File: 0256957

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HYDROLOGY DIVISION REPORT

REVERSE FLOWS INTO OSOYOOS LAKE

1. Purpose of the Study

The study was carried out at the request of the Chief Engineer in order to determine the effect of high flows on the Similkameen River on the level of Osoyoos Lake.

2. General

Osoyoos Lake forms part of Okanagan River flowing from north to south, the flow into the lake from the Okanagan River is gauged near Oliver. Osoyoos Lake stretches over the International Boundary for a few miles to Oroville. The Okanogan River flows out of Osoyoos Lake and is met by the Similkameen River about one mile below the Lake. Levels on Osoyoos Lake are gauged near Oroville, the outflow from Osoyoos Lake is gauged at Oroville and the Similkameen River is gauged at Nighthawk; the combined flow in the Okanogan River is gauged some 20 miles south of Oroville at Tonasket.

During periods of high flows on the Similkameen River, the flow tends to back up at Oroville and a reverse flow from the Similkameen to Osoyoos Lake is observed. The magnitude of the reverse flow is dependent on the flow in the Similkameen River and the level of Osoyoos Lake. However, this relationship may vary from year to year due to channel changes.

3. Reverse Flow Observations

Date	Okanagan River nr. Oliver flow-cfs	Osoyoos Lk. nr. Oroville Elev.-ft	Okanogan R. @ Oroville flow-cfs	Similkameen River nr. Nighthawk flow-cfs	Okanogan River nr. Tonasket flow-cfs
25 May, 1948	1690	912.57	- 815	20,700	16,900
26	1700	913.12	-1070	23,300	20,400
27	1770	913.77	-1170	27,000	23,200
28	1800	914.61	-1570	31,800	27,000
29	1820	915.59	-2270	37,000	32,400
30	1910	916.40	-1840	38,100	38,000
13 May, 1949	-	912.57	- 170	23,100	19,700
14	-	913.24	- 288	25,300	22,400
15	-	913.82	- 359	26,500	24,800
16	-	914.07	0	26,500	26,600
14 June, 1950	-	912.96	- 220	22,000	20,000
15	-	913.55	- 384	25,300	22,400
16	-	914.27	- 645	28,500	25,400
17	-	914.87	- 844	28,900	28,200
11 June, 1955	1440	912.89	20	22,300	18,900
12	1440	913.48	- 410	25,600	22,400
13	1410	914.10	- 540	28,000	25,500
3 June, 1960	620	912.42	- 100	13,100	11,300
4	606	912.40	0	14,600	13,200
19 May, 1968	422	911.00	182	10,300	8,400
20	601	911.22	- 100	12,300	10,000

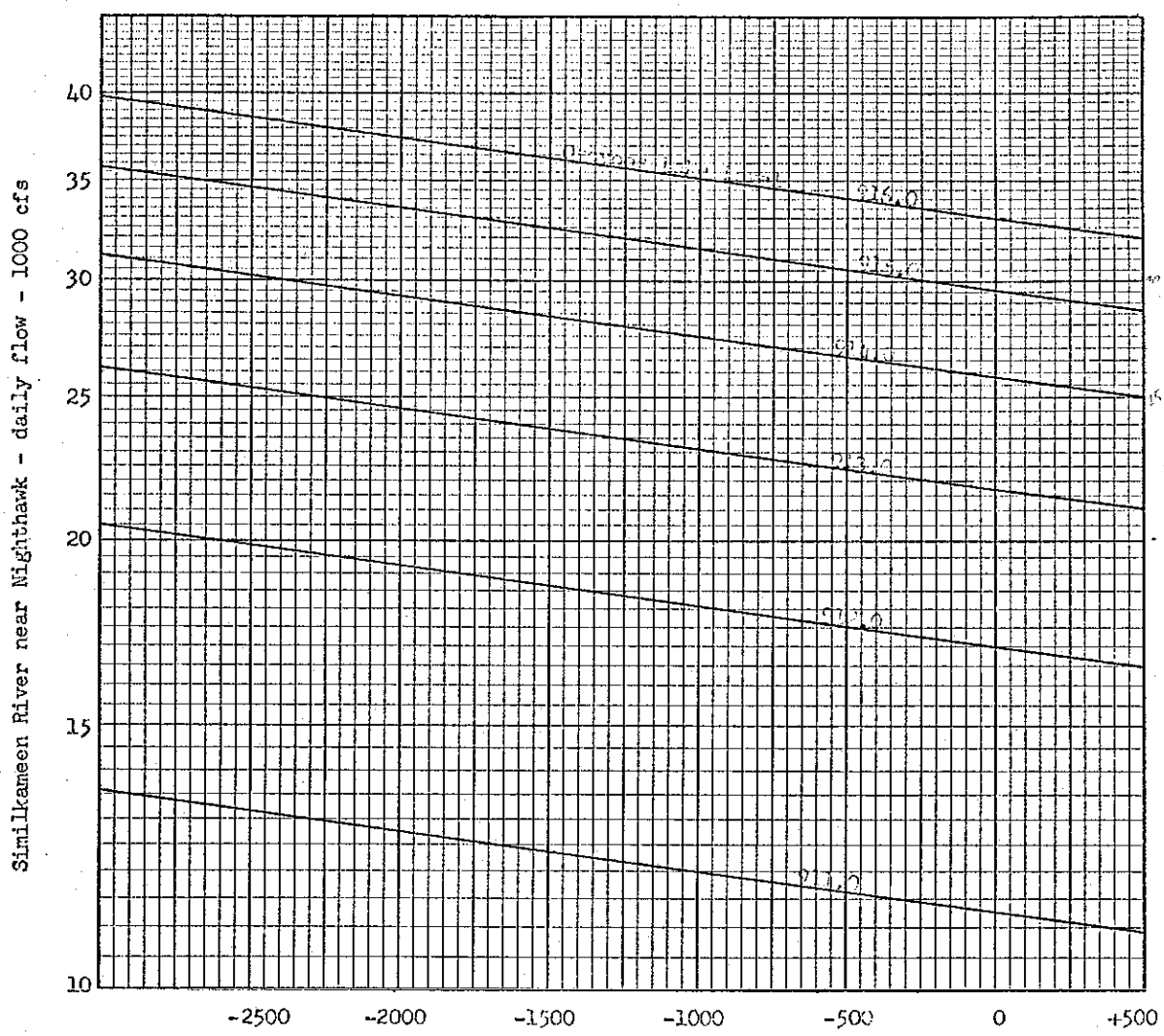
The above dates are the only ones where reverse flow conditions have been observed between 1943 and 1970. The negative sign for flows at Oroville indicates water flowing upstream into Osoyoos Lake.

4. Reverse Flow Relationship

Based on the assumption that the amount of reverse flow at Oroville is dependent on the flow at Nighthawk and the level of Osoyoos Lake and no other factors, a graphical relationship between the three variables was plotted. The lines on the graph following are lines of "best fit" for the

plotted points and it should be noted, however, that there was some scatter of points from the lines. This scatter would be due to measurement errors, rapidly changing conditions and changes in channel control.

REVERSE FLOWS AT OROVILLE



5. Results

From the data and graphical relationship, it can be deducted that regulation of flows on Okanagan River upstream from Oliver will have little effect on the level of Osoyoos Lake during periods of high flow on the Similkameen River. A sharp reduction of flows at Oliver would only increase reverse flows at Oroville by approximately the same amount.

The graphical relationship determined in this study should be considered approximate only as the channel conditions which vary yearly, have an important effect on flows at Oroville. Also, under rapidly changing conditions such as would be experienced during high reverse flows, mean daily flows and levels are inadequate to explain the hydraulic relationship.

C.H. Coulson, P.Eng.
Hydraulic Engineer

May 28, 1971

File: 0256957

HYDROLOGY DIVISION REPORT

(2) OSOYOOS LAKE OUTFLOW

1. Purpose of Study

This study was carried out at the request of the Chief Engineer in order to determine the discharge capacity of Osoyoos Lake at various lake levels.

2. General

The international gauging station on Osoyoos Lake is located one mile south of the International Border on the west side of the lake, and three miles north of Oroville. Records from this station are available from July 1928. Extremes of stage recorded are 8.82 feet (October 14, 1929) to 16.74 (May 31, 1948) but it is stated that the lake level reached 18.8±0.5 on May 29, 1894. The gauging records state that levels may occasionally be affected by the dam at Zosel's mill in Oroville.

The outflow from Osoyoos Lake is gauged at Oroville, 1-1/2 miles downstream from the lake. Daily flow at this station is available from October 1942 to date. Flow at this station various from 0 cfs to -2,270 cfs and 3,430 cfs.

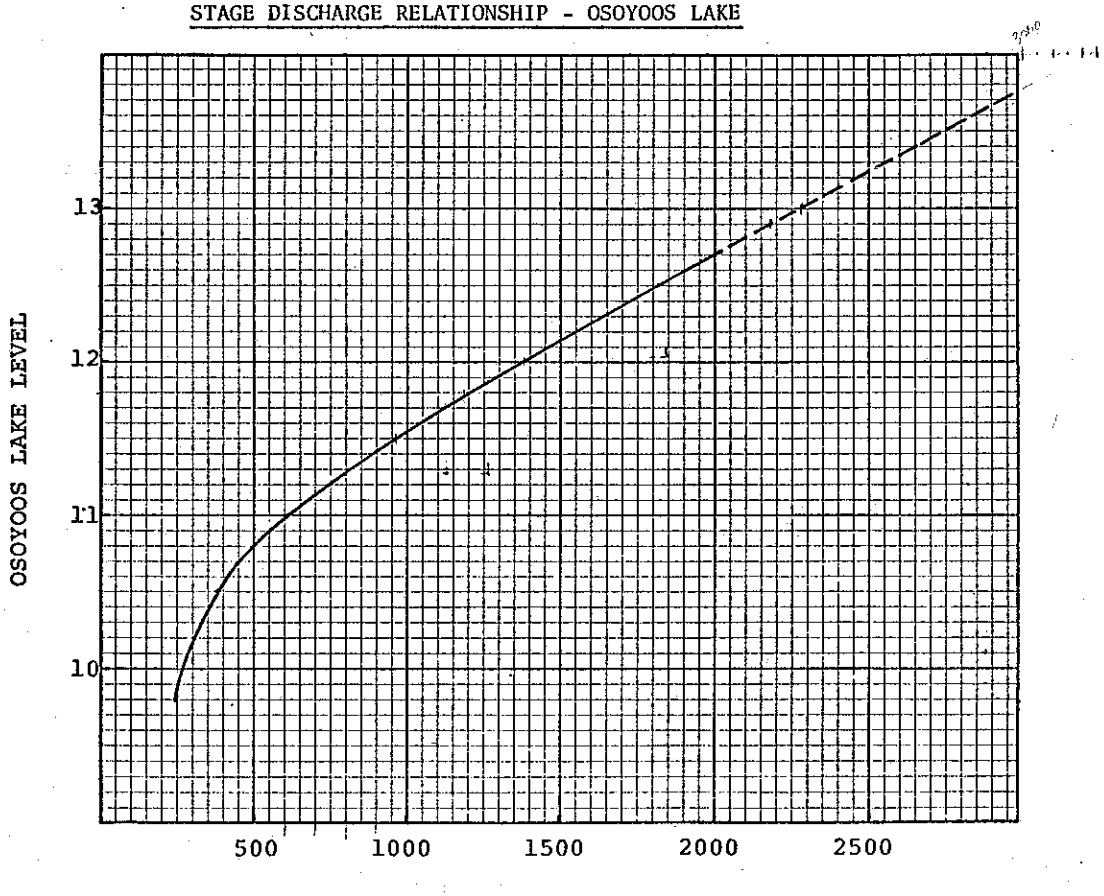
Two other gauge height stations have been installed between the above two. These extra stations were installed by the U.S. Geological Survey as a continuing study on outflow conditions of Osoyoos Lake.

3. Lake Level - Outflow Relationship

The relationship between lake elevation and outflow at Oroville should be good when Zosel's dam is open. Closure of this dam and backwater effects of high flows on the Similkameen River would cause this relationship to break down. However, all deviations from this relationship would give lower outflow than the relationship would indicate.

Numerous points were plotted on the stage discharge graph and a definite trend was indicated. Many points fell close to the line shown while all others fell above the line.

STAGE DISCHARGE RELATIONSHIP - OSOYOOS LAKE



4. Results

This graphical relationships indicates the outflow capacity of Osoyoos Lake for the range of lake levels. However, if Zosel's mill-dam is closed or if the flow in the Similkameen River produces backwater effects, this relationship is not applicable.

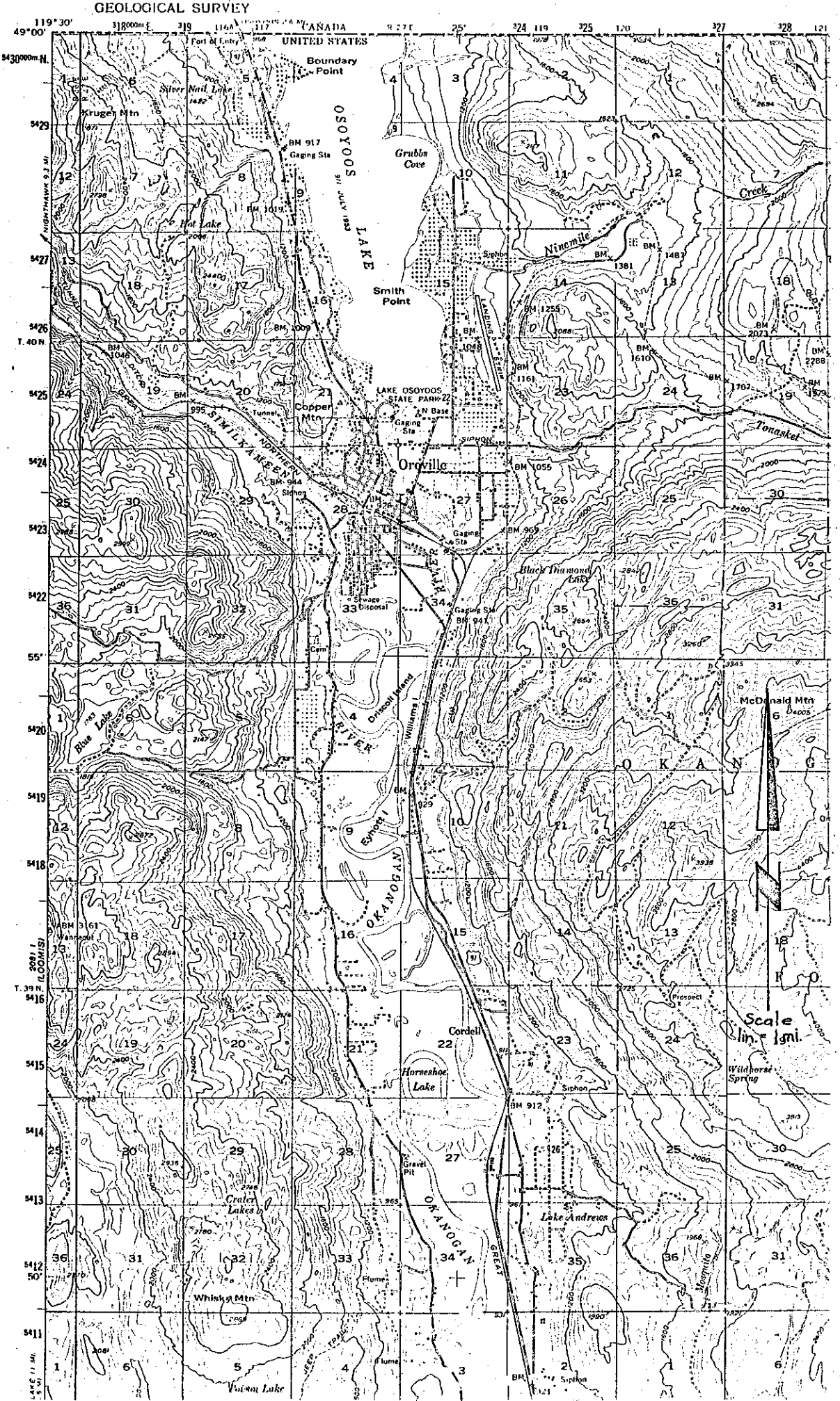
C.H. Coulson, P.Eng.
Senior Hydraulic Engineer

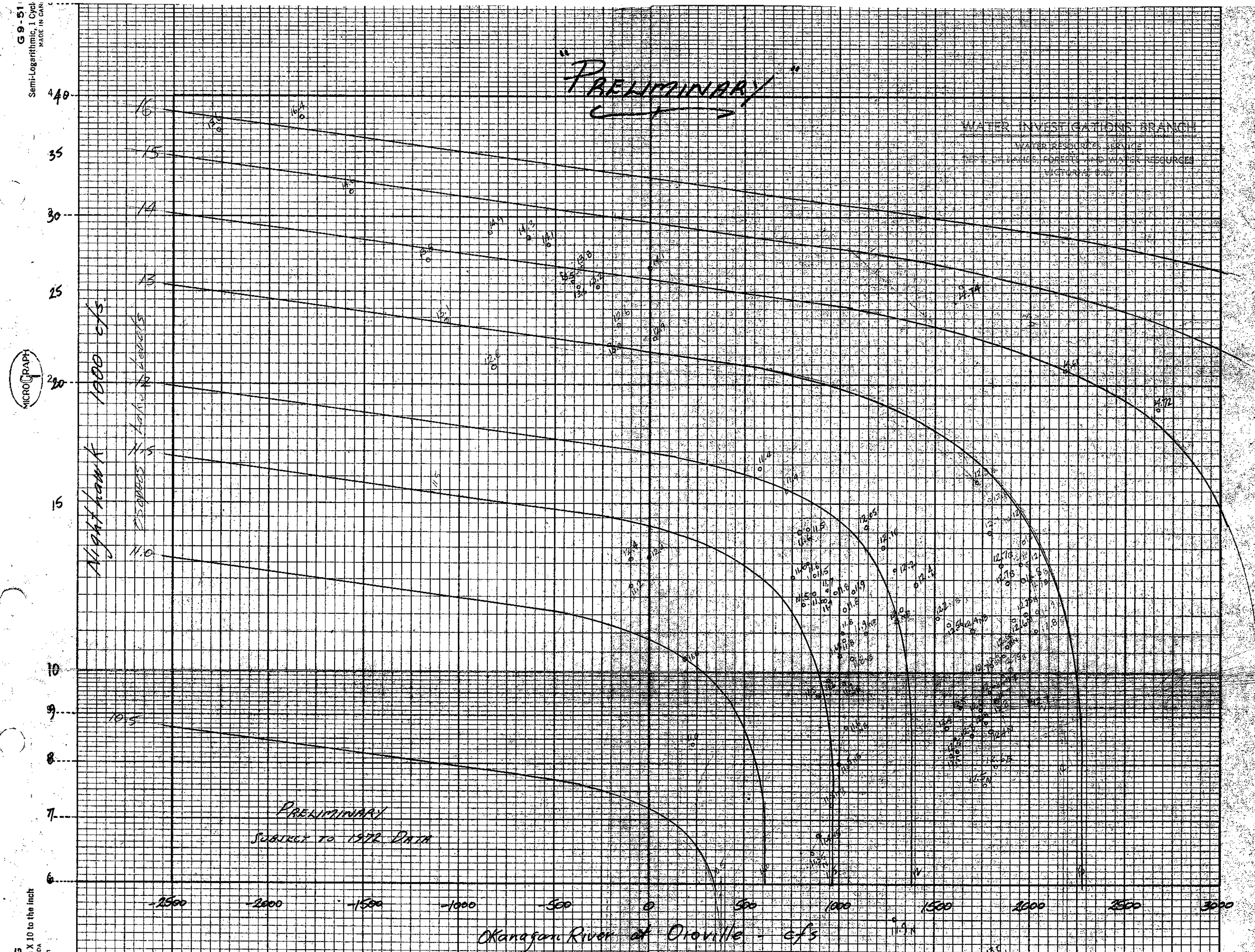
CHC/ls

April 14, 1972

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Map: Oroville, Wash. 2181 IV




"PRELIMINARY"
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
VICTORIA, B.C.
Nighthawk 1000 cfs
Osoyoos Lake Levels
40
35
30
25
20
15
10
9
8
7
6
16
15
14
13
12
11.5
11.0
10.5
PRELIMINARY
SUBJECT TO 1972 DATA
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
Okanagan River at Oroville - cfs
G9-51 Semi-Logarithmic, 1 Cycle
MICROGRAPH
X 10 to the Inch

MEMORANDUM

TO Mr. T.A.J. Leach
Asst. Chief Engineer (Admin.)
Water Investigations Branch
Water Resources Service
BUILDINGS

FROM
OFFICE OF CHIEF ENGINEER
WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS, AND WATER RESOURCES
PARLIAMENT BUILDINGS
VICTORIA, BRITISH COLUMBIA

SUBJECT Maximum discharges in Okanagan Canal

DATE May 10, 1972 OUR FILE 0281792-C-1

In developing alternatives for the water management framework plan for the Okanagan Basin one of the constraints must be the capacity of the Okanagan flood control canal.

As you know, the design capacity of the system varies from 2,100 c.f.s. at Penticton to 3,400 c.f.s. at Oliver, the difference being an allowance for sidestream inflow between Okanagan Lake and Osoyoos Lake.

The above quoted figures are peak capacity and the question remains as to the realistic discharges that can be counted on during the runoff season.

An analysis of the stage-discharge relationship for Osoyoos Lake suggests that under good operating conditions i.e. with no backwater effect from the Zosel mill dam downstream or from high stages in the Similkameen River at its junction with the Okanagan River, the outflow capacity of Osoyoos Lake ranges as follows:

Lake elevation*	Outflow
911.00	600 c.f.s.
912.00	1,350 c.f.s.
913.00	2,250 c.f.s. estimated

*(U.S. Coast and Geodetic Survey datum of 1929)

Under poor operating conditions occasioned by high discharges in the Similkameen River and backwater effect on Osoyoos Lake these discharges are seriously reduced. This is best illustrated by the following example:

Similkameen R.@ Nighthawk	Osoyoos Lake Elev.	Lake Outflow
20,000 c.f.s.	912.00	- 2,600 c.f.s.
20,000 c.f.s.	913.00	+ 1,000 c.f.s. (estimated)

If we assume that Osoyoos Lake must be maintained below elevation 913.00 (believed to be start of flooding) and further that good (non-backwater) operating conditions exist then the maximum sustained inflow to Osoyoos Lake becomes 2,250 c.f.s. Based on design capacity of this canal allowing for inflow between Okanagan Lake and Osoyoos Lake the maximum sustained outflow from Okanagan Lake during the runoff period becomes

$$\frac{2,000}{3,400} \times 2,250 \text{ or } 1,390 \text{ c.f.s.}$$

B.E. Marr

BEM/ls