Environment Canada / Environnement Canada
Fisheries and Marine Service / Service des pêches et des sciences de la mer

Water Requirements for the Fisheries Resource of the Deadman River

by
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Internal Report Series No. PAC/I-74-1

Southern Operations Branch
Pacific Region

WATER REQUIREMENTS FOR THE FISHERIES RESOURCE OF THE DEADMAN RIVER

by

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SOUTHERN OPERATIONS BRANCH

Canada
Department of the Environment
Fisheries and Marine Service

Pacific Region
Vancouver, B.C.

February, 1974

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Introduction

An engineering report prepared in 1971 by Strong, Lamb & Nelson for the Deadman's Creek Indian Band proposed construction of a dam at the outlet of Snohoosh Lake (Figure 1) to store approximately 4000 acre feet for controlled release during the irrigation season.

An application was made for assistance under the Agricultural Rehabilitation and Development Act (A.R.D.A.). Provincial approval of the project was obtained on June 22nd, 1972, and Federal approval, through the Department of Regional Economic Expansion (D.R.E.E.), was obtained on August 29th, 1972. On May 9th, 1973, the Deadman's Creek Improvement District was incorporated.

On April 30th, 1973, application was made for a water licence for 4473 acre feet for the purpose of storage and irrigation.

Under the proposed development program, the 1790 acres of irrigable land will require 6850 acre feet, including allowances for evaporation and other losses (Table 1). It has been assumed by Strong, Lamb & Nelson that the irrigation demand would be spread equally over the five months April to September resulting in a monthly demand of 1400 acre feet.

In April, 1971, a schedule of estimated minimum flows for fisheries was supplied to Strong, Lamb & Nelson by the Fisheries Service for incorporation into their preliminary studies. The schedule of minimum flows have subsequently been modified as a consequence of additional bio-engineering surveys (Table 2).

This report reviews the hydrology, fisheries resource and the developmental history of the Deadman River watershed and outlines minimum fisheries' flow requirements and the means of implementing them.

Basin Hydrology and Development

Deadman River has its source in numerous small lakes on the plateau south of Bonaparte Lake at an elevation of 4000 feet (Figure 3) and flows southerly into the Thompson River near Savona at an elevation of 1100 feet. The watershed has a total area of 541 square miles and is situated within the Interior Dry Belt zone which is characterized by hot, dry summers and cold, dry winters.

Annual precipitation near the river mouth is about 10 inches. Criss Creek is the main tributary, accounting for 36% of the total watershed. The annual freshet, derived principally from snow melt, occurs in the early summer. The series of lakes in the upper reaches partially buffer the runoff and aid in the maintenance of low flows in the fall and winter.

Hydrological records have been maintained on Deadman River and Criss Creek from 1913 to 1921, during irrigation season only, and from 1962 to the present, on a continuous basis. Monthly summaries for the years of record are presented in Tables 3 and 4, and a graph of their relative monthly flows is shown in Figure 4.

The Deadman River gauge, 08LF027, is located about 1.5 miles above Criss Creek. The watershed area above the gauge is 300 square miles. The lowest daily average flow recorded was 2.8 c.f.s. on December 17th, 1967. The gauge on Criss Creek, 08LF007, is located just above the confluence at the road bridge, and the watershed area above this gauge is 193 square miles. A minimum flow of zero was recorded on August 18th, 1970. The remaining 48 acres of the watershed is below the gauge sites (Fig. 3).

Although the Criss Creek watershed is only 0.64 as large as the Deadman River watershed above Gauge 08LF027, it has a maximum daily discharge 2.59 greater, and an average runoff for the freshet months of May and June 1.97 greater than Deadman River. This disparity is to be expected because the Criss Creek watershed does not have the storage capacity provided by the extensive network of headwater lakes in the Deadman River watershed.

The rapid runoff characteristic of Criss Creek results in proportionately lower summer flows. During August and September of some years the average monthly flows have been less than 1.0 c.f.s. Zero or near-zero flow was recorded for the better part of August, 1971. Flows during these months are, of course, affected by irrigation diversions. During the winter months, October to February, the flows are closely proportional to the Deadman River flows.

In 1910 a timber-crib dam was built at the outlet of Snohoosh Lake about 26 miles above the river mouth (Figure 1), for the purpose of controlling flows for irrigation. The dam and irrigation system fell into disuse and following a structural examination in 1942 a portion was removed for reasons of safety. At the present time there is no flow control.

The river flow below Snohoosh Lake is very irregular, not only because of irrigation diversions but also because of the coarse substrate of the riverbed accommodating a substantial subsurface flow. The channel between Tobacco and Gorge Creeks is frequently dry, although there may still be substantial subflow (Figure 5).

Most of the irrigation water is used for hay growing. At the present time most of the development is between Criss Creek and Tobacco Creek (Figure 1), and in an area west and below Highway #97. One-half the irrigable land lies within the Indian reserve below Criss Creek, but it is not extensively used at the present time.

A preliminary survey of 14 irrigation intake locations was made by Fisheries Service in November, 1972. (Fig. 1). In April, 1973, a large capacity intake (#15) was installed just below the main highway bridge.

Existing water licenses on Deadman River and Criss Creek are listed in Tables 5 and 6. They show that the annual irrigation use totals 2376 acre feet on the Deadman River and 1855 acre feet on Criss Creek.

There are major obstructions in the river associated with some of the intakes. At the location of #7 intake there is a 3 foot high timber dam across the full width of the river. Its original purpose, apparently, was to raise the water level for a ditch diversion. This ditch now seems to be abandoned and silt and gravel have accumulated to within a foot of the surface behind the dam.

Another apparently unused old timber dam with an inadequate fish ladder built into one end is located at #9 intake.

A concrete dam and unscreened intake structure was constructed at Location #12 about 1962 by the Deadman Creek Indian Band. Some modification of the structure is required to ensure satisfactory upstream migration at low flows.

There is a trend to replace the old gravity-intake diversions with electric pumps. These facilities do not require dams to raise the water level and screening to exclude salmon fry is much easier to accomplish.

The Fisheries Resource

Deadman River has been an important southern interior salmon stream. Spawning records have been maintained since 1928. Concern has been frequently expressed in Fisheries' reports dating back as far as 1919 over maintenance of the salmon resource of the Deadman River. It has proven difficult to maintain even modest runs and since 1968 the numbers of returning adults have decreased alarmingly. The chinook return has dropped from a pre-1968 average of 500 to 25 in 1971 and 10 in 1972. Corresponding coho returns have dropped from 1000 to 50 in 1971 and 25 in 1972.

Small numbers of pink salmon have been recorded on five occasions since 1953 and Kokanee have been observed in the section of river between Snohoosh and Mowich Lakes (Figs. 6 to 8).

Reports indicate that, historically, coho distributed widely throughout the system. It is probable that the introduction of irrigation works in the 1880's has contributed to the gradual restriction of their range. At the present time it is very difficult for adult coho to migrate upstream beyond the 3 foot dam at Diversion #7, especially during low flows.

Adult chinook arrive in the river in late July or early August, commence spawning in late August, and continue until mid-September. The eggs incubate over winter and the fry emerge from the gravel in March. They remain in the river about 90 days before proceeding seaward in June.

Mature coho arrive in late September or early October, and have completed spawning by late November. The fry emerge from the gravel in April to take up residence in the river. The following year, from April to June, they migrate as smolts to the sea.

The decline in the salmon stocks of the Deadman River system has been attributed to four major factors:

1. Increasing irrigation demand has resulted in less water for migration and rearing. Lower residual flows are usually accompanied by increasing temperature. During hot dry weather, water temperatures approach lethal conditions for rearing fish (Fig. 10).

2. Man-made obstructions and beaver dams now limit access to a 13 mile section above the mouth. Historically, at least the 26 miles from the Thompson River to Snohoosh Lake was accessible. These obstacles become increasingly critical when flows are reduced.

3. Some of the diversion intakes are not adequately screened, resulting in loss of juvenile fish into the irrigation system.

4. There is a relatively high incidence of poaching. These activities are especially significant when the salmon stocks are critically reduced.

<u>Bio-engineering surveys and discussion</u>

Over the last three years several engineering and biological studies of Deadman River have been undertaken by Fisheries Service for the purpose of establishing minimum flow criteria.

From October 1970 to May 1971 four short sections of the river (areas 1 to 4 in Figure 1) were studied in some detail. River cross-sections were surveyed and water depths and velocities were measured at several discharges. Spawning gravel areas and water surface areas (indicators of spawning and rearing potential) were calculated from these measurements. In the areas examined it was found that spawning and rearing habitat increased rapidly in response to increased discharges up to 20 to 25 cfs (Figures 11 and 12).

These studies, which included biological appraisal, together with analysis of the hydrographic records, formed the basis for setting minimum flows for fisheries for each month of the year. Table 2 shows these minimum flows so determined and their relationship to mean average monthly flows.

Note that fishery flows are required throughout the year to support rearing coho fry.

From Figure 2, it can be seen that in January, February and March the fisheries flow is close to the natural flow. During the spring runoff months, April, May and June, there is a considerable water surplus even allowing for complete replenishment of storage in the proposed reservoir. August and September are critical months. The irrigation requirements are high, the natural runoff is rapidly declining and the chinook are attempting upstream migration and spawning. Even so, the minimum flow for fisheries for these two months has been set at a value generally much lower than the natural river flow. For the last three months of the year the required minimum flows again approximate natural flows.

Using the revised fisheries required minimum flows and the values of 1400 acre feet per month, established by Strong, Lamb & Nelson, water budgets were prepared for the driest two years on record, 1965-66 and 1970-71, Tables 7 and 8. The 1965-66 year indicates a live storage requirement of 4657 acre feet. The water budget calculations are based on flow records from Station 08LF027 which has been affected by upstream diversion of up to 400 acre feet per year. Deducting this amount from 4657 gives 4257 as a value closer to the required storage. However, in 1970-71, the worst year on record (up to 1973), a storage requirement of 5780 (6180-400) acre feet would have been required.

Rather than have guaranteed fixed monthly flows for fisheries as described above and listed in Table 2, a more flexible schedule of flows is considered possible. By reducing the minimum flow for fisheries to 10 c.f.s. in July, and limiting the maximum reservoir drawdown rate to 1400 acre feet per month, there would be sufficient water for even the driest year, 1970-71. Figure 14 shows a rule curve for the Snohoosh reservoir, based on a 1400 acre feet monthly drawdown rate and, for comparison, the hypothetical drawdown curves for the two driest years on record, 1970 and 1965. In drought years, this schedule would result in less fisheries flows during July, August and September, particularly below the lowest intake, but it would ensure adequate storage reserve for irrigation.

To compensate for the reduced flows, it would be expected that Fisheries Service could request additional releases or surges if required during this period. Providing the drawdown curve remains above the rule curve, reserve storage would be available for such additional releases and by keeping the releases to a minimum some of the reserve storage would be available in most years for fisheries use after September 30th. It would be most beneficial to have this reserve to provide surges to attract upstream migrant salmon at critical times and to provide sufficient depth at natural obstruction.

As it is necessary to maintain the full natural flow over winter for egg incubation, refilling the reservoir should not be commenced until high runoff time in April or May. Minimum flows for fisheries would, of course, have to be maintained during reservoir recharging.

The intent of the schedule just outlined, and included in the recommendations which follow, is to conserve the use of fisheries water in the spring for later use in the fall; and also to ensure that there will be always sufficient reserve in storage to maintain a maximum irrigation use of 1400 acre feet per month, plus some reserve for fisheries use at critical times.

It would not be acceptable to Fisheries Service if the residual storage were to be used for irrigation purposes after September 30th. In the report prepared by Strong, Lamb & Nelson, calculations for the storage volume were based on irrigation releases up to the end of September. If it is planned to extend irrigation beyond this date, then either additional storage should be provided, or a reduced rate of use adopted.

The proposed irrigation demand is based on use by licensees below Snohoosh Lake. A graphic representation of use along the river is shown in Figure 13; the contribution from Criss Creek was not considered because of the probability of it being very small during dry years.

The daily temperature rise of the water becomes very critical during hot weather , particularly at low flows. Temperatures measured in July and August of 1973 showed that a high of 75° F occurred about 4:30 in the afternoon, after which a gradual cooling takes place (Figure 10). At temperatures above 65°F, salmonids become stressed. Above 75°F, lethal conditions exist and mortality may result if these conditions are prolonged. If water is drawn from the surface of the reservoir, it will be considerably warmer than water at depth. Surface water could increase the incidence and duration of unsatisfactory or lethal temperature conditions in the river.

Recommendations:

1. All existing man-made dams or barriers below Snohoosh Lake to be removed or, alternatively, adequate fishways to be constructed to permit unimpeded fish passage.

2. All intakes to be screened in accordance with the screening specifications contained in Appendix 1.

3. Continue to maintain the existing Deadman River gauge (8LF027).

4. An additional gauge to be installed and maintained immediately downstream of the lowermost intake.

5. Diversion of water for agricultural purposes from the Deadman River to be terminated on the 30th of September, unless the capacity of the reservoir is increased to provide additional storage for this purpose.

6. Additional diversion of water on or above Snohoosh Lake not to be permitted unless equivalent storage is provided.

7. Water to be released from the Snohoosh lake reservoir in accordance with the following:-

   a) Maximum rate of storage drawdown not to exceed 1400 acre feet per month, unless requested otherwise by authorized Fisheries personnel (see Recommendation #8).

   b) May 1st to July 31st - Commence to release water from storage when the flow below the lowest intake decreases to 10 cfs.

      Increase the release as required to maintain the flow at 10 cfs., until a maximum release rate of 1400 acre feet per month is reached.

   c) August 1st to September 30th - release water from storage as required to maintain a flow of 20 cfs below the lowest intake, until a maximum release rate of 1400 acre feet per month is reached.

   d) October 1st to April 30th - Water remaining in storage on September 30th to be released for the benefit of Fisheries, such releases to be planned and implemented in concert with the District Supervisor of Fisheries, Kamloops.

8. During the period May 1st to September 30th, Fisheries and Marine Service to have the option of requesting higher flows if required for fisheries, providing the drawdown curve remains above the rule curve, Figure 14.

9. A bailiff to be appointed who, in addition to usual duties, would be responsible for ensuring compliance with fisheries flow requirements.

10. The Snohoosh dam be provided with controls that may be readily adjusted throughout the year to maintain desired flow rates.

Conclusion:

The decline of the fisheries resource of the Deadman River can be arrested and the stocks substantially fostered through proper storage development and control. A viable aquatic environment and increasing demand for irrigation water, as evidenced by recent development, and the storage proposal cited herein clearly indicates that recognized multiple use concepts and responsible management are essential components of water use planning in the southern interior of B.C.

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Summary of Proposed Irrigated Acreages - Deadman River Valley

(Reproduced from 1971 report by Strong, Lamb & Nelson Ltd.)

	Acres	Water Requirement/Acre	Total Acre Feet
Indian Band	600	36"	1,800
G. Dudley	450	48"*	1,800
Allan	100	36"	360
Brousseau	100	36"	360
Craig	35	36"	105
Docksteader	85	36"	255
Eld	20	36"	60
Massey	100	36"	360
Phillips	50	36"	150
Snell	250	36"	750
Totals	1,790		6,000

Estimated Evaporation Loss (Allow 12 in. x 250 ac.) =250 ac. ft.

Estimated Seepage and Conveyance Losses (Allowing for Replenishment by Rainfall, Groundwater and Downstream Tributaries)

Allow 10% = 600 ac. ft.

Total Irrigation Demand = 6,850 ac. ft.

* Requested by owner - cost would be made up in toll charges

DEADMAN RIVER

Minimum Flows for Fisheries

Mean monthly averages are those recorded at Station 08LF-027 up to and including 1970.

Month	Mean Average Monthly cfs	Minimum flows for Fisheries cfs
January	15.1	12
February	16.7	12
March	17.1	15
April	55.9	20
May	242.0	60
June	136.0	30
July	84.3	20*
August	37.7	20
September	25.1	20
October	18.1	15
November	19.0	15
December	17.0	12

* May be reduced to 10 cfs. See text.

Table 3

DEADMAN RIVER

Historical streamflow summary to 1970

DEADMAN RIVER ABOVE CRISS CREEK - STATION NO. 08LF027

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

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1913	---	---	---	---	261	89.6	92.1	31.5	10.3	10.8	---	---	---
1914	---	---	---	154	365	96.7	54.3	54.0	25.2	9.1	11.1	---	---
1915	---	---	---	14.3	45.9	94.1	197	63.4	24.8	---	---	---	---
1916	---	---	---	84.6	273	225	148	63.8	64.2	23.8	---	---	---
1917	---	---	---	10.8	445	292	96.6	56.5	37.2	---	---	---	---
1918	---	---	---	28.8	214	96.7	39.7	47.0	33.1	---	---	---	---
1919	---	---	---	---	10.0	19.0	37.7	33.7	19.7	---	---	---	---
1920	---	---	---	5.8	33.5	72.6	45.0	46.3	31.1	---	---	---	---
1921	---	---	---	9.0	95.1	69.0	30.5	32.2	32.2	---	---	---	---
1962	4.8	6.7	9.1	111	362	275	121	47.6	31.4	27.7	30.7	27.9	88.3
1963	20.0	21.2	20.8	105	255	106	48.2	16.7	12.4	12.3	11.0	8.7	53.3
1964	10.5	15.3	16.9	19.8	173	265	90.5	21.4	23.8	26.0	20.3	12.9	58.0
1965	15.9	14.1	15.6	53.3	251	119	22.6	16.3	14.0	10.4	13.7	12.5	46.7
1966	13.8	14.6	20.4	98.0	229	116	86.1	66.2	17.9	14.2	11.7	14.4	58.8
1967	17.1	23.7	22.1	26.8	452	172	32.7	11.1	15.9	4.1	4.7	4.7	66.1
1968	5.0	5.1	7.8	9.0	279	203	44.5	16.1	14.8	14.8	15.8	15.3	52.8
1969	16.4	18.3	13.8	112	439	47.8	313	47.5	39.4	60.3	66.0	52.7	103
1970	32.2	30.9	27.2	52.1	173	91.2	17.2	6.7	3.6	4.2	5.4	4.1	37.3
MEAN	15.1	16.7	17.1	55.9	242	136	84.3	37.7	25.1	18.1	19.0	17.0	62.7

DEADMAN RIVER ABOVE CRISS CREEK - STATION NO. 08LF027

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	YEAR	TOTAL DISCHARGE
1913	---	---	---	1913	---
1914	---	---	---	1914	---
1915	---	---	---	1915	---
1916	---	---	---	1916	---
1917	---	---	---	1917	---
1918	---	---	---	1918	---
1919	---	---	---	1919	---
1920	---	---	---	1920	---
1921	---	---	---	1921	---
1962	---	733 CFS ON MAY 28	3.0 CFS ON JAN 1	1962	64000 AC-FT
1963	---	322 CFS ON MAY 4	8.1 CFS ON NOV 28	1963	38600 AC-FT
1964	---	335 CFS ON JUN 21	8.5 CFS ON JAN 1	1964	42100 AC-FT
1965	---	365 CFS ON MAY 2	9.0 CFS ON OCT 9	1965	33800 AC-FT
1966	---	362 CFS ON MAY 12	8.4 CFS ON NOV 30	1966	42600 AC-FT
1967	---	628 CFS ON MAY 24	2.8 CFS ON DEC 17	1967	47900 AC-FT
1968	---	527 CFS ON MAY 27	3.2 CFS ON JAN 29	1968	38300 AC-FT
1969	---	1090 CFS ON JUL 9	9.5 CFS ON MAR 9	1969	74800 AC-FT
1970	---	242 CFS ON MAY 12	3.0 CFS ON OCT 2	1970	27000 AC-FT
				MEAN	45500 AC-FT

EXTREMES OF DISCHARGE FOR THE PERIOD OF RECORD

MAX. INST. DISCHARGE IS ---
MAX. DAILY DISCHARGE IS 1090 CFS ON JUL 9 1969
MIN. DAILY DISCHARGE IS 2.8 CFS ON DEC 17 1967

CRISS CREEK

Historical streamflow summary to 1970

Table 4

CRISS CREEK NEAR SAVONA - STATION NO. 08LF007

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

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1912	---	---	---	---	---	---	84.2	29.7	---	---	---	---	---
1913	---	---	---	---	260	167	168	32.2	11.6	30.8	---	---	---
1914	---	---	---	102	328	145	26.6	9.9	10.7	15.5	15.5	---	---
1915	---	---	---	89.2	274	299	242	100	11.6	---	---	---	---
1916	---	---	---	71.2	286	328	126	25.0	5.3	5.7	---	---	---
1917	---	---	---	---	370	373	68.6	2.9	0.81	---	---	---	---
1918	---	---	---	72.5	362	181	4.6	1.4	1.3	---	---	---	---
1919	---	---	---	---	189	111	10.0	1.8	0.34	---	---	---	---
1920	---	---	---	3.8	136	195	23.3	4.3	29.1	---	---	---	---
1921	---	---	---	13.4	320	171	8.7	1.0	2.6	---	---	---	---
1962	4.7	6.0	5.7	115	440	245	70.8	16.4	23.5	29.4	23.2	14.2	83.3
1963	9.1	4.4	9.9	107	352	144	61.1	12.0	9.6	5.9	7.2	5.0	61.1
1964	6.2	5.1	4.8	16.1	117	384	40.3	3.0	32.0	26.4	10.2	5.3	53.9
1965	9.4	12.7	6.4	63.9	186	130	18.4	28.2	26.4	20.7	21.3	11.7	44.7
1966	8.7	8.5	11.8	55.7	371	167	73.9	27.0	5.5	9.2	8.8	10.4	63.6
1967	10.1	8.9	8.8	13.2	315	273	14.9	2.0	1.6	2.4	7.4	6.0	55.4
1968	6.4	6.6	22.9	12.4	319	327	35.1	9.7	14.2	15.8	14.4	9.9	66.2
1969	6.7	8.5	12.5	132	503	177	272	12.4	29.9	44.0	45.2	25.9	107
1970	14.3	13.0	14.7	21.0	228	145	9.1	0.47	1.5	5.0	5.0	5.8	38.7
MEAN	8.4	8.2	10.8	59.2	298	220	71.5	16.8	12.1	17.6	15.8	10.5	63.8

CRISS CREEK NEAR SAVONA - STATION NO. 08LF007

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	YEAR	TOTAL DISCHARGE
1912	---	---	---	1912	---
1913	---	---	---	1913	---
1914	---	---	---	1914	---
1915	---	---	---	1915	---
1916	---	---	---	1916	---
1917	---	---	---	1917	---
1918	---	---	---	1918	---
1919	---	---	---	1919	---
1920	---	---	---	1920	---
1921	---	---	---	1921	---
1962	---	1300 CFS ON MAY 29	2.0 CFS ON FEB 20	1962	60400 AC-FT
1963	---	651 CFS ON MAY 24	3.0 CFS ON SEP 29	1963	44200 AC-FT
1964	---	678 CFS ON JUN 12	2.1 CFS ON AUG 24	1964	39200 AC-FT
1965	---	574 CFS ON JUN 1	4.6 CFS ON MAR 24	1965	32300 AC-FT
1966	---	642 CFS ON MAY 9	3.2 CFS ON SEP 9	1966	46000 AC-FT
1967	---	790 CFS ON MAY 23	0.48 CFS ON OCT 8	1967	40000 AC-FT
1968	---	650 CFS ON MAY 21	3.8 CFS ON AUG 11	1968	48100 AC-FT
1969	---	1670 CFS ON JUL 6	4.6 CFS ON AUG 31	1969	77200 AC-FT
1970	---	720 CFS ON MAY 26	0 CFS ON AUG 18	1970	28000 AC-FT
				MEAN	46200 AC-FT

EXTREMES OF DISCHARGE FOR THE PERIOD OF RECORD

MAX. INST. DISCHARGE IS ---
MAX. DAILY DISCHARGE IS 1670 CFS ON JUL 6 1969
MIN. DAILY DISCHARGE IS 0 CFS ON AUG 18 1970

DEADMAN RIVER

Water Licences

Licence No. Cond.	Final	Licensee	Quantity Irrigation (ac. ft.)	Domestic (g.p.d.)
A. From or above Snohoosh Lake				
5592	7512	C.W. Moar	40	
7548	9872	Walachin Ranch	48	
17883		J.M. & R.C. Lomon	8	1,000
22137		Winberg, Land & Invest.		1,500
22732		L.W. Macauley		500
31217		B.C. Forest Service		1,000
31218		B.C. Forest Service		1,000
34436		R.H. Craig	60	
3 July, 1973		R.H. Diederick		500
13 Aug., 1973		H. & G. Gron	20.0	1,000
B. Between Snohoosh Lake and Criss Creek				
2958	15787	L.X.P. Massy	90.9	(500)
35716		J.C. Snell	73.5	(500)
2599	5940	J.W. Allen	50.0	(500)
2603	5931	D.M. & P.A.Docksteader	10.0	(500)
2604	6057	C.E. Brousseau	4.0	
2601	5860	T. Welsch	52.5	
8928	9262	W.P. Phillip	50.0	
9143	8271	H.D. Schmitz	9.0	
9107	8270	J.J. Allan	21.5	
14726	12209	T. Welsch	46.2	
14311	12246	Circle 7 Stock Ranch	60.0	
15754	19289	J.C. Snell	30.0	
16638	14655	A.F. Cooper	30.0	
16860	14976	W.P. Philip	2.0	
35893		M.T. & E.L. Hunter	25.0	
20590		G.L. & S.E. Thacker	45.0	500
19966	15311	Circle W. Ranch Ltd.	4.2	1,500
20110	15312	D.M. & D.A. Docksteader	37.5	
16580	16313	ditto	6.2	
22136	19332	T. Welsch	42.5	
23210	18897	M.E. Philip	13.2	
29325		D.&P. Docksteader	75.0	
31026		R.R. Eld	50.0	
33800		D.M. Docksteader	51.0	
35789		W.P. Philip	12.5	
	21509	J.W. Allen	125.0	1,000
23 April, 1970		C.E. Brousseau	60.0	
19 Oct., 1971		W.P. Philip	30.0	

Cond.	Final	Licensee	Irrigation (ac. ft.)	Domestic (g.p.d.)
17 Nov.1971		C.E. Brousseau	300.0	
C. Below Criss Creek				
8226	10505	Director, Ind.Affairs	718	(5,000)
8226	10504	ditto	75	
Totals (below Snohoosh Lake)			2,375.7 ac. ft.	9,500 g.p.d.

Table 6

CRISS CREEK

Water Licences

Licence No. Cond.	Final	Licensee	Irrigation (ac. ft.)	Domestic (g.p.d.)
35666		C.W. Dansey	1.4	500
35667		J.C. Snell	77.2	
35668		L.X.P. & H.M. Massy		500
35669		J. Snell	28.5	
35663		L.X.P. & H.M. Massy	63.0	
4925	7272	S. Mikulasik	17.0	(500)
5865	7563	L.J. La Guerra	32.5	
6480	6747	G. & J. Bepple	8.5	
8929	7580	J.R. Somavia	25.0	
10825	10284	Red Lake Holdings	6.7	(500)
16300		D.J. & F.M. LeBlond	100.0	
16380		T.& P.Piccirillo	30.0	
17651		J.D. & J.R. Somavia	50.0	
19632		L.J. La Guerra		1,000
19672		J.D. & J.R. Somavia	120.0	
19712		L.& J. La Guerra	50.0	
19714		J.D. & J.R. Somavia	25.0	
22882		M.T. & V.L. Abel		5,000
29597		D.J. & F.M. LeBlond	200.0	
29528		T.& P. Piccirillo	100.0	
29449		S. Mikulasik	120.0	500
		C. & J. Bepple	640.0	
36304		D. Reamsbottom	160.0	1,000

Licence No.				
Cond.	Final	Licensee	Irrigation (ac. ft.)	Domestic (g.p.d.)
		Red Lake Holdings Ltd.		2,000
		ditto		2,000
		ditto		2,000
			1854.8	14,500

DEADMAN RIVER

Water budget calculation for the year 1965-66

(Tabulated values in acre feet)

	River Discharge[1]	Fishery Requirement	Irrigation Demand	Storage	Waste
May	15,400	3,720	1,400	+4,473[2]	6,280
June	7,090	1,800	1,400		3,890
July	1,390	1,240	1,400	-1,250	
August	1,000	1,240	1,400	-1,640	
Sept.	833	1,200	1,400	-1,767	
Oct.	637	915		- 278	
Nov.	816	915		- 101	
Dec.	770	733			
Jan.	850	733			
Feb.	809	733			
Mar.	1,250	913			
April	5,830	1,200			

1. Deadman River discharge as recorded at Station 08LF027
2. Reservoir refilling, 4473 acre feet total live storage
3. The dotted line marks the end of the irrigation season

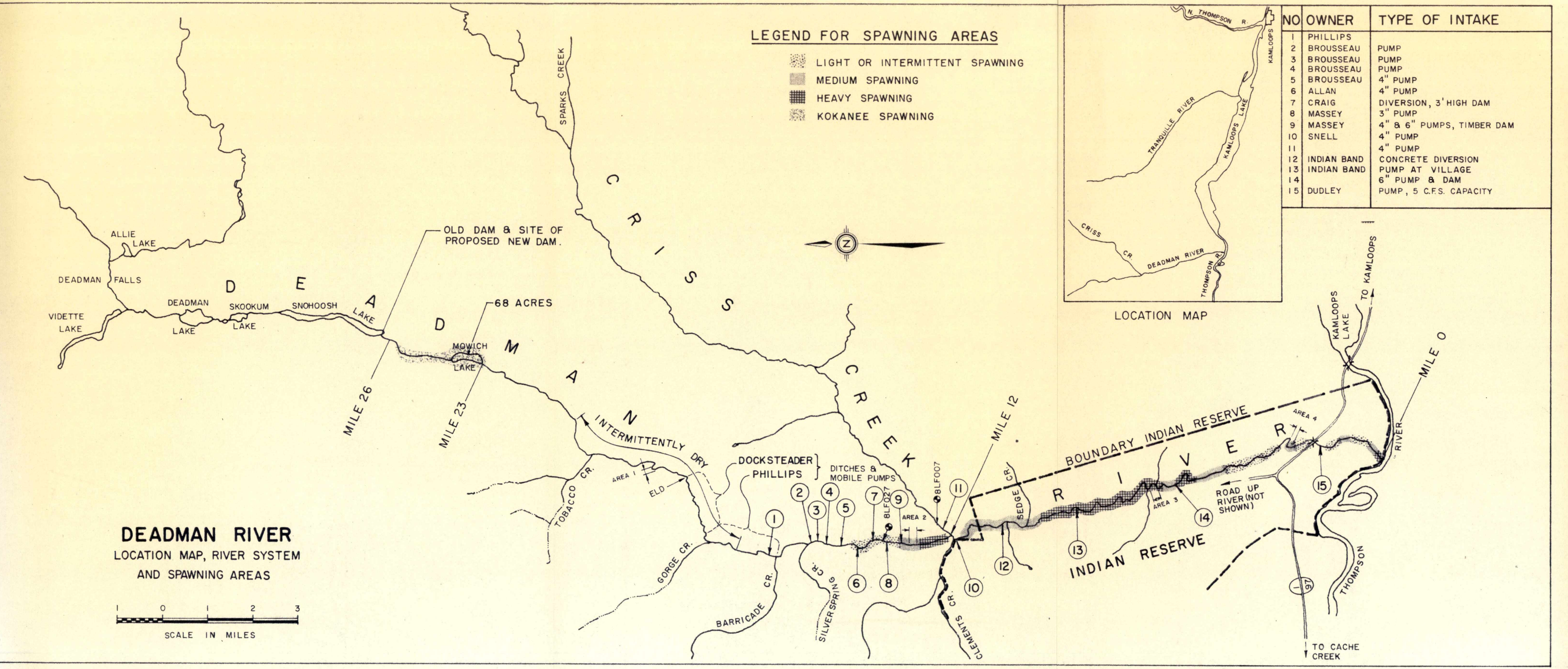
DEADMAN RIVER

Water Budget Calculation for the year 1970-71, Values in Acre Feet

	River Discharge[1]	Fishery Requirement	Irrigation Demand	Storage	Waste
May	10,600	3,720	1,400	+4473[2]	
June	5,460	1,800	1,400		
July	1,070	1,240	1,400	-1570	
August	415	1,240	1,400	-2225	
September	215	1,200	1,400	-2385	
October	260	915		-655	
November	324	915		-591	
December	254	733		-479	
January	274	733		-459	
February	324	733		-409	
March	493	915		-422	
April	1,800	1,200			

1. Deadman River discharge as recorded at Station 08LF027
2. Reservoir refilling, 4473 acre feet total live storage
3. The dotted line marks the end of the irrigation season

FIGURE 1



NO	OWNER	TYPE OF INTAKE
1	PHILLIPS	
2	BROUSSEAU	PUMP
3	BROUSSEAU	PUMP
4	BROUSSEAU	PUMP
5	BROUSSEAU	4" PUMP
6	ALLAN	4" PUMP
7	CRAIG	DIVERSION, 3' HIGH DAM
8	MASSEY	3" PUMP
9	MASSEY	4" & 6" PUMPS, TIMBER DAM
10	SNELL	4" PUMP
11		4" PUMP
12	INDIAN BAND	CONCRETE DIVERSION
13	INDIAN BAND	PUMP AT VILLAGE
14		6" PUMP & DAM
15	DUDLEY	PUMP, 5 C.F.S. CAPACITY

DEADMAN RIVER
LOCATION MAP, RIVER SYSTEM AND SPAWNING AREAS

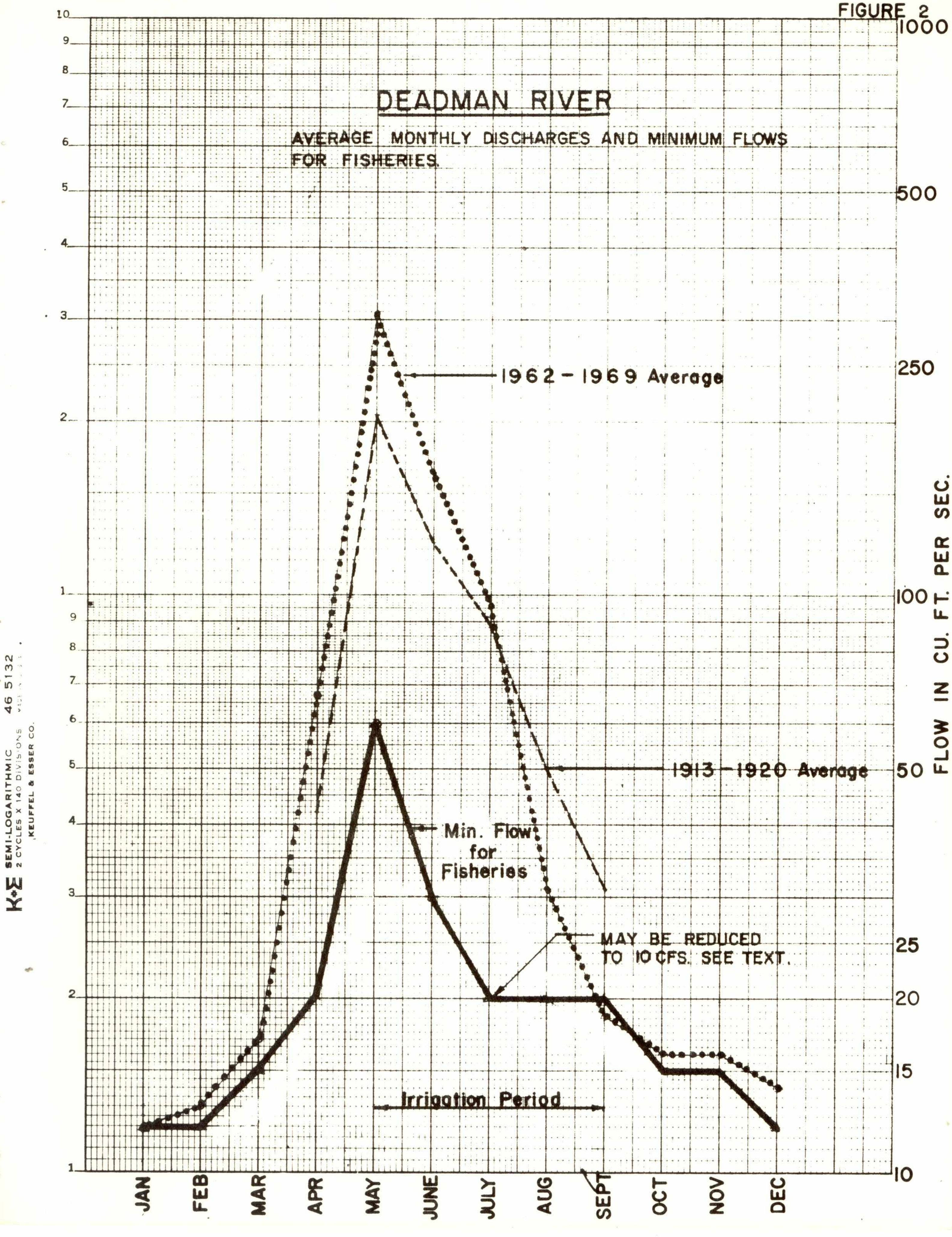
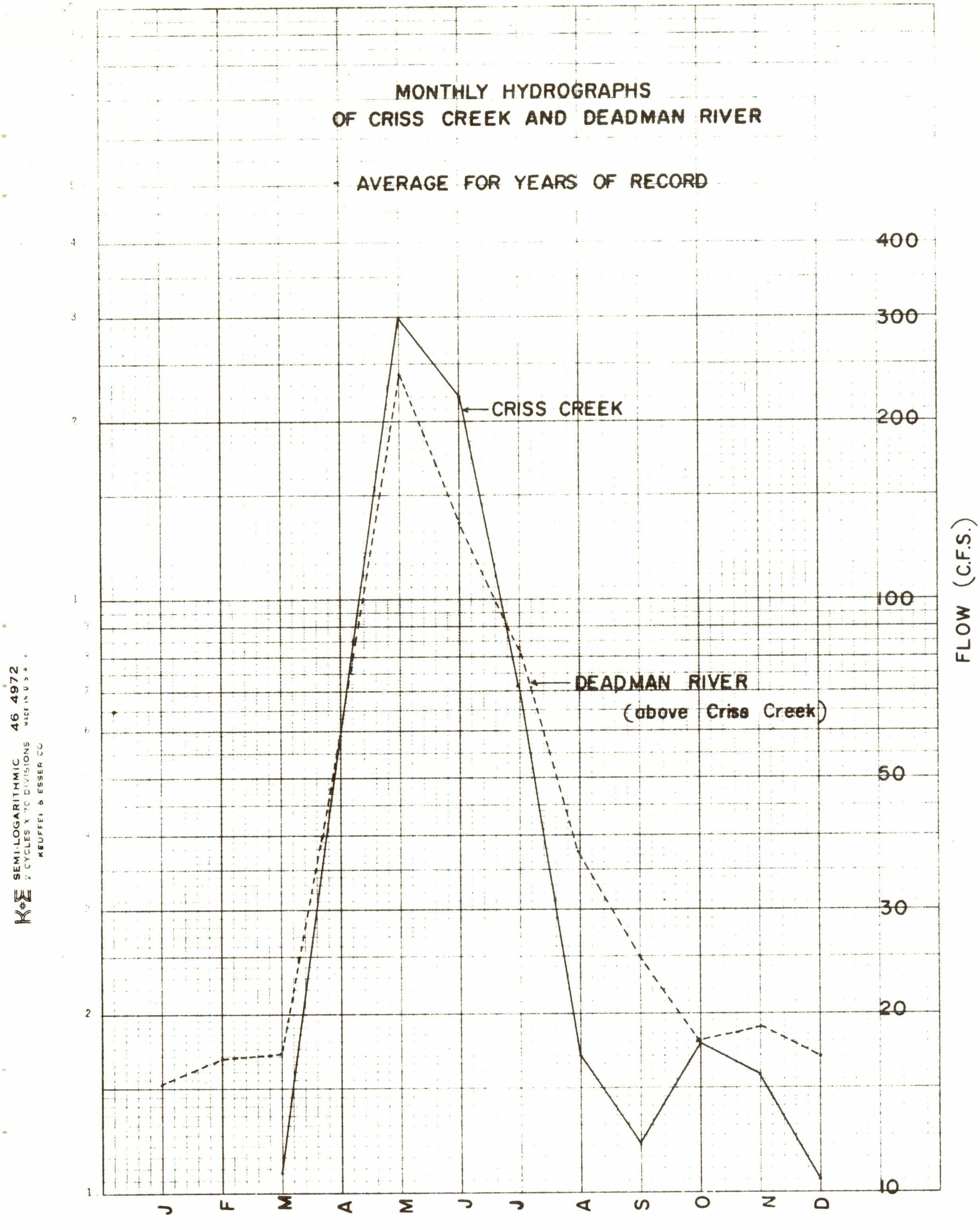
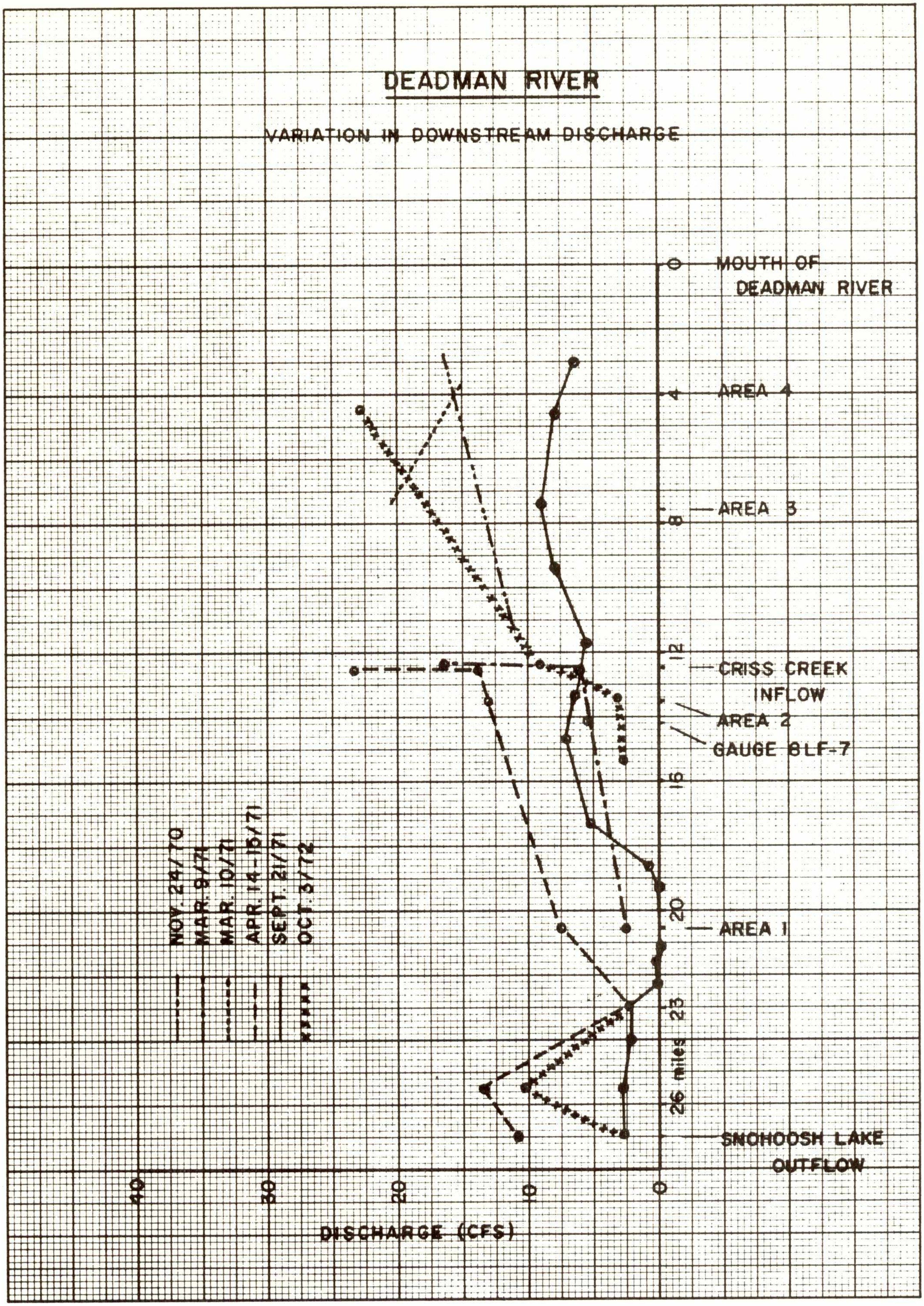
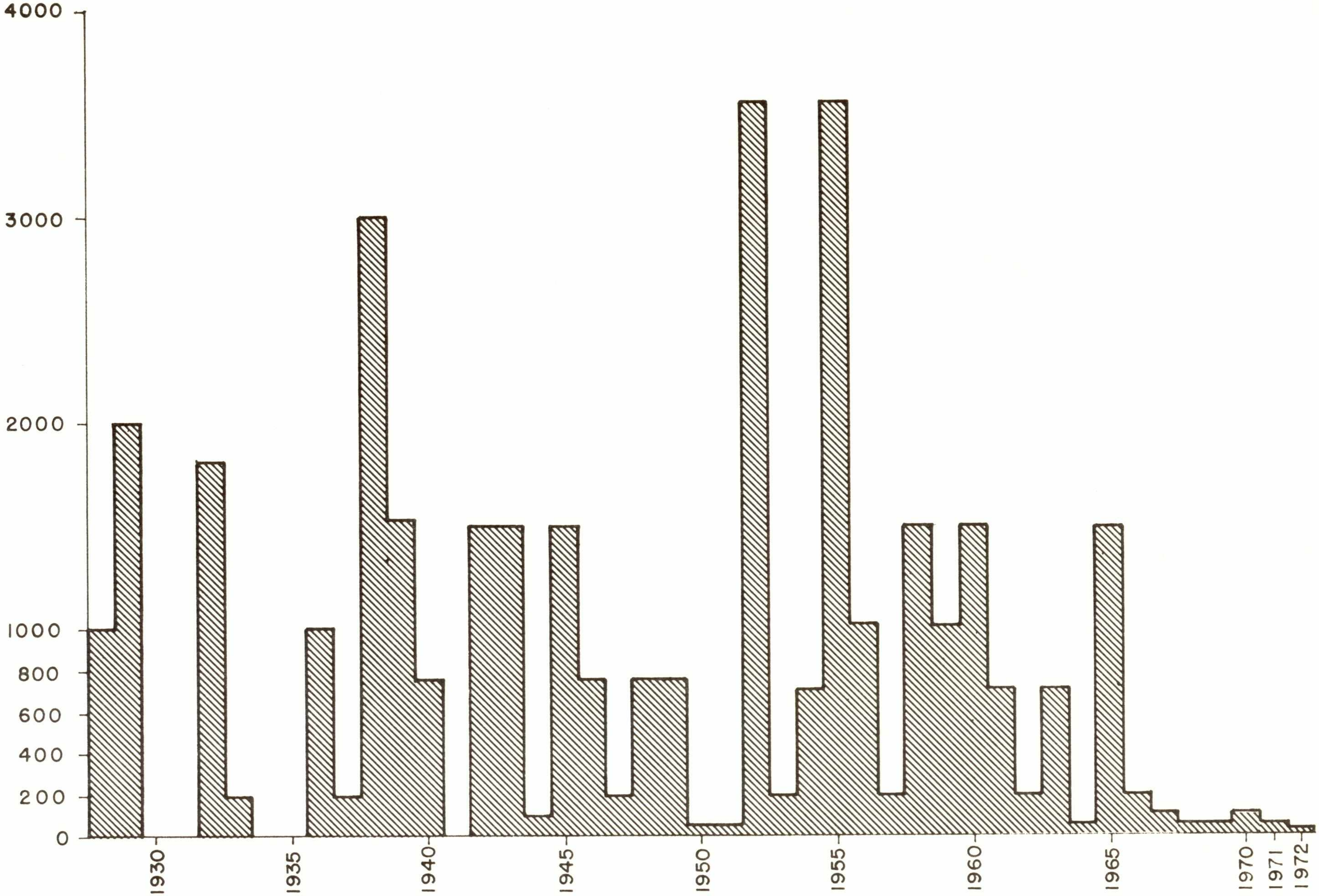


FIGURE 2
DEADMAN RIVER
AVERAGE MONTHLY DISCHARGES AND MINIMUM FLOWS FOR FISHERIES
1962 - 1969 Average
1913 - 1920 Average
Min. Flow for Fisheries
MAY BE REDUCED TO 10 CFS. SEE TEXT.
Irrigation Period
FLOW IN CU. FT. PER SEC.
1000
500
250
100
50
25
20
15
10
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
K+E SEMI-LOGARITHMIC 46 5132
2 CYCLES X 140 DIVISIONS
KEUFFEL & ESSER CO.


300 SQ. MI.
193 SQ. MI.
48 SQ. MI.
LILLOOET DISTRICT
KAMLOOPS DIVISION OF YALE DISTRICT
TRANQUILLE PROVINCIAL FOREST
TRANQUILLE PROVINCIAL FOREST
TRANQUILLE PLATEAU
NEHALLISTON PROVINCIAL FOREST
ARROWSTONE HILLS
CACHE CREEK HILLS
KAMLOOPS LAKE
Deadman River
Bonaparte River
Loon Lake
Clinton
Cache Creek
Ashcroft
Savona
Kamloops
North Kamloops
Barrière
Louis Creek
McLure
Tp 24 R 22 W 6
Tp 24 R 21 W 6
Tp 24 R 20 W 6
Tp 23 R 23 W 6
Tp 23 R 22 W 6
Scale 1:250,000 Échelle
Miles
Kilometres
Kilomètres
FIG. 3

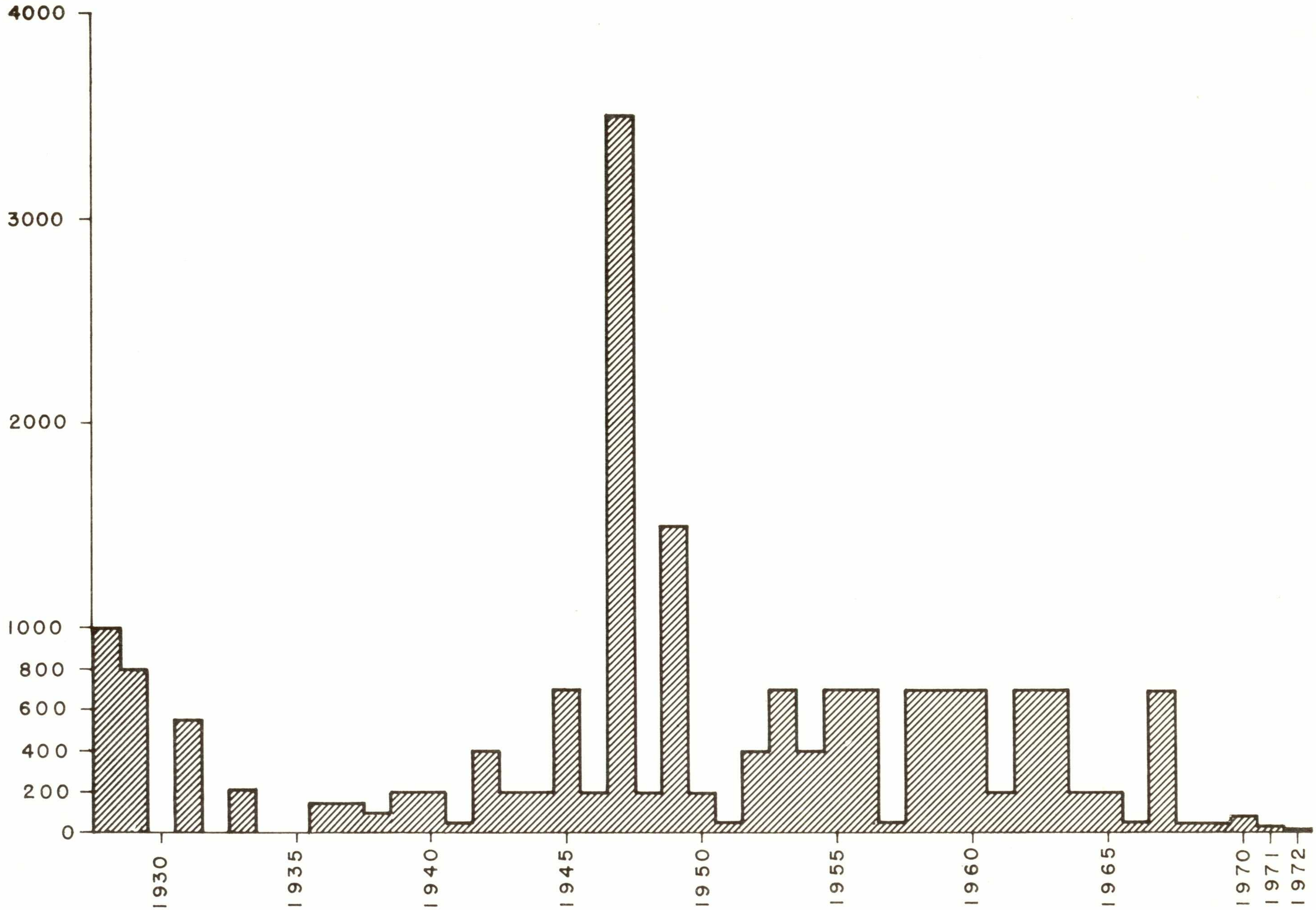

MONTHLY HYDROGRAPHS
OF CRISS CREEK AND DEADMAN RIVER
AVERAGE FOR YEARS OF RECORD
CRISS CREEK
DEADMAN RIVER
(above Criss Creek)
FLOW (C.F.S.)
400
300
200
100
50
30
20
10
J
F
M
A
M
J
J
A
S
O
N
D
SEMI-LOGARITHMIC 46 4972


DEADMAN RIVER
VARIATION IN DOWNSTREAM DISCHARGE
MOUTH OF DEADMAN RIVER
AREA 4
AREA 3
CRISS CREEK INFLOW
AREA 2
GAUGE 8LF-7
AREA 1
SNOHOOSH LAKE OUTFLOW
0
4
8
12
16
20
23
26 miles
NOV. 24/70
MAR. 9/71
MAR. 10/71
APR. 14-15/71
SEPT. 21/71
OCT. 3/72
40
30
20
10
0
DISCHARGE (CFS)



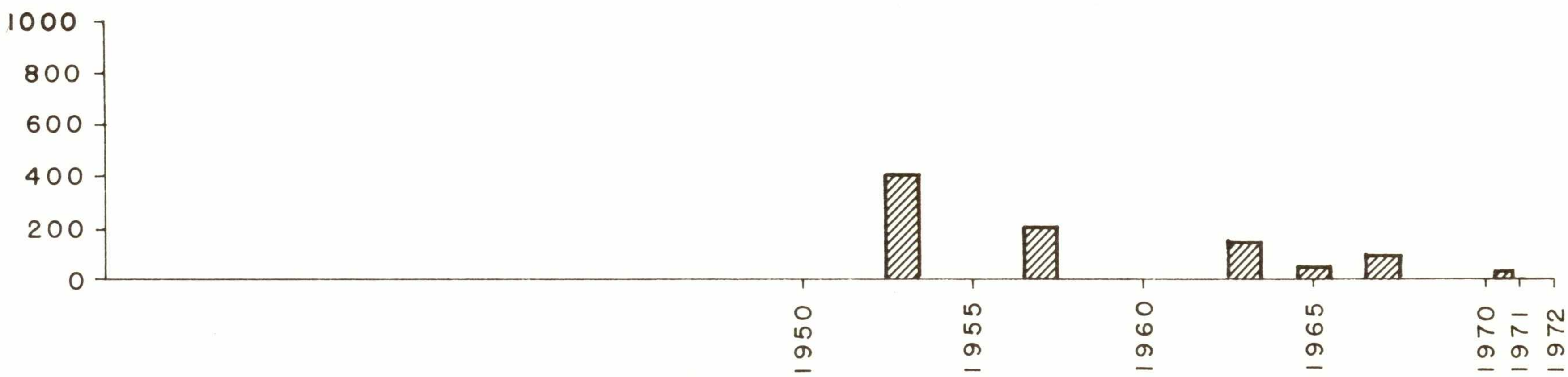
DEADMAN RIVER COHO SPAWNING RECORDS

FIGURE 6.



DEADMAN RIVER CHINOOK SPAWNING RECORDS

FIGURE 7.



DEADMAN RIVER PINK SPAWNING RECORDS

FIGURE 8

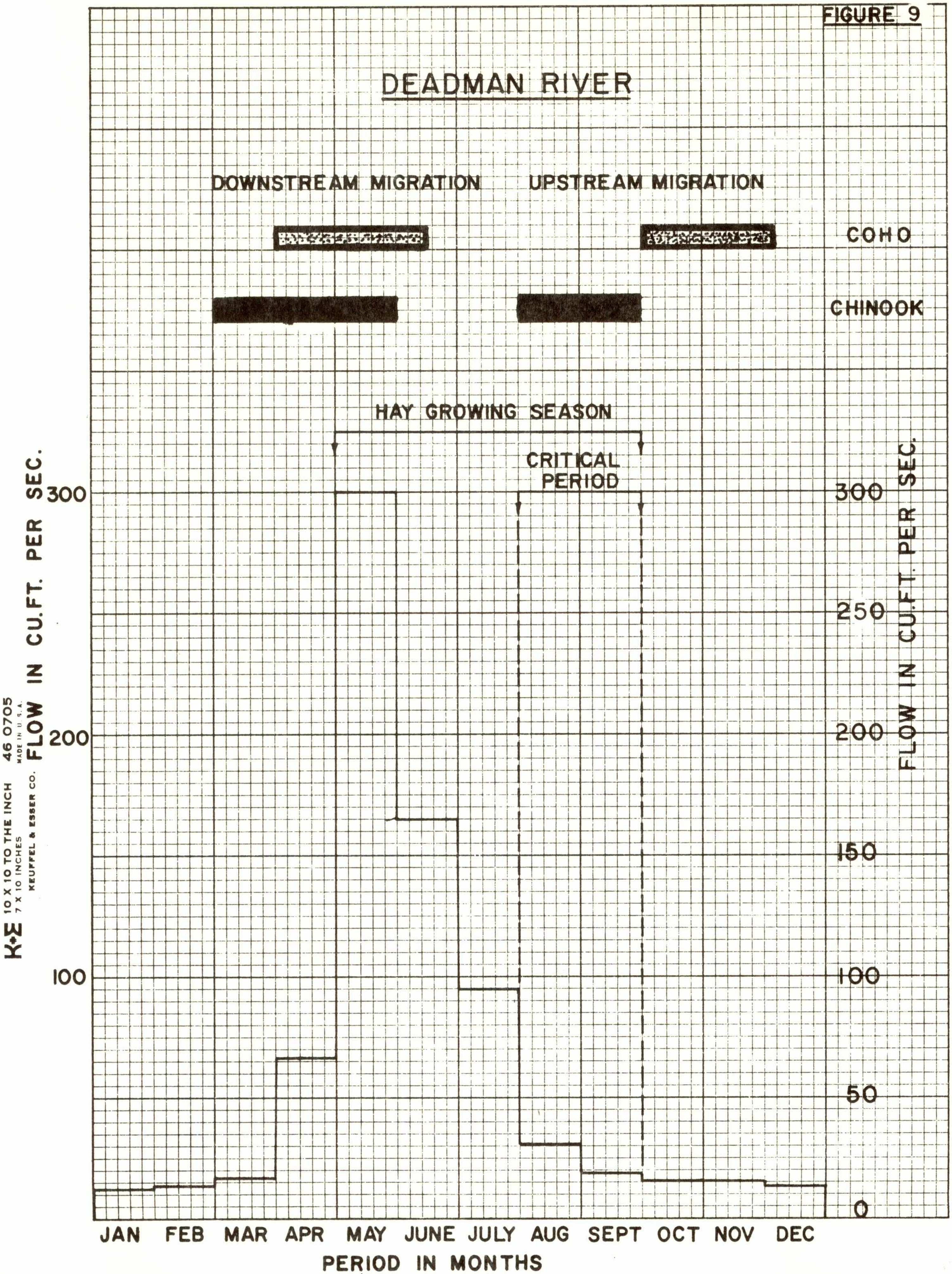
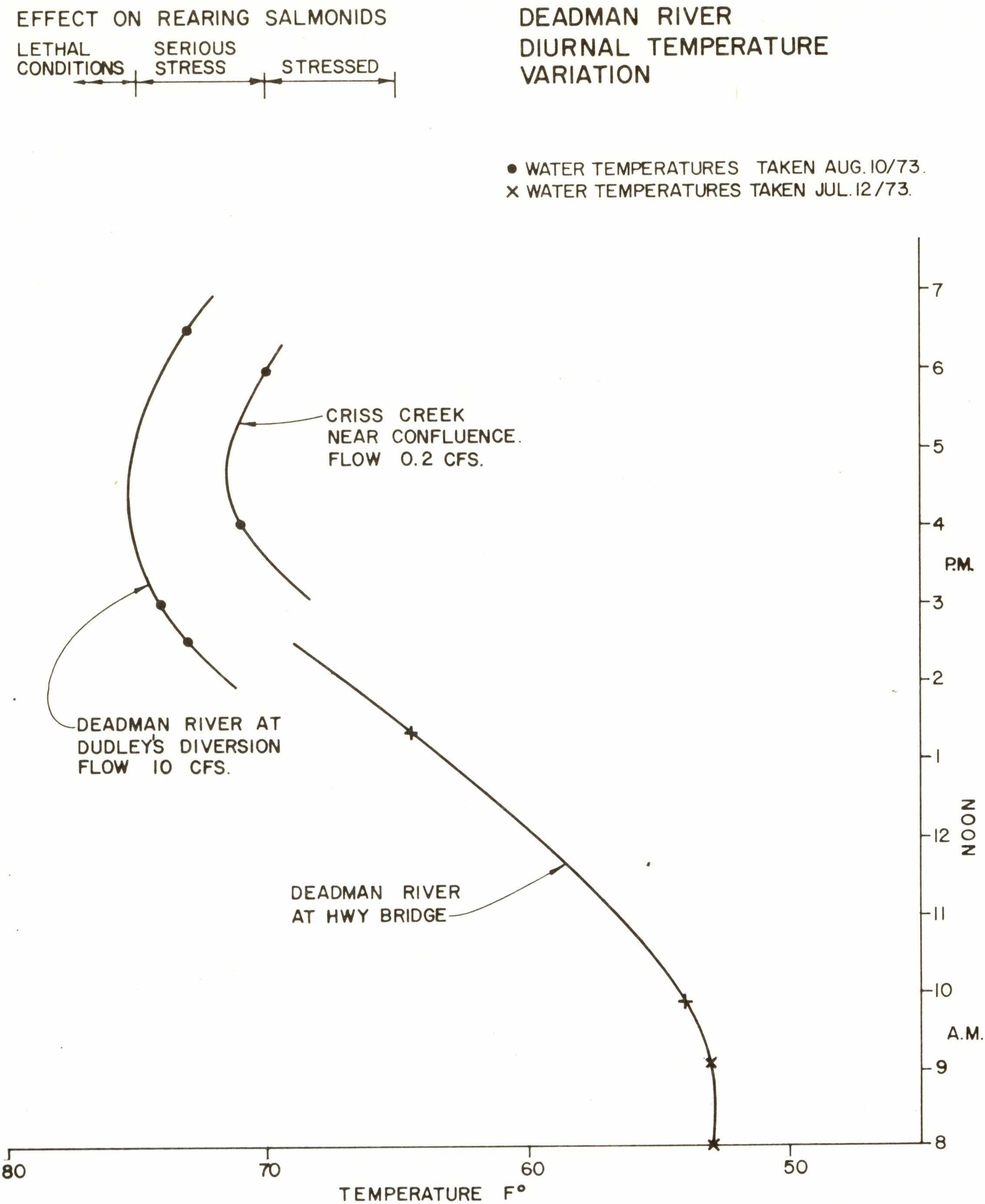
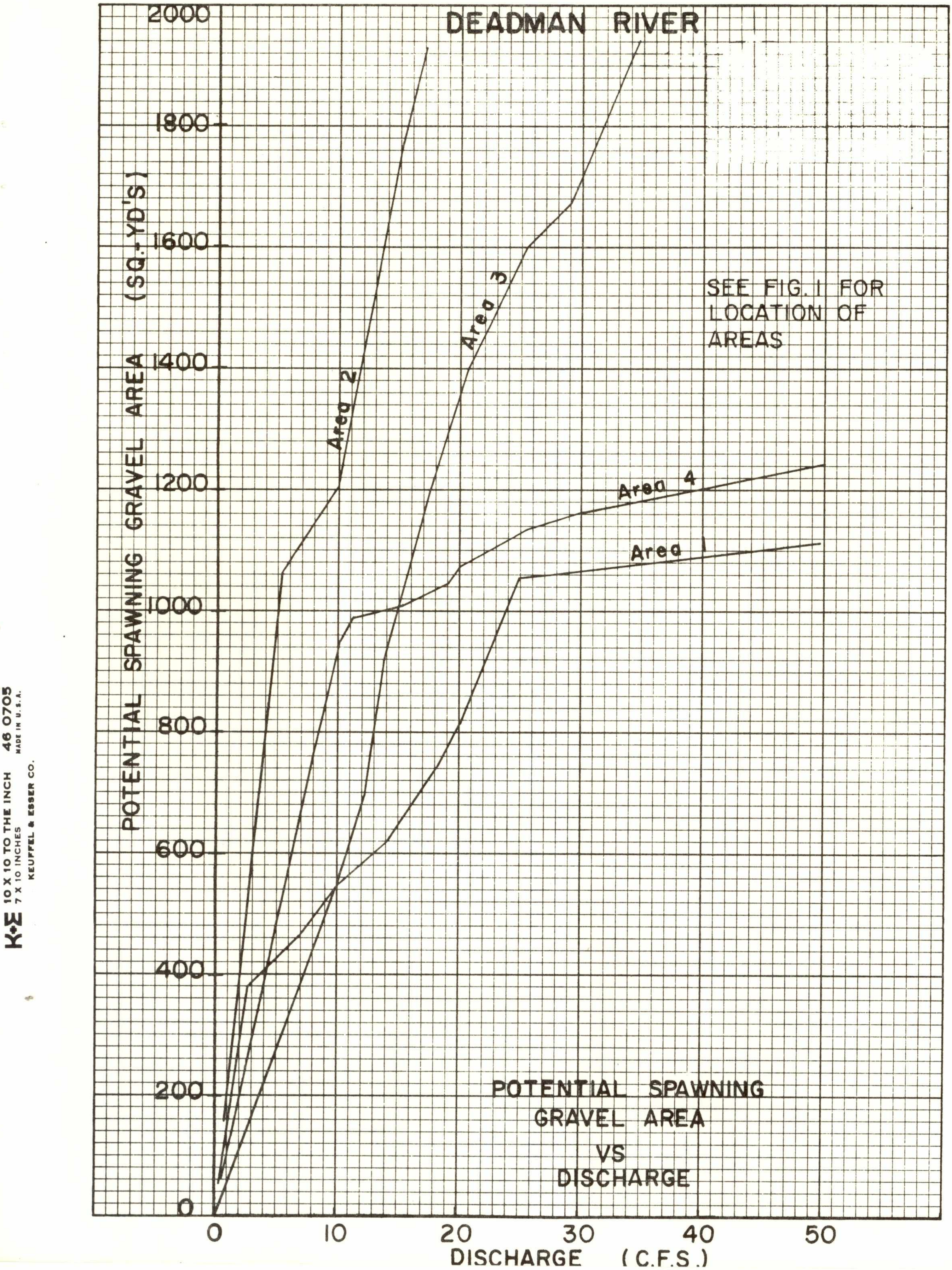

DEADMAN RIVER
DOWNSTREAM MIGRATION
UPSTREAM MIGRATION
COHO
CHINOOK
HAY GROWING SEASON
CRITICAL PERIOD
FLOW IN CU.FT. PER SEC.
300
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
PERIOD IN MONTHS
K+E 10 X 10 TO THE INCH 7 X 10 INCHES 46 0705 KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 9



EFFECT ON REARING SALMONIDS
LETHAL CONDITIONS
SERIOUS STRESS
STRESSED
DEADMAN RIVER
DIURNAL TEMPERATURE
VARIATION
● WATER TEMPERATURES TAKEN AUG. 10/73.
× WATER TEMPERATURES TAKEN JUL. 12/73.
CRISS CREEK
NEAR CONFLUENCE.
FLOW 0.2 CFS.
DEADMAN RIVER AT
DUDLEY'S DIVERSION
FLOW 10 CFS.
DEADMAN RIVER
AT HWY BRIDGE
7
6
5
4
P.M.
3
2
1
12
NOON
11
10
A.M.
9
8
80
70
60
50
TEMPERATURE F°


DEADMAN RIVER
POTENTIAL SPAWNING GRAVEL AREA (SQ. YD'S)
DISCHARGE (C.F.S.)
0
10
20
30
40
50
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Area 1
Area 2
Area 3
Area 4
SEE FIG. 1 FOR LOCATION OF AREAS
POTENTIAL SPAWNING GRAVEL AREA VS DISCHARGE
K+E 10 X 10 TO THE INCH 46 0705
7 X 10 INCHES
KEUFFEL & ESSER CO.
MADE IN U.S.A.

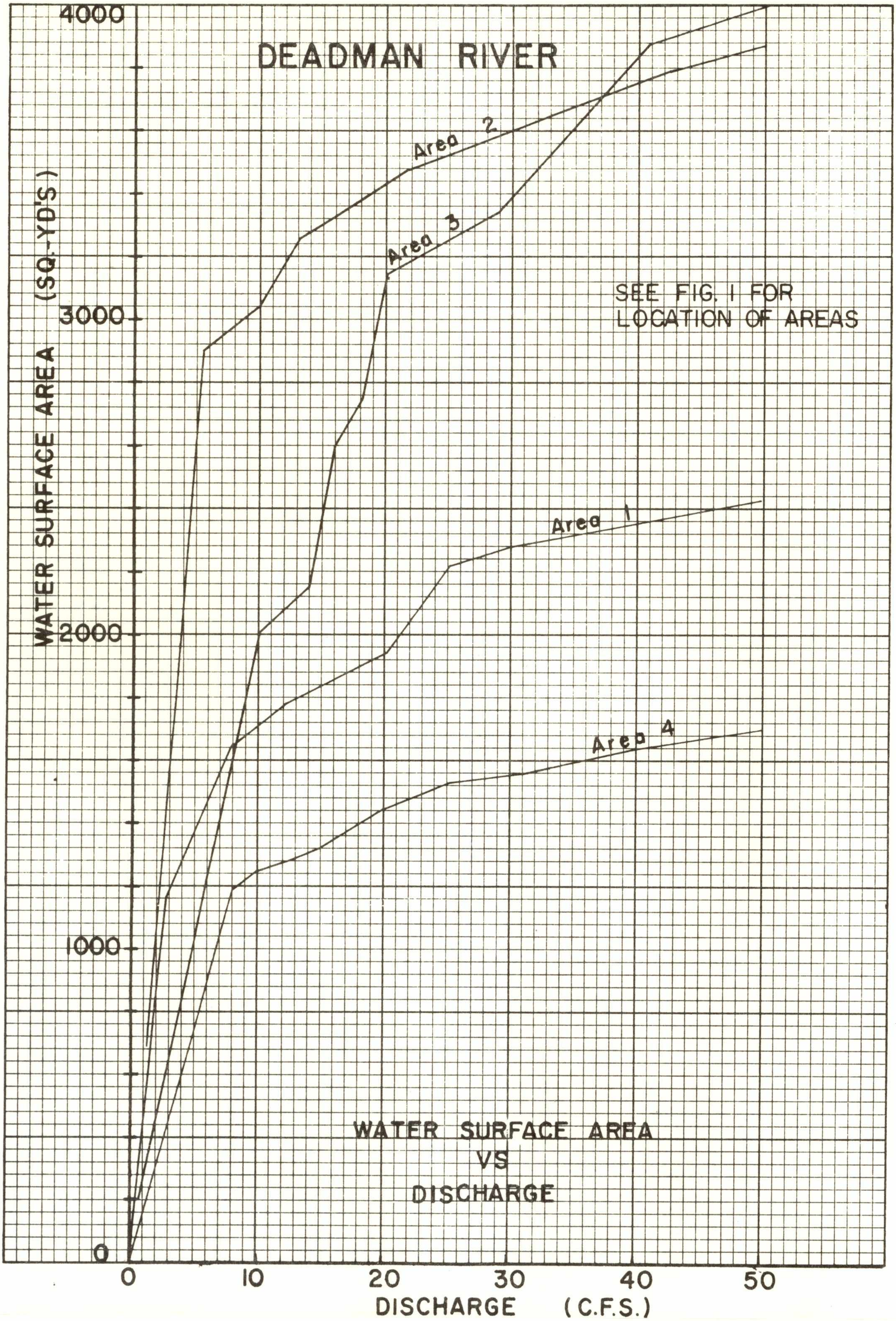
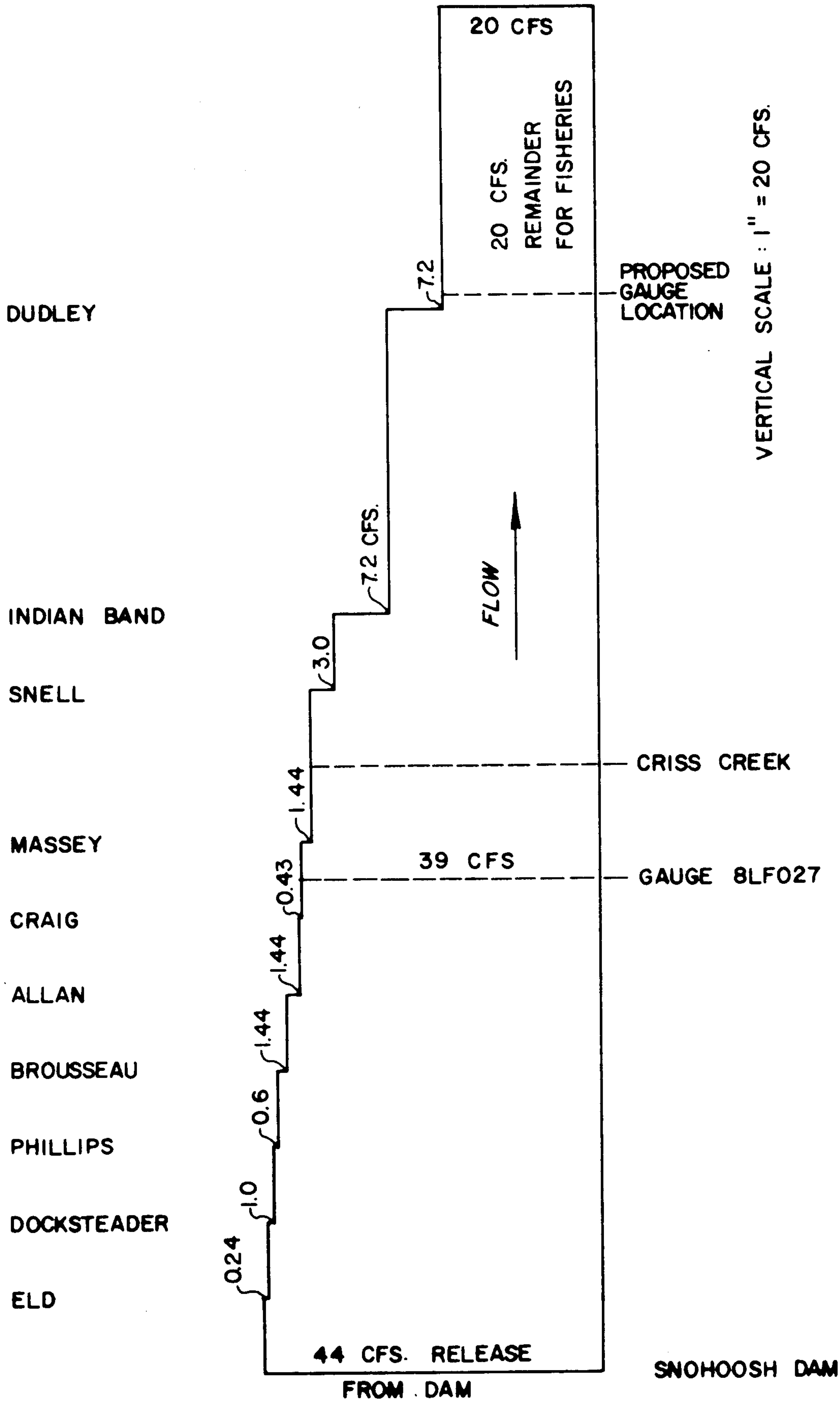

DEADMAN RIVER
WATER SURFACE AREA (SQ.-YD'S)
4000
3000
2000
1000
0
0
10
20
30
40
50
DISCHARGE (C.F.S.)
Area 1
Area 2
Area 3
Area 4
SEE FIG. I FOR LOCATION OF AREAS
WATER SURFACE AREA VS DISCHARGE

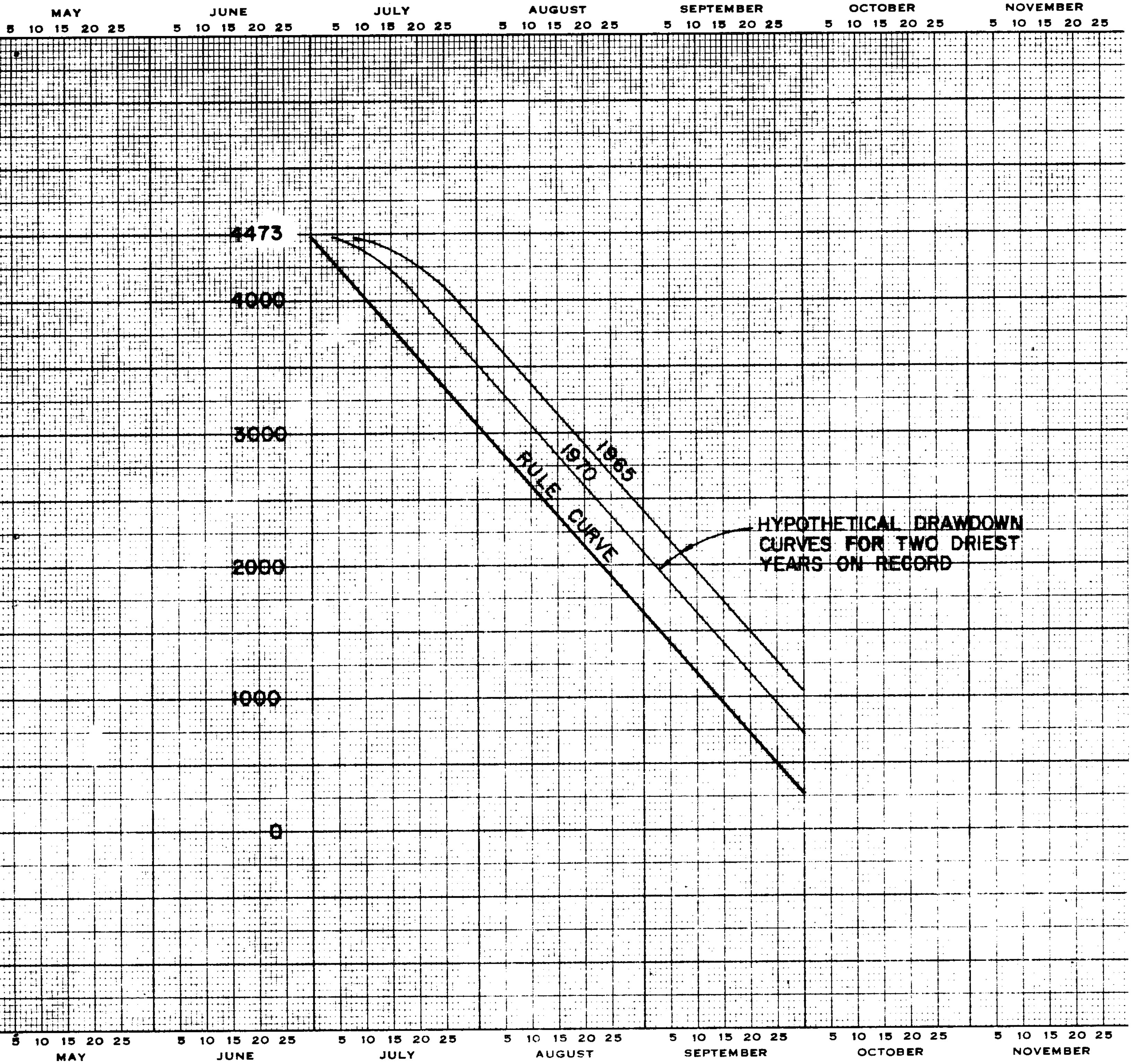
FIG. 13.



DEADMAN RIVER – PROFILE OF WATER USE

BASED ON PROPOSED AUGUST VALUES OF 1400 AC FT. (24 CFS) FOR IRRIGATION AND 1240 ACRE FEET (20 CFS) FOR FISHERIES.

DEADMAN RIVER TENTATIVE RULE CURVE FOR OPERATION OF SNOHOOSH RESERVOIR



Department of the Environment
Fisheries and Marine Service

WATER INTAKE FISH PROTECTION FACILITIES

PROVISIONS OF THE FISHERIES ACT - SECTION 28

In the Provinces of British Columbia, Manitoba, Saskatchewan and Alberta, the Northwest Territories and the Yukon Territory, every ditch, channel or canal constructed or adapted for conducting water from any lake, river or stream, for irrigating, manufacturing, domestic or other purposes, shall if the Minister deems it necessary in the public interest, be provided at its entrance or intake with a fish guard or a metal or wire grating, covering or netting, so fixed as to prevent the passage of fish from any lake, river or stream into such ditch, channel or canal.

Such fish guards shall have meshes or holes of such dimensions as the Minister may prescribe, and shall be built and maintained by the owner or occupier of such ditch, channel or canal, subject to the approval of the Minister or of such officer as he may appoint to examine it.

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

SPECIFICATIONS FOR INTAKE STRUCTURES WITH STATIONARY SCREENS

1. Screen Material: The screen material shall be either aluminum, stainless steel, brass or bronze.

2. Screen Mesh Size: Clear openings of the screen (the space between strands) shall not exceed 0.10 inch*. The open screen area shall not be less than 50% of total screen area. The recommended screen is 8 strands per lineal inch, square-mesh wire cloth with .028 or .025 inch diameter wire.

3. Screen Area: A minimum unobstructed screen area of 10 square feet shall be provided for each cubic foot per second** entering the intake. The required screen area shall be installed below minimum water level. (Screen area lost by framing shall not be included as part of the unobstructed screen area.)

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

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

* 0.10 inch = 3/32" (approximately)
** One cubic foot per second = 450 U.S. gallons per minute
= 375 Imperial gallons per minute

6. Screen Accessibility: The screen shall be readily accessible for cleaning and inspection. (Screen panels or screen assemblies which cannot be removed for cleaning, inspection and repairs should be avoided.)

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

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

PROCEDURES FOR INSPECTION AND APPROVAL OF INTAKE STRUCTURES

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

Diversions greater than one cubic foot per second: The owner shall submit to the Regional Director of Fisheries, Department of the Environment, 1090 West Pender Street, Vancouver 1, B.C., detailed plans of the proposed installation for review and approval prior to fabrication. The plans shall contain the following information: intake structure location and dimensions, maximum capacity of diversion (expressed either in cubic feet per second, U.S. or Imperial gallons per minute), screen dimensions, screen material, mesh size, fabrication details and minimum water level at the intake site.

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

ALTERNATE FISH PROTECTION FACILITIES

Self-cleaning type screens or infiltration-type intakes are sometimes used when diversions present major maintenance and cleaning problems. Enquiries concerning the Department's requirements for these types of structures should be directed to the Fisheries & Marine Service, 1090 West Pender Street, Vancouver 1, B.C.

Revised February 23, 1972.