LAMBLY (Bear) CREEK

ASSESSMENT OF ALTERNATIVES

TO

ENHANCE OKANAGAN LAKE FISHERY

- All measurements used in this report are in metric
- To convert m^3/s to cfs, multiply by 35.315
- To convert $dams^3$ to acre feet, multiply by 0.81

Prepared by:

DOBSON ENGINEERING
Kelowna, British Columbia

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LAMBLY (Bear) CREEK

1.0 INTRODUCTION

Lambly Creek is located on the west side of Okanagan Lake opposite the north end of Kelowna (see Figure 1). The watershed has a drainage area of approximately 272 km^2. There is an historic use of the creek for spawning and rearing of both rainbow trout and kokanee from Okanagan Lake. The intent of this report is to detail the opportunities that may exist to enhance either or both of the existing species through improvement of the water supply.

This report will identify the reach(es) of the stream that are accessible to the fish and the flows required to maintain spawning and rearing. Based on the required flows, for both trout and kokanee, the deficits will be determined using both the mean monthly and the one in 10-year low flows as indicators.

Once the deficits in flow have been determined, the available alternatives will be identified to supply the additional water needed to achieve the optimum flows. Included in the assessment will be the present licenced use of the stream, based on a survey of the water licences with regards to their level of use, and the projected full utilization of the existing water licences.

Finally, a recommendation will be made regarding the cost effectiveness of each flow enhancement option and the consequences of failing to provide these flows.

The complete Terms of Reference are contained in Appendix 1.

2.0 FISH REQUIREMENTS

Only the first 1.1 km of Lambly Creek are accessible to fish entering from Okanagan Lake. A waterfall occurs at this point forming an impassable barrier.

There has been considerable work done over the years to investigate the flows for both the kokanee and the rainbow trout. The suggestions for both kokanee and trout range from a low of 0.14 m^3/s to a high of 0.416 m^3/s. The most recent work was carried out by C.D. Tredger in 1987 and 1988. In his work Tredger visited the creek on four occasions and measured both the flow and the available habitat. Based on this work and with the additional local expertise available from the Fisheries staff of the Ministry of Environment in Penticton, the flow requirements were set as follows:

KOKANEE:	• Migrating and Spawning Flows (September and October)	0.202 m^3/s
	• Incubation Flows (November to March)	
	OPTION 1: 50% of spawning flow	0.101 m^3/s
	OPTION 2: 75% of spawning flow	0.151 m^3/s
TROUT:	• Flow (all year)	0.202 m^3/s

These flows will form the basis for the computations in a later section that will determine whether or not there is adequate water available in the stream under varying conditions to support fish.

Tredger found that kokanee spawning habitat was limited at all flows due to the high gradient and large substrate nature of Lambly Creek. Improvements to the substrate are not practicable because of high peak flows. He found that although the spawning habitat increases with higher flows, there is a diminishing rate of increase above the capacity of 3 730 kokanee spawners at 0.202 m^3/s, to only 3 898 spawners at 0.393 m^3/s. Tredger's measurements of stream width, depth and velocity indicate that reductions in flow during the incubation period of up to 50% of the spawning flow (Q_s) would decrease the depth of the stream without substantially decreasing the width, thereby having minimal effect on incubation.

For the trout it was Tredger's opinion that this fishery was limited by the amount of parr rearing habitat. Although this habitat was found to increase with higher flows, the increase was more gradual above 0.202 m^3/s. The estimated capacity of 484 at 0.202 m^3/s increased only to 574 parr at 0.393 m^3/s.

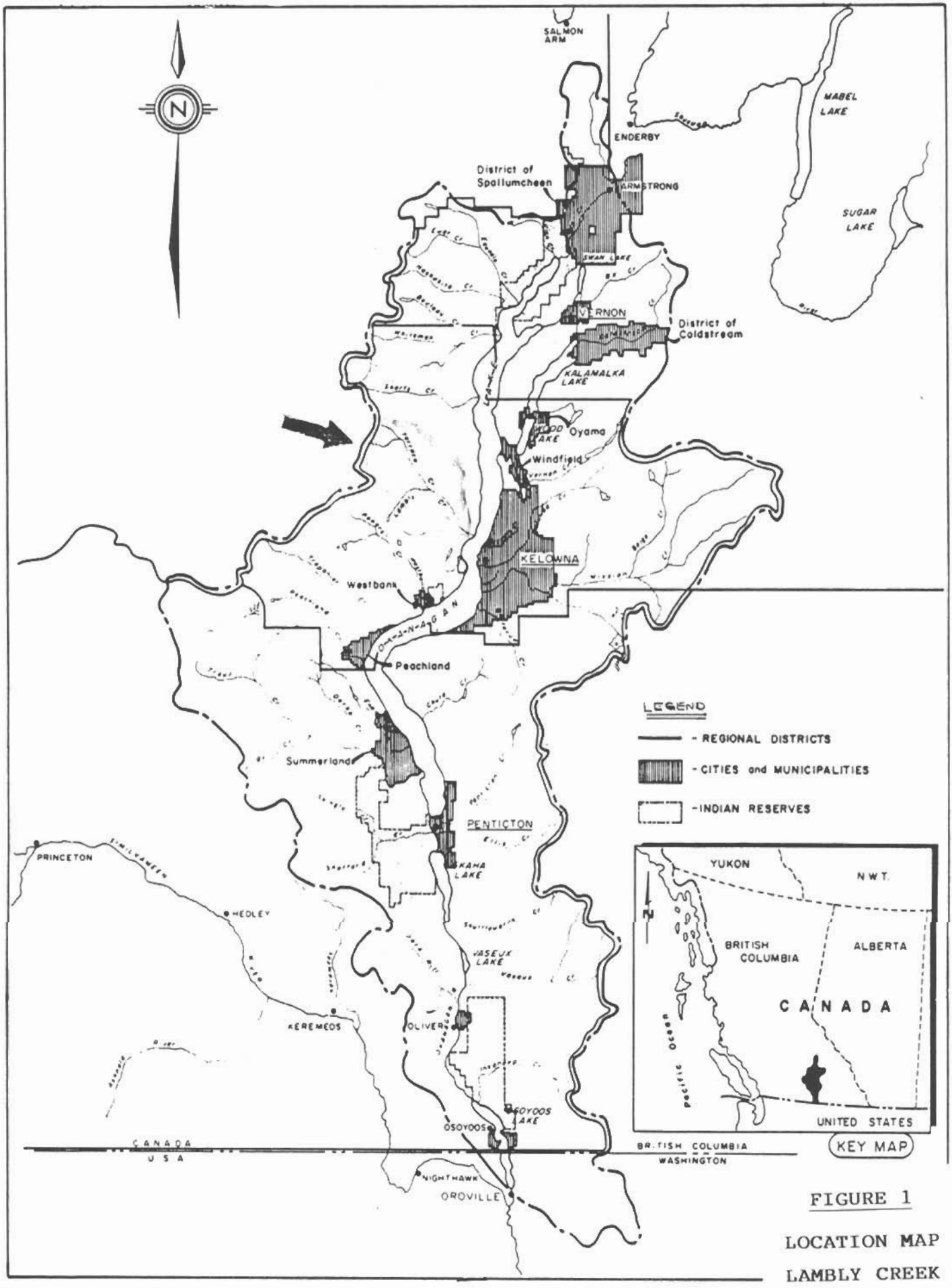

FIGURE 1

LOCATION MAP

LAMBLY CREEK

3.0 HISTORICAL STREAMFLOW RECORDS

Hydrometric data on Lambly Creek has been collected since 1919. Gauging stations operated by the Water Survey of Canada were established at five different locations. The period of record and the type of data collected is summarized in Table 1. The locations of the stations are shown on the map in the back pocket of this report [see Figure 2].

The portion of Lambly Creek watershed above Lambly Lake has been largely diverted to Powers Creek watershed since 1952 and entirely diverted since 1969. This area (23 km^2) is now considered to be part of the Powers Creek watershed. Similarly, the recently completed Tadpole Lake Reservoir will be filled by diverting runoff from a 6.2 km^2 portion of North Lambly Creek watershed, but only during the period April 1st to June 15th. The estimated diversion amounts to some 3.6% of the total Lambly Creek runoff for this freshet period, resulting in no significant reduction of flow.

TABLE 1

SUMMARY OF HYDROMETRIC DATA FOR LAMBLY (Bear) CREEK

Station	Drainage Area (km^2)	Records (All Regulated)
08NM165 Lambly Creek above Terrace Creek	76.1 km^2	1970-Present: Recorder, continuous operation
08NM166 Lambly Creek below Bald Range Creek (above Lakeview Irrigation District Intake)	228.7 km^2	1970 - 1982: Recorder, continuous operation
08NM141 Lambly Creek below Terrace Creek	235.2 km^2	1967 - 1971: Manual, seasonal
08NM058 Lambly Creek near Kelowna	246.0 km^2	1924: Manual, seasonal 1925: Manual, partial 1927: Manual, seasonal
08NM003 Lambly Creek near the mouth	272.0 km^2	1919: Manual, partial 1920 - 1921: Manual, seasonal 1965 - 1966: Manual, seasonal 1969: Recorder, partial 1970 - 1974: Recorder, continuous 1975: Recorder, partial

Lambly Creek flow has been regulated through manipulation of storage since the earliest records were collected. The data from all five hydrometric stations was reviewed and it was decided to use station number 08NM166, "Lambly Creek below Bald Range Creek" as the data base for the following reasons:

(1) The location is above the Lakeview Irrigation District intake.

(2) There has been continuous operation with a recorder for a thirteen year period which included several drought and high runoff years as well as more normal flows. These records indicate mean annual discharge of 46 900 $dams^3$ at a mean annual flow of 1.49 m^3/s. The lowest recorded annual discharge was 20,000 $dams^3$ (1977) while the lowest monthly mean flow was January at 0.220 m^3/s. The minimum recorded daily flow was 0.093 m^3/s on September 13, 1973 and again on August 19, 1977.

4.0 WATER LICENCE REQUIREMENTS

A complete list of the existing water licences is included with this report as Appendix 2. Westbank Irrigation District licences on Lambly Creek above Lambly Lake have been omitted because that portion of the watershed has been fully diverted to Powers Creek since 1969. Similarly the Westbank Irrigation District North Lambly Creek diversion and Tadpole Lake storage licences have been excluded from this report and included in the Powers Creek report. Lambly Creek is considered "fully recorded". This means

that no additional diversion licences will be issued unless supplementary storage licences are included, except for individual domestic use. Actual use during low flow periods would be dependent upon releases from developed storage.

There are eighteen water licences issued in the Lambly Creek watershed, mostly held or supplied by Lakeview Irrigation District. These licences permit the use of 3 277 dams^3 per year for waterworks use (domestic, industrial, etc.); 4 650 dams^3 per year for irrigation use, supplemented by 7 771 dams^3 of storage. In the fall of 1989 a field survey of the non-district licences determined that they had been in full use. Lakeview Irrigation District flow records were obtained, which indicated that their maximum annual consumption had occurred in 1987. Of the above authorized volumes, about 50% of the waterworks use and 57.5% of the irrigation use has been developed, while 68% of the authorized storage is in place.

A summary of the licences is detailed in Table 2.

It should be noted that Lakeview Irrigation District's entire distribution system originates from Rose Valley Reservoir, which is downstream from Lambly Creek. Although the reservoir is normally filled in the spring, the licences permit diversion from the creek all year. The District is also committed to convey irrigation water for the individual licensees between Lambly Creek and the reservoir.

The review of the licences carried out in late 1989 indicated that there was 3 601 dams^3 of undeveloped storage. The details are presented in Table 3.

TABLE 2

LAMBLY (Bear) CREEK WATER LICENCES

Purpose	Licenced Use	Present Developed Use
1. WATERWORKS (Dom./Ind./Etc.)		
~ m^3 / year	3 277 163.0	1 651 026.0
~ average m^3 / day	8 979.0	4 523.0
~ equivalent m^3/s	0.104	0.052
~ winter m^3 / day	4 370.0	2 201.0
~ equivalent m^3/s	0.051	0.025
~ peak day use m^3	26 937.0	13 569.0
~ equivalent m^3/s	0.312	0.157
2. IRRIGATION		
~ $dams^3$ / year	4 650.0	2 675.0
~ peak day use m^3/s	0.539	0.310
3. DIVERSION TOTAL		
~ $dams^3$ / year	7 927.0	4 326.0
~ peak day use m^3/s	0.851	0.467
4. STORAGE		
~ $dams^3$ / year	7 771.0	5 304.0
~ 100 days release m^3/s	0.901	0.615

TABLE 3

UNUSED LICENCED DIVERSION AND STORAGE

* * *

All unused water licences in the Lambly Creek watershed are held by the Lakeview Irrigation District and are assumed to be fully utilized over the long term (ie: within twenty years).

* * *

5.0 FLOW AVAILABILITY

Based on the flows for fish as set out in section 2.0 and the criteria set out in the Terms of Reference, there will be four flow scenarios examined. The short term situation is considered to be for the current utilization of the water licences. The long term scenario would be at full utilization of the water licences. In addition to mean monthly flows, both the scenarios will be examined under 10-year low flow conditions, which have an 88% probability of occurring at least once in any twenty year period.

Mean monthly flows are based on the historical hydrometric data from the Water Survey of Canada gauging station "Lambly Creek below Bald Range Creek" (station number 08NM166). The data is summarized in Appendix 3. One in 10-year low flows are estimated, based on the work by B. Letvak. Hydrographs for the two flows are shown in Figure 3.

FLOW SCENARIOS

1. Mean Monthly Flows (current utilization)	3. Mean Monthly Flows (full utilization)
2. 1 in 10-Year Low Flow (current utilization)	4. 1 in 10-Year Low Flow (full utilization)

Tables 4 through 7 present the flows and deficits for each of the scenarios described above for Kokanee. The impact of each case will be examined in section 5.1. Tables 8 through 11 present the flows and deficits for the same scenarios for rainbow trout. The results are discussed in section 5.2.

Lambly Creek
Hydrograph

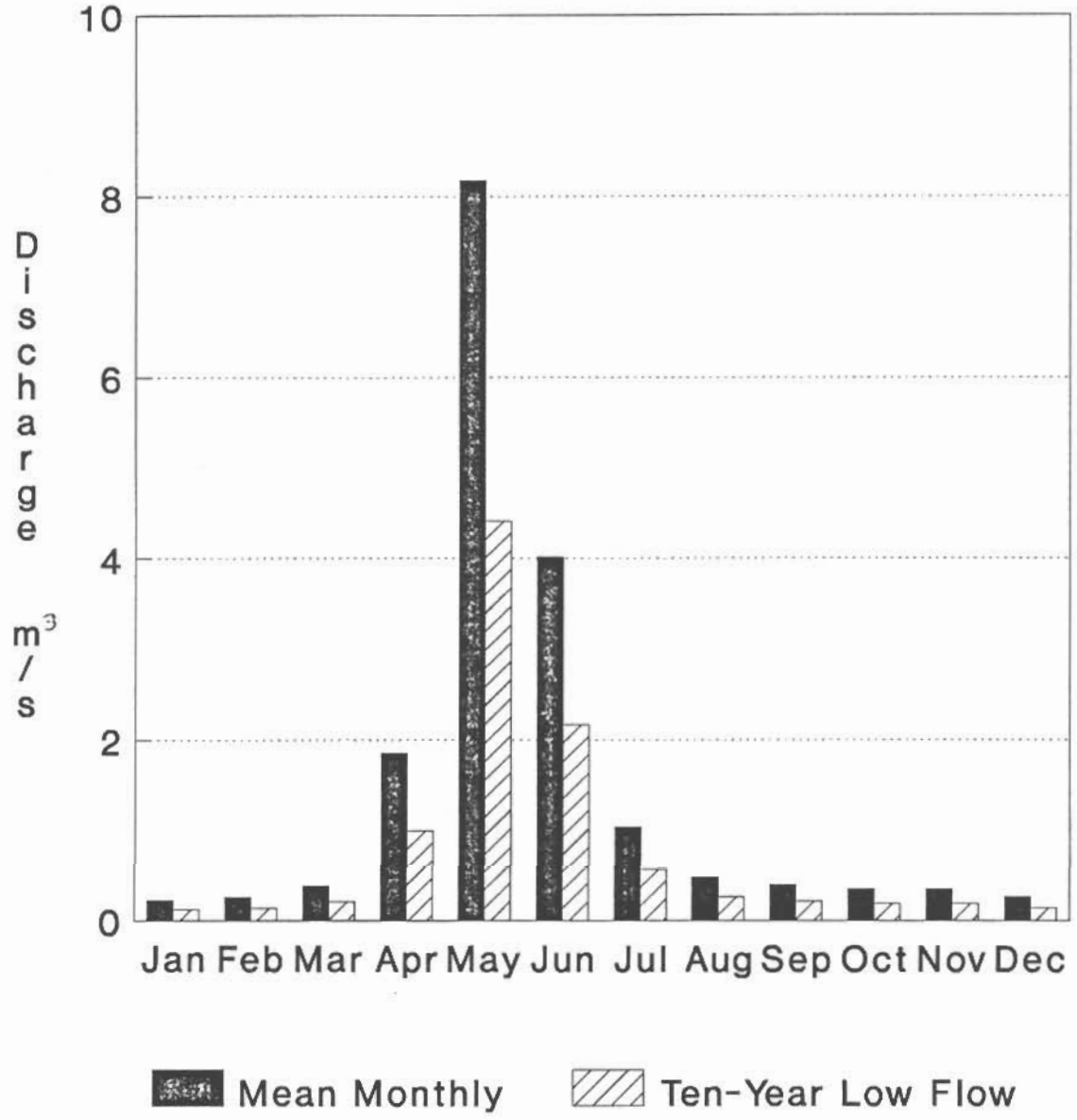

Figure 3

5.1 KOKANEE

5.1.1 Mean Monthly Flow at Current Utilization

There are no flow deficits for the kokanee at mean monthly flows based on the current use [refer to Table 4]. Field investigations at a discharge of 0.202 m^3/s (ie: migration and spawning flow) were carried out by Tredger on July 9, 1987.

5.1.2 One in Ten-Year Low Flow at Current Utilization

In the event of a one in ten-year low flow there are significant deficits in both September (64%) and October (21%) as well as in January (7% @ 50% Q_s) [refer to Table 5]. The low flows in September will have a serious impact on the migration of kokanee into the creek. The deficit in October will further reduce the available spawning habitat which is already limited. In January a flow deficit may place the redds at risk of being frozen.

5.1.3 Mean Monthly Flow at Full Utilization

Full utilization of the water licences will result in a deficit in September [refer to Table 6]. Low flow during this time will hamper the migration of the kokanee.

5.1.4 One in Ten-Year Low Flow at Full Utilization

This scenario creates the worst situation for the kokanee. There are deficits in September, October, December, January and February [refer to Table 7]. In September 100% of the flow would be diverted.

At an incubation flow of 50% of the spawning flow (Q_s) the accumulated deficit totals would be 864 dams^3. For an incubation flow of 75% (Q_s) the total deficit would be 1 296 dams^3.

The total diversion in September would either delay the run until there was some flow in the stream or eliminate it completely. The redds of any migrants that did enter the stream in October would be compromised by the low flows in the December through February period.

5.2 TROUT

5.2.1 Mean Monthly Flow at Current Utilization

Since trout require higher flows than kokanee, they are impacted even at mean monthly flows at current levels of diversion in both August (47%) and January (3%) [refer to Table 8]. The January deficit is probably not significant but a 47% deficit in August combined with high water temperatures may be fatal.

5.2.2 One in Ten-Year Low Flow at Current Utilization

During a ten-year low flow event, eight out of the twelve months are in deficit [refer to Table 9]. The size of the deficit ranges from 100% in August to 12% in March. The accumulated shortfall is 1 887 dams^3 which is nearly 25% of the total licenced storage in the watershed.

The probability of occurrence of the ten-year low flow is once in a twenty year period. Based on the size of the deficit and the low risk of this scenario, the cost of supplementing the flows may exceed any benefit derived.

5.2.3 Mean Monthly Flow at Full Utilization

When the water licences are fully developed the trout will be impacted in August, September, January and February [refer to Table 10]. In August 100% of the flow would be diverted which would effectively eliminate the parr population. The short falls for the remaining months would also affect the parr though not to the same extent. The supplementary volume required is 788 dams^3.

5.2.4 One in Ten-Year Low Flow at Full Utilization

This scenario would be devastating for the trout [refer to Table 11]. At full utilization of the water licences there are deficits for nine of the twelve months with July, August and September

being 100%. The least deficit would be March at 25%, excluding the freshet period of April through June. The supplementary volume required would be 3 002 dams^3 or nearly 40% of the total licenced storage in the watershed. As stated in section 5.2.2, the ten-year low flow event has a relatively low risk of occurrence (once in a twenty year period) and therefore requires careful consideration regarding the benefits of trying to protect against.

6.0 FLOW ENHANCEMENT ALTERNATIVES

The opportunities to enhance flows in Lambly Creek for kokanee and rainbow trout are:

6.1 Petition the Lieutenant Governor in Council to establish a Crown Reserve on any unrecorded water in Lambly Creek under Section 44 of the *Water Act*. The benefit of this action would be that the water under any cancelled or abandoned licences becomes "unrecorded water" and any reallocation is subject to review by the Fisheries Program.

6.2 Participate in the development of upstream storage at Terrace Meadows through agreement with Lakeview Irrigation District.

TABLE 4

KOKANEE

MEAN MONTHLY FLOW AT CURRENT UTILIZATION

Month	Discharge (m^3/s)	Current Utilization (m^3/s)	Q_k 50% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Q_k 75% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %
January	0.220	0.025	0.101	0	0	0	0.151	0	0	0
February	0.248	0.025	0.101	0	0	0	0.151	0	0	0
March	0.375	0.025	0.101	0	0	0	0.151	0	0	0
April	1.850	0.069	0.101	0	0	0	0.151	0	0	0
May	8.170	0.203	0.101	0	0	0	0.151	0	0	0
June	4.010	0.327	0	0	0	0	0	0	0	0
July	1.040	0.358	0	0	0	0	0	0	0	0
August	0.476	0.369	0	0	0	0	0	0	0	0
September	0.394	0.141	0.202	0	0	0	0.202	0	0	0
October	0.342	0.025	0.202	0	0	0	0.202	0	0	0
November	0.343	0.025	0.101	0	0	0	0.151	0	0	0
December	0.260	0.025	0.101	0	0	0	0.151	0	0	0
				Total	0			Total	0	

NOTE: Q_s = Spawning Flow
Q_k = Incubation Flow for Kokanee based on Q_s

TABLE 5

KOKANEE

ONE IN 10-YEAR LOW FLOW AT CURRENT UTILIZATION

Month	Discharge (m^3/s)	Current Utilization (m^3/s)	Q_k 50% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Q_k 75% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %
January	0.119	0.025	0.101	0.007	18	7	0.151	0.057	148	38
February	0.134	0.025	0.101	0	0	0	0.151	0.042	109	28
March	0.203	0.025	0.101	0	0	0	0.151	0	0	0
April	0.999	0.069	0.101	0	0	0	0.151	0	0	0
May	4.412	0.203	0.101	0	0	0	0.151	0	0	0
June	2.165	0.327	0	0	0	0	0	0	0	0
July	0.562	0.358	0	0	0	0	0	0	0	0
August	0.257	0.369	0	0	0	0	0	0	0	0
September	0.213	0.141	0.202	0.130	335	64	0.202	0.13	337	64
October	0.185	0.025	0.202	0.042	109	21	0.202	0.042	109	21
November	0.185	0.025	0.101	0	0	0	0.151	0	0	0
December	0.140	0.025	0.101	0	0	0	0.151	0.036	93	24
				Total	462			Total	796	

NOTE: Q_s = Spawning Flow
Q_k = Incubation Flow for Kokanee based on Q_s

TABLE 6

KOKANEE

MEAN MONTHLY FLOW AT FULL UTILIZATION

Month	Discharge (m^3/s)	Full Utilization (m^3/s)	Q_k 50% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Q_k 75% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %
January	0.220	0.051	0.101	0	0	0	0.151	0	0	0
February	0.248	0.051	0.101	0	0	0	0.151	0	0	0
March	0.375	0.051	0.101	0	0	0	0.151	0	0	0
April	1.850	0.131	0.101	0	0	0	0.151	0	0	0
May	8.170	0.383	0.101	0	0	0	0.151	0	0	0
June	4.010	0.599	0	0	0	0	0	0	0	0
July	1.040	0.652	0	0	0	0	0	0	0	0
August	0.476	0.67	0	0	0	0	0	0	0	0
September	0.394	0.256	0.202	0.064	166	32	0.202	0.064	166	32
October	0.342	0.051	0.202	0	0	0	0.202	0	0	0
November	0.343	0.051	0.101	0	0	0	0.151	0	0	0
December	0.260	0.051	0.101	0	0	0	0.151	0	0	0
				Total	166			Total	166	

NOTE: Q_s = Spawning Flow
Q_k = Incubation Flow for Kokanee based on Q_s

TABLE 7

KOKANEE

ONE IN 10-YEAR LOW FLOW AT FULL UTILIZATION

Month	Discharge (m^3/s)	Full Utilization (m^3/s)	Q_k 50% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Q_k 75% Q_s (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %
January	0.119	0.051	0.101	0.033	86	33	0.151	0.083	215	55
February	0.134	0.051	0.101	0.018	47	18	0.151	0.068	176	45
March	0.203	0.051	0.101	0	0	0	0.151	0	0	0
April	0.999	0.131	0.101	0	0	0	0.151	0	0	0
May	4.412	0.383	0.101	0	0	0	0.151	0	0	0
June	2.165	0.599	0	0	0	0	0	0	0	0
July	0.562	0.652	0	0	0	0	0	0	0	0
August	0.257	0.67	0	0	0	0	0	0	0	0
September	0.213	0.256	0.202	0.202	524	100	0.202	0.202	524	100
October	0.185	0.051	0.202	0.068	176	34	0.202	0.068	176	34
November	0.185	0.051	0.101	0	0	0	0.151	0.017	44	11
December	0.140	0.051	0.101	0.012	31	12	0.151	0.062	161	41
				Total	864			Total	1,296	

NOTE: Q_s = Spawning Flow
Q_k = Incubation Flow for Kokanee based on Q_s

TABLE 8

TROUT - MEAN MONTHLY FLOW AT CURRENT UTILIZATION

Month	Discharge (m^3/s)	Current Utilization (m^3/s)	Trout (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %
January	0.22	0.025	0.202	0.007	18	3
February	0.248	0.025	0.202	0	0	0
March	0.375	0.025	0.202	0	0	0
April	1.85	0.069	0.202	0	0	0
May	8.17	0.203	0.202	0	0	0
June	4.01	0.327	0.202	0	0	0
July	1.04	0.358	0.202	0	0	0
August	0.476	0.369	0.202	0.095	246	47
September	0.394	0.141	0.202	0	0	0
October	0.342	0.025	0.202	0	0	0
November	0.343	0.025	0.202	0	0	0
December	0.26	0.025	0.202	0	0	0
				Total	246	

TABLE 9

TROUT - ONE IN 10-YEAR LOW FLOW AT CURRENT UTILIZATION

Month	Discharge (m^3/s)	Current Utilization (m^3/s)	Trout (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Stor (m^3/s)	Stor ($dams^3$)
January	0.119	0.025	0.202	0.108	280	53	0	0
February	0.134	0.025	0.202	0.093	241	46	0	0
March	0.203	0.025	0.202	0.024	62	12	0	0
April	0.999	0.069	0.202	0	0	0	0	0
May	4.412	0.203	0.202	0	0	0	0	0
June	2.165	0.327	0.202	0	0	0	0	0
July	0.562	0.358	0.202	0	0	0	0	0
August	0.257	0.369	0.202	0.202	524	100	112	290
September	0.213	0.141	0.202	0.13	337	64	0	0
October	0.185	0.025	0.202	0.042	10	21	0	0
November	0.185	0.025	0.202	0.042	109	21	0	0
December	0.14	0.025	0.202	0.087	225	43	0	0
				Total	1,887		Total	290

NOTE: Storage Release in August is from Esperon Lake

TABLE 10

TROUT - MEAN MONTHLY FLOW AT FULL UTILIZATION

Month	Discharge (m^3/s)	Full Utilization (m^3/s)	Trout (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Stor (m^3/s)	Stor ($dams^3$)
January	0.22	0.051	0.202	0.033	85	16	0	0
February	0.248	0.051	0.202	0.005	13	2	0	0
March	0.375	0.051	0.202	0	0	0	0	0
April	1.85	0.131	0.202	0	0	0	0	0
May	8.17	0.383	0.202	0	0	0	0	0
June	4.01	0.599	0.202	0	0	0	0	0
July	1.04	0.652	0.202	0	0	0	0	0
August	0.476	0.670	0.202	0.202	524	100	0.194	520
September	0.394	0.256	0.202	0.064	166	32	0	0
October	0.342	0.051	0.202	0	0	0	0	0
November	0.343	0.051	0.202	0	0	0	0	0
December	0.26	0.051	0.202	0	0	0	0	0
				Total	788		Total	520

TABLE 11

TROUT - ONE IN 10-YEAR LOW FLOW AT FULL UTILIZATION

Month	Discharge (m^3/s)	Full Utilization (m^3/s)	Trout (m^3/s)	Deficit (m^3/s)	Deficit ($dams^3$)	Deficit %	Stor (m^3/s)	Stor ($dams^3$)
January	0.119	0.051	0.202	0.134	347	66	0	0
February	0.134	0.051	0.202	0.119	308	60	0	0
March	0.203	0.051	0.202	0.05	130	25	0	0
April	0.999	0.131	0.202	0	0	0	0	0
May	4.412	0.383	0.202	0	0	0	0	0
June	2.165	0.599	0.202	0	0	0	0	0
July	0.562	0.652	0.202	0.202	524	100	0.090	241
August	0.257	0.670	0.202	0.202	524	100	0.413	1,106
September	0.213	0.256	0.202	0.202	524	100	0.043	111
October	0.185	0.051	0.202	0.068	176	34	0	0
November	0.185	0.051	0.202	0.068	176	34	0	0
December	0.14	0.051	0.202	0.113	293	56	0	0
				Total	3,002		Total	1,458

6.3 Develop a groundwater well near the mouth of the creek to supply the supplementary flows required.

6.4 Make application to Water Management and develop a water licence to pump the required water from Okanagan Lake.

6.5 Negotiate an agreement with Lakeview Irrigation District for the release of natural flows past the District's intake at specific times to enhance the downstream fishery. Lakeview Irrigation District would divert only that water required to meet the other licenced needs between the intake and Rose Valley Reservoir. The District's requirements would be met through the use of storage in Rose Valley Reservoir.

7.0 ASSESSMENT OF ALTERNATIVES

There have been five options presented in Section 5 to improve the flows in the lower reach of Lambly Creek. The assessment and ranking of these alternatives in order of feasibility and cost effectiveness is as follows:

7.1 The first priority should be to secure a Crown Reserve on Lambly Creek under Section 44 of the *Water Act.* A reserve on any unrecorded water will provide protection against any future water licence applications.

7.2 An agreement with Lakeview Irrigation District for the release of natural flows would be of significant benefit to the Fishery Program at no cost. During normal runoff years there is adequate volume for the District to utilize the storage in Rose Valley Reservoir and to avoid diverting from the creek except to meet the other licence requirements in the late summer when the flows are normally low. This was confirmed in a review of the Lambly Creek water supply carried out by Bruce Letvak (Hydrology Section - Victoria) in October of 1989.

7.3 Eventually Lakeview Irrigation District will develop the storage under their licence for Terrace Meadows. It may be possible for the Fisheries Program to participate in this project and to gain access to additional water. Although there are no figures available at this time on the cost, the storage potential for this site is 2 467 dams^3. It would be prudent to initiate discussions with Lakeview Irrigation District and to work out the details on this venture. The District may require all the storage when they reach full utilization and there is below normal supply. However this may be a rare event and still justify making an investment in storage.

7.4 The development of a pumping facility on Okanagan Lake is an alternative to supply the necessary water to the spawning grounds. Both the capital and operating cost for such a facility would be high.

7.5 Groundwater is an alternate source of water but there are significant risks associated with its development as well as high costs. This alternative is the least attractive of all those discussed.

8.0 OPTIONS TO SATISFY SHORT TERM FLOW REQUIREMENTS

8.1 KOKANEE

For the short term, that is, at the current level of utilization, there is sufficient flow to meet the requirements for the kokanee at mean monthly flows [refer to Table 4]. During a one in ten-year low flow event supplementary flows would be required in September and October and possibly in January [refer to Table 5]. The additional flows could be supplied through cooperation with Lakeview Irrigation District and the release of water past their intake for this period. An arrangement of this nature already exists between the Fisheries Program and Lakeview Irrigation District. If a simple method was developed of determining when a flow of 0.202 m^3/s or 0.101 m^3/s was passing the intake, it would greatly assist the District.

Depending upon the flow in the stream, it should be possible for the District to pass sufficient water for migration and spawning as well as incubation flows of either 50% or 75% of the spawning flow even during the ten-year low flow event.

8.2 TROUT

For the mean monthly flow scenario, the deficit for trout occurs in August [refer to Table 8]. The required flow may be available through agreement with Lakeview Irrigation District in a similar manner to that for the kokanee as detailed in Section 8.1. August is a high demand period for irrigation water also, therefore availability will depend upon the storage level in Rose Valley Reservoir and the flow in Lambly Creek at the time. At the present level of utilization this flow should be available.

The ten-year low flow event results in significant flow deficits for the trout [refer to Table 9]. In a situation where it is evident that there are below normal flows the irrigation district will have first priority on the water. It is unlikely that there will be any releases by the District beyond those in accordance with their licences. In August they would be releasing from Esperon Lake to meet their own needs [refer to Table 9].

The probability of this event occurring is only once in a twenty year period and does not justify the expense of protecting against it.

9.0 OPTIONS TO SATISFY THE LONG TERM FLOW REQUIREMENTS

9.1 KOKANEE

If the conclusions made in the Letvak study of the Lakeview Irrigation District water supply (October, 1989) are correct, then there should be adequate water to meet the flows for the kokanee even at full utilization of their licences during normal years (ie: at mean monthly flows). The deficit in September [refer to Table 6] occurs at a time when the irrigation demand is decreasing. Therefore it should be possible for the District to curtail their diversion from the creek and use their storage in the Rose Valley Reservoir. In this case the requirements for the incubation flows whether 50% Q_s or 75% Q_s are already satisfied.

A one in ten-year low flow event results in significantly greater deficits [refer to Table 7]. The complications associated with low flows as discussed in Section 8.2 are further exacerbated at full utilization. Expenditure to develop supplementary flows for this case are not warranted. Tredger determined from field work carried out in 1987 and 1988 in Lambly Creek that there is limited suitable substrate for kokanee due to the high gradient. He estimated the capacity of the stream to be 3 700 fish at a flow of 0.202 m^3/s.

9.2 TROUT

Trout will be impacted at full utilization at both mean monthly flows [refer to Table 10] and the one in ten-year low flow [refer to Table 11]. As discussed in the previous section, 9.1, it should be possible to secure the flows for September (0.064 m^3/s). For August however, the demand for irrigation is high and the District may already be releasing 0.194 m^3/s from Esperon Lake to meet their own needs. It would be at this point in time (ie: at full utilization) that the Terrace Meadows reservoir may be considered for construction. If this project was completed and the Fisheries Program had participated with Lakeview Irrigation District then there should be water available to meet not only the deficit in August but also in January and February if necessary.

For the one in ten-year low flow scenario the demands for diversion and for the trout exceed the capacity of the system including the Terrace Meadows reservoir [refer to Table 11]. The combined water required to meet all the deficits is 4 460 $dams^3$. Terrace Meadows storage is only 2 467 $dams^3$. Because of the unknowns during a period of low flow, the District will want to conserve as much water as possible in case there are supply problems in the following year also.

Tredger estimated the capacity for trout to be 485 fish at a flow of 0.202 m^3/s. The cost to develop additional water is not warranted for an event that might occur once in a twenty year period.

10.0 IMPACT IF NOTHING DONE

If the decision is to leave the status quo and do nothing, the situation for fish in Lambly Creek will deteriorate as more water is diverted from the stream. At current utilization of licences, the kokanee would not be affected during mean monthly flows; however, in the event of a one in ten-year low flow, kokanee would be impacted significantly due to deficits in flow during September (64%) and October (21%) which affect both the migration and spawning. Incubation flows of 50% Q_s would be present except for an 7% deficit in January [refer to Table 5].

The trout, at current utilization and mean monthly flows, would be impacted by severe flow deficit in August 47%) and a slight deficit in January (3%). However, a one in ten-year low flow event would destroy the fishery, even at current utilization. The deficits would range from 100% in August through to March, when the deficit would ease to 12% [refer to Table 9]. With the flows impacted this severely for all the year outside of the freshet, not only would the redds for that year be destroyed, but so would the fry and the parr. The impact of a single year such as this expands to affect more than just the production for that one year since the parr reside in the stream for up to two years.

The situation will become worse as utilization of Lakeview Irrigation District licences increases. Although Lakeview Irrigation District do not fully utilize the available storage in Rose Valley Reservoir, the rapid and accelerating rate of growth in the Central Okanagan gives every reason to believe that

within the next ten to fifteen years, Lakeview will be using all the water available under their licences.

Under full utilization and mean monthly flows, the kokanee would experience a 32% flow deficit in September. During a one in ten-year low flow event, the kokanee fishery for that year would be virtually destroyed by spawning deficits during September (100%) and October (34%) followed by incubation period deficits of 50% Q_s in December through February, ranging from 12% to 30% [refer to Table 7].

For the trout, if any had survived the full utilization at mean monthly flow scenario, a one in ten-year low flow event would be disastrous. Major deficits would occur in all but the freshet months, ranging from 100% during July to September to a low of 25% in March [refer to Table 11].

In order to maintain a perspective of the impact if no action is taken on Lambly Creek, it is necessary to understand the priority of the stream, first in relation to its capacity to produce fish and second, in relation to other streams around Okanagan Lake. The work by Tredger has been referred to earlier in this report. His assessment of the system is that it is not a high quality kokanee spawning stream and there is insufficient data to assess its value for trout. Wightman and Taylor in their ranking of tributaries to Okanagan Lake, place Lambly Creek as number sixteen out of twenty three. It would appear that there are other streams where resources could be better placed than in Lambly Creek.

11.0 **WATER CONSERVATION**

Water conservation practices by water users can have a significant impact on the volume of water used for both domestic uses and agricultural uses. It was observed in 1988, when there was a risk of inadequate water supplies in a number of areas in the valley, that as a result of the careful use of water there may have been as much as a 20% reduction in demand [pers. comm. SEKID]. A study was commissioned by the Association of British Columbia Irrigation Districts to investigate the most effective means to shift from supply management to demand management. This study, which was funded by both federal and provincial governments through the ARDSA Program, was the first time that a comprehensive look will have been made into this area. The consultant investigated all possible options including metering of use and the repricing of water to better reflect its true value. The final report was due March 31, 1990.

There are two ways in which water conservation can be implemented. The first is through public education and the use of literature campaigns. Public education, at the adult level, can be effective in the short term when there is an emergency situation. Over the long term, it will not be successful. Education of children through the school system, as part of the normal curriculum has a better chance of success. If a program was developed that focused on all the grades so that water conservation became a "matter of course", over the long term, for that school generation and beyond, there may be some real gains. The pay off is in the future, it would not be immediate.

Other means of public education, such as field trips and the use of newspaper and television will have a minor short term effect but the public soon forgets or becomes insensitive to the message.

The second means of effecting water conservation is through regulation. This may indeed be the conclusion of the study being done for the A.B.C.I.D. Regulations can be developed to enforce reduced demand through regulated use or demand can be reduced through increasing the cost of water to the user. If the price on the resource is high enough it becomes self regulating.

Of the two methods, the second is most likely to be successful. The Fisheries Program could invest substantial funds in a public education campaign with the resulting benefits being very marginal. The public has a limited appreciation of the fishery resource and the impact that development is having on it. The greatest potential return may come from implementation of the A.B.C.I.D. report and investing in a public information campaign that would explain the positive aspects of conserving water on the valley fishery.

12.0 **RECOMMENDATIONS**

There are actions that can be taken by the Fisheries Program that would improve the fishery in Lambly Creek at limited cost. Application for a Crown Reserve under Section 44 of the *Water Act* should be initiated

immediately. An agreement with the Lakeview Irrigation District should be negotiated whereby specific flows would bypass the District intake during critical periods for fish migration, spawning and incubation. A recent study (Letvak, 1989) indicates that there should be adequate water to meet both the diversion requirements and the fish flows. To assist the District in measuring the flow passing over the weir at their intake, the Fisheries Program should request that Water Management help develop a means of rating the structure at low flows. This work should also be done as soon as possible since the District has already demonstrated a willingness to cooperate in releasing flows.

At full utilization of the water licences, the trout fishery will be lost due to total diversion of flows in August. There are three alternatives to supplement the flow, they are (1) develop storage, (2) pump from Okanagan Lake, or (3) develop groundwater. Each of these options is expensive. Additional storage could be developed in cooperation with Lakeview Irrigation District. There is no estimate available but the Fisheries Program share can be expected to be well in excess of $100,000.00. A pumping facility on Okanagan Lake that would have a capacity of 12 100 litres per minute (3 200 USGPM) would cost at least $200,000.00. The chance of developing a groundwater well or wells that would have a yield of 12 000 litres per minute is highly unlikely. The records show that there have been two wells drilled near the mouth of Lambly Creek, the yield for one is unknown and for the other was one gallon per minute. Unless there was a major opportunity for trout in this stream, which there does not appear to be, expenditures of this size are not recommended.

For Lambly Creek the recommendations presented in this section should be proceeded with. Although the capacity in the stream for kokanee is not great, it is worth protecting since the cost of doing so is minimal. The trout fishery will remain probably at its present level until the utilization of the water licences increases to near capacity. When this occurs the projected deficit for the month of August will destroy this fishery. Unfortunately there does not appear to be a feasible means of maintaining the rainbow trout.

13.0 **REFERENCES**

Okanagan Basin Implementation Agreement	Review of Framework Plan - Fisheries Component
Canada-British Columbia Okanagan Basin Agreement	Technical Supplement IX - Fisheries and Wildlife
Canada-British Columbia Okanagan Basin Agreement	Technical Supplement III - Water Quantity Alternatives
Pearson, G.A.	Degradation in Production of Stream Spawning Kokanee in Okanagan Lake System - 1977
Tredger, C.D.	Adult Kokanee Enumeration and Population Estimates for Some Streams Tributary to the Upper Okanagan Basin Lakes, October 1976
Canada-British Columbia Okanagan Basin Agreement (MacDonald / Molnar	Task 115 - Description of Stream Spawning Populations of Kokanee in Streams Tributary to Okanagan Basin Mainstem Lakes - 1971
Houston, C.J.G.	Kokanee Escapements in Okanagan Lake 1971-1984

Environment Canada	Historical Streamflow Summary - British Columbia - Canada - 1988
Letvak, D.B.	Annual Runoff Estimates for West side of Okanagan Valley - Memo to File - 1980
Letvak, D.B.	Summary Report on Tributary Water Management Studies - January 1983
Letvak, D.B.	Lambly Creek / Lakeview Irrigation District, Memo to C.H. Coulson, File S2109, November 3, 1989
Wightman, J.C. Taylor, G.D.	Overview and Rating of Production Capabilities and Enhancement Opportunities for Rainbow Trout and Kokanee in Tributaries to Upper Okanagan Basin Lakes, Parts A and B - 1978
Okanagan Basin Implementation Agreement (Letvak, D.B.)	Summary Report on Tributary Water Management Studies - 1983
Reksten, D.E.	Preliminary Report on Lambly Creek water yield for Lakeview Irrigation District - 1970
Smith, D.R.	A Summary of Existing Data on Kokanee (O. Nerka) in Okanagan Lake
Canada British Columbia Okanagan Basin Agreement	Preliminary Report No. 6
Obedkoff, W.	Inventory of Storage and Diversion and their Effect on Flow Records in the Okanagan River Basin

APPENDIX 1

TERMS OF REFERENCE

LAMBLY (Bear) CREEK

ASSESSMENT OF ALTERNATIVES TO ENHANCE OKANAGAN LAKE FISHERY

HABITAT CONSERVATION FUND

Project Name: Okanagan Tributary Assessment

The purpose of this contract is to explore ways of providing and securing flows for fish in six spawning streams (Mission, Powers, Trepanier, Lambly, Shorts, and Equesis Creeks) tributary to Okanagan Lake. This contract will identify and priorize what options exist for each stream. These assessments will identify both short and long term solutions to water shortages for fish. Each stream is different and, as such, has different opportunities for enhancing or maintaining flows. Most stream flows are largely committed to other licensed uses.

It is intended that these plans, when completed, would be reviewed and accepted by Water Management and endorsed by the Ministry. They would also form the basis for ongoing consultation with other water users within the watershed and possibly result in the formation of a tributary management committee that would determine flow releases.

The solution to securing and providing flows for kokanee and rainbow fall into three categories:

(1) Reserve status and use of conditional water licences. Conditional water licences may only be useful where surplus water exists.

(2) Conduct a licence survey to determine if actual use of water represents licensed amounts. The purpose of this survey is two-fold; it would alert us to problems of non-beneficial use and indicate opportunities for Fisheries to acquire senior licences from individuals who no longer have a need for them.

(3) This category would consider a number of options for increasing supply, for example, storage, pumping from Okanagan Lake, or groundwater water development. These are expensive items and our resource values must be significant to justify such expenditures.

Other options involve operating agreements with Irrigation Districts. One is presently in place with Black Mountain Irrigation District, water conservation, etc.

THE MINISTRY OF ENVIRONMENT WILL:

(1) provide minimum flow objectives for fish for each of the six streams;

(2) make available to all relevant information in our files and library;

(3) identify the reach of stream of concern; and

(4) provide access to Fisheries and Habitat staff within Ministry of Environment.

THE CONTRACTOR WILL:

(1) prepare separate reports for each of the following six streams: Mission, Lambly, Powers, Trepanier, Shorts and Equesis. Equesis Creek flows through an Indian Reserve and any access onto reserve lands will have to be negotiated with the band. These six reports will include a summary of existing licences and projected domestic and irrigation demands and what the fisheries implications are;

(2) include a summary of active irrigation licences and those that are not presently utilized. The purpose of this licence survey would be to alert Water Management to non-beneficial use of water and provide documentation for possible forfeiture of licences to the Crown and indicate opportunities for Fisheries to acquire senior licences directly from individuals who no longer have a need for them. Application for Transfer of Appurtency forms will be completed by the contractor and forwarded to the Habitat Section of the Ministry of Environment for processing;

(3) include a summary of historical flow records for each stream from Surface Water Records or Irrigation Districts;

(4) meet with the appropriate Irrigation Districts to determine their long range plans for distribution and operation and what impacts they may have on present flows;

(5) assess the impact of Black Mountain Irrigation District's Gopher Flat proposal on flows in Mission Creek for fish;

(6) use existing information, where it exists, to determine the most cost effective means of ensuring and providing minimum flows for fish. The information available includes, but is not restricted to, the reports given in Appendix 1;

(7) examine and report on all reasonable cost effective options for obtaining and securing minimum flows for both kokanee and rainbow trout in each stream (flow throughout the year) for both the short term (five years) and the long term (twenty years). In addition, the contractor will determine the most cost effective way of providing flows for only kokanee (September 1st through May 31st) for each stream for the short and long term;

(8) address consequences of failure to achieve minimum flow objectives;

(9) negotiate operating agreements with the Irrigation Districts on Powers, Lambly and Mill Creeks similar to the agreement in place on Mission Creek with Black Mountain Irrigation District and Fisheries;

(10) identify any water conservation measures that would be effective in providing more water for fish and the costs of implementing such a program for each stream.

APPENDIX 2

CURRENT WATER LICENCES ON LAMBLY (Bear) CREEK

WATER LICENCES

LAMBLY (Bear) CREEK AND TRIBUTARIES

License No.	Licensee	Source	Quantity	Purpose	Remarks
C 34762	Lakeview Irrigation	Lambly Cr.	25,550,000 GY	Wwks	70,000 GD
C 50778	Lakeview Irrigation	Lambly Cr.	365,000,000 GY	Wwks	1,000,000 GD
C 39006	Lakeview Irrigation	Terrace Cr. Shorts Creek	328,500,000 GY	Wwks	55% from Shorts Creek
C 40155	Fletcher Challenge	Kalljo Br.	500 GD	Dom	
C 40156	Range Br.	Kalljo Br.	500 GD	Dom	
C 45630	Guss, C.D. & R.	Lambly Cr.	1,000 GD	Dom	
C 49405	Jones, Lila	Blue Grouse	1,500 GD	Dom	
C 58073	Range Br.	Blue Grouse	500 GD	Dom	
C 60447	Moonstruck Hldgs	Lambly Cr.	1,000 GD	Dom	
C 34762	Lakeview Irrigation	Lambly Cr.	3,500 GD	Irr	
C 17063	Solmer Ltd.	Lambly Cr.	75 AF	Irr	Conveyed by L.I.D.
C 22389	Patterson, I.M.	Lambly Cr.	12.5 AF	Irr	Conveyed by L.I.D.
F 10097	Solmer Ltd.	Lambly Cr.	82 AF	Irr	Conveyed by L.I.D.
C 17064	Solmer Ltd.	Lambly Cr.	100 AF	Stor	Esperon Lake
C 33085	Lakeview Irrigation	Lambly Cr.	200 AF	Stor	Esperon Lake
C 34763	Lakeview Irrigation	Lambly Cr.	2,500 AF	Stor	Rover Valley Reservoir
C 50779	Lakeview Irrigation	Lambly Cr.	1,500 AF	Stor	Rose Valley Reservoir
C 39007	Lakeview Irrigation	Terrace Cr. Shorts Cr.	2,000 AF	Stor	Terrace Meadow Reserv.

WATER LICENCES - SUMMARY

LAMBLY (Bear) CREEK AND TRIBUTARIES

Source	No. Lic.	Wwks GY	Domestic GD	Irrigation AF	Storage AF	Remarks
Lambly Creek	12	390,550,000	2,000	3,769.5	4,300	
Terrace / Shorts Creeks	2	328,500,000	-	-	2,000	1,100 AF from Shorts
Kalljo / Blue Grouse Creeks	4	-	3,000	-	-	
TOTALS	18	719,050,000	5,000 *	3,769.5	6,300	* 1,825,000 GY
Peak Day Equiv. (cfs)		10.96	0.01	19.04	31.82 *	* Over 100 Day Release

APPENDIX 3

HYDROMETRIC DATA
for
LAMBLY (Bear) CREEK

LAMBLY CREEK NEAR THE MOUTH - STATION NO. 08NM003

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m^3/s)	MAXIMUM DAILY DISCHARGE (m^3/s)	MINIMUM DAILY DISCHARGE (m^3/s)	TOTAL DISCHARGE (dam^3)	YEAR
1919	---	---	---	---	1919
1920	---	5.37 ON JUN 11	---	---	1920
1921	---	23.8 ON MAY 25	---	---	1921
1965	---	---	---	---	1965
1966	---	0.33 ON MAY 8	---	---	1966
1969	---	---	0 ON AUG 4 *	---	1969
1970	---	22.6 ON MAY 22	0 ON JUL 16	29 000	1970
1971	---	23.1 ON MAY 13	0 ON JUL 30	40 300	1971
1972	---	31.7 ON MAY 30 *	0.037 ON DEC 3	72 500	1972
1973	---	13.3 ON MAY 24	0 ON JUL 31	20 200	1973
1974	---	22.3 ON MAY 26	0.016 ON NOV 3	53 000	1974
1975	---	---	---	---	1975
		* - EXTREME RECORDED FOR THE PERIOD OF RECORD		48 000	MEAN

LAMBLY LAKE DIVERSION TO POWERS CREEK - STATION NO. 08NM135

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1965	---	---	---	---	---	0.196	0.156	0.127	0.037	---	---	---	---	1965
1966	---	---	---	---	0.066	0.099	0.095	0.133	0.114	---	---	---	---	1966
1968	---	---	---	---	---	0.301	0.233	0.206	0.036	---	---	---	---	1968
1970	---	---	---	---	---	---	0.288	0.206	0.176	---	---	---	---	1970
1971	---	---	---	---	---	0.476	0.366	0.479	0.146	---	---	---	---	1971
1972	---	---	---	---	---	1.32	0.266	0.227	0.187	---	---	---	---	1972
MEAN	---	---	---	---	0.066	0.497	0.242	0.259	0.112	---	---	---	---	MEAN

LOCATION - LAT 49 57 10 N
LONG 119 43 36 W REGULATED SINCE 1969

LAMBLY LAKE DIVERSION TO POWERS CREEK - STATION NO. 08NM135

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m^3/s)	MAXIMUM DAILY DISCHARGE (m^3/s)	MINIMUM DAILY DISCHARGE (m^3/s)	TOTAL DISCHARGE (dam^3)	YEA
1965	---	0.300 ON MAY 26	0 ON SEP 13 *	---	196
1966	---	---	---	---	196
1968	---	---	0.035 ON SEP 30	---	196
1970	---	---	---	---	197
1971	---	2.57 ON MAY 14	0 E ON SEP 11	---	197
1972	---	3.60 ON MAY 30 *	0.113 ON SEP 20	---	197
	E - ESTIMATED	* - EXTREME RECORDED FOR THE PERIOD OF RECORD		---	MEA

LAMBLY CREEK DIVERSION TO ROSE VALLEY LAKE - STATION NO. 08NM167

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

AR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
	...	...	...	...	...	...	...	...	...	...	0.061	0.032	...	1970
	0.031	0.031	0.030	0.031	0.016	0.064	0.231	0.150	0.301	0.121	0.058	0.013	0.080	1971
	0.010	0.010	0.016	0.035	0.035	0.046	0.167	0.145	0.085	0.006	0.004	0.015	0.062	1972
73	0.024	0.026	0.027	0.059	0.137	0.305	0.235	0.106	0.137	0.167	0.013	0.008	0.106	1973
74	0.006	0.008	0.007	0.016	0.022	0.331	0.238	0.122	0.060	0.062	0.056	0.029	0.083	1974
	0.002	0.001	0.002	0.015	0.020	0.267	0.230	0.150	0.023	0.075	0	0.016	0.080	1975
	0.014	0.015	0.011	0.004	0.000	0.400	0.321	0.061	0.045	0.048	0.006	0.000	0.077	1976
	0.000	0.023	0.075	0.072	0.121	0.315	0.335	0.075	0.005	0.074	0.045	0.030	0.085	1977
	0.013	0.008	0.006	0.013	0.034	0.368	0.280	0.038	0.007	0.003	0.006	0.006	0.057	1978
AN	0.012	0.014	0.021	0.030	0.051	0.280	0.223	0.103	0.060	0.073	0.027	0.017	0.070	MEAN

LOCATION - LAT 49 54 36 N
LONG 119 33 16 W REGULATED

LAMBLY CREEK DIVERSION TO ROSE VALLEY LAKE - STATION NO. 08NM167

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

	MAXIMUM INSTANTANEOUS DISCHARGE (m^3/s)	MAXIMUM DAILY DISCHARGE (m^3/s)	MINIMUM DAILY DISCHARGE (m^3/s)	TOTAL DISCHARGE (dam^3)	YEAR
70	...	...	...	...	1970
71	0.371 AT 17:00 PST ON JUL 31	0.346 ON JUL 26	0.006 ON MAY 9	2 540	1971
72	0.288 AT 13:00 PST ON AUG 7	0.246 ON AUG 8	0.001 ON NOV 10	1 650	1972
73	0.547 AT 16:00 PST ON MAY 30	0.504 ON JUN 10	0.005 ON DEC 8	3 420	1973
74	0.746 AT 00:56 PST ON JUN 17	0.716 ON JUN 18	0 ON JAN 11 *	2 630	1974
75	0.733 AT 00:40 PST ON JUN 13	0.716 ON JUN 14	0 ON NOV 1	2 510	1975
76	0.814 AT 15:45 PST ON JUN 22	0.810 ON JUN 23 *	0 ON MAR 27	3 450	1976
77	0.563 AT 13:23 PST ON MAY 26	0.482 ON JUN 13	0.001 ON MAY 3	3 010	1977
78	0.838 AT 10:50 PST ON JUN 12 *	0.814 ON JUL 3	0.001 ON SEP 26	1 400	1978
		* - EXTREME RECORDED FOR THE PERIOD OF RECORD		2 590	MEAN

LAMBLY CREEK NEAR KELOWNA - STATION NO. 08NM056

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

AR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
	...	...	...	...	0.83	1.61	0.300	0.200	0.120	...	...	...	...	1934
	...	...	...	...	...	1.80	...	...	...	...	...	...	...	1935
37	...	...	...	...	3.84	4.65	0.637	0.178	0.818	...	...	...	...	1937
AN	...	...	...	...	0.00	2.66	0.573	0.186	0.388	...	...	...	...	MEAN

LOCATION - LAT 49 57 36 N DRAINAGE AREA, 346 km^2
LONG 119 33 16 W REGULATED

LAMBLY CREEK NEAR KELOWNA - STATION NO. 08NM056

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

	MAXIMUM INSTANTANEOUS DISCHARGE (m^3/s)	MAXIMUM DAILY DISCHARGE (m^3/s)	MINIMUM DAILY DISCHARGE (m^3/s)	TOTAL DISCHARGE (dam^3)	YEAR
34	...	15.0 ON MAY 15 *	0.000 ON SEP 15 *	...	1934
	...	12.0 ON MAY 15	...	...	1935
	...	8.20 ON JUN 6	0.113 ON AUG 26	...	1937
		* - EXTREME RECORDED FOR THE PERIOD OF RECORD		...	MEAN

LAMBLY CREEK NEAR THE MOUTH - STATION NO. 08NM003

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
	...	...	...	...	...	3.08	...	0.107	0.068	...	...	...	...	1910
20	...	...	...	...	2.84	4.08	0.705	0.168	...	...	...	...	...	1920
21	...	...	...	1.17	10.8	7.82	1.00	0.178	0.178	...	...	...	...	1921
	...	...	...	...	...	2.71	0.284	0.085	0.071	...	...	...	...	1965
	...	...	...	0.811	5.13	1.47	0.402	0.075	0.068	...	...	...	...	1966
67	...	...	...	...	...	...	0.316	0.083	0.061	0.301	0.362	0.225	...	1969
70	0.105	0.103	0.305	0.378	7.07	1.78	0.085	0.062	0.068	0.068	0.068	0.071	0.818	1970
	0.061	0.057	0.101	0.564	5.81	3.77	0.588	0	0.002	0.031	0.113	0.147	1.28	1971
2	0.111	0.118	0.437	1.33	10.4	6.81	1.20	0.181	0.165	0.246	0.222	0.116	2.26	1972
3	0.126	0.120	0.185	0.503	4.81	1.68	0.112	0.062	0	0.101	0.204	0.272	0.838	1973
4	0.310	0.283	0.534	4.40	13.8	8.36	2.07	0.348	0.141	0.065	0.103	0.106	3.03	1974
975	0.113	0.110	0.175	...	...	...	...	...	...	0.162	...	...	...	1975
	0.168	0.170	0.256	1.23	8.87	4.30	0.573	0.181	0.072	0.116	0.202	0.168	1.55	MEAN

LOCATION - LAT 49 55 49 N DRAINAGE AREA, 372 km^2
LONG 119 30 36 W REGULATED

LAMOLY CREEK BELOW BALD RANGE CREEK - STATION NO. 08NM166

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEA
1970	...	...	...	...	...	...	...	...	...	...	...	0.196	...	197
1971	0.133	0.154	0.167	1.33	10.4	4.50	0.791	0.290	0.163	0.183	0.233	0.186	1.89	197
1972	0.143	0.161	0.473	1.36	12.7	5.34	1.36	0.410	0.269	0.256	0.243	0.159	2.00	197
1973	0.156	0.162	0.182	0.616	4.76	1.43	0.493	0.196	0.152	0.201	0.238	0.202	0.750	197
1974	0.227	0.267	0.471	3.05	10.6	5.06	2.06	0.483	0.235	0.201	0.150	0.200	2.43	197
1975	0.170	0.166	0.295	0.690	5.74	7.33	0.905	0.436	0.302	0.256	0.256	0.221	1.77	197
1976	0.203	0.271	0.570	1.67	8.27	3.96	0.991	1.63	0.531	0.513	0.360	0.275	1.56	197
1977	0.226	0.268	0.331	1.08	3.82	1.32	0.360	0.137	0.173	0.188	0.183	0.145	0.638	197
1978	0.126	0.168	0.458	3.21	9.72	4.30	0.777	0.302	0.671	0.510	0.410	0.337	1.77	197
1979	0.207	0.255	0.304	1.01	8.21	1.38	0.414	0.212	0.270	0.222	0.186	0.150	0.821	197
1980	0.186	0.177	0.372	3.50	8.16	1.56	0.670	0.256	0.403	0.252	0.364	0.236	1.10	198
1981	0.302	0.415	0.571	1.76	8.83	3.83	1.31	0.537	0.306	0.705	0.515	0.450	1.35	198
1982	0.346	0.410	0.466	1.47	10.9	4.44	2.50	0.748	0.661	0.643	0.413	0.356	1.84	198
MEAN	0.220	0.240	0.376	1.68	8.17	4.01	1.06	0.478	0.304	0.342	0.243	0.200	1.48	MEA

LOCATION - LAT 60 57 30 N, LONG 118 33 24 W. DRAINAGE AREA, 220 km². REGULATED

LAMOLY CREEK BELOW BALD RANGE CREEK - STATION NO. 08NM166

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m³/s)	MAXIMUM DAILY DISCHARGE (m³/s)	MINIMUM DAILY DISCHARGE (m³/s)	TOTAL DISCHARGE (dam³)	YEA
1970	...	...	...	...	197
1	33.0 AT 06:40 PST ON MAY 13	33.5 ON MAY 13	0.1060 ON JAN 15	69 000	197
2	30.1 AT 21:45 PST ON MAY 30 *	30.2 ON MAY 30	0.0670 ON DEC 6 *	63 100	197
3	11.8 AT 23:00 PST ON MAY 24	9.24 ON MAY 16	0.093 ON SEP 13	33 700	197
1974	33.2 AT 23:30 PST ON MAY 26	30.8 ON MAY 26	0.1530 ON DEC 31	75 600	197
1975	33.3 AT 00:40 PST ON JUN 3	33.5 ON JUN 1	0.1270 ON JAN 16	55 800	197
1976	...	15.9 E ON MAY 8	0.173 ON NOV 26	49 800	197
1977	9.00 AT 20:30 PST ON APR 26	8.53 ON APR 26	0.093 ON AUG 16	30 000	197
1978	25.5 AT 00:17 PST ON MAY 31	21.5 ON MAY 31	0.1000 ON JAN 3	55 300	197
1979	14.9 AT 00:56 PST ON MAY 6	11.4 ON MAY 6	0.110 ON AUG 14	39 000	197
1980	20.5 AT 00:15 PST ON MAY 6	18.1 ON MAY 6	0.1500 ON JAN 29	36 500	198
1981	13.0 AT 02:00 PST ON MAY 31	11.5 ON MAY 31	0.2070 ON JAN 14	43 500	198
1982	36.2 AT 00:45 PST ON MAY 26	30.5 ON MAY 26 *	0.2400 ON DEC 31	61 200	198
	E - ESTIMATED	* - EXTREME RECORDED FOR THE PERIOD OF RECORD		69 000	MEA

LAMOLY CREEK BELOW TERRACE CREEK - STATION NO. 08NM161

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEA
1967	...	...	...	...	0.01	0.16	0.972	0.240	0.066	...	...	...	...	196
1968	...	...	...	...	...	5.71	0.703	0.373	0.266	...	...	...	...	196
1969	...	...	...	...	...	0.856	0.430	0.171	0.109	...	...	...	...	196
1970	...	...	...	...	...	...	0.316	0.103	0.116	0.137	0.133	0.000	...	197
1971	...	...	...	0.055	0.40	3.35	0.641	0.156	0.164	...	...	...	...	197
MEAN	...	...	...	0.055	0.70	4.40	0.530	0.190	0.156	0.137	0.133	0.000	...	MEA

LOCATION - LAT 60 56 40 N, LONG 118 34 00 W. DRAINAGE AREA, 220 km². REGULATED

LAMOLY CREEK BELOW TERRACE CREEK - STATION NO. 08NM161

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m³/s)	MAXIMUM DAILY DISCHARGE (m³/s)	MINIMUM DAILY DISCHARGE (m³/s)	TOTAL DISCHARGE (dam³)	YEA
1967	...	26.4 ON JUN 3 *	0.046 ON SEP 21	...	196
1968	...	...	0.176 ON SEP 13	...	196
1969	...	...	0.062 ON SEP 30 *	...	196
9	...	...	0.0436 ON OCT 7	...	197
	...	...	...	...	197
	E - ESTIMATED	* - EXTREME RECORDED FOR THE PERIOD OF RECORD		...	MEA

LAMBLY CREEK ABOVE TERRACE CREEK - STATION NO. 08NM166

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

A	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
970	...	...	...	...	...	...	...	...	...	...	...	0.068	...	1970
971	0.064	0.069	0.081	0.311	3.67	2.06	0.431	0.096	0.066	0.099	0.068	0.062	0.598	1971
972	0.074	0.072	0.101	0.344	3.76	3.30	0.666	0.218	0.147	0.126	0.106	0.068	0.746	1972
973	0.077	0.076	0.063	0.248	1.64	0.616	0.241	0.065	0.063	0.159	0.210	0.154	0.342	1973
974	0.144	0.185	0.203	1.61	4.33	5.17	1.17	0.282	0.140	0.104	0.067	0.062	1.11	1974
975	0.075	0.068	0.071	0.255	3.05	3.38	0.611	0.187	0.134	0.131	0.141	0.095	0.677	1975
976	0.107	0.113	0.177	0.500	3.72	1.66	0.488	0.786	0.410	0.230	0.181	0.147	0.704	1976
977	0.111	0.114	0.112	0.571	1.32	0.630	0.206	0.075	0.060	0.077	0.074	0.060	0.267	1977
978	0.076	0.103	0.201	1.09	4.08	2.58	0.456	0.170	0.306	0.245	0.185	0.136	0.616	1978
979	0.113	0.132	0.161	0.363	2.56	0.663	0.246	0.127	0.100	0.120	0.102	0.087	0.402	1979
980	0.064	0.093	0.176	1.46	3.35	0.773	0.373	0.164	0.276	0.166	0.184	0.216	0.629	1980
981	0.178	0.200	0.261	0.744	3.10	1.19	0.686	0.260	0.216	0.344	0.404	0.277	0.861	1981
982	0.176	0.186	0.216	0.634	3.81	2.16	1.31	0.360	0.276	0.261	0.222	0.181	0.832	1982
983	0.103	0.108	0.473	1.86	5.42	1.86	0.528	0.200	0.166	0.116	0.336	0.114	0.921	1983
984	0.202	0.180	0.258	0.620	2.42	3.38	0.847	0.204	0.162	0.133	0.103	0.087	0.704	1984
985	0.032	0.046	0.073	0.540	2.56	0.747	0.133	0.053	0.065	0.132	0.063	0.030	0.262	1985
986	0.024	0.031	0.182	0.748	2.53	1.12	0.402	0.121	0.134	0.158	0.106	0.068	0.661	1986
987	0.075	0.073	0.284	1.22	3.51	0.690	0.180	0.066	0.030	0.031	0.043	0.056	0.632	1987
988	0.047	0.046	0.056	0.956	1.81	0.727	0.232	0.062	0.077	0.066	0.124	0.067	0.364	1988
EAN	0.086	0.106	0.174	0.770	3.06	1.80	0.481	0.168	0.172	0.160	0.166	0.110	0.810	MEAN

LOCATION - LAT 60 59 30 N DRAINAGE AREA, 76.1 km²
LONG 118 36 52 W REGULATED

LAMBLY CREEK ABOVE TERRACE CREEK - STATION NO. 08NM166

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

AR	MAXIMUM INSTANTANEOUS DISCHARGE (m³/s)	MAXIMUM DAILY DISCHARGE (m³/s)	MINIMUM DAILY DISCHARGE (m³/s)	TOTAL DISCHARGE (dam³)	YEAR
970	...	...	...	...	1970
971	10.6 AT 06:00 PST ON MAY 13	5.80 ON MAY 13	0.0580 ON JAN 16	18 800	1971
972	13.7 AT 22:45 PST ON MAY 28 *	10.8/ ON MAY 30 *	0.0118 ON DEC 3	23 700	1972
973	5.61 AT 18:20 PST ON MAY 24	4.53 ON MAY 24	0.051 ON SEP 12	10 800	1973
974	10.6 AT 21:45 PST ON JUN 14	5.56 ON JUN 15	0.0668 ON DEC 31	35 000	1974
975	6.23 AT 02:20 PST ON JUN 2	5.55 ON JUN 2	0.0548 ON FEB 6	21 400	1975
976	6.62 AT 08:24 PST ON MAY 17	6.34E ON MAY 8	0.0658 ON FEB 5	23 300	1976
977	3.00 AT 01:30 PST ON MAY 3	2.52 ON MAY 3	0.042 ON AUG 18	9 060	1977
978	8.77 AT 22:20 PST ON MAY 20	7.84 ON MAY 21	0.0548 ON JAN 1	25 700	1978
979	4.73 AT 21:55 PST ON MAY 5	4.31 ON MAY 5	0.076 ON AUG 14	13 700	1979
980	7.14 AT 07:45 PST ON MAY 6	5.15 ON MAY 6	0.0658 ON JAN 28	18 700	1980
981	6.17 AT 07:00 PST ON MAY 21	5.44 ON MAY 21	0.1108 ON JAN 14	20 500	1981
982	8.43 AT 21:35 PST ON MAY 24	7.65 ON MAY 25	0.1328 ON NOV 22	26 300	1982
983	11.2 AT 20:58 PST ON MAY 24	8.48 ON MAY 24	0.0838 ON FEB 5	28 300	1983
984	6.96 AT 17:26 PST ON MAY 30	7.82 ON MAY 30	0.0368 ON DEC 18	23 300	1984
985	5.65 AT 22:54 PST ON MAY 16	5.63 ON MAY 15	0.005 ON NOV 27 *	12 000	1985
986	8.44 AT 22:56 PST ON MAY 26	7.08 ON MAY 27	0.0218 ON JAN 13	16 200	1986
987	8.65 AT 06:31 PST ON MAY 1	7.50 ON MAY 1	0.023 ON SEP 30	13 300	1987
988	5.56 AT 00:50 PST ON MAY 13	4.86 ON MAY 13	0.030 ON JAN 31	11 800	1988
				18 300	MEAN

B - ICE CONDITIONS * - EXTREME RECORDED FOR THE PERIOD OF RECORD
E - ESTIMATED

FIGURE 2

Province of British Columbia
Ministry of Environment
Planning and Assessment Branch

Okanagan Sub-Regional Plan

LAMBLY CREEK

Scale

Metres 1000 0 1000

Miles 1 0

Project Area Location

N

82L/5 82L/6 82L/7
82L/4 82L/3 82L/2
92H/16 82E/13 82E/14 82E/15
92H/9 82E/12 82E/11 82E/10

VERNON
KAMLOOPS
PENTICTON

PROVINCIAL FOREST

KAMLOOPS DIVISION OF YALE LAND DISTRICT
OSOYOOS DIVISION OF YALE LAND DISTRICT

TREE FARM LICENCE 9

WEST OKANAGAN PROVINCIAL FOREST

BARTON HILL

LAMBLY CREEK ABOVE TERRACE CREEK
WSC STN NO 08NM145

LAMBLY CREEK BELOW TERRACE CREEK
WSC STN NO 08NM141

LAMBLY CREEK BELOW BOULDER CREEK
WSC STN NO 08NM116

LAMBLY CREEK BELOW LOUIS CREEK
WSC STN NO 08NM049

LAMBLY CREEK NEAR THE MOUTH
WSC STN NO 08NM003