REPORT ON OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1973 THROUGH JULY 1974

COLUMBIA RIVER TREATY OPERATING COMMITTEE

September 1974

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OPERATION OF COLUMBIA RIVER

TREATY PROJECTS

1 AUGUST 1973 THROUGH 31 JULY 1974

COLUMBIA RIVER TREATY OPERATING COMMITTEE

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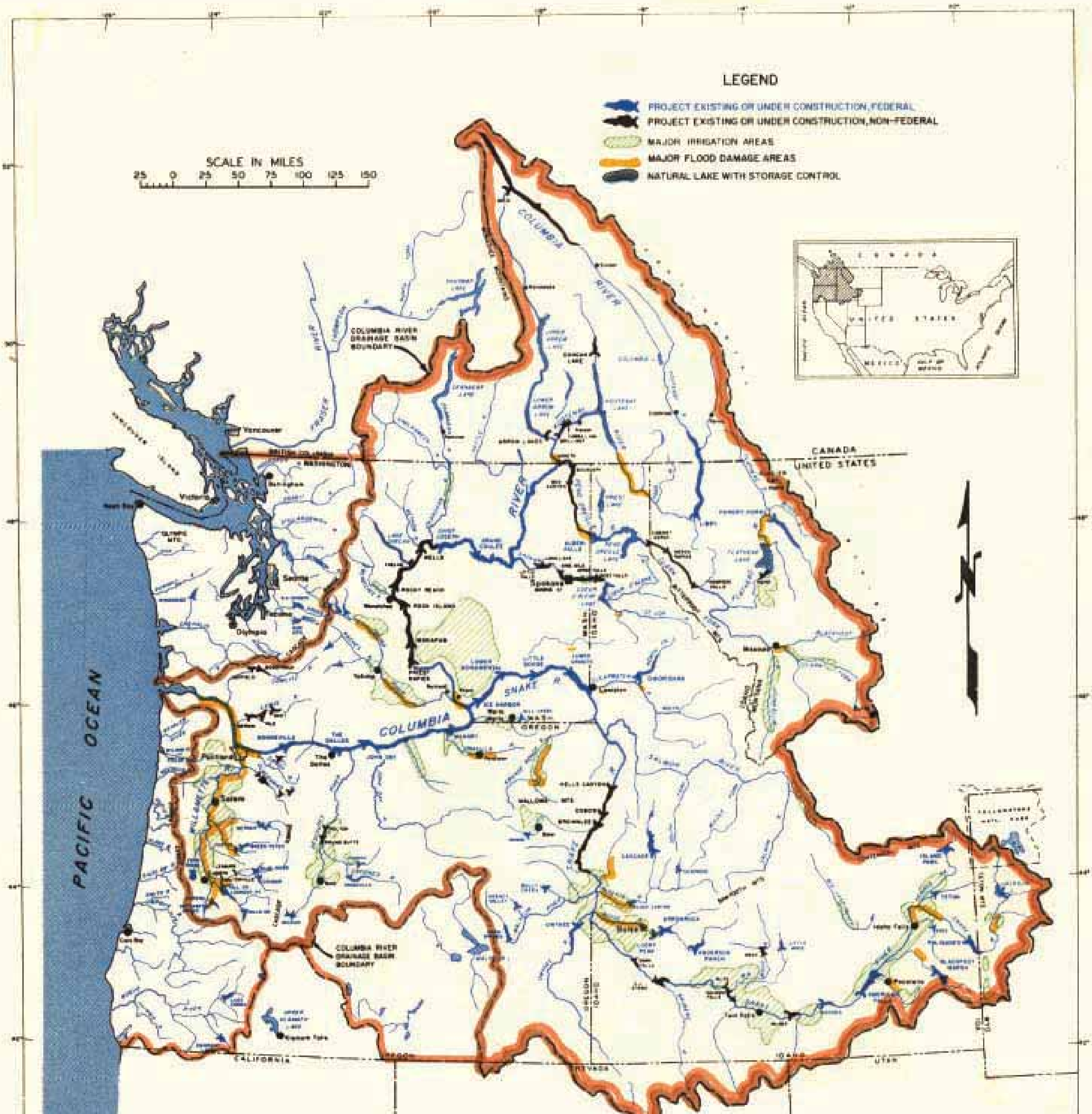
TABLE OF CONTENTS

Page

COLUMBIA RIVER BASIN



REPORT ON
OPERATION OF COLUMBIA RIVER TREATY PROJECTS
1 AUGUST 1973 THROUGH 31 JULY 1974

I INTRODUCTION

A. AUTHORITY

Duncan, Arrow, and Mica reservoirs in Canada and Libby reservoir in the United States of America were constructed under the provisions of the Columbia River Treaty of January 1961. The Treaty requires that the reservoirs be operated for the purpose of increasing hydroelectric power generation and flood control in the United States of America and in Canada. In 1964, the Canadian and United States governments each designated an Entity to formulate and carry out the operating arrangements necessary to implement the Treaty. The Canadian Entity is British Columbia Hydro and Power Authority; the United States Entity is the Administrator, Bonneville Power Administration and the Division Engineer, North Pacific Division, Corps of Engineers.

The Columbia River Treaty Operating Committee, established in September 1968 by the Entities, is responsible for preparing and implementing operating plans as required by the Columbia River Treaty. This report records and reviews the operation of Mica, Arrow, Libby, and Duncan reservoirs for power and flood control during the period 1 August 1973 through 31 July 1974., including the major effects downstream in Canada and in the United States of America.

B. OPERATING PROCEDURE

Throughout the period covered by this report, storage operations were implemented by the Operating Committee in accordance with the Detailed Operating Plan for Columbia River Treaty Storage, dated 14 September 1973. During the drawdown season from mid-August 1973 to mid-April 1974, the regulation of the Canadian storage content was normally determined by the Operating Committee on a weekly basis. From 29 April through 24 July, during the 1974 Flood Control Refill Period, project outflows were determined on a daily basis.

II WEATHER AND STREAMFLOW

A. WEATHER

The abnormally dry weather that was established early in 1973 continued through August, but numerous storms during the latter half of September began to improve the moisture supply and above-average October precipitation brought an end to the drought over much of the basin. November 1973 was one of the wettest in history for the Columbia Basin with most stations exceeding their maximum of record precipitation totals. Some Cascade Range snow courses had exceeded their normal 1 April water content by the end of November. Wet weather continued over the Columbia Basin through April, with the result that precipitation throughout the snow accumulation season was significantly above normal. Chart 1 shows the geographical distribution of the accumulated October through April precipitation over the entire Columbia River Basin expressed as percentage of the 1958-1973 average. As shown, most of the basin with exception of southern Idaho and a small area in Canada had more than 120 percent of the 15-year average and the central portion of the basin had more than 150 percent. Chart 2 depicts the sequence of precipitation and temperatures that occurred throughout the winter, as measured by index stations in the basin.

Snow accumulation as of the 1st of April was well above normal with numerous snow courses throughout the Columbia Basin showing the greatest water content of record. Even low elevation courses were above normal, despite warmer-than-normal temperatures that occurred during the last half of March. Considerable additional snow fell at higher elevations during early April, increasing the runoff potential. Significant runoff was delayed by below-normal temperatures in May, so that by 1 June, snow water content at many snow courses exceeded those of 1972, a very high runoff year. June temperatures averaged above normal, with a sequence of much-above normal temperatures being experienced in mid-June. The pattern of temperature and precipitation throughout the March-July season is shown on Charts 3 and 4. Chart 3 applies to the Columbia River Basin above The Dalles, Oregon, and Chart 4 applies to the upper Columbia and Kootenay River Basins in Canada. Since the major portion of the runoff which occurs during this season is produced by snowmelt, the temperatures shown are of special significance to system reservoir regulation in that they largely influence the pattern of streamflow.

B. STREAMFLOW

The well-below normal streamflows that were experienced during the 1972-73 operating year continued into August and September throughout the Columbia River Basin. River flow began increasing in October, and in November above average streamflow was experienced in the basin. The trend of average to above average streamflow continued throughout the winter, and by 1 April 1974 the total unregulated runoff at The Dalles since October 1973 was about 140 percent of average.

An intense rainstorm during 12-16 January caused the Pend Oreille, Kootenay, and Spokane River streamflow to rise to record levels for the winter season. The inflow into Grand Coulee rose sharply and threatened to cause flooding of the third powerhouse construction area. Upstream reservoirs stored water during this period and helped to prevent a major set back in construction progress. Widespread flooding occurred throughout the United States portion of the basin, and at Vancouver, Washington, the combined flow of the Willamette and Columbia Rivers produced a stage of 23.2 feet, the maximum stage for the year.

Streamflow during the spring-summer snowmelt period was well above normal, and at many stream gaging stations record high flows were recorded. A pronounced rise in streamflow was delayed by cool weather until 10 June when a sequence of high temperatures throughout the basin resulted in extremely rapid runoff. Maximum mean daily inflows of the season were 128,000 cfs on 23 June for Mica, 22,000 cfs on 24 June for Duncan, and 111,000 cfs on 19 June for Libby.

The natural streamflow patterns for the year are shown on the inflow hydrographs for the Treaty Reservoirs, Charts 5, 6, 7, and 8. Observed and computed unregulated hydrographs for Kootenay Lake and Columbia River at Birchbank, Grand Coulee Dam and The Dalles are shown on Charts 9, 10, 11, and 12.

C. SEASONAL RUNOFF VOLUMES

Volume of runoff during the snowmelt season, as well as the variation with time, is of great importance because the reservoir regulation plans are determined in part by the expected runoff volume. Runoff volume forecasts, based on precipitation and snowpack data, were prepared for a large number of locations in the Columbia River Basin and updated each month as the season advanced. Table 1 lists the seasonal volume inflow forecasts for Mica, Arrow, Duncan, and Libby projects and the unregulated runoff of Columbia River at The Dalles. The forecasts for Mica, Arrow, and Duncan inflow were prepared by B.C. Hydro and Power Authority and those for the lower Columbia River and Libby inflow were prepared by the Columbia River Forecasting Service. Also shown on Table 1 are the actual volumes for these five locations.

Actual April-August runoff volumes, adjusted for upstream reservoir storage effects, are listed for eight locations in the following tabulation:

STREAM AND LOCATION	THOUSANDS OF ACRE-FEET	PERCENT OF 1958-73 AVERAGE
Libby Reservoir Inflow	9,100	129
Duncan Reservoir Inflow	2,270	104
Columbia River at Mica Dam	12,300	101
Arrow Reservoir Inflow	25,900	108
Columbia River at Birchbank	51,100	118
Grand Coulee (FDR) Reservoir Inflow	81,300	125
Snake River near Clarkston	36,500	154
Columbia River at The Dalles	134,200	136

Comparison of the above tabulation with the seasonal precipitation map on Chart 1 reveals the general relationship between snow-accumulation season precipitation and snowmelt season runoff when expressed in percent of average.

III RESERVOIR OPERATION

A. MICA RESERVOIR

Reservoir Evacuation Period. As indicated on Chart 5, Mica reservoir (McNaughton Lake) was at elevation 2257.1 ft. on 31 July 1973 and it reached the maximum elevation for 1973 of 2269 ft. on 16 August. Because of the much below-normal elevation of Arrow reservoir through the late summer and fall of 1973, Mica discharges were kept at the maximum possible with the 3 low level outlets fully open.

By late November the storage balance between the Arrow and Mica reservoirs indicated that, with reference to the Second Critical Rule Curves for 1973-74, Mica discharges should be reduced to the 1000 cfs minimum. The minimum discharges continued throughout the storage drawdown period with the exception of seven days in January 1974 when discharges of approximately 9000 cfs were made to alleviate Mica powerhouse construction problems. The 1 January Variable Refill Curves indicated 31 January 1974 elevations of 2074.9 ft. for Mica and 1378.0 ft. for Arrow. Since Arrow reservoir was maintained approximately 15 to 20 feet above its Variable Refill Curve for the remainder of the storage evacuation period, Mica discharges were kept at minimum levels to maintain McNaughton Lake elevations above the Variable Refill Curve in accordance with the "Program for Initial Filling of Mica Reservoir". The minimum elevation reached during the storage evacuation period was 2157.4 ft. on 30 November.

Refill Period. Because of the above-normal snowmelt runoff in the Columbia River Basin in 1974, it was possible to maintain Mica discharges below 1000 cfs completely throughout the refill period to 31 July. At the end of the 1973 refill period no dead storage had been accumulated in McNaughton Lake except for 510.3 ksfd (1.01 maf) accumulated by means of thermal energy deliveries from B.C. Hydro to the United States Coordinated System. During the 1974 refill period, however, the accumulation of dead storage was greatly improved. By 7 August 1974, a total dead storage content of 3112.0 ksfd (6.2 maf) had been accumulated with approximately 2329 ksfd (4.6 maf) being obtained from water surplus to United States power requirements during the 1974 refill period. Approximately 261 ksfd (.52 maf) of dead storage content was obtained from transfer of 132 ksfd of B.C. Hydro storage in Arrow reservoir to McNaughton Lake which had been retained in Arrow reservoir during the spring of 1974, and by allocation of an additional 129 ksfd (.256 maf) to dead storage in accordance with an agreement between Bonneville Power Administration and B.C. Hydro dated 18 May 1972. This 261 ksfd was credited to Mica dead storage during the period from 31 July to 7 August 1974. In addition, approximately 22 ksfd of dead storage was obtained from 4720 megawatt-hours (mwh) of thermal energy delivered in January and from 15,000 mwh delivered in late July to the United States Coordinated System. The McNaughton Lake elevation on 31 July was 2397.8 ft. and the maximum elevation reached during the 1974 refill period was 2409.1 ft. on 25 August. The 1974 volume inflow forecasts and the Variable Refill Curve computations for Mica are shown in Table 2.

B. ARROW RESERVOIR

Reservoir Evacuation Period. As indicated on Chart 6, Arrow reservoir was at elevation 1399.7 ft. on 1 August 1973, 44 ft. below the normal full pool elevation of 1444 ft. The low water level in the Arrow Lakes was a result of the below-normal runoff experienced the previous year, and of the limited discharge capacity available at Mica during its initial operation. The 1973 snowmelt runoff for the Lower Columbia was the lowest since 1944, creating a critical power situation in the United States that required large storage drafts from Canadian Treaty reservoirs during the summer months.

Discharges in excess of 90,000 cfs were required from the Arrow reservoir between 22 July and 13 August and by 30 September the reservoir was at elevation 1380.7 ft. Low elevations during the summer months created problems for navigation on the lake and adversely affected recreational use of the reservoir. The reservoir remained at approximately 1381 ft. from late September to early November, and by 4 November was below its 31 October and 30 November Second Critical Rule Curve elevations. However, by mid-November the critical water supply situation in the United States had eased and Arrow storage filled 15 ft. during the month. Maximum discharges were continued from Mica for most of the month of November, but only minimum discharges were required from Arrow reservoir for downstream generation in the United States.

The reservoir was maintained between elevations 1395 and 1400 ft. for the remainder of the winter months until late March when it was drafted to 1394 ft. prior to the start of the spring freshet.

During February and March, B.C. Hydro delivered thermal energy to the United States Coordinated System in lieu of water releases from Canadian Treaty storage. Since Mica was discharging minimum release at the time, the additional storage was retained in Arrow reservoir. This storage, totalling 99.0 ksfd (0.196 maf), plus additional storage of 33.0 ksfd (0.066 maf) of water surplus to United States power requirements, was retained as B.C. Hydro storage in Arrow for subsequent transfer to McNaughton Lake as dead storage.

Refill Period. With the 132 ksfd (0.262 maf) of B.C. Hydro storage retained in Arrow reservoir prior to the snowmelt runoff season it was agreed that the reservoir would be filled to elevation 1446 ft. during the 1974 refill period, 2 ft. above the normal full pool elevation of 1444 ft.

The 1974 snowmelt runoff for the Columbia River Basin was above normal, considerably higher than the 1973 runoff. The Arrow reservoir was maintained below the required flood control storage evacuation elevation of 1400.0 ft. until early May when it was operated to provide flood control protection downstream in Canada and in the United States. Arrow reservoir was filled to elevation 1444 ft. by 15 July and reached the agreed 1974 full pool elevation of 1446 ft. four days later. At 31 July, the Arrow Lakes were at 1445.9 ft., approximately 46 ft. higher than the elevation at the same date in 1973. The 1974 volume inflow forecasts and the Variable Refill Curve computations for Arrow are shown in Table 3.

C. DUNCAN RESERVOIR

Reservoir Evacuation Period. As indicated on Chart 7, Duncan reservoir was also at a below-normal elevation on 1 August 1973 of 1874 ft. In contrast with the normal operation of the reservoir during August, outflows of up to 10,000 cfs were required for downstream generation in the United States resulting in storage draft during the month. Since high discharges in the order of 20,000 cfs were also being made from Libby reservoir, considerable spill occurred at the Kootenay River plants in Canada.

Operating plans at that time indicated the high releases from both Duncan and Libby would be continued until the reservoirs were empty. As a result of concern expressed by West Kootenay Power and Light Company that its power supply could be in a critical situation during the winter and early spring of 1974 should streamflows in the Kootenay River basin remain below normal, an agreement was made relating to the re-regulation of the Kootenay River.

The agreement, dated 25 September 1973, between Bonneville Power Administration, B.C. Hydro and Power Authority and West Kootenay Power and Light Company, specified that the maximum discharge past the Kootenay River plants would be no greater than 18,000 cfs. This modified operation of Duncan and Libby reservoirs would cause an estimated 131,400 megawatt-hours of head loss mainly at Grand Coulee, and it was agreed this amount of energy would be delivered by West Kootenay Power and Light to the United States Coordinated System as compensation. Any additional generation at the Kootenay River plants would accrue to West Kootenay and B.C. Hydro. The agreement was terminated by Bonneville Power Administration on 30 October 1973 when it was determined that the head loss at Grand Coulee had been fully compensated for after delivery of 72,864 megawatt-hours. The above agreement was the first to be made in accordance with Article XII(5) of the Columbia River Treaty.

Streamflows in the Kootenay River basin increased to well above critical levels during late 1973 and extremely high local inflows to Kootenay Lake occurred in mid-January 1974. Since this trend was common to the whole Columbia River basin, Duncan was not drafted to its Variable Refill Curve elevation of 1794 ft. during the period from January through April. Storage drafts from Duncan and Libby were, for the most part, spilled past Kootenay River plants from the end of January to the end of the evacuation period. Drafting of the reservoir to about elevation 1811 ft., slightly above the flood control evacuation elevation of 1807.7 ft. was completed by 3 March 1974.

Refill Period. The Duncan reservoir was maintained at approximately elevation 1813 ft. until 3 May 1974, then outflows were restricted to 1000 cfs for flood control until 27 June. Discharges were then gradually increased until 20 July when the reservoir reached the normal full pool of 1892 ft., and this elevation was maintained through the remainder of the month. Table 4 shows the 1974 volume inflow-forecasts and the Variable Refill Curve computations for Duncan.

D. LIBBY RESERVOIR

Reservoir Evacuation Period. Lake Koocanusa also failed to fill in 1973 due to the low runoff volume experienced over the Columbia Basin. As shown on Chart 8, the lake was at elevation 2412.0 ft. on 31 July 1973, and a maximum elevation of 2415.3 ft. was attained on 16 August. With the completion of a fish study downstream of Libby, the draft of the lake for downstream power generation was initiated. Improved streamflow conditions permitted Libby to store water during December, but the heavy snowpack accumulated by 1 January made it necessary to continue draft of Lake Koocanusa for flood control to its normal minimum 15 March elevation of 2287 ft. During the rainfloods in the middle of January, the Libby project outflow was reduced to near minimum to reduce flows into Kootenay Lake and to assist in reducing flows into Grand Coulee project which had threatened the third powerhouse construction. During February, the Libby outflow was restricted to about 18,000 cfs to prevent inundation of the Deep Creek bridge on a tributary near Bonners Ferry. Libby outflow was further reduced during March to permit the continued drafting of Kootenay Lake along its IJC rule curve. Lake Koocanusa was lowered to elevation 2305 ft. by 19 March making about 4.7 million acre-feet of storage space available. The rest of the storage (0.3 maf) was not drafted because of the relatively high winter inflows from the areas in the Kootenai basin below Libby project and requirements not to violate the 1938 IJC order for operation of Kootenay Lake.

Refill Period. Lake Koocanusa was maintained near elevation 2305 ft. through April, and on 5 May the lake began filling as the outflow was reduced for flood control. The outflow from Libby project was maintained near 15,000 cfs until after the natural peak on the Kootenai was passed, then the outflow was gradually increased to a maximum of 34,500 cfs on 30 June to reduce the rate of fill of the reservoir. The outflow was reduced daily thereafter and was back to near 15,000 cfs by 6 July. On 25 July 1974, Lake Koocanusa reached the normal full pool elevation of 2459 ft. for the first time. Volume inflow forecasts and Variable Refill Curve computations for Libby are shown on Table 5.

IV DOWNSTREAM EFFECTS OF STORAGE OPERATION

A. POWER

General. During the period covered by this report, the Treaty storage was operated in accordance with the 1973-74 Detailed Operating Plan designed to achieve optimum power generation downstream in the United States of America. The Canadian Entitlement to downstream power benefits for the 1973-74 operating year having been sold in 1964 to Columbia Storage Power Exchange, deliveries of power and energy specified under the Canadian Entitlement Exchange Agreements and attributable to Arrow, Duncan and Mica under the provisions of these agreements were made during the 1973-74 Operating Year.

The actual generation at downstream projects in the United States attributable to Canadian Storage during the period 1 April 1973 through 31 March 1974 was 433 average megawatts at rates up to 801 megawatts. These amounts are lower than the amounts provided in the Canadian Entitlement Exchange Agreement and are due to the failure of Mica to fill to the Treaty storage content of 7 million acre-feet. Subsequent to 31 March 1974 the energy amount increased to 759 average megawatts and the maximum rate of generation increased to 1385 megawatts.

Chronology. Power operations for 1973-74 had the potential to be far more critical than experienced during 1972-73. Below-normal precipitation during the winter and spring of 1972-73 produced runoff in the Columbia River that was one of the lowest since record keeping began in 1878 and was the lowest since 1944. Actual runoff at The Dalles, Oregon, during the January-July 1973 period was approximately 71 million acre-feet, compared with median runoff at The Dalles for this period of approximately 106 million acre-feet. The extremely low runoff resulted in the region's major reservoirs being about one-third below their full storage capacity at the start of the storage-drawdown season in August 1973. The storage deficit of approximately 15 million acre-feet is equivalent to 15 billion kilowatt-hours of energy.

As streamflows continued below critical levels, the reservoir storage deficiency on 1 September 1973 amounted to 7-1/2 percent of the firm energy requirements of the region for the remainder of the 20-1/2-month critical hydro period ending 30 April 1975. Studies showed that if streamflows improved to "critical" levels and loads materialized as projected, all reservoir storage would be depleted early in March 1974 and Bonneville Power Administration (BPA) would have to curtail up to 30 percent of firm loads during March and April.

Many actions were taken to help alleviate the critical energy shortage facing the region. Curtailment of direct service to interruptible industrial loads and utility secondary energy loads which began 1 October 1972, was continued. The industries obtained some replacement power from other sources for part of their interruptible load and operated at a drastically reduced level with attendant economic repercussions felt throughout the region. The utilities operated their thermal plants including high-cost gas turbines. Low sulphur fuel was in short supply and some plants required extensive modification to meet air pollution standards for stack emission. All energy surplus to the needs of British Columbia, California and the Rocky Mountain utilities was purchased. In August 1973, after receiving authority to purchase all available power, BPA made its first purchases of energy during the 1973-74 operating year. By early January 1974, when BPA was able to suspend power purchases, more than 364 million kWh had been purchased at a cost of more than $2.5 million.

To help offset the region's serious power deficits BPA and Northwest utilities cooperated in a regionwide energy conservation program which will continue indefinitely. Appeals were made directly to ultimate power consumers and leadership, coordination, and assistance provided to all BPA industrial and utility customers in carrying out programs to reduce the use of electricity by all consumers. As a result, loads, after adjustment for temperature variations have been consistently below forecasts. Firm loads in the region during October were 8 percent less than the estimate; close to two-thirds of the reduction was estimated to be due to energy conservation efforts. In November energy conservation accounted for nearly a 5 percent reduction in firm loads.

A dramatic change in the weather throughout the region began in early November producing marked increases in streamflow. Together with substantial savings achieved through energy conservation programs the short-term electric energy crisis in the Northwest was greatly alleviated. In only 18 Novembers out of 96 years of record were natural streamflows at The Dalles greater than November 1973, at one time reaching 300 percent of median. The unpredictable rapid increase in streamflow brought some reservoirs to spill levels. By 11 December 1973, for the first time since October 1972, BPA began deliveries of secondary energy to utilities and to direct service industrial customers.

From 31 December 1973 through 13 January 1974, the region experienced a strong cold spell. Average temperatures at three major load centers were 13 to 18 degrees below normal, and once again streamflows receded much below median. Because the region's loads are very sensitive to wintertime temperatures new records for power generation were set on the Federal system despite the on-going energy conservation program. BPA curtailed portions of the interruptible load through some peakload hours during the cold spell. The cold spell broke suddenly on Sunday, 13 January 1974. It was followed by intense rains that caused millions of dollars of damage from flooding in the region.

As a result of the high November and December precipitation, January snow surveys indicated above-normal snowpack generally throughout the region. The dramatic improvement in streamflow made it possible for the Northwest to export power over the Pacific Northwest-Pacific Southwest Intertie enabling California utilities to reduce their oil-fired generation. The favorable load-resource condition continued through the balance of the operating year and all power reservoirs were filled by 31 July, including the total 15.5 million acre-feet of Canadian Treaty storage. In addition, 5.7 maf of dead storage was filled in Mica reservoir. Dead storage was increased to 6.2 maf in August. During the period December 1973 through July 1974, about 9.2 billion kilowatt-hours of surplus hydroelectric energy was exported over the Pacific Northwest-Pacific Southwest Intertie to Pacific Southwest utilities. These exports were generally limited to light load hours because of a shortage of generating capacity in the Northwest. Some curtailments of energy deliveries to BPA interruptible industrial loads were also required over heavy load hours because of the shortage of generating capacity.

B. FLOOD CONTROL

Lower Columbia River Regulation. Without regulation by upstream reservoirs, the 1974 high water season would have produced the largest April through August runoff volume, (136 maf), and the second highest peak flow of the century at The Dalles, Oregon. The computed unregulated peak discharge at The Dalles was 1,010,000 cfs on 21 June; the actual observed peak discharge was 590,000 cfs on 20 June. By comparison, the 1948 observed peak discharge was 1,010,000 cfs and the computed unregulated 1972 peak discharge was 1,050,000 cfs. The 1948 and 1972 April through August volumes were 123 maf and 129 maf, respectively. At Vancouver, Washington, a key gaging station for evaluating flooding on the Lower Columbia River, the maximum stage during the spring freshet was 21.1 ft. observed on 22-23 June instead of a computed unregulated stage of 30.6 ft. Bankfull stage at Vancouver is 16 feet and major flood stage is 26 feet at this gage.

Chart 12 shows the 1973-74 flows at The Dalles, both as observed and as they would have been under unregulated conditions. These hydrographs are shown compared with the summary hydrograph of observed flows at The Dalles. Chart 13 shows the flow at The Dalles for the spring flood period in 1974. On this chart the effects of regulation by Mica, Arrow, Duncan, and Libby projects are separated from those of all other major storage projects in the Columbia River Basin. The Treaty projects contributed about 40 percent of the total storage volume for flood control regulation for the lower Columbia River during the peak runoff month of June 1974.

The flood control regulation of the lower Columbia River is significantly affected by the operation of Grand Coulee project. Chart 11 shows the regulation by Grand Coulee reservoir during the period July 1973-July 1974. The actual peak inflow to Roosevelt Lake at Grand Coulee Dam was 311,000 cfs on 21 June 1974 when the outflow was 208,000 cfs. The computed unregulated peak inflow was 567,000 cfs on 26 June, at which time the actual outflow was 272,000 cfs. Chart 14 documents the relative filling of Arrow and Grand Coulee during the principal filling period and compares the coordinated regulation of the two reservoirs to guidelines in the Flood Control Operating Plan. The guideline shown on Chart 14 is based on relative space available on 31 May. The basis for the computation of initial controlled flow of 510,000 cfs for the Columbia River at The Dalles, Oregon, is shown on Table 6.

Local Regulation. Local flood control by individual reservoirs was very significant in 1974. Unregulated discharges at Bonners Ferry, Idaho would have caused stages substantially higher than 36 feet, the top of the levees. The operation of Libby Reservoir reduced the Kootenai River flow to a non-damaging maximum stage of 22 feet. Kootenai Flats area received similar major flood control benefits from Libby project operation. The operation of Libby reservoir on the Kootenai River combined with the operation of Duncan reservoir on the Duncan River reduced the peak stage of Kootenay Lake by about 9.9 ft., as indicated on Chart 9.

The operation of Mica and Arrow projects not only contributed significantly to the reduction of flooding in the lower Columbia River, but effectively controlled flooding on the Columbia River in Canada as well. As shown on Chart 10 the peak discharge of the Columbia River at Birchbank, British Columbia was 158,000 cfs which is well below the bankfull level as measured at Trail, B.C. The computed unregulated flow at Birchbank would have been 375,000 cfs on 26 June, exceeding the computed 1972 unregulated peak and equalling the disastrous record flood peak of 1961.

V OPERATING CRITERIA

A. GENERAL

The Columbia River Treaty requires that the reservoirs constructed in Canada be operated pursuant to flood control and hydroelectric operating plans developed thereunder. Annex A of the Treaty stipulates that the United States Entity will submit flood control operating plans and that the Canadian Entity will operate in accordance with flood control storage diagrams or any variation which the Entities agree will not derogate from the desired aim of the flood control plan. Annex A also provides for the development of hydroelectric operating plans five years in advance to furnish the Entities with an Assured Operating Plan for Canadian Storage. In addition, Article XIV.2.k of the Treaty provides that a Detailed Operating Plan may be developed to produce more advantageous results through use of current estimates of loads and resources. The Protocol to the Treaty provides further detail and clarification of the principles and requirements of Annex A. The Principles and Procedures of 25 July 1967, together with the Columbia River Treaty Flood Control Operating Plan dated October 1972, both developed by special task forces, establish the general criteria of operations.

The Assured Operating Plan dated 15 February 1969 established Operating Rule Curves for Duncan, Arrow and Mica during the 1973-74 operating year. The Operating Rule Curves provided guidelines for refill levels as well as drawdown levels. They were derived from Critical Rule Curves, Assured Refill Curves, and simulated Variable Refill Curves, consistent with flood control requirements, as described in the Principles and Procedures. The Flood Control Storage Reservation Curves were established to conform to the Flood Control Operating Plan.

The Detailed Operating Plan dated 14 September 1973 established Operating Rule Curves based on power loads and resource data available just prior to the operating year for use in actual operations. The Variable Refill Curves and flood control requirements subsequent to 1 January 1974 were determined on the basis of seasonal volume runoff forecasts during actual operation.

B. POWER OPERATION

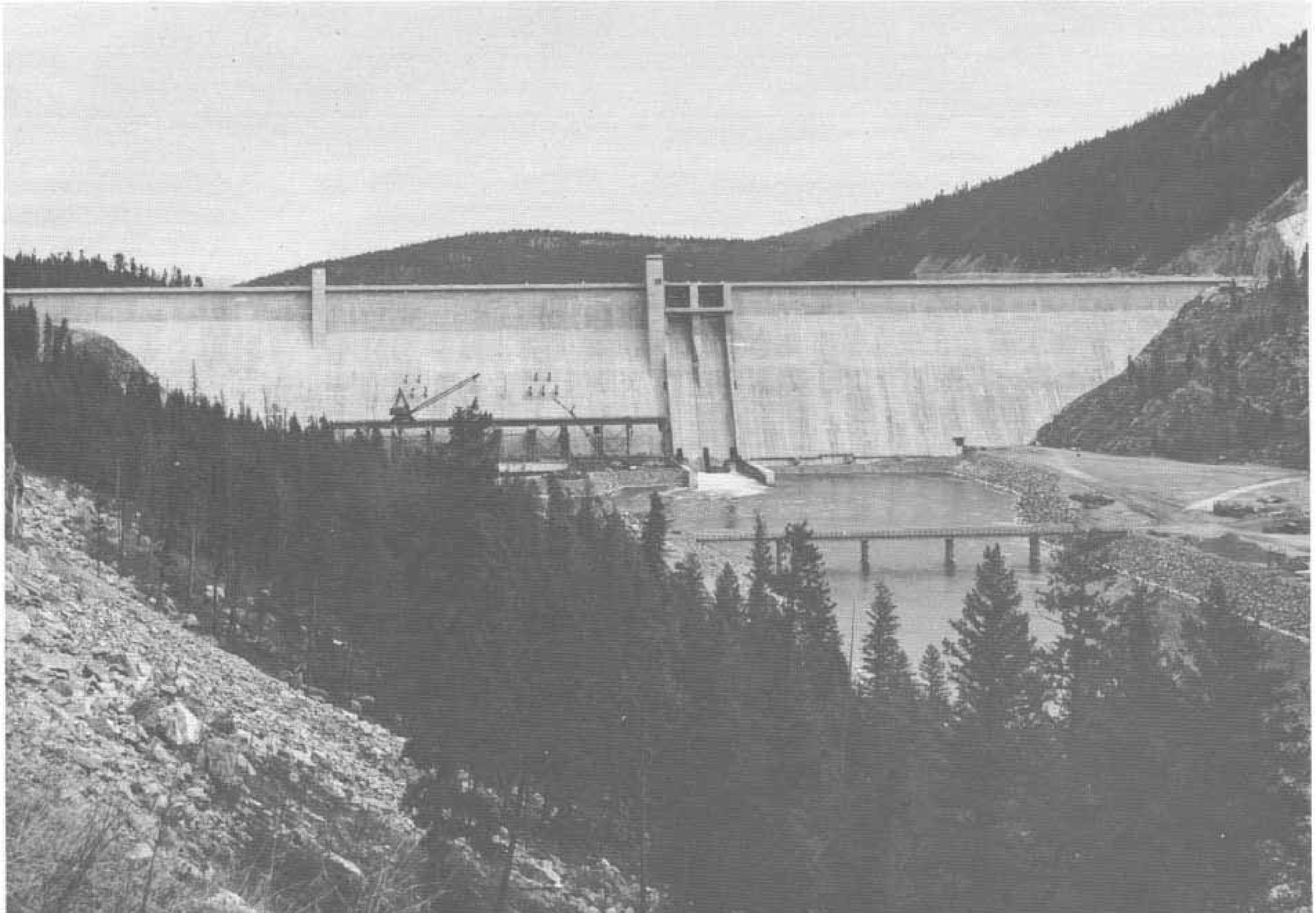
The Detailed Operating Plan dated 14 September 1973 was designed to achieve optimum power generation downstream in the United States, consistent with project operating limits and flood control requirements.

The power facilities in the United States which are downstream from the Treaty storage projects are all operated under the Pacific Northwest Coordination Agreement dated September 1964. Optimum generation in the United States was assured by the adoption, in the Assured and Detailed Operating Plans, of criteria and operating guides designed to coordinate the operation of Treaty projects with the projects operating under the Agreement. Optimum operation of Treaty reservoirs was accomplished, for the actual water condition experienced, by operating with reference to the Critical Rule Curves, Assured Refill Curves, Variable Refill Curves, Flood Control Storage Reservation Curves and related criteria determined in accordance with the Detailed Operating Plan.

C. FLOOD CONTROL OPERATION

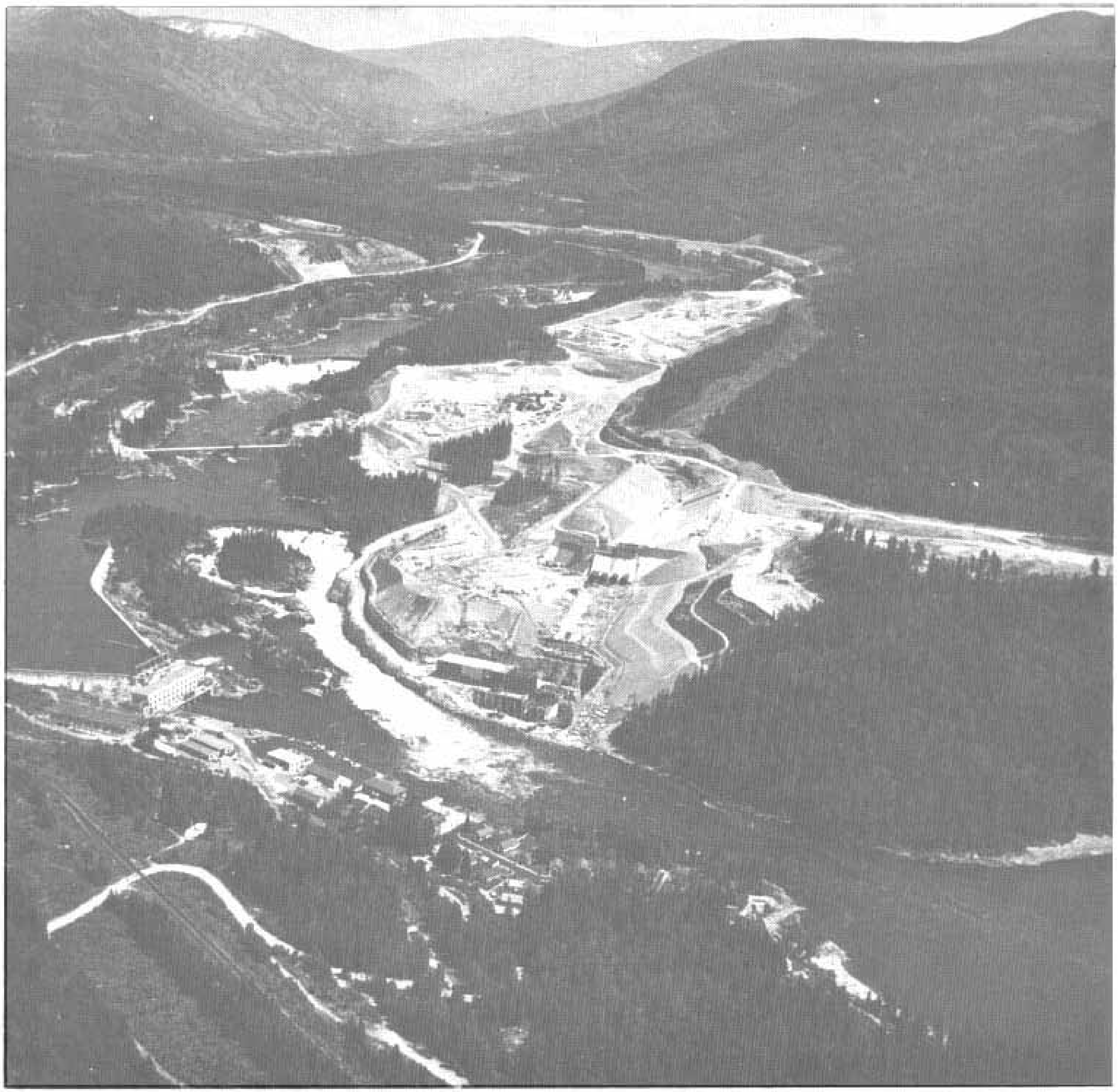
The Flood Control Operating Plan was designed to minimize flood damage both in Canada and in the United States. The flood control operation during the drawdown period consisted of evacuating and holding available, consistent with refill criteria, storage space sufficient to control the maximum flood that may occur under forecast conditions. Runoff volume forecasts determined the volume of storage space required.

Flood control operation of the Columbia River Treaty projects during the refill period was controlled in part by the computed Initial Controlled Flow of Columbia River at The Dalles. Other operating rules and local criteria were utilized to prepare day-to-day streamflow forecasts for key points in Canada and the United States and to establish the operations of the flood control storage. These forecasts were prepared daily during the snowmelt season by the Columbia River Forecasting Service for periods of 30 to 45 days using both moderate and severe snowmelt sequences.



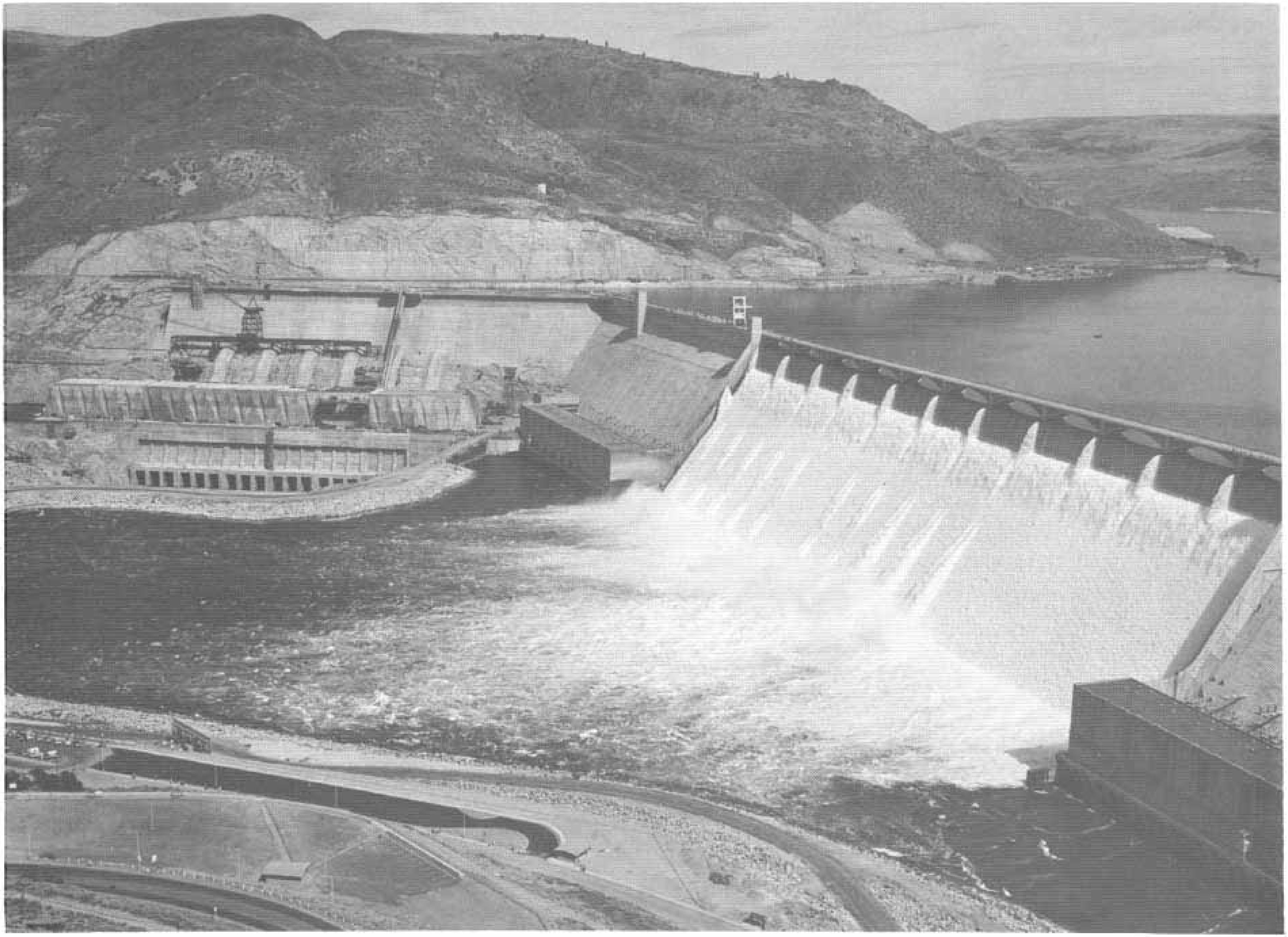
A May 1974 view of Libby Dam. Construction on the powerhouse, seen to the left of the spillway, was about 60% complete at this point, with the first unit scheduled to be on line in July 1975. Libby Reservoir (Lake Koocanusa) reached its normal full pool elevation for the first time on 25 July 1974.

U.S. Army Corps of Engineers Photograph



View of Kootenay Canal project construction as of May 1974. The upstream end of the canal can be seen along the south bank of the Kootenay River in the background. Near the upper center of the picture is the central pool, and below that is the concrete-lined forebay and powerhouse intake structure. The powerhouse is adjacent to the upper end of the Brilliant pool, in the foreground.

B.C. Hydro and Power Authority Photograph



A July 1974 view of Grand Coulee Dam and Lake Roosevelt, with the third powerhouse construction to the left. During the 1973-74 operating year, Lake Roosevelt was lowered more than 50 feet below its normal minimum level to accommodate this construction.

U.S. Bureau of Reclamation Photograph

TABLE 1

UNREGULATED RUNOFF VOLUME FORECASTS
MILLIONS OF ACRE-FEET
1974

	DUNCAN	ARROW	MICA	LIBBY	UNREGULATED RUNOFF COLUMBIA RIVER AT THE DALLES, OREGON
Forecast Date - 1st of:	Most Probable 1 Apr - 31 Aug	Most Probable 1 Apr - 31 Aug	Most Probable 1 Apr - 31 Aug	Most Probable 1 Apr - 31 Aug	Most Probable 1 Jan - 31 Jul
January	2.18	22.2	11.5	8.17	123
February	2.20	23.0	11.8	9.09	133
March	2.20	24.3	12.2	9.05	140
April	2.34	24.6	12.4	8.39	148
May	2.37	24.8	12.5	8.96	149
June	2.33	24.3	12.3	8.87	147
Actual	2.27	25.9	12.3	9.10	156

Note: These data are as used in actual operations. Subsequent revisions have been made in some cases.

TABLE 2

MICA RESERVOIR COMPUTATION FORM

95 PERCENT CONFIDENCE FORECAST AND VARIABLE ENERGY CONTENT CURVE

1974

	INITIAL	JAN. 1	FEB. 1	MAR. 1	APR. 1	MAY 1	JUNE 1
1. PROBABLE FEB. 1-JULY 31 INFLOW, KSFD 1/		4767.4	4938.5	5361.0	5152.8	5193.8	5028.8
2. 95% FORECAST ERROR, KSFD		841.4	674.7	644.5	602.2	596.7	569.4
3. 95% CONFIDENCE FEB. 1-JULY 31 INFLOW, KSFD 2/		3926.0	4263.8	4416.5	4550.6	4597.1	4459.4
4. OBSERVED FEB. 1-DATE INFLOW, KSFD				104.1	206.1	452.9	1094.9
5. 95% CONFIDENCE DATE-JULY 31 INFLOW, KSFD 3/		3926.0	4263.8	4312.4	4344.5	4144.2	3364.5
ASSUMED FEB. 1-JULY 31 INFLOW, % VOLUME		100.0					
ASSUMED FEB. 1-JULY 31 INFLOW, KSFD 4/		3926.0					
MIN. FEB. 1-JULY 31 OUTFLOW, KSFD		543.0					
MIN. JAN. 31 RESERVOIR CONTENT, KSFD 5/		146.2					
MIN. JAN. 31 RESERVOIR ELEV., FT. 6/	2249.90	2074.9					
JAN. 31 VARIABLE REFILL CURVE, FT. 7/		2074.9					
ASSUMED MAR. 1-JULY 31 INFLOW, % VOLUME		98.0	98.2				
ASSUMED MAR. 1-JULY 31 INFLOW, KSFD 4/		3847.5	4178.6				
MIN. MAR. 1-JULY 31 OUTFLOW, KSFD		459.0	459.0				
MIN. FEB. 28 RESERVOIR CONTENT, KSFD 5/		140.7	34.4*				
MIN. FEB. 28 RESERVOIR ELEV., FT. 6/	2234.10	2074.1	2058.7				
FEB. 28 VARIABLE REFILL CURVE, FT. 7/		2074.1	2058.7				
ASSUMED APR. 1-JULY 31 INFLOW, % VOLUME		95.7	95.7	95.7			
ASSUMED APR. 1-JULY 31 INFLOW, KSFD 4/		3757.2	4080.5	4127.0			
MIN. APR. 1-JULY 31 OUTFLOW, KSFD		366.0	366.0	366.0			
MIN. MAR. 31 RESERVOIR CONTENT, KSFD 5/		138.0	9.4*	9.4*			
MIN. MAR. 31 RESERVOIR ELEV., FT. 6/	2205.80	2073.6	2054.5	2057.3			
MAR. 31 VARIABLE REFILL CURVE, FT. 7/		2073.6	2054.5	2057.3			
ASSUMED MAY 1-JULY 31 INFLOW, % VOLUME		91.6	91.6	93.6	95.8		
ASSUMED MAY 1-JULY 31 INFLOW, KSFD 4/		3596.2	3935.7	4036.4	4162.1		
MIN. MAY 1-JULY 31 OUTFLOW, KSFD		276.0	276.0	276.0	276.0		
MIN. APR. 30 RESERVOIR CONTENT, KSFD 5/		259.0	.0*	.0*	.0*		
MIN. APR. 30 RESERVOIR ELEV., FT. 6/	2197.60	2084.5	2052.8	2055.7	2069.3		
APR. 30 VARIABLE REFILL CURVE, FT. 7/		2084.6	2052.8	2055.7	2069.3		
ASSUMED JUN. 1-JULY 31 INFLOW, % VOLUME		73.8	73.8	75.4	77.2	80.6	
ASSUMED JUN. 1-JULY 31 INFLOW, KSFD 4/		2897.4	3146.7	3251.6	3354.0	3346.2	
MIN. JUN. 1-JULY 31 OUTFLOW, KSFD		183.0	183.0	183.0	183.0	183.0	
MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/		814.8	565.5	460.6	358.2	372.0	
MIN. MAY 31 RESERVOIR ELEV., FT. 6/	2198.80	2164.9	2136.5	2125.0	2122.3	2124.1	
MAY 31 VARIABLE REFILL CURVE, FT. 7/		2164.9	2136.5	2125.0	2122.3	2124.1	
ASSUMED JUL. 1-JULY 31 INFLOW, % VOLUME		37.7	37.7	38.5	39.4	41.2	51.1
ASSUMED JUL. 1-JULY 31 INFLOW, KSFD 4/		1490.1	1607.5	1660.3	1711.7	1707.4	1719.3
MIN. JUL. 1-JULY 31 OUTFLOW, KSFD		93.0	93.0	93.0	93.0	93.0	93.0
MIN. JUNE 30 RESERVOIR CONTENT, KSFD 5/		2142.1	2014.7	1361.9	1910.5	1914.4	1902.9
MIN. JUNE 30 RESERVOIR ELEV., FT. 6/	2272.80	2264.1	2258.6	2256.8	2258.3	2258.5	2253.0
JUNE 30 VARIABLE REFILL CURVE, FT. 7/		2264.1	2258.6	2256.8	2258.3	2258.5	2253.0
JULY 31 VARIABLE REFILL CURVE, FT. 7/	2323.40	2323.4	2323.4	2323.4	2323.4	2323.4	2323.4
NOTE- ACCUMULATED DEAD STORAGE IS		510.3	521.9	538.4	620.9	620.9	521.9

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ FULL CONTENT (3529.2) PLUS PRECEDING LINE LESS LINE PRECEDING THAT (USABLE STORAGE).
6/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE DATED FEBRUARY 26, 1967 (FOOTNOTE 5 PLUS ACCUMULATED DEAD STORAGE).
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED BY ADDING DEAD STORAGE TO INITIAL CONTENTS.
* LIMITED TO SECOND YEAR CRITICAL RULE CURVE

TABLE 3

ARROW LAKES COMPUTATION FORM

95 PERCENT CONFIDENCE FORECAST AND VARIABLE ENERGY CONTENT CURVE

1974

	INITIAL	JAN. 1	FEB. 1	MAR. 1	APR. 1	MAY 1	JUNE 1
1. PROBABLE FEB 1-JULY 31 INFLOW, KSFD 1/		9757.6	10228.5	10728.0	10847.2	10917.5	10577.3
2. 95% FORECAST ERROR, KSFD		1755.5	1375.0	1285.1	1215.5	1127.8	1067.5
3. 95% CONFIDENCE FEB 1-JULY 31 INFLOW, KSFD 2/		8002.1	8853.5	9442.9	9631.7	9789.7	9509.5
4. OBSERVED FEB 1-DATE INFLOW, KSFD				270.8	558.5	1331.1	3154.1
5. 95% CONFIDENCE DATE-JULY 31 INFLOW, KSFD 3/		8002.1	8853.5	9172.1	9073.2	8458.6	6355.4
ASSUMED FEB 1-JULY 31 INFLOW, % VOLUME		100.0					
ASSUMED FEB 1-JULY 31 INFLOW, KSFD 4/		8002.1					
MIN. FEB 1-JULY 31 OUTFLOW, KSFD		935.0					
MICA REFILL REQUIREMENTS, KSFD 5/		3383.0					
MIN. JAN 31 CONTENTS, KSFD 6/		.0					
MIN. JAN 31 ELEVATION, FT. 7/		1378.0					
JAN 31 VARIABLE REFILL CURVE, FT. 8/	1414.8	1378.0					
ASSUMED MAR 1-JULY 31 INFLOW, % VOLUME		97.6	97.6				
ASSUMED MAR 1-JULY 31 INFLOW, KSFD 4/		7810.0	8641.0				
MIN. MAR 1-JULY 31 OUTFLOW, KSFD		765.0	765.0				
MICA REFILL REQUIREMENTS, KSFD 5/		3388.5	3494.8				
MIN. FEB 28 CONTENTS, KSFD 6/		.0	.0				
MIN. FEB 28 ELEVATION, FT. 7/		1378.0	1378.0				
FEB 28 VARIABLE REFILL CURVE, FT. 8/	1417.0	1378.0	1378.0				
ASSUMED APR 1-JULY 31 INFLOW, % VOLUME		94.9	94.9	97.3			
ASSUMED APR 1-JULY 31 INFLOW, KSFD 4/		7594.0	8402.0	8924.4			
MIN. APR 1-JULY 31 OUTFLOW, KSFD		610.0	610.0	610.0			
MICA REFILL REQUIREMENTS, KSFD 5/		3391.2	3519.8	3519.8			
MIN. MAR 31 CONTENTS, KSFD 6/		.0	.0	.0			
MIN. MAR 31 ELEVATION, FT. 7/		1378.0	1378.0	1378.0			
MAR 31 VARIABLE REFILL CURVE, FT. 8/	1417.8	1378.0	1378.0	1378.0			
ASSUMED MAY 1-JULY 31 INFLOW, % VOLUME		88.3	88.3	90.6	93.1		
ASSUMED MAY 1-JULY 31 INFLOW, KSFD 4/		7065.8	7817.7	8309.9	8447.2		
MIN. MAY 1-JULY 31 OUTFLOW, KSFD		460.0	460.0	460.0	460.0		
MICA REFILL REQUIREMENTS, KSFD 5/		3320.2	3529.2	3529.2	3529.2		
MIN. APR 30 CONTENTS, KSFD 6/		294.0	.0	.0	.0		
MIN. APR 30 ELEVATION, FT. 7/		1384.9	1378.0	1378.0	1378.0		
APR 30 VARIABLE REFILL CURVE, FT. 8/	1416.4	1384.9	1378.0	1378.0	1378.0		
ASSUMED JUN 1-JULY 31 INFLOW, % VOLUME		66.3	66.3	68.1	70.0	75.1	
ASSUMED JUN 1-JULY 31 INFLOW, KSFD 4/		5305.4	5869.9	6246.2	6351.2	6352.4	
MIN. JUN 1-JULY 31 OUTFLOW, KSFD		335.0	305.0	305.0	305.0	305.0	
MICA REFILL REQUIREMENTS, KSFD 5/		2714.4	2963.7	3068.6	3171.0	3157.2	
MIN. MAY 31 CONTENTS, KSFD 6/		1293.6	978.4	707.0	704.3	689.4	
MIN. MAY 31 ELEVATION, FT. 7/		1405.1	1399.1	1393.7	1393.6	1393.3	
MAY 31 VARIABLE REFILL CURVE, FT. 8/	1415.1	1405.1	1399.1	1393.7	1393.6	1393.3	
ASSUMED JUL 1-JULY 31 INFLOW, % VOLUME		30.9	30.9	31.7	32.6	35.0	46.6
ASSUMED JUL 1-JULY 31 INFLOW, KSFD 4/		2472.6	2735.7	2907.6	2957.9	2960.5	2961.6
MIN. JUL 1-JULY 31 OUTFLOW, KSFD		155.0	155.0	155.0	155.0	155.0	155.0
MICA REFILL REQUIREMENTS, KSFD 5/		1387.1	1514.5	1567.3	1618.1	1614.4	1626.3
MIN. JUN 30 CONTENTS, KSFD 6/		2649.1	2513.3	2394.3	2395.5	2388.5	2399.2
MIN. JUN 30 ELEVATION, FT. 7/		1428.9	1426.6	1424.7	1424.7	1424.6	1424.7
JUN 30 VARIABLE REFILL CURVE, FT. 8/	1439.7	1428.9	1426.6	1424.7	1424.7	1424.6	1424.7
JULY 31 VARIABLE REFILL CURVE, FT. 8/	1443.5	1443.5	1443.5	1443.5	1443.5	1443.5	1443.5

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ MICA FULL CONTENT- ASSURED REFILL CURVE FROM MICA VEC COMPUTATION FORM
6/ FULL CONTENT (3579.6 KSFD) PLUS TWO PRECEDING LINES LESS LINE PRECEDING THAT.
7/ FROM RESERVOIR ELEVATION-STORAGE CONTENT TABLE DATED JUNE 30, 1972
8/ LOWER OF THE ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR (INITIAL)

TABLE 4

DUNCAN RESERVOIR COMPUTATION FORM

95 PERCENT CONFIDENCE FORECAST AND VARIABLE ENERGY CONTENT CURVE

1974

	INITIAL	JAN. 1	FEB. 1	MAR. 1	APR. 1	MAY 1	JUNE 1
1.PROBABLE FEB. 1-JULY 31 INFLOW, KSFD 1/		931.5	946.4	969.1	1006.8	1019.6	390.4
2.95% FORECAST ERROR, KSFD		191.5	155.7	129.8	116.8	106.9	95.5
3.95% CONFIDENCE FEB. 1-JULY 31 INFLOW, KSFD 2/		740.0	790.7	839.3	890.0	912.7	494.9
4.OBSERVED FEB. 1-DATE INFLOW,KSFD				20.4	41.4	97.9	242.9
5.95% CONFIDENCE DATE-JULY 31 INFLOW, KSFD 3/		740.0	790.7	818.9	848.6	814.8	652.2
ASSUMED FEB. 1-JULY 31 INFLOW, % VOLUME		100.0					
ASSUMED FEB. 1-JULY 31 INFLOW,KSFD 4/		740.0					
MIN. FEB. 1-JULY 31 OUTFLOW, KSFD		18.1					
MIN. JAN. 31 RESERVOIR CONTENT, KSFD 5/		.0					
MIN. JAN. 31 RESERVOIR ELEVATION, FT. 6/		1794.2					
JAN. 31 VARIABLE REFILL CURVE, FT. 7/	1834.0	1794.2					
ASSUMED MAR. 1-JULY 31 INFLOW, % VOLUME		98.1	98.1				
ASSUMED MAR. 1-JULY 31 INFLOW,KSFD 4/		726.0	775.6				
MIN. MAR. 1-JULY 31 OUTFLOW, KSFD		15.3	15.3				
MIN. FEB. 28 RESERVOIR CONTENT, KSFD 5/		.0	.0				
MIN. FEB. 28 RESERVOIR ELEVATION, FT. 6/		1794.2	1794.2				
FEB. 28 VARIABLE REFILL CURVE, FT. 7/	1835.9	1794.2	1794.2				
ASSUMED APR. 1-JULY 31 INFLOW, % VOLUME		96.1	96.1	98.6			
ASSUMED APR. 1-JULY 31 INFLOW,KSFD 4/		711.2	759.8	832.5			
MIN. APR. 1-JULY 31 OUTFLOW, KSFD		14.2	12.2	12.2			
MIN. MAR. 31 RESERVOIR CONTENT, KSFD 5/		6.8	.0	.0			
MIN. MAR. 31 RESERVOIR ELEVATION, FT. 6/		1795.9	1794.2	1794.2			
MAR. 31 VARIABLE REFILL CURVE, FT. 7/	1837.2	1795.9	1794.2	1794.2			
ASSUMED APR. 16-JULY 31 INFLOW, % VOLUME		94.6	94.6	96.5	98.5		
ASSUMED APR. 16-JULY 31 INFLOW,KSFD 4/		700.1	748.0	790.2	835.9		
MIN. APR. 16-JULY 31 OUTFLOW, KSFD		10.7	10.7	10.7	10.7		
MIN. APR. 15 RESERVOIR CONTENT, KSFD 5/		16.4	.0	.0	.0		
MIN. APR. 15 RESERVOIR ELEVATION, FT. 6/		1798.2	1794.2	1794.2	1794.2		
APR. 15 VARIABLE REFILL CURVE, FT. 7/	1835.7	1798.2	1794.2	1794.2	1794.2		
ASSUMED MAY 1-JULY 31 INFLOW, % VOLUME		91.1	91.1	92.9	94.9		
ASSUMED MAY 1-JULY 31 INFLOW, KSFD 4/		674.2	720.3	760.7	804.5		
MIN. MAY 1-JULY 31 OUTFLOW, KSFD		9.2	9.2	9.2	9.2		
MIN. APR. 30 RESERVOIR CONTENT, KSFD 5/		40.8	.0	.0	.0		
MIN. APR. 30 RESERVOIR ELEVATION, FT. 6/		1803.2	1794.2	1794.2	1794.2		
APR. 30 VARIABLE REFILL CURVE, FT. 7/	1834.2	1803.2	1794.2	1794.2	1794.2		
ASSUMED JUNE 1-JULY 31 INFLOW, % VOLUME		71.7	71.7	73.1	74.6	79.7	
ASSUMED JUNE 1-JULY 31 INFLOW, KSFD 4/		530.6	566.9	598.6	633.0	641.2	
MIN. JUNE 1-JULY 31 OUTFLOW, KSFD		6.1	6.1	6.1	5.1	5.1	
MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/		181.3	145.0	113.3	78.9	71.7	
MIN. MAY 31 RESERVOIR ELEVATION, FT. 6/		1826.3	1820.9	1815.8	1810.1	1808.7	
MAY 31 VARIABLE REFILL CURVE, FT. 7/	1848.6	1826.3	1820.9	1815.8	1810.1	1808.7	
ASSUMED JULY 1-JULY 31 INFLOW, % VOLUME		33.9	33.9	34.6	35.3	37.2	47.3
ASSUMED JULY 1-JULY 31 INFLOW, KSFD 4/		250.9	268.0	283.3	299.5	303.1	308.5
MIN. JULY 1-JULY 31 OUTFLOW, KSFD		3.1	3.1	3.1	3.1	3.1	3.1
MIN. JUNE 30 RESERVOIR CONTENT, KSFD 5/		458.0	440.9	425.6	409.4	405.8	400.4
MIN. JUNE 30 RESERVOIR ELEVATION, FT. 6/		1863.0	1860.9	1859.0	1857.0	1855.6	1855.9
JUNE 30 VARIABLE REFILL CURVE, FT. 7/	1872.0	1862.0	1860.9	1859.0	1857.0	1856.6	1855.9
JULY 31 VARIABLE REFILL CURVE, FT.	1892.0	1892.0	1892.0	1892.0	1892.0	1892.0	1892.0

1/ DEVELOPED BY CANADIAN ENTITY.
2/ LINE 1-LINE 2
3/ LINE 3-LINE 4
4/ PRECEDING LINE X LINE 5
5/ FULL CONTENT(705.8) PLUS PRECEDING LINE LESS LINE PRECEDING THAT
6/ FROM RESERVOIR ELEVATION-STORAGE CONTENT TABLE DATED JUNE 20, 1973
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR (INITIAL)

TABLE 5

LIBBY
COMPUTATION FORM
95 PERCENT CONFIDENCE FORECAST AND VARIABLE ENERGY CONTENT CURVE

1974

FORECAST DATE	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUNE 1
RESIDUAL 95% DATE-JUL 31 INFLOW, KSFD 1/		3172.2	3713.0	3632.0	3283.2	3290.2	2406.5
ASSUMED FEB 1-JUL 31 INFLOW, % OF VOLUME		96.94					
ASSUMED FEB 1-JUL 31 INFLOW, KSFD 2/		3075.1					
MIN. FEB 1-JUL 31 OUTFLOW, KSFD		362.0					
MIN. JAN 31 RESERVOIR CONTENT, KSFD 3/		0					
MIN. JAN 31 RESERVOIR ELEV., FT. 4/		2287.0					
JAN 31 VARIABLE ENERGY CURVE, FT. 5/		2287.0					
	2390.0						
ASSUMED MAR 1-JUL 31 INFLOW, % OF VOLUME		94.17	97.14				
ASSUMED MAR 1-JUL 31 INFLOW, KSFD 2/		2987.3	3606.8				
MIN. MAR 1-JUL 31 OUTFLOW, KSFD		306.0	306.0				
MIN. FEB 28 RESERVOIR CONTENT, KSFD 3/		0	0				
MIN. FEB 28 RESERVOIR ELEV. FT. 4/		2287.0	2287.0				
FEB 28 VARIABLE ENERGY CURVE, FT. 5/		2287.0	2287.0				
	2390.0						
ASSUMED APR 1-JUL 31 INFLOW, % OF VOLUME		90.79	93.66	96.42			
ASSUMED APR 1-JUL 31 INFLOW, KSFD 2/		2880.0	3477.6	3502.0			
MIN. APR 1-JUL 31 OUTFLOW, KSFD		244.0	244.0	244.0			
MIN. MAR 31 RESERVOIR CONTENT, KSFD 3/		0	0	0			
MIN. MAR 31 RESERVOIR ELEV. FT. 4/		2287.0	2287.0	2287.0			
MAR 31 VARIABLE ENERGY CURVE, FT. 5/		2287.0	2287.0	2287.0			
	2390.0						
ASSUMED MAY 1-JUL 31 INFLOW, % OF VOLUME		81.71	84.29	86.77	90.00		
ASSUMED MAY 1-JUL 31 INFLOW, KSFD 2/		2592.0	3129.7	3151.5	2954.8		
MIN. MAY 1-JUL 31 OUTFLOW, KSFD		184.0	184.0	184.0	184.0		
MIN. APR 30 RESERVOIR CONTENT, KSFD 3/		95.0	0	0	0		
MIN. APR 30 RESERVOIR ELEV. FT. 4/		2299.2	2287.0	2287.0	2287.0		
APR 30 VARIABLE ENERGY CURVE, FT. 5/		2299.2	2287.0	2287.0	2287.0		
	2403.2						
ASSUMED JUN 1-JUL 31 INFLOW, % OF VOLUME		52.75	54.42	56.02	58.10	64.56	
ASSUMED JUN 1-JUL 31 INFLOW, KSFD 2/		1673.3	2020.6	2034.6	1907.5	2124.2	
MIN. JUN 1-JUL 31 OUTFLOW, KSFD		122.0	122.0	122.0	122.0	122.0	
MIN. MAY 31 RESERVOIR CONTENT, KSFD 3/		951.7	604.4	590.4	717.5	500.8	
MIN. MAY 31 RESERVOIR ELEV. FT 4/		2377.2	2350.5	2349.5	2359.9	2341.6	
MAY 31 VARIABLE ENERGY CURVE, FT. 5/		2377.2	2350.5	2349.5	2359.9	2341.6	
	2427.1						
ASSUMED JUL 1-31 INFLOW, % OF VOLUME		18.97	19.57	20.15	20.90	23.22	35.97
ASSUMED JUL 1-31 INFLOW, KSFD 2/		601.8	726.6	731.8	686.2	764.0	865.6
MIN. JUL 1-31 OUTFLOW, KSFD		62.0	62.0	62.0	62.0	62.0	62.0
MIN. JUN 30 RESERVOIR CONTENT, KSFD 3/		1963.2	1838.4	1833.2	1878.8	1801.0	1699.4
MIN. JUN 30 RESERVOIR ELEV. FT. 4/		2435.2	2429.0	2428.8	2431.1	2427.2	2421.9
JUN 30 VARIABLE ENERGY CURVE, FT. 5/		2435.2	2429.0	2428.8	2431.1	2427.2	2421.9
	2451.6						
JUL 31 VARIABLE ENERGY CURVE, FT.		2459.0	2459.0	2459.0	2459.0	2459.0	2459.0

1/ FROM LIBBY FORECAST COMPUTATION FORMS
2/ PRECEDING LINE X LINE 3.
3/ FULL CONTENT (2503 KSFD) PLUS PRECEDING LINE LESS LINE PRECEDING THAT.
4/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE DATED MARCH 17, 1972.
5/ LOWER OF ELEV. ON PRECEDING LINE OR ELEV. DETERMINED PRIOR TO YEAR.

TABLE 6

COMPUTATION OF INITIAL CONTROLLED FLOW
COLUMBIA RIVER AT THE DALLES, OREGON
1 MAY 1974

1 April Forecast of May - August Unregulated Runoff Volume, MAF		112.0
Less Estimated Depletions, MAF		1.5
Less Upstream Storage Corrections, MAF		
Mica	9.6	
Arrow	5.0	
Duncan	1.2	
Libby	4.7	
Hungry Horse	2.0	
Flathead Lake	.5	
Noxon	.2	
Pend Oreille Lake	.5	
Grand Coulee	5.2	
Brownlee	.5	
Dworshak	2.0	
John Day	.5	
TOTAL	31.9	31.9
Forecast of Adjusted Residual Runoff Volume, MAF		78.6
Computed Initial Controlled Flow (From Chart 1, of Interim Flood Control Plan), KCFS		510.0

COLUMBIA RIVER BASIN

OCTOBER 1973 – APRIL 1974 PRECIPITATION
PERCENT OF 1958–73 AVERAGE

CHART I
SEASONAL
PRECIPITATION

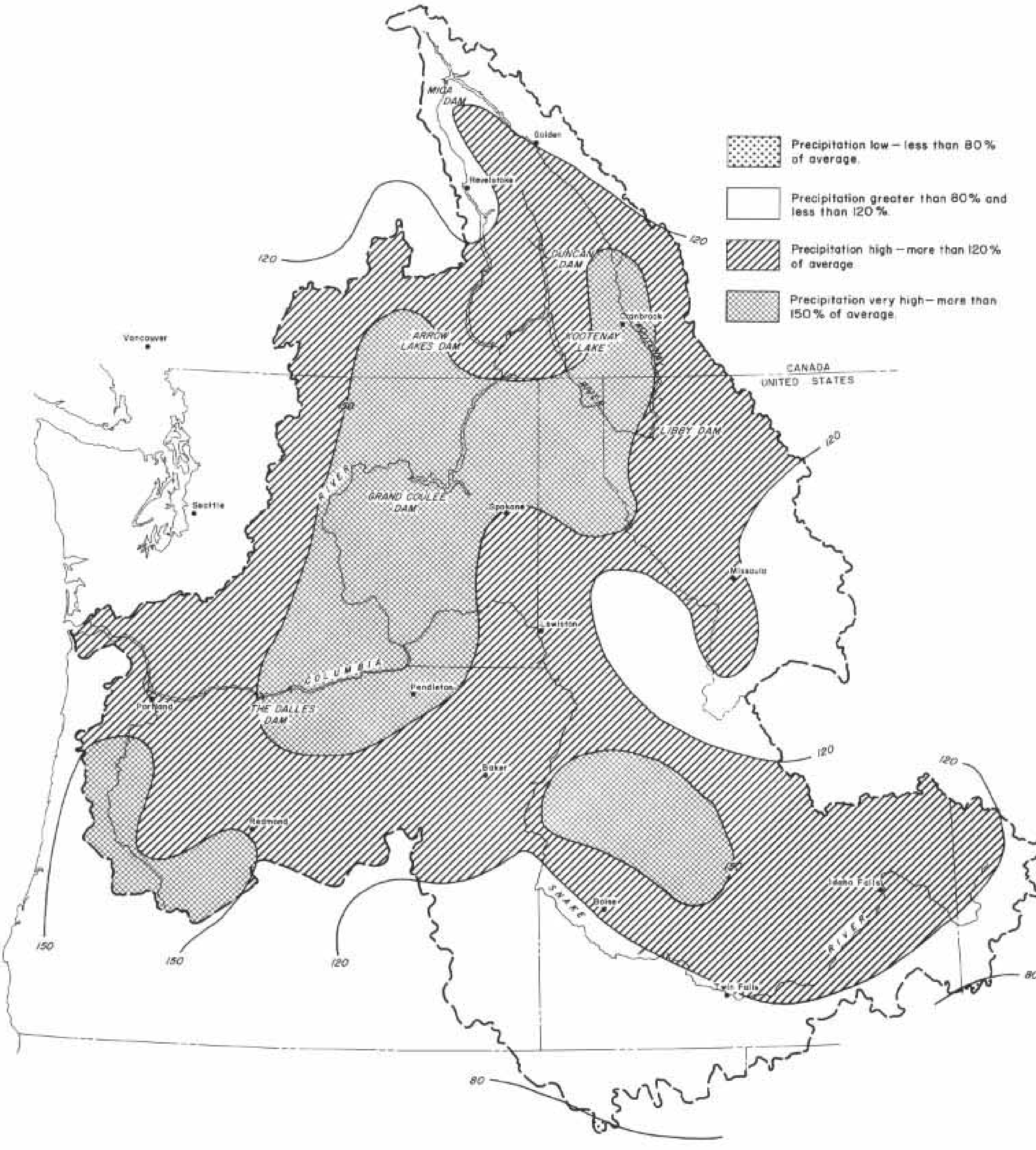
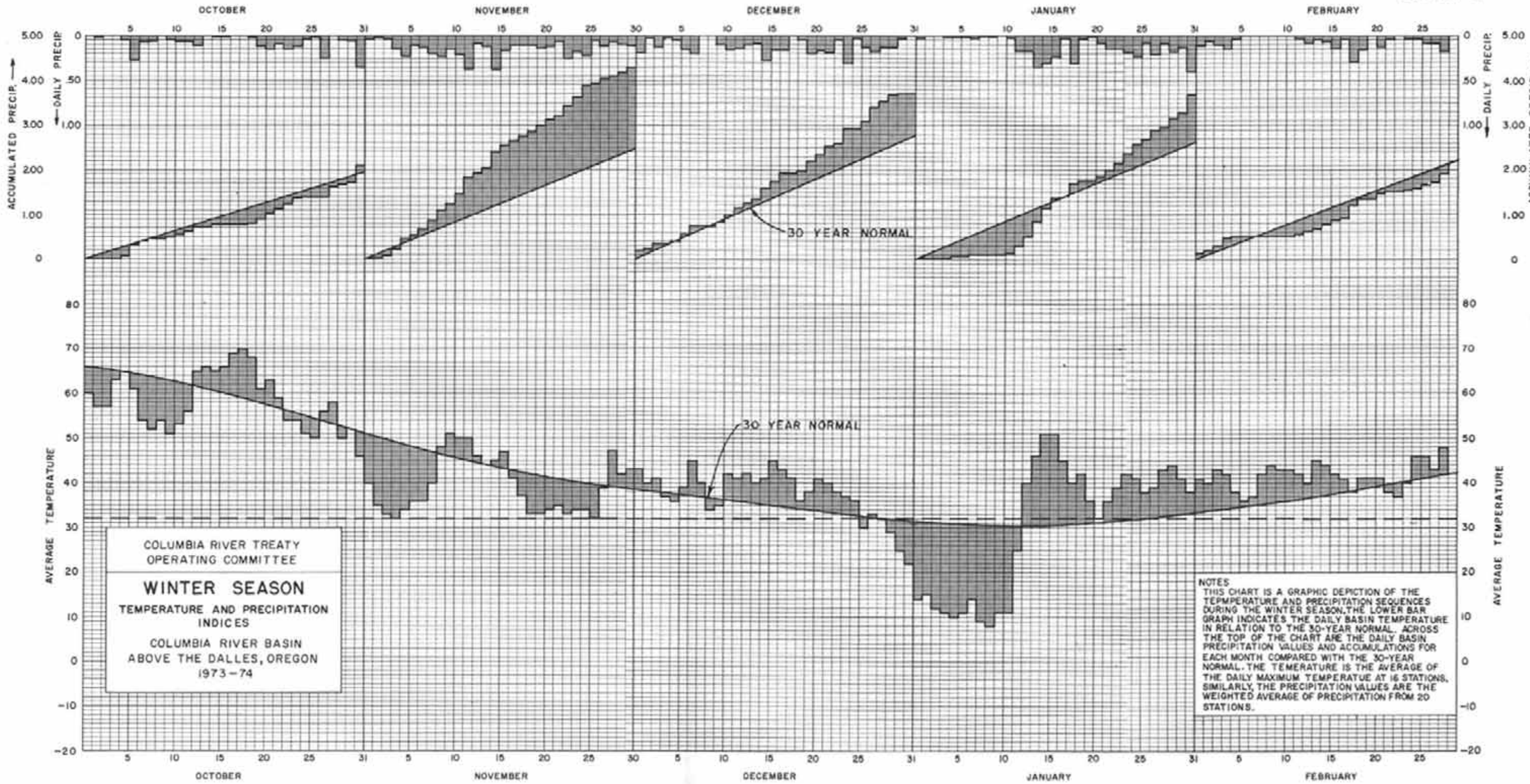
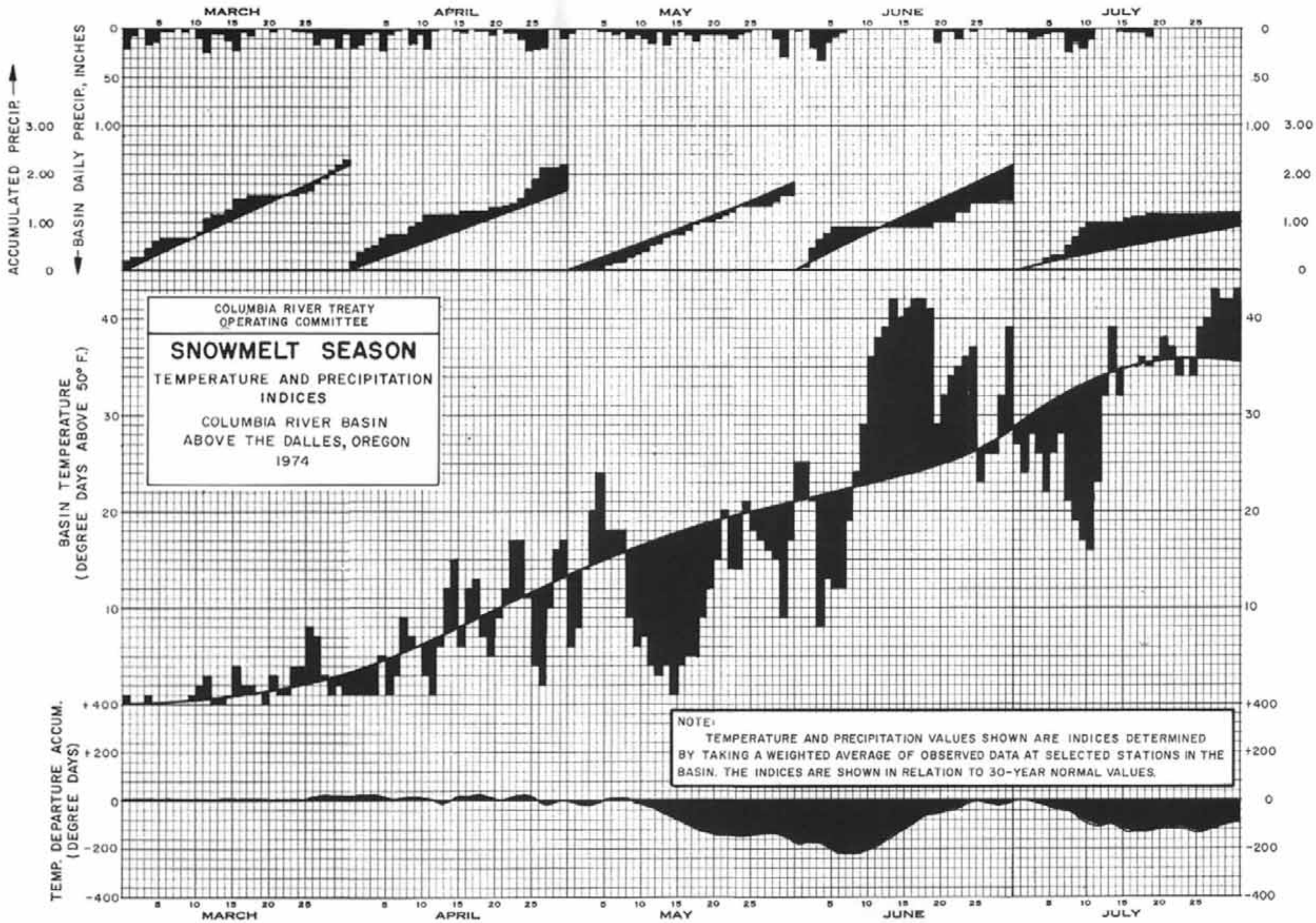


CHART 2



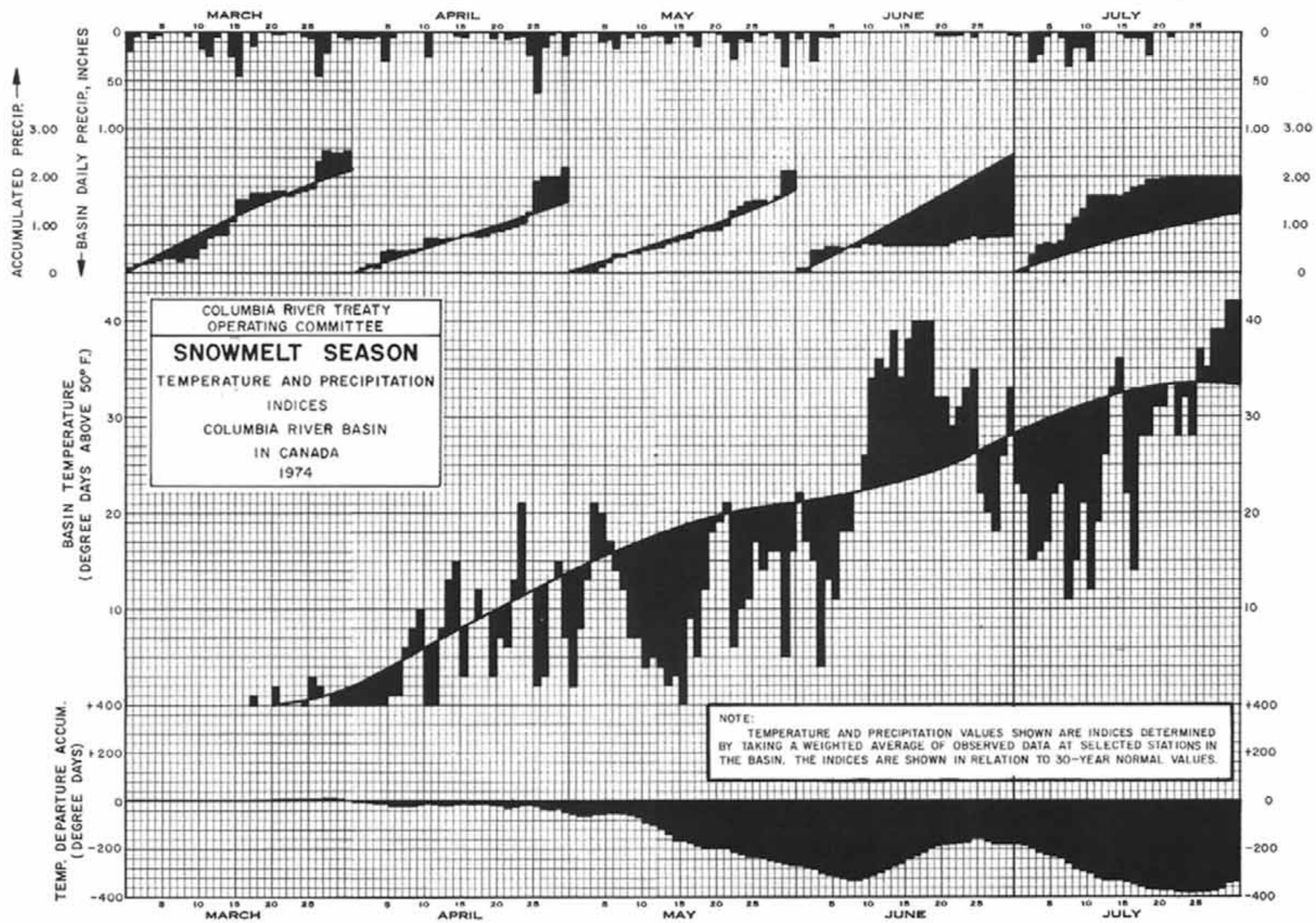
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
ACCUMULATED PRECIP.
DAILY PRECIP.
AVERAGE TEMPERATURE
30 YEAR NORMAL
30 YEAR NORMAL
COLUMBIA RIVER TREATY
OPERATING COMMITTEE
WINTER SEASON
TEMPERATURE AND PRECIPITATION
INDICES
COLUMBIA RIVER BASIN
ABOVE THE DALLES, OREGON
1973–74
NOTES
THIS CHART IS A GRAPHIC DEPICTION OF THE TEPMPERATURE AND PRECIPITATION SEQUENCES DURING THE WINTER SEASON. THE LOWER BAR GRAPH INDICATES THE DAILY BASIN TEMPERATURE IN RELATION TO THE 30-YEAR NORMAL. ACROSS THE TOP OF THE CHART ARE THE DAILY BASIN PRECIPITATION VALUES AND ACCUMULATIONS FOR EACH MONTH COMPARED WITH THE 30-YEAR NORMAL. THE TEMERATURE IS THE AVERAGE OF THE DAILY MAXIMUM TEMPERATUE AT 16 STATIONS. SIMILARLY, THE PRECIPITATION VALUES ARE THE WEIGHTED AVERAGE OF PRECIPITATION FROM 20 STATIONS.

CHART 3



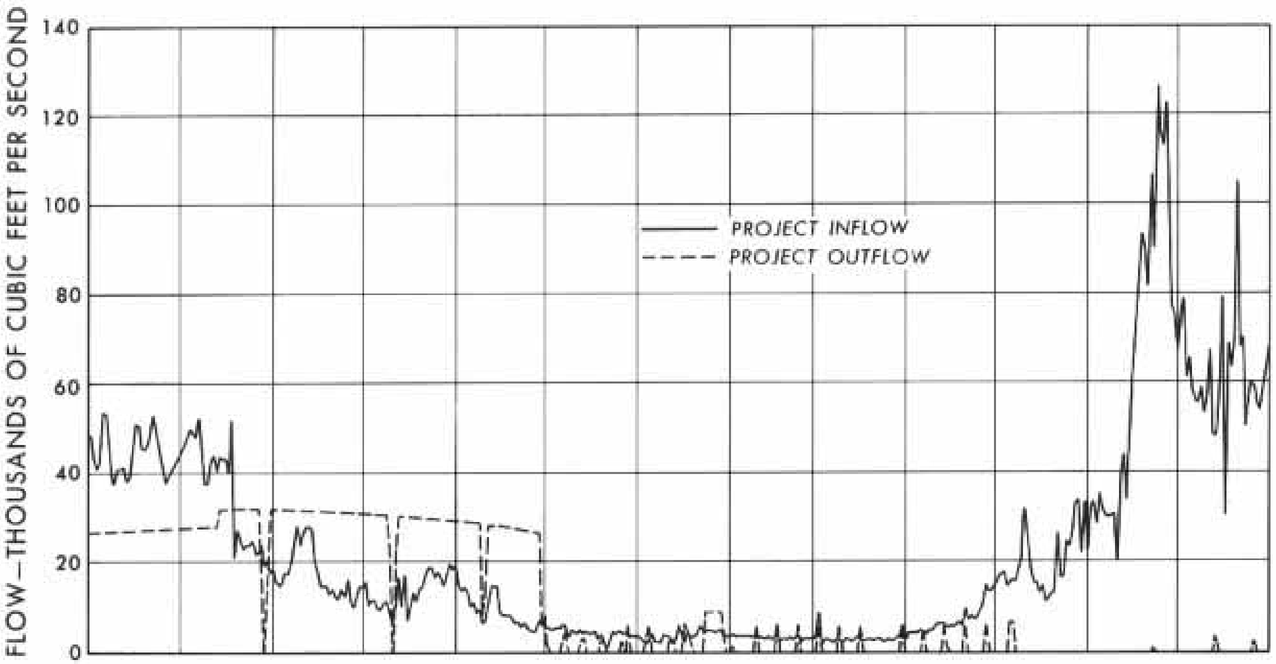
COLUMBIA RIVER TREATY
OPERATING COMMITTEE
SNOWMELT SEASON
TEMPERATURE AND PRECIPITATION INDICES
COLUMBIA RIVER BASIN
ABOVE THE DALLES, OREGON
1974
NOTE:
TEMPERATURE AND PRECIPITATION VALUES SHOWN ARE INDICES DETERMINED BY TAKING A WEIGHTED AVERAGE OF OBSERVED DATA AT SELECTED STATIONS IN THE BASIN. THE INDICES ARE SHOWN IN RELATION TO 30-YEAR NORMAL VALUES.
ACCUMULATED PRECIP.
BASIN DAILY PRECIP., INCHES
BASIN TEMPERATURE (DEGREE DAYS ABOVE 50° F.)
TEMP. DEPARTURE ACCUM. (DEGREE DAYS)
MARCH
APRIL
MAY
JUNE
JULY

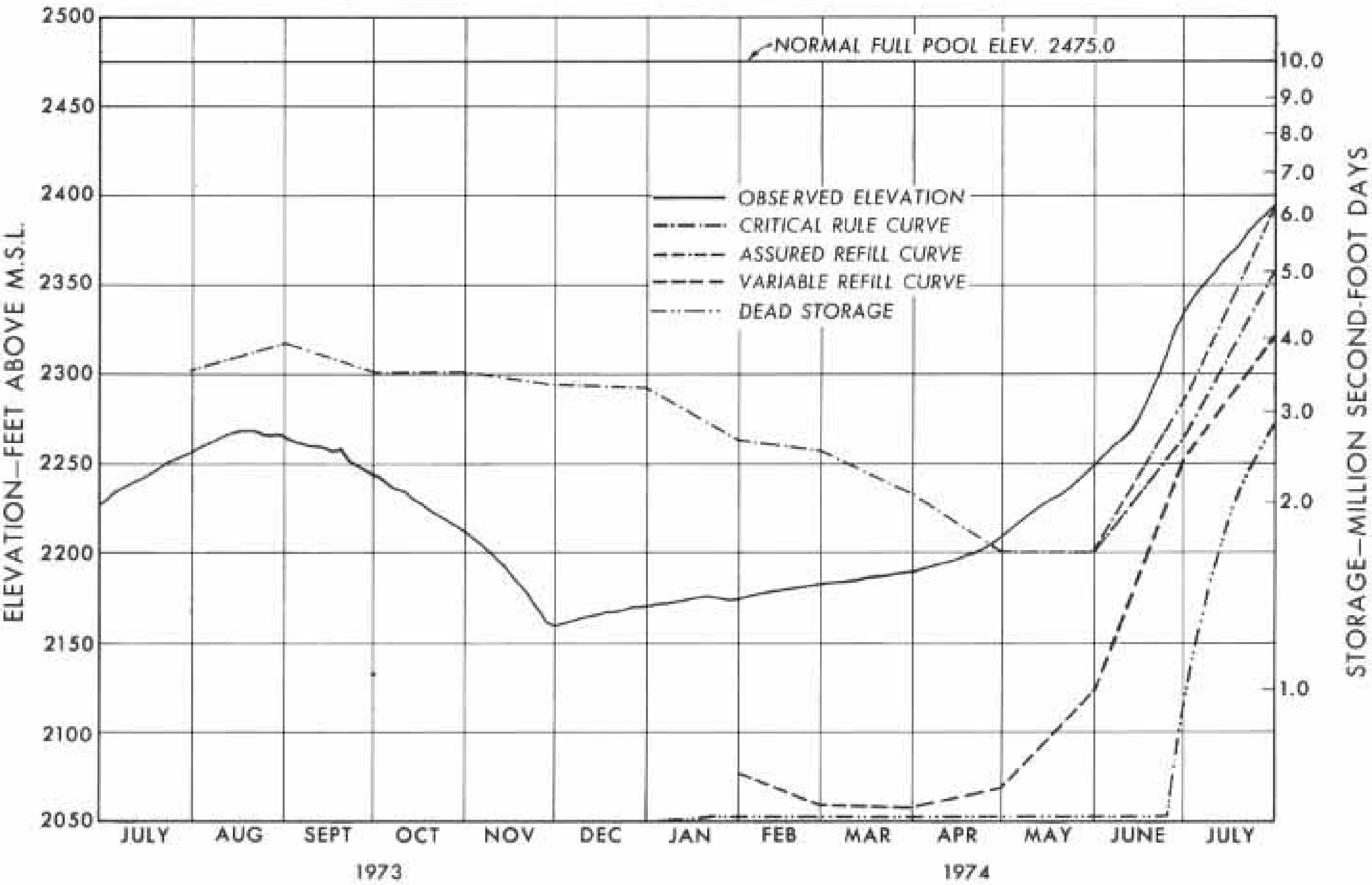
CHART 4



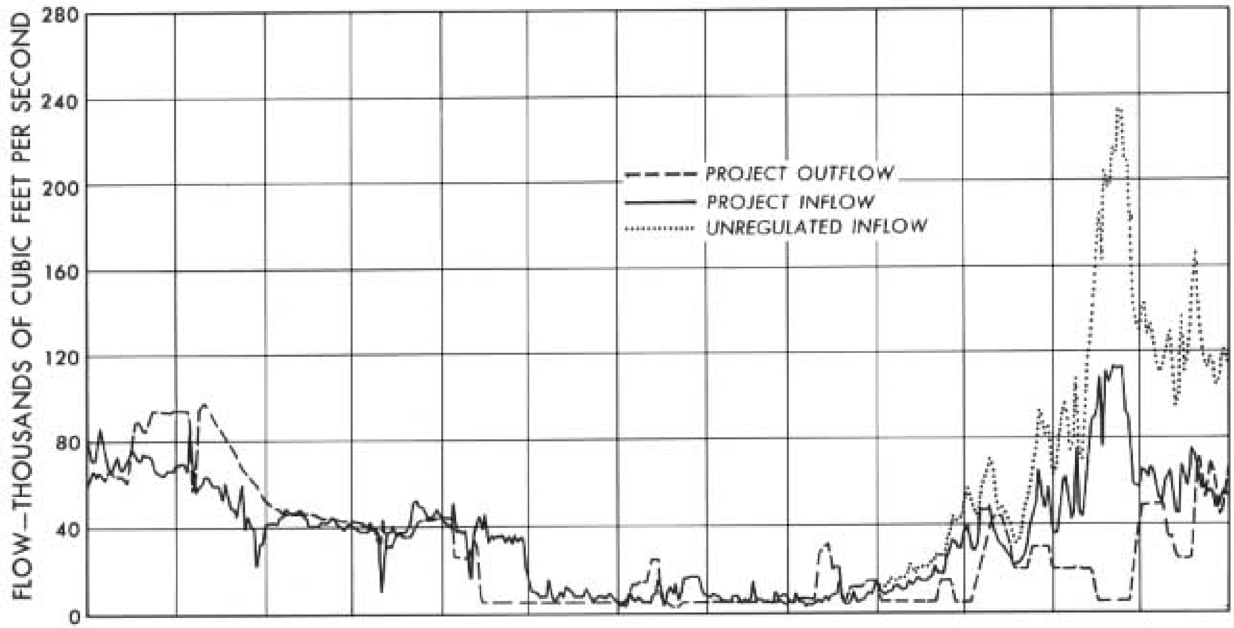
COLUMBIA RIVER TREATY
OPERATING COMMITTEE
SNOWMELT SEASON
TEMPERATURE AND PRECIPITATION
INDICES
COLUMBIA RIVER BASIN
IN CANADA
1974
ACCUMULATED PRECIP.
BASIN DAILY PRECIP., INCHES
BASIN TEMPERATURE
(DEGREE DAYS ABOVE 50° F.)
TEMP. DEPARTURE ACCUM.
(DEGREE DAYS)
MARCH
APRIL
MAY
JUNE
JULY
NOTE:
TEMPERATURE AND PRECIPITATION VALUES SHOWN ARE INDICES DETERMINED BY TAKING A WEIGHTED AVERAGE OF OBSERVED DATA AT SELECTED STATIONS IN THE BASIN. THE INDICES ARE SHOWN IN RELATION TO 30-YEAR NORMAL VALUES.

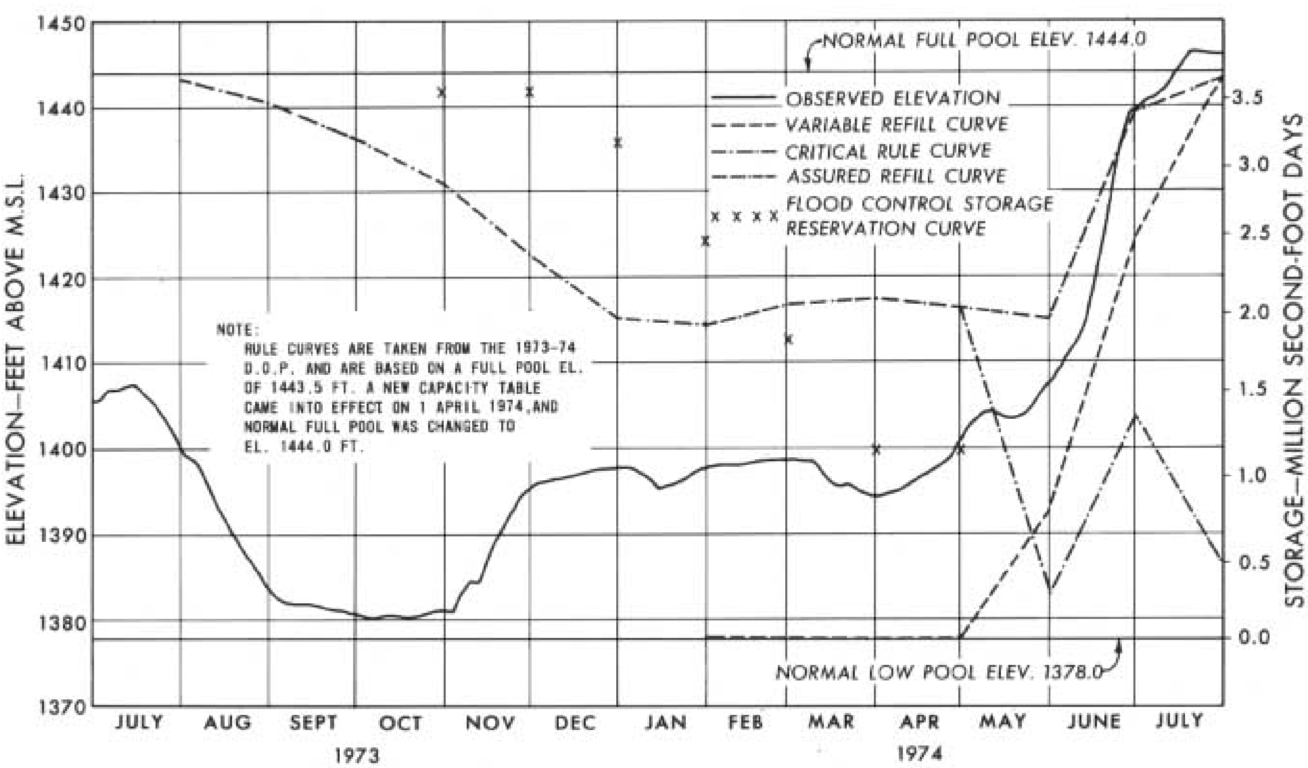
REGULATION OF MICA
1 JULY 1973–31 JULY 1974



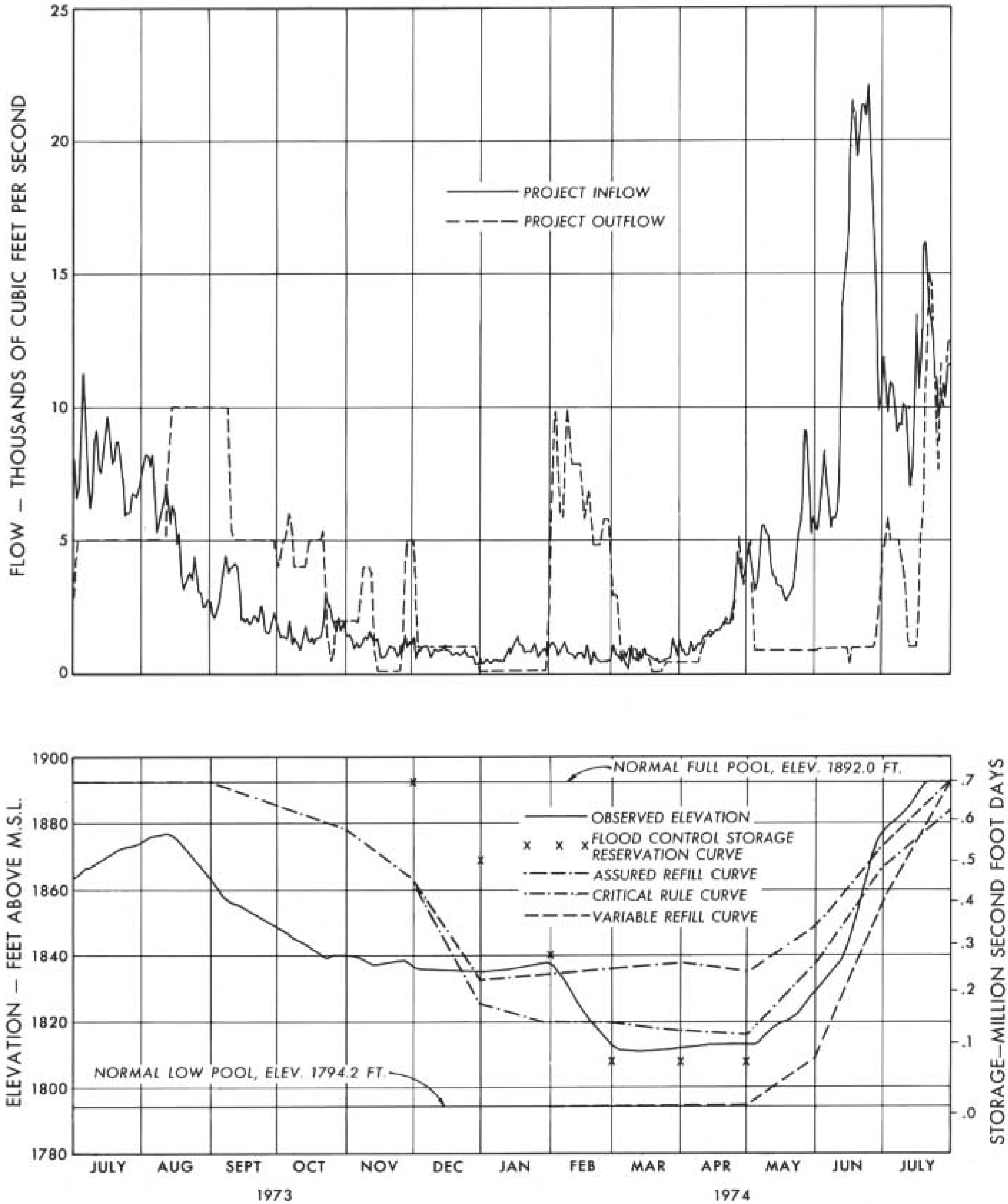


REGULATION OF ARROW
1 JULY 1973—31 JULY 1974

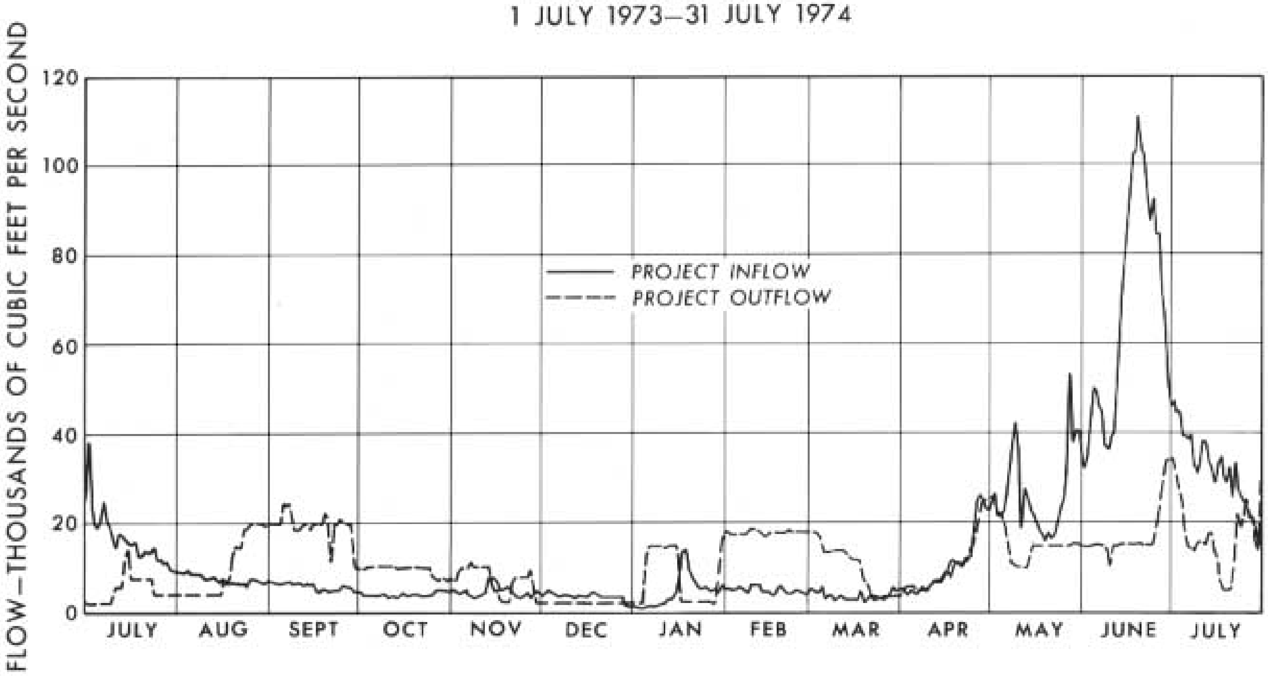




REGULATION OF DUNCAN
1JULY 1973 — 31 JULY 1974



REGULATION OF LIBBY
1 JULY 1973—31 JULY 1974



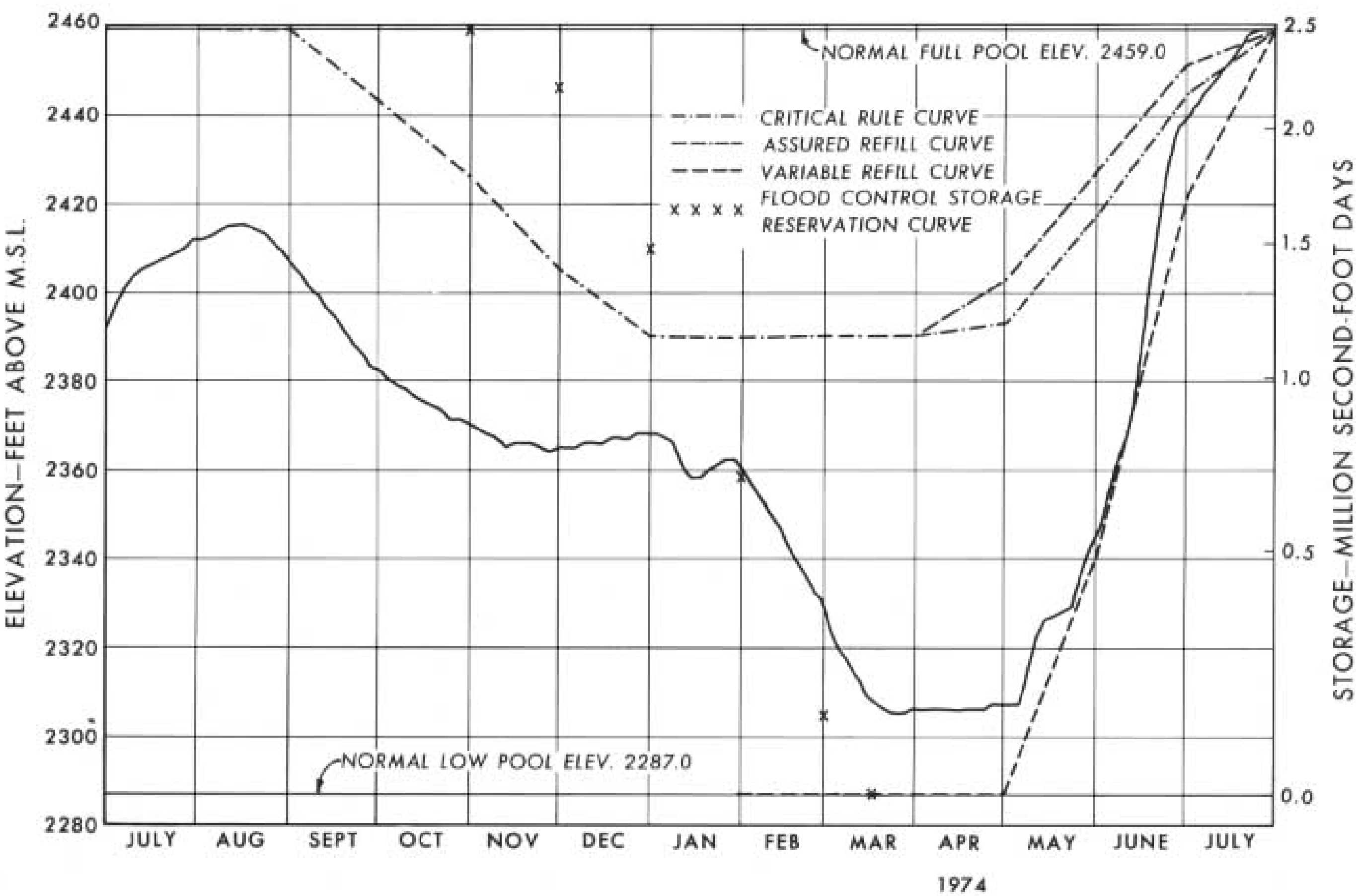
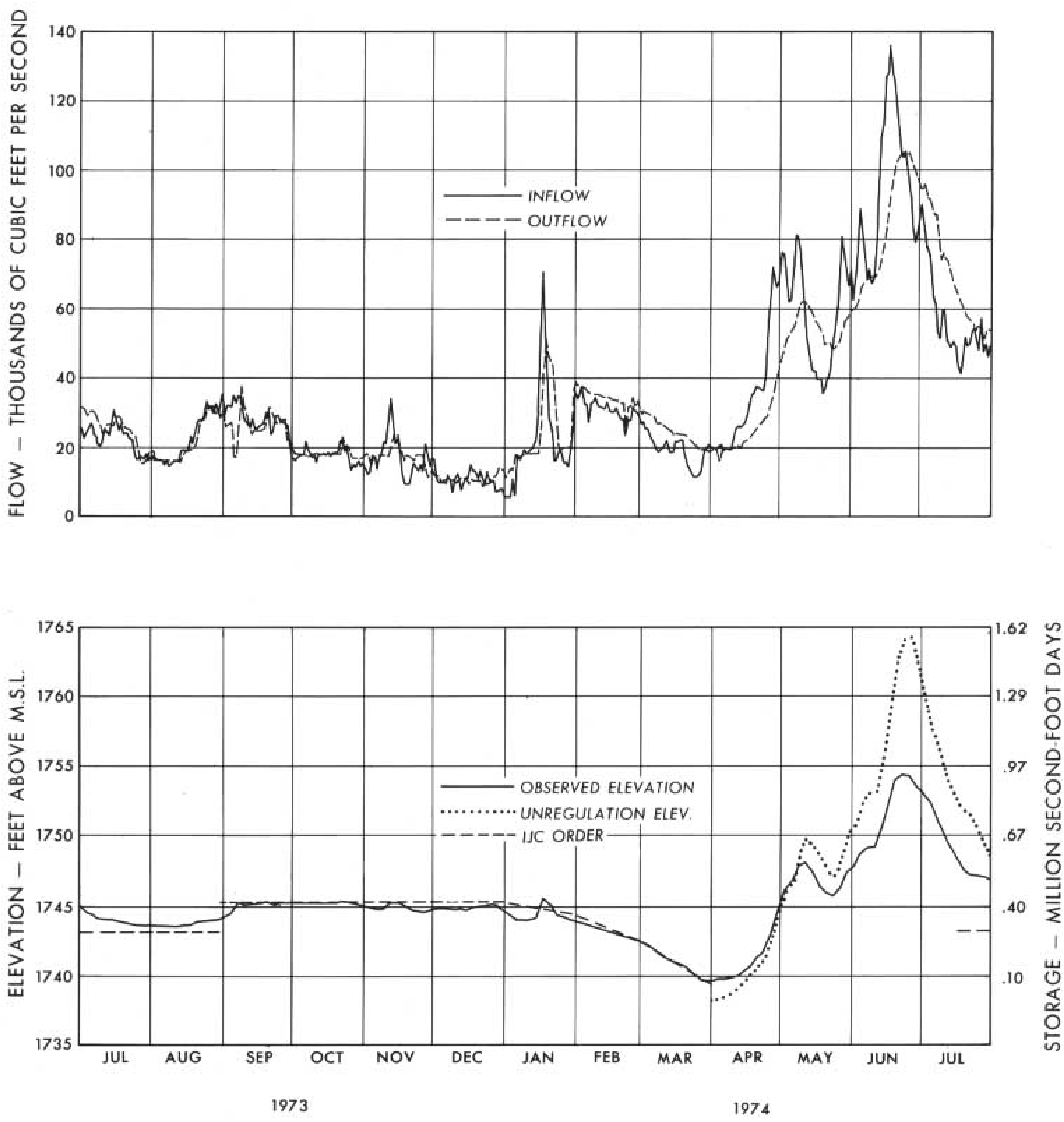
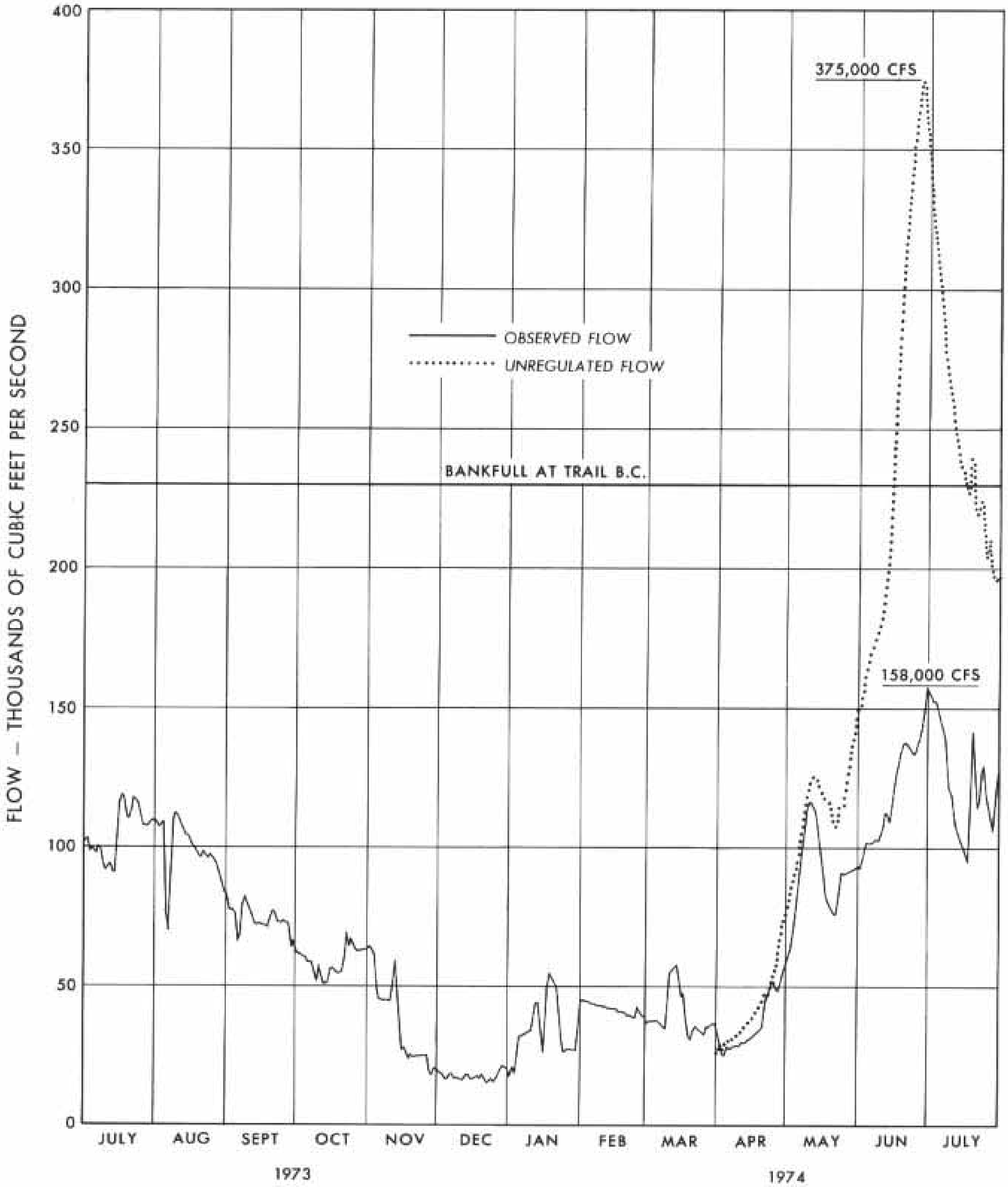


CHART 9
KOOTENAY LAKE

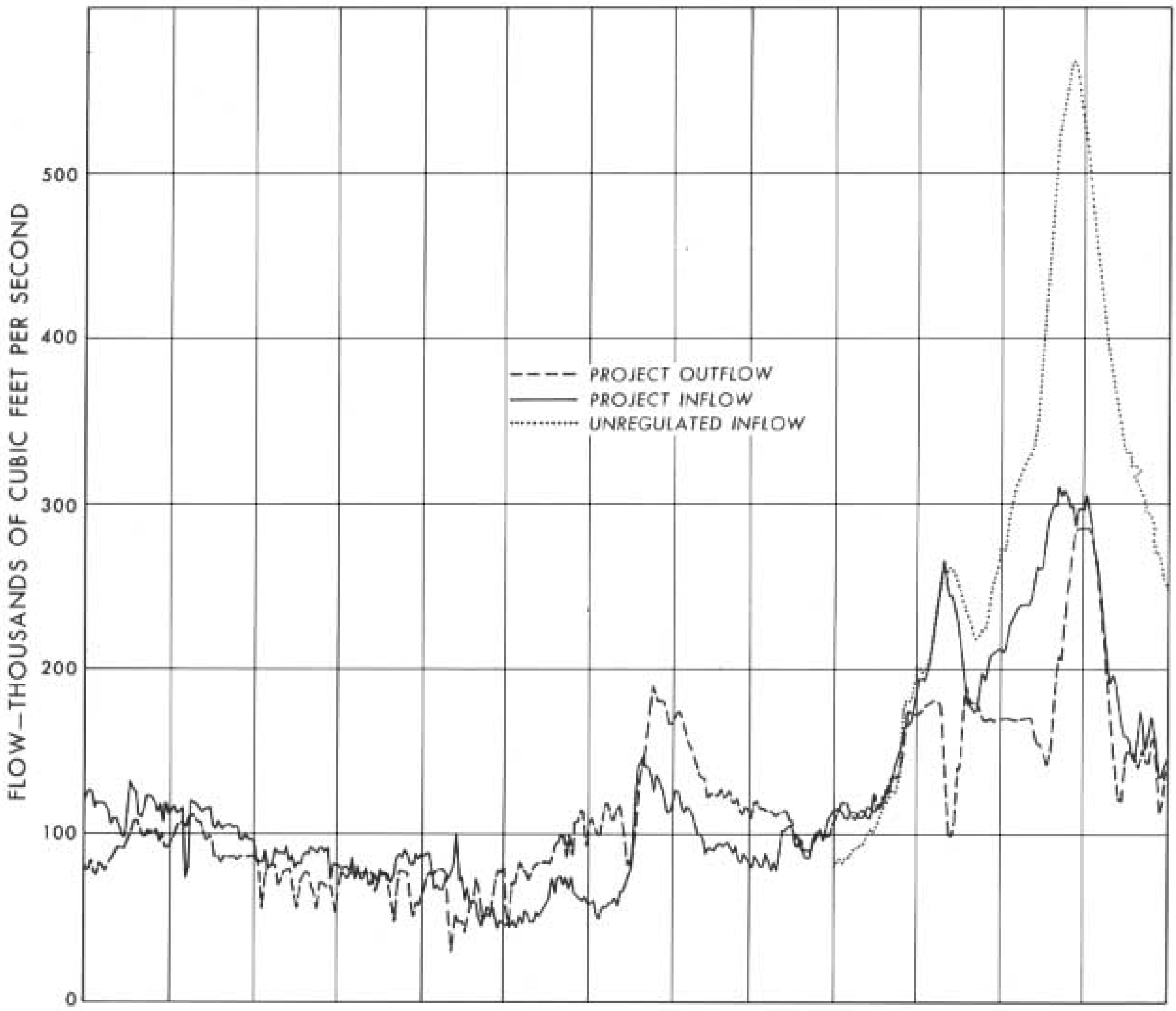
REGULATION OF KOOTENAY LAKE
1 JULY 1973 — 31 JULY 1974

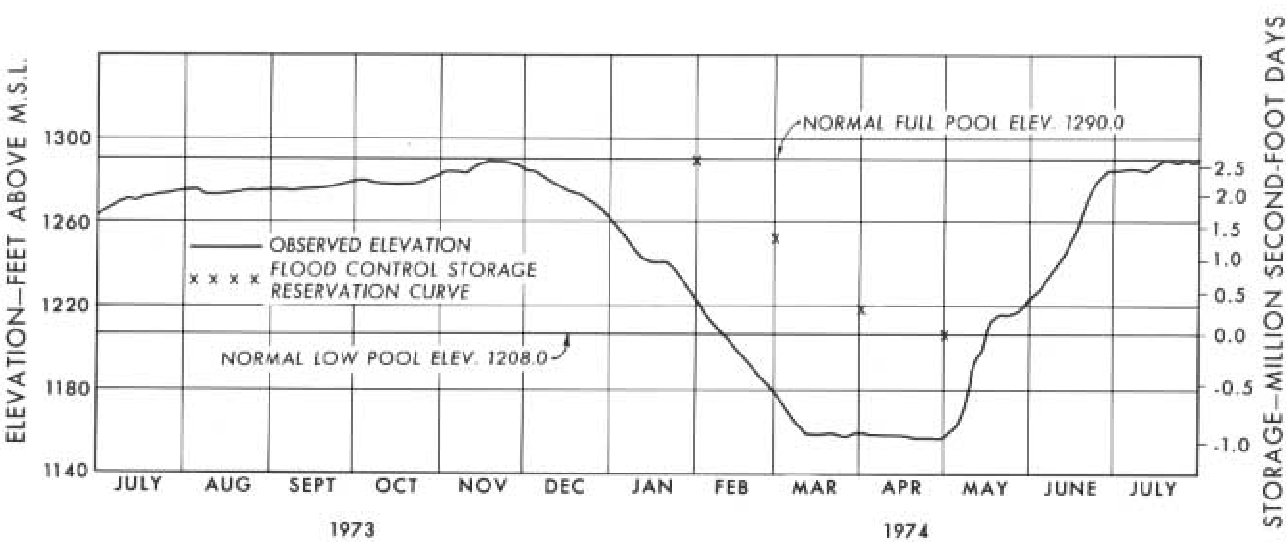


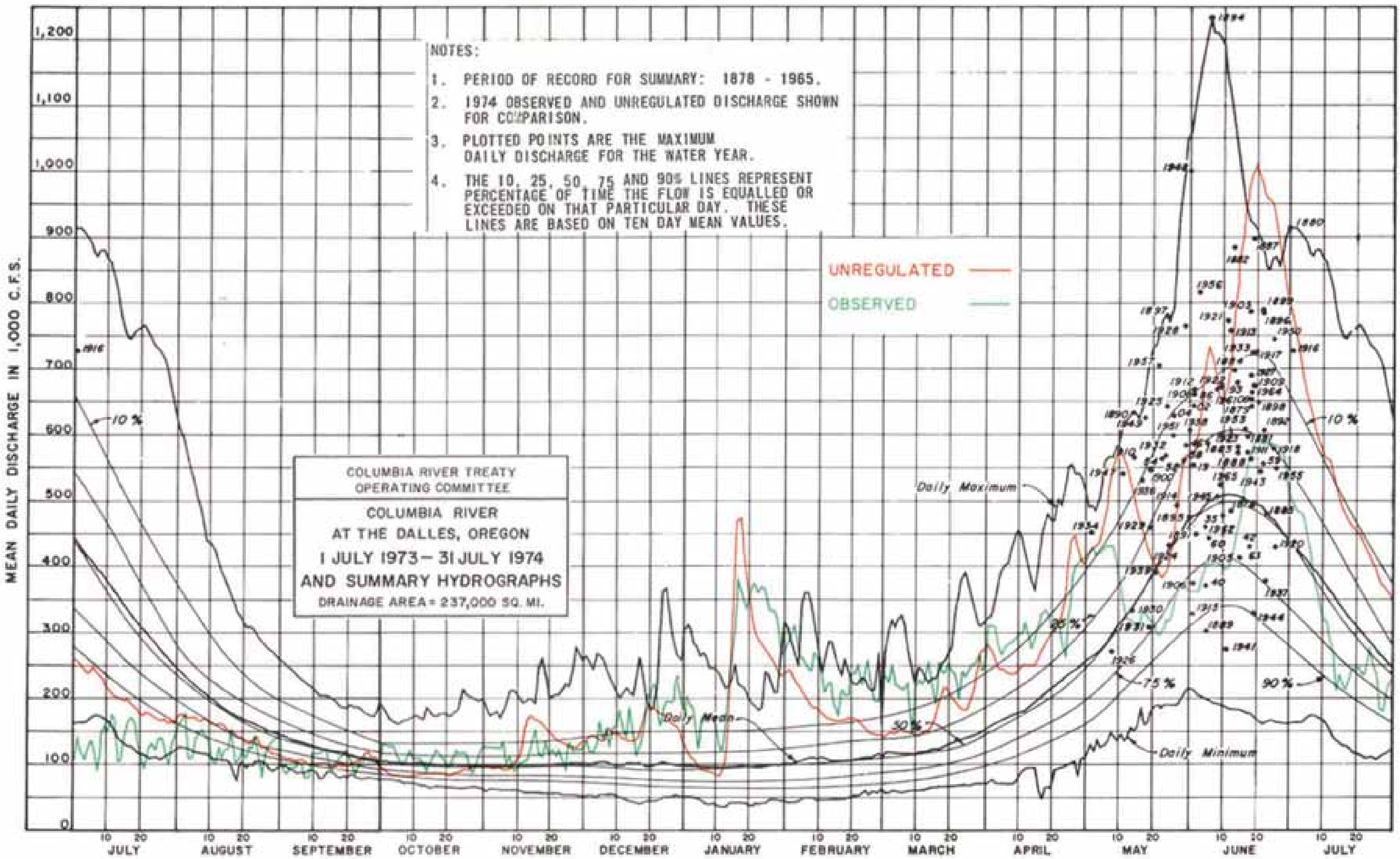
COLUMBIA RIVER AT BIRCHBANK
1 JULY 1973 – 31 JULY 1974



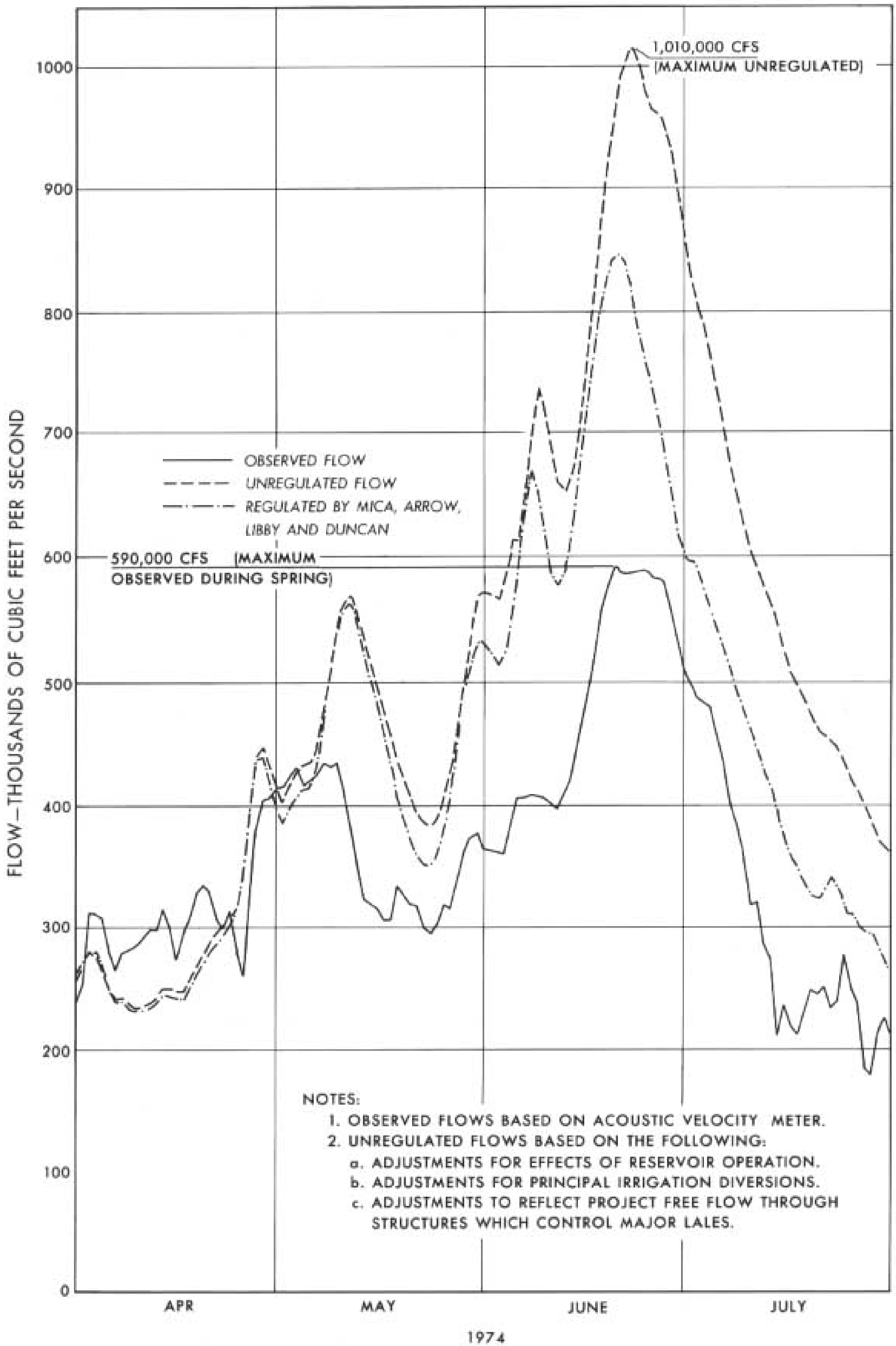
REGULATION OF GRAND COULEE
1 JULY 1973—31 JULY 1974



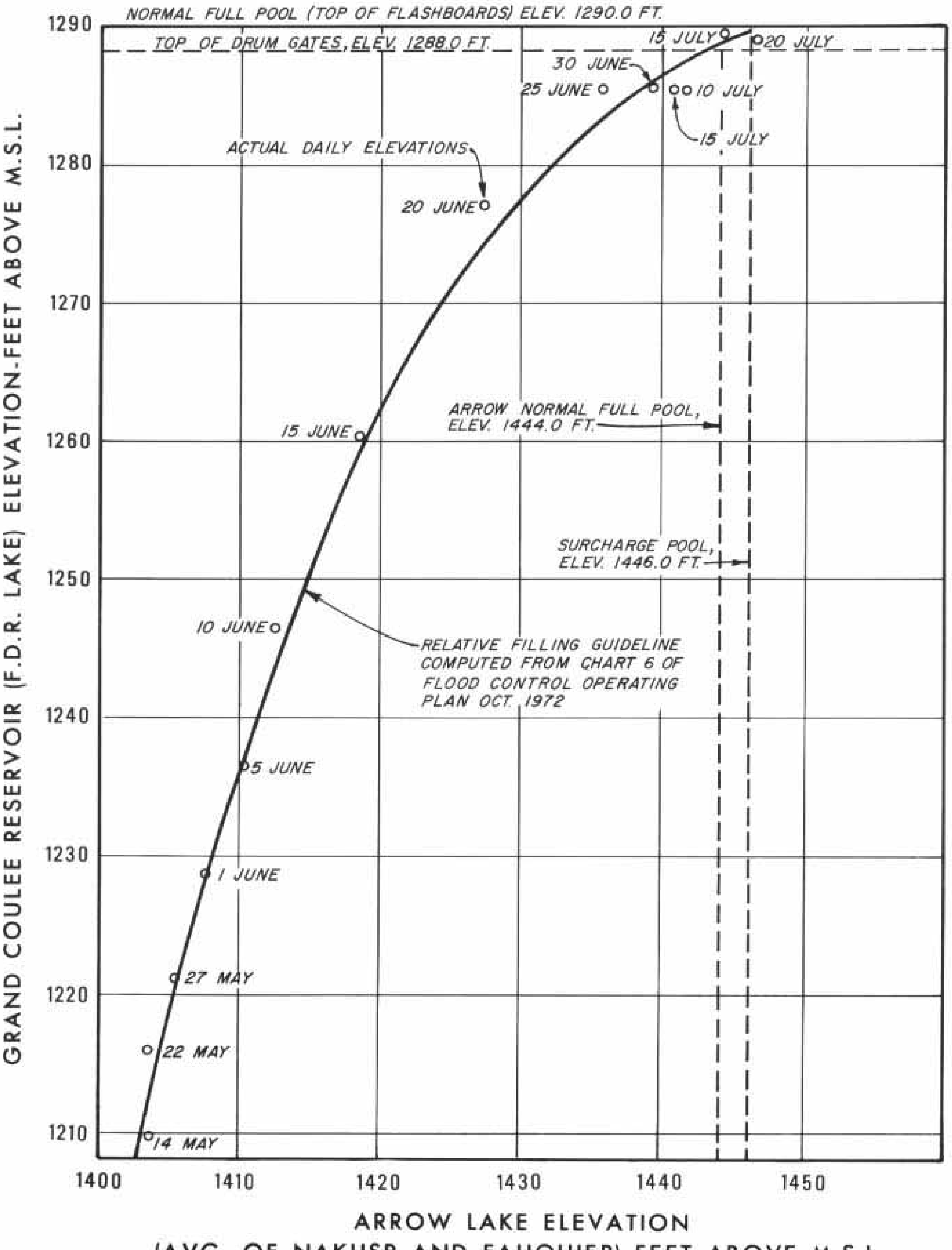



NOTES:
1. PERIOD OF RECORD FOR SUMMARY: 1878 - 1965.
2. 1974 OBSERVED AND UNREGULATED DISCHARGE SHOWN FOR COMPARISON.
3. PLOTTED POINTS ARE THE MAXIMUM DAILY DISCHARGE FOR THE WATER YEAR.
4. THE 10, 25, 50, 75 AND 90% LINES REPRESENT PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY. THESE LINES ARE BASED ON TEN DAY MEAN VALUES.
UNREGULATED
OBSERVED
COLUMBIA RIVER TREATY OPERATING COMMITTEE
COLUMBIA RIVER
AT THE DALLES, OREGON
1 JULY 1973 – 31 JULY 1974
AND SUMMARY HYDROGRAPHS
DRAINAGE AREA = 237,000 SQ. MI.
MEAN DAILY DISCHARGE IN 1,000 C.F.S.
Daily Maximum
Daily Mean
Daily Minimum
10 %
25 %
50 %
75 %
90 %
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY

COLUMBIA RIVER AT THE DALLES
1 APRIL 1974 – 31 JULY 1974



RELATIVE FILLING
ARROW AND GRAND COULEE



REFERENCES

The following documents governed the operation of the Columbia Treaty Projects during the period 1 August 1973 through 31 July 1974:

1. "Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage", dated 25 July 1967.

2. "Columbia River Treaty Hydroelectric Operating Plans for Canadian Storage, Operating Years 1969-70 through 1974-75", dated 15 February 1969.

3. "Columbia River Treaty Detailed Operating Plan for Canadian Storage, 1 July 1973 through 31 July 1974", dated 14 August 1974. 14 Sept 1973

4. "Columbia River Treaty Flood Control Operating Plan", dated 12 November 1968.

5. "Program for Initial Filling of Mica Reservoir", dated 26 July 1967.