PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
PLANNING AND RESOURCE MANAGEMENT DIVISION

ENGINEERING FEASIBILITY STUDY ON REBUILDING OUTLET OF NICOLA LAKE

by

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Water Management Branch

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ENGINEERING FEASIBILITY STUDY ON REBUILDING OUTLET OF NICOLA LAKE

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1. INTRODUCTION

The Planning Branch produced a report (see Reference 1, Appendix A) in the spring of 1981 which assessed in a preliminary manner the benefits which might be available if the outlet of Nicola Lake were to be rebuilt. Subsequently, closer investigations of the information were made in the two main benefitting areas (agriculture and fisheries) and a preliminary design and cost estimate were made of the new outlet. This report basically brings the results of these separate investigations together in a summarized manner for the interest of those who will be involved in the next stage of the storage development project. The background reports and memoranda from which the information was drawn are listed in Appendix A. Anyone wishing more detail are advised to seek out the information in the background reports.

The reason the rebuilding of Nicola Lake dam is being investigated at this time is being influenced by a number of factors:

i) Desired abandonment of the existing structure by the owner.

ii) Concern and effort by a number of groups to make water resource improvements in the Nicola Valley. A local working committee made an application for ARDSA assistance in 1981 on behalf of the benefitting farmers to investigate the feasibility of rebuilding the outlet structure. Fisheries and Oceans Canada, who manage the main species of fish which stand to benefit from improved Nicola River flows and have participated in discussions and meetings on possible water resource improvements, see the rebuilding of the Nicola Lake outlet structure as an opportunity to establish "minimum guaranteed" flows for the Nicola River, and thus not only preserve the fishery that has built up a dependency on the limited and unsecured regulation provided by the existing structure, but also enhance the fishery by improved regulation of the river flows which will result from the new structure.

iii) A local entity will be required to represent the local benefitters of the water resource improvement. The Nicola Storage project, which

would benefit the greatest number of farmers of any one single project in the Nicola drainage basin, is being put forward as the "bone to chew on," to be used as an example for the people of the Nicola Valley of possible water resource management improvements, and to assist the Provincial Government in the selection of the most suitable legislative vehicle (e.g. Improvement District, Regional District, new legislation, etc?).

The Ministry of Environment is in the process of developing strategic plans for approximately 40 Environmental Planning Units in the Province. One of the purposes of these plans is to provide the Regional Managers with guidance and direction in the allocation and management of resources under the mandate of the Ministry of Environment. The Nicola drainage basin is one such Planning Unit. Good progress has been made in the development of the Nicola Strategic Plan. Presently a second draft of the document is out for review. Assessing the development of storage on Nicola Lake is considered to be operational level type planning and arises out of, or as a consequence of, the strategic planning process (which is intended to be framework type planning). The proposed project fits in well with identified Ministry of Environment objectives for the Nicola.

This report has been prepared by the Water Supply Section of the Water Management Branch in Victoria as a service to the Thompson-Nicola Region and in response to the request by the Local Working Committee.

2. EXISTING SITUATION

2.1 Setting

A substantial amount of ranching is carried out in the Nicola Valley. Beef cattle production makes a significant contribution to the local economy, both through direct employment and the service sector. In only the area being considered in this report, for example, there are approximately 60 farms and 12,000 cattle (Reference 3, Appendix A). Forage crops (alfalfa hay) are the

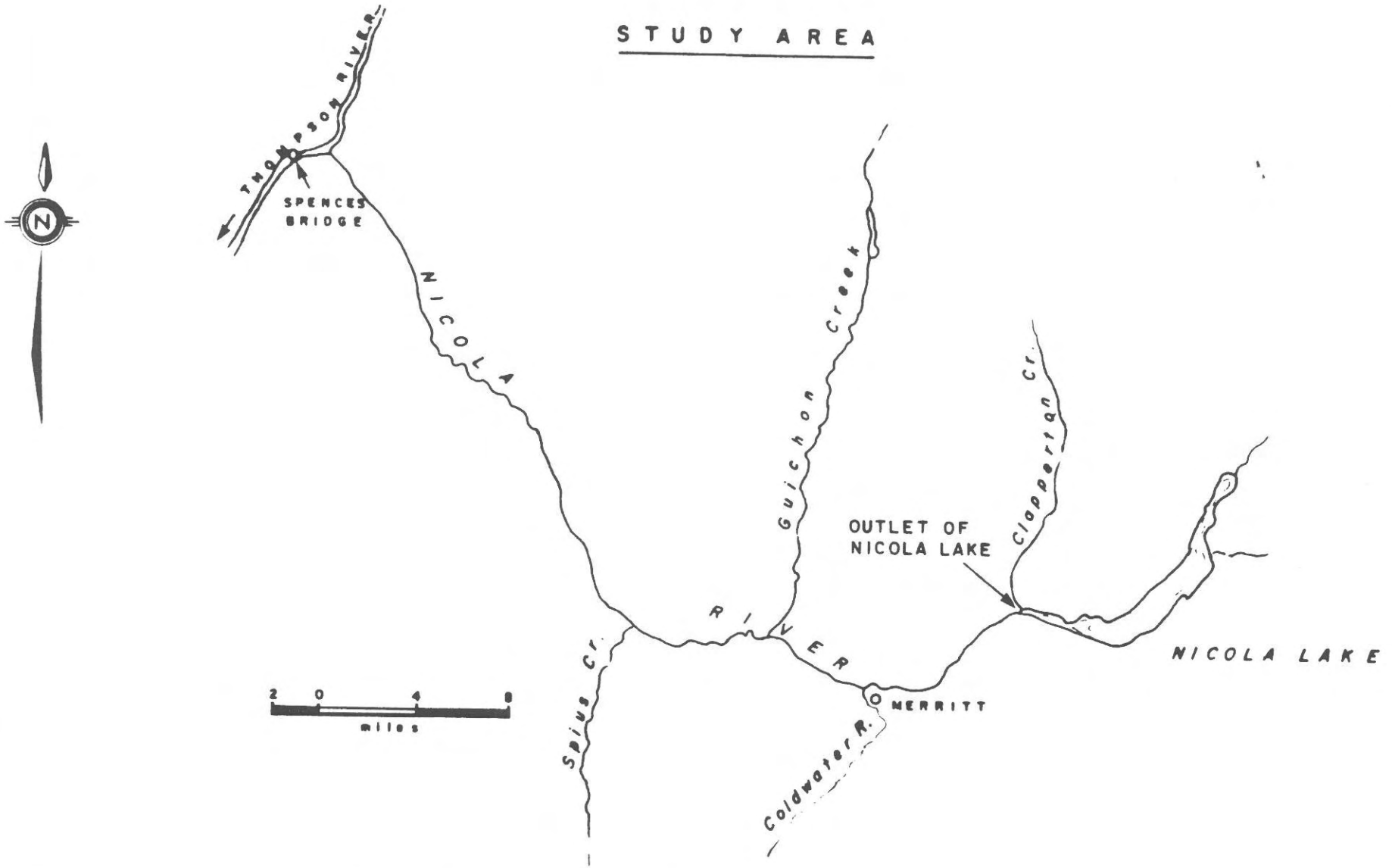
main users of irrigation water. Most of the farmers who would benefit from Nicola Lake storage currently obtain their irrigation water supply from the Nicola River through individually owned water systems.

Anadromous fish (chinook, coho and pink salmon) and steelhead trout utilize the Nicola River downstream of Nicola Lake. The river is important to spawning and rearing fish and fish migrating to tributary streams, a number of which also form a valuable part of the Nicola Valley fishery resource. The importance of the Nicola River to the fishery resource has been recognized by the Comptroller of Water Rights as demonstrated by the fact that no full-term irrigation water licences have been issued on the Nicola River since 1970. Any improvement to current river flows during the late summer and fall period in years of below average runoff would benefit the Nicola Valley fishery resource.

Nicola Lake is located about 60 miles south of Kamloops and eight miles east of Merritt, B.C. (Figure 2.1). The lake has a surface area of 6175 acres and is the largest lake in the basin. The tributary drainage area to the lake is fairly large (1100 square miles), consequently the natural water supply to the lake is quite good (mean annual net inflow estimated at 142,000 acre-feet per annum or 23 feet on Nicola Lake; 1:15 year drought condition net inflow estimated at 50,000 acre-feet or eight feet depth equivalent on Nicola Lake).

Nicola Ranch Ltd. holds the only storage water right on Nicola Lake (Conditional Licence No. 13594). This water right authorizes the storage of 28,000 acre-feet of water (equivalent to 4.53 feet on lake) but a 1948 Order under the Water Act restricts the amount of storage to three feet (maximum operating water level of 2052.76' A.M.S.L.).

The dam at the outlet of Nicola Lake was built in 1927. It is of concrete and wood construction and consists of a stoplog spillway, wooden slide gates, a fishway (of sorts) and a diversion headwall and ditch (power canal). The purpose of the structure was to capture spring runoff for subsequent release for hydro-power generation. Power has not been generated for many years



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON

NICOLA LAKE STORAGE
FEASIBILITY STUDY

SCALE VERT / HOR.	DATE SEPT. 1982
L. A. BERGMAN	ENGINEER
FILE No 0242512-164	DWG No. A 5316 - 21

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FIGURE 2.1

now with the regulated flow (brought about by the storage dam). The power authorization water right (Condition Licence No. 13593) was abandoned in 1979. Abandonment or cancellation of the storage water right is being held up pending this assessment.

2.2 Condition of Existing Dam

The existing dam is 56 years old. An inspection by specialists of the Water Management Branch in the fall of 1981 (see Reference 5, Appendix A) concluded that the dam should be usable for a few more years if:

i) no flashboards are used;

ii) the operators comply with the 1948 Order specifying all gates be open whenever there is three feet of water or more on the staff gauge (this is about 0.5 feet on the spillway sill); and

iii) normal maintenance work is carried out on the gate structure.

This amount of time was deemed to be required to determine whether or not the existing dam should be removed, repaired or replaced.

2.3 Influence of Existing Dam on River Flows

The development of storage on Nicola Lake had a significant influence on Nicola River flows, especially between the lake and the first major tributary, the Coldwater River. Table 2.1 shows the estimated flows before and after the dam was built, for a 1:15 year drought runoff condition. During the non-freshet or low flow period of the year (August to March) the improvement in river flows was up to two to three times that which occurred under natural, unregulated conditions.

The flow improvement downstream of Coldwater River confluence would not be as dramatic as the first reach because of the contribution of flow from major tributaries of the Nicola River.

Table 2.1

Estimated Flow Improvement to Nicola River Caused by Existing Nicola Lake Dam[1]

	Before[2]	After[3]
July	247	169
August	48	71
September	23	48
October	13	43
November	9	16
December	9	27
January	10	38
February	11	56
March	16	63

1. Nicola Lake to Coldwater confluence, 1:15 year return period.
2. Hydrology Section estimate of January 17, 1983 (see Reference 18, Appendix A).
3. Planning Branch estimate of February 2, 1982 (see Reference 19, Appendix A).

These flow improvements are critical when consideration is given to the removal of the dam. Since the water storage is no longer used for the purpose the water licence was issued and the licensee wants to abandon the licence, the dam must either be:

i) removed because the structure may become a hazard to the public if it were not properly maintained and operated. Irrespective of an abandonment of rights under a licence, the owner remains liable for damage resulting from the works and for the cost of their removal which may be ordered by the Comptroller.

ii) tranferred to some person, persons or agency that is prepared and able to assume responsibility for its operation and maintenance, and is successful in applying for or otherwise acquiring the necessary water licence.

As should become apparent in the following sections, other users have become dependent on the regulated release flows and should give serious thought to making arrangements to look after the existing structure if it is not to be replaced.

Water is withdrawn for agricultural, industrial and other purposes as well as for in-stream use to maintain fish stocks.

3. AGRICULTURAL INTERESTS

This section examines water use around Nicola Lake and along the Nicola River (the area that would benefit from storage on Nicola Lake) to clarify the dependency most of the water users have on the existing storage on Nicola Lake.

3.1 Licences

Currently there is no authorized use of water from Nicola Lake.

Diversion licences along the Nicola River are grouped by reach as follows (information from Appendix B):

i) Nicola Lake to Coldwater River:

13 irrigation licences totalling 4462.2 acre-feet for the irrigation of 3250.5 acres (one licence distorts the duty - 400 acre-feet to irrigate 2000 acres).

2 industrial licences (gravel washing) totalling 30,000 gpd.

ii) Coldwater River to Spius Creek:

30 irrigation licences totalling 3040.7 acre-feet for the irrigation of 1175.8 acres.

1 mining licence totalling 1,300,000 gpd.
1 waterworks licence totalling 100,000 gpd.

iii) Spius Creek to Thompson River:

23 irrigation licence totalling 4524.2 acre-feet for the irrigation of 1644.7 acres.

iv) In summary, from the Nicola Lake to Spences Bridge, authorized use of water out of the Nicola River is as follows:

66 irrigation licences totalling 12,027.1 acre-feet for the irrigation of 6071 acres (as mentioned earlier one licence distorts the average duty).

4 other uses (excluding domestic) totalling 1,433,000 gpd. Over the irrigation season this licenced use is equivalent to 962.5 acre-feet. Thus total licenced demand during the irrigation season is 12,989.6 acre-feet.

The approximate locations of the licences with respect to each other and major tributaries are shown in Foldout 1 at the back of this report.

Licenced demand on the Nicola River through the summer or irrigation season is shown in Figure 3.1. Non-irrigation use averages 2.6 cfs. The apportionment of the annual irrigation demand into monthly amounts as shown on Figure 3.1 is as recommended by the Regional Water Manager. The maximum withdrawal occurs during July when 70 cfs is withdrawn. It can be seen that a substantial rate of withdrawal has been licenced since the dam was constructed in 1927.

On an acreage basis the percentage withdrawal by reach is approximately as follows:

Nicola Lake to Coldwater River	53 percent
Coldwater River to Spius Creek	20 percent
Spius Creek to Thompson River	27 percent

3.2 Restricted Use Licences

Twenty irrigation licences have been issued since 1970 on the Nicola River. These licences are restricted either in time, i.e. diversion may only take place between April 1 and June 30 of each year, or are dependent on a certain river flow, i.e. if the river flow falls below a certain discharge, then no diversion is allowed. These restricted use licences also are referred to as "fish clause" licences.

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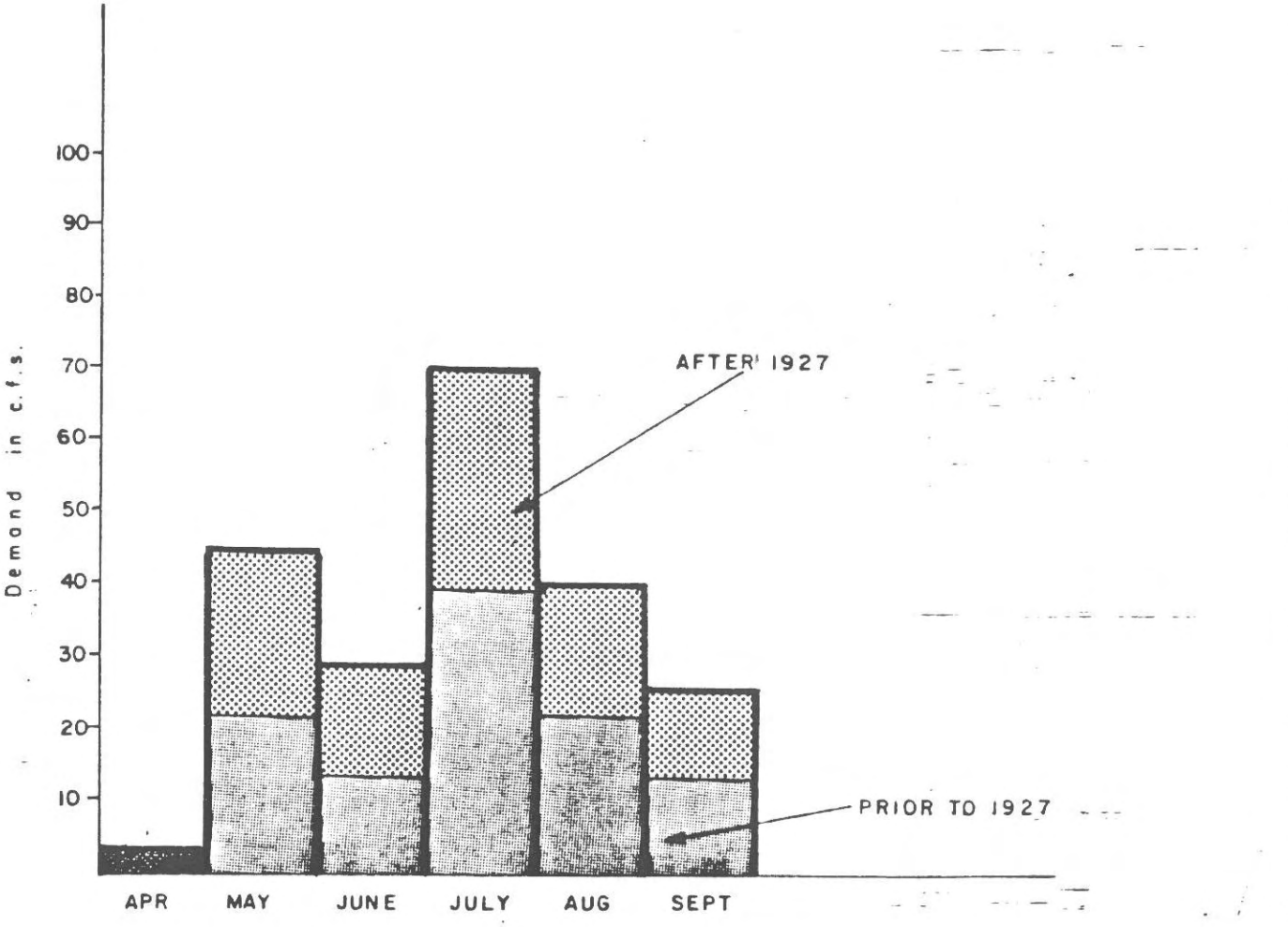
LICENCED USE OF WATER IN NICOLA RIVER DOWNSTREAM NICOLA LAKE

Withdrawals on Monthly Basis over Irrigation Season

Licenced use includes irrigation, waterworks and mining purposes but not domestic (insignificant)

Nicola Lake Dam was constructed in 1927.



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FILE No 0242512-164 DWG No A5316-16	

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FIGURE 3.1

Licences falling into this category authorize the withdrawal of 1476.3 acre-feet to irrigate 570.3 acres. They are listed in Table 3.1.

The 20 licences represent 30 percent of the total number issued but only cover 10 percent of the total land authorized to be irrigated (the restricted use licences are smaller on the average than the full irrigation season licences).

3.3 Historical Use of Water

Table 3.2 lists the water licences according to their priority date in 5-year groupings.

The most significant event to affect water use on the Nicola River has been the construction of the dam at the outlet of Nicola Lake. Prior to this date the flows in the Nicola River were unregulated or natural. After 1927 the storage significantly increased summer flows downstream as earlier discussed in 2.3 and shown in Table 2.1.

Eighteen licences were issued prior to 1927. Those licences authorize the withdrawal of 6715.2 acre-feet. Since 1927, 52 licences have been issued and these total 6274.4 acre-feet. On a volume basis, then, approximately one-half the authorized withdrawals were issued after the dam was built. On a number-of-licences-issued basis 75 percent (52 out of 70) of the water licences currently in existence were issued after 1927.

Figure 3.3 depicts the growth of licenced use of water out of the Nicola River.

3.4 Applications for Water Licences

Appendix C lists applications for irrigation water licences on the Nicola Lake and River made in the last five years. Nine applications have been

TABLE 3.1

RESTRICTED USE* IRRIGATION LICENCES ON THE NICOLA RIVER DOWNSTREAM OF NICOLA LAKE (as of January 25, 1982)

User Point No.	Licensee	Acres Irrigated	Quantity (acre-feet)
6	Douglas Lake Cattle Co.	15.0	45.0
12	Emmerick	.5	1.0
19	Collett	52.0	130.0
20	Thomas & Bevan	20.0	50.0
31	Gardner Ranch	90.5	226.5
33	Witt	.5	1.25
35	Sterling	100.0	250.0
42	Torgenson	24.0	72.0
43	Wilson	4.0	10.0
44	Cripps	60.0	150.0
45	Maaske	8.0	24.0
48	Johnston	20.0	50.0
54	Bukchuk & Kynoch	22.0	55.0
55	Bukchuk & Kynoch	85.0	212.5
60	Trinity Properties Ltd.	12.0	30.0
64	Whetstone	10.0	30.0
65	Smith	12.0	36.0
67	Nicola Lenora	2.8	7.0
69	Jeffries	20.0	60.0
70	O'Laughlin	12.0	36.0
	TOTALS (20 licences)	570.3	1,476.3

* Since 1970 all irrigation licences issued on Nicola River have been restricted either through time (not full irrigation season, say, only authorized to divert over April 1 to June 30 period) or through river flow (if river falls below certain flow then cannot divert).

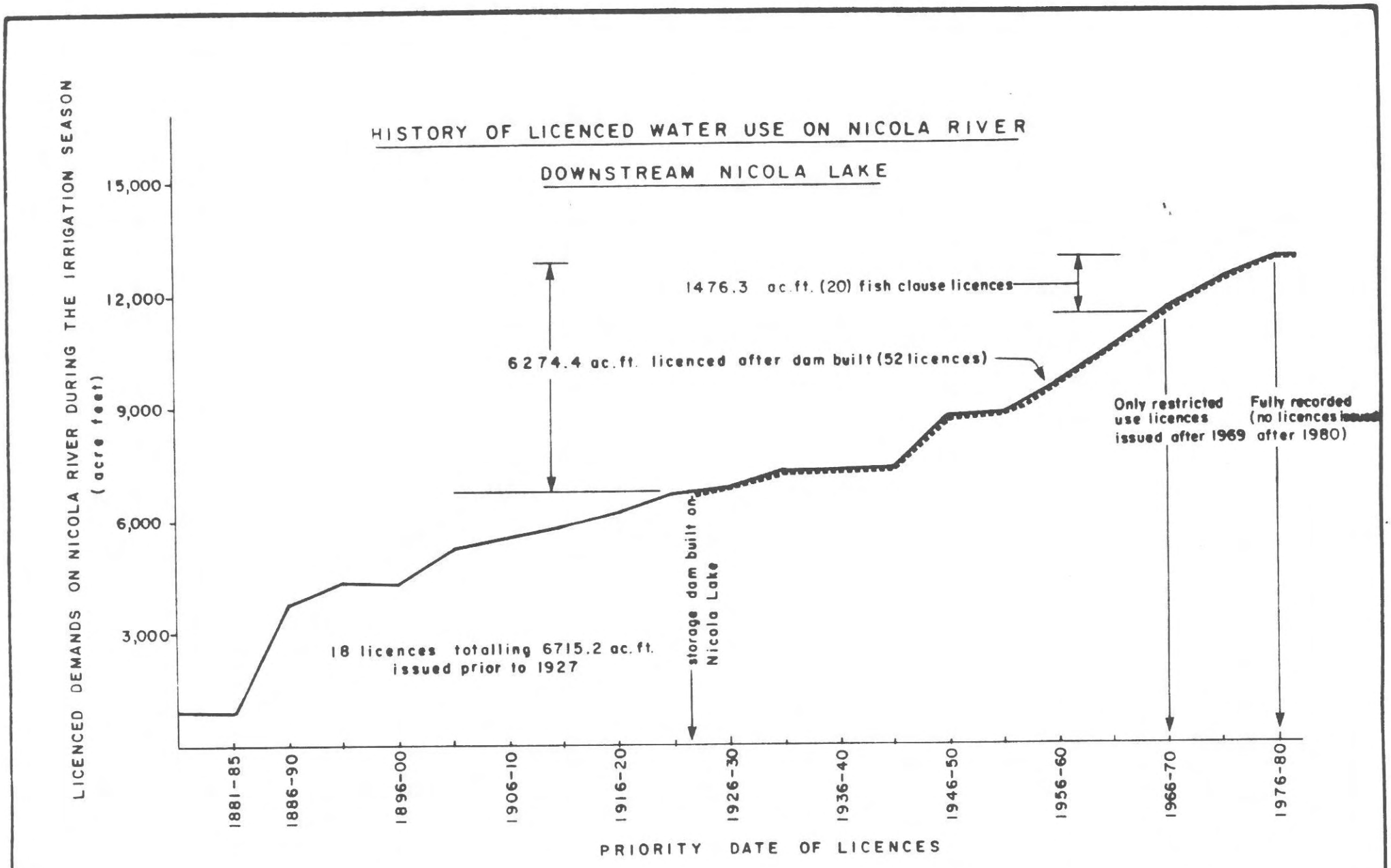
See Foldout 1 for location of point of diversion of licence.

TABLE 3.2

SUMMARY OF LICENCES ISSUED ON NICOLA RIVER IN 5 YEAR GROUPINGS AND LISTING USER POINT NUMBERS ONLY

Priority Date	Number of Licences in Period	User Point Numbers
1876 - 80	1	3
1881 - 85	0	-
1886 - 90	2	52, 57
1891 - 95	2	36, 53
1896-1900	0	-
1901 - 05	4	4, 16, 17, 18
1906 - 10	4	2, 21, 39, 46
1911 - 15	1	30
1916 - 20	1	5
1921 - 25	3	1, 26, 47
1926 - 30	1	23
1931 - 35	1	27
1936 - 40	2	37, 38
1941 - 45	1	71
1946 - 50	2	7, 51
1951 - 55	0	-
1956 - 60	1	24
1961 - 65	9	8, 9, 14, 22, 61, 63, 64, 66, 68
1966 - 70	17	10, 11, 13, 15, 25, 28, 29, 34, 40, 41, 50, 56, 59, 60, 62, 67, 72
1971 - 75	10	19, 35, 42, 43, 44, 45, 48, 65, 69, 70
1976 - 80	8	6, 12, 20, 31, 33, 54, 55, 64
TOTAL Number of Licences:	70	

* See Foldout 1 for location of point of diversion of licence.



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NICOLA LAKE

STORAGE FEASIBILITY STUDY

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APRIL 1982

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FIGURE 3.

made which involve 2555.75 acre-feet of water and 761.5 acres of land. Three of these applications have been refused thus far because of the policy of allocation of the remaining river flow (if any at times) to fisheries interests.

These nine applications attest to the growing demand for water which can be met by additional storage on Nicola Lake.

3.5 Required Storage to Support Current Licenced Demand

With one exception (C.L. 13193 held by Nicola Ranch Ltd. to irrigate 400 acres), none of the 66 irrigation licences and four other major use licences have upstream storage support. The amount of storage required to fully support these licences through July, August, September amounts to 8662 acre-feet* or 1.40 feet in Nicola Lake. "Fully support" is defined here as developing sufficient storage upstream and releasing it such that all licenced diversions are always using release (storage) water. In this manner, theoretically, the licences would never use any of the natural river flow during the river's low flow period. There would be no "mining" of the natural river flow.

A significant proportion of the water licences under discussion (measured either in numbers of water licences or volume authorized to be withdrawn) depend upon the regulated release of water from Nicola Lake. However, it is virtually impossible to determine at which point in time water licences issued thereafter were dependent on Nicola Lake storage. It follows that, if there is not a general acceptance by all licensees that the responsibility for providing and operating storage should be shared on a pro-rata basis, it will be difficult to determine which of the earlier licences could be exempted from the related costs.

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* 68% of 12,027.1 plus 1,433,000 $(3.67)(92)(10^{-6})$ = 8178 + 484 = 8662 acre-feet or 1.40 feet on Nicola Lake

3.6 Design Criteria for Storage for Agriculture

3.6.1 Number of Acres to Develop Storage For Agriculture

3.6.1.1 Gross Amount

Land within the Agricultural Land Reserve, with a capability rating of Class IV or better, within 200 feet elevation or three miles distance of the lake or river were the basic criteria used to determine the gross number of acres of land which could benefit from Nicola Lake storage*. These figures are adjusted downward in 3.6.1.3 to arrive at those used in the design. The office assessment was made on an individual farm by farm basis using aerial photos, ALR maps and topographic maps with the results tabulated in Appendix D and summarized as follows:

	Around Nicola Lake (acres)	Downstream Nicola Lake (acres)	Totals (acres)
Currently irrigated land	2,637	5,551	8,188
Potentially irrigable (unadjusted)	3,526	6,260	9,786
Totals	6,163	11,811	17,974

3.6.1.2 Land Currently Irrigated from Tributaries

In the ultimate irrigation development of the Nicola Valley it is possible that all land within our designated economically viable-to-irrigate distance which is currently irrigated from tributary streams, would be irrigated from Nicola River or Lake. Thus some storage could be provided on Nicola Lake for this switch-over. Presumably by doing so one would be maintaining some flexibility in the direction of improving water resource management. Provision of some storage for "switchovers" would "free-up" tributary water for other uses in that particular tributary sub-basin. For example, Nicola Ranch

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* These were the criteria used by Y. Bajard Associates Ltd. in its work in the Nicola Valley.

Limited is presently considering switching from Clapperton Creek to the Nicola River because of greater irrigation efficiencies. Fisheries managers have expressed an interest in the "freed-up" water.

It is believed to be simply too conservative to provide for 100 percent switch-over.

All of the 2637 acres of land currently irrigated around Nicola Lake, is irrigated from tributaries to Nicola Lake.

Downstream of Nicola Lake some 5551 acres are currently irrigated according to air photos (see Appendix D). In a farm-to-farm survey McNeil determined that approximately 4100 acres of land currently are irrigated from the Nicola River (see Reference 3, Appendix A). This would leave 5551 - 4100 = 1451 acres irrigated from tributaries.

It will be assumed in this report that storage will be provided in Nicola Lake for switch-overs to the following extent:

Around Nicola Lake 25% of 2637 or	659 acres
Downstream of Lake 87.5% of 1451 or	1272 acres
Total provision	1931 acres

3.6.1.3 Potentially Irrigable Land

The number of acres of land fitting into the category described in 3.6.1.1 but not currently irrigated was determined to be as follows:

Around Nicola Lake	3526 acres
Downstream Nicola Lake	6260 acres
	9786 acres

From air photo and ground inspections a good portion of the potentially irrigable land is believed to be simply too steep to irrigate. Therefore, a downward adjustment of one-third was made to the above numbers to account for this land steepness:

Around Nicola Lake 2/3(3526) =	2351 acres
Downstream Nicola Lake 2/3(6260) =	3925 acres
	6276 acres

3.6.1.4 Summary

The amount of land which would benefit from storage on Nicola Lake is composed of land around the lake and downstream along the Nicola River. An allowance has been made for land currently irrigated from tributaries to "switchover" to the Nicola River and Lake. Land not currently irrigated but believed to be irrigable has been determined. This information is summarized as follows:

		Around Nicola Lake	Downstream Nicola Lake	Totals
i)	Land currently irrigated from Nicola Lake or River	0	4,100	4,100
ii)	Land currently irrigated from tributaries (adjusted downward)	659	1,272	1,931
iii)	Potentially irrigable land (adjusted downward)	2,351	3,925	6,276
iv)	Ultimate design acreage:	3,010	9,297	12,307

3.6.2 Drought Condition to Design for Agriculture

In the Okanagan Valley the design criteria for determining the amount of storage required is to meet the demand through the 1929-31 runoff years,

which is the worst drought period of record. Fruit tree farming is the main agricultural demand use.

Crippen Consultants recommends a 1:15 year drought condition be used (see Reference 2, Appendix A).

Since the crop irrigated in the Nicola is alfalfa hay (which is more tolerant to drought conditions than fruit trees) a 1:5 year drought condition may be satisfactory.

McNeil (page 6, Reference 3, Appendix A) points out that fall watering is most important for forage plants to enable them to go into winter in a healthy condition thus maintaining a high quality crop over a longer period. Further he points out that all crops will be stronger and more disease resistant if not stressed by lack of water.

The Regional Water Manager prefers using a 1:20 year drought for reservoir design. He points out that designing for this degree of severeness will involve very little additional storage and he believes it would be easily justified in terms of incremental benefits/costs (Reference 11, Appendix A).

Other factors to be considered in selecting the design drought condition for agriculture:

i) Over the life of the structure is there a possibility of changing to higher productivity crops which are more drought sensitive?

ii) How much more storage (i.e. cost) is involved in going to a more conservative design drought? (As will be discussed later in 6.1, the additional storage in going from a 1:5 to a 1:15 year drought condition for <u>both</u> agricultural and fisheries interests amounts to 0.91 feet on Nicola Lake.)

iii) How much confidence is put in the accuracy of the irrigation demand estimates (duty of 2.5 feet, monthly apportionment of demand: July-36 percent, August-20 percent and September-12 percent)?

iv) How efficient will the operation of the reservoir be? the operation of each individual irrigation system?

v) The more conservative design drought condition selected should result in less water use conflicts which in turn should translate into less time demanded of the Regional Water Manager.

vi) Should the Provincial Government have a uniform policy throughout the Province?

vii) There is some validity in selecting a conservative design drought condition for a major structure which has a life expectancy of over 50 years.

This report has selected a 1:15 year drought condition to design for in the determination of the amount of storage required for agricultural interests.

3.7 Agricultural Benefits

Information in this section has been extracted from Reference 3, Appendix A.

The economic analysis of the agricultural benefits and costs followed those guidelines as set out by the ARDSA Part III Technical Subcommittee. A 25-year period of analysis and ten percent discount factor were used in the present worth calculations.

Briefly, the main assumptions made were as follows:

i) The increased forage production would be utilized on-farm (i.e. less hay would have to be purchased).

ii) The increased market garden vegetables would be sold the same as they are now sold, through roadside stands.

iii) With the additional water available after June 30th all land currently irrigated by "fish clause" licences would produce an additional one ton per acre.

iv) The estimated yield during the first year of hay production was 2 1/2 tons per acre valued at $75 per ton. Thereafter the yield increased to four tons per acre and the price $85 per ton. On-farm expenses were $109.13 per ton during the first year and $44.50 per ton thereafter.

The estimated yield on sweet corn was 800 dozen per acre and selling price of $1.35 per dozen. On-farm costs were estimated at $0.95 per dozen.

The estimated yield on potatoes was 12 tons per acre and selling price $240 per ton. On-farm expenses were estimated at $150 per ton.

v) Good on-farm water management would occur with the new dam.

vi) Nicola Ranch would switch its source of supply from Clapperton Creek to the Nicola River because of the high cost of rebuilding the storage dams in the Clapperton Creek valley.

Currently about 4100 acres are irrigated directly from the Nicola River downstream of Nicola Lake. Existing hay production is estimated at 9600 tons. From a farm-to-farm questionnaire survey conducted last year, the farmers involved advised the land they would probably place into production and require irrigation water for in the foreseeable future (within ten years) would total 6960 acres*.

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* This figure was used in the benefit analysis although storage has been provided for the estimated ultimate number of acres to be irrigated (12,307 acres).

Three situations were examined: removal, repair and dam replacement.

i) Dam Removal - it was estimated that 40 percent of production would be lost (only one cut of hay could be harvested because the river would either be dry or no irrigation would be allowed because of a desire to maintain fisheries resource maintenance flows). Water would be available only during the freshet period. It was assumed that sweet corn, vegetables and fruit crops could not be grown. Estimated present worth of agricultural benefits (loss) = ($1,375,500).

ii) Dam Repair - Current production would be maintained. There would be no expansion of the current land base as the Nicola River has been considered fully recorded since 1970. There may be some minor increases in production due to better and more efficient use of water. Estimated present worth of agricultural benefits due to dam repair is equal to the loss prevented or $1,375,000.

iii) Dam Replacement - It has been estimated that 6960 acres of land (4100 existing, 1200 Nicola Ranch Ltd. switchover and 1660 new land) would be in production in the foreseeable future (within ten years) due to the availability of water. This land base would produce 20,200 tons of hay annually. The present worth of agricultural benefits due to replacing the dam is estimated to be $4,359,000. This amount includes the benefits to be gained by the Nicola Ranch Ltd. in switching to a pumped sprinkler irrigation system from the Nicola River to irrigate some 1200 acres of land. Currently this land is irrigated by ditch and flood method from Clapperton Creek but substantial rebuilding of storage works in the Clapperton drainage will be required if no switchover takes place.

In summary the present worth of the agricultural benefits for the three scenarios considered are as follows:

i)	Remove dam	($1,375,000)
ii)	Repair dam	$1,375,000
iii)	Replace dam	$4,359,000

Costs associated with these alternatives are discussed in 6.1 and 7.3

4. FISHERIES INTERESTS

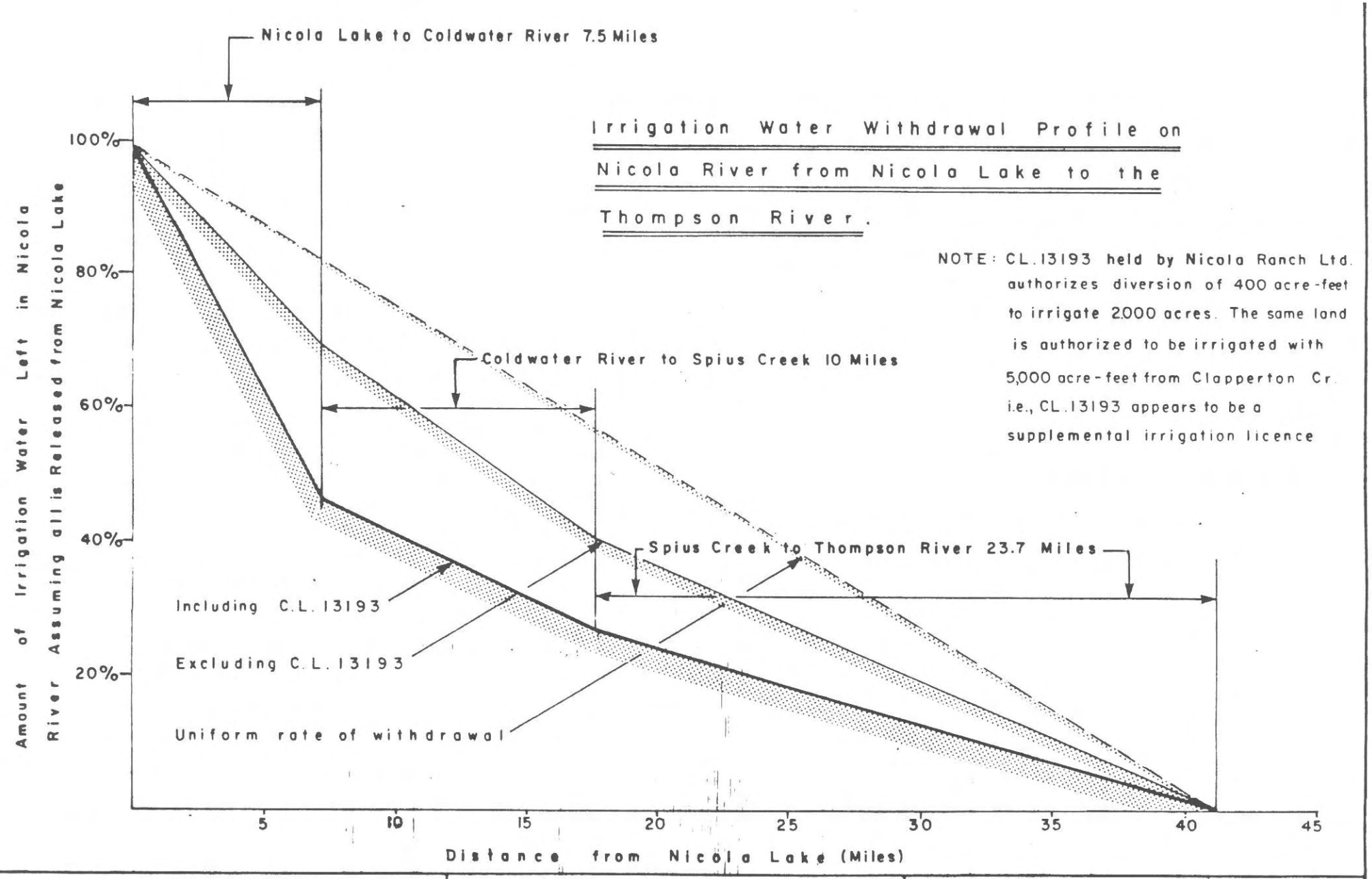
4.1 General

The greatest part of the information contained in this section has been extracted from the Nicola Strategic Plan Technical Document (see Reference 6) the greatest part of which, in turn, was supplied by Fisheries and Oceans Canada.

The Nicola River is the largest tributary to the Thompson River below Kamloops Lake that supports anadromous fish (chinook, coho and pink salmon) and steelhead trout. The mainstem Nicola is not only an important spawning and rearing habitat, it also serves as a major transportation corridor for anadromous fish who migrate into tributaries. These tributaries also support significant stocks of juvenile and adult salmonids. The importance of maintaining adequate flows and quality habitat in the mainstem Nicola cannot be over-emphasized. It will be shown that storage on Nicola Lake is essential to maintenance of these desired flows.

4.2 Maintenance Flows

Resource managers use the term "maintenance flows" or "Fisheries Resource Maintenance (FRM) flows" to define the amount of water believed necessary to maintain the natural productive potential of habitats. These flows have been defined after extensive analysis during the August-November spawning and rearing period and for the December-April incubation and over wintering period (for salmonids). Higher flows are required during the freshet (May-July) to clear the gravels in the spawning areas. Chinook, coho and pink salmon spawn during the August-November period. Steelhead trout spawn during the April-June period. The desired FRM flows (in cfs) for the Nicola River are as follows:



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SEPT. 1982

L. A. BERGMAN ENGINEER

FILE No. 0242512-164 DWG No. A 5316-18

FIGURE 4.1

	Aug-Nov	Dec-April
Nicola Lake to Coldwater	60	40
Coldwater to Spius	110	110
Spius to Thompson River	200	200

These flow estimates may be refined further following additional analysis.

Fisheries and Oceans Canada like to think of flows being released from Nicola Lake to ensure the FRM flows occur in the above noted reaches. As such the release flows could be considered "topping up" flows. Under this type of reservoir regulation in some months more than what is required in the 1st reach (say 60 cfs) may be required to achieve the FRM flows downstream (110 cfs 2nd reach and 200 cfs 3rd reach) because of insufficient tributary inflow.

This type of reservoir operation at times would be in conflict with a desire to develop some carry-over storage (see 7.2 for a discussion of possible reservoir operation).

Note there has been no dependency of the FRM flows on the irrigation water release flows. Both have been determined separately. The irrigation water is released from Nicola Lake and is withdrawn from the river at many locations downstream. A profile of the irrigation water remaining in the river at certain locations is shown in Figure 4.1. Note that most of the currently licenced diversion takes place in the reach between Nicola Lake and Coldwater River. Fifty-three percent (53%) of the demand is withdrawn in this reach. Between Coldwater and Spius another 20 percent is withdrawn leaving 27 percent to be withdrawn between Spius and the Thompson River.

TABLE 4.1

Comparison of Fisheries Resource Maintenance Flow to Existing Flows[1] on the Nicola River August - November Period

(figures in cubic feet per second)

(1) Nicola River - Nicola Lake To Coldwater

Month	FRM Flow	Estimated Existing Flow (with Dam)			
		1:2	1:5	1:10	1:20
August	60	111	84	74	68
September	60	68	52	49	47
October	60	67	54	46	39
November	60	60	32	20	12

(2) Nicola River - Coldwater River to Spuis Creek

August	110	163	112	95	84
September	110	108	74	65	60
October	110	141	98	80	66
November	110	165	93	65	47

(3) Nicola River - Spius Creek to Thompson River

August	200	327	222	179	146
September	200	215	158	140	130
October	200	255	182	154	136
November	200	320	200	157	130

1 - Planning Branch estimates.

No assessment has been made whether or not this use pattern would change much when all the benefitting lands are irrigated.

The greatest value of these irrigation water release flows appears to be in improving the rearing habitat. They would be of limited value for migrating fish because, as shown in Figure 4.1, there should be nothing available at the mouth of the Nicola River (i.e., the fish must get into the river in order to utilize the release flow).

Until the new land included in the design acreage is irrigated the storage and release flow for this purpose would be available for maximum fisheries benefit.

There would be some irrigation water returned to the river through underground seepage and this would be available to fisheries.

4.3 Importance of Existing Nicola Lake Outlet Structure to Fisheries

A comparison of the FRM flows and existing Nicola River flows is made in Table 4.1, for the August-November period. The following observations can be made:

i) From Nicola Lake to the Coldwater River, the FRM flows are only achieved in August for all drought conditions assessed (up to 1:20 year). The FRM flows are met only for the average runoff or wetter conditions.

ii) From Coldwater River to Spius Creek, the FRM flows are only achieved during August up to the 1:5 year drought condition, not at all in

TABLE 4.2

CURRENT AND OPTIMUM SALMON PRODUCTION AND ANNUAL VALUE IN NICOLA BASIN

		CURRENT PRODUCTION					OPTIMUM PRODUCTION				
SYSTEM	SPECIES	ESCAPEMENT	CATCH	TOTAL	C/E RATIO	VALUE ($1982)	ESCAPEMENT	CATCH	TOTAL	OPTIMUM C/E RATIO	VALUE ($1982)
Nicola River	chinook	3320	14,940	18,260	4.5:1	436,194	7,000	21,000	28,000	3:1	613,231
	coho	325	975	1,300	3:1	17,833	950	1,900	2,850	2:1	34,748
	pink	708	1,983	2,691	2.8:1	11,389	780	1,983	2,691	2.8:1	11,389
						465,416					642,515
Coldwater River	chinook	572	2,574	3,146	4.5:1	75,163	1,500	4,500	6,000	3:1	131,406
	coho	445	1,335	1,980	3:1	24,404	3,000	6,000	9,000	2:1	109,733
						99,567					241,139
Spius Creek	chinook	136	612	745	4.5:1	17,919	750	2,250	3,000		65,681
	coho	231	693	924	3:1	12,681	600	1,200	1,800		21,948
						30,600					87,629
Total	chinook	4028	18,126	22,151		529,276	9,250	27,750	37,000		810,318
	coho	1001	3,003	4,004		54,918	4,550	9,100	13,650		166,429
	pink	780	1,983	2,691		11,389	708	1,983	2,691		11,389
System Total		5737	23,112	28,846		595,583	14,508	38,833	53,341		971,283

Source: Reference 4, Appendix A

Notes: The "optimum" production estimates are based on maintenance flows set out in Nicola Strategic Plan. Higher levels of productivity might be obtained if additional flows were available.

Production levels include estimate of U.S. catch (approximately 5-10 percent of annual amounts)

September and only for the average flow condition for the months of October and November.

iii) From Spius Creek to the Thompson River the existing flows with respect to the desired FRM flows are somewhat better. During August the FRM flows occur to at least the 1:5 year drought condition, in September the FRM flows only occur during an average runoff year or wetter, and during the months of October and November the FRM flows are achieved to at least the 1:5 year drought condition.

In general then, the existing flows in the Nicola River only provide the desired FRM flows in average or wetter than average runoff years. Some improvement in these flows is believed possible if the existing storage in Nicola Lake was regulated for this purpose.

See 2.3 regarding the significance of the existing Nicola Lake dam to the existing Nicola River flows. The conclusion drawn in that Section was that abandonment of the storage water right and removal of the dam would have a severe impact on Nicola River flows and hence fisheries.

4.4 Current and Potential Production

i) Chinook

Current production in the Nicola River is estimated to be 18,240 fish which represents 82 percent of the entire Nicola basin production of 22,200 (see Table 4.2). Optimum production in the Nicola River is estimated at 28,000 fish, an increase of 53 percent over current production levels.

ii) Coho

Current production in the Nicola River is estimated at 1300 fish which represents 32 percent of the basin total of 4000 (see Table 4.2). Optimum production would increase the number of coho in the Nicola to 2850 fish, an increase of 120 percent over current production levels.

iii) Pink

Current production in the Nicola River is estimated at 2700 fish (see Table 4.2). This represents the entire Nicola basin production. No specific enhancement measures are being contemplated for pink salmon in the Nicola at the present time.

iv) Steelhead

Current production of steelhead in the Nicola River is estimated at 4900 fish. This represents 77 percent of the basin's production of 6400. Optimum steelhead production in the Nicola River is believed to be some 12,000 fish which represents an increase of approximately 150 percent over current production levels.

4.5 Design Drought Condition for Fisheries

What should be the drought return period for the fisheries resource maintenance flows? What degree of "assurance of occurring" should be designed for?

Fisheries and Oceans Canada have indicated that if the opportunity is available to provide a regulated release from a storage dam these FRM flows should be considered "minimum guaranteed" flows (see Reference 8, Appendix A). This would seem to mean one should be designing to provide storage for a fairly conservative drought condition (ie. 1:15 year return period). Provision of storage to capture snowmelt runoff to be later released, when natural flows fall below the desired FRM flows for a 1:15 year drought condition, would then qualify these flows to be labelled or referred to as being "minimum guaranteed."

For the fisheries resource maintenance flows in the Bessette Creek Watershed Study, the design drought condition selected was 1:20 years (see page 8, Reference 7, Appendix A). The fish involved were chinook and coho salmon, resident sports fish and kokanee, almost identical to those we are concerned with in the Nicola. Members of the committee included staff from

Fisheries and Oceans Canada and the Fish and Wildlife Branch, Ministry of Environment.

In the determination of the desired FRM flows in Deadman Creek, Fisheries and Oceans Canada referred to these flows as "guaranteed" flows (page 10, Reference 12, Appendix A). The amount of upstream storage required was determined by comparing the FRM flows with flows in Deadman Creek in 1970-71 which was referred to in the report as a "dry" runoff year. Subsequently the Hydrology Section, Water Management Branch, estimated the 1970-71 runoff year had a drought return period of 1:15 years (Reference 13, Appendix A).

Another point to be considered is that the design drought condition for a multi-purpose storage project should be the same for all purposes. In the Nicola Lake storage case the two main purposes are fisheries and agriculture. One would think that only the release period during July, August and September, when both uses would be drawing on the storage water, would there be a concern for conformity. However, if carry-over storage is involved, which is the case with the Nicola, it is extremely important that both purposes use a common design drought condition. Here all months of the year would be important, not just when the releases were taking place. The reason this is of concern has to do with the drought condition itself. One simply does not know the severity of a drought (i.e. 1:5, 1:15?) until it's over and rated with other droughts. Using the same design drought condition will simplify the reservoir release operation. It should avoid the problem or possible conflict regarding how much flow one party is entitled to vis à vis how much he has cost-shared for.

In summary the design drought condition selected for the FRM flows in the Nicola River is the 1:15 year drought, the same as for Agriculture.

4.6 Required Storage for Fisheries

Having selected the desired flows for fisheries and the drought condition to design for (water supply available), one should be able to determine

TABLE 4.3

Required Storage on Nicola Lake in 1:15 year Drought to Meet Ultimate Irrigation Demand plus Fisheries Resource Maintenance Flows

(all figures expressed in terms of depth of water on Nicola Lake in feet)

Month	Irrigation Demand[1]	Other Licenced Demand[2]	FRM Flow[3]	Lake Evaporation[4]	Lake Inflow[5]	Deficit	Accum. Deficit
Jan.	0	.03	.4	0	.11	.32	6.53
Feb.	0	.02	.4	0	.15	.27	6.80
March	0	.03	.4	0	.15	.28	7.08
April	0	.02	.4	0	.47	(.05)	
May	1.00	.03	.4	.34	4.15	(2.38)	
June	.60	.02	.4	.20	3.03	(1.81)	
July	1.79	.03	.4	.62	1.16	1.68	1.68
Aug.	1.00	.03	.6	.34	.34	1.63	3.31
Sept.	.60	.02	.6	.21	.19	1.24	4.55
Oct.	0	.03	.6	0	0	.63	5.18
Nov.	0	.02	.6	0	.02	.60	5.78
Dec.	0	.03	.4	0	0	.43	6.21
TOTALS	4.99	.31	5.60	1.71	9.83		

1 - Ultimate number of acres of land which could be irrigated by Nicola Lake Storage Project = 12,307 acres. See L.A. Bergman to J.V. Eby memo of April 15, 1982, WMB file 0242512-164.

2 - Existing licenced demand other than irrigation = 1,433,000 gpd. See Bergman to Eby memo of April 29, 1982, WMB file 0242512-164.

3 - See letter of March 31, 1982 to J. O'Riordan from R. Bell-Irving, WMB file 0242512-164.

4 - See memo to file of July 22, 1982, WMB file 0242512-164 (evaporation assumed to be equal to the May-September potential evapotranspiration; monthly breakdown same as irrigation demand.

5 - Sept. 1982 estimate by Brian Guy, Planning Branch. (Nicola Lake inflow equal to sum of runoff from three tributary sub-basins: Stump-Moore plus Upper Nicola plus Quilchena.) Precipitation assumed to be zero.

the amount of storage required. However, before this can be done a decision must be made as to who gets first priority, second priority, etc., on the natural water supply.

Under the Water Act, a legal right to divert and use water can only be obtained under a water licence issued under the Act. Generally, the relative priority of licences on a source of water is established chronologically, the earlier licence taking priority over the later unless the terms and conditions in any licence or licences state otherwise.

As discussed in 3.2, some licences contain a "fish clause" which, in effect, states that, in a dry year, the licensed amount may be curtailed in order to preserve fisheries resource maintenance flows.

For the purposes of this report it is assumed that, in general, existing licences would have first priority followed by FRM flows and by any new licensed demand, in that order. The non-irrigation licensed demand (waterworks, mining, industrial, but excluding domestic) has been included with the irrigation demand.

The required storage on Nicola Lake to meet the identified demands in a 1:15 year drought is determined in Table 4.3 and amounts to 7.08 feet in depth in total. This demand and water supply is portrayed in hydrograph form in Figure 4.2. Following the priority assumption above, the amount of storage required to meet the FRM flows desired was determined to be 4.07 feet and this determination is portrayed graphically in Figure 4.3.

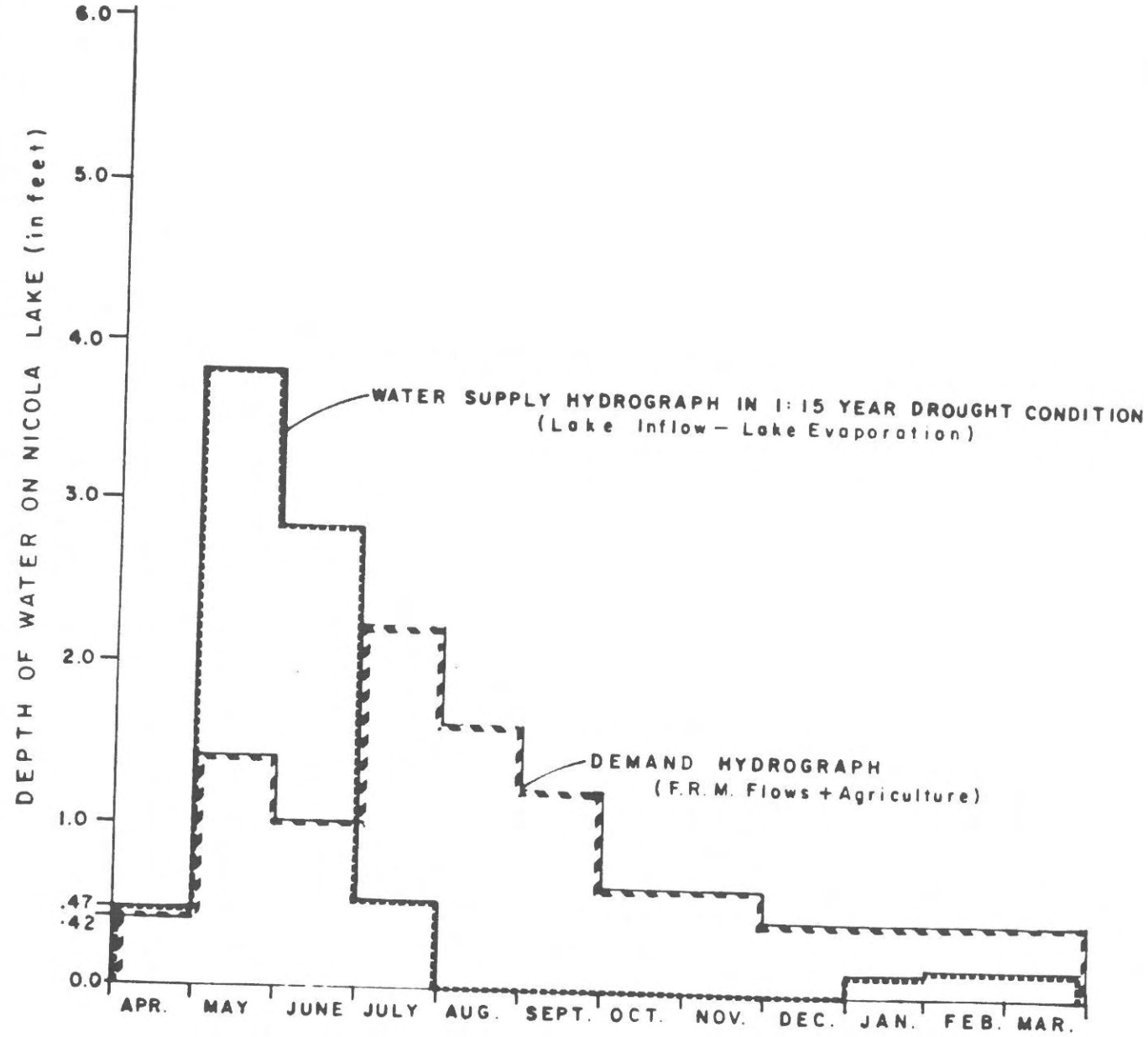
Of interest, it should be noted that if the priorities were reversed, i.e. the FRM flows were allocated all the available water supply first, the reduction in storage for the FRM flows would only be 0.40 feet.

4.7 Fisheries Benefits

The annual values and present worths of current and optimum production of the anadromous fishery of the Nicola River are listed in Table 4.4.

Water Supply and Demand Hydrographs for Nicola Lake

1:15 year drought condition Ultimate Irrigation demand and Fisheries Resource Maintenance Flows.



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TO ACCOMPANY REPORT ON
NICOLA LAKE
STORAGE FEASIBILITY STUDY

SCALE VERT .....
HOR .....
DATE SEPT 1982

L. A. BERGMAN ..... ENGINEER
FILE No 0242512-164 DWG No. A 5316-22

BCIL 7873-M E

FIGURE 4.2

Required Storage on Nicola Lake in 1:15 Year Drought

Portrayal of monthly deficits (demand less natural flow) and hence volume which must be captured in order to meet demand.

Existing demand = .94 ft.
Additional demand = 2.07 ft.
} 3.01 ft.

F.R.M. flow = 4.07 ft.

Required Storage = 7.08 ft.

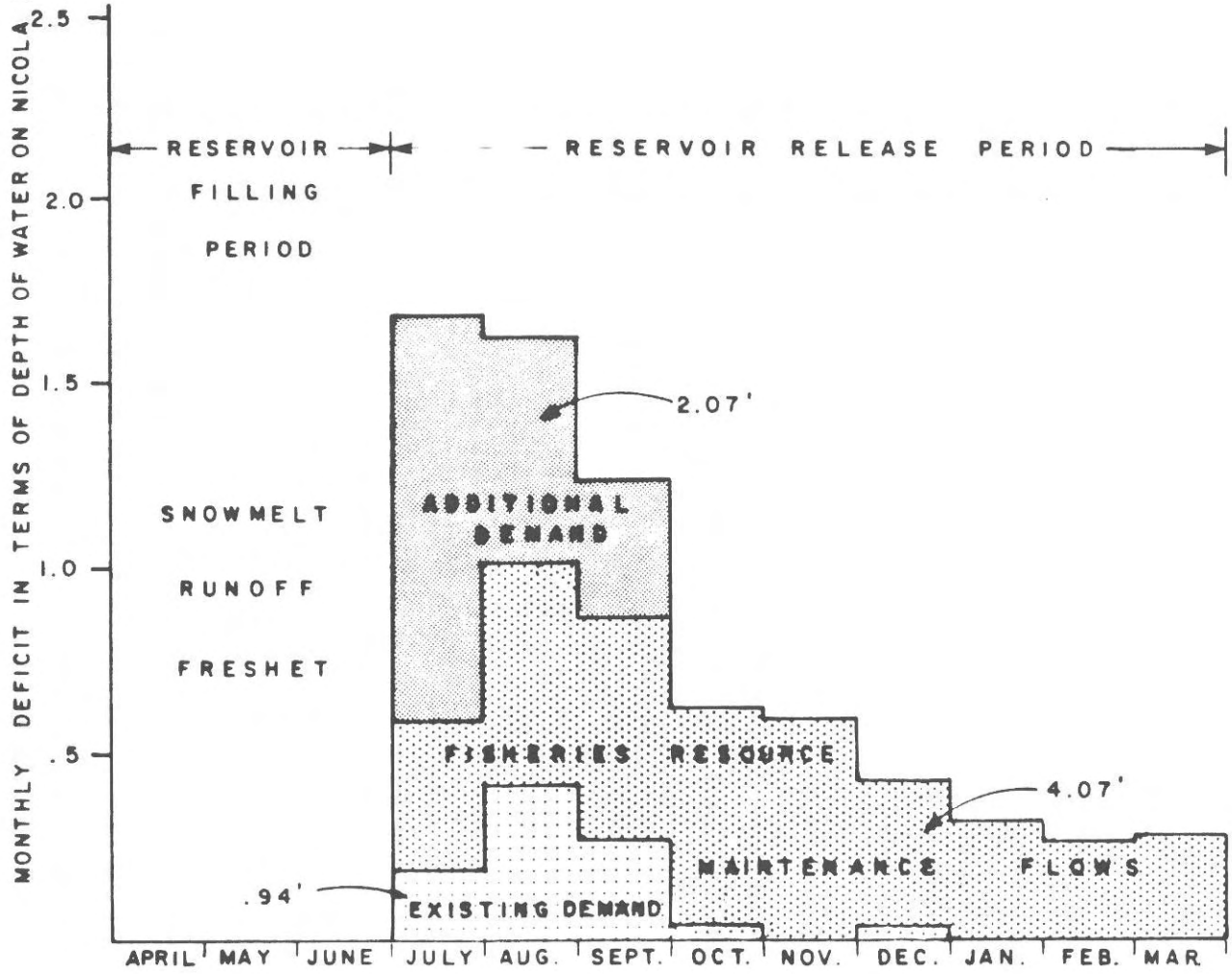

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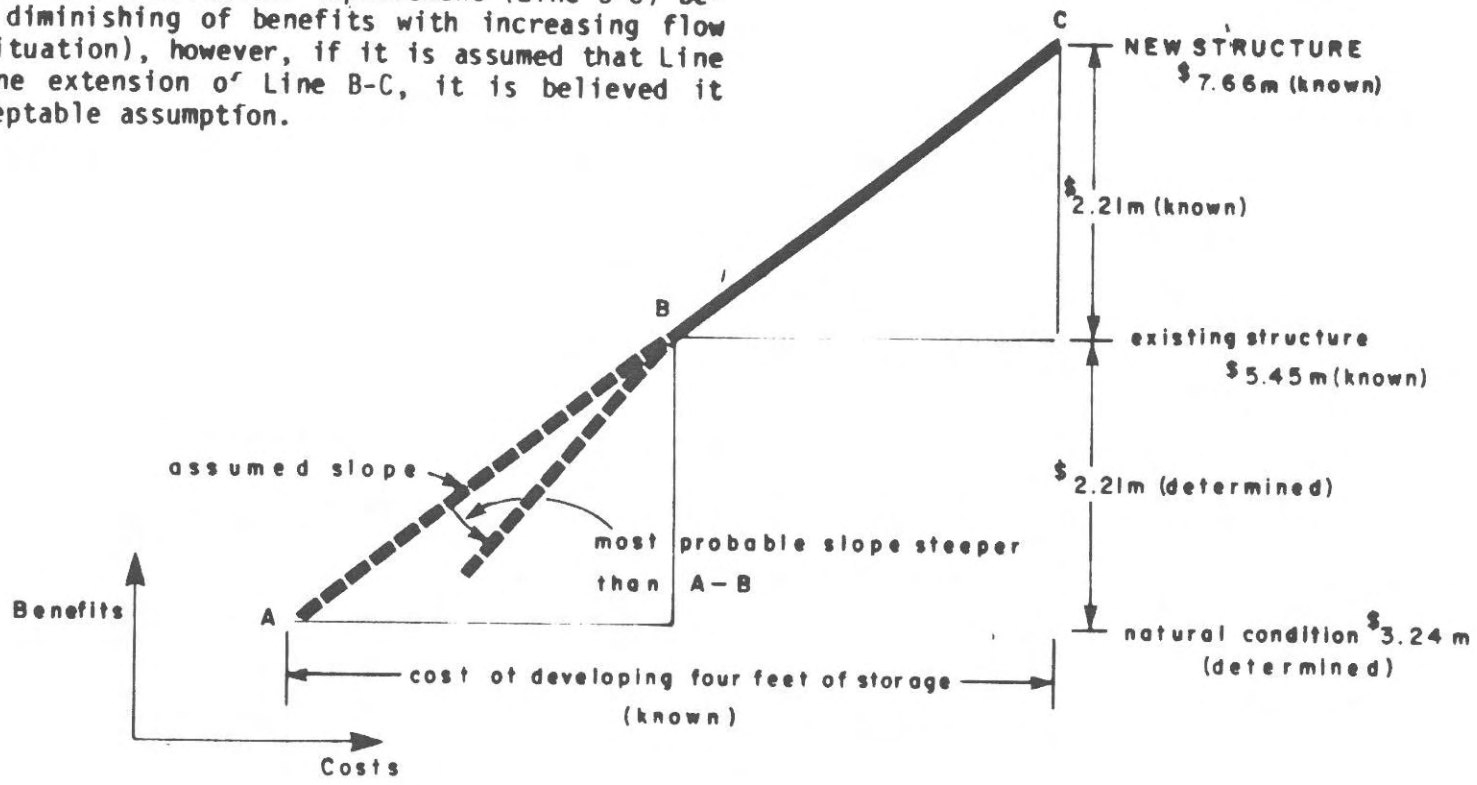
FIGURE 4.3

Most probable slope of first incremental improvement (Line A-B) is that it is steeper than next incremental improvement (Line B-C) because of fall-off or diminishing of benefits with increasing flow improvement (normal situation), however, if it is assumed that Line A-B is a straight line extension of Line B-C, it is believed it would be quite an acceptable assumption.



DETERMINATION OF THE VALUE OF THE EXISTING STRUCTURE TO FISHERIES

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Province of British Columbia Ministry of Environment WATER MANAGEMENT BRANCH	TO ACCOMPANY REPORT ON NICOLA LAKE STORAGE FEASIBILITY STUDY	SCALE VERT HOR	DATE MARCH 1983
		L. A. BERGMAN	ENGINEER
		FILE No. 0242512-164 DWG No.	A 5316-19

FIGURE 4.4

Table 4.4

Annual Value and Present Worth of Current and Optimum Levels of Production of the Fishery of the Nicola River

	Current Production		Optimum Production	
	Annual Value	Present Worth	Annual Value	Present Worth
Steelhead	$167,500	$1,520,300	$ 408,800	$2,741,100
Salmon	$432,900	$3,929,600	$ 613,500	$4,918,900
Totals:	$600,400	$5,449,900	$1,022,300	$7,659,900

Source: see Reference 10, Appendix A.

These values are considered to be at the wholesale price level less management costs. They were determined with the following assumptions:

i) The annual value of salmon production does not include the value of U.S. catch,

ii) Production increases to optimum levels would occur over a five year period and benefits would accrue three to six years later depending on the species,

iii) Rough estimates of the costs of fry stocking were subtracted from the benefits when calculating present worth of optimum production, and

iv) A discount rate of 10 percent and 25 year period of analysis were used in the calculation of the present worths.

It is assumed that the optimum level of production would be achieved with the new dam which would provide the amount of required storage to meet the desired FRM flows in a 1:15 year drought runoff condition.

The worthiness of participating in the construction of the new structure should be determined using net benefits. From Table 4.4 the net benefit of the new structure, from that which currently exists, would be the difference between the present worths at optimum and current level of production ($7,659,000 - $5,449,000 = $2,210,000). The amount of storage provided for the FRM flows from the existing level of storage to that which would be provided by a new structure is two feet (this is the amount required as determined by Fisheries and Oceans Canada - see page 30, Reference 4, Appendix A). However, to assess the full net benefit of storage to fisheries the difference between the level of production with the new dam and no dam at all should be used. It is difficult to estimate the value of the Nicola River fishery prior to when the dam was constructed in 1927. There simply isn't much information available before this time on which to base an estimate. One way could be by studying the estimated flows of the Nicola River without the dam (Table 2.1) and applying the same assessment techniques as used to estimate the FRM flows. Another shorter and simpler approach, which perhaps is more suitable or appropriate to our purposes considering our limited information of that time, is to project today's estimates of fisheries values backwards and by making some assumptions.

The existing licenced demand downstream of Nicola Lake requires one foot of storage on Nicola Lake in order to manage a 1:15 year drought runoff condition (our assumed design drought - see Figure 4.1). The existing dam can store three feet of water. If it is assumed that the balance of the storage which has been developed <u>but not licenced for the FRM flows</u> is for the FRM flows (although neither the downstream licenced water users or fisheries have any legal right to the existing storage, the fact that the Nicola River has been considered fully recorded since 1970 would imply the balance of the storage could be for FRM flows), then one can state that the amount of storage provided by the existing structure for FRM flows is approximately two feet (this discussion ignores the actual storage water right and assumes a situation whereby arrangements might take place to look after the existing structure - see Section 6). This is the same incremental amount of storage as

provided in going from the current structure to a new structure. Further, if the incremental storage provision is the same (natural to current as current to optimum), it would seem reasonable to assume the net benefits of developing this storage would be the same; i.e. the net beneift of the existing structure to fisheries would be approximately $2,210,000.

The estimate of this benefit is based on nothing more than the observation that, normally, when one is improving flows in a stream the first increment of improvement is more beneficial than the next and those that follow. Applied to development of storage on Nicola Lake the benefits to fisheries of the first two feet of storage (natural to current production levels) would be greater than developing the next two feet of storage (current to optimum levels). If this is so, then our assumption that the incremental benefits would be the same (natural to current as current to optimum) would be a conservative or possibly under estimated value (see Figure 4.4). Based on an incremental net benefit of $2,210,000 (natural to current level of production), the value of the Nicola River fishery under natural conditions or at the base level of production would then be $5,449,000 - $2,210,000 = $3,239,000. Finally, the net benefit of constructing a new dam (natural to optimum levels of production) would be the sum of the net benefits of the two increments of storage development or $4,420,000.

Summary of Net Benefits of New Structure to Fisheries

Incremental storage development	Net Benefit
Natural to current	$2,210,000
Current to optimum	$2,210,000
Natural to optimum	$4,420,000

5. OTHER BENEFITTING USES

5.1 Flood Damage Prevention

The main problem caused by high river flows in the Nicola Valley downstream of Nicola Lake is erosion, not land inundation by high flood water levels. These high river flows are caused mostly by the two major tributaries to the Nicola River, the Coldwater River and Spius Creek. The contribution from Nicola Lake to Nicola River flows at Merritt (downstream of Coldwater confluence) constitutes about 30 percent of the total peak daily flow on average. A frequency analysis of maximum daily discharges indicates the 1:10 year return period flow to be 4660 cfs. If the Nicola Lake outflow peak discharge coincided with the peak on the Coldwater River, the flow reduction as a consequence of the new structure would be about 175 cfs or only four percent of the total flow. Therefore, the flood control benefits of the new structure would be fairly minimal at Merritt. The main benefit of reduced flows would be reduced erosion of the riverbanks upstream of the Coldwater River confluence (Reference 9, Appendix A).

Because the new structure would have a lower sill elevation than the existing structure, it would be able to discharge greater flows at any given lake level. Generally, this feature would result in lower maximum lake levels during the freshet period. This lower maximum lake level may be as much as two to three feet in high runoff (inflow) years (illustrated in Figure 7.1). The lower sill also means that a greater quantity can be discharged when there is low inflow - see Figure 7.1.

5.2 Water Quality Improvement

Increased storage on Nicola Lake would ensure greater flows during the low runoff period. This would give the Nicola River a greater capacity to dilute waste loadings.

No specific quantity of storage has been allocated for water quality improvement. It is believed the improvement would be accomplished through that required for the fisheries resource maintenance flows.

5.3 Miscellaneous Benefits

The project would provide the opportunity to construct water fowl islands in the 15,000 foot long shallows area at the outlet of Nicola Lake with the spoil material from the ditching operation.

Improved river flows would improve the aesthetic value of the river. Opportunities for canoeing and kayaking on the river would be increased.

There may be some benefit associated with the greater beach area exposed during the late summer (not necessarily an annual occurence; probably only occurs in less than average runoff years - see Figure 7.1.)

6. REPAIRING THE EXISTING DAM

6.1 Arrangements Necessary

The focus of this report is on the construction of a new dam at the outlet of Nicola Lake. If the objectives are to secure a safe dependable source of supply for existing users, to enable new land to be irrigated and at the same time establish FRM flows, then more storage will be required than

what is presently available. Put another way the existing dam is simply inadequate to meet the desired downstream demands. The amount of additional storage would be substantial. In the opinion of the writer it is so much that it cannot be developed in any one reservoir location upstream of Nicola Lake without causing severe environmental problems (the required additional four feet of water on Nicola Lake would be equivalent, approximately, to 16 feet on Douglas Lake). There is some possibility it could be developed at several locations upstream but hardly cheaper than on Nicola Lake. Repairing the existing dam should not be viewed as part of a comprehensive development with several other storage reservoirs as an alternative which is comparable in cost to a new dam on Nicola Lake. Rather, repairing the existing dam should be considered as essential and necessary if no new dam is to be constructed. As discussed in 2.3 and 3.5 there is a dependency by licenced water withdrawers and fisheries on the regulated release of water brought about by the existing dam. These users would be well advised to initiate the required legal, administrative and cost-sharing arrangements to ensure the regulated release of water will continue, if no new dam is to be built. The key arrangements would be:

i) Administration - all existing licensees who hold diversion licences and all landowners who are potential licensees, should form an agency such as an Improvement District having powers to assess and collect monies to meet the costs of the initial dam repairs and the future operating and maintenance costs.

ii) Water Rights - having formed the agency referred to in i) above, and having reached tentative agreement with the existing owner of the dam, it will be necessary to consult with the Comptroller of Water Rights to obtain an indication of the terms he considers proper to transfer the appurtenancy of the licence to lands administered by the agency and to equitably effect the transfer and amendment of the licence.

iii) Subject to i) and ii) above, the agency should negotiate a cost-sharing agreement with Federal Fisheries which reflects the pro-rata interest in the storage provided by the dam.

6.2 Costs

It is assumed that the existing dam and a reasonably sized area there around would be acquired by the joint users at no cost to them.

A very rough estimate of the cost of the repairs is $300,000. The work required to bring the dam up to a satisfactory standard may include the following:

- new gates and access walkway,
- miscellaneous concrete patching (dental work),
- filling in of downstream undermined area,
- building up to grade and riprapping of downstream channel,
- improving existing fishway.

The operating and maintenance costs for the existing structure are assumed to be equal to those for the new structure which have been estimated at $3,000 per year for operating and $7,000 per year for maintenance.

In summary, identified costs would be:

Repairs	$300,000
Operation, maintenance	$ 10,000 per year

The present worth of these costs is $391,000, based on a ten percent discount factor and 25-year period of analysis.

These costs should be apportioned between the users. It is suggested here this apportionment be based on the amount of storage allocated for each use.

It is assumed that the existing licensees would receive storage water rights equal to the amount they would require to get through a 1:15 year drought. This amount of storage has been determined to be 0.94 feet on Nicola Lake. This amount is illustrated in Figure 4.3. It is less than that determined in 3.5 (1.40 feet) as some reduction is possible in July because of natural river flow (see Figure 4.2). Further, it is assumed that the remaining developed storage would go towards maintaining the fisheries resource.

In summary, the suggested apportionment recognizes the dependency of both users on the existing storage, favours neither party (i.e. maintains the status quo) and suggests the apportionment be on the basis of volume. This works out to be:

Existing licensees	.94'	31%
Fisheries	2.06'	69%
	3.00'	100%

Costs associated with the repair would be apportioned as follows:

	Repair Cost	Operation and Maintenance Costs	Present Worth of Costs
Existing Licensees	$ 94,000	$ 3,100	$122,500
Fisheries	$206,000	$ 6,900	$268,500
Totals:	$300,000	$10,000	$391,000

The project may even qualify for ARDSA assistance which would reduce the cost to the farmers below that shown above.

7. THE PROPOSED NEW STRUCTURE

7.1 Required Storage

The storage to be developed on Nicola Lake would be for two main purposes:

i) Irrigation water for 12,307 acres of land around and downstream of Nicola Lake to Spences Bridge (see 3.6.1.4).

ii) Fisheries Resource Maintenance flows - releases from the dam would be 60 cfs during the August-November period and 40 cfs during the December-July period (see 4.2).

Storage would be developed such that the release flows required would be met in a runoff year that had a drought return period of 1:15 years. This design drought condition is thought appropriate for the circumstances being dealt with here (see 3.6.2 and 4.5). The determination of the required storage is shown in Table 4.3. To meet the demands in a 1:15 year drought runoff condition, 7.08 feet of storage on Nicola Lake would be required. This amount of storage takes into consideration lake inflow, evaporation, precipitation and carry-over storage from the previous year.

Of interest the amount of storage required under a number of conditions (demand and runoff) is presented in Table 7.1. The amount of storage required for each condition was determined in a similar manner as that shown in Table 4.3. Note that the existing three feet of storage provides approximately sufficient water to meet the existing irrigation demand and the desired FRM flows for a 1:5 year drought condition but only to the end of the irrigation season (September). Thereafter, to the next freshet period, the FRM flows leaving Nicola Lake would be whatever came into the lake. This would be quite satisfactory for average runoff years or wetter, but highly unsatisfactory for years of low runoff (for the 1:15 year drought condition, for example, see Figure 4.2 - inflow during fall and winter is estimated to be near zero).

TABLE 7.1

Required Storage on Nicola Lake Under Various Conditions of Runoff and Demand

(depth in feet on Lake)

Runoff Condition	Existing Irrigation Demand plus FRM flows	Ultimate Irrigation Demand plus FRM flows
1:2 (Average)	.64	2.44
1:5 through irr. period)) 1:2 remainder of) runoff year)	3.12	4.90
1:5 year return period	4.09	6.17
1:15 year return period	5.01	7.08

Note:

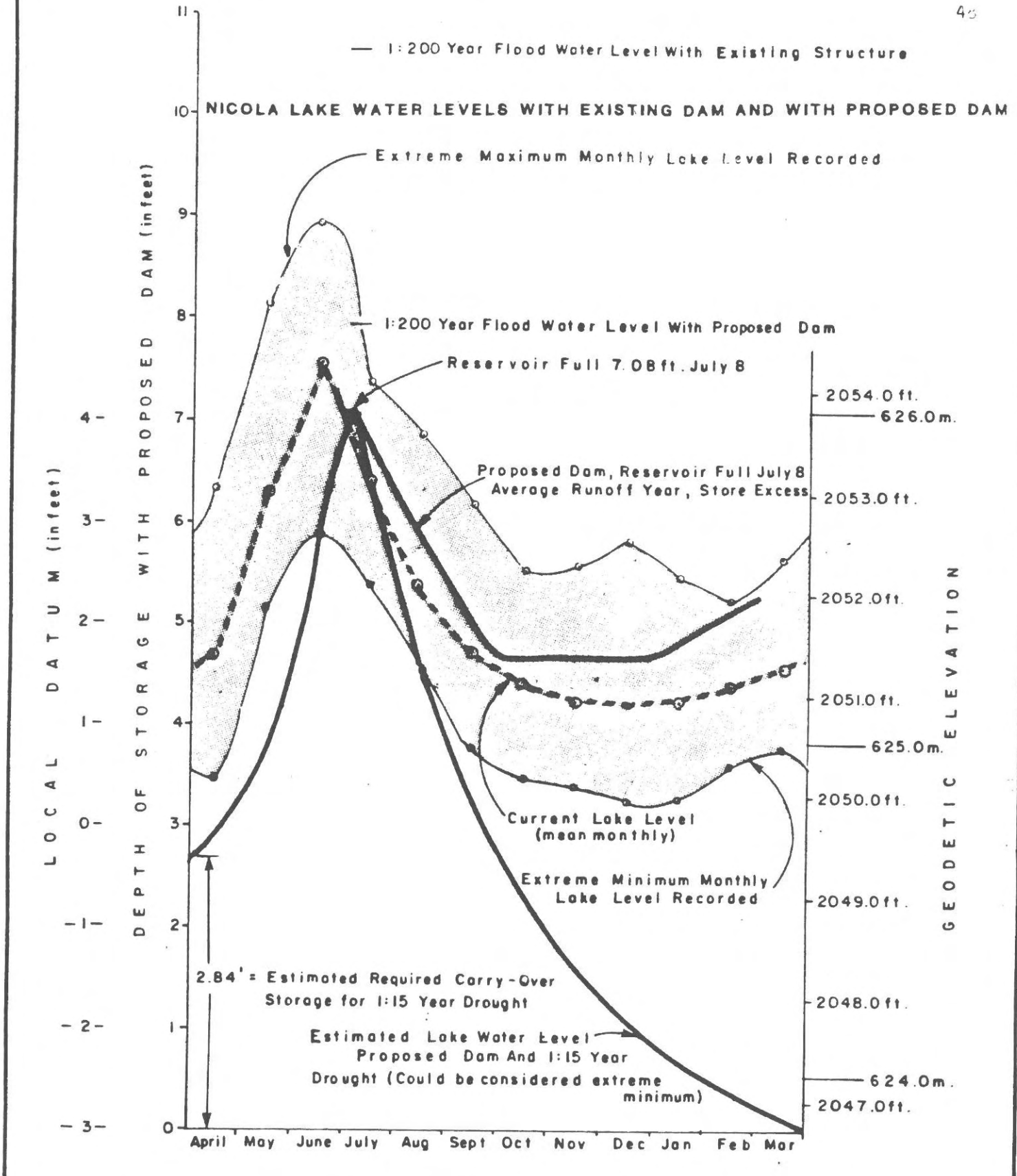
Existing structure provides 3.0 feet of storage. Proposed structure would provide 7.08 feet. Estimates of runoff (water supply available) for the drought conditions shown were made by the Planning Branch - see Reference 6, Appendix A.

7.2 Nicola Lake Water Levels

Water levels on Nicola Lake which occur now with the existing structure and those estimated to occur with the new structure, are shown in Figure 7.1. Information on the existing lake levels has been taken from the Water Survey of Canada gauging station number 08LG046, located near the lake outlet. This station has been gathering lake water level data since 1933 (50 years). The extreme minimum and maximum monthly lake levels have been plotted. This forms an approximate two foot band across the figure.

An estimate of what water levels will occur with the proposed structure is also shown. For this purpose it has been assumed that the reservoir would be full and drawdown would start on July 8 each year. For the 1:15 year drought condition the lake would fall steadily to the next freshet period. During the summer of an average runoff year, water levels with the new structure would be much the same as the 1:15 drought condition and existing situation. Lake inflow during the fall with an average runoff year or wetter, would be such that water in excess of downstream demand would have to be released in order to hold lake levels down. Thus lake levels with the new dam need only drop below those which occur now in drier than average runoff years (July-January period).

Of interest an estimate of the 1:200 year flood water level is shown with the existing structure and with the proposed structure. The flood water level with the new structure is almost three feet below that which would occur with the existing structure. This is due to the new outlet being approximately the same width as the old structure and its sill elevation being about three feet lower than the existing structure. In general then, one can state that the lake water levels resulting from any snowmelt freshet should be lower than those which presently occur. This is of importance to some of the lakeshore landowners who currently experience a multitude of problems (poor septic tank - field tile performance, flooding, wave damage, land slippage, mustiness in cabin due to high groundwater level and capillary action).



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON

NICOLA LAKE STORAGE FEASIBILITY STUDY

SCALE: VERT.
HOR.

DATE
OCT. 1982

L. A. BERGMAN ENGINEER

FILE No. 0242512-164 DWG No. A5316-20

BCIL 7873-M E

It is suggested that the regulation be such that during the summer:

i) demand is met or

ii) the lake level approximates the mean monthly lake level of what occurs now.

Through the fall and early winter demand could be met and if there is any excess the lake level could be held between the mean monthly lake level and the sill of the existing structure (1.0' to 0 Local Datum). On February 1st of each year a decision could be made, depending on the snowpack, to draw the lake slowly down to maximize its flood control effectiveness or to carry over the storage to ensure a full starting reservoir level next July[1]. The capacity of the downstream river channel will determine the rate at which the reservoir can be drawn down.

In summary, with the new structure flood water lake levels should be lower, summer lake levels should be much the same as those occurring now, and fall and winter lake levels should only be less than those which occur now when runoff is less than average or when storage is being released to get ready for another freshet. In other words the new structure will provide a greater degree of flexibility of operation than that which is now possible.

7.3 Design of New Structure

Crippen Consultants of North Vancouver were retained by the Ministry of Environment (with funding support from ARDSA) to produce a preliminary design and cost estimate of a new outlet structure on Nicola Lake (Reference 2, Appendix A). The new structure was designed to carry out the following functions:

i) Store sufficient water to meet the low seasonal flow downstream demands.

ii) Release flows to meet irrigation water demands, fisheries resource maintenance flows and river water quality maintenance.

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1. Note that 2.84' of carry-over storage would be required in a 1:15 year drought.

iii) Permit fish passage.

iv) Pass flood flows without causing abnormally high lake water levels.

v) Maintain the current method of water supply to Nicola Ranch Ltd. through the old power canal or provide a satisfactory alternative.

After field inspections which included foundation drilling, Crippen recommended the new structure be located approximately 400 feet downstream of the existing structure (see Foldouts 2 and 3 at the back of this report, which have been reproduced from Crippen's report, for the proposed location, plan, elevation and cross-sections of the new structure). The new structure would be of reinforced concrete construction. Regulation would be provided by two radial gates and one slide gate all electrically operated. A fish ladder, designed in consultation with Fisheries and Oceans Canada, was incorporated in the structure. Estimated cost (1982) of the new dam ranged from $1,764,000 to $1,938,000 and depended on the amount of dredging initally carried out through the shallows to Nicola Lake. In this report we shall use the full cost of $1,938,000 in our analysis (assume everything would be done at the time the new dam was built; the dredging would not be delayed). No allowance has been included in this amount for acquisition of the land required for the dam or cost of a satisfactory alternate water supply for Nicola Ranch Ltd.

This cost estimate was based on developing 7.31 feet of storage. This depth of storage is slightly different than that which we have evolved in this report because the demands given to Crippen, and on which their storage was based, were slightly different than those we used. This difference, however, should not change the estimated cost.

Similarly, a recent review of the amount of storage required on Nicola Lake by the Hydrology Section of the Water Management Branch using the same demands as were used in this report but utilizing a more rigourous hydrologic analysis determined the amount of storage required to be 6.73 feet (see Reference 18, Appendix A). As with the Crippen estimate the difference is not deemed large enough to warrant a change to the 7.08 feet we are using in this

report (figures, tables, calculations and text would have to be amended). In other words, whether one uses 7.08 or 6.73 feet should not affect the decision to proceed or not proceed. If anything, the resulting costs should be in the right direction (slightly less). The Hydrology Section analysis, no doubt, is the more accurate one for a number of reasons, one of which is that it did not require an estimate of lake evaporation which was the case with the 7.08 foot estimate. Thus, I would recommend that final design and the application for storage water rights use the 6.73 foot figure but for efficiency, that this report continue to use 7.08 feet.

Operation and maintenance costs are estimated at $10,000 per annum.

The existing structure would be utilized as the upstream cofferdam during the construction of the new dam, with river flows being diverted around the construction area in the old power canal. Fish passage would be possible during the construction period.

The new dam would require a new water licence because an increase in storage is involved. During the assessment process full consideration would be taken of any concerns expressed by lakeshore landowners.

7.4 Apportionment of Costs

The cost of the new structure would be shared between the irrigation water users and fisheries according to the amount of storage developed for each purpose. In this report all benefitters of the storage and improved river flows[1] (other than the consumptive or licenced water users) have been included in with the FRM flows for no other reason than the difficulty of doing otherwise. But it should be recognized there are other non-consumptive or instream-use benefitters, and opportunities hopefully will present themselves to reduce the cost apportioned to fisheries.

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1. Note that 2.84' of carry-over storage would be required in a 1:15 year drought.

The amount of storage required was determined to be 7.08 feet (see 4.6). The amount required for each purpose was determined by ranking the users in order of priority for the available water supply. This priority ranking, however, did not significantly change the amount of storage required by each user since there was hardly any water available in the design drought condition selected (other than during the freshet period). The shortage or deficit was determined on a monthly basis. This is portrayed in Figure 4.3. The depth of storage required by each and the percent this is of the total storage is as follows:

	Depth of Storage on Nicola Lake feet	Percent of Total
Irrigation	3.01	42.5%
FRM flows	4.07	57.5%
	7.08	100.0%

The capital, operation and maintenance costs are apportioned accordingly:

	Capital Cost	Operation and Maintenance Costs
Irrigation Water	$ 823,650	$ 4,250/annum
FRM flows	$1,114,350	$ 5,750/annum
	$1,938,000	$10,000/annum

The present worths of these costs are $862,200 and $1,167,500 for the irrigation water and FRM flows respectively, based on a 10 percent discount rate and 25 year period of analysis.

The annual cost to the irrigation water users assumes that the FRM flows portion is paid by others, that the project will qualify for ARDSA assistance (75 percent funding assistance on the capital cost), that 15 percent debentures will be issued to finance the 25 percent local share of the capital cost and that a 12 percent sinking fund would be established in order

to retire the debentures in 25 years. Administration costs are not included in the annual cost calculation following:

i)	Annual cost of capital:		
	15% of 25% of $823,650	=	$30,886.88
ii)	Sinking fund:		
	12% rate of return to yield		
	$205,912.50 in 25 years	=	$ 1,544.34
iii)	Operation and maintenance	=	$ 4,250.00
	Annual Cost	=	$36,681.22

On an acreage basis the annual cost would be as follows:

4,100 acres = $8.95/acre (currently irrigated land)
6,960 acres = $5.27/acre (to be irrigated in foreseeable future)
12,307 acres = $2.98/acre (ultimate development)

There is a cost to the farmers not accounted for above which has to do with the additional on-farm capital costs required in order to bring about the increased production. These on-farm capital costs are non-uniform and therefore have not been included in above costs, which are solely due to the new dam. Also, there is the cost of switching Nicola Ranch Ltd. from Clapperton Creek to Nicola River. These two costs add up to a present worth of $1,604,000 in the McNeil report (Reference 3, Appendix A). Thus the total cost of the new project to the farmers would be $862,200 plus $1,605,400 or $2,467,600.

7.5 Benefit/Cost Ratios

Expressed in terms of benefit/cost ratios to each major user and the project as a whole, the project feasibility would be as follows:

Agriculture	$4,359,000/$2,467,200 = 1.8:1
Fisheries	$4,420,000/$1,167,500 = 3.8:1
Project	$8,779,000/$3,634,700 = 2.4:1

Based on the analyses presented in this report the project has a Benefit/Cost ratio of 2.4:1 and thus is considered to be quite feasible. Institutional arrangements believed necessary to construct this new structure are discussed briefly in Section 9 "Proposed Course of Action."

8. SUMMARY

This report reviews the history of water use on the Nicola River, the inadequacy of the existing structure to meet the desired demands for major users (agriculture and fisheries), the amount of storage required to do so and its approximate cost.

The report draws most of its contents from assessments made by representatives or managers of the two major benefitters involved (Ministry of Agriculture and Food and Fisheries and Oceans Canada). Preliminary design and cost estimate of the new structure were carried out by Crippen Consultants, an engineering firm, through MOE and ARDSA funding.

The new storage would assure water supply to approximately 4100 acres of currently irrigated land and also enable expansion of the irrigated land base, whose growth has been restricted because of inadequate water supply since 1970, to its estimated ultimate development of just over 12,000 acres. Agricultural benefits with the new structure have been estimated to have a present worth of $4,359,000 based on the irrigation of 6960 acres of land, a ten percent discount factor and 25 year period of analysis.

Release flows for fisheries would be as follows:

August 1st to November 30th - 60 cfs
December 1st to July 31st - 40 cfs

A design drought return period of 15 years was used to determine the amount of storage required for both agriculture and fisheries.

Because the existing structure is 56 years old, is in need of major repairs, is inadequate to store the amount of water required, and neither major water user considered in this report has any legal right to the existing storage, the benefit assessment of the new structure was made from the natural, unregulated base condition (no dam) to that which would be provided by the new structure.

Note that in the allocation of costs, all consumptive water users (e.g. mining, industrial, etc.) were included under irrigation for no other reason than simplicity. Other than the irrigators, there simply are not that many consumptive water users. Provision has been made in the storage calculation for these users. They would be expected to cost-share in the storage development in the final analysis. The amount they would contribute would reduce the amount the farmers would have to pay, however, it should be understood that the reduction is not expected to be significant.

The situation is somewhat different with the non-consumptive users. Here there are some definitely identifiable benefitters other than fisheries but the problem I believe would center around how much one category of in-stream use was benefitting with respect to another. For instance, if one could agree there are five "measureable" categories in non-consumptive water use - fisheries resource maintenance flows, water quality, flood damage prevention, water-based recreation and aesthetics, how would one apportion the cost attributable to the in-stream users? An associated problem would be identifying the group that would pay for each category, i.e. who should pay for, or probably more to the point, who would agree to contribute towards the cost of the river water quality improvement - the Federal Government? the Provincial Government? the Regional District? the City of Merritt (partly)?

Thus the cost apportionment has only involved the two known major benefitters, agriculture and fisheries, and involvement of the other benefitters will reduce the shareable cost to these first two.

Fisheries benefits have been estimated to have a present worth of $4,420,000, using the same discount rate and period of analysis as above.

The cost of the new structure has been estimated at $1,938,000 (1982 dollar value). Annual operation and maintenance costs are estimated at $10,000. The present worth of the cost of the new structure has been estimated at $2,029,900, using the above discount rate and period of analysis. This cost has been apportioned between agricultural and fisheries interests according to the amount of storage required by each (3.01'/4.07' = 7.08' total or 42.5%/57.5% respectively).

Costs to each major user based on the above apportionment would be as follows. Note the additional on-farm capital costs and the Nicola Ranch switchover costs have been included in the agricultural costs.

Agriculture	$862,200 + 1,604,000 = $2,467,600
Fisheries	$1,167,500

Benefit/cost ratios to each major user and to the project as a whole would be as follows:

Agriculture	$4,359,000/$2,467,200 = 1.8:1
Fisheries	$4,420,000/$1,167,500 = 3.8:1
Project	$8,779,000/$3,634,700 = 2.4:1

With a benefit/cost ratio of 2.4:1, the project is considered quite feasible.

Cost to the local benefitting farmers assuming ARDSA assistance and 6960 acres participating in the project, is estimated to be $5.27 per acre per annum plus administration costs. There would be an additional cost to some farmers who had to increase their machinery capability in order to bring about the increased production.

9. PROPOSED COURSE OF ACTION

It is essential that the farmers and other property owners whose best interests are dependent upon the rebuilding of the Nicola Lake dam make an early official decision to proceed with the project.

Farmers would benefit significantly from the project, and it is, therefore, suggested that the Local Working Committee assume a leadership role in informing both the effected farmers and other potentially benefitting property owners of the contents of this report. At some point all concerned must vote to accept or reject the proposed project, but there is a time restraint of which everyone should be made aware. Under the current ARDSA program, the last opportunity for new projects to be considered for funding is July 31, 1983, unless there is an extension agreed upon by both senior governments. Further, all projects which qualify for ARDSA assistance must be completed by October, 1984. There is, therefore, an urgent need for local initiative in deciding on the project.

Assuming the decision is to proceed, it is believed that the application for ARDSA assistance could be made by the Local Working Committee. Thereafter it will be necessary to form a local representative agency with powers to borrow money and to levy charges in respect of the installation, operation and maintenance of the project. Such an agency is an essential requisite to negotiating an agreement with the ARDSA authorities.

Assuming the decision is not to proceed, the licensees are advised to initiate steps to form an Irrigation District to own and operate the existing structure.

There has been considerable discussion regarding the type of local agency best suited to respond to the Valley-wide scope of water resource management improvements and to the varying levels of representative government concerned with the integrated resource management. The Ministry of Environment favours the formation of a local entity which would represent the interests of all the people in the Nicola Valley, thus facilitating local involvement and direct participation in any related project. In this respect the Thompson-Nicola Regional District would be most appropriate as it encompasses the entire Nicola watershed. Provided it is agreeable to do this the Regional District would have to secure the necessary authority to develop, operate and maintain bulk water supply projects from the Provincial Government under the Municipal Act. We do not see this as a problem as a number of other Regional Districts currently have this functional responsibility (Comox-Strathcona, Sunshine Coast). The Regional District would deal with the Ministry of Municipal Affairs in this regard and I'm sure are well aware of the procedure. A referendum vote would probably be required. The Ministry of Environment favours the Regional District being the local entity. Whatever legislative vehicle is chosen would largely be up to the local benefitting people and the Ministry of Municipal Affairs. Federal Fisheries, the other major participant in this project, is in agreement that the Regional District would be quite appropriate for this purpose. It is not the purpose of this report, however, to document the advantages and disadvantages of who would be best to look after the new dam. Rather, the most important local issue to be resolved at this time is whether or not to proceed.

With respect to other interests, much discussion has been directed to the anadromous fishery (managed by Fisheries and Oceans Canada). There are, however, other benefitters such as the steelhead trout sports fishery, water quality management, water-based recreation, and riparian landowners. It can be expected, therefore, that any local agency formed to participate in overall integrated resource management would seek pro-rata cost-sharing support from all benefitting agencies and individuals.

APPENDICES

A. Reference Reports

B. Diversion water licences (excluding domestics) on the Nicola River downstream Nicola Lake (as of January 25, 1982)

C. Applications for water licences on the Nicola River (as of February 11, 1982)

D. Properties benefitting from Nicola Lake storage (possible)

Appendix A

REFERENCES

1. Bergman, L.A., 1981, Preliminary Engineering Feasibility Study on Rebuilding Outlet of Nicola Lake, Planning Branch, Ministry of Environment, Victoria, B.C.

2. Crippen Consultants, 1982, Nicola Lake Storage Feasibility Study and Preliminary Design, North Vancouver, B.C.

3. McNeil, A., 1982, Nicola Lake Dam Study, ARDA Branch, Ministry of Agriculture and Food, Prince George, B.C.

4. Kosakoski, G.T. and Roy E. Hamilton, September 1982, Water Requirements for the Fisheries Resource of the Nicola River, B. C., Department of Fisheries and Oceans, 1090 West Pender Street, Vancouver, B.C., V6E 2P1. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1860.

5. Cox, G.F. and R.J. Bugslag, 1982, Dam Inspection Reports of January 20 and 21, 1982 on condition of Nicola Lake Dam, Water Management Branch, Ministry of Environment file 0270545, Victoria, B.C.

6. Nicola Basin Strategic Plan Technical Document, Planning Branch and Thompson-Nicola Region, Ministry of Environment, July, 1982.

7. Anthony, E.D., 1976, Report on the Bessette Creek Watershed Committee, Water Rights Branch, Department of Environment, Kelowna, B.C.

8. Letter of March 31, 1982, from R. Bell-Irving to Dr. J. O'Riordan, Fisheries and Oceans Canada file 5903-85-N110, Ministry of Environment file 0242512-164.

9. Memo of August 4, 1982 to D.E. Reksten from E. Weiss re. Flood Control Benefits of the Proposed Nicola Lake Storage Development, Surface Water Section, Water Management Branch, Ministry of Environment, file 0256957-82-011.

10. Memo of October 6, 1982 to L.A. Bergman from C. Brown re. Fisheries Values on Nicola River, Socioeconomic Section, Assessment and Planning Branch, Ministry of Environment, file 0242512-164.

11. Memo of November 22, 1982 to L.A. Bergman from A.D. Zackodnik re. Comments of Nicola Lake Storage Feasibility Report, Water Management Branch, Ministry of Environment, file 0242512-164.

12. Water Requirements for the Fisheries Resource of the Deadman River by Roy Hamilton, Habitat Protection Unit, Southern Operations Branch, Fisheries and Marine Service, Department of Environment, Vancouver, B.C., February 1974.

13. Letvak, B., 1974, Snohoosh Lake on Deadman River Irrigation and Fisheries Storage Requirements. Hydrology Division, Water Investigations Branch, Water Resources Service, Department of Lands, Forests and Water Resources, file 0242512-109, Victoria, B.C.

14. Memo of April 15, 1982 to J.V. Eby from L.A. Bergman re. Ultimate number of areas of land that could be irrigated by Nicola Lake Storage Prject, Water Management Branch, Ministry of Environment, file 0242512-164.

15. Memo of April 29, 1982 to J. V. Eby from L.A. Bergman re. Nicola River, Water Management Branch, Ministry of Environment, file 0242512-164.

16. Memo to file of July 22, 1982 by L.A. Bergman, re. Lake evaporation, Water Management Branch, Ministry of Environment, file 0242512-164.

17. Memo of August 16, 1982 to A. Zackodnik from P.F. Doyle re. Nicola River flows without Nicola Lake dam, Water Management Branch, Ministry of Environment, Kamloops file 61.2001, Victoria file 0242512-164.

18. Memo of January 17, 1983 to Don Reksten from Eric Weiss re. Flows downstream Nicola Lake under natural conditions and Storage required on Nicola Lake, Hydrology Section, Water Management Branch, Ministry of Environment, file 0156957.

19. Memo to file of February 2, 1983 by Linda Hannah re. Flows downstream Nicola Lake under existing conditions, Planning Branch, Ministry of Environment, file 0242512-164.

Appendix B

DIVERSION WATER LICENCES (excluding domestics) ON THE NICOLA RIVER

BOWNSTREAM NICOLA LAKE (as of January 25, 1982)

User Point No.	Licence No.	Licensee	Acres Authorized to be Irrigated (acres)	Quantity Authorized to be Diverted (acre-feet)
Nicola Lake				
1	CL 13193	Nicola Ranch Limited	2,000.0	400.0
2	FL 3821	Chutter	26.5	132.5
3	FL 3771	Chutter	190.0	900.0
4	FL 3793	Chutter	120.0	600.0
5	FL 3794	Chutter	78.0	390.0
6	CL 50394	Douglas Lake Cattle Co.	15.0	45.0
7	CL 19468	Nicola Ranch Limited	520.0	1,300.0
8	CL 31187	Benchland Dev.	100.0	250.0
9	FL 47571	Garthwaite	115.1	230.2
10	CL 37183	School District #31	4.0	10.0
11	CL 37181	Collett Ranch	21.4	53.5
12	CL 50681	Emmerick	.5	1.0
13	CL 37182	Nicklin Holdings Limited	60.0	150.0
14	FL 19951	Norgaard Ready Mix		8,000.0 gpd indust.
15	FL 50163	Norgaard Ready Mix		25,000.0 gpd indust.
Coldwater River				
16	FL 17315	Bevan	49.0	122.5
17	FL 17316	Hanna	83.0	207.5
18	FL 17317	Hanna	3.0	7.5
19	FL 50529	Collett	52.0	130.0
20	CL 53593	Thomas & Bevan	20.0	50.0
21	FL 5669	Neale Bros. Ranch	11.8	24.0

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DIVERSION WATER LICENCES (excluding domestics) ON THE NICOLA RIVER DOWNSTREAM NICOLA LAKE (as of January 25, 1982)

User Point No.	Licence No.	Licensee	Acres Authorized to be Irrigated (acres)	Quantity Authorized to be Diverted (acre-feet)
22	CL 31416	Neale Bros. Ranch	60.0	120.0
23	FL 9267	Gardner, K.	40.0	100.0
Guichon Creek				
24	CL 26215	Craigmont Mines	1,300,000 gpd Mining	
25	CL 32981	Lower Nicola Wwks. Dis.		100,000.0 gpd Wwks
26	FL 8273	Gavelin	63.3	158.5
27	FL 10456	Miller	132.7	399.0
28	FL 51169	Miller	45.0	135.0
29	FL 49864	Stadele	4.0	12.0
30	CL 49855	Gardner Ranch	79.5	199.0
31	FL 50346	Gardner Ranch	90.5	226.5
32	-	-		
33	CL 50391	Witt	.5	1.25
34	FL 46068	Green	1.5	4.5
35	CL 47068	Sterling	100.0	250.0
36	FL 53268	Sterling	123.7	309.0
37	FL 50166	Ramsey	2.0	2.0
38	FL 20556	Maaske	7.0	7.0
39	FL 50527	Brandon	14.5	43.5
40	FL 51491	Brandon	26.0	78.0
41	FL 51490	RJ & MM Ranch	14.5	43.5
42	FL 50528	Torgenson	24.0	72.0
43	CL 44011	Wilson	4.0	10.0
44	CL 43480	Cripps	60.0	150.0
45	FL 49863	Maaske	8.0	24.0
46	CL 5948	Woods	27.3	81.9
47	CL 47069	Johnston	9.0	22.5
48	CL 46590	Johnston	20.0	50.0

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DIVERSION WATER LICENCES (excluding domestics) ON THE NICOLA RIVER

DOWNSTREAM NICOLA LAKE (as of January 25, 1982)

User Point No.	Licence No.	Licensee	Acres Authorized to be Irrigated (acres)	Quantity Authorized to be Diverted (acre-feet)
49	-	-		
Spius Creek				
50	FL 50545	Peter	1.3	3.9
51	CL 17029	I.R. #10 Nooaitch	30.0	90.0
52	CL 7618	I.R. #10 Nooaitch	508.0	1,270.0
53	FL 8226	Kynoch	44.6	133.8
54	CL 51605	Bukchuk & Kynoch	22.0	55.0
55	CL 51604	Bukchuk & Kynoch	85.0	212.5
56	CL 34295	Keyser	50.0	150.0
57	CL 7799	I.R. #11	571.0	1,713.0
58	CL 36000	Moses	40.0	80.0
59	CL 32707	Trinity Properties Ltd.	15.0	30.0
60	CL 40818	Trinity Properties Ltd.	12.0	30.0
61	CL 29530	Lorac Logging Ltd.	75.0	187.5
62	CL 33395	Wyatt-Purden	15.0	45.0
63	CL 28345	Whetstone	10.0	30.0
64	CL 49068	Whetstone	10.0	30.0
65	CL 43326	Smith	12.0	36.0
66	CL 33648	Wong	5.0	12.5
67	CL 40819	Nicola Lenora	2.8	7.0
68	CL 28343	Ventura Enterprises	10.0	30.0
69	CL 40987	Jeffries	20.0	60.0
70	CL 48919	O'Laughlin	12.0	36.0
71	FL 15609	Curnow	34.0	102.0
72	CL 32099	Curnow	60.0	180.0
		TOTALS:	6,071.0	12,027.1
				plus 1,433,000.0 gpd

APPLICATIONS FOR WATER LICENCES ON THE NICOLA RIVER AS OF FEBRUARY 11, 1982

Merritt Precinct

1. 0342195, V.G.R. & M.P. Cripps, P.O.D. W^3, X^3, W.R.M. 6050, applied April 24, 1977; 200 acre-feet to irrigate 80 acres of Lot 1610, except Plan 23855
   Refused because of no water.

2. 0364906, N. Marstone, P.O.D. K^4, W.R.M. 6050; applied November 22, 1978, (3.75 acre-feet) to irrigate 1.5 acres of Lot C of Lot 138, Plan 9423.

3. 0365350, F.L. McCallum, P.O.D. E^3, W.R.M. 6052^B; applied March 26, 1979; 2 acre-feet to irrigate 2 acres of Lot 32 and Lot 124, Plan 747.

4. 0365832, Neale Bros. Ranch, P.O.D. P^3, W.R.M. 6052; applied June 22, 1979; 100 acre-feet to irrigate 35 acres of Lot 534.
   Refused because of no water.

5. 0368191, S. A. Gavelin, P.O.D. T^3, W.R.M. 6052 applied March 27, 1981; 50 acre-feet to irrigate the East ½ of Lot 158.

Lower Nicola Precinct

6. 0365290 Nicola Ranch Ltd., P.O.D. W, W.R.M. 6000; applied March 12, 1979; 1200 acre-feet to irrigate 300 acres of Lots 115, 1888 and 520. Note source of supply is Nicola Lake.

7. 0366054, M. Pozzobon, P.O.D. F^4, W.R.M. 6006; applied February 19, 1980; 200 acre-feet to irrigate 75 acres of Lot 153.
   Refused because of no water.

8. 0369300, Miller F.D. & L.A., P.O.D. G^4, W.R.M. 6006, applied September 29, 1981; 600 acre-feet to irrigate 200 acres of Lots 1790 and 4662, K.D.Y.D.

Spences Bridge Precinct

9 0365276, L. Duncan & J. Williams, P.O.D. K^3, W.R.M. 6100; applied March 5, 1979; 120 acre-feet to irrigate (48) acres of Sec. 1, Tp. 14, R.23.

..../2

Summary

		Acres Involved	Water Required (acre-feet)
1.	0342195 (Cripps)	80.0	200.0
2.	0364906 (Marstone)	1.5	3.75
3.	0365350 (McCallum)	2.0	2.0
4.	0365832 (Neale Bros. Ranch)	35.0	100.0
5.	0368191 (Gavelin)	20.0	50.0
6.	0365290 (Nicola Ranch Ltd.)	300.0	1,200.0
7.	0366054 (Pozzobon)	75.0	200.0
8.	0369300 (Miller)	200.0	600.0
9.	0365276 (Duncan & Williams)	48.0	200.0
	TOTALS:	761.5	2,555.75

Appendix D

NICOLA VALLEY PROJECT
PROPERTIES BENEFITTING FROM NICOLA LAKE STORAGE (Possible)

Revised: Jan. 11, 1983

Ranchers	Land Irrigated from Nicola River or Lake** (accord. to water lic.) (acres)	Land Irrigated from Sources other than Nicola R. or Lake ** (accord. to water lic.) (acres)	Land Authorized to be Irrigated through Water Licence (acres)	Land Irrigated According to Air Photos (acres)	Potentially Irrigable Land (acres)	Additional Land Interested in Irrigating if Water Becomes Available (acres)
AROUND NICOLA LAKE						
Gerard Guichon	0	898.6	898.6	966*	898	
Nicola Lake I.R. #1	0	190.2	190.2	389*	383	
Quilchena Ranch (Nicola River)	0	377.0	377.0	512*	585	
(Quilchena Creek & trib.)	0	760.4	760.4	630	1,492	
M. Huber	0	161	161	140	76	
Harry Parker	0	0	0	0	92	
Sub-totals (lake only)	0	2,387.2	2,387.2	2,637	3,526	
NICOLA LAKE OUTLET						
Nicola Ranch	2,520+	2,000+	2,520	1,715	1,170	
CLAPPERTON CREEK						
Chutter Ranch	414.5	yes, but 200' above river	414.5	415	780	
Douglas L.Cattle Co.	15.0	0	15.0	15.0§	10	
Benchlands Dev. Co.	100	0	100	150*	95	
Garthwaite	115.1	0	115.1	50	81	81-(115-50)
School District #31	4	0	4	4§	0	

NICOLA VALLEY PROJECT
PROPERTIES BENEFITTING FROM NICOLA LAKE STORAGE (Possible)

Revised: Jan. 11, 1983

Ranchers	Land Irrigated from Nicola River or Lake** (accord. to water lic.) (acres)	Land Irrigated from Sources other than Nicola R. or Lake ** (accord. to water lic.) (acres)	Land Authorized to be Irrigated through Water Licence (acres)	Land Irrigated According to Air Photos (acres)	Potentially Irrigable Land (acres)	Additiona Land Interested in Irriga ing if Water Becomes Available (acres)
Nicklin Holdings	60	0	60	71*	0	
COLDWATER RIVER						
Collett Ranch	73.4	134	207.4	250*	120	
Emmerick	.5	0	.5	.5§	0	
Hanna	86	20°	86	90	5	
Bevan	49	45.2	94.2	125*	213	
Nicola Mameet #1	data listed under Guichon Valley assessment					
Neale Bros.	71.8	96.5	168.3	162	28	
Thomas & Bevan	20	0	20	56*	19	
Gardner, K. & Ranch	40	196.5	236.5	325*	0	
GUICHON CREEK						
Dodding	0	27	27	70*	45	
Craigmont Mines	data listed under Guichon Valley assessment					
Gavelin	63.3	0	63.3	135*	60	
Miller	177.7	0	177.7	285*	160	
Stadele	4	0	4	4§	0	
Gardner Ranch	170	6.8	176.8	180	127	
Witt	.5	0	.5	.5§	1	
Cripps	60	17	77	100*	500	

NICOLA VALLEY PROJECT
PROPERTIES BENEFITTING FROM NICOLA LAKE STORAGE (Possible)

Revised: Jan. 11, 1983

Ranchers	Land Irrigated from Nicola River or Lake** (accord. to water lic.) (acres)	Land Irrigated from Sources other than Nicola R. or Lake ** (accord. to water lic.) (acres)	Land Authorized to be Irrigated through Water Licence (acres)	Land Irrigated According to Air Photos (acres)	Potentially Irrigable Land (acres)	Additional Land Interested in Irrigating if Water Becomes Available (acres)
Maaske	15	0	15	8§	3	
Sterling	223.7	0	223.7	180	52	
Wilson	4	0	4	4§	0	
Johnston	29	8	37	35	70	
Torgenson	24	0	24	24§	17	
Ramsey	2	0	2	2§	0	
Green	1.5	0	1.5	1.5§	0	
Brandon	40.5	0	40.5	40.5§	23	
RJ & MM Ranch	14.5	0	14.5	14.5§	0	
Woods	27.3	0	27.3	27.3§	84	
SPIUS CREEK						
Peter	1.3	0	1.3	1.3§	0	
Post Cattle Co.	0	56.4	56.4	140*	12	
Nooaitch #10	538	10	548	180	550	
Kynoch	44.6	0	44.6	44.6§	37	
Bukchuk & Kynoch	107	0	107	200*	170	
Keyser	50	22.6	72.6	40	175	
Forsyth	0	0	0	8.5	14	
Shackan #11	571	see licence	571	175	850	

NICOLA VALLEY PROJECT
PROPERTIES BENEFITTING FROM NICOLA LAKE STORAGE (Possible)

Revised: Jan. 11, 1983

Ranchers	Land Irrigated from Nicola River or Lake** (accord. to water lic.) (acres)	Land Irrigated from Sources other than Nicola R. or Lake ** (accord. to water lic.) (acres)	Land Authorized to be Irrigated through Water Licence (acres)	Land Irrigated According to Air Photos (acres)	Potentially Irrigable Land (acres)	Additiona Land Interested in Irrigat ing if Water Becomes Available (acres)
Moses	40	0	40	35.9	17	
Trinity Properties	27	0	27	2	19	
Lorac Logging	75	0	75	45	235	
Wyatt-Purdon	15	0	15	15	12	
Whetstone	20	0	20	0	42	
Smith	12	0	12	10	5	
Wong	5	0	5	5§	3	
Nicola Lenaro	2.8	0	2.8	2.8§	0	
Ventura Enterprises	10	1	11	10	30	
Jeffries	20	0	20	6	71	
O'Laughlin	12	0	12	0	65	
Curnow	94	0	94	90	285	
Sub-totals (river only)	4,071+	2,620+	6,691	5,550.9	6,260	
TOTALS:	4,071+	5,008.2+	9,079.2	8,187.9	9,786	

NOTES: * indicates land irrigated according to air photos exceeds that authorized to be irrigated through water licence.

** Nicola River upstream of Nicola Lake is a tributary to Nicola Lake thus any land irrigated from it is listed in Column 2.

§ assumption made that currently irrigated land equals that authorized to be irrigated in licence.

+ assumption made that land irrigated from Clapperton Creek (2000 acres) is same land licenced to be irrigated from Nicola River. To count both would be double counting. Totals do not show Nicola River 2000 acre irrigation authorization.

˘ supplemental licence (do not add in).

RIVER

72 N, 6105 CL.32099 CURNOW
71 D, 6105 FL.15609 CURNOW
70 T, 6105 CL.48919 O'LAUGHLIN
69 Q, 6105 CL.40987 JEFFRIES
68 H, 6105 CL.28343 VENTURA ENTERPRISES
67 .40819 NICOLA LENARO
66 L^{L}, 6104 CL.33648 WONG
65 N^{N}, 6104 CL. 43326 SMITH
64 P^{P}, 6104 CL.49068 WHETSTONE
63 T, 6104 CL.28345 WHETSTONE
62 G^{G}, Z, 6104 CL.33395 WYATT-PURDEN
61 V, 6104 CL.29530 LORAC LOGGING
60 F^{F}, 6104 CL.40818 TRINITY PROPERTIES LTD.
59 " CL.32707 " "
58 K^{K}, H^{H}, 6103 CL.36000 MOSES
57 L, N, Q, 6101, C^{C} D^{D} 6102, E^{E} L^{L}, 6103, CL.7799 SHACKAN I.R. No. 11
56 P^{P}, 6102 CL.34295 KEYSER
55 B^{B}, 6101 CL.51604 JAFFRAY & CRONK
54 CC, 6101 CL.51605 BUKCHUK HOLDINGS & GORDON KYNOCH
53 C^{C}, " FL.8226 KYNOCH
52 A, B, 921 015.4.1 CL.7618 NOOAITCH I.R. No. 10
51 A, " " CL.17029 " "
50 Y, 6100 FL.50545 PETER

NICOLA RIVER

ENCES BRIDGE PRECINCT

K³, 6100 0365276 DUNCAN & WILLIAMS APPLN.
F³, 6100 CL.46580 JOHNSTON
Y³ 6006 CL 47069 JOHNSTON
48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

P³, 6006 FL.49863 MAASKE
F³, 6006 FL.20556 MAASKE
C⁴, 6006 FL.50166 RAMSEY
D⁴, 6006 FL.53268 STERLING
A⁴ Z³, CL.47068 GREEN
M³, 6006 FL.46265
B⁴ 6006 CL.50391 WITT
P³ 6050 CL.5948 WOODS
W³, X³, 6050 CL.43480 CRIPPS
" " APPLN.0342195
V³, 6050 CL.44011 WILSON
M³ 6050 FL.50528 TORGENSON
L³, 6050 FL.50527 AMENDED BRANDON
L³, 6050 FL.51491 BRANDON
C⁴, 6050 FL.51490 RJ & MM RANCH
T³, U³, 6050 CL.49855 GARDNER RANCH
" " F.L.50346 " "
L³, 6052 FL.8273 GAVELIN

SPIUS CR.

LOWER NICOLA PRECINCT

N, 6000 CL.13193 NICOLA RANCH LTD.
R, 6000 CL.19468 NICOLA RANCH LTD
B, 6002A CL. 31187 BENCHLAND DEV. LTD.
WW, 6002A CL.37182 NICKLIN HOLDINGS
T^{T}, 6002 FL.19951 NORGAARD READY MIX LTD.
T^{T}, " FL.50163 " "
C, 6002 FL.17315 BEVAN
C " FL.17316 HANNA
C " FL.17317 "

GUICHON CR.

CLAPPERTON C.R.

UPPER NICOLA

NICOLA LAKE

PRECINCT

W, 6000 APPLN.0365290 NICOLA RANCH LTD

Y^Y, 6006 FL.49864 STADELE
X^X, 6006 FL.51169 MILLER
APPLNS. F⁴ 6006 0366054 POZZOBON
G⁴ 6006 0369300 MILLER FB & LA.
F^F, X^X, 6006 FL.10456 AMENDED MILLER
R^R, 6006 CL.32981 LOWER NICOLA WWKS DIST.
R^R, 6006 CL.26215 CRAIGMONT MINES

A, 6056 FL.3821 CHUTTER
B, 6056 FL.3771 CHUTTER
B, 6056 FL.3793 CHUTTER
B, 6056 FL.3794 CHUTTER
J, B 6056 CL.50394 DOUGLAS LAKE CATTLE CO.

X^X, 6006A CL.53593 THOMAS & BEVAN
E^E, 6006A FL.9267 GARDNER

B^B, 6052B FL.47571 GARTHWAITE
V^V, 6052B CL.37183 SCHOOL DISTRICT No. 31
K^K, 6052B CL.37181 COLLETT RANCH
E³, 6052B CL.50681 EMMERICK
E³, " APPL. 0365350 Mc CALLUM
J 6052A FL.50529 COLLETT RANCH LTD
P³, 6052 FL.5669 AMENDED NEALE BROS. RANCH
P³ " CL.31416 NEALE BROS. RANCH
P³ " APPLN. 0365832 R.N.W

COLDWATER RIVER

MERRITT PRECINCT

E
LICENCE
UMBER
E NUMBER
NO WATER
ERSION ON WR MAP

ix B For Information on Acreages and Quantities

REFERENCES			REVISIONS		
DWG. No.	DESCRIPTION	DATE	No.	DESCRIPTION	DATE

SURVEYED DATE
DESIGNED L. A. BERGMAN
CHECKED DATE
DRAWN
CHECKED DATE MAY, 1982

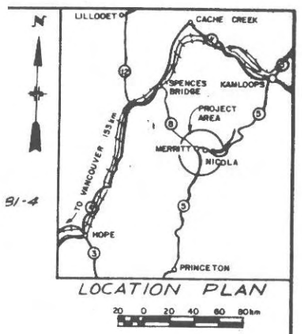
Province of British Columbia — Ministry of Environment — WATER MANAGEMENT BRANCH

NICOLA RIVER SCHEMATIC OF LICENCED WATER USE

ENGINEER DATE — RECOMMENDED DATE — APPROVED DIRECTOR DATE

FILE NO. 0242512-164
ENG. PROJECT NO.
NTS MAP NO.
SCALE N. T. S.
DRAWING NO. A5316-15
SHEET 1 OF 1

A 5316-15 FOLD-OUT 1



91-4

Dwg D2
illimetres
coordinates in metres
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- Highway Bridge
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ngitude 121°. Elevations
Bench Mark 1327-J, Nicola,
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nistry of Environment Dwg 1630-3F

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10 20 30m

RY OF ENVIRONMENT

STORAGE

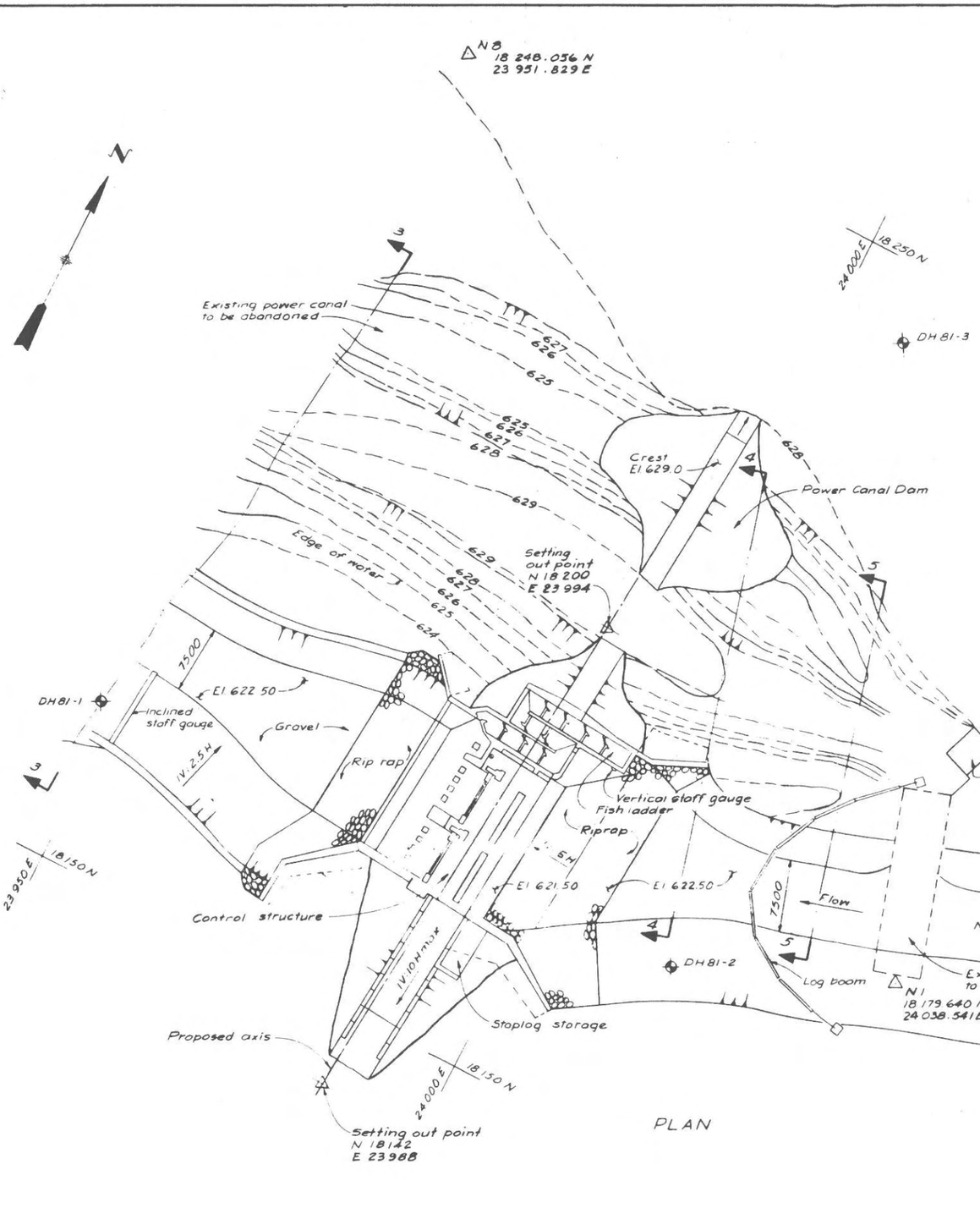
NGEMENT

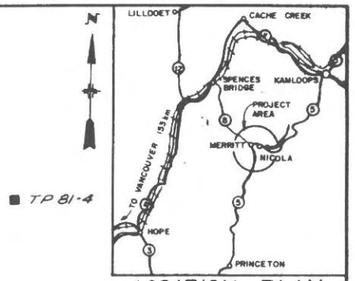
SULTANTS - NORTH VANCOUVER, B.C.

SIGNER G. D. F.
AWN J.L.
HECKER K.C.
OJECT MGR. M.M.
IC ENGINEERING

SCALE: As shown
DATE: 16 April 1982
CONTRACT NO.: 10036
DRAWING NO.: D1
REV. No.

A 5316-15 FOLD-OUT 2





NOTES

1. For Sections, see Dwg D2
2. All dimensions in millimetres
3. All elevations and coordinates in metres
4. "Bolt 4 L" - denotes Ministry of Environment control points near Highway Bridge
5. Coordinates are polyconic rectangular referred to Latitude 50° and Longitude 121°. Elevations are referred to Bench Mark 1327-J, Nicola, established by Geodetic Survey of Canada, 1959 all as reference on Ministry of Environment Dwg 1630-3F

LEGEND

- Setting out point
- Survey triangulation points
- TP Test pit
- DH Drill hole
- Estimated contour
- Survey control points

10 0 10 20 30m

MINISTRY OF ENVIRONMENT

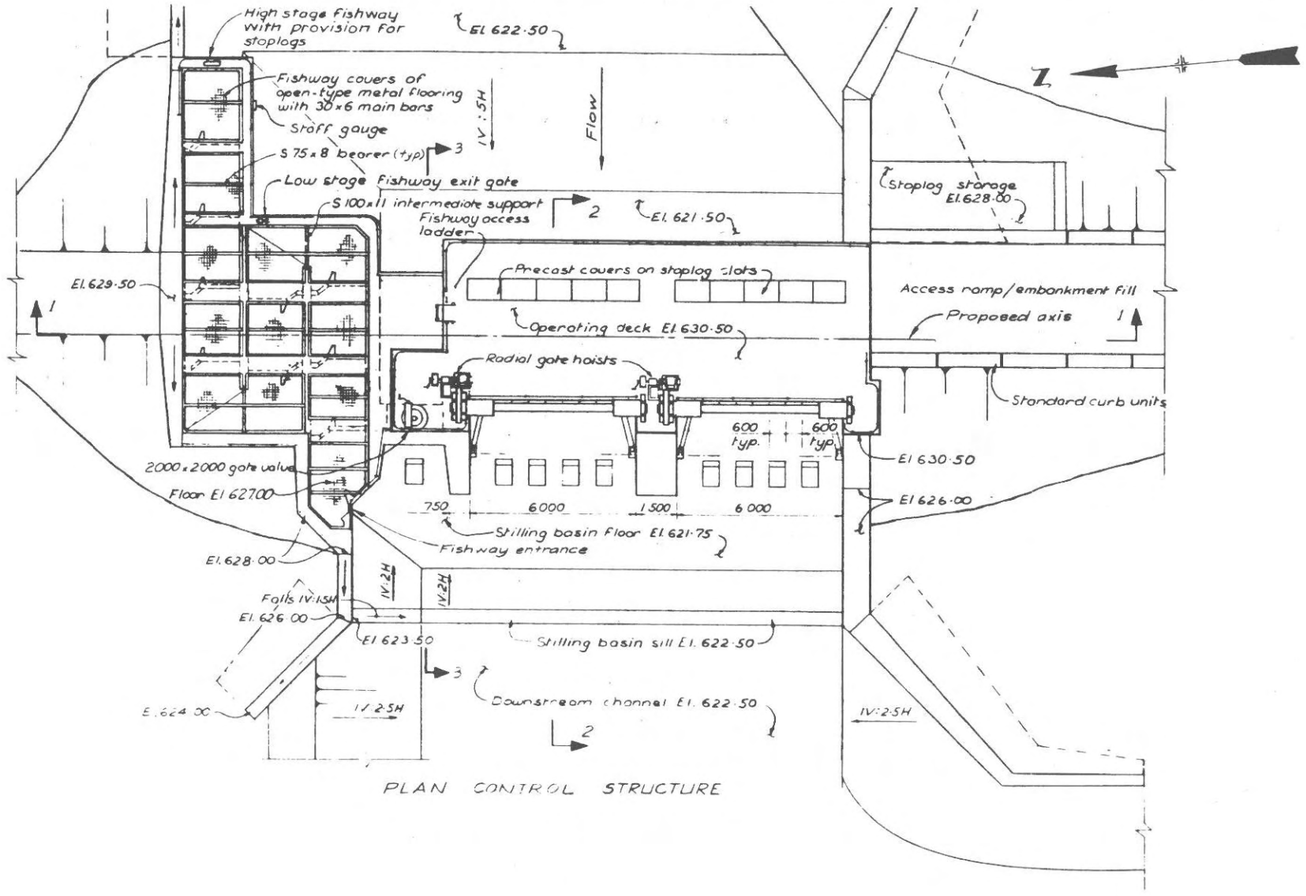
NICOLA LAKE STORAGE
GENERAL ARRANGEMENT

CRIPPEN CONSULTANTS - NORTH VANCOUVER, B.C.

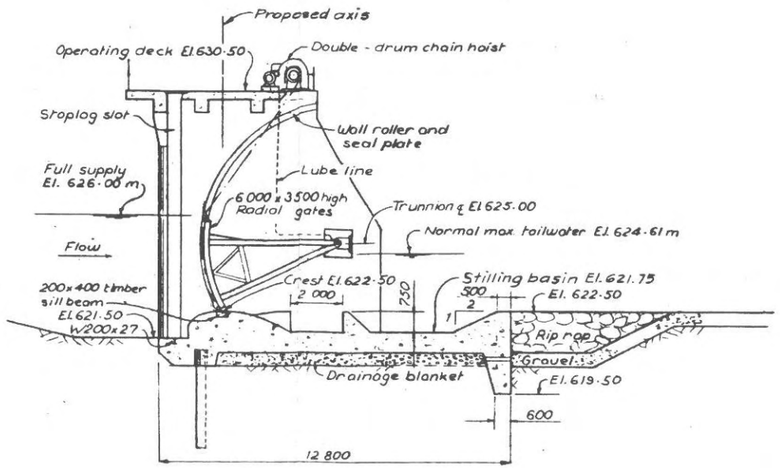
DESIGNER	G.D.F.
DRAWN	J.L.
CHECKER	R.C.
PROJECT MGR.	
MGR. ENGINEERING	
SCALE:	As shown
DATE:	16 April 1982
CONTRACT NO.:	10036
DRAWING NO.:	D1
REV. NO.	

REVISIONS

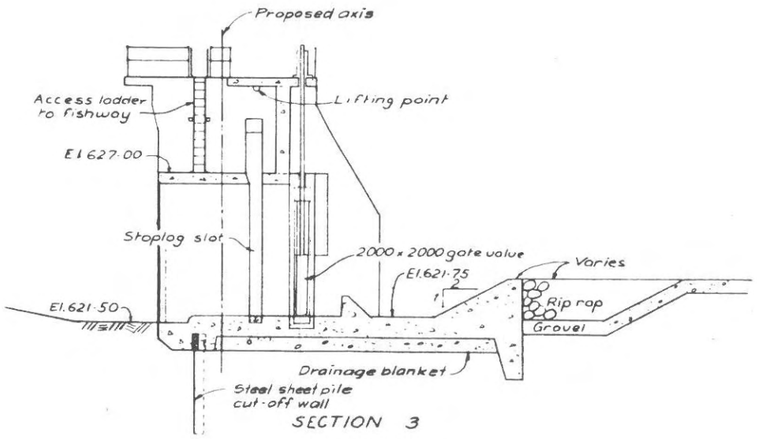
NO.	DESCRIPTION	BY	CH'D	APPD.	DATE



PLAN CONTROL STRUCTURE



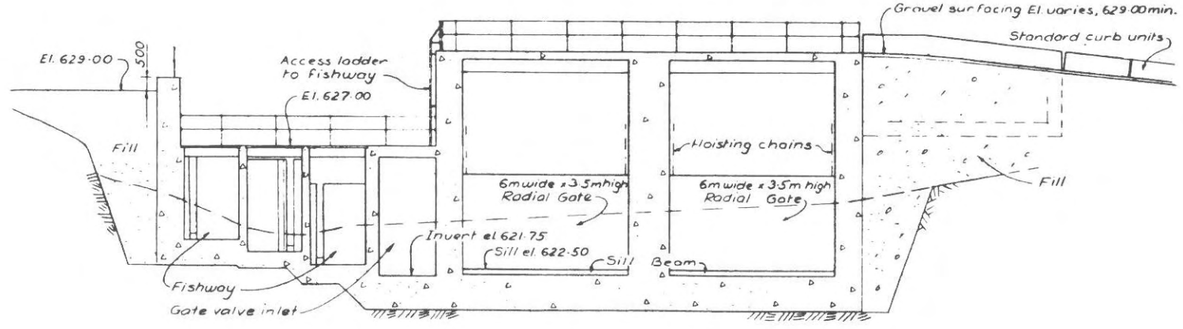
SECTION 2



SECTION 3

NOTES

1. For location, see Dwg D1



SECTION 1

1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15m

MINISTRY OF ENVIRONMENT

NICOLA LAKE STORAGE
CONTROL STRUCTURE
PLAN AND SECTIONS

CRIPPEN CONSULTANTS - NORTH VANCOUVER, B.C.

DESIGNER GDF	SCALE: As shown
DRAWN GDF	DATE: 16 April 1982
CHECKER	CONTRACT NO.: 10036
PROJECT MGR.	DRAWING NO.: D 3
MGR. ENGINEERING	REV. No.

REVISIONS

No.	DESCRIPTION	BY	CH'D	APPD.	DATE

A 5316 – 15 FOLD-OUT 3