If irrigation gun and flood 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 sprinkler irrigation system. Trickle irrigation can reduce water requirements by 35% and should be encouraged where practical. Irrigators are encouraged to employ good agricultural practices (field size, system selection and farm management) to conserve water.

The peak irrigation water withdrawal rate shall not exceed 47 litres/minute per hectare (4.2 imperial gallons per minute per acre).

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

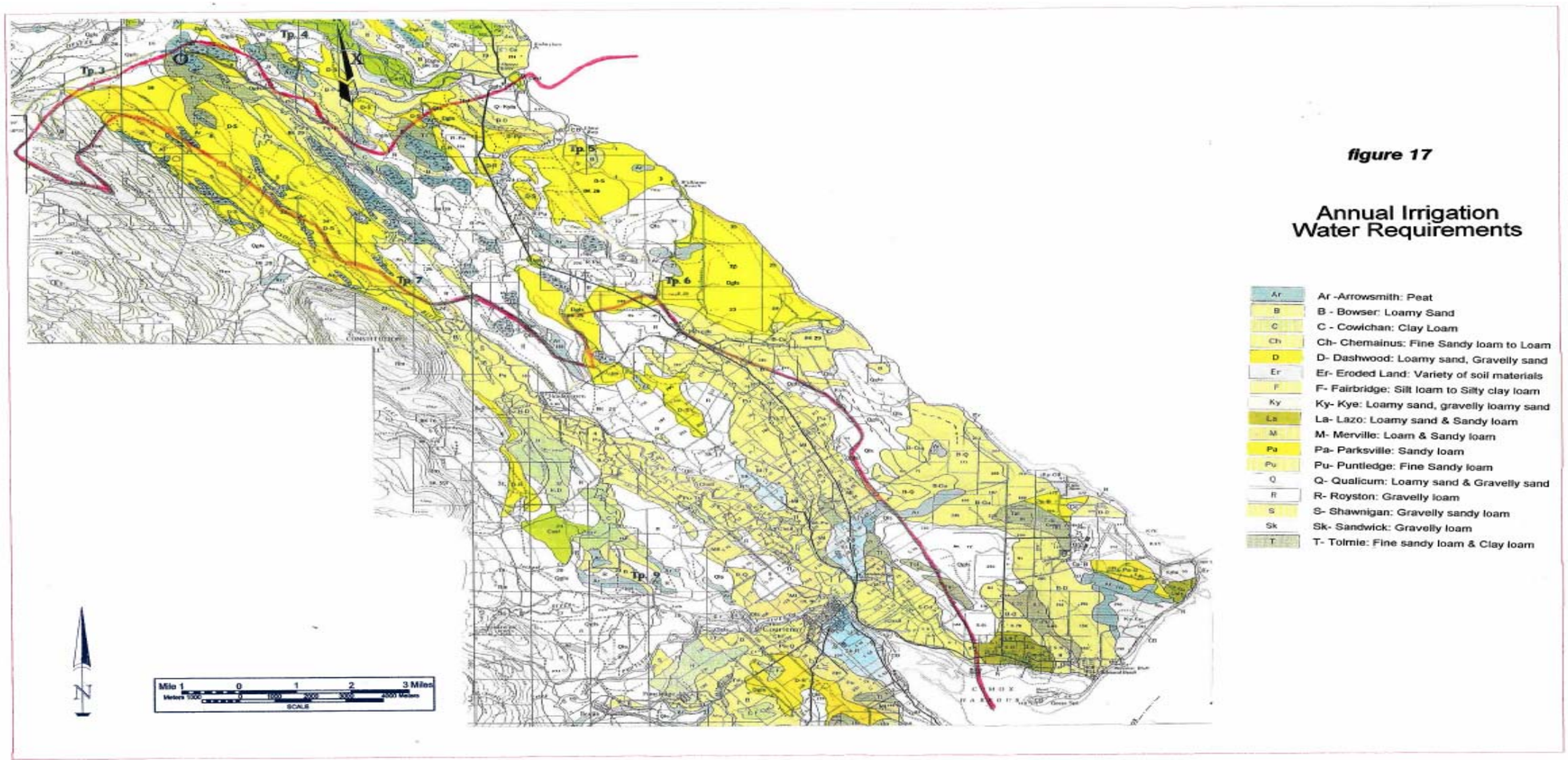


Figure 17: Annual Irrigation Water Requirements

All irrigation water demands must be adequately supported by storage.

All intake works in fish bearing waters shall be adequately screened to prevent fish and debris from entering the intake.

Meters must be installed by the licensee and the water withdrawals regulated by Regional Water Management for all farms that have irrigation water licences that total over 123 dam³ (100 acft) on fish bearing waters.

6.4 Industrial

The industrial water licenses and water licence applications within the plan area are demands associated with agricultural uses; including frost protection and flood harvesting of cranberries, fish farming and livestock watering.

The water requirement for frost protection of cranberries is 12 dam³ per hectare (4 acft per acre) during the periods of March to May and September to November to prevent frost damage to crops. Storage of at least 0.3 dam³ per hectare (0.1 acft per acre) of water is required for one night of frost protection. Water recycling and reuse should be encouraged. Approximately 60% of the water used for frost protection can be returned to storage; reducing the demand from streams.

The water requirement for flood harvesting of cranberries is 600 mm (2 ft) of water over the land to be harvested at the same time. Generally the cranberry bog will be divided into 0.8 to 1.6 hectares (2 to 4 acre) cells surrounded by low dykes. These cells can be flood harvested consecutively so that only 5 to 10 dam³ (4 to 8 acft) is required to flood harvest a cell. An additional 2.5 dam³ (2 acft) of water for every 4 hectares (10 acres) of planted area is required for leakage and other water losses in the cells. Larger farms may have to harvest more cells at the same time and may have a larger demand. Flood harvesting occurs from late September to November.

The water requirements for frost protection and flood harvesting of cranberries are very dependent on the nature of the local topography and local climate of the cranberry bog. If the applicant for a water license can provide more specific water requirement information for a given area, it may be used to assess these demands.

The water demands for frost protection and flood harvesting of cranberries occur primarily during the high flow period of streams when adequate water is available in the stream. However any water demands for frost protection and flood harvesting of cranberries that may extend into the low flow period must be adequately supported by storage.

Extensive fish pond and fish farming with no aeration, little water flow through the summer months and minimum feeding require at least 1 m³ of water per fish to be reared from

fingerling size (5-20 grams) to marketable size (200-300 grams). Intensive fish farming with aeration, significant summer flows and mechanical fish feeders may rear up to 30 fish per m^3 from fingerling size (5-20 grams) to marketable size (200-300 grams) in a fish pond or in fish cages in a larger pond. The following table provides an indication of the water volume requirements of fish ponds.

Fish Pond Water Volume Requirements per 100 Fish m^3 (acft)	
Extensive Fish Farming	100 (0.081)
Intensive Fish Farming	3.3 (0.003)

Specific fish pond water requirements, fish screening requirements and isolation requirements (from natural fish stocks) should be discussed with the fish biologist of the Ministry of Environment. Only fish ponds or fish farms that have or will get a "Live Fish Permit" (rearing fish for personal use, hobby or aesthetic purposes) from the Ministry of Environment, Lands and Parks or an "Aquiculture Licence" (rearing fish for commercial purposes) from the Ministry of Agriculture, Fish and Food may obtain a water licence.

A water licence for industrial (fish farming) purpose may be issued only for fish reared in dugouts, sloughs, reservoirs and small lakes that do not sustain natural fish populations. Fish reared in fish pond and fish farming operations must be adequately isolated from natural fish stocks.

Cattle or livestock watering requiring more than 450 litres/day (100 lmperial gpd) are to be considered an Industrial (Agricultural) demand. Cattle or livestock requiring 450 l/day (100 Igpd) or less will be considered a Domestic (livestock) demand. Estimated livestock demands are:

Recommended Livestock Water Requirements		
	Water Requirements	
Livestock	**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

6.5 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 and wildlife for non-profit purposes. The conservation water licenses and water licence applications within the plan area are

demands associated with fish hatcheries and the construction of water level control structures to maintain water levels for wild fowl habitat and fish habitat

The following chart provides an estimate of the flow required in a hatchery to support 1,000 fish of a given size. Hatcheries must identify the species, the target size, the number of fish to be hatched or reared and the average water temperature.

Fish Hatchery Water Flow Requirements per 1,000 Fish litres/min (gallons/min)

	Temp		Target Size of Fish in Grams (Ounces)					
Species	**ºC**	**ºF**	**0.45 (0.02)**	**0.9 (0.03)**	**9 (0.3)**	**18 (0.6)**	**30 (1.1)**	**77 (2.7)**
Coho	3	38	1.3 (0.3)	1.8 (0.4)	10.4 (2.3)	10.9 (2.4)	15.2 (3.3)	- -
	9	48	1.7 (0.4)	2.3 (0.5)	11.4 (2.5)	14.2 (3.1)	20.9 (4.6)	- -
	14	58	2.1 (0.5)	3.0 (0.7)	16.3 (3.6)	18.9 (4.2)	25.2 (5.6)	- -
	17	63	- -	4.6 (1.0)	22.7 (5.0)	25.3 (5.6)	37.9 (8.3)	- -
	20	68	- -	- -	57 (13)	76 (17)	95 (21)	- -
Chinook Steelhead and Sockeye	3	38	1.5 (0.3)	2.3 (0.5)	14.2 (3.1)	18.9 (4.2)	29.1 (6.4)	- -
	9	48	1.8 (0.4)	3.0 (0.7)	17.5 (3.8)	22.7 (5.0)	34.6 (7.6)	- -
	14	58	2.3 (0.5)	4.2 (0.9)	25.3 (5.6)	24.2 (5.3)	42.1 (9.3)	106 (24)
	17	63	- -	- -	- -	45 (10)	69 (15)	- -

In an intensive Aquiculture operation up to 90% - 95% of the water may be recirculated water that is aerated, stripped of nitrogen, and temperature modified. The supplemental water supply required may be as little as 5% - 10% of the requirement in a single pass, flow through hatchery. Specific hatchery water requirements, fish screening requirements and isolation (from natural fish stocks) requirements should be discussed with the fish biologist of the Ministry of Environment.

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

The applicable requirements for storage development shall be required for the construction of storage to maintain water levels for wild fowl habitat and fish habitat.

6.6 Land Improvement

Land improvement purpose is the impoundment of water on a stream or the diversion of water from a stream to facilitate the development of a park, to construct and maintain an aesthetic pond, to protect property from erosion or to drain and reclaim land. No significant water quantity is removed from the stream and the use is non-consumptive.

The water quantity required to facilitate the development of a park or create an aesthetic pond shall be the volume of the impoundment. No supporting storage water licence is required as the land improvement licence authorizes the storage. The applicable requirements for storage development shall be required.

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 farm or subdivision development. Streams should not be relocated to accommodate development. Post-development flow conditions 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 not be authorized.

6.7 Storage

Storage purpose is the impoundment of water, either on-stream of off-stream in a dugout or behind a dam.

The storage quantity required to support the smaller water demands anticipated to support domestic, industrial, commercial and irrigation uses shall be the volume of the water demand during the low flow period as noted above plus an additional allowance of 0.3 metres (1.0 foot) depth over the surface area of the storage reservoir for evaporation and other losses.

The water licence applicant shall be required to submit a completed report form entitled “Dam and Reservoir Information Required in Support of a Water Licence Application for Storage Purpose (Schedule 2)” before the application is considered.

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.

Diversion of water into off-stream storage will be during the high flow period.

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

Fish passage is required for both juvenile and adult fish at all dams in fish bearing streams. Design of storage dams must consider fish ladders and provide adequate flow release and maintain fish passage where required. Instream storage works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resource. Instream work will normally be allowed only during the low flow period. Mitigation work will be required for loss of spawning areas in the creeks affected by any storage.

Design plans must be submitted and accepted in writing before construction commences on any proposed dam over 3 metres (10 feet) in height or on storage of 12 dam^3 (10 acft) or more.

Off-stream storage dugouts that are outside the high water winter wetted perimeter of any watercourse, are not accessible by fish and do not adversely impact on flows in any watercourse during the low flow period are encouraged.

All water licensees that develop storage greater than 123 dam^3 (100 acft) shall be required to record and report the water level of the reservoir and flows from the reservoir as directed by the “Engineer” as defined in the Water Act of B.C.

6.8 Allocation Plan Revision

The Comox/Black Creek Water Allocation Plan should be reviewed and updated on or before January 1, 2003.

APPENDIX A

Canadian Climatic Normals
1951-1980

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE
BLACK CREEK 49° 51'N 125° 8'W 46 m														
Daily Maximum Temperature														
Daily Minimum Temperature														
Daily Temperature														
Standard Deviation, Daily Temperature														
Extreme Maximum Temperature														
Years of Record														
Extreme Minimum Temperature														
Years of Record														
Rainfall	197.3	157.4	159.1	71.0	55.6	48.4	35.6	54.9	65.7	157.5	233.2	246.3	1482.0	6
Snowfall	44.8	12.8	9.9	1.0	0.0	0.0	0.0	0.0	0.0	0.3	9.8	32.1	110.5	6
Total Precipitation	**236.2**	**171.9**	**168.3**	**71.9**	**55.6**	**48.4**	**35.6**	**54.9**	**65.7**	**157.8**	**243.2**	**278.7**	**1588.2**	**6**
Standard Deviation, Total Precipitation	118.8	70.2	62.9	45.9	25.7	26.6	24.9	38.5	40.1	105.2	125.4	95.2	204.5	4
Greatest Rainfall in 24 hours	138.4	86.9	74.4	67.3	45.0	43.9	52.8	45.2	54.0	67.6	101.1	92.5	138.4	
Years of Record	16	16	16	15	13	14	14	15	15	16	17	16		
Greatest Snowfall in 24 hours	46.6	27.9	27.9	6.4	T	0.0	0.0	0.0	0.0	7.6	42.9	45.7	46.6	
Years of Record	16	16	16	16	16	16	15	16	17	17	17	17		
Greatest Precipitation in 24 hours	138.4	94.5	89.7	67.3	45.0	43.9	52.8	45.2	54.0	67.6	101.1	92.5	138.4	
Years of Record	16	16	16	15	13	14	14	15	15	16	17	16		
Days with Rain	15	15	14	11	10	9	7	8	10	14	16	17	146	6
Days with Snow	5	2	1	0	0	0	0	0	0	0	1	3	12	6
Days with Precipitation	19	16	14	11	10	9	7	8	10	14	17	19	154	6

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE
COMOX A 49° 43'N 124° 54'W 24 m														
Daily Maximum Temperature	4.9	7.2	8.8	12.4	16.8	19.7	22.7	22.0	18.4	12.9	8.4	6.3	13.4	1
Daily Minimum Temperature	-0.6	0.9	1.2	3.6	6.8	10.2	12.1	11.9	9.0	5.4	2.3	0.9	5.3	1
Daily Temperature	**2.2**	**4.0**	**5.0**	**8.0**	**11.8**	**15.0**	**17.4**	**17.0**	**13.7**	**9.2**	**5.3**	**3.7**	**9.4**	1
Standard Deviation, Daily Temperature	1.7	1.3	1.1	0.8	1.1	1.6	1.3	1.3	0.9	0.7	1.2	1.6	0.6	1
Extreme Maximum Temperature	16.7	15.5	18.9	23.9	31.1	34.4	34.4	32.8	30.6	22.2	17.8	16.0	34.4	
Years of Record	36	36	36	36	36	36	37	37	37	37	37	37		
Extreme Minimum Temperature	-21.1	-16.1	-13.9	-4.4	-2.8	3.3	5.0	4.4	-1.7	-3.3	-10.0	-15.0	-21.1	
Years of Record	36	36	36	36	36	36	37	37	37	37	36	37		
Rainfall	149.1	110.2	100.7	55.8	37.4	35.2	27.8	44.4	51.7	127.5	182.4	184.4	1106.6	1
Snowfall	42.5	14.5	10.3	1.3	T	0.0	0.0	0.0	0.0	0.1	8.0	29.8	106.5	1
Total Precipitation	**193.2**	**125.1**	**111.5**	**57.1**	**37.4**	**35.2**	**27.8**	**44.4**	**51.7**	**127.7**	**191.8**	**212.7**	**1215.4**	1
Standard Deviation, Total Precipitation	81.2	59.4	48.6	33.1	14.8	24.2	19.1	38.1	29.5	70.6	84.2	62.9	176.2	1
Greatest Rainfall in 24 hours	77.0	63.5	56.6	40.9	29.2	30.5	37.3	69.1	42.2	59.4	69.9	113.0	113.0	
Years of Record	36	36	36	36	36	36	37	37	37	37	37	37		
Greatest Snowfall in 24 hours	60.2	27.7	37.3	15.2	0.3	T	0.0	0.0	T	3.3	26.4	59.7	60.2	
Years of Record	36	36	36	36	36	36	37	37	37	37	37	37		
Greatest Precipitation in 24 hours	77.0	63.5	56.6	46.5	29.2	30.5	37.3	69.1	42.2	65.5	69.9	113.0	113.0	
Years of Record	36	36	36	36	36	36	37	37	37	37	37	37		
Days with Rain	17	15	15	12	10	10	7	8	10	15	18	19	156	1
Days with Snow	6	2	2	*	*	0	0	0	0	*	1	3	14	1
Days with Precipitation	20	15	15	12	10	10	7	8	10	15	18	21	161	1

APPENDIX B

Hydrometric Information

Station Name: **BLACK CREEK AT STURGESS ROAD**

Station Number: **08HD014**

Natural Flow

Drainage Area (sq.km.): 71.7

Flow in m^3/sec

	Degrees	Minutes	Seconds
Latitude	49	48	29
Longitude	125	8	33

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
1980				0.862	0.144	0.186	0.335	0.004	0.02				
1981				0.791	0.624								
1982				0.859	0.14	0.001	0	0	0				
1983				0.731	0.053	0.074	0.068	0.026	0				
1984				0.911	0.814	0.155	0.001	0	0				
1985				0.547	0.225	0.038	0	0	0				
1986					0.553		0.061	0.003	0				
1987				0.354	0.298	0.048	0.03	0.037	0				
1988				1.05	0.167	0.103	0	0	0				
1989				0.969	0.072	0.005	0.181	0.012	0.027				
Mean				0.786	0.309	0.076	0.075	0.009	0.005				

Station Name: **BLACK CREEK NEAR MIRACLE BEACH PARK**

Station Number: **08HD008**

Natural Flow:

Drainage Area (sq.km.):72.8

Flow in m^3/sec

	Degrees	Minutes	Seconds
Latitude	49	49	53
Longitude	125	7	27

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
1968							0.007	0.004	0.006				
MEAN							0.007	0.004	0.006				

Station Name: **DOVE CREEK NEAR THE MOUTH**

Station Number: **08HB075**

Natural Flow:

Drainage Area (sq.km.): 41.1

Flow in m^3/sec

	Degrees	Minutes	Seconds
Latitude	49	44	13
Longitude	125	5	0

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
1985	0.585	1.02	1.35	2.53	1.25	0.173	0.006	0.004	0.164	1.64	0.656	1.34	0.892
1986	6.21	2.97	3.41	1.4	1.62	M	M	M	M	0.148	2.66	5.92	M
1987	5.29	4.87	4.46	1.19	0.974	0.395	0.048	0.011	0.002	0.003	1.68	3.91	1.89
1988	2.7	1.51	2.11	2.48	1.23	0.448	0.059	0.013	0.017	0.106	5.05	2.43	1.51
1989	1.72	1.57	2.55	2.94	0.597	0.113	0.464	0.14	0.045	1.54	1.15	2.76	1.3
1990	3.03	2.17	2.02	1.27	0.647	1.72	0.219	0.006	0.003	1.87	6.21	3.75	1.9
1991	1.6	6.75	0.961	1.6	0.416	0.199	0.157	0.548	0.326	0.099	3.7	4.09	1.67
1992	8.95	4.72	0.905	1.09	0.277	0.095	0.057	0.001	0.006	2.22	3.01	1.44	1.89
1993	1.97	1.28	3.64	4.05	1.27	1.57	0.559	0.147	0.013	0.304	0.737	4.77	1.7
1994	3.73	3.34	3.79	2.15	0.419	0.357	0.091	0.081	0.204	0.888	2.8	5.85	1.97
MEAN	3.58	3.02	2.52	2.07	0.87	0.56	0.18	0.11	0.09	0.88	2.77	3.63	1.64

Station Name: **TSOLUM RIVER NEAR COURTENAY**

Station Number: **08HB011**

Natural Flow:

Drainage Area (sq.km.): 258

Flow in m^3/sec

	Degrees	Minutes	Seconds
Latitude	49	42	26
Longitude	125	0	41

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
1914						6.53	1.79	0.323	8.82		24.8	10.6	
1915	21.3	19.6	18.2	12.5	4.84	1.3	0.537	0.12	0.182	12.6	13.2	28	11
1916	1.49	6.21	23.6	21.1	19.5	13	8.21	1.16	0.094	1.58	8.25	9.44	9.48
1917	5.26	9.35	8.26										
1955			5.03	9.99			2.72	1.72	1.8	8.62			
1956	28.1	6.03	14.5	16.1	15.2	10	2.44	0.23	0.744	8.68	9.7	21.3	11.1
1957	8.28	10.4	21	16.3	6.51								
1964				7.25	4.55	5.07	3.87	1.9	0.957	1.74	6.89	13.8	
1965	10.5	17.1	7.49	10.8	3.6	0.889	0.169	0.922	0.892	13.3	24.3	29.9	9.94
1966	33.6	17	21.6	8.72	4.79	3.07	1.4	0.741	1.55	3.38	24.5	51.4	14.3
1967	19.9	10.3	21.1	6.91	6.79	3.58	0.386	0.21	0.687	15.3	8.53	17.3	9.29
1968	42.1	19.6	22.6	4.62	4.95	2.15	0.513	1.5	1.62	25.3	31	29	15.4
1969	5.94	22.6	19.5	30.6						5.45	22.8	29.3	
1970	10.2	10.8	9.16	6.21	3.36	1.86	0.709	0.406	0.245	8.47	10.9	26.5	7.4
1971	17.9	14.7	12.7	11.3	16.1	7.1	2.57	0.556	1.59	4.63	29	11.5	10.8
1972	5.35	17.4					1.88	0.496	2.27	1.55	15.2	23.3	
1973	34	7.76	14.7	5.94	8.57	3.9	1.74	0.498	1.11	6.24	16.8	42.4	12.1
1974	19.6	19.9	29.5	19.5	8.04	5.39	3.65	0.478	0.763	0.666			
1975	9.01	7.92	15.9	11.5	13.7	3.54	0.784	1.15	1	20.1	44.6	18.9	12.3
1976	15.8	10.2				4.16	2.5	0.654			5.02	10.1	
1977	5.66	19	17.1	8.28	5.34	4.65	0.719	0.203	2.34	13.2	25.3	18.6	9.96
1978	14	18.7	15	11.4	4.7	2.4	0.747	4.9	7.99	1.63	5.13	8.02	7.81

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MAD
1979	4.03	24.7	14.5	11.2	7.35	1.42	1.61	0.423	6.09	12.8	7.82	28.9	9.99
1980	12.2	25.3	14.1	12.1	4.35	4.69	4.47	0.43	0.847	1.16	22.8	30.9	11.1
1981	20.4	17.5	5.47	7.42	6.72	3.49	1.8	1.09	3.77	14.4	29.9	23.6	11.3
1982	13.8	21.6	15.7	10.8	9.68	4.34	1	0.263	0.672	20.3	10.1	25.2	11.1
1983	30.7	43.2	26.7	8.02	5.13	2.81	2.56	0.682	1.5	3.53	44.9	6.81	14.5
1984	14.3	25.5	17.9	10.4	11.2	3.18	0.986	0.332	0.49	13.9	27.1	10.6	11.3
1985	3.46	6.76	8.3	11.5	6.5	1.76	0.135	0.039	0.871	6.52	4.17	8.26	4.85
1986	36.5	13.5	16	7.23	8.7	3.88	1.08	0.119	0.104	0.859	11.8	30.1	10.9
1987	28.1	23.7	23.2	6.27	5.71	2.4	1.04	0.214	0.156	0.229	6.94	24	10.1
1988	17.2	8.23	10.7	11.6	6.08	3.49	0.776	0.263	0.252	0.578	29.5	15.3	8.64
1989	9.1	8.32	14	14	4.01	1.49	2.51	0.625	0.206	5.55	6.77	13.5	6.67
1990	15.6	11.3	11.1	6.02	3.8	9.47	1.03	0.087	0.155	7.66	26.4	11.1	8.6
1991	9.86	39.5	6.82	10.6	2.43	1.42	0.815	6.18	2.02	0.331	21.1	22	10
1992	42.8	27.7	5.43	6.2	2.41	1.1	0.767	0.088	0.302	7.59	17.9	9.75	10.1
1993	9.96	7.43	17.8	17.7	11.3	9.39	2.94	1.24	0.232	0.962	2.21	24.9	8.86
1994	19.4	17.6	18.1	11.3	2.58	2.56	0.819	1.81	1.35	3.5	16.6	29.3	10.4
MEAN	17.0	16.8	15.4	11.2	7.1	4.1	1.8	0.9	1.6	7.4	18.0	21.0	10.3

Station Name: **LITTLE RIVER AT WILKINSON ROAD**

Station Number: **08HBBII**

Natural Flow: Degrees Minutes Seconds

Drainage Area (sq.km.): 19.3 Latitude

Flow in m^3/sec Longitude

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAD
1987												0.582	
1988		0.249	0.322	0.301		0.064	0.024	0.028	0.135	0.085	0.881	0.561	0.219
1989	0.484	0.683	0.532	0.308	0.083	0.041	0.045	0.049	0.051	0.219	0.380	0.618	0.289
1990	0.825	0.789	0.487	0.251	0.153	0.245	0.046	0.004	0.026	0.222	0.739	0.721	0.373
1991	1.054	1.046	0.511	0.276	0.088	0.073	0.060		0.124	0.112			0.321
1992			0.295	0.400							0.562		
MEAN	0.788	0.692	0.429	0.307	0.108	0.106	0.044	0.027	0.084	0.159	0.640	0.621	0.332

Miscellaneous Flow Data				
Location	**Source**	**Date**	**Measurement (cfs)**	**Discharge (litres/sec)**
Black Creek at Sturgess Road	WSC Station	Mar-29-88	1.33	37.7
		Mar-25-86	0.927	26.2
		Mar-26-87	0.614	17.4
Black Creek near Miracle Beach Park	WSC Station	July-68 *	0.23	6.5
		Aug-68 *	0.13	3.7
		Sept-68 *	0.22	6.2
Black Creek	WSC Station	July-77 *	0.42	11.9
		Aug-77 *	0.01	0.3
		Sept-77 *	0.01	0.3
Little River	WSC Station	July-77 *	0.24	6.8
		Aug-77 *	0.39	11.0
		Sept-77 *	1.1	31.1
Scales Creek (tributary to Little river)	WSC Station	July-77 *	0.11	3.1
		Aug-77 *	0.15	4.2
		Sept-77 *	0.37	10.5
	Current Meter	Aug 27-80	0.528	15.0
		Sept 16-80	1.575	44.6
		Sept 17-80	0.809	22.9
		Oct 3-80	0.421	11.9
Millar Brook (tributary to Black Creek)	Current Meter	Jul-29-80	1.114	31.5
		Aug 27-80	1.336	37.8
		Oct 3-80	0.471	13.3
Queens Ditch at East Lot Line	Observation	Oct. 21-87	0.272	7.7
Hilton Springs (tributary to Queens Ditch)	Observations	June-82 *	0.288	8.2
		Oct 21-82	0.24	6.8
Brooklyn Creek	Current Meter	Aug 14-85	0.026	0.7

* - mean monthly

APPENDIX C

Water Licenses

File No.	Licence No.	Licencee	Source	Quantity/ Units	Annual Demand dam³
Conservation Purpose					
0368181	C056654	DU, MELP and Nature Trust of B.C.	Lazo Marsh	65 acft	
	Number =	1	**Sub-total**	**65 acft**	80
Domestic Purpose					
0038391	F005136	Zolner Toffie W & Elaine A	Little River	500 gpd	
0102127	F008481	Hamilton Elsie F	Anderton Spring	2000 gpd	
0107598	F009088	Johnson Alvin F	Scales Creek	2000 gpd	
0107826	F019435	Smith Sidney W	Anderton Spring	1000 gpd	
0130574	F011676	Jasbec Sheila G & Robin D	Kye Spring	150 gpd	
0130858	F011675	Kye Bay Guest Lodge & Cottages Ltd.	Kye Spring	150 gpd	
0198644	C053166	Adams Donald A & Renee L	Anderton Spring	500 gpd	
0200141	C108084	Beaver Meadow Farms (1971) Ltd.	Edgar Spring	2000 gpd	
0222853	C025291	Henrich Berta	Black Creek	5000 gpd	
0259003	F020133	Ptak Susan	Huntley Spring	500 gpd	
0259030	F108155	Glover Ross N & Lynda L	Huntley Spring	500 gpd	
0264808	F021371	Girard Olive M & Timothy K	Black Creek	1000 gpd	
0267195	C031366	Patsch Leo H & Alinda L M	Penner Spring	1000 gpd	
0269353	F040864	Opelka Karl J	Anderton Spring	500 gpd	
0270178	F021139	Baker Peter R & Patricia E	Huntley Spring	500 gpd	
0270575	C037766	Macmillan Bloedel Ltd.	Sayer Creek	1000 gpd	
0270820	F040697	Brown Nell	Anderton Spring	1000 gpd	
0273421	C032798	Baskin Joan L	Black Creek	500 gpd	
0277765	C033495	Tarves Roger L & Shirley A	Black Creek	1000 gpd	
0300175	F108156	Telosky Robert G & Sonja	Huntley Spring	500 gpd	
0300838	C037624	Davidson Gordon W	Jackman Brook	1000 gpd	
0310090	C040120	McRae Ian S & Mary Jane	Huntley Spring	500 gpd	

File No.	Licence No.	Licencee	Source	Quantity/ Units	Annual Demand dam³
0328194	C045101	Isenor Dickey E & Alice R	Kitty Coleman Creek	1500 gpd	
0330968	C048692	Ludwig Dairies	Black Creek	500 gpd	
0341663	C050689	Hollins Raymond N	Colfax Spring	1000 gpd	
0346521	C053167	Spichtig Otto	Anderton Spring	500 gpd	
0355187	C054348	Farmer William W	Galba Spring	500 gpd	
0364667	C059676	Henrich Berta	Keddy, Black Creek & Northy Lake	3000 gpd	
0364767	C059204	Mountain View Farms Ltd.	Northy Lake	2600 gpd	
0370657	F011677	Briggs Tillman A	Kye Spring	150 gpd	
0370658	F011678	McFarlane William B A	Kye Spring	150 gpd	
0370661	F016228	Kye Bay Guest Lodge & Cottages Ltd.	Kye Spring	300 gpd	
	Number =	32	**Sub-total**	**33000 gpd**	27
Irrigation Purpose					
0075183	F007396	Smith Richard & David M	Scales Creek	4.5 acft	
0197191	F047409	Beaver Meadow Farms (1971) Ltd.	Little River	100 acft	
0200141	C108084	Beaver Meadow Farms (1971) Ltd.	Edgar Spring	40 acft	
0222853	C025291	Henrich Berta	Black Creek	115 acft	
0229017	F105815	Woodrow Alan D	Queens Ditch	150 acft	
0257337	C029964	Finlay V David & Glenda S	Black Creek	10 acft	
0258714	F020405	Janes David W	Kitty Coleman Creek	0.7 acft	
0267195	C031366	Patsch Leo H & Alinda L M	Penner Spring	1 acft	
0270575	C037766	MacMillan Bloedel Ltd.	Sayer Creek	25 acft	
0277082	C041147	Halstead Donald	Williams Swamp	10 acft	
0296619	C037156	Knight Donald J	Queens Ditch	20 acft	
0300838	C037624	Davidson Gordon W	Jackman Brook	10 acft	
0323916	C108154	Glover Ross N & Lynda L	Rhoda Spring	3 acft	
0364667	C059676	Henrich Berta	Keddy, Black Creek & Northy Lake	160 acft	
0368668	C058042	Stevedore Holdings Ltd.	Huband Swamp	30 acft	
0370829	C067584	Meehan James B & Bertha	Verwolf Brook	0.37 acft	
0370893	C067583	Salo Dennis & Maria	Verwolf Brook	0.19 acft	
1000499	C061470	Beacham William B & Diane M	Garlick Brook	30 acft	
	Number =	18	**Sub-total**	**709.76 acft**	875

File No.	Licence No.	Licencee	Source	Quantity/ Units	Annual Demand dam³
Land Improvement Purpose					
1001692	C106795	Northey Lake Project	Black & Millar Creek	20 acft	
1001829	C109448	Endeavour Developments Ltd.	Fairway Pond	12 acft	
	Number =	2	**Sub-total**	**32 acft**	39
Industrial Purpose					
1000047	C061469	Reinhold Frederick G & Susie	Reinhold Spring	100 gpd	
0147465	C065707	Beaver Meadow Farms (1971) Ltd.	Muir Spring	1000 gpd	
			Sub-total	**1100 gpd**	1
1001169	C100985	Beaver Meadow Farms (1971) Ltd.	Beaver Springs	33 acft	
	Number =	3	**Sub-total**	**33 acft**	41
Storage Purpose					
0270575	C037767	MacMillan Bloedel Ltd.	Sayer Creek	25 acft	
0300838	C037625	Davidson Gordon W	Jackman Brook	8 acft	
0368668	C058043	Stevedore Holdings Ltd.	Huband Swamp	30 acft	
1000161	C059677	Henrich Berta	Keddy Creek	160 acft	
1000499	C061471	Beacham William B & Diane M	Craigie Brook	30 acft	
1001169	C100985	Beaver Meadow Farms (1971) Ltd.	Beaver Springs	33 acft	
	Number =	6	**Sub-total**	**286 acft**	353
Waterworks Purpose					
0185370	C019762	Lands Branch	Park Springs	5000 gpd	
	Number =	1	**Sub-total**	**5000 gpd**	4
	Total	63		Total	1,421

APPENDIX D

Water License Applications

File No.	Licence No.	Licencee	Source	Quantity/ Units	Annual Demand dam³
Irrigation Purpose					
1001457	Z104413	Raven Forest Products Ltd.	ZZ Creek (65478)	12 acft	
1001523	Z103740	Clark Jack B & Ellen C	Hilton Springs	54 acft	
1001657	Z106100	Smith William E J G	Sayer Creek	123 acft	
1001938	Z111219	Beaver Meadow Farms (1971) Ltd.	Beaver Springs	230 acft	
	Number =	4	**Sub-total**	**419 acft**	517
Conservation Purpose					
1001790	Z108357	Little River Enhancement Society	Little River	1 acft	
1001889	Z110405	Beaver Meadow Farms (1971) Ltd. & Little River Enhancement Society	ZZ Spring (71565)	1 acft	
1001871	Z109691	Duck's Unlimited (Canada) & Lazo Tyee Farms Ltd.	ZZ Creek (71239)	186.46 acft	
	Number =	3	**Sub-total**	**188.46 acft**	232
Industrial Purpose					
1001523	Z103740	Clark Jack B & Ellen C	Hilton Springs	1200 gpd	
			Sub-total	**1200 gpd**	1
1001936	Z111217	Beaver Meadow Farms (1971) Ltd.	McKernan Spring	4 acft	
1001937	Z111218	Beaver Meadow Farms (1971) Ltd.	Beaver Springs	1 acft	
1001457	Z104413	Raven Forest Products Ltd.	ZZ Creek (65478)	12 acft	
	Number =	4	**Sub-total**	**5 acft**	6
Land Improvement Purpose					
1001935	Z111216	Beaver Meadow Farms (1971) Ltd.	Little River & Marsh	1 acft	
	Number =	1	**Sub-total**	**1 acft**	1
	Total	12		**Total**	**241**

APPENDIX E

Fish Screening Requirements

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 fatigued. 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.

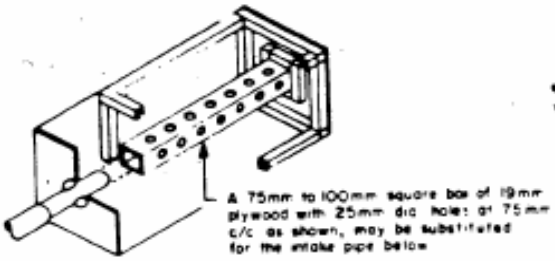
3. B.C. Ministry of Environment
   Water Management.

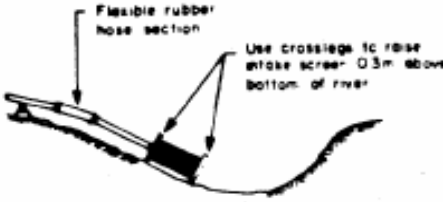
4. B.C. Ministry of Agriculture and Food.

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

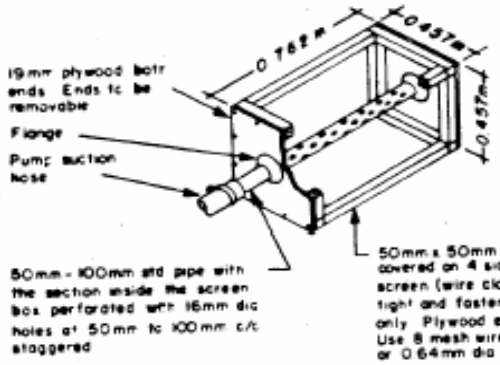
It may be necessary that several or all these agencies also be solicited for approvals prior to the installation of a water intake.

Revised January, 1986

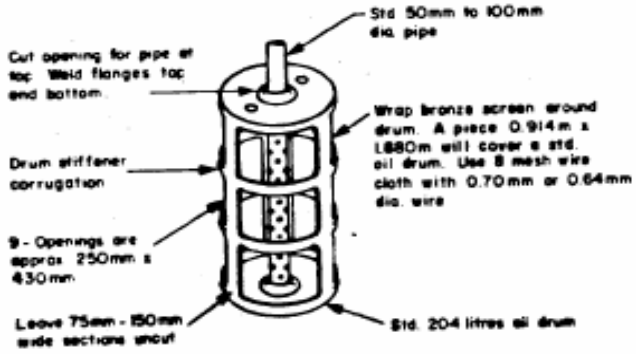


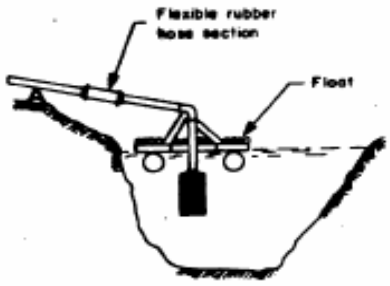


STANDARD INSTALLATION



INSTALLATION IN SHALLOW WATER MUDDY OVERGROWN BOTTOM





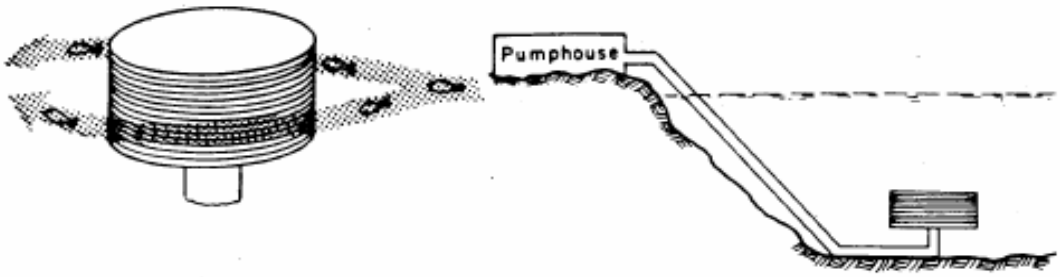
INSTALLATION IN DEEP WATER

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 epoxy 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 [1 cfs, 449 U.S. or 374 Igpm])



DEEP WATER WELL SCREEN

May be installed in lakes and the ocean.

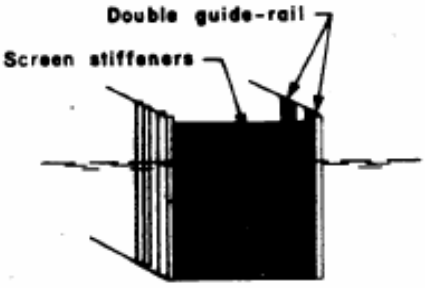
SHALLOW WATER WELL SCREEN

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).

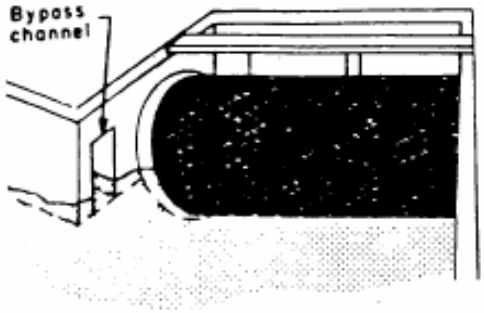
VERTICAL PANEL SCREENS

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.



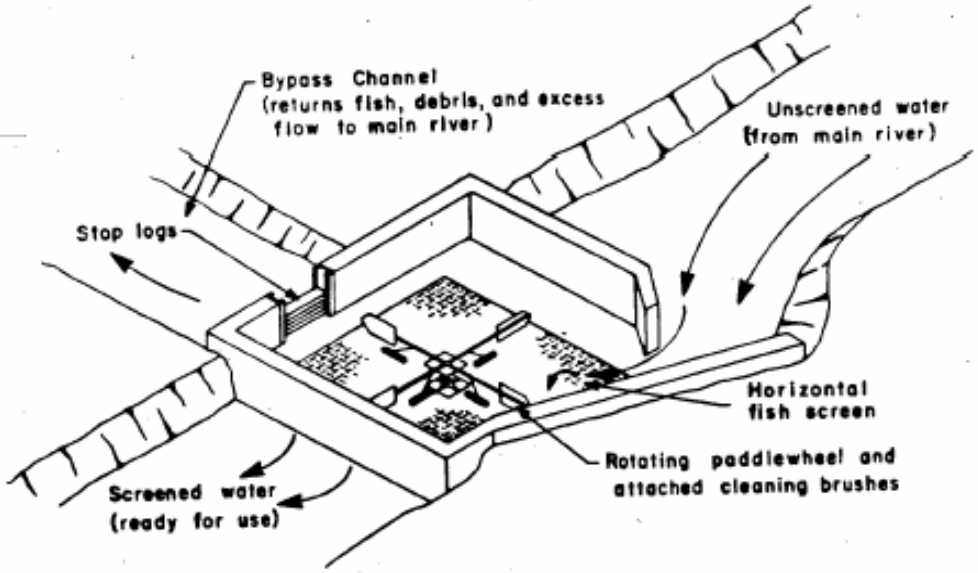
LARGE STATIONARY WATER INTAKE SCREENS

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



REVOLVING DRUM SCREEN, HORIZONTAL AXIS

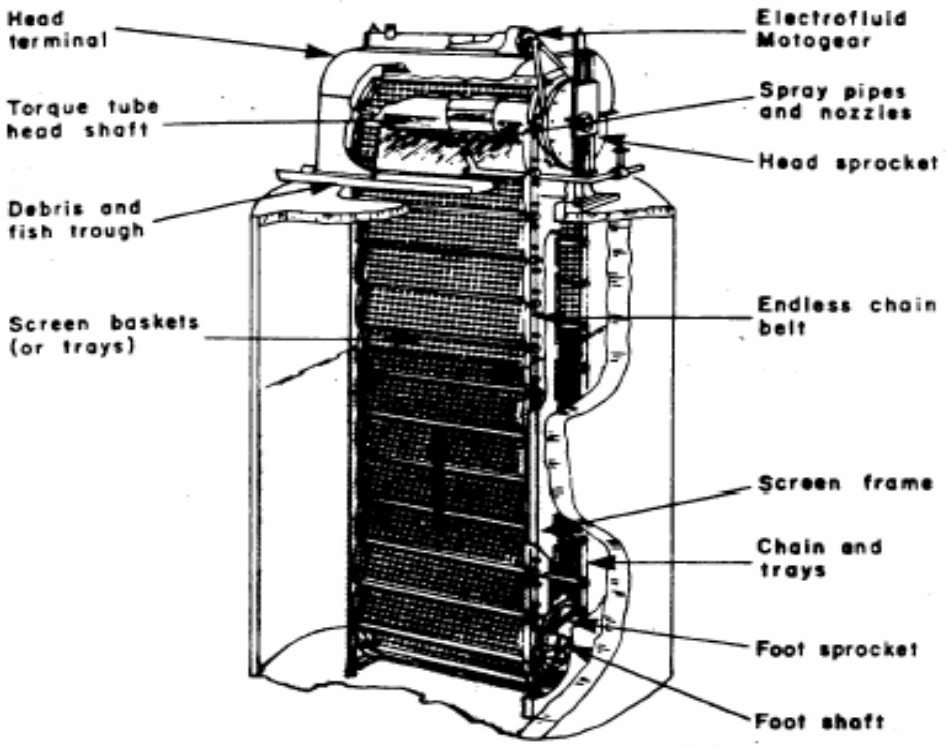
Generally, installed to divert fish from irrigation canals. Can be driven by a small motor or by a paddle wheel. To avoid juvenile fish impingement, a bypass channel is required near the front of the screen. Rubber seals are necessary along the base and sides.



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