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

Nile Creek to Trent River

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 advantages include:

1. Making information regarding our position on water allocation decisions available to the public and future applicants;
2. Application response time is reduced;
3. Eliminating the need for individual studies and reports on each application;
4. Improving the consistency of our approach and decisions;
5. Definition of specific allocation directions and decisions;
6. Plans are more comprehensive than present reports;
7. Eliminates the need for referrals on individual applications.

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 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

2.1 Geography and Morphology

The Nile Creek to Trent River Water Allocation Plan area (Figure 1) is located approximately one third of the way up the eastern coast of Vancouver Island. It stretches for about 32 kilometres between the municipalities of Qualicum Bay to the south and Royston to the north. The average width of the area is approximately 13 kilometres, but in reality varies significantly from north to south. The Beaufort Mountain Range defines the western boundary of the plan area and contains the headwaters for most of the rivers and creeks in the plan area. Most of the drainage flows to the northeast on its way to Baynes Sound and the Strait of Georgia, the eastern boundary of the plan area. The size of the allocation plan area was determined to approximate 440 square kilometres.

At 1550 metres, Mt. Joan is the highest point found in the allocation area. It, along with a number of other smaller peaks to the north and south, defines the divide which separates those streams flowing eastward to the Strait of Georgia from those that flow inland into Comox Lake, Elsie Lake, Ash River, Stamp River, and Horne Lake. Distribution of lakes in the plan area is mainly restricted to higher elevations, particularly within the Tsable River drainage area.

2.2 Climate

The Nile Creek to Trent River Water Allocation Plan area lies in a region that is characterized by wet, mild winters and warm, dry summers. Climatic normals have been derived using information from an Environment Canada, Atmospheric Environment Science (AES) station at Mud Bay over a thirty year period (Appendix A). The mean daily temperature is 9.3°C throughout the year. January is the coldest month of the year with a mean daily temperature of 1.8°C; whereas July is the warmest time of the year with a mean daily temperature of 17.4°C.

Precipitation in the region is low during the summer months and high during winter months. Information on this subject is available in the Precipitation segment of the Hydrology section, as well as Appendix A. The lack of precipitation in the summer months, coupled with high evaporation rates and the rainshadow effect created by the Beaufort Range to the west effectively burdens the plan area with an annual moisture deficit. Because of this, the implementation of a water allocation plan is crucial to this area.

2.3 Geology and Groundwater

The Nile Creek to Trent River Water Allocation Plan area has a varied geological history. Fluvial, colluvial (mass wasting), and marine processes have played a role in shaping the landscape. The most influential mechanism in the formation of the present landscape is that of glaciation. The surficial deposits found within the area are predominantly the result of glaciation during the Pleistocene epoch (Jungen, 1985). As a result, unconsolidated sands, gravels and tills (boulder clay) are commonly found deposits within the plan area. Marine silts, clays, sands and gravels are also common at elevations low enough to be affected by episodes of sea level transgression.

There is evidence from a number of sources that potential exists for the use of groundwater within the plan area. Ronneseth (1984 & 1985) points out that the largest groundwater reserves in the area are contained in recent alluvial deposits, terraced fluvial and deltaic deposits, and in the Quadra Sand and other sediments of the Vashon Drift. At least three possible sites for groundwater development have been identified, they include the deltas of Rosewall Creek, Tsable River, and Trent River (Zubel, 1979 and AESL, 1975). Evidence also points towards large aquifers that supplement certain creeks with abnormally high summer low flows. It is theorized that the flows in Nile Creek, Chef Creek, Waterloo Creek, Wilfred Creek and others are influenced by these aquifers.

2.4 History and Development

During the mid 1800's to early 1900's the northern part of the Nile Creek to Trent River Water Allocation Plan area was a prosperous coal mining and exporting region. A deep-sea port located in the town of Union Bay was used to ship the coal that was mined in the Cumberland/Royston area. Development in Union Bay was continuous until the mid 1900's when the use of coal declined worldwide. Water licences that once called for the extraction of water from Hart Creek (which flows through Union Bay) date back to 1913. Those licences still exist but have been converted from the purpose of coal washing to waterworks and storage purposes.

The population within the plan area lives close to the highway, within one kilometre of the shoreline. There are no large communities in the area, but there are numerous municipalities with potential for growth, including Qualicum Bay, Bowser, Mud Bay, Fanny Bay, Buckley Bay, Union Bay, Bayton and the southern portion of Royston.

2.5 Significant Drainage Areas

For the purpose of assessing water supplies for allocation demands significant drainages were identified and their areas were established. These areas were digitized using 1:50,000 NTS maps. The following table and Figure 2 illustrate these watershed areas.

Significant Drainage Areas	
Drainage	**Area (km^2)**
Black Brook	1.3
Nash Creek/Norene Spring	4.1
Nile Creek	16.9
Thames Creek	8.8
Whitman Creek	1.3
Sandy Creek	3.9
Chef Creek	8.1
Cook Creek	19.7
McNaughton Creek	9.5
Rosewall Creek	43.6
Waterloo Creek	11.1
Wilfred Creek	27.3
Cowie Creek	21.4
Tsable River	105.1
Hindoo Creek	5.1
Hart Creek/Langley Lake	28.7
Trent River	66.9

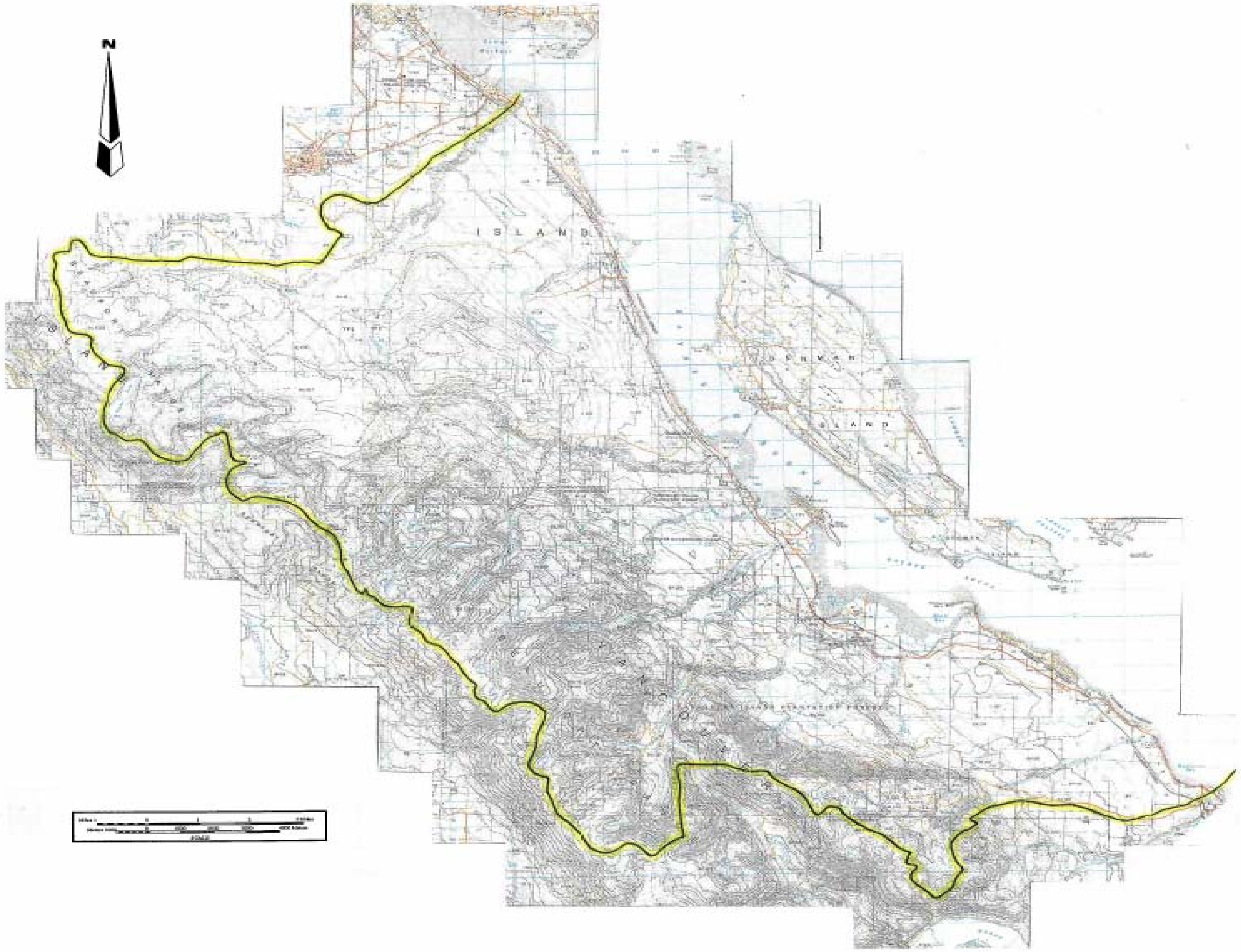
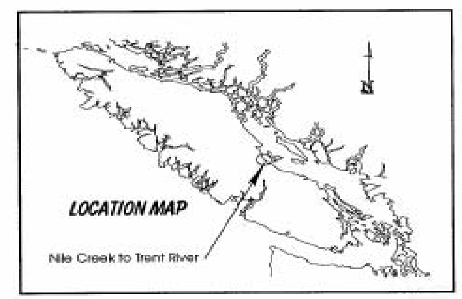


FIGURE 1

Nile Creek to Trent River Water Allocation Plan Area



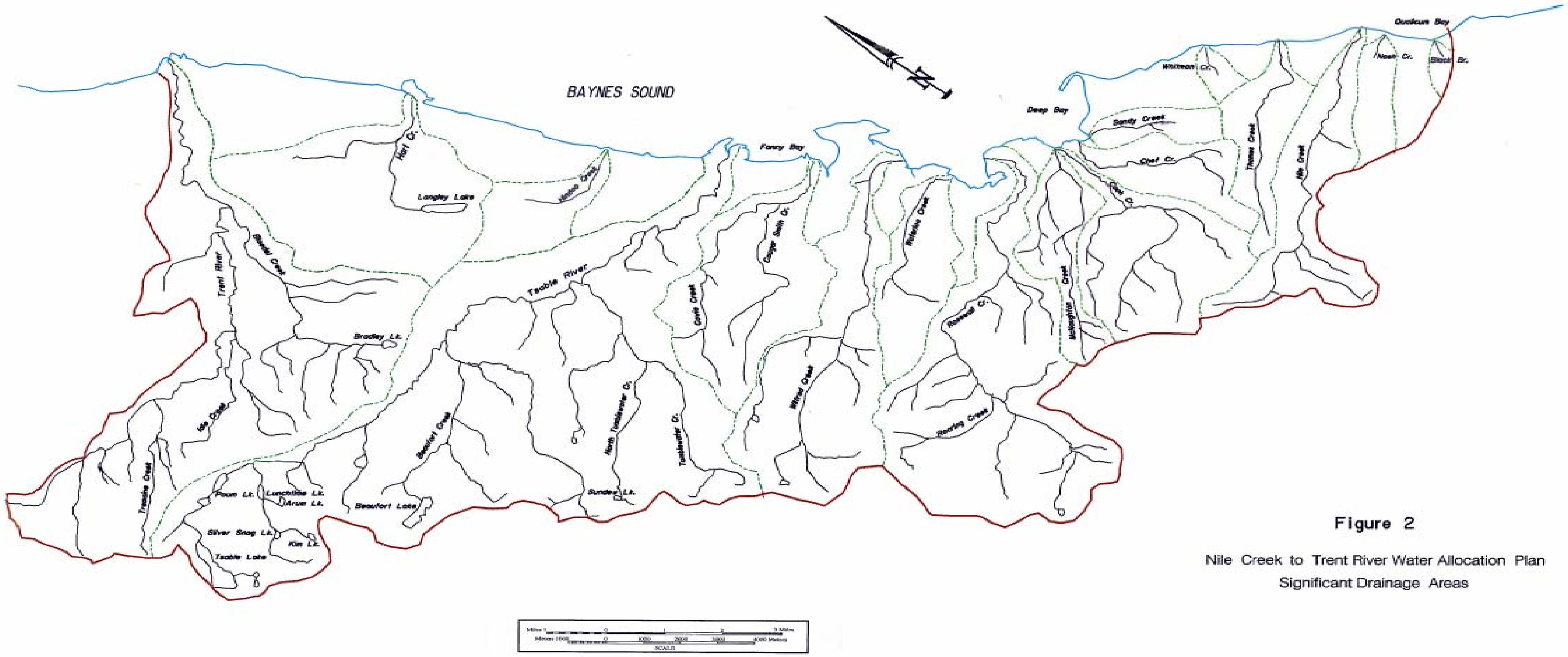


Figure 2

Nile Creek to Trent River Water Allocation Plan
Significant Drainage Areas

3.0 HYDROLOGY

3.1 Precipitation

Using data collected from 1951 to 1980 at the Mud Bay AES station (49°28'N 124°47'W), the following bar graph (Figure 3) showing the monthly precipitation normals was constructed. Appendix A provides the Canadian Climatic Normals for this area.

The mean total annual precipitation is 1,714.1 mm (67.5 inches). The minimum mean monthly precipitation is 26.9 mm (1.1 inches) and occurs in July. Conversely, the maximum mean monthly precipitation occurs in December with a value of 340 mm (13.4 inches). The mean number of days with measurable precipitation is 154; with 144 mean days of rain and 12 mean days of snow.

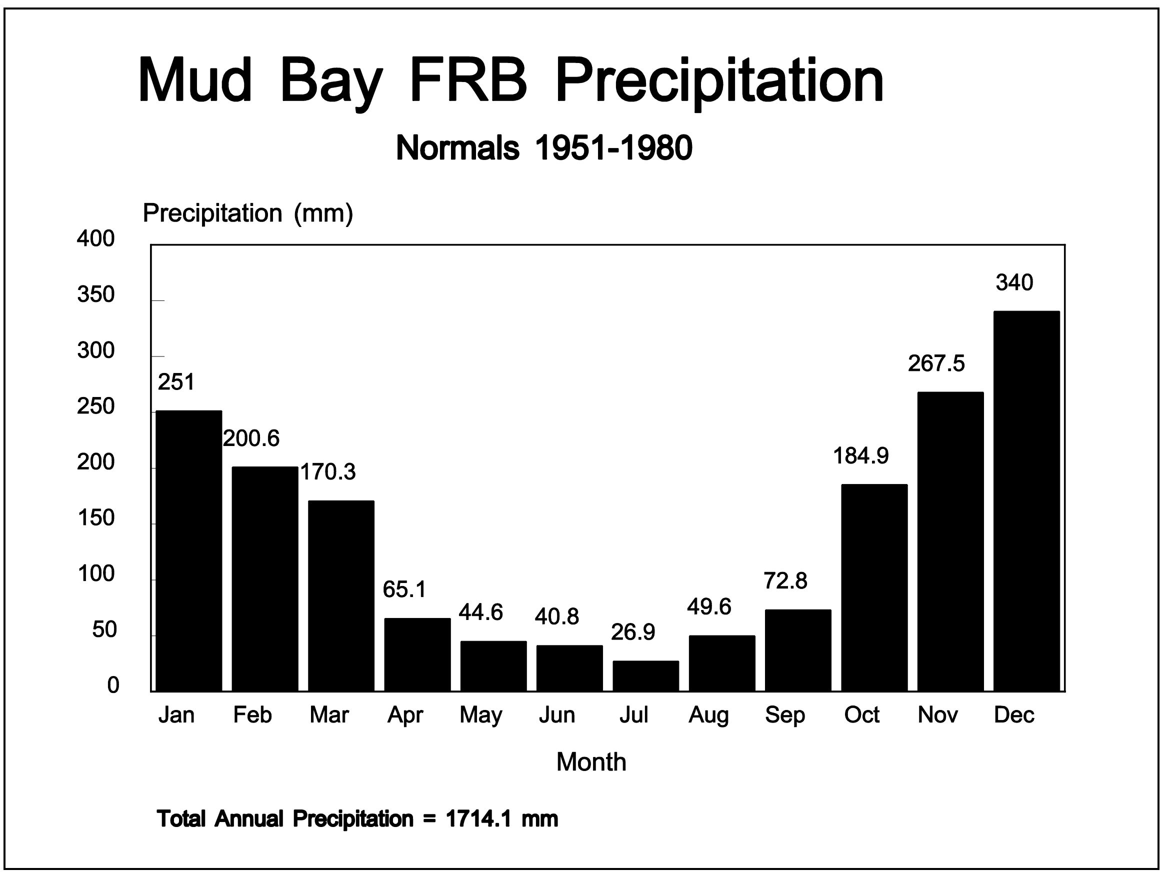


Figure 3

3.2 Hydrometric Information

There are three Water Survey of Canada (WSC) hydrometric stations within the Nile Creek to Trent River Water Allocation Plan area which have been operated on an annual basis, namely; Nile Creek near Bowser (08HB022), Rosewall Creek at the Mouth (08HB037) and Tsable River near Fanny Bay (08HB024). There is also one Water Survey of Canada (WSC) hydrometric station within the Nile Creek to Trent River Water Allocation Plan area which has been operated on a seasonal basis, namely; Trent River near Royston (08HB044). The following table lists these WSC stations and the period of record, drainage area, mean annual discharge and mean 7-day average low flow.

Water Survey of Canada Hydrometric Discharge Stations

Station Name	Station Number	Period of Record	Drainage Area (km^2)	Mean Annual Discharge (m^3/s)	Mean 7-Day Average Low Flow (m^3/sec)
Nile Creek near Bowser	08HB022	1959-92	16.9	0.985	0.154
Rosewall Creek at the Mouth	08HB037	1968-78	43.6	2.62	0.004
Tsable River near Fanny Bay	08HB024	1960-92	105.1	7.8	0.334
Trent River near Royston	08HB044	Apr-Sep 1971-76	66.9	-	0.022

The Water Survey Canada hydrometric station discharge records are summarized in Appendix B.

Figure 4 illustrates the location of each WSC hydrometric station within the plan area, as well as the location of the Mud Bay AES station.

In addition there are miscellaneous stream flow measurements available from Regional Engineer's Reports related to water licenses and provincial low flow monitoring studies (1985 and 1992). In particular there are discharge records for September of 1985 on Thames Creek, Cook Creek, Waterloo Creek, Wilfred Creek and Bloedel Creek and for July, August and September of 1992 on Chef Creek, Waterloo Creek and Wilfred Creek. The miscellaneous stream flow records are summarized in Appendix C.

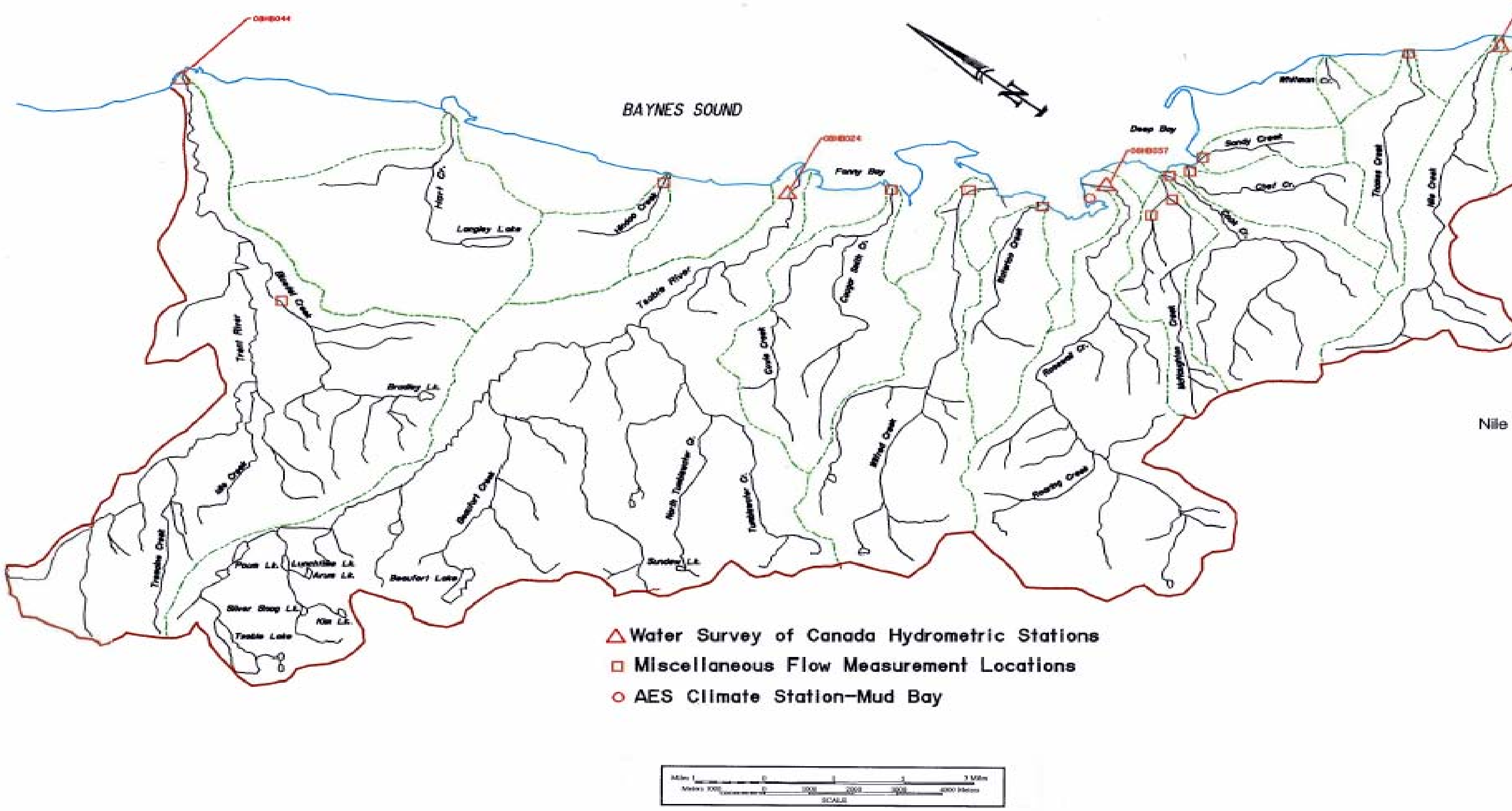


Figure 4
Nile Creek to Trent River Water Allocation Plan
Flow Measurement Stations

The discharge runoff per square kilometre was estimated from the mean monthly and mean annual records for each WSC hydrometric station for the period of record. The average annual discharge runoff and average monthly discharges runoff per square kilometre were used to estimate the mean monthly discharges (MMD) and mean annual discharge (MAD) in all identified significant drainages which lacked annual discharge records within the Nile Creek to Trent River Water Allocation Plan area. These estimated discharge runoffs per square kilometre are in the following table.

Discharge Runoff per Square Kilometre (litres/second/Km^2)

Station Number	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAD
Nile Creek	107	101	75	62	41	20	14	12	13	52	92	110	58
Rosewall Creek	75	77	84	72	90	67	27	10	22	59	92	96	60
Tsable River	107	99	76	70	88	69	29	14	17	75	121	124	74
Trent River				52	56	17	6	3	5				
Average	96	92	78	64	69	43	19	10	14	62	102	110	64
% MAD	150	144	122	100	108	67	30	16	22	97	159	172	100

For each identified significant watershed without annual discharge records, the average discharge runoff per square kilometre noted in the above table were multiplied by the drainage area to obtain a first estimate of the mean monthly discharges and mean annual discharge. The seasonal WSC hydrometric record on the Trent River and the miscellaneous stream flow measurements were used to modify the estimated mean monthly discharges.

3.2.1 Black Brook

The estimated drainage area of Black Brook is 1.3 km^2 (0.5 mi^2). There is a significant swamp in the headwaters of the drainage area which may maintain flows in the stream. The drainage area of Black Brook is below the 100 metre contour and therefore is a low elevation watershed in relatively flat terrain. There are no flow measurements for Black Brook.

As this is a low elevation watershed, the mean monthly discharge flows per square kilometre are assumed to be the same as Thames Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Thames Creek.

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

Black Brook Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
131	126	106	88	93	61	3	2	3	87	139	150	83

3.2.2 Nash Creek

The estimated drainage area of Nash Creek is 4.1 km^2 (1.6 mi^2). Norene Spring is tributary to Nash Creek. The drainage area of Nash Creek is below the 200 metre contour and therefore is a low elevation watershed in relatively flat terrain. There are no flow measurements for Nash Creek.

As this is a low elevation watershed, the mean monthly discharge flows per square kilometre is assumed to be the same as Thames Creek. The mean monthly discharge flows per kilometre were modified as described in the section on Thames Creek.

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

Nash Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
415	399	336	278	299	191	8	7	10	276	438	472	262

3.2.3 Nile Creek

The estimated drainage area of Nile Creek is 16.9 km^2 (6.5 mi^2). There are 35 years of flow discharge records (1959-1993) available for Nile Creek. The upper watershed drains northeast from Mount Mark at 970 metres elevation and southeast from Mount Schofield at 1100 metres.

The following table summarizes the mean monthly discharge and mean annual discharge flow estimates for the period of record (1959-1993) on Nile Creek.

Nile Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
1800	1710	1260	1040	693	334	229	198	277	879	1560	1860	985

The following figure illustrates the mean flow discharges for Nile Creek.

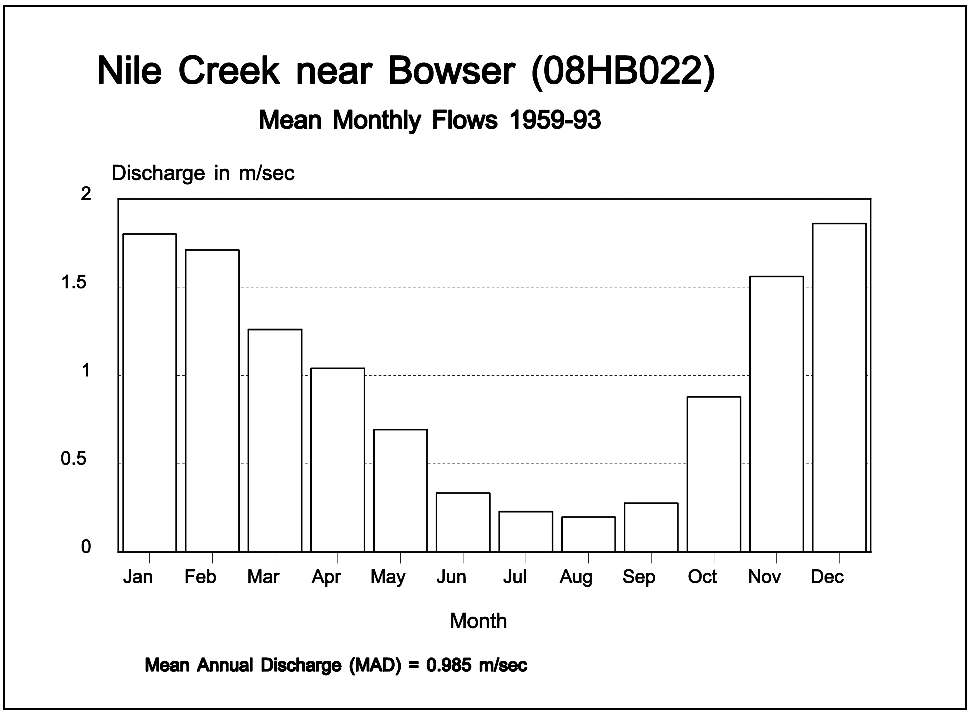


Figure 5

3.2.4 Thames Creek

The estimated drainage area of Thames Creek is 8.8 km^2 (3.4 mi^2). Thames Creek drains from the 700 metre contour elevation. Less than 1/3 of this watershed is above 200 metres elevation, the remaining is in relatively flat terrain below 200 metres elevation.

Thames Creek flow was measured on August 29, 1985 and between September 1 to September 15, 1985. The measured flow on August 29, 1985 was 5 litres/sec. The average of the measured and estimated flows for the September 1 to September 15, 1985 period is 14.9

litres/second (1.8 litres/sec/km^2).

The discharge runoff per square kilometre measured on Thames Creek is approximately 15% of the discharge runoff per square kilometre recorded on Nile Creek for the same period. Therefore, the Thames Creek discharge runoff per square kilometre during the low flow months of July, August and September were assumed to be 15% of the Nile Creek discharge runoff per square kilometre. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows of October through February have been adjusted approximately 8% higher and March through June have been adjusted approximately 6% higher to compensate for the lower mean monthly July to September discharge flow. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the four WSC hydrometric stations.

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

Thames Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
890	856	721	597	642	411	18	16	22	591	940	1013	563

3.2.5 Whitman Creek

The estimated drainage area of Whitman Creek is 1.3 km^2 (0.5 mi^2). The drainage area of Whitman Creek is below the 100 metre contour and, therefore, is a low elevation watershed in relatively flat terrain. There are no flow measurements for Whitman Creek.

The drainage area of Whitman Creek is one of the smallest drainage areas identified within the plan area and has no significant depression storage. As this is a low elevation watershed, the mean monthly discharge flows per square kilometre are assumed to be the same as Chef Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Chef Creek.

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

Whitman Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
131	126	107	89	96	61	1	1	1	87	139	150	83

3.2.6 Sandy Creek

The estimated drainage area of Sandy Creek is 3.9 km^2 (1.5 mi^2). Sandy Creek drains from a maximum elevation of 120 metres and, therefore, is a low elevation watershed in relatively flat terrain. There is a significant swamp in the headwaters of the drainage area which may maintain flows in the creek.

The flow in Sandy Creek was measured on August 29, 1985 to be 2 litres/second. This single flow record indicates that the low flows during the months of July, August and September may be similar to the flows in adjacent Chef Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Chef Creek.

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

Sandy Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
394	379	322	267	287	184	3	2	3	262	417	449	250

3.2.7 Chef Creek

The estimated drainage area of Chef Creek is 8.1 km^2 (3.1 mi^2). Chef Creek drains from a maximum elevation of 620 metres. However, more than 90% of the drainage area is below 200 metres and is characterized by relatively flat terrain. There is a significant swamp in the headwaters of a tributary to Chef Creek which may maintain flows in the stream.

Chef Creek flow was measured between July 24 and September 24, 1992. The average measured flow for this period was 4 litres/second (0.5 litres/sec/km^2).

The discharge runoff per square kilometre measured on Chef Creek is approximately 5% of the discharge runoff per square kilometre recorded on Nile Creek for the same period.

Therefore, the Chef Creek discharge runoffs per square kilometre during the low flow months of July, August and September were assumed to be 5% of the Nile Creek discharge runoff per square kilometre. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows of October through February have been adjusted approximately 8% higher, and the March through June flows have been adjusted approximately 7% higher to compensate for the lower July to September flows. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the four WSC hydrometric stations.

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

Chef Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
818	787	668	554	596	383	6	5	6	544	865	932	518

3.2.8 Cook Creek

The estimated drainage area of Cook Creek is 19.7 km^2 (7.6 mi^2). It drains predominately northeast from Mount Schofield at approximately 1100 metres elevation. Less than one third of this drainage area is below the 200 metres contour elevation. The remainder of the drainage area is relatively steep terrain above 200 metres elevation.

Cook Creek flow was measured on August 29, 1985 and between September 1 to September 15, 1985. The measured flow on August 29, 1985 was 7 litres/second. The average flow measured from September 1 to September 15, 1985 is 16.0 litres/second (0.9 litres/sec/km^2).

The discharge runoff per square kilometre measured on Cook Creek is approximately 8% of the discharge runoff per square kilometre recorded on Nile Creek for the same period. Therefore, the Cook Creek discharge runoff per square kilometre during the low flow months of July, August and September were assumed to be 8% of the Nile Creek discharge runoff per square kilometre. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows for October through February have been adjusted approximately 8% higher, and the flows for March through June have been adjusted

approximately 6% higher to compensate for the lower July to September flow. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the four WSC hydrometric stations.

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

Cook Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
1992	1917	1614	1337	1438	921	22	18	26	1328	2106	2270	1261

3.2.9 McNaughton Creek

The estimated drainage area of McNaughton Creek is 9.5 km^2 (3.7 mi^2). McNaughton Creek drains from a maximum elevation of 1080 metres and has similar topographic drainage characteristics as Cook Creek.

The discharge flow in McNaughton Creek was measured on August 29, 1985, at the Island Highway, to be 0.1 litres/second. This single flow record indicates that the low flows during the months of July, August and September may be similar to the flows in neighbouring Cook Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Cook Creek.

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

McNaughton Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
960	924	778	645	694	444	10	9	12	640	1016	1094	608

3.2.10 Rosewall Creek

The estimated drainage area of Rosewall Creek is 43.6 km^2 (16.8 mi^2). There are 10 years of flow discharge records from 1968 to 1978 (missing 1973) available for Rosewall Creek. The upper watershed drains northeast from Mount Hal at 1489 metres elevation and east southeast from Mount Joan at 1540 metres, The Squarehead at 1500 metres and Mount Curran at 1478 metres. Most of the drainage area is above 100 metres elevation and is relatively steep terrain.

The following table summarizes the mean monthly discharge and mean annual discharge flow estimates for the period of record (1968-1978) on Rosewall Creek.

Rosewall Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
3260	3340	3680	3130	3940	2910	1160	419	978	2580	4030	4190	2620

The following figure illustrates the mean flow discharges.

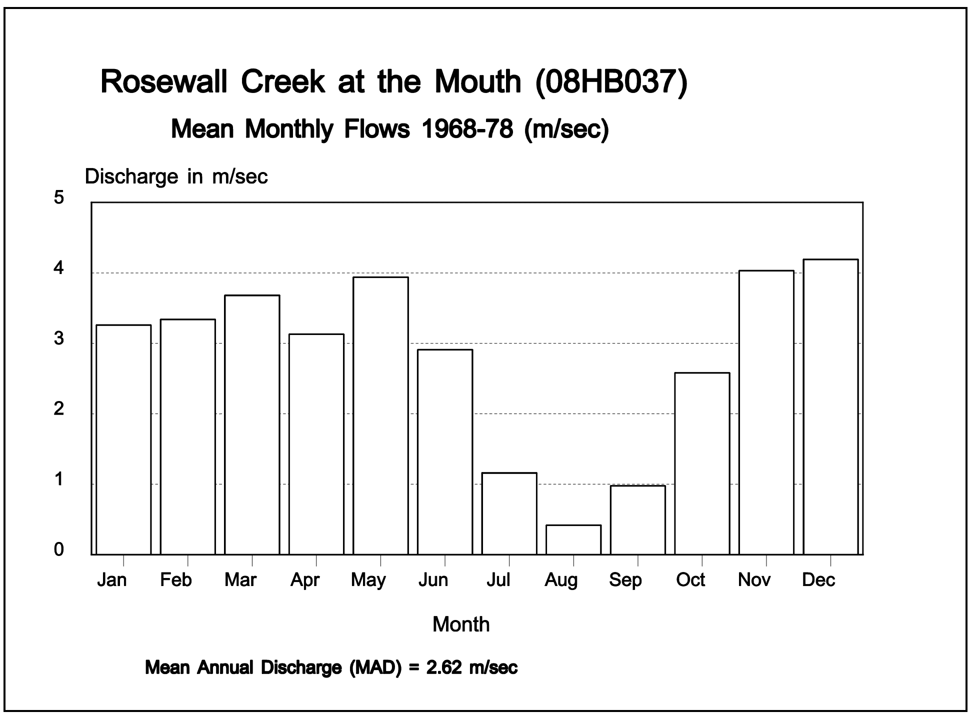


Figure 6

3.2.11 Waterloo Creek

The estimated drainage area of Waterloo Creek is 11.1 km^2 (4.3 mi^2). It drains from 1200 metres elevation on the east northeast flank of Mount Curran. Most of the drainage area is above 100 metres elevation and is in relatively steep terrain.

Waterloo Creek discharge flow was measured on August 29, 1985 and September 24, 1987, and between September 1 to September 15, 1985. The discharge flow was also measured from July 24 to September 24, in 1992. The measured discharge flow on August 29, 1985 was 14 litres/second. The measured discharge flow on September 24, 1987 was 13 litres\second. The average measured flow for September 1 to September 15, 1985 is 20.6 litres/second (1.9 litres/sec/km^2). The average measured flow for July 24 to September 24, 1992 is 24 litres/sec (2.2 litres/sec/km^2).

The discharge runoff per square kilometre measured on Waterloo Creek is approximately 20% of the discharge runoff per square kilometre recorded on Nile Creek for the same periods. Therefore, the Waterloo Creek discharge runoff per square kilometre during the low flow months of July, August and September were assumed to be 20% of the Nile Creek discharge runoff per square kilometre. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows for October through February have been adjusted approximately 7% higher, and the March through June flows have been adjusted approximately 5% higher to compensate for the lower July to September flow. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the four WSC hydrometric stations.

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

Waterloo Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
1115	1072	902	746	802	511	30	26	37	738	1179	1271	710

3.2.12 Wilfred Creek

The estimated drainage area of Wilfred Creek is 27.3 km^2 (10.5 mi^2). It drains northeast from Mount Apps at approximately 1500 metres elevation. Most of the drainage area is above 100 metres elevation and is in relatively steep terrain.

Wilfred Creek discharge flow was measured on August 29, 1985 and September 24, 1987, and from September 1 to September 15, 1985. The discharge flow was also measured between July 23 to September 24, 1992. The measured discharge flow on August 29, 1985 was 102 litres/second. The measured discharge flow on September 24, 1987 was 146 litres\second. The average measured flow for September 1 to September 15, 1985 is 158.8 litres/second (5.6 litres/sec/km^2). The average measured flow for July 23 to September 24, 1992 is 191 litres/second (7.0 litres/sec/km^2).

The discharge runoff per square kilometre measured on Wilfred Creek is approximately 65% of the discharge runoff per square kilometre recorded on Nile Creek for the same periods. Therefore, the Wilfred Creek discharge runoff per square kilometre during the low flow months of July, August and September were assumed to be 65% of the Nile Creek discharge runoff per square kilometre. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows for October through June have been adjusted approximately 3% higher to compensate for the lower July to September flow. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the four WSC hydrometric stations.

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

Wilfred Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
2673	2568	2184	1799	1939	1223	240	207	292	1747	2830	3057	1747

3.2.13 Cowie Creek

The estimated drainage area of Cowie Creek is 21.4 km^2 (8.3 mi^2). Cowie Creek and Cougar Smith Creek meet at a confluence 1.6 kilometres above the Island Highway. Both Cowie Creek and Cougar Smith Creek drain northeast to east from below the summit of

Mount Apps. Approximately half of the drainage area is above 220 metres elevation and is in steep terrain, while the other half is in relatively less steep terrain. There is a significant swamp that is located between 200 and 220 metres elevation, approximately in the middle of the drainage area and is a tributary to Cowie Creek. This swamp may contribute to maintaining flows in the creek.

The discharge flow in Cowie Creek was measured on August 29, 1985 to be 38 litres/second (1.8 litres/sec/km^2). This single flow record indicates that the low flows during the months of July, August and September may be similar to the flows in Waterloo Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Waterloo Creek.

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

Cowie Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
2149	2067	1740	1438	1547	984	58	49	71	1423	2273	2450	1370

3.2.14 Tsable River

The estimated drainage area of Tsable River is 105.1 km^2 (40.6 mi^2), which is the largest drainage area within the plan area. There are 34 years of flow discharge records (1960-1993) available for Tsable River. Most of the drainage area is in relatively steep terrain. Tumblewater Creek and North Tumblewater Creek flow northeast from a ridge between Mount Apps at 1500 metres elevation and Tumblewater Meadows at 1420 metres elevation into the Tsable River. Beaufort Creek flows northeast from Beaufort Lake, which is nestled in a triangle between Mount Stubbs (1486 metre elevation), Tsable Mountain (1440 metre elevation) and Mount Chief Frank (1470 metre elevation), into the Tsable River. North of Mount Clinton (1300 metre elevation), the Tsable River flows predominately east from Tsable Lake and then through Poum Lake. There are numerous small lakes in the headwaters of the Tsable River and its tributaries; including Sundew Lake, Beaufort Lake, Kim Lake, Silver Snag Lake, Arum Lake, Lunchtime Lake, Tsable Lake and Poum Lake; which may contribute to maintaining flows.

The following table summarizes the mean monthly discharge and mean annual discharge flow estimates for the period of record (1960-1993) on Tsable River.

Tsable River Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
11200	10400	8000	7400	9300	7200	3100	1500	1800	7900	12700	13000	7800

The following figure illustrates the mean monthly discharge flow.

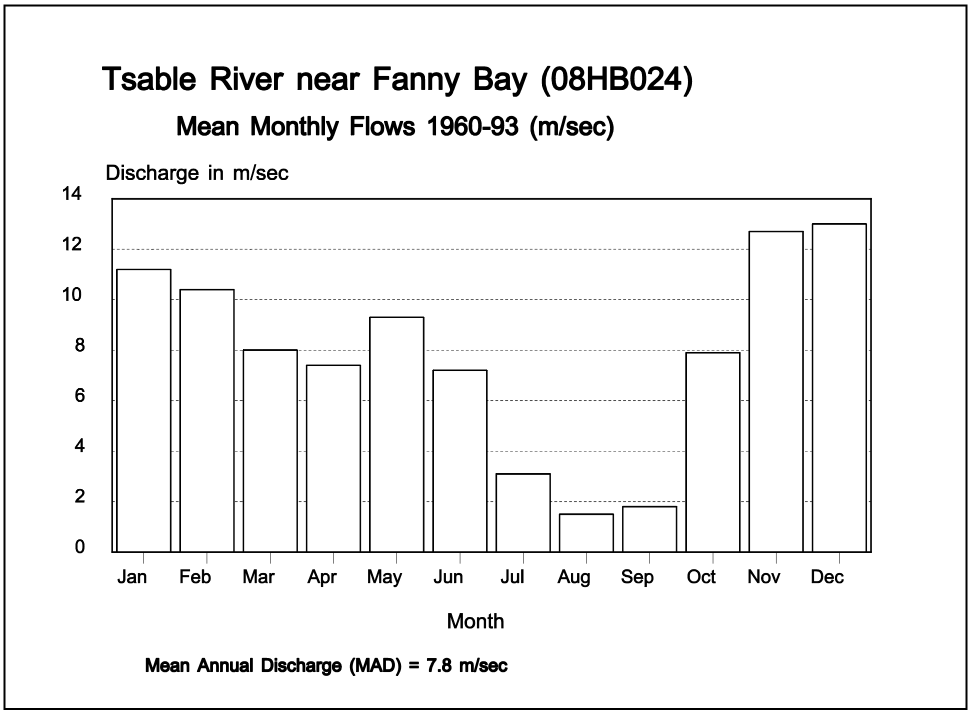


Figure 7

3.2.15 Hindoo Creek

The estimated drainage area of Hindoo Creek is 5.1 km^2 (2.0 mi^2). It drains from a maximum elevation of 440 metres and is predominately a low elevation drainage area in relatively flat terrain.

There is one recorded flow observation indicating a zero flow on August 15, 1985 in Hindoo Creek. This single flow observation indicates that the low flows during the months of July, August and September may be similar to the flows in Chef Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Chef Creek.

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

Hindoo Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
515	496	421	349	375	241	4	3	4	343	541	587	326

3.2.16 Hart Creek

The estimated drainage area of Hart Creek is 28.7 km^2 (11.1 mi^2). It drains from a maximum elevation of 480 metres and is a predominately low elevation drainage area in relatively flat terrain. Langley Lake, at an elevation of 156 metres may contribute to maintaining flows.

There is one recorded flow observation indicating a zero flow on August 2, 1985 in Hart Creek. This single flow observation indicates that the low flows during the months of July, August and September may be similar to the flows in Chef Creek. The mean monthly discharge flows per square kilometre were modified as described in the section on Chef Creek.

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

Hart Creek Mean Monthly and Mean Annual Discharge (litres/sec)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
2899	2790	2368	1963	2112	1358	20	17	23	1929	3065	3303	1837

3.2.17 Trent River

The estimated drainage area of Trent River is 66.9 km^2 (25.9 mi^2), which is the second largest drainage area within the plan area. The Trent River drainage area is relatively less steep terrain than the Tsable River drainage area. Bloedel Creek flows north from Bradley Lake and a maximum elevation of 680 metres into the Trent River. Idle Creek flows northeast from a maximum elevation of 860 metres into the Trent River. Tremain Creek flows northeast from a small unnamed lake at an elevation of 1196 metres into the Trent. The

Trent River flows predominately east and then north-east after its confluence with Idle Creek from a maximum elevation of 1070 metres. Bradley Lake on Bloedel Creek, a significant swamp area downstream of Bradley Lake on Bloedel Creek, and a small unnamed lake at the head of Tremain Creek are the few bodies of water which may contribute to maintaining flows in this relatively large drainage area.

There are 6 years of flow discharge records from May to September (1971-1976) available for the Trent River. Also, three of these years of flow discharge records include April flow records (1973, 1975 and 1976).

The mean monthly discharge flow records for the period of record (1971-1976) on the Trent River were used as the best estimate of the flows for the April through September period. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows for October through March have been adjusted approximately 20% higher to compensate for the lower April to September flow. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the four WSC hydrometric stations.

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

Trent River Mean Monthly and Mean Annual Discharge (litres/sec)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
7279	7022	6080	3480	3730	1410	420	199	324	5010	7665	8221	4282

The following figure illustrates the mean monthly discharge flow.

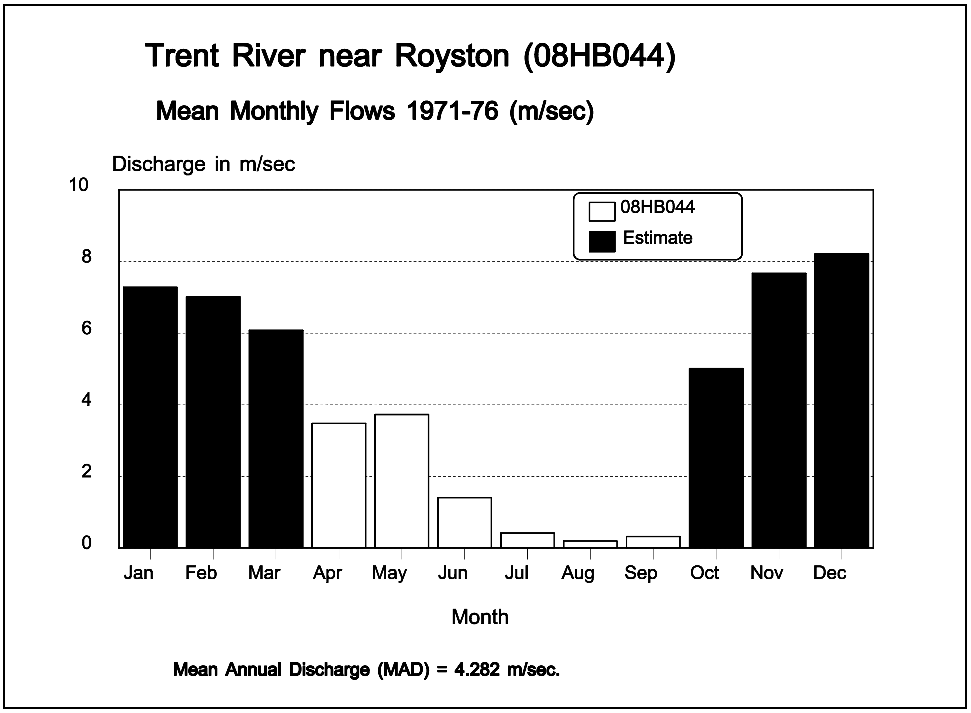


Figure 8

3.3 Low Flows

The minimum monthly discharge flows occur in July, August and September. The minimum mean monthly discharge (MMD) occurs in August.

The 7-day average low flows occur predominately in August or September. There are rarer occurrences of 7-day average low flows in July or October.

The calculated 7-day average low flows for Nile Creek near Bowser (08HB022), Rosewall Creek at the Mouth ((08HB037), Tsable River near Fanny Bay (08HB024) and Trent River near Royston (08HB044) are listed in Appendix B and illustrated in the following figure.

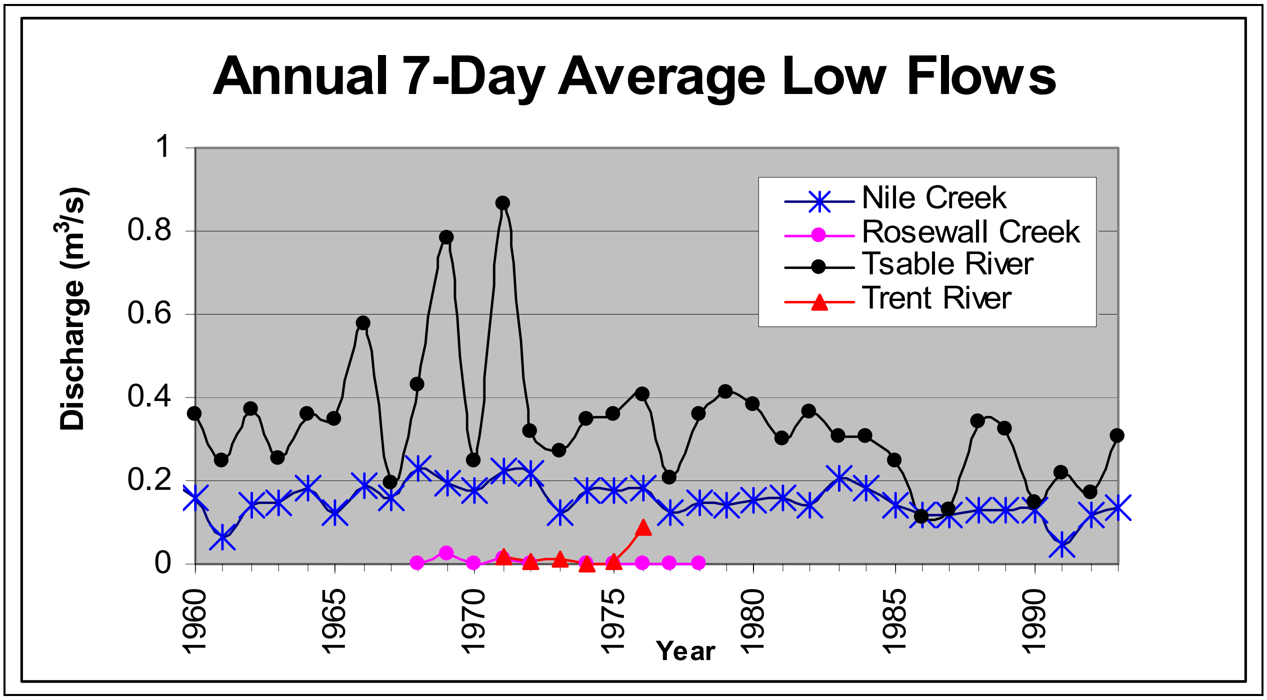


Figure 9

The following graphs illustrates the 7-day average low flow runoff per square kilometre of drainage area for the above WSC hydrometric stations.

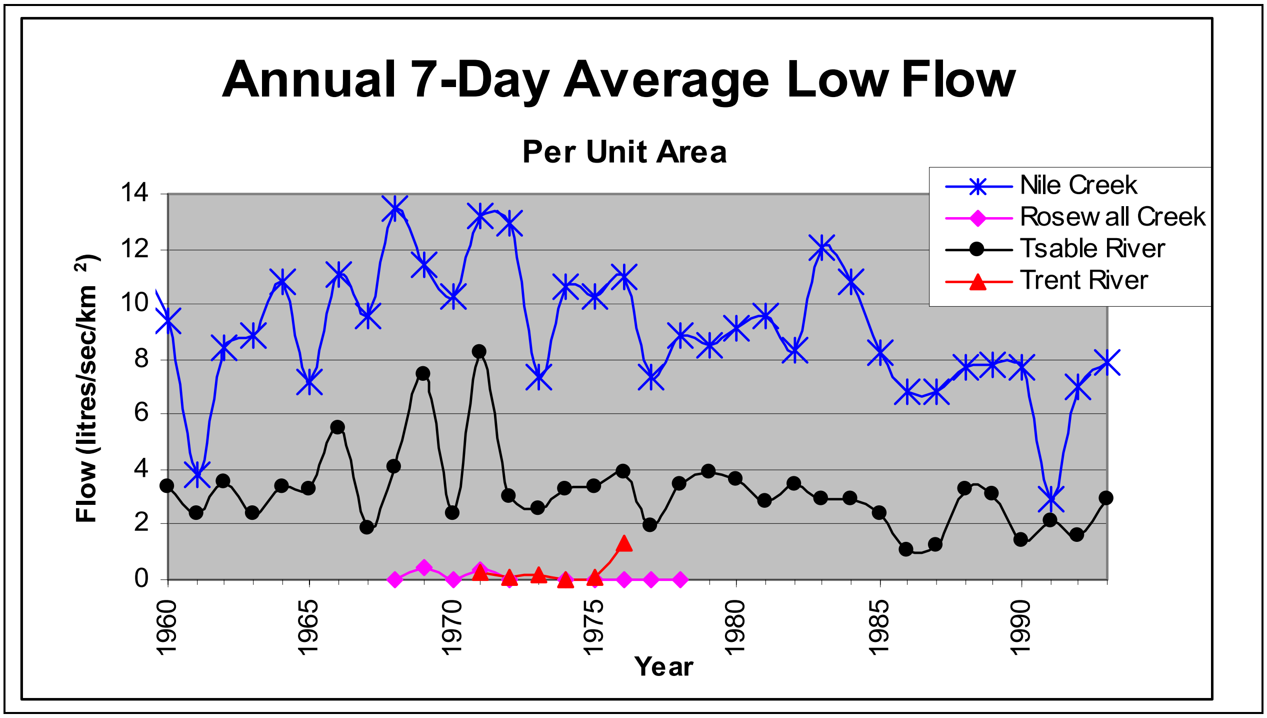


Figure 10

Estimates of the 7-day average low flow for Chef Creek, Waterloo Creek and Wilfred Creek were obtained from the July to September, 1992 miscellaneous flow measurements which covered the low flow period.

The mean monthly discharge flows per square kilometre of drainage area and the 7-day average low flow in Nile Creek are higher than the other similar flow records in the plan area. This anomaly has led to speculation that the Nile Creek flow is supported by a large aquifer in the upper part of the watershed.

A summary of the mean annual discharge (MAD), minimum mean monthly discharge (Min MMD) and mean 7-day average low flow is in the following table.

MAD, Min MMD and 7-Day Average Low Flow (litres/sec)			
Drainage Area	**MAD**	**Min MMD**	**7-Day Avg Low**
Black Brook	83	2	1
Nash Creek	262	7	4
Nile Creek	985	198	154
Thames Creek	563	16	8
Whitman Creek	83	1	0
Sandy Creek	250	2	1
Chef Creek	518	5	3
Cook Creek	1261	18	9
McNaughton Creek	608	9	5
Rosewall Creek	2620	419	4
Waterloo Creek	710	26	8
Wilfred Creek	1747	207	100
Cowie Creek	1370	49	25
Tsable River	7800	1500	334
Hindoo Creek	326	3	0
Hart Creek	1837	17	2
Trent River	4282	199	22

3.4 Lakes

Lakes within the Nile Creek to Trent River Water Allocation Plan area exhibit a largely uneven distribution. Lake frequency tends to be sparse in the southern portion of the plan area and increases northward. The largest distribution of lakes occurs within the Tsable River drainage area followed by the Trent River drainage area. The following table summarizes the available data for significant lakes in the plan area.

Lake Information				
Lake	Drainage	Surface Area (ha)*	Volume (dam^3)	Mean Depth (m)
Langley	Hart Creek	32	888	2.8
Beaufort	Tsable River	34	-	-
Tsable	Tsable River	65	-	-
Poum	Tsable River	23	863	4.0
Bradley	Trent River	4	265	6.3
* areas digitized using 1:50000 NTS maps (except Bradley Lk. which was digitized using a 1:2000 bathymetric map).				

Information on summer-time evaporation rates was unavailable, but it is assumed that the net loss is approximately 0.3 metres (1 foot) over the surface of the water body.

Volumes and mean depths for the above lakes were determined in various ways. The mean depth of Langley lake was determined using the volume of water licenced for storage (888 dam^3), which was assumed to be equivalent to the total capacity of the lake.

Information for Poum and Bradley Lakes was obtained from previously derived data in their respective Fisheries files. Bradley Lake is the only lake in the plan area on which a complete bathymetric survey has been performed.

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%.**

Most of the streams in the Nile Creek to Trent River Water Allocation Plan area are naturally limiting to fish habitat and, therefore, fish survival. Figure 11 illustrates fish habitat within the plan area.

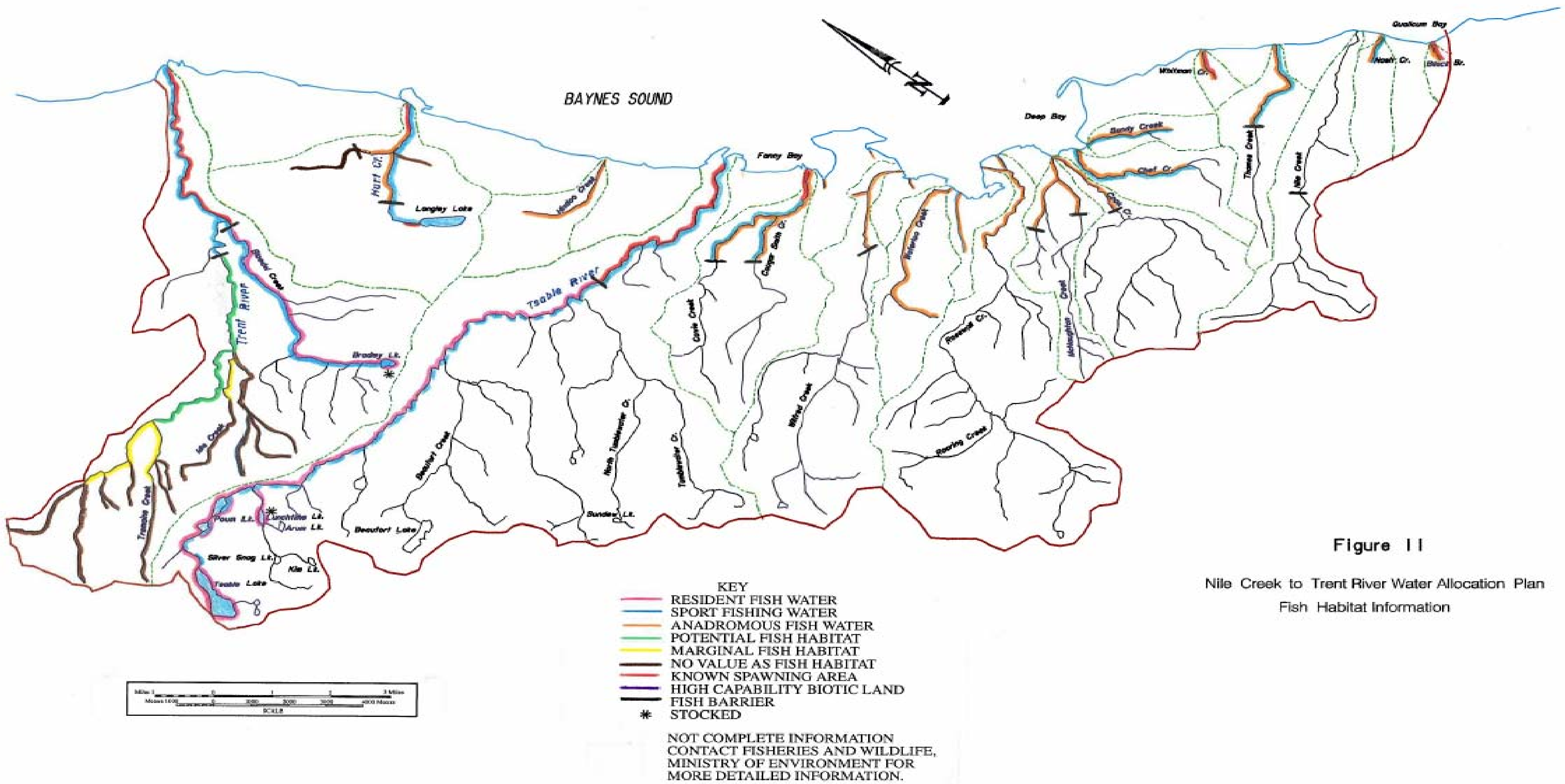


Figure 11

Nile Creek to Trent River Water Allocation Plan
Fish Habitat Information

4.1 Black Brook

Black Brook has been identified as a spawning and rearing stream for a small number of Coho salmon and Cutthroat trout.

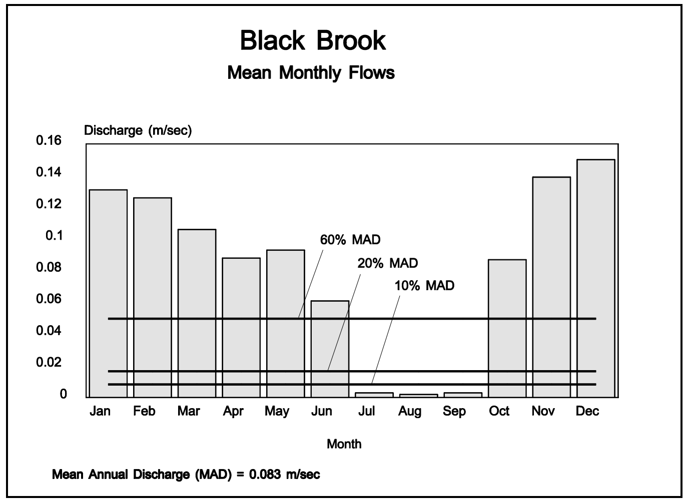


Figure 12

Figure 12 illustrates that the estimated mean monthly flow in Black Brook falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Black Brook when the flow is below 60% MAD or 50 litres/second. Thus, the estimated volume of water available from October through June is 1,391 dam^3.

4.2 Nash Creek

Anadromous fish such as sea-run Cutthroat trout and the occasional Chum salmon utilize Nash Creek. It has also been identified as being a venue for anglers.

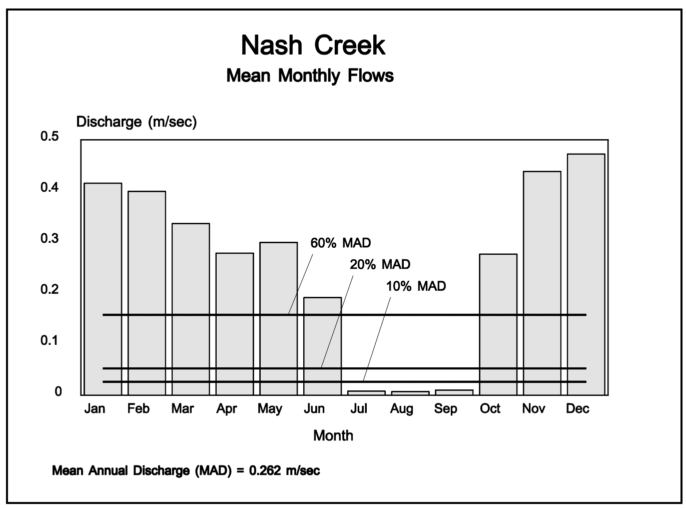


Figure 13

Figure 13 illustrates that the estimated mean monthly flow in Nash Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Nash Creek when the flow is below 60% MAD or 157 litres/second. Thus, the estimated volume of water available from October through June is 4,429 dam^3.

4.3 Nile Creek

A waterfall approximately 5.6 kilometres from the mouth of Nile Creek marks the upper limit of the anadromous fish habitat and, thus, the sportfishing water. Sea-going fish such as Pink salmon, Chum, Steelhead, Coho, and sea-run Cutthroat are found in Nile Creek along with a native Rainbow trout population.

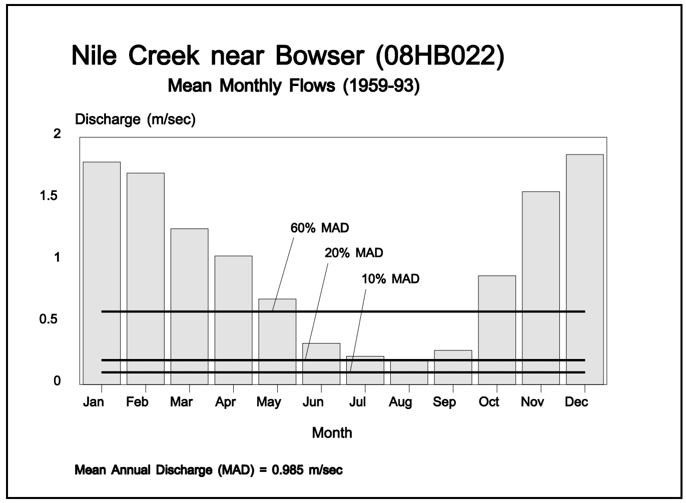


Figure 14

Figure 14 illustrates that the estimated mean monthly flow in Nile Creek remains above 20% of the mean annual discharge (MAD) throughout the entire year. Therefore, water is available for extractive use all year round. From October through May, the quantity of water available over 60% MAD (591 litres/second) is estimated to be 15,856 dam^3. From June through September, the quantity of water available is the minimum mean monthly flow above 10% MAD (99 litres/second), which is estimated at 1,044 dam^3.

4.4 Thames Creek

Thames Creek supports sea-run Cutthroat trout and Coho salmon. Sportfishing is restricted to the lower 4.0 kilometres of Thames Creek by a large gravel deposit which blocks the passage of fish trying to migrate upstream.

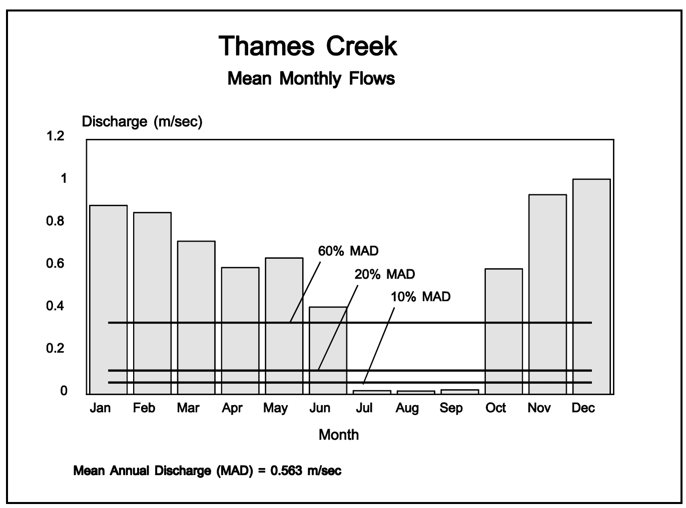


Figure 15

Figure 15 illustrates that the estimated mean monthly flow in Thames Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Thames Creek when the flow is below 60% MAD or 338 litres/second. Thus, the estimated volume of water available from October through June is 9,478 dam^3.

4.5 Whitman Creek

Whitman Creek is a spawning stream for certain species of salmon and also supports a native fish population.

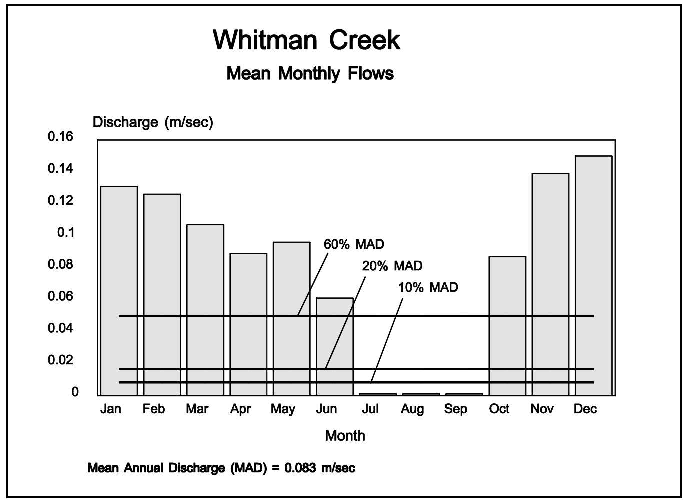


Figure 16

Figure 16 illustrates that the estimated mean monthly flow in Whitman Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Whitman Creek when the flow is below 60% MAD or 50 litres/second. Thus, the estimated volume of water available from October through June is 1,404 dam^3.

4.6 Sandy Creek

Sandy Creek supports anadromous fish such as Coho, Chum and Cutthroat, and associated sportfishing activities.

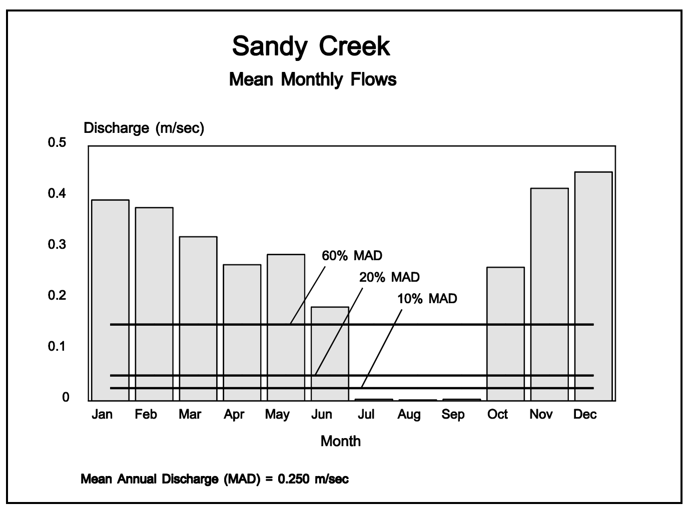


Figure 17

Figure 17 illustrates that the estimated mean monthly flow in Sandy Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Sandy Creek when the flow is below 60% MAD or 150 litres/second. Thus, the estimated volume of water available from October through June is 4,219 dam^3.

4.7 Chef Creek

Chef Creek is an identified anadromous fish stream which supports Coho, Chum, and Cutthroat, as well as sportfishing.

Figure 18 illustrates that the estimated mean monthly flow in Chef Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Chef Creek when the flow is below 60% MAD or 311 litres/second. Thus, the estimated volume of water available from October through June is 8,769 dam^3.

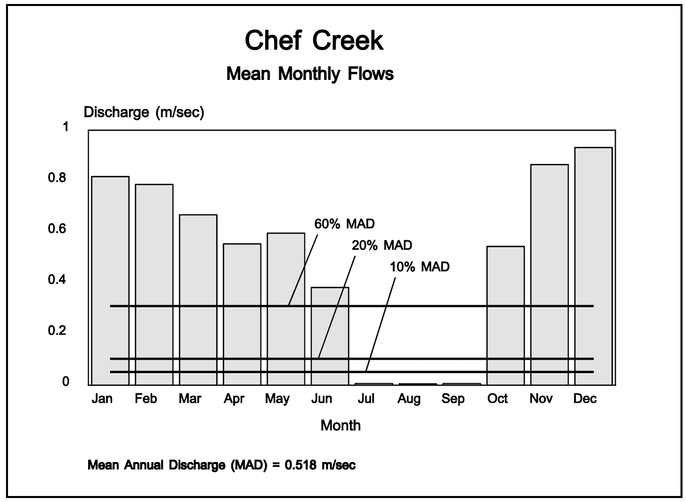


Figure 18

4.8 Cook Creek

Chum salmon use a section of Cook Creek near the mouth as a spawning ground. Coho and Cutthroat are also found here, but only in the lower regions of the creek since a waterfall approximately 2.5 kilometres upstream of the mouth blocks the passage of all fish.

Figure 19 illustrates that the estimated mean monthly flow in Cook Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Cook Creek when the flow is below 60% MAD or 757 litres/second. Thus, the estimated volume of water available from October through June is 21,240 dam^3.

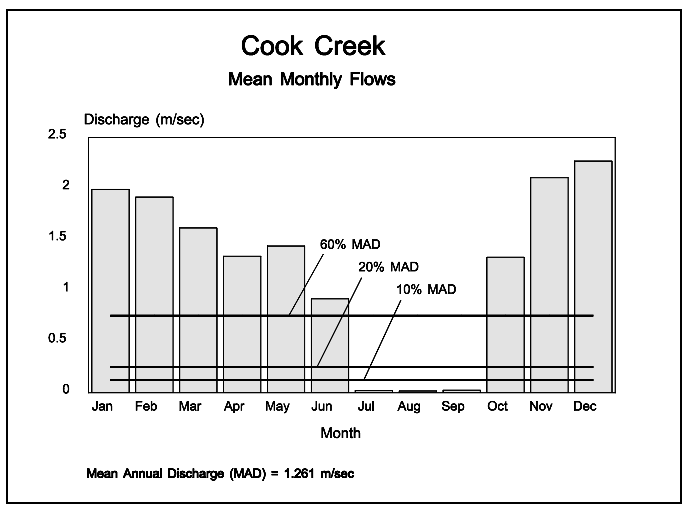


Figure 19

4.9 McNaughton Creek

Coho, Chum, Steelhead, and Cutthroat are supported in approximately the lower 2.5 kilometres of McNaughton Creek. The northern tributary to McNaughton supports Coho, Chum and Steelhead, but only for a short distance from its confluence with the main channel of McNaughton.

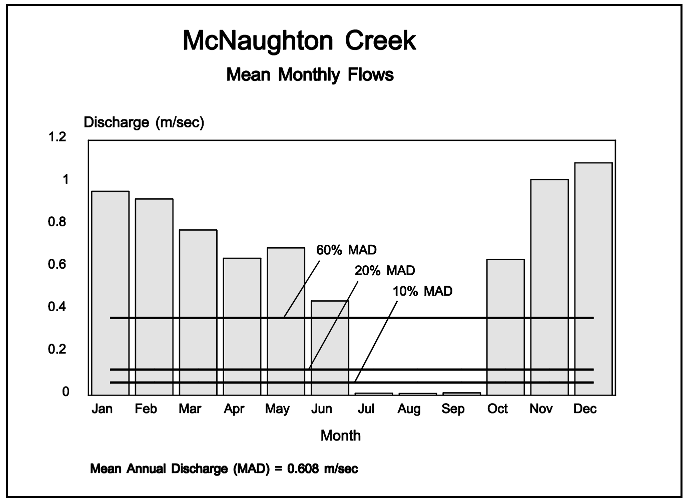


Figure 20

Figure 20 illustrates that the estimated mean monthly flow in McNaughton Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from McNaughton Creek when the flow is below 60% MAD or 365 litres/second. Thus, the estimated volume of water available from October through June is 10,240 dam^3.

4.10 Rosewall Creek

Rosewall Creek supports anadromous fish such as Coho, Chum, Steelhead, and Cutthroat. A series of rapids and falls blocks the passage of all fish approximately 4.3 kilometres from the mouth of the creek.

As part of the "Rosewall/Big Qualicum Steelhead Project", the Federal Department of Fisheries and Oceans operates a hatchery on Rosewall Creek for the incubation and rearing of Oyster and Big Qualicum River Steelhead.

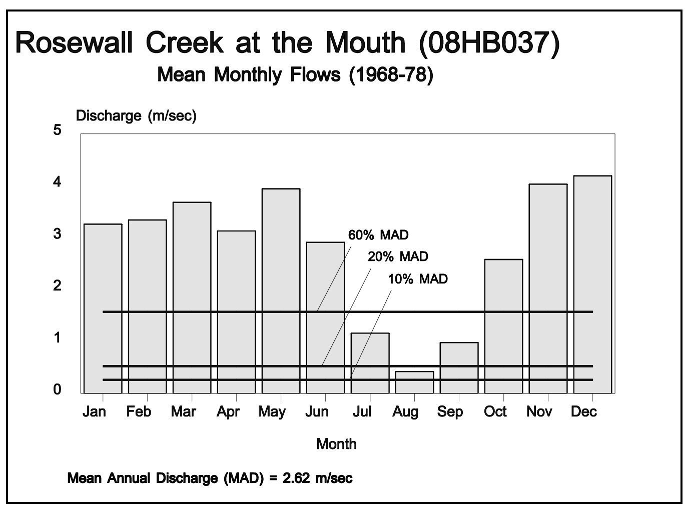


Figure 21

Figure 21 illustrates that the estimated mean monthly flow in Rosewall Creek falls between 10% and 20% of the mean annual discharge (MAD) during the month of August. The 7-day average low flow for Rosewall Creek is around 4 litres/second, which is less than 10% MAD (262 litres/second). Therefore, no extractive demands may be made when the mean monthly flows are below 60% MAD or 1572 litres/second. July, August and September fall into this non-extractive period. Thus, water is only available from Rosewall Creek during the months of October through June. The estimated quantity of water available for this period is 44,376 dam^3.

4.11 Waterloo Creek

Waterloo Creek contains migrating populations of anadromous fish, including Coho, Chum, Steelhead and Cutthroat trout.

Figure 22 illustrates that the estimated mean monthly flow in Waterloo Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Waterloo Creek when the flow is below 60% MAD or 426 litres/second. Thus, the estimated volume of water available from October through June is 11,791 dam^3.

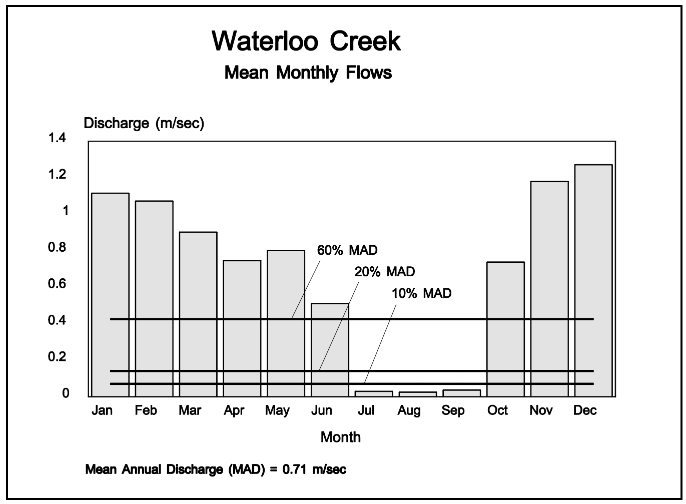


Figure 22

4.12 Wilfred Creek

Wilfred Creek contains Coho, Pink, Chum, Steelhead, and Cutthroat trout. A six foot waterfall approximately 3.8 kilometres from the mouth blocks the passage of all fish in Wilfred Creek.

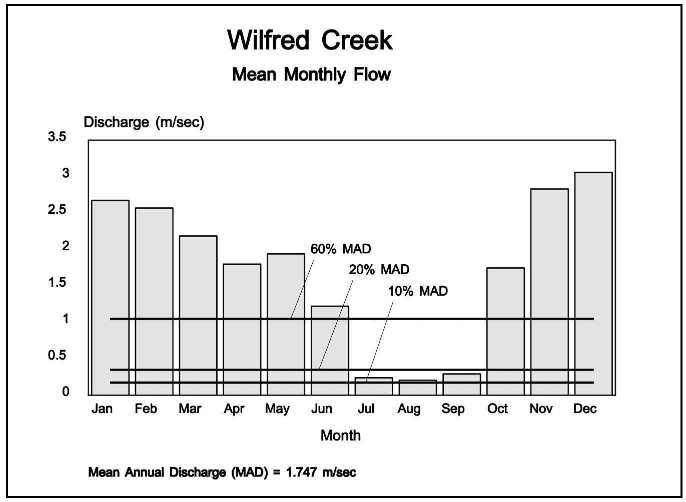


Figure 23

Figure 23 illustrates that the estimated mean monthly flow in Wilfred Creek falls between 10% and 20% of the mean annual discharge (MAD) for the months of July, August and September. The 7-day average low flow for Wilfred Creek is 100 litres/second, which is less than 10% MAD (175 litres/second). Therefore, no extractive demands should be allowed when the mean monthly flows are less than 60% MAD or 1048 litres/second. July, August and September fall into this non-extractive period. Thus, water is only available from Wilfred Creek during the months of October through June. The estimated volume of water available for this period is 27,731 dam^3.

4.13 Cowie Creek

Anadromous fish such as Coho, Pink, and Chum salmon, Steelhead, and Cutthroat utilize the lower portion of Cowie Creek. A 30 foot waterfall approximately 5.0 kilometres from the mouth of the creek marks the limit of anadromous and sportfishing water. A waterfall just below the confluence of Cowie and Cougar Smith Creeks marks the upstream spawning limit of Chum salmon.

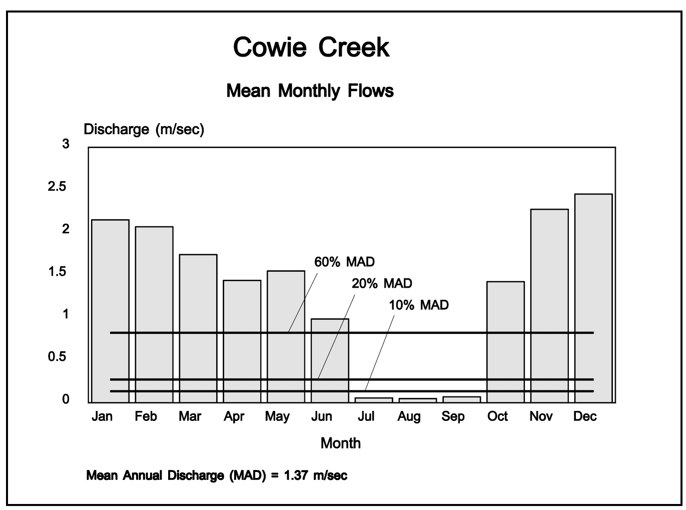


Figure 24

Cougar Smith Creek supports Coho from its confluence with Cowie Creek to a waterfall approximately 1.5 kilometres upstream of the confluence that blocks fish passage.

Figure 24 illustrates that the estimated mean monthly flow in Cowie Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Cowie Creek when the flow is below 60% MAD or 822 litres/second. Thus, the estimated volume of water available from October through June is 22,714 dam^3.

4.14 Tsable River

Tsable River supports Coho, Pink and Chum salmon, with some Steelhead and Cutthroat trout. There are Pink and Chum salmon spawning grounds located near the mouth of the river. A waterfall approximately 6.7 kilometres from the mouth marks the limit of the usable anadromous fish water.

There are lakes in the Tsable River watershed that support wild and/or stocked Rainbow and Cutthroat trout populations. Anglers utilize many areas on the river as well as headwater lakes such as Poum, Lunchtime, and Tsable.

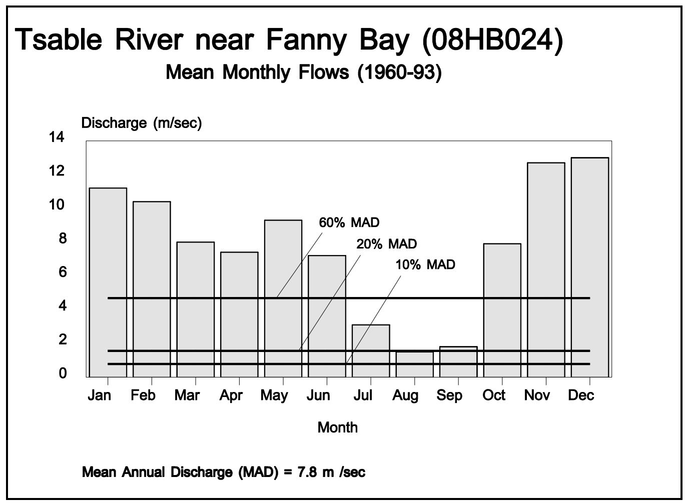


Figure 25

Figure 25 illustrates that the estimated mean monthly flow in the Tsable River falls between 10% and 20% of the mean annual discharge (MAD) during the month of August. The 7-day average low flow for the Tsable River is around 334 litres/second, which is less than 10% MAD (780 litres/second). Therefore, no extractive demands can be made during months when the mean monthly flows are less than 60% MAD or 4680 litres/second. July, August and September fall into this non-extractive period. Thus, water is only available from Tsable River during the months of October through June. The estimated volume of water available for this period is 117,846 dam^3.

4.15 Hindoo Creek

Hindoo Creek supports both Coho and Cutthroat.

Figure 26 illustrates that the estimated mean monthly flow in Hindoo Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Hindoo Creek when the flow is below 60% MAD or 196 litres/second. Thus, the estimated volume of water available from October through June is 5,511 dam^3.

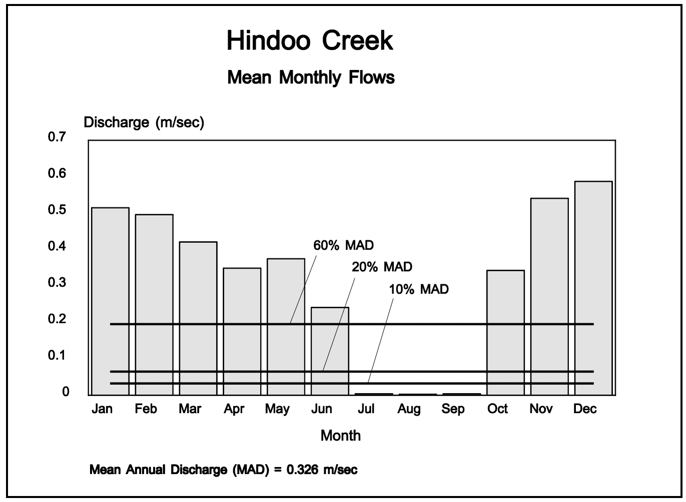


Figure 26

4.16 Hart Creek

Hart Creek supports several species of fish including Chum, Coho and Cutthroat, especially the lower region of the creek. A first waterfall at approximately 1.3 kilometres from the mouth stops the migration of Chum salmon. A second waterfall approximately 3.8 kilometres from the mouth is a barrier to the rest of the anadromous species. The unnamed northern tributary to Hart Creek contains both Coho and Cutthroat.

Langley Lake supports a population of resident Cutthroat trout and is a sportfishing area.

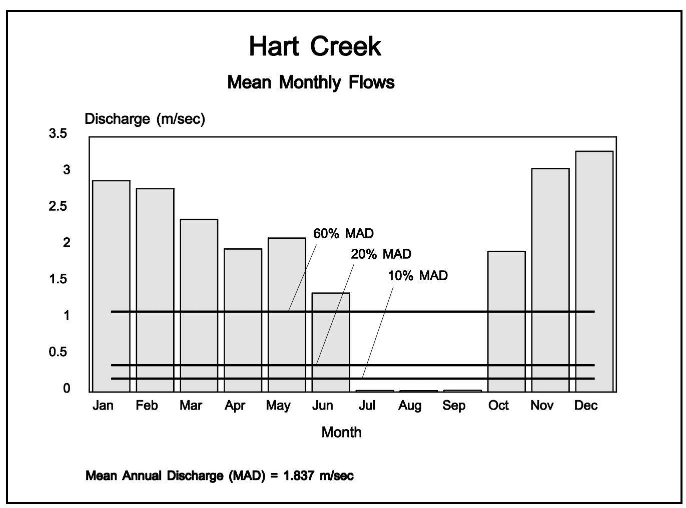


Figure 27

Figure 27 illustrates that the estimated mean monthly flow in Hart Creek falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Hart Creek when the flow is below 60% MAD or 1102 litres/second. Thus, the estimated volume of water available from October through June is 31,086 dam^3.

4.17 Trent River

The lower region of the Trent River is utilized by various anadromous fish species such as Coho, Pink, and Chum salmon, Steelhead, Cutthroat, and Rainbow trout. A waterfall approximately 9.4 kilometres from the mouth of the river blocks upstream migration. There is identified potential fish habitat just past the waterfall. Trent River was touted as having excellent Steelhead fishing in the past.

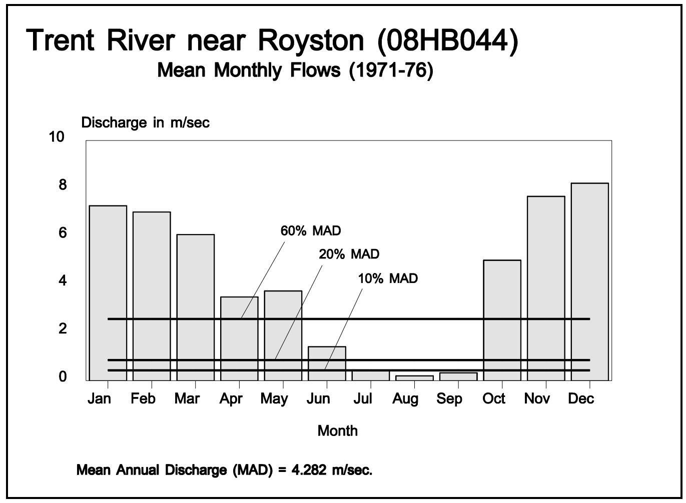


Figure 28

Bloedel Creek, tributary to Trent River, is reported to have a large population of Rainbow trout. A waterfall near the mouth of Bloedel Creek stops further migration of anadromous fish upstream.

Bradley Lake, in the headwaters of Bloedel Creek, has been stocked on numerous occasions and now supports a population of Rainbow trout. Both Bradley Lake and Bloedel Creek are sportfishing waters.

Figure 28 illustrates that the estimated mean monthly flow in Trent River falls below 10% of the mean annual discharge (MAD) during the months of July, August and September. Therefore, water is only available for extractive use during months when the mean monthly discharge is greater than 60% MAD or 2569 litres/second. June, July, August and September have mean monthly flows less than 60% MAD and, therefore, make up the non-extractive low flow period. Thus, water is only available from Trent River during the months of October through May. The estimated volume of water available for this period is 73,148 dam^3.

4.18 Other Streams

Various small streams situated between the identified significant drainage areas, such as Christie Brook, Steele Creek, Bob Creek, and Tweedie Creek, support small populations of anadromous salmon and Cutthroat trout.

It is reasonable to assume that, like the majority of the streams in the plan area, the mean monthly flow will fall below 10% of the mean annual discharge (MAD) during the months of July, August, and September in each of the streams mentioned in the previous paragraph. Therefore, water will only be available from these streams during the period of October through June when the mean monthly flow is presumably greater than 60% MAD.

5.0 WATER DEMAND

5.1 Licenced Demand

There are 63 water licences currently (September 1994) within the Nile Creek to Trent River Water Allocation Plan area. Figure 29 illustrates the number of water licences issued for each purpose for streams within the plan area. More than half of these water licences (39) are for domestic purposes for rural residential demands. There are 6 licences for industrial purposes, another 6 licences for irrigation purposes, 5 water licences for waterworks purposes, 4 water licences for storage purposes, 2 licences for conservation purposes, and 1 water licence for land improvement purposes.

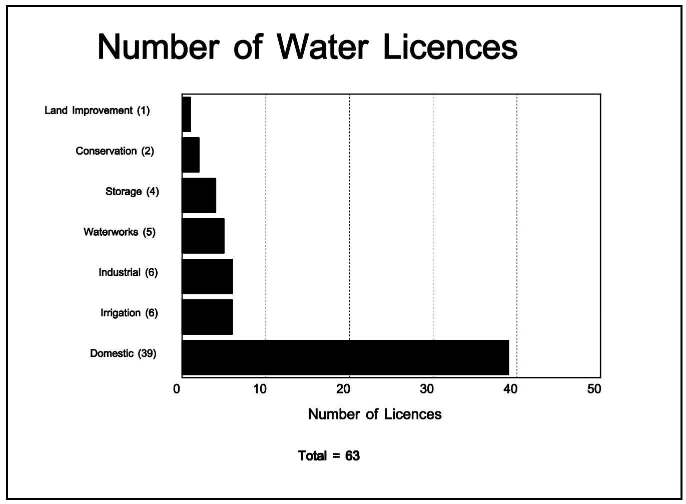


Figure 29

Of greater significance for water management is the estimated average annual licenced water demand and low flow water demand. The total estimated average annual licenced water demand for the plan area is 12,305.5 dam^3. Figure 30 illustrates the estimated average annual licenced water demand for each purpose under which water licences have been issued within the plan area. At 73% of the total annual water demand, conservation purpose constitutes the largest annual water demand in the plan area. The second largest annual water demand is for municipal waterworks purpose (19%); followed by storage purpose (7%),

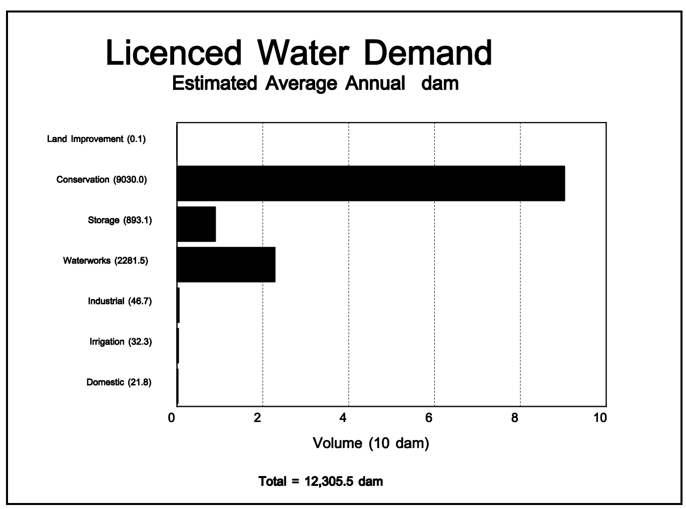


Figure 30

industrial purpose (0.4%), irrigation purpose (0.3%), domestic purpose (0.2%), and finally land improvement purpose (0.0009%). The following table summarizes these annual water demands (also see Appendix D).

Estimated Average Annual Licenced Water Demand			
PURPOSE	**NUMBER OF LICENCES**	**QUANTITY LICENCED**	**ANNUAL DEMAND (dam^3)***
Municipal Waterworks	5	2,750,000 GD	2,281.5
Domestic	39	26,250 GD	21.8
Industrial			
(Fish Culture)	2	32.5 AF	40.1
(Golf Course)	1	2 AF	2.5
(Oyster Processing)	3	2,500 GD	4.2
Sub-total	6		46.8
Irrigation	6	26.2 AF	32.3
Storage	4	724 AF	893.1
Land Improvement	1	65 GD	0.1
Conservation			
(Fish Culture)	2	10.1 cfs	9,030.0
Total	**63**	-	**12,305.6**

* Assumes that municipal waterworks demand and domestic demand is the authorized maximum daily licenced divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand. Industrial (oyster processing), conservation and land improvement demands are assumed to be uniform demands over the year and the licenced volume is the total annual demand. Industrial (fish culture and golf course), irrigation and storage licenced demands are the total annual licenced volumes.

The low flow licenced water demand may be critical between competing water uses and instream flow requirements to maintain the fish resources. The estimated low flow licenced demand for each identified drainage area and for other drainages in the Nile Creek to Trent River Water Allocation Plan area is summarized in the following table (also see Appendix E).

Low Flow Licenced (Consumptive) Water Demand per Drainage Area		
DRAINAGE AREA	**LOW FLOW WATER DEMAND***	
	litres/second	**dam^3**
Black Brook	0.08	0.61
Nash Creek	5.29	41.11
Nile Creek	7.89	61.37
Whitman Creek	0.14	1.13
Sandy Creek	0.16	1.23
Chef Creek	0.03	0.2
Wilfred Creek	5.84	45.43
Cowie Creek	0.05	0.41
Hart Creek	17.33	134.71
Other	4.27	33.17
Total	41.08	319.37

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

5.2 Projected Demand

There are eleven water licence applications pending as of September 1994. The potential annual water demand of these existing applications totals 116,502.71 dam^3 and includes 124.44 dam^3 (150,000 gpd max.) for waterworks purpose, 1.65 dam^3 (2,000 gpd max.) for domestic purpose, 219.36 dam^3 (177.83 AF) for irrigation purpose, 0.01 dam^3 (0.011 AF) for industrial (fish pond) purpose, 3.32 dam^3 (4,000 gpd max.) for industrial (stock watering) purpose, 8,931.53 dam^3 (10 cfs) for conservation purpose and 107,222.4 dam^3 (120 cfs) for power generation purpose. The water licence applications within the plan area are summarized in Appendix F.

Most future water demands are anticipated to be similar to existing licenced water demands. Waterworks, domestic, industrial, irrigation, and land improvement licences will increase in number as the population of the area expands. Conservation purpose demands will increase as groups/agencies struggle to preserve and protect fish and wildlife habitat from urban encroachment and habitat destruction. Storage of winter high flows will be required to support water requirements during the summer low flow period.

A water licence application for the generation of power, and subsequent sale to BC Hydro, calls for the diversion and non-consumptive use of 3.4 m^3/sec (at 60% plant efficiency) of water from Rosewall Creek. The approval of this application would make Power purpose the single largest water demand in the plan area with an annual demand of 107,222.4 dam^3. However, this application is only in the preliminary stages of consideration and further information will be required to make any water licencing decisions.

There has also been a proposed development of a subdivision, hotel, marina complex and golf course at Union Bay by Weldwood of Canada. The existing Union Bay waterworks system has a water licence supply capacity of approximately 200 additional connections (as of 1991). Additional water supplies will be required to accommodate the full proposed development. The total projected water demand for the Union Bay Improvement District, which includes the proposed Weldwood lands, through the year 2010 is approximately 4,795,025 gallons per peak day. There is also a projected storage demand of 1,138,756 gallons. To increase the water supply two proposals are being considered. One involves a diversion from the Tsable River via a gravity feed pipe with storage in Langley Lake, and the other involves an extension of the regional water system from the BC Hydro penstock in the Puntledge River. A more specific hydrologic and environmental assessment will be required if the proposed development proceeds.

6.0 CONCLUSIONS and RECOMMENDATIONS

Most of the streams within the Nile Creek to Trent River Water Allocation Plan area experience a three month low flow period from July through September in which water is unavailable for extractive purposes. The exceptions include: Nile Creek, which does not have a mean monthly flow below 20% of its mean annual discharge and Trent River, both of which have a four month low flow period from June through September. The minimum mean monthly flow occurs in August and ranges from 1 litre/second in Whitman Creek to 1500 litres/second in the Tsable River.

High flow periods, in which mean monthly flows are greater that 60% of the mean annual discharge, occur in most streams within the plan area from October through June. Again, the exceptions are Nile Creek and Trent River, both of which experience an eight month high flow period from October through May. Therefore, there is considerable flow available for part of the year to develop supporting storage for water demands during the low flow months. The maximum mean monthly flow occurs in December and ranges from 150 litres/second in Black Brook and Whitman Creek to 13,000 litres/second in the Tsable River.

All significant streams within the plan area support an important and varied fish resource. Anadromous fish such as salmon, Steelhead and sea-run Cutthroat trout use these streams to spawn and rear their offspring. As well, resident fish such as Rainbow and Cutthroat trout spend their entire lives in certain streams and lakes within the plan area. Despite the relative abundance of fish and fish habitat, flows in most of the streams within the plan area are naturally limiting to fish production and maintenance of fish habitat. In order to protect and maintain the fish resources, storage development will be required on all streams, except for Nile Creek, to support further extractive water demand during the low flow periods (June through September for Trent River and July through September for all other streams).

To meet instream flow requirements downstream and to preserve primary fish habitat in natural water bodies, extractions from fish bearing lakes such as Langley, Bradley, Poum, Tsable and Lunchtime are not to reduce the shoal area (i.e. the top 6 metres of the lake height) by more than 10%.

Fish and debris screens shall be required on all intake or diversion works within the identified fish habitat areas. Fish and debris screens are part of good intake design and should be encouraged on all intakes or diversion works. 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. Appendix G contains information on fish screening requirements.

In stream works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resources. In stream work will normally only be allowed during the low flow period from June or July through September.

The licenced water demand within the Nile Creek to Trent River Water Allocation Plan area consists of Domestic, Waterworks, Industrial, Irrigation, Storage, Land Improvement and Conservation purpose licences. Although the largest number of water licences issued are for domestic purposes, the licenced demand for domestic purpose does not significantly impact other water interests, except where there is a local competing water demand conflict. The largest existing annual licenced water demands are for conservation purposes and community waterworks purpose. These larger demands may conflict with local fish enhancement and maintenance efforts.

Irrigation water demands have the largest impacts on the low flows in the Plan area. Demand is coincident with the low flow period and the critical instream flow requirements for fish.

There is not sufficient storage developed or proposed to maintain and support the existing and projected water demands through the low flow period. Further extractive demands, such as municipal waterworks and irrigation will require supporting storage if the instream fish resources are to be maintained. Also, any further significant salmon enhancement proposals that would increase fish stocks in the stream will require the development of supporting storage to maintain required low flows. Storage shall be required for all existing and proposed licenced water demands when applications for increased licenced water demands are received from an existing licencee.

The following table summarizes the water available for the identified significant drainage areas, not accounting for existing licenced water demand.

NILE CREEK TO TRENT RIVER - WATER AVAILABILITY			
DRAINAGE	**DRAINAGE AREA (km^2)**	**WATER VOLUME AVAILABLE (dam^3)**	
		HIGH FLOW*	**LOW FLOW****
Black Brook	1.3	1,391	0
Nash Creek	4.1	4,429	0
Nile Creek	16.9	15,856	1,044
Thames Creek	8.8	9,478	0
Whitman Creek	1.3	1,404	0
Sandy Creek	3.9	4,219	0
Chef Creek	8.1	8,769	0
Cook Creek	19.7	21,240	0
McNaughton Creek	9.5	10,240	0
Rosewall Creek	43.6	44,376	0
Waterloo Creek	11.1	11,791	0
Wilfred Creek	27.3	27,731	0
Cowie Creek	21.4	22,714	0
Tsable River	105.1	117,846	0
Hindoo Creek	5.1	5,511	0
Hart Creek	28.7	31,086	0
Trent River	66.9	73,148	0

* High Flow is the quantity of water available above 60% MAD during the period from October through June, except Nile Creek and Trent River where the high flow period is from October through May.
** Low Flow is the minimum mean monthly quantity of water available above 10% MAD during the period from July through September, except Nile Creek and Trent River where the low flow period is from June through September.

6.1 Domestic

A domestic water licence shall be 2,273 litres/day (500 gpd) for each rural dwelling as indicated on the plan attached to the water licence application. This amount will allow for the maintenance of 0.10 hectares (0.25 acres) of garden associated with the dwelling. It is not appropriate, where the primary source of domestic water supply is insufficient, to issue additional water licences for the maintenance of green lawns and gardens.

Domestic water licence 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 or develop a community water system of their own.

To ensure an adequate domestic water supply for household uses, applicants shall be required 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 or 0.08 acre feet) is required. This requires a reservoir or dugout approximately 7 metres (23 feet) long by 5 metres (16 feet) wide, with an average depth of 3.5 metres (12 feet); allowing 0.3 metres (1 foot) for evaporation loss.

A spring shall be licensed for an individual domestic water demand provided that it is 30 metres away from any existing licensed springs. 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 (ie. pump test in August or September) and by satisfying any written concerns and objections of any existing water licencees.

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

Measuring or regulating (i.e. metering) is not usually 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 demand for waterworks will greatly increase in the coming years, as the Nile Creek to Trent River Water Allocation Plan area is further developed.

Applicants for a waterworks demand shall be require to assess the supply for a ten year projected demand and provide evidence that the projected demand is not excessive in comparison with adjoining community demands, water conservation is being promoted (ie. residential meters, pricing practices, education) and adequate system balancing storage (ie. volume difference between maximum hour and maximum day demands) will be constructed or is available for peek hour demands. Water Utilities will also have to provide evidence that the appropriate requirements for a Certificate of Public Convenience and Necessity (CPCN) have been met and a CPCN will be obtained. Licenced allocations will be limited to a 10 year projected demand except where the applicant can provide satisfactory evidence that a longer projection period is required (ie. because the cost of construction of works must be amortised over a longer period).

The licencee shall be required to meter or measure and record the water diverted from the source stream. The licencee shall be required to treat the water supply in accordance with Ministry of Health requirements. All waterworks licences will require storage at the source stream.

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 practiced at all times and no increase in the amount of water in existing community waterworks licences shall be allowed unless meters and other conservation measures have been used.

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

6.3 Irrigation

The crop rooting depth, soil type and climatic characteristics determine requirements for irrigation.

Different crops and their rooting depth and water availability coefficient were classified into shallow (0.5 metre) and deep (1.0 metre) effective rooting depths. The available water storage capacity (AWSC) was estimated for shallow and deep root zone depth for classes of similar soil associations identified for the Nile Creek to Trent River Water Allocation Plan area on the maps for the publication Soils of Southern Vancouver Island (J.R. Jungen, P.Ag., Ministry of Environment, August 1985). Where composites of two or three soil associations are intermixed or occupy such small areas that they cannot be separated at the scale of the mapping, only the predominant soil association was considered. The following table was made using the climatic information for Parksville and the AWSC of irrigation requirements for different crop effective rooting depth classes and soil classes. Figure 31 indicates the annual irrigation water requirements for various soil groups in the plan area.

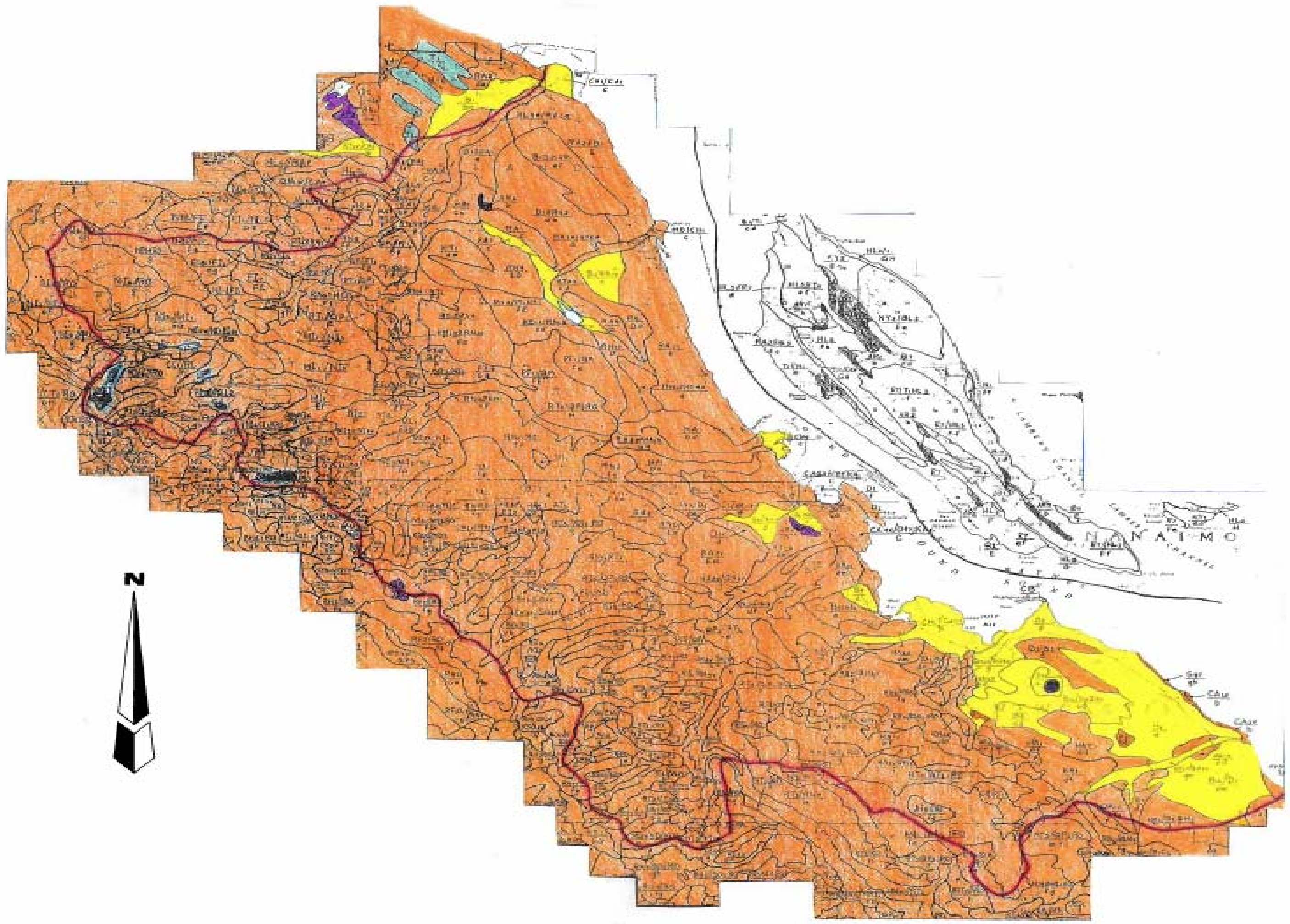


Figure 31

ANNUAL IRRIGATION WATER REGUIREMENTS

Figure 31 - Annual Irrigation Water Requirements in millimetres (inches)

Crops	[illegible]	[illegible]
Soils / Effective Rooting Depth	Shallow 0.5 m (1.6 ft)	Deep 1.0 m (3.3 ft)
Ahousat (AS) Arrowsmith (AR) - organic	380 (15)	305 (12)
Tolmie (T) - sandy clay loam Cowichan (C) - silty clay	460 (18)	305 (12)
Bowser (B) - loamy sand to gravelly sandy loam Kennsal (KT) Kinkade (KG) Sukushan (SA) - sandy loam to loamy sand Rye (RY) - loamy sand Chemainus (CH) - loam	530 (21)	460 (18)
Quinsam (QM) Quimper (QP) Robertson (RB) Shawnigan (S) Rossiter (RT) Stockett (SC) Nitinat (NI) Ritherdon (RH) Moyeha (MI) Crespi (CI) Shelford (SO) Kildonan (KO) Rainer (RI) - gravelly sandy loam Dashwood (D) - very gravelly loamy sand to gravelly sandy loam Haworth (HA) Qualicum (Q) Honeymoon (HM) Cassidy (CA) - very gravelly loamy sand Piggott (PT) Chelwood (CW) Espinosa (EI) Hiller (HL) - gravelly loamy sand Ronald (RA) Royston (R) Reagan (RN) Holyoak (HY) Fleetwood (FI) - gravelly loam Clayoquot (CY) - gravelly sand	610 (24)	610 (24)

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 ft)	Deep 1.0 m (3.3 ft)
Ahousat (AS) Arrowsmith (AR) - **organic**	380 (15)	305 (12)
Tolmie (T) - **sandy clay loam** Cowichan (C) - **silty clay**	460 (18)	305 (12)
Bowser (B) - **loamy sand to gravelly sandy loam** Kammat (KT) Kinkade (KE) Kuhushan (KA) - **sandy loam to loamy sand** Kye (KY) - **loamy sand** Chemainus (CH) - **loam**	530 (21)	460 (18)
Quinsam (QN), Quimper (QP), Robertson (RB), Shawnigan (S), Rossiter (RT), Stockett (SC), Nitinat (NI), Moyeha (MI), Ritherton(RH), Crespi (CI), Shofield (SO), Kildonan (KI), Rainer (RI) - **gravelly sandy loam** Dashwood (D) - **very gravelly loamy sand to gravelly sandy loam** Hawarth (HA), Qualicum (Q), Honeymoon (HM), Cassidy (CA) - **very gravelly loamy sand** Piggot (PT), Chetwood (CW), Espinosa (EI), Hiller (HL) - **gravelly loamy sand** Ronald (RA), Royston (R), Reegan (RN), Holyoak (HY), Fleetwood (FI) - **gravelly loam** Clayoquot (CY) - **gravelly sand**	610 (24)	610 (24)

If the applicant for a water licence can provide more specific soil assessment information for a given area, that soil assessment 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 irrigation practices are to be used, suitable meters shall be installed and water withdrawals limited to the equivalent annual irrigation requirements for sprinkler systems. As the equivalent annual irrigation water requirements for sprinkler systems may not be adequate to sustain crops using these less efficient methods of irrigation, the applicant may be required to reduce crops, limit the acreage irrigated or convert to a more efficient 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 maximum irrigation system flow rate shall not exceed 19.1 litres/sec (4.2 imperial gals. per minute) per 0.4 hectare (1 acre), and users must be encouraged to employ good agricultural practices (field size, system selection and farm management) to conserve water. The authorized period of use for irrigation shall be from April 1 to September 30.

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

6.4 Industrial

The industrial water licenses and water licence applications within the plan area are demands associated with fish culture, golf courses, oyster processing and stock watering.

Commercial fish hatcheries 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 in support of an application for a water licence. Fish Farm and Waste Management Permits will also be required. Off-stream storage is required for fish ponds associated with commercial fish farming

Golf course watering is essentially an irrigation water demand except that the watering is not restricted to the irrigation period of April to September. The quantity of water required should be determined as previously stated in the irrigation section. Except for the period of water withdrawal, which shall be the whole year, the same requirements and conditions as irrigation demands shall apply. Storage is required to support these demands.

Cattle or livestock watering requiring more than 450 l/day (100 Igpd) 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		
Livestock	Water Requirements	
	l/day	Igpd
cattle (beef) per animal	45	10
cattle (dairy) per animal	132	29
chickens per 100 animals	27	6
turkeys per 100 animals	55	12

Industrial demands related to commercial and resort development should be handled similar to multiple domestic demands with the same requirements.

6.5 Power

There are no existing Power purpose water licences within the Nile Creek to Trent River Water Allocation Plan area. There is, however, a pending water licence application for the diversion and non-consumptive use of 3.4 m^3/sec of water from Rosewall Creek. The flows in Rosewall Creek are not adequate to support a sustained demand of 3.4 m^3/sec. (120 ft^3/sec.) through most months. Also, the diversion of such a large quantity may affect the fish resource in the creek between the intake and outfall of the power plant. Therefore, this power demand proposal will be deemed unacceptable and the water licence application may be refused.

Water demand for power generation within the Nile Creek to Trent River Water Allocation Plan area would generally not be feasible because of low flows and potential impacts on the instream flow requirements for maintaining fish habitat.

6.6 Storage

Storage purpose is the impoundment of water, either on-stream or off-stream in a dugout or behind a dam. In the unlikely event that a large storage development to support a major water demand (eg. BC Hydro power, pulp & paper, large waterworks, etc.) is proposed a more specific supply versus demand and environmental impact assessment will be required.

The storage quantity required to support the smaller water demands 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 complete an adequate report for "Dam and Reservoir Information Required in Support of a Water Licence Application for Storage Purpose (Schedule 2)" with the water licence application. If the required report is not provided, the application will be refused.

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 of October through May/June (8/9 months). All in-stream storage will be required to pass any inflow to the reservoir down stream during the low flow period from June/July through September.

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. In-stream storage works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resources. In-stream work will normally only be allowed during the low flow period from June/July to October. 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.

All water licencees that develop storage greater than 100 dam^3 (80 acft) shall be require 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 BC.

Off-stream storage dugouts that are outside the high water winter wetted perimetre 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.

6.7 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. Land improvement water demands are non-consumptive uses of the water resource.

Water used to facilitate the development of a park is usually maintained in a dammed lake or reservoir for recreation (i.e. boating, fishing, swimming, golf course water traps) and aesthetics. The dammed lake or reservoir is usually filled during the high flow period and the water levels maintained or gradually lowered during the low flow period. Golf courses also acquire water licences to construct and maintain dugouts or control the volume of water in small ponds for water traps and aesthetics. Property owners likewise may acquire a water licence to construct and maintain dugouts or control the volume of small ponds for aesthetics and to increase property values. These water demands are essentially storage developments that do not support an extractive use. Therefore, all the requirements noted for storage development shall be required for land improvement development where applicable. No supporting storage is required. The water quantity required to facilitate the development of a park or create an aesthetic pond shall be the volume of the impoundment.

Constructing ditches to drain swamps or marshes, confining or straightening the meandering of stream channels and relocating a stream channel adjacent to a property line is sometimes proposed to accommodate subdivision or building development. Streams should 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.

6.8 Conservation

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

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

All the requirements noted for storage development shall be required for conservation development where applicable.

6.9 Allocation Plan Revision

The Nile Creek to Trent River Water Allocation Plan should be reviewed and updated on or before January 2000.

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APPENDIX A

Mud Bay
Canadian Climatic Normals
1951 -1980

BRITISH COLUMBIA

MUD BAY FRS
49° 28'N 124° 47'W 11 m

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	CODE
Daily Maximum Temperature	4.2	6.9	9.2	13.1	17.3	20.2	23.2	22.4	18.8	13.1	7.5	5.4	13.4	6
Daily Minimum Temperature	-0.7	0.5	0.8	3.2	6.4	9.7	11.5	11.5	8.8	5.6	2.1	0.6	5.0	6
Daily Temperature	1.8	3.7	5.0	8.2	11.9	15.0	17.4	17.0	13.9	9.4	4.8	3.0	9.3	6
Standard Deviation, Daily Temperature	1.1	1.3	1.0	0.9	0.7	1.0	1.1	1.2	1.1	0.6	1.2	1.8	0.3	5
Extreme Maximum Temperature	12.8	14.5	18.0	25.0	27.2	29.0	31.7	33.3	28.3	23.5	17.2	18.7	33.3	
Years of Record	9	9	9	10	9	10	10	10	10	10	10	10		
Extreme Minimum Temperature	-10.6	-7.8	-6.7	-2.8	0.5	2.2	5.0	5.5	-0.8	-3.3	-7.0	-9.5	-10.6	
Years of Record	9	9	9	10	10	10	10	10	10	10	10	10		
Rainfall	228.7	178.4	155.3	64.3	44.8	40.8	26.9	49.6	72.8	186.4	262.2	305.8	1614.8	6
Snowfall	44.8	22.7	8.3	0.8	0.0	0.0	0.0	0.0	0.0	0.1	8.0	32.7	113.4	6
Total Precipitation	281.6	200.6	170.3	65.1	44.8	40.8	26.9	49.6	72.8	184.9	267.5	340.0	1714.1	6
Standard Deviation, Total Precipitation	162.9	75.5	96.0	34.1	20.2	28.4	22.3	42.3	42.9	139.7	158.9	124.0	329.8	5
Greatest Rainfall in 24 hours	135.4	105.2	146.1	53.8	57.7	28.0	46.0	39.9	66.0	86.4	107.4	112.0	146.1	
Years of Record	9	9	9	10	10	10	10	10	10	10	10	10		
Greatest Snowfall in 24 hours	60.0	61.0	7.6	7.8	0.0	0.0	0.0	0.0	0.0	2.5	15.2	27.9	61.0	
Years of Record	9	9	9	10	10	10	10	10	10	10	10	10		
Greatest Precipitation in 24 hours	135.4	105.2	146.1	53.8	57.7	28.0	46.0	39.9	66.0	86.4	107.4	118.0	146.1	
Years of Record	9	9	9	10	10	10	10	10	10	10	10	10		
Days with Rain	15	14	13	10	10	8	5	7	11	16	17	18	144	6
Days with Snow	5	2	1	0	0	0	0	0	0	0	1	3	12	6
Days with Precipitation	20	15	14	10	10	8	5	7	11	16	17	21	154	6

APPENDIX B

Water Survey of Canada
Monthly and Annual Mean Discharges
and
7-day Low Flows

Nile Creek
Rosewall Creek
Tsable River
Trent River

NILE CREEK NEAR BOWSER (08HB022)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1959						0.298	0.231	0.198	0.263	0.442	1.1	1.78	
1960	1.1	1.32	0.888	1.42	0.827	0.325	0.165	0.17	0.214	0.911	1.19	1.09	0.799
1961	2.84	2.95	1.67	1.2	0.741	0.24	0.178	0.084	0.265	0.752	1.11	2.14	1.17
1962	1.6	0.783	0.667	1.19	0.681	0.393	0.226	0.407	0.298	1.03	2.62	3.38	1.11
1963	0.909	2.66	1.4	1.07	0.482	0.198	0.231	0.198	0.198	1.99	1.85	2.23	1.11
1964	2.35	1.36	1.25	1.08	0.911	0.418	0.358	0.208	0.345	0.491	0.963	0.935	0.888
1965	1.3	1.85	0.833	1.16	0.596	0.224	0.168	0.15	0.146	1.82	1.78	2.72	1.06
1966	2.69	1.27	1.59	1.04	0.603	0.392	0.276	0.201	0.236	1.07	1.8	2.98	1.18
1967	2.02	1.32	1.21	0.685	0.848	0.248	0.185	0.164	0.173	1.72	0.898	2.08	0.965
1968	3.45	1.93	1.47	0.848	0.652	0.337	0.285	0.26	0.423	1.89	2.11	1.66	1.28
1969	0.712	0.989	1.36	1.73	1.72	0.475	0.243	0.216	0.82	0.716	1.31	1.4	0.974
1970	1.09	1.1	0.779	1.27	0.429	0.239	0.193	0.181	0.212	0.503	1.01	1.39	0.697
1971	1.95	1.54	1.18	1.13	1.51	0.652	0.296	0.231	0.349	0.703	1.77	0.506	0.981
1972	0.877	1.67	2.83	1.2	1.01	0.342	0.353	0.232	0.434	0.244	0.831	2.76	1.07
1973	3.31	1.49	0.829	0.534	0.56	0.242	0.148	0.129	0.145	0.834	1.22	3.34	1.07
1974	4.26	1.83	2.8	1.44	1.16	0.585	0.513	0.196	0.199	0.209	1.81	2.29	1.44
1975	1.01	0.827	1.25	0.86	1.26	0.372	0.201	0.429	0.214	1.64	3.88	2.13	1.17
1976	1.55	1.19	0.986	1.21	1.09	0.455	0.268	0.297	0.295	0.517	0.734	1.13	0.81
1977	0.631	1.55	1.15	0.875	0.308	0.215	0.146	0.142	0.228	0.911	1.58	1.72	0.782
1978	1.3	1.29	1.42	0.666	0.341	0.224	0.17	0.24	0.588	0.356	0.729	0.873	0.679
1979	0.423	2.12	1.49	0.773	0.462	0.193	0.215	0.166	0.536	0.807	0.719	3.88	0.977
1980	1.31	2.94	0.979	1.2	0.288	0.402	0.308	0.173	0.608	0.243	2.58	4.54	1.29
1981	1.15	2.85	0.732	1.29	0.513	0.357	0.246	0.175	0.395	2.04	2.2	1.54	1.11
1982	1.27	2.42	0.89	0.905	1.12	0.45	0.221	0.159	0.17	1.88	1.05	2.4	1.07
1983	2.34	3.71	1.46	0.622	0.342	0.302	0.37	0.217	0.256	0.497	2.69	0.764	1.11

NILE CREEK NEAR BOWSER (08HB022)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1984	2	2.08	1.21	0.816	0.796	0.327	0.204	0.192	0.294	1.53	2.2	1.06	1.06
1985	0.515	0.909	0.541	1.46	0.672	0.226	0.155	0.144	0.204	1.29	0.481	0.935	0.625
1986	4.73	3.4	2.04	0.657	0.714	0.251	0.192	0.139	0.136	0.153	1.36	1.89	1.3
1987	2.52	1.73	1.68	0.95	0.458	0.395	0.188	0.152	0.157	0.132	0.875	1.88	0.924
1988	1.14	1.08	1.13	1.39	0.71	0.303	0.205	0.141	0.161	0.284	2.23	1.04	0.814
1989	1.3	0.688	0.993	1.24	0.304	0.183	0.233	0.155	0.139	0.685	0.887	1.11	0.66
1990	1.71	1.55	1.18	0.976	0.296	0.587	0.186	0.148	0.145	1.43	3.73	1.38	1.1
1991	1.04	1.58	0.564	0.763	0.3	0.211	0.122	0.33	0.162	0.089	1.31	1.61	0.666
1992	3.76	1.54	0.419	0.664	0.357	0.193	0.151	0.147	0.152	0.747	1.16	0.63	0.826
1993	0.896	0.645	2.04	0.971	0.486	0.445	0.194	0.158	0.138	0.214	0.696	1.88	0.732
MEAN	1.80	1.71	1.26	1.04	0.693	0.334	0.229	0.198	0.277	0.879	1.56	1.86	0.985
%MAD	182%	174%	128%	105%	70.3%	33.9%	23.3%	20.1%	28.1%	89.2%	158%	189%	100%

NILE CREEK NEAR BOWSER (08HB022) 7-Day Average Low Flow (m^3/sec)				
YEAR	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1959	8/22/59	0.193	8/22/59	0.193
1960	7/13/60	0.159	7/13/60	0.159
1961	8/3/61	0.065	8/3/61	0.065
1962	9/23/62	0.143	9/23/62	0.143
1963	6/16/63	0.173	10/4/63	0.149
1964	9/11/64	0.182	9/11/64	0.182
1965	8/3/65	0.121	8/3/65	0.121
1966	8/23/66	0.187	8/23/66	0.187
1967	8/16/67	0.161	8/16/67	0.161
1968	8/4/68	0.227	8/4/68	0.227
1969	7/27/69	0.193	7/27/69	0.193
1970	8/24/70	0.174	8/24/70	0.174
1971	8/10/71	0.223	8/10/71	0.223
1972	9/1/72	0.218	9/1/72	0.218
1973	8/5/73	0.125	8/5/73	0.125
1974	9/27/74	0.179	9/27/74	0.179
1975	8/3/75	0.174	8/3/75	0.174
1976	8/9/76	0.191	10/20/76	0.185
1977	8/13/77	0.125	8/13/77	0.125
1978	8/6/78	0.149	8/6/78	0.149
1979	8/12/79	0.144	8/12/79	0.144
1980	8/14/80	0.154	8/14/80	0.154
1981	8/20/81	0.161	8/20/81	0.161
1982	8/27/82	0.141	8/27/82	0.141
1983	8/24/83	0.203	8/24/83	0.203
1984	7/28/84	0.183	7/28/84	0.183
1985	8/24/85	0.14	8/24/85	0.14
1986	8/25/86	0.127	10/7/86	0.115
1987	9/22/87	0.138	10/21/87	0.115
1988	9/5/88	0.131	9/5/88	0.131
1989	9/12/89	0.132	9/12/89	0.132
1990	9/27/90	0.131	9/27/90	0.131
1991	9/27/91	0.077	10/9/91	0.050
1992	8/27/92	0.119	8/27/92	0.119
1993	9/14/93	0.134	10/2/93	0.133
	MEAN	0.156	MEAN	0.154

ROSEWALL CREEK AT THE MOUTH (08HB037)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1968							0.555	0.113	0.33	10.1	6.79	8.13	
1969				5.03	7.5	4.28	0.673	0.204	1.92	1.93	4.41	4.36	
1970	2.38	2.94	2.25	3.09	2.29	1.7	0.305	0.02	0.156	1.47	3.04	3	1.88
1971	4.21	4.86	2.48	3.09	6.02	3.65	2	0.477	0.818	1.74	6.56	0.944	3.05
1972	1.05	2.98	7.72	3.48	3.96	2.78	1.47	0.074	0.738	0.109	2.39	6.91	2.81
1974					3.63	4.3	2.91	0.747	0.152	0.088			
1975	1.81	1.18	2.17	1.85	3.89	2.76	0.835	1.01	0.291				
1976	3.25	2.31	2.03	2.63	3.78	3.02	2.31	0.872	0.433	1.07	1.74	3.75	2.27
1977	1.56	5.3	3.34	3.4	2.1	1.71	0.221	0.045	0.698	5.69	5.64	4.91	2.86
1978	8.56	3.78	5.8	2.44	2.28	1.95	0.301	0.631	4.24	1.04	1.69	1.5	2.85
MEAN	3.26	3.34	3.68	3.13	3.94	2.91	1.16	0.419	0.978	2.58	4.03	4.19	2.62
%MAD	124%	127%	141%	119%	150%	111%	44.2%	16.0%	37.3%	98.5%	154%	160%	100%

ROSEWALL CREEK AT THE MOUTH (08HB037) 7-Day Average Low Flow (m^3/sec)				
YEAR	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1968	8/9/68	0.001	8/9/68	0.001
1969	8/16/69	0.021	8/16/69	0.021
1970	8/17/70	0	8/17/70	0
1971	8/30/71	0.014	8/30/71	0.014
1972	8/25/72	0	8/25/72	0
1974	9/22/74	0	9/22/74	0
1975	8/12/75	0	8/12/75	0
1976	9/27/76	0.266	10/19/76	0
1977	7/28/77	0	7/28/77	0
1978	7/27/78	0	7/27/78	0
	MEAN	0.030	MEAN	0.004

TSABLE RIVER NEAR FANNY BAY (08HB024)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1960								0.801	0.89	10.9	14	17.6	
1961	29.2	17.4	11.7	10.6	13.4	7.62	2.47	0.474	1.14	5.65	9.33	12	10
1962	8.95	8.34	2.78	10.9	8.04	6.91	1.8	3.43	3.25	11.9	17.8	24	9.01
1963	7.19	18.8	8.56	7.5	8.36	3.81	2.6	0.473	0.453	17.9	14.4	15	8.69
1964	9.63	6.23	4.87	5.97	8.1	11.1	5.9	1.25	2.29	4.15	8.96	7.66	6.33
1965	6.44	8.91	4.62	8.32	6.42	4.15	1.26	0.713	0.384	11.8	17.9	15.5	7.18
1966	15	7.28	10.5	8.18	8.55	10.2	5.71	1.22	1.56	8.99	14.6	23.5	9.63
1967	15	7.58	8.28	3.49	11.8	10.7	2.57	0.468	0.472	21.1	7.82	15	8.73
1968	23.4	11.7	10.9	4.21	9.57	6.42	2.84	1.68	1.75	20.9	18.8	11	10.3
1969	3.65	8.2	7.27	12.3	19.7	13.4	3.33	1.75	6.75	5.65	15.3	12.5	9.13
1970	5.03	7.78	6.56	8.16	7.14	6.03	2.03	0.734	0.958	4.63	6.58	7.37	5.23
1971	10	9.31	4.92	8.08	16.2	13.2	6.58	2.7	2.56	5.19	17.4	2.49	8.19
1972	2.93	7	16.5	9.86	13.4	9.47	5.39	1.1	3.03	0.711	8.16	15.7	7.77
1973	16.3	6.45	5.5	4.32	11.7	7.04	2.97	0.717	0.874	6.37	7	19.7	7.44
1974	17.6	8.76	14.7	8.78	10.2	13.2	8.39	2.88	1.16	0.673	12.6	13.7	9.4
1975	4.3	2.58	4.28	4.73	12	8.41	2.83	3.61	1.03	13.9	31.4	17.5	8.91
1976	7.6	4.74	4.45	6.29	10.8	8.55	6.83	2.73	1.33	2.79	5.74	5.6	5.63
1977				8.77	5.95	5.33	1.1	0.497	2.27	11.6	11.6	11.8	
1978	9.08	10.1	11.6	5.97	6.21	5.33	1.47	4.3	6.66	2.27	6.76	2.9	6.02
1979	2.35	11.5	9.95	5.23	9.81	3.95	2.81	0.607	6.8	9.02	5.35	24.9	7.69
1980	7.7	15.3	5.15	9.35	6.06	4.47	2.91	0.559	2.58	1.89	17.2	37.9	9.23
1981	10.5	15	3.5	6.71	5.69	3.5	1.66	0.451	3.93	15.6	19.3	10.7	7.98
1982	5.48	10.7	4.49	5.25	12.3	11.1	3.69	1.12	0.744	20	5.27	13.8	7.83

TSABLE RIVER NEAR FANNY BAY (08HB024)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1983	14.6	21.6	9.59	5.06	8.01	6.3	4.62	0.854	1.28	3.94	25.5	3.45	8.62
1984	11.4	11.9	11.9	5.76	9.01	7	3.67	0.904	1.47	13.4	10.3	5.84	7.71
1985	2.5	2.6	2.45	8.08	8.19	4.94	1.02	0.367	0.677	8.34	2.79	4.64	3.89
1986	21.6	14.2	14.7	4.83	10.1	4.44	1.69	0.36	0.293	1.48	12.3	17	8.57
1987	14.7	19.2	17.3	6.48	9.01	8.84	2.3	0.861	0.437	0.267	11	9.12	8.21
1988	10.8	5.86	5.79	10.1	10.4	7.93	4.14	1.14	0.872	2.13	15.4	6.31	6.73
1989	7.11	3.52	5.76	9.44	6.93	5.29	2.48	1.05	0.438	8.07	5.78	7.36	5.28
1990	9.3	5.74	5.68	7.95	5.91	6.94	1.61	0.299	0.234	7.38	25.1	13.6	7.47
1991	9.97	25.2	2.3	6.03	5.15	3.21	0.919	8.03	1.2	0.365	18	19.6	8.21
1992	33.5	12.7	4.81	7.84	3.5	1.67	0.618	0.285	0.62	9.32	8.39	3.47	7.23
1993	4.47	5.74	14.2	10.2	10.6	5.85	2.16	1.03	0.414	1.44	4.51	13.3	6.18
MEAN	11.2	10.4	8.0	7.4	9.3	7.2	3.1	1.5	1.8	7.9	12.7	13.0	7.8
% of MAD	144%	134%	103%	95.5%	120%	92.2%	40.0%	18.7%	23.0%	102%	164%	167%	100%

TSABLE RIVER NEAR FANNY BAY (08HB024) 7-Day Average Low Flow (m^3/sec)				
YEAR	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1960	9/16/60	0.358	9/16/60	0.358
1961	8/27/61	0.249	8/27/61	0.249
1962	9/23/62	0.370	9/23/62	0.370
1963	9/7/63	0.253	9/7/63	0.253
1964	9/12/64	0.356	9/12/64	0.356
1965	9/27/65	0.346	9/28/65	0.345
1966	9/5/66	0.578	9/5/66	0.578
1967	9/26/67	0.193	9/26/67	0.193
1968	8/10/68	0.432	8/10/68	0.432
1969	9/9/69	0.781	9/9/69	0.781
1970	9/14/70	0.247	9/14/70	0.247
1971	9/25/71	0.866	9/25/71	0.866
1972	9/3/72	0.316	9/3/72	0.316
1973	9/16/73	0.273	9/16/73	0.273
1974	9/27/74	0.442	10/23/74	0.346
1975	9/27/75	0.372	9/29/75	0.358
1976	9/27/76	0.670	10/20/76	0.408
1977	8/19/77	0.206	8/19/77	0.206
1978	8/8/78	0.360	8/8/78	0.360
1979	8/13/79	0.412	8/13/79	0.412
1980	8/22/80	0.385	8/22/80	0.385
1981	8/21/81	0.298	8/21/81	0.298
1982	9/22/82	0.424	10/1/82	0.367
1983	8/24/83	0.446	10/12/83	0.305
1984	9/1/84	0.306	9/1/84	0.306
1985	9/2/85	0.250	9/2/85	0.250
1986	9/4/86	0.178	10/18/86	0.112
1987	9/12/87	0.208	10/20/87	0.128
1988	9/15/88	0.343	9/15/88	0.343
1989	9/12/89	0.326	9/12/89	0.326
1990	9/27/90	0.145	9/27/90	0.145
1991	8/4/91	0.298	10/12/91	0.220
1992	8/26/92	0.169	8/26/92	0.169
1993	9/27/93	0.338	10/10/93	0.306
	MEAN	0.359	MEAN	0.334

TRENT RIVER NEAR ROYSTON (08HB044)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1971					5.44	2.05	0.481	0.063	0.569				
1972					3.16	1.04	0.277	0.04	0.68				
1973				2.01	2.33	0.86	0.148	0.024	0.077				
1974					3.31	1.96	1.07	0.053	0.018				
1975				4.05	5.1	0.955	0.061	0.784	0.288				
1976				4.37	3.02	1.57	0.484	0.231	0.311				
MEAN				3.48	3.73	1.41	0.420	0.199	0.324				

TRENT RIVER NEAR ROYSTON (08HB044) 7-Day Average Low Flow (m^3/sec)				
YEAR	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1971	8/15/71	0.016		
1972	9/4/72	0.007		
1973	8/25/73	0.014		
1974	9/6/74	0.001		
1975	8/5/75	0.004		
1976	8/7/76	0.087		
	MEAN	0.022		

APPENDIX C

Miscellaneous Flow Measurements

Miscellaneous Flow Measurements

STREAM	SITE	DRAINAGE AREA (km^2)	METHOD	DATE	FLOW (Liters/sec.)
Nile Creek	W.S.C. staff gauge	16.4	SD	22/9/87	130
Thames Creek	20 ft. downstream of Hwy #19	6.2	BS	29/8/85	5
	near Bowser	8.1	E	1985/01/09	10
			E	1985/02/09	10
			E	1985/03/09	10
			E	1985/04/09	11
			E	1985/05/09	11
			SD	1985/06/09	12
			E	1985/07/09	17
			E	1985/08/09	18
			E	1985/09/09	17
			E	1985/10/09	12
			CM	1985/11/09	12
			CM	1985/12/09	17
			E	13/9/85	20
			E	14/9/85	24
			E	15/9/85	23
	upstream end of Hwy #19 culvert	6.2	F	24/9/87	8
Sandy Creek	downstream end of concrete culvert	2.7	BS	29/8/85	2
Chef Creek	near Fanny Bay	?	E	24/7/92	5
			E	25/7/92	5
			E	26/7/92	5
			F	27/7/92	5
			E	28/7/92	4
			E	29/7/92	4
			E	30/7/92	4
			F	31/7/92	4
			E	1992/01/08	4
			E	1992/02/08	4
			E	1992/03/08	3
			E	1992/04/08	3
			E	1992/05/08	5
			E	1992/06/08	4
			E	1992/07/08	4
			E	1992/08/08	4
			E	1992/09/08	4
			F	1992/10/08	4
			E	1992/11/08	3
			E	1992/12/08	3
			E	13/8/92	3
			E	14/8/92	3
			E	15/8/92	3
			E	16/8/92	3
			E	17/8/92	3
			E	18/8/92	3

STREAM	SITE	DRAINAGE AREA (km^2)	METHOD	DATE	FLOW (Liters/sec.)
Chef Creek cont.	near Fanny Bay	?	E	19/8/92	3
			E	20/8/92	3
			F	21/8/92	4
			E	22/8/92	3
			E	23/8/92	3
			E	24/8/92	3
			E	25/8/92	3
			E	26/8/92	3
			F	27/8/92	3
			E	28/8/92	3
			E	29/8/92	3
			E	30/8/92	3
			E	31/8/92	3
			E	1992/01/09	3
			E	1992/02/09	3
			F	1992/03/09	3
			E	1992/04/09	3
			E	1992/05/09	3
			E	1992/06/09	3
			E	1992/07/09	3
			E	1992/08/09	3
			E	1992/09/09	3
			F	1992/10/09	3
			E	1992/11/09	3
			E	1992/12/09	3
			E	13/9/92	3
			E	14/9/92	3
			E	15/9/92	3
			E	16/9/92	3
			E	17/9/92	2
			F	18/9/92	4
			E	19/9/92	4
			E	20/9/92	4
			E	21/9/92	4
			E	22/9/92	3
			E	23/9/92	3
			F	24/9/92	5
Cook Creek	50 m downstream of bridge	17.6	CM	29/8/85	7
	near Fanny Bay	25.7	E	1985/01/09	10
			E	1985/02/09	10
			E	1985/03/09	10
			E	1985/04/09	14
			E	1985/05/09	18
			SD	1985/06/09	16
			E	1985/07/09	17
			E	1985/08/09	18
			E	1985/09/09	16

STREAM	***SITE***	***DRAINAGE AREA (km^2)***	***METHOD***	***DATE***	***FLOW (Liters/sec.)***
Cook Creek cont.	near Fanny Bay	25.7	CM	1985/10/09	14
			E	1985/11/09	13
			CM	1985/12/09	17
			E	13/9/85	20
			E	14/9/85	24
			E	15/9/85	23
McNaughton Creek	Hwy #19 culvert outlet	4.6	BS	29/8/85	0.1
Trib. to McNaughton Creek	Hwy #19 culvert outlet	3.1	-	29/8/85	0
Waterloo creek	Hwy #19 bridge (downstream side)	11.1	CM	29/8/85	14
	near Fanny Bay	7.2	E	1985/01/09	14
			E	1985/02/09	14
			E	1985/03/09	13
			E	1985/04/09	15
			E	1985/05/09	20
			SD	1985/06/09	24
			E	1985/07/09	23
			E	1985/08/09	22
			E	1985/09/09	20
			CM	1985/10/09	19
			E	1985/11/09	19
			CM	1985/12/09	19
			E	13/9/85	28
			E	14/9/85	30
			E	15/9/85	29
	20 m upstream of Hwy #19	11	F	24/9/87	13
	near Fanny Bay	?	E	24/7/92	26
			E	25/7/92	24
			E	26/7/92	23
			CM	27/7/92	22
			E	28/7/92	21
			E	29/7/92	20
			E	30/7/92	21
			CM	31/7/92	22
			E	1992/01/08	21
			E	1992/02/08	20
			E	1992/03/08	19
			E	1992/04/08	18
			E	1992/05/08	17
			E	1992/06/08	32
			E	1992/07/08	30
			E	1992/08/08	44
			E	1992/09/08	35
			CM	1992/10/08	30
			E	1992/11/08	29
			E	1992/12/08	28
			E	13/8/92	26
			E	14/8/92	25
STREAM	***SITE***	***DRAINAGE***	***METHOD***	***DATE***	***FLOW***

		AREA (km^2)			*(Liters/sec.)*
Waterloo Creek cont.	near Fanny Bay	?	E	15/8/92	23
			E	16/8/92	22
			E	17/8/92	21
			E	18/8/92	20
			E	19/8/92	19
			E	20/8/92	18
			CM	21/8/92	18
			E	22/8/92	25
			E	23/8/92	24
			E	24/8/92	22
			E	25/8/92	20
			E	26/8/92	19
			CM	27/8/92	18
			E	28/8/92	17
			E	29/8/92	16
			E	30/8/92	15
			E	31/8/92	19
			E	1992/01/09	29
			E	1992/02/09	25
			CM	1992/03/09	23
			E	1992/04/09	20
			E	1992/05/09	22
			E	1992/06/09	16
			E	1992/07/09	14
			E	1992/08/09	13
			E	1992/09/09	12
			E	1992/10/09	11
			E	1992/11/09	11
			E	1992/12/09	10
			E	13/9/92	10
			E	14/9/92	9
			E	15/9/92	9
			E	16/9/92	9
			E	17/9/92	9
			CM	18/9/92	8
			E	19/9/92	8
			E	20/9/92	8
			E	21/9/92	7
			E	22/9/92	7
			E	23/9/92	25
			CM	24/9/92	54
Wilfred Creek	50 ft. downstream from Hwy #19	28.2	CM	29/8/85	102
	near Fanny Bay	29	E	1985/01/09	108
			E	1985/02/09	104
			E	1985/03/09	100
			E	1985/04/09	120
			E	1985/05/09	150
STREAM	***SITE***	***DRAINAGE AREA (km^2)***	***METHOD***	***DATE***	***FLOW (Liters/sec.)***

Wilfred Creek cont.	near Fanny Bay	29	SD	1985/06/09	170
			E	1985/07/09	160
			E	1985/08/09	150
			E	1985/09/09	140
			CM	1985/10/09	133
			E	1985/11/09	125
			CM	1985/12/09	142
			E	13/9/85	200
			E	14/9/85	250
			E	15/9/85	240
	upstream of Hwy #19 bridge	28	CM	24/9/87	146
	near Fanny Bay - below R.R. crossing	?	E	23/7/92	210
			E	24/7/92	200
			E	25/7/92	192
			E	26/7/92	185
			CM	27/7/92	178
			E	28/7/92	170
			E	29/7/92	166
			E	30/7/92	163
			CM	31/7/92	161
			E	1992/01/08	155
			E	1992/02/08	150
			E	1992/03/08	145
			E	1992/04/08	140
			E	1992/05/08	135
			E	1992/06/08	250
			E	1992/07/08	240
			E	1992/08/08	400
			E	1992/09/08	430
			CM	1992/10/08	351
			E	1992/11/08	250
			E	1992/12/08	210
			E	13/8/92	180
			E	14/8/92	170
			E	15/8/92	160
			E	16/8/92	150
			E	17/8/92	145
			E	18/8/92	140
			E	19/8/92	135
			E	20/8/92	130
			E	21/8/92	150
			E	22/8/92	180
			E	23/8/92	165
			E	24/8/92	155
			E	25/8/92	150
			E	26/8/92	145
			CM	27/8/92	139
STREAM	***SITE***	***DRAINAGE AREA (km^2)***	***METHOD***	***DATE***	***FLOW (Liters/sec.)***
Wilfred Creek cont.	near Fanny Bay - below R.R. crossing	?	E	28/8/92	133

			E	29/8/92	127
			E	30/8/92	122
			E	31/8/92	320
			E	1992/01/09	300
			E	1992/02/09	250
			CM	1992/03/09	205
			E	1992/04/09	185
			E	1992/05/09	170
			E	1992/06/09	160
			E	1992/07/09	190
			E	1992/08/09	170
			E	1992/09/09	150
			E	1992/10/09	140
			E	1992/11/09	132
			E	1992/12/09	126
			E	13/9/92	123
			E	14/9/92	120
			E	15/9/92	117
			E	16/9/92	114
			E	17/9/92	111
			CM	18/9/92	109
			E	19/9/92	106
			E	20/9/92	103
			E	21/9/92	100
			E	22/9/92	96
			E	23/9/92	94
			E	24/9/92	92
Cowie Creek	100 ft. upstream of Hwy #19 bridge	21.9	CM	29/8/85	38
Remmel's Spring	south property line of Lot 1, pl.42299	?	F	23/6/88	0.3
			F	27/6/88	0.3
			F	31/6/88	0.3
			F	1988/06/07	0.4
			F	1988/11/07	0.4
			F	15/7/88/	0.3
			F	17/7/88	0
			F	27/7/88	0.4
			F	30/7/88	0
			F	18/10/88	0.4
Hindoo Creek	Hwy #19 culvert	5.6	-	15/8/85	0
Hart Creek	Hwy #19 bridge	23.8	-	1985/02/08	0
Trent River	250 ft. upstream of Hwy #19 bridge	73	F	15/8/85	1
Bloedel Creek	near Union Bay	21.1	E	1985/01/09	3
(trib. to Trent River)			E	1985/02/09	3
			E	1985/03/09	2
			E	1985/04/09	3
			E	1985/05/09	5

STREAM	***SITE***	***DRAINAGE AREA (km^2)***	***METHOD***	***DATE***	***FLOW (Liters/sec.)***
Bloedel Creek cont.	near Union Bay	21.1	SD	1985/06/09	6
			E	1985/07/09	7

			E	1985/08/09	6
			E	1985/09/09	5
			CM	1985/10/09	4
			E	1985/11/09	3
			E	1985/12/09	5
			E	13/9/85	8
			E	14/9/85	9
			E	15/9/85	8
METHOD CODES: BS=BUCKET & STOPWATCH; E=ESTIMATED (BASED ON FLOW INDEX STATION); SD=STAGE - DISCHARGE RELATIONSHIP; CM=CURRENT METER; F=FLUME.					

APPENDIX D

Licenced Water Demand by Purpose
(September 1994)

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY / UNITS	LITRES/ SEC.	DEMAND (dam³/year)
Domestic Purpose°					
F013915	182944	Black Brook	500 GD	0.03	
F016577	198559	Black Brook	500 GD	0.03	
C028073	248076	Black Brook	500 GD	0.03	
F003657	31408	Nash Creek	500 GD	0.03	
F016635	37617	Nash Creek	500 GD	0.03	
F016931	56664	Nash Creek	500 GD	0.03	
F017591	203647	Nash Creek	500 GD	0.03	
F017597	217307	Nash Creek	500 GD	0.03	
F017598	217567	Nash Creek	500 GD	0.03	
C026256	232119	Nash Creek	1,000 GD	0.05	
C026924	238255	Whitman Creek	500 GD	0.03	
C029081	256559	Whitman Creek	500 GD	0.03	
C030206	261307	Whitman Creek	500 GD	0.03	
C039678	309905	Whitman Creek	500 GD	0.03	
C048065	329111	Whitman Creek	250 GD	0.01	
C059696	369485	Whitman Creek	500 GD	0.03	
C056813	107801	Tremayne Creek	500 GD	0.03	
F017746	223880	Tremayne Creek	500 GD	0.03	
C035283	285602	Sandy Creek	2,000 GD	0.11	
C047879	329395	Chef Creek	500 GD	0.03	
C047717	330754	Cooper Spring	2,000 GD	0.11	
C055730	200639	Wilfred Creek	500 GD	0.03	
F016551	200638	Wilfred Creek	500 GD	0.03	
F039580	236888	Wilfred Creek	500 GD	0.03	
C032243	270675	Wilfred Creek	1,500 GD	0.08	
F039210	270681	Wilfred Creek	500 GD	0.03	
F039211	270682	Wilfred Creek	500 GD	0.03	
F039373	270685	Wilfred Creek	500 GD	0.03	
F039374	270683	Wilfred Creek	500 GD	0.03	
C034305	281755	Cushing Creek	1,000 GD	0.05	
F012943	172596	Tweedie Creek	500 GD	0.03	
F012944	346189	Tweedie Creek	500 GD	0.03	
F014808	180787	Tweedie Creek	500 GD	0.03	
F014809	180787	Tweedie Creek	500 GD	0.03	
C072624	1000725	Remmel's Brook	1,000 GD	0.05	
C072625	1000747	Remmel's Brook	1,000 GD	0.05	
C072626	1000764	Remmel's Brook	1,000 GD	0.05	
C019534	182633	Casement Spring	1,000 GD	0.05	
F042995	222180	Emily Brook	500 GD	0.03	
		Sub-total	**26,250 GD**	**1.38**	**21.78**

LICENCE NUMBER	*FILE NUMBER*	*SOURCE*	*QUANTITY/ UNITS*	*LITRES/ SEC.*	*DEMAND (dam³/year)*
Industrial Purpose (Ponds)°°					
C058444	370055	Norene Spring	30.5 AF	4.84	
C072653	1000725	Remmel's Brook	2 AF	0.32	
		Sub-total	**32.5 AF**	**5.16**	**40.09**
Industrial Purpose (Watering)°°					
C058442	366411	Rudd Spring	2 AF	0.32	
		Sub-total	**2 AF**	**0.32**	**2.47**
Industrial Purpose (Processing)					
C035283	285602	Sandy Creek	1,000 GD	0.05	
F015229	181574	Cowie Creek	1,000 GD	0.05	
C056814	290265	Tarnowski Brook	500 GD	0.03	
		Sub-total	**2,500 GD**	**0.13**	**4.15**
Irrigation Purpose°°					
F013705	155579	Nash Creek	1.5 AF	0.24	
C063939	1000539	Wilfred Creek	2 AF	0.32	
C063203	273501	Bob Springs	5.3 AF	0.84	
C063204	370559	Bob Springs	10.8 AF	1.71	
C072624	1000725	Remmel's Brook	3 AF	0.48	
C045740	222518	McKay Spring	3.6 AF	0.57	
		Sub-total	**26.2 AF**	**4.16**	**32.32**
Storage Purpose°°					
C058443	366411	Rudd Spring	2 AF	-0.32	
C072624	1000725	Remmel's Brook	2 AF	-0.32	
C027747	245746	Hart Creek	160 AF	-25.38	
F018001	265330	Hart Creek	560 AF	-88.83	
		Sub-total	**724 AF**	**-114.85**	**893.05**
Land Improvement Purpose					
C048187	340023	Christie Brook	65 GD	0.003	
		Sub-total	**65 GD**	**0.003**	**0.11**
Conservation Purpose					
C034226	277761	Rosewall Creek	10 CS	283.22	
C101011	1001313	Steele Creek	0.11 CS	3.12	
		Sub-total	**10.11 CS**	**286.34**	**9,030.02**
Waterworks Purpose°					
C034268	281933	Nile Creek	100,000 GD	5.26	

LICENCE NUMBER	***FILE NUMBER***	***SOURCE***	***QUANTITY/ UNITS***	***LITRES/ SEC.***	***DEMAND (dam³/year)***
C061387	1000094	Nile Creek	50,000 GD	2.63	
C033059	270553	Wilfred Creek	100,000 GD	5.26	
C027746	245746	Hart Creek	500,000 GD	26.31	
F018000	265330	Hart Creek	2,000,000 GD	105.23	
		Sub-total	**2,750,000 GD**	**144.69**	**2,281.47**
			Total Demand	**327.33**	**12,305.46**

° Based on the assumption that the demand is the authorized maximum daily licenced divided divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand.

°° The rate (litres/sec.) is based on an estimated 90 day period demand assuming that storage, industrial and irrigation demands are totally withdrawn over the 90 day period.

APPENDIX E

Low Flow Licenced Water Demand by Drainage Area
(September 1994)

DRAINAGE / PURPOSE	*LICENCED QUANTITY*	*LOW FLOW WATER DEMAND°*	
		(litres/sec.)	*(dam³)*
Black Brook			
Domestic	1,500 GD (max day)	0.08	0.61
	Total Consumption	**0.08**	**0.61**
Nash Creek			
Domestic	4,000 GD (max day)	0.21	1.64
Industrial	30.5 AF	4.84	37.62
Irrigation	1.5 AF	0.24	1.85
	Total Consumption	**5.29**	**41.11**
Nile Creek			
Waterworks	150,000 GD (max day)	7.89	61.37
	Total Consumption	**7.89**	**61.37**
Whitman Creek			
Domestic	2,750 GD (max day)	0.14	1.13
	Total Consumption	**0.14**	**1.13**
Sandy Creek			
Domestic	2,000 GD (max day)	0.11	0.82
Industrial	1,000GD	0.05	0.41
	Total Consumption	**0.16**	**1.23**
Chef Creek			
Domestic	500 GD (max day)	0.03	0.2
	Total Consumption	**0.03**	**0.2**
Rosewall Creek			
Conservation	10 ft³/sec.	**Non - consumptive**	
Wilfred Creek			
Waterworks	100,000 GD (max day)	5.26	40.91
Domestic	5,000 GD (max day)	0.26	2.05
Irrigation	2 AF	0.32	2.47
	Total Consumption	**5.84**	**45.43**
Cowie Creek			
Industrial	1,000 GD	0.05	0.41
	Total Consumption	**0.05**	**0.41**
Hart Creek			
Waterworks	2,500,000 GD (max day)	131.54	1,022.83
Storage	720 AF	-114.21	-888.12
	Total Consumption	**17.33**	**134.71**
Other			
Domestic	10,500 GD (max day)	0.55	4.3
Industrial	4.7 AF	0.75	5.8
Irrigation	22.7 AF	3.6	28

DRAINAGE / PURPOSE	***LICENCED QUANTITY***	***LOW FLOW WATER DEMAND°***	
		(litres/sec.)	***(dam³)***
Storage	4 AF	-0.63	-4.93
	Total Consumption	**4.27**	**33.17**
Land Improvement	65 GD	**Non - consumptive**	
Conservation	0.11 cfs	**Non - consumptive**	

° Based on an estimated 90 day period demand assuming that: irrigation and industrial demands are totally withdrawn over the 90 day period; domestic and municipal waterworks demand is the authorized licenced maximum daily for 90 days; authorized storage balances demand and, therefore, is a negative demand over the 90 days; land improvement and conservation are non-consumptive and, therefore, have no demand.

APPENDIX F

Pending Water Licence Applications
(September 1994)

LICENCE NUMBER	*FILE NUMBER*	*SOURCE*	*QUANTITY (units)*	*LITRES/ SEC.*	*DEMAND (dam^3/year)*
Waterworks Purpose°					
Z100999	1001295	Nile Creek	150,000 GD	7.89	
		Sub-total	**150,000 GD**	**7.89**	**124.44**
Domestic Purpose°					
Z100917	1001022	Cook Creek	500 GD	0.03	
Z101653	1001394	Wilfred Creek	500 GD	0.03	
Z101012	1001327	Remmel's Brook	1,000 GD	0.05	
		Sub-total	**2,000 GD**	**0.11**	**1.65**
Irrigation Purpose°°					
Z104230	1001545	Black Brook	0.33 AF	0.05	
Z100917	1001022	Cook Creek	177 AF	28.08	
Z101012	1001327	Remmel's Brook	0.5 AF	0.08	
		Sub-total	**177.83 AF**	**28.21**	**219.36**
Industrial Purpose (Ponds)°°					
Z107366	1001738	Domey Creek	0.011 AF	0.002	
		Sub-total	**0.011 AF**	**0.002**	**0.01**
Industrial Purpose (Stock Watering)°					
Z100917	1001022	Cook Creek	4,000 GD	0.21	
		Sub-total	**4,000 GD**	**0.21**	**3.32**
Power Purpose°°°					
Z100990	1001204	Rosewall Creek	3.4 m^3/sec.	3400	
		Sub-total	**3.4 m^3/sec.**	**3400**	**107,222.40**
Conservation Purpose°°°					
Z100987	1001188	Wilfred Creek	10 $feet^3$/sec.	283.22	
		Sub-total	**10 $feet^3$/sec.**	**283.22**	**8,931.53**
			Total Demand	**3,719.64**	**116,502.71**

° Based on the assumption that the demand is the authorized maximum daily licenced divided divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand.

°° The rate (litres/sec.) is based on an estimated 90 day period demand assuming that the licenced quantities are totally withdrawn over the 90 day period.

°°° Non-consumptive demand.

APPENDIX G

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

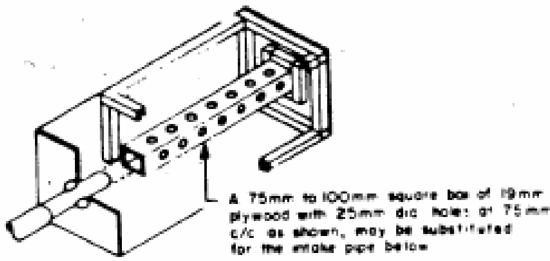
3. Senior Habitat Management Biologist
   North Coast Division
   Department of Fisheries and Oceans
   Room 109, 417 - 2nd Avenue West
   Prince Rupert, B.C. V6J 1G8 — Phone: 624-9385

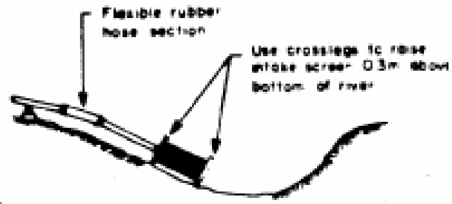
Other Federal and Provincial agencies having jurisdiction in water withdrawals and construction pertaining to watercourses in British Columbia include:

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.

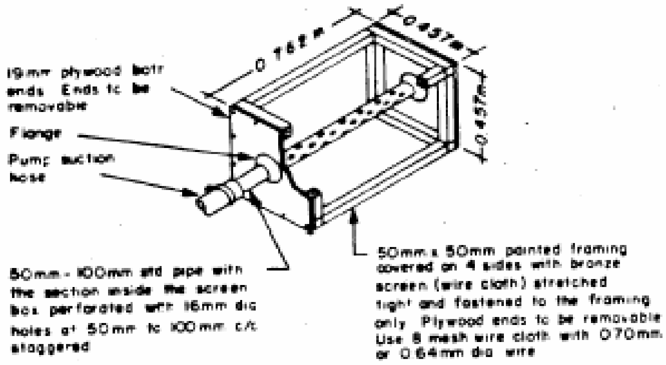
It may be necessary that several or all these agencies also be solicited for approvals prior to the installation of a water intake.

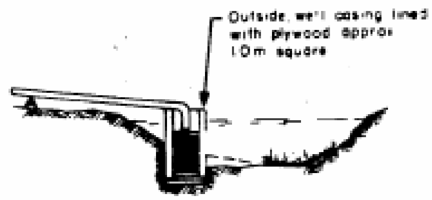
Revised January, 1986



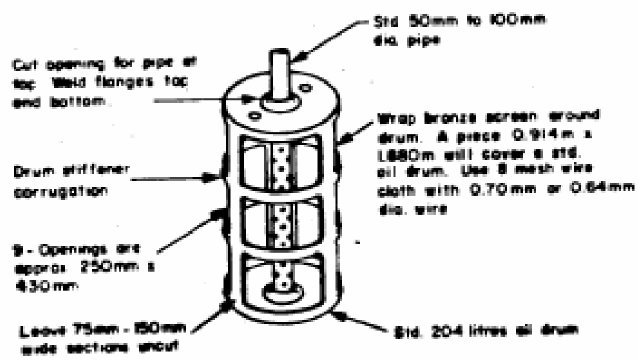


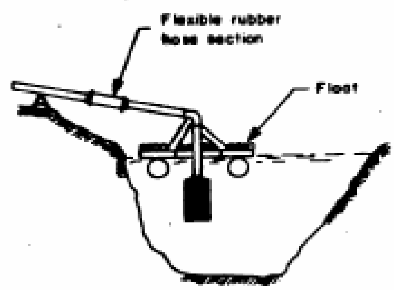
STANDARD INSTALLATION





INSTALLATION IN SHALLOW WATER
MUDDY OVERGROWN BOTTOM





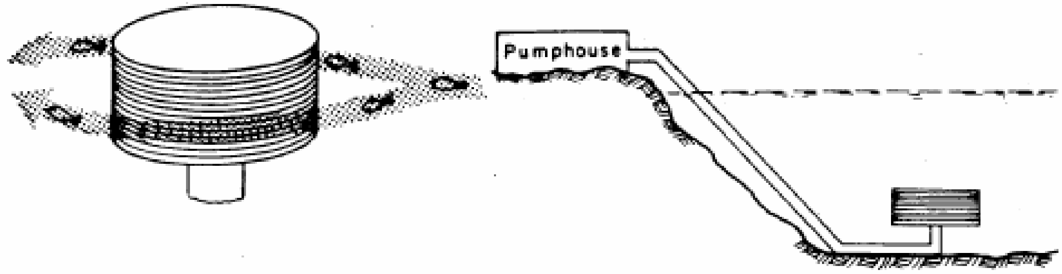
INSTALLATION IN DEEP WATER

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 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.

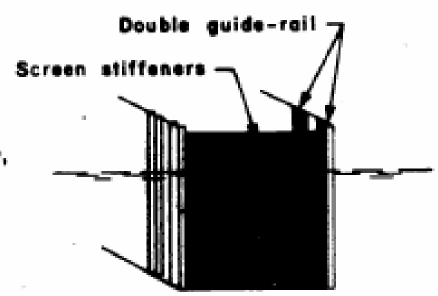
SHALLOW WATER WELL SCREEN

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).

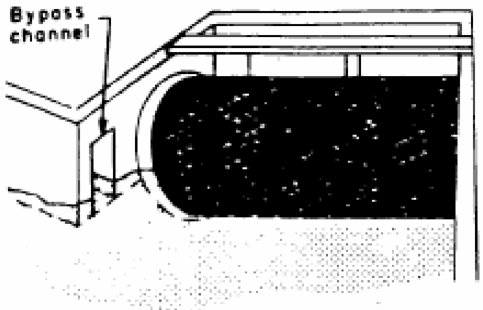
VERTICAL PANEL SCREENS

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.



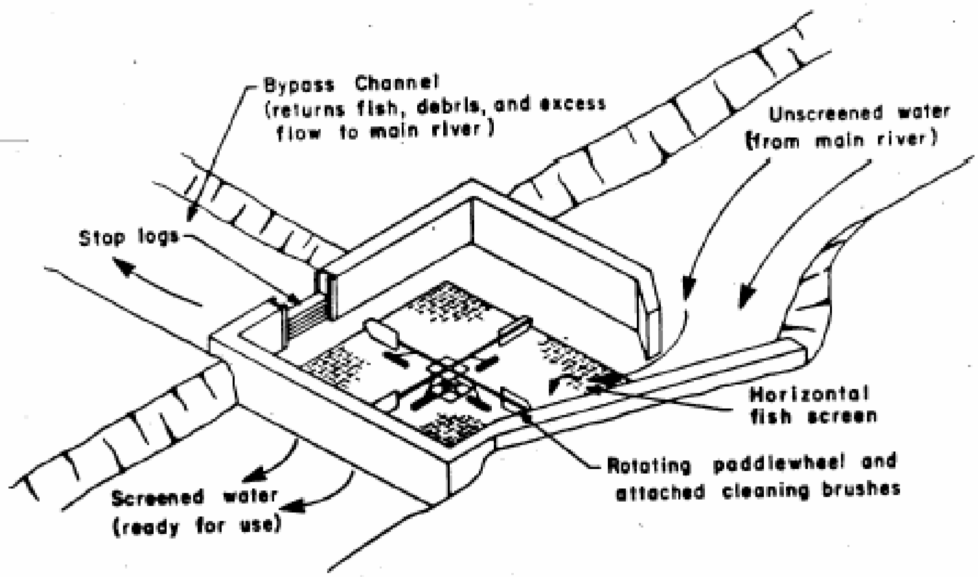
LARGE STATIONARY WATER INTAKE SCREENS

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



REVOLVING DRUM SCREEN, HORIZONTAL AXIS

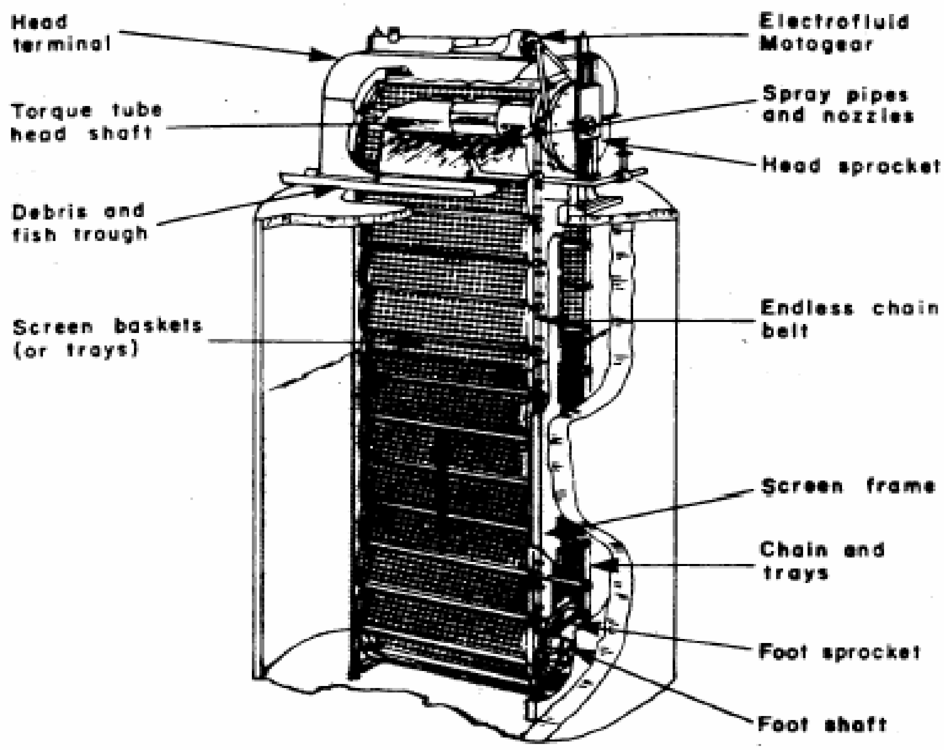
Generally, installed to divert fish from irrigation canals. Can be driven by a small motor or by a paddle wheel. To avoid juvenile fish impingement, a bypass channel is required near the front of the screen. Rubber seals are necessary along the base and sides.



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