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REPORT OF COLUMBIA RIVER TREATY CANADIAN AND UNITED STATES ENTITIES

for the period
1 October 1980 to
30 September 1981

October 1981

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INTRODUCTION

This report describes the joint actions of the Canadian and United States Entities during the period 1 October 1980 through 30 September 1981 in discharging their responsibilities for formulating and carrying out operating arrangements necessary to implement the Columbia River Treaty. It is the fifteenth of a series covering the period since the ratification of the Columbia River Treaty in September 1964.

ORGANIZATION AND MEETINGS

The names of the members and representatives of the two Entities during the reporting period are shown in Appendix A. There was one meeting of the Entities and one meeting of the Canadian Entity representative and U. S. Coordinators during the year.

The two international committees, listed in Appendix B, met as required throughout the reporting period to direct and coordinate Treaty storage operations and studies with the support of the staffs of B. C. Hydro, Bonneville Power Administration, and the U. S. Army Corps of Engineers, North Pacific Division.

COLUMBIA STORAGE OPERATION

Operating Arrangements

During the period covered by this report, Duncan, Arrow, Mica and Libby reservoirs were operated in accordance with the Columbia River Treaty for power and flood control.

The Canadian entitlement to downstream power benefits from Duncan, Arrow, and Mica for the 1980-81 operating year had been purchased in 1964 by the Columbia Storage Power Exchange. In accordance with the Canadian Entitlement Exchange Agreements dated 13 August 1964, the United States Entity delivered capacity and energy to the CSPE participants.

The operation of the storages was generally in accordance with:

(a) "Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1980-81", dated September 1975.

(b) "Detailed Operating Plan for Columbia River Treaty Storage - 1 August 1980 through 31 July 1981", dated September 1980.

(c) "Columbia River Treaty Flood Control Operating Plan", dated October 1972.

Consistent with all Detailed Operating Plans prepared since the installation of generation at Mica, the 1980-81 Detailed Operating Plan was designed to achieve optimum power generation at-site in Canada and downstream in Canada and the United States, in accordance with paragraph 7 of Annex A of the Treaty. The 1980-81 Assured Operating Plan prepared 6 years ago, was used as the basis for the preparation of the 1980-81 Detailed Operating Plan.

For each Operating Year the downstream power benefits resulting from Canadian storage are determined 6 years in advance. For the 1980-81 Operating Year, the determination indicated that there was a reduction in benefits of 2.5 average megawatts of average annual usable energy, but no reduction in dependable capacity, attributable to the re-regulation to achieve an optimum operation in both countries. The determination made for the 1981-82 Operating Year indicated a reduction in Canadian Entitlement of 3.0 average megawatts of average annual usable energy, but no reduction in dependable capacity.

In accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement, the Entities agreed that the United States Entity is entitled to receive 2.5 average megawatts of energy during the period 1 August 1980 through 31 March 1981 and 3.0 average megawatts of energy during the period from 1 April through 31 July 1981. Suitable arrangements have been made between the Bonneville Power Administration and B. C. Hydro for delivery of this energy.

Attached to this report as Appendix D is the "Report on Operation of Columbia River Treaty projects - 1 August 1980 through 31 July 1981" dated October 1981. Appendix D reports in detail on the runoff conditions prevailing and on the operation of the Treaty storages for the first 10 months of the 12-month period of this report.

A brief summary follows of the Columbia River Treaty operation of the Mica, Arrow, Duncan, and Libby reservoirs during the period 1 October 1980 to 30 September 1981.

General

The actual runoff volume of the Columbia River at The Dalles for the period January - July 1980 totalled 95.8 million acre-feet, equal to 87.4 percent of the 15-year average from 1963 to 1977. At

31 July 1980 the Coordinated System Reservoirs had refilled to 98 percent of their normal full contents. By the end of September 1980 the reservoirs were deficit approximately 1.4 billion kilowatt hours below operating rule curves due to below median streamflows in August and delay of the Hanford nuclear plant to return to service after its annual maintenance period.

Precipitation was reported as near average for the fall season in the Columbia River Basin. Much above normal precipitation was recorded throughout most of the Northwest during December. This warm, moist trend resulted in above average snow accumulation in British Columbia basins, but it left the southern regions with little or no snow in the Cascades or Idaho basins.

By 30 November improved natural streamflows erased energy deficiencies accumulated in August and September and reservoir levels were again at their operating rule curves. On 11 December 1980 Bonneville Power Administration (BPA) restored secondary energy deliveries to its non-firm industrial loads and made an equivalent amount of secondary energy available for sale to Pacific Northwest investor-owned utilities. As a result of heavy precipitation and record-setting warm temperatures during December, Coordinated System reservoirs were 4.9 billion kilowatt hours above rule curves by 31 December.

Temperatures remained above normal in January but precipitation dropped to only 32 percent of normal. The warm dry weather reduced the snowpack to only 66 percent of normal by month-end. However, above normal streamflows on the mainstem of the Columbia and reservoir levels above rule curves permitted BPA to offer surplus energy to Pacific Southwest utilities during the period from 26 December to 12 January 1981.

Warm and rainy weather generally prevailed in February and March and streamflows remained above normal. By 1 April the snowpack was only about two-thirds of normal except for the Canadian portion of the basin which indicated an accumulation of about 90 percent of average. Many stations in the Cascades reported their worst year of record.

BPA continued to supply secondary energy to all of its Pacific Northwest customers and Direct Service Industries through 27 March 1981. Operations for the juvenile fish out-migration began on 28 April. The over-generation in the United States Federal System allowed secondary energy deliveries to BPA's Pacific Northwest and Pacific Southwest customers to be resumed. BPA also stored excess energy in B. C. Hydro reservoirs.

Precipitation during May, June and July was 170, 143 and 163 percent of normal, respectively, over the Columbia River Basin above The Dalles. As a result, the actual January - July volume runoff of the Columbia River above The Dalles was 103.5 million acre-feet (maf), or 21.6 maf higher than the 1 April runoff forecast. All major reservoirs were full on 31 July 1981, the date they are programmed to refill. By the end of this report period, 30 September, with flows on a seasonal recession, the Coordinated System reservoirs were 0.3 billion kilowatt hours below programmed levels.

Flood control during the 1981 spring runoff was provided by a faster than normal refill operation of the Treaty projects and other storage reservoirs in the Columbia Basin. Peak flows, resulting from snowmelt and above normal rainfall, occurred in June. The unregulated peak at The Dalles was 579,000 cfs on 10 June 1981, approximately 5.7 feet above bankfull capacity. The maximum observed daily discharge during the spring runoff at The Dalles was 436,400 cfs.

Mica Reservoir

The Treaty storage space in Mica Reservoir was filled by 15 August 1980 and remained full through 30 September. Approximately three feet of B. C. Hydro non-Treaty storage was drafted during September to meet B. C. Hydro's system load requirements. On 30 September the Mica Reservoir was at elevation 2466.7 feet.

A reduction in generation required at Mica to meet B. C. Hydro's system load resulted in Mica Reservoir refilling to elevation 2469.4 feet by 19 October. From late October through December, Mica reservoir was drafted to B. C. Hydro system load and downstream United States storage requirements. During this period the Mica reservoir discharges averaged somewhat less than the Detailed Operating Plan target releases.

During the last week of December, generation at Mica was curtailed and the reservoir was held at elevation 2455.0 feet. Mica reservoir drafting resumed in January and continued until late April. The reservoir reached elevation 2406.1 feet on 22 April 1981, its lowest elevation of the 1980-81 Operating Year.

Mica Reservoir began to refill in late April when inflow increased due to snowmelt. It reached elevation 2425.9 feet by 31 May and elevation 2445.4 feet by 30 June. Treaty storage space was filled at elevation 2470.4 feet on 29 July (which includes 34.3 thousand-second-foot days (sfd) of storage in a special account). The reservoir continued to fill and reached elevation 2471.6 feet by 31 July. Inflows reached almost 60,000 cfs during the first half of August, and spilling occurred as inflows were discharged in order to prevent the reservoir from rising further. Treaty storage space remained full through the summer, and on 30 September the Mica Reservoir was at elevation 2469.6 feet. The reservoir elevation at full Treaty storage is presently elevation 2469.8 feet, 500,000 acre-feet below normal full pool elvation of 2474.5 feet, to provide additional flood protection at the Revelstoke Project during its construction.

Arrow Reservoir

At 30 September 1980 the elevation of Arrow Reservoir was 1442.4 feet and it remained near that level through October. From November 1980 through January 1981, storage was evacuated from the reservoir according to the Flood Control Rule Curve for the project. The actual reservoir level was below this rule curve due to the Treaty storage imbalance between Mica and Arrow, as Mica discharges had averaged less than the Detailed Operating Plan target releases during November and December.

Outflows from Arrow Reservoir were increased to 77,000 cfs during February and the reservoir reached its lowest point of the Operating Year of 1409.9 feet on 23 February 1981. The outflows were then reduced, and the reservoir was held at approximately 1410 feet during March.

The Arrow Reservoir began to refill in April and reached 1419.5 feet by 30 April. As a result of higher than average inflows to the reservoir in May, the reservoir elevation rose by almost 20 feet during the month, reaching elevation 1438.9 feet by 31 May. The regulated inflow peaked at a daily average of 100,640 cfs on 27 May.

From 4 through 10 June, Arrow discharges were reduced to store an additional 132,100 sfd of water surplus to U. S. requirements under the "Arrow Lakes Storage Agreement" between BPA and B. C. Hydro. The reservoir was filled to 1446.0 feet on 14 July. The reservoir was drafted slightly through the summer and on 30 September the reservoir was at elevation 1442.8 feet.

Duncan Reservoir

Duncan Reservoir was near full pool elevation of 1892.0 feet on 31 July 1980 and remained at about that level until late August. During September, Duncan outflows were increased to help fill Kootenay Lake to elevation 1745.3 feet. On 30 September the reservoir was at elevation 1876.4 feet.

From 3 October through 29 November, Duncan outflow was reduced to 100 cfs to minimize spillage at downstream power projects. This resulted in the reservoir elevation rising to 1884.8 feet by 30 November. From December 1980 through mid-February 1981, Duncan Reservoir was evacuated according to its Flood Control Rule Curve and it reached its lowest elevation of 1819.5 feet by 12 March.

Outflows were reduced to the minimum discharge of 100 cfs commencing on 15 March. By 30 June the reservoir had refilled to elevation 1880.2 feet, and it reached full pool elevation of 1892.0 feet on 14 July. The inflow to the Duncan Reservoir peaked at a daily average of 19,100 cfs on 6 July. Storage draft began on 21 September and on 30 September the reservoir was at elevation 1886.9 feet.

Libby Reservoir

The Libby Reservoir reached its full pool elevation of 2459.0 feet by mid-July 1980 and was held above elevation 2458 feet through July and August. On 30 September it was at elevation 2456.0 feet. Releases were increased to full powerhouse capacity of 20,000 cfs in November and December, and by 1 January 1981 the reservoir had drafted to elevation 2409.6 feet. Storage draft continued in January and February with outflows up to 26,000 cfs (including 6,000 cfs of spill) being required for about two weeks in January to meet flood control drawdown requirements. The lake level was at elevation 2356.6 feet on 28 February. The reservoir reached its lowest elevation of the year, 2349.7 feet, on 14 March 1981.

Inflows to Libby increased in late April and the seasonal peak was reached on 27 April with a daily average inflow of 69,700 cfs. Libby outflows were reduced to 3,000 cfs from mid-March through 27 May at which time the lake had filled to elevation 2412.7 feet. Releases were then gradually increased, and by 2 July 1981 the project began spilling. Outflows reached a maximum of 40,000 cfs on 7 July, and the reservoir filled slowly throughout the month. The Libby Reservoir (Lake Koocanusa) was at full pool on 31 July 1981 and was held above elevation 2458 feet until mid-September. On 30 September it was at elevation 2455.9 feet.

COMMITTEE ACTIVITIES

Hydrometeorological Committee

Progress continued on the conversion of the hydromet monitoring stations in Canada from conventional VHF/UHF telemetry to satellite telemetry. This will utilize data collection platforms to transmit to a GOES satellite, which will relay the data to a National Weather Service communication network. A new central processor is being installed at B. C. Hydro's Burnaby Mountain Control Centre, which will be linked with CROHMS via the Bonneville Power Administration microwave system. The Corps of Engineers replaced the IBM computer, which acted as the CROHMS processor, with an Amdahl computer. It is several times faster than the old computer in processing CROHMS data, and up to eight times faster in other applications. The Canadian conversion to metric units is expected by July 1982. It is anticipated that advance planning will avoid any possible problems.

Aerial snow surveillance activities were satisfactory, other than some grounded flights due to bad weather.

Studies continue on modelling techniques for runoff and streamflow forecasting.

The sizeable forecast error in the 1981 runoff volume was attributed to the substantial spring rainfall. The forecast procedure reflects the winter precipitation and snowpack quite accurately, but the majority of the forecast error can be traced to spring precipitation.

The consolidation of Hydromet documents remains in draft form. The final draft will be deferred, pending changes in the Canadian hydromet system.

Operating Committee

The Committee coordinated the operation of the Treaty storage in accordance with the current hydroelectric and flood control operating plans. This aspect of the Committee's work is described in Appendix D, "Report on Operation of Columbia River Treaty Projects - 1 August 1980 through 31 July 1981".

The Committee also prepared the Entity agreements listed in Appendix C and assured that the implementation of the "Arrow Lakes Storage Agreement" was consistent with the operating plans.

COOPERATION WITH PERMANENT ENGINEERING BOARD

The Entities continued their cooperation with the Permanent Engineering Board in the discharge of its functions and a joint meeting of the Permanent Engineering Board and the Entities was held on 24 November 1980 in Vancouver, British Columbia.

Copies of the agreements listed in Appendix C were sent to the Board.

COLUMBIA RIVER TREATY ENTITIES

CANADA

ROBERT W. BONNER
CHAIRMAN

Chairman
B. C. Hydro
Vancouver, B. C.

UNITED STATES OF AMERICA

PETER T. JOHNSON 1/
CHAIRMAN

Administrator
Bonneville Power Administration
Department of Energy
Portland, Oregon

BRIGADIER GENERAL JAMES W. VAN LOBEN SELS 2/

Division Engineer
North Pacific Division
Corps of Engineers, U. S. Army
Portland, Oregon

Canadian Entity Representative

D. R. FORREST

Manager
Canadian Entity Services
B. C. Hydro
Vancouver, B. C.

United States Entity Coordinators

EDWARD W. SIENKIEWICZ, COORDINATOR 3/

Power Manager
Bonneville Power Administration
Portland, Oregon

HERBERT H. KENNON, COORDINATOR

Chief, Engineering Division
North Pacific Division
Corps of Engineers, U. S. Army
Portland, Oregon

CHARLES E. CANCILLA, SECRETARY

Bonneville Power Administration
Portland, Oregon

1/ Succeeded Sterling Munro, 11 August 1981
2/ Succeeded Major General Richard M. Wells, 11 August 1981
3/ Succeeded Earl E. Gjelde, 11 August 1981

APPENDIX B

COLUMBIA RIVER TREATY

OPERATING COMMITTEE

Canadian Section	United States Section
T. J. NEWTON Chairman	L. A. DEAN (BPA) Co-Chairman
R. D. LEGGE	N. A. DODGE (USCE) Co-Chairman
K. R. SPAFFORD	C. E. CANCILLA (BPA)
W. N. TIVY 1/	G. G. GREEN (USCE)

HYDROMETEOROLOGICAL COMMITTEE

Canadian Section	United States Section
U. SPORNS Chairman	D. D. SPEERS (USCE) Co-Chairman
J. R. GORDON	R. C. LAMB (BPA) Co-Chairman

All Canadian committee members represent British Columbia Hydro. United States committee members represent either the United States Army Corps of Engineers, or Bonneville Power Administration.

1/ Succeeded W. E. Kenny, 20 August 1981

COLUMBIA RIVER TREATY

OFFICIAL AGREEMENTS OF THE ENTITIES

Description	Date Agreement Signed by Entities
Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1985-86 dated September 1980	30 October 1980
Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1985-86 dated September 1980	30 October 1980
Detailed Operating Plan for Columbia River Treaty Storage, 1 August 1980 through 31 July 1981 dated September 1980	30 October 1980
Arrow Lakes Storage Agreement (1444.0 - 1446.0 feet)	24 June 1981

APPENDIX D

REPORT ON

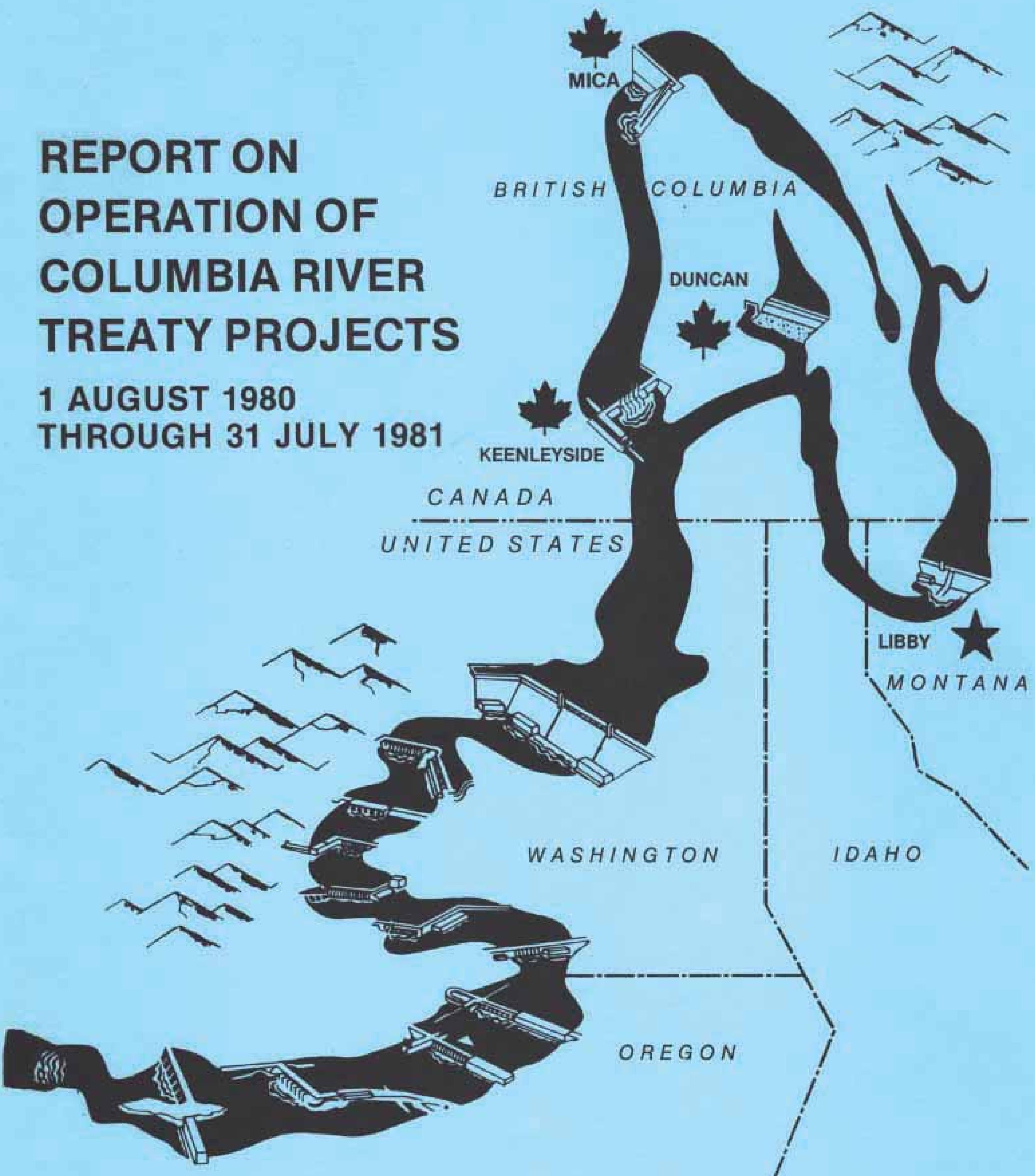
OPERATION OF COLUMBIA RIVER

TREATY PROJECTS

1 AUGUST 1980 through 31 JULY 1981

REPORT ON OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1980 THROUGH 31 JULY 1981



COLUMBIA RIVER TREATY OPERATING COMMITTEE

OCTOBER 1981

PS 13-10-78

REPORT ON

OPERATION OF COLUMBIA RIVER

TREATY PROJECTS

1 AUGUST 1980 THROUGH 31 JULY 1981

COLUMBIA RIVER TREATY OPERATING COMMITTEE

L. A. Dean
Bonneville Power Administration
Co-Chairman, U. S. Section

N. A. Dodge
Corps of Engineers
Co-Chairman, U. S. Section

C. E. Cancilla
Bonneville Power Administration
Member, U. S. Section

G. G. Green
Corps of Engineers
Member, U. S. Section

T. J. Newton
B. C. Hydro and Power Authority
Chairman, Canadian Section

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B. C. Hydro and Power Authority
Member, Canadian Section

K. R. Spafford
B. C. Hydro and Power Authority
Member, Canadian Section

W. N. Tivy
B. C. Hydro and Power Authority
Member, Canadian Section

REPORT ON

OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1980 THROUGH 31 JULY 1981

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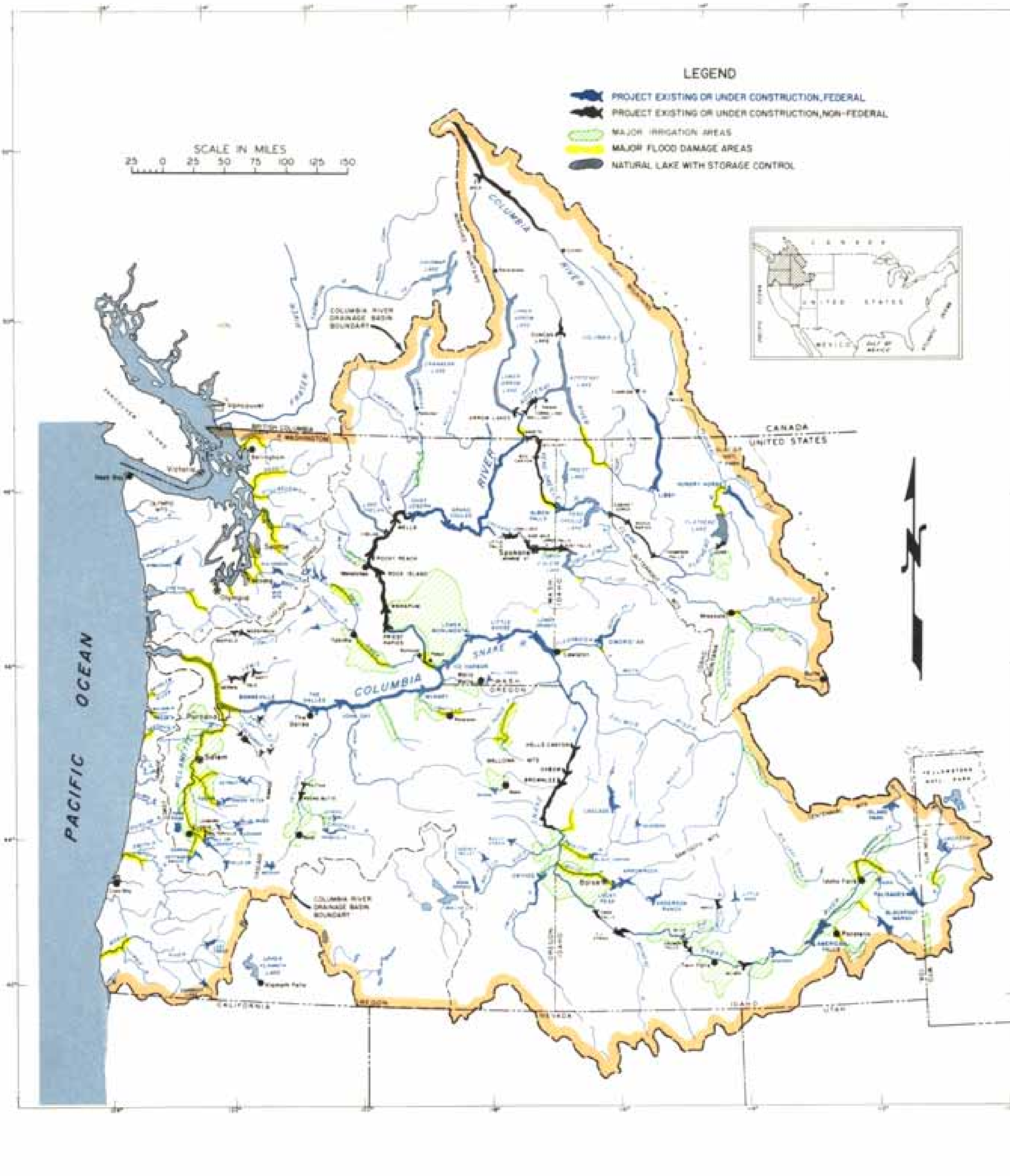
COLUMBIA RIVER AND COASTAL BASINS



REPORT ON
OPERATION OF COLUMBIA RIVER TREATY PROJECTS
1 AUGUST 1980 THROUGH 31 JULY 1981

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. Treaty storage in Canada is required to 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 (B. C. Hydro); the United States Entity is the Administrator, Bonneville Power Administration (BPA) and the Division Engineer, North Pacific Division, Corps of Engineers (USCE).

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, Duncan and Libby reservoirs for power and flood control during the period 1 August 1980 through 31 July 1981, 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 (DOP) for Columbia River Treaty Storage, dated September 1980. The regulation of the Canadian storage content was normally determined by the Operating Committee on a weekly basis during the entire operating year.

II. WEATHER AND STREAMFLOW

A. WEATHER

Precipitation was near average for the fall season in the Columbia River Basin. A sunny and dry August preceded the mild and near normal temperatures of September. Basins east of the Cascades received above average precipitation in September but this pattern changed to warm and dry in October, with basinwide precipitation diminishing to only one-half of normal. The warmer temperatures continued throughout November and December. While precipitation in November was only slightly above normal across the northerly basins, much above normal precipitation was recorded throughout most of the Northwest during December. This warm, moist trend allowed for above average snow accumulations in British Columbia basins, but resulted in high runoff in southern regions, leaving little or no low level snow in the Cascades or Idaho basins. Basinwide, the 1 January snowpack estimate was 88 percent of normal.

Temperatures remained on the warmer side in January but the precipitation dropped to only 32 percent of normal. The warm dry weather reduced the snowpack estimate to a mere 66 percent of normal by month's end. Precipitation returned to above average in February everywhere except in the upper Snake River basin where precipitation was below normal. March came in warm and dry but became wet, resulting in near normal or above normal precipitation over basins in eastern Oregon, southeastern Washington and the upper Snake River plain. Although the British Columbia snowpack estimate was 80 percent of normal, the basinwide average was only 65 percent due to little snow in the Cascades or Idaho ranges. Precipitation varied widely over the Columbia basin in April with British Columbia, western Washington, and southern Idaho being wet while below average precipitation continued in western Oregon and Montana. By the beginning of the spring runoff, the overall snowpack estimate was approximately 66 percent of normal even though the Canadian accumulation was 90 percent of average.

The spring of 1981 was highly unusual in that it was marked by heavy precipitation, accompanied by below-normal temperatures. The rainy and cool weather continued throughout June and on into July. April through July precipitation for the Columbia basin above Grand Coulee was 160 percent of normal while the total basin above The Dalles was 146 percent of normal. Some stations in the Kootenay basin were over 180 percent of normal for this period. The total August 1980-July 1981 precipitation was 113 percent of average for the Columbia Basin above Grand Coulee and 105 percent of average for the Columbia Basin above The Dalles.

The geographical distribution of the accumulated October through April precipitation for the basin, expressed as a percentage of the 15-year average, 1963-1977, is shown on Chart 1. This shows the October through April precipitation at or below normal for virtually the entire Pacific Northwest. Large portions of the Clark Fork, Clearwater, Snake, Similkameen, and Okanagan river basins and much of the Oregon Cascades received less than 80 percent of average precipitation.

Chart 2 depicts the winter season precipitation and temperature sequences that occurred thoughout the basin, as measured by index stations in the basin. Warm temperatures, combined with average October-December precipitation, limited snow accumulations to the upper elevations and British Columbia basins. A warm dry January reduced the 1 February snowpack estimate to 66 percent of normal. Continued near or above average temperatures and normal precipitation never allowed for recovery, and the snowpack remained at approximately two-thirds of normal throughout the remainder of the season, with many Cascade stations reporting their worst year on record.

The pattern of temperature and precipitation throughout the April-August 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 seasonal runoff is produced by snowmelt, the temperatures shown are of special significance to system regulation in that they largely influence the pattern of streamflow.

B. STREAMFLOW

Streamflow in August was generally below normal in the upper Columbia and Kootenay River basins in Canada and near average elsewhere. Flows remained near average across the Columbia River basin through November except for below average streamflows reported west of the Cascades and on the upper Snake River plain. Heavy warm rains over Christmas week depleted many low elevation snowpacks to produce above average streamflows across the entire Pacific Northwest. Many Washington stations recorded new record maximum mean daily flows. Western Washington and western Oregon streams returned to below average flows in January in contrast to all the northerly Columbia system basins reporting above average flows.

February flows bounced back to above average across all but the southern Oregon and upper Snake River basins, in response to the warm and rainy weather. March saw the return of the January pattern; low flows west of the Cascades, but continued high flows in the northern U. S. and British Columbia streams. All streamflows returned to near average during April and May with the exception of portions of the upper Columbia-Kootenay drainage where above average flows continued. This pattern continued through June and July, except for local above average flows on the John Day, Grand Ronde and Spokane Rivers.

The 1980-1981 monthly modified streamflows and average monthly flows for the period 1926-1981 are shown in the following table for the Columbia River at Grand Coulee and The Dalles. These modified flows are corrected for storage in lakes and reservoirs to exclude the effects of regulation, and are adjusted to the 1970 level of development for irrigation.

Mean Monthly Modified Streamflow, in CFS

	Columbia River at Grand Coulee		Columbia River at The Dalles	
Month	Year 1980-1981	Average 1926-1981	Year 1980-1981	Average 1926-1981
AUG	74640	97150	99390	133120
SEP	57930	60200	87820	92690
OCT	48610	51080	79070	88330
NOV	48710	46370	85890	90870
DEC	74140	43650	138600	95530
JAN	60600	38710	120300	91760
FEB	63030	41400	140400	103430
MAR	55910	48230	115200	118520
APR	102800	114870	185200	217170
MAY	295900	266440	419100	416830
JUN	291500	313370	441300	466130
JUL	236400	186500	283600	252000
YEAR	117500	109000	183000	180500

The maximum mean monthly modified streamflow for the Columbia River at Grand Coulee occurred in May this year and was 112 percent of the long-term average. The maximum value for the Columbia River at The Dalles occurred during the usual maximum month of June and was 93 percent of the long-term average.

Maximum observed mean daily inflows during the 1980-81 operating year were 80,800 cfs at Mica on 31 May, 101,000 cfs at Arrow on 27 May, 19,100 cfs at Duncan on 6 July, and 60,700 cfs at Libby on 27 May. The maximum observed mean daily flow in the Columbia River at The Dalles was 436,400 cfs on 10 June. The observed 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, Columbia River at Birchbank, Grand Coulee, and The Dalles are shown on Charts 9, 10, 11, and 12, respectively.

C. SEASONAL RUNOFF VOLUMES

The volume and distribution of runoff during the snowmelt season are 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 for the unregulated runoff of the Columbia River at The Dalles. The forecasts for Mica, Arrow, and Duncan inflows were prepared by B. C. Hydro and those for the lower Columbia River and Libby inflows were prepared by the United States Columbia River Forecasting Service. Also shown on Table 1 and the actual volumes for these five locations. Note that actual spring runoff for all basins was greater than the April forecasts, due to the copious amounts of spring precipitation that occurred.

Observed April-August runoff volumes, adjusted to exclude the effects of regulation of upstream storage, are listed for eight locations in the following tabulation:

Streamflow and Location	April - August Runoff	
	Thousands of Acre-Feet	Percent of 1963-77 Average
Libby Reservoir Inflow	7359	108
Duncan Reservoir Inflow	2151	103
Mica Reservoir Inflow	11810	100
Arrow Reservoir Inflow	24347	103
Columbia River at Birchbank	44322	105
Grand Coulee Reservoir Inflow	66328	104
Snake River at Lower Granite Dam	19622	80
Columbia River at The Dalles	90676	93

III. RESERVOIR OPERATION

A. MICA RESERVOIR

Storage Evacuation Period. As shown on Chart 5, Mica Reservoir was at elevation 2466.0 feet on 31 July 1980. The reservoir storage account on that day showed that Mica Treaty Storage was 304,770 sfd below full. In addition to the Treaty Storage, Mica reservoir contained 34,300 sfd of Mica Special Reserve Storage (surplus inflow captured at Arrow and transferred to Mica in June 1980), and 50,161 sfd of BPA Mica Surplus Storage (remainder of 112,894 sfd of water stored in Mica Reservoir under the 1980 Agreement to Enhance Filling of Mica Reservoir). Return of the BPA Mica Surplus Storage to BPA was completed by 8 August. Mica Reservoir continued to fill in early August, completely refilling the Treaty space by 15 August 1980.

In order to meet B. C. Hydro's system load requirements in the month of September, Mica discharged more than its DOP target release, drafting the reservoir by approximately three feet to elevation 2466.3 feet by 29 September. This resulted in a Treaty storage imbalance of 197,810 sfd between Mica and Arrow Reservoirs.

A change in B. C. Hydro's system load requirements resulted in Mica refilling to elevation 2469.4 feet by 19 October. From late October through to December, Mica Reservoir was drafted to meet B. C. Hydro's system load and U. S. storage requirements. The reservoir discharge averaged less than the DOP target release for the period and the accumulated imbalance was 215,800 sfd on 24 December. During the last week in December 1980, generation at Mica was curtailed due to a reduction in B. C. Hydro's system load and the reservoir was held near elevation 2455.0 feet.

Mica Reservoir drafting resumed in January and continued through March 1981. By 31 March, the reservoir was at elevation 2412.0 feet. Daily project outflow varied between 15,000 cfs and 42,000 cfs, averaging close to the DOP target release for the three month period. The reservoir continued to draft in April and reached its lowest elevation, 2406.1 feet, on 22 April.

Refill Period. Mica began to refill in late April when inflow increased due to snowmelt. The reservoir was filled to elevation 2425.9 feet by 31 May and to elevation 2445.4 feet by 30 June with discharges averaging 10,000 cfs for both months. The discharge was increased above 10,000 cfs in early July as the runoff forecast indicated that Mica would probably fill and spill well before 31 July. The outflow was adjusted every several days according to the inflow forecasts until the Treaty space was completely filled at elevation 2470.4 feet on 29 July. Mica Reservoir surcharged to elevation 2471.6 feet by 31 July and started spilling the same day to discharge inflow.

B. C. Hydro agreed that the BPA Special Reservoir Storage (34,300 sfd) should remain in Mica Reservoir until a decision on its disposition can be reached.

B. ARROW RESERVOIR

Storage Evacuation Period. As shown on Chart 6, Arrow Reservoir was at elevation 1445.4 feet on 31 July 1980, on which day the reservoir storage account included full Treaty storage of 3,579,600 sfd (25,500 sfd being in Mica Reservoir due to Mica discharging less than its DOP target release earlier in the refill period), as well as 66,050 sfd of Canadian Arrow storage and 66,050 sfd of U. S. Arrow storage. The additional 132,100 sfd of Arrow storage was surplus water stored in the reservoir during the 1980 refill period. The August inflows in most areas were below average, requiring Arrow Reservoir to be drafted to provide storage for power generation at downstream U. S. projects. The reservoir outflow, which varied between 45,000 cfs and 70,000 cfs during August, included Treaty storage releases, return of BPA Mica Surplus storage (completed by 8 August) and return of Canadian Arrow storage (completed by 20 August). The reservoir level dropped approximately 8 feet to elevation 1437.3 feet by 31 August.

Average to above average inflows, together with a reduction in downstream power requirements, caused Arrow to refill and remain slightly below full pool during the months of September and October. Between 19 and 20 September, the reservoir outflow was reduced to 5,000 cfs, allowing measurements to be taken to determine the pollutant concentration on the Columbia River downstream of the Arrow Project.

From November 1980 through January 1981, storage was evacuated from the reservoir according to the Flood Control Rule Curve for the project. The actual reservoir level was well below Flood Control Rule Curve due to the Treaty storage imbalance between Mica and Arrow Reservoirs created by Mica discharging less than its DOP target release during this period.

Outflows from Arrow Reservoir were increased to 77,000 cfs during February, further drafting the reservoir until it reached its lowest elevation of 1409.9 feet on 23 February, approximately 23 feet above its 28 February Variable Refill Curve elevation. The reservoir outflow was later reduced, maintaining the reservoir elevation about 1410.0 feet for most of March.

Refill Period. Arrow Reservoir gradually refilled during April to elevation 1419.5 feet by 30 April and then refilled rapidly in the month of May due to higher than average inflows. As a result, the reservoir rose 20 feet to elevation 1438.9 feet by 31 May. Regulated inflow into the reservoir peaked on 27 May, with a daily average of 100,640 cfs.

Beginning 5 June, Arrow was operated for downstream flood control, with the discharges adjusted daily as required. From 4 through 10 June, Arrow discharges were reduced below what would normally have been required for flood control space, in order to fill the 2 foot space between elevations 1444.0 feet and 1446.0 feet with water surplus to U. S. requirements under an Arrow Lake Storage Agreement (DE-MS79-81BP90329) between BPA and B. C. Hydro. The reservoir level was held near elevation 1443.0 feet through most of June. The flood control operation was discontinued effective 11 July, and shortly afterwards Arrow Reservoir was filled to elevation 1446.0 feet.

C. DUNCAN RESERVOIR

Storage Evacuation Period. Duncan Reservoir was near full pool elevation 1892.0 feet on 31 July 1980, as shown on Chart 7. The project discharged inflow holding the reservoir at full pool until late August and was then drafted slightly to elevation 1890.4 feet by 31 August. During the month of September, Duncan outflow was increased to fill Kootenay Lake to elevation 1745.3 feet. The project outflow varied between 3,000 cfs and 10,000 cfs during this period, drafting the reservoir to elevation 1875.9 feet by 2 October. From 3 October through 29 November, Duncan outflow was reduced to 100 cfs to minimize spilling at downstream power projects. Consequently, the reservoir refilled to elevation 1884.8 feet by 30 November.

From December 1980 through mid-February 1981, Duncan Reservoir essentially operated according to Flood Control Rule Curve, drafting to elevation 1824.9 feet by 15 February. Project outflow was adjusted between 4,000 cfs and 10,000 cfs except for a three day period near Christmas when outflow was reduced to 100 cfs to minimize spilling at downstream projects.

Duncan continued to draft through early March and reached its lowest elevation, 1819.5 feet, on 12 March.

Refill Period. Duncan Reservoir began to refill on 15 March. Project outflow was maintained at 100 cfs through the end of May except for the period 20 to 22 April when the discharge was increased to 2,000 cfs to provide water for generation at downstream projects on the Kootenay River. Capturing the snowmelt runoff in April and May, Duncan was above its Variable Refill Curve on 10 May, and refilled to elevation 1858.0 feet by 31 May.

Despite below average inflows in the month of June, Duncan Reservoir was able to store another 22 feet of water and reached elevation 1880.2 feet by 30 June. Warm weather and thunderstorms increased the inflow in early July, producing a peak daily inflow of 19,100 cfs on 6 July. Full pool elevation of 1892.0 feet was reached on 14 July, after which the project discharged inflow, holding the reservoir at full pool.

D. LIBBY RESERVOIR

Storage Evacuation Period. The 1980 spring runoff was sufficient to fill the reservoir. Full pool elevation 2459.0 feet was reached by mid-July 1980 and then the reservoir was drafted slightly by the end of the month. On 1 August 1980, Libby Reservoir was at elevation 2458.1 feet as shown on Chart 8. Higher reservoir release requirements for the Montana Department of Fish and Game for a fish population study, along with power demands, resulted in drafting Libby Reservoir during August, September and October. Releases were increased to full powerhouse capacity, about 20,000 cfs, in November and December, accelerating the draft rate. The pool reached elevation 2409.6 feet by 1 January 1981, about 0.4 feet below the 1 January flood control requirement and 113.3 feet above the 31 January variable refill curve.

Libby continued to draft for power and flood control in January. The 1 January water supply forecast indicated spill was necessary to meet the drawdown requirements for flood control. Libby began spilling about 5,000 cfs on 12 January (total discharge averaging about 26,000 cfs) until spill was terminated on 16 January for a flow reduction study. Outflow was reduced to 4,000 cfs for three days for the study and for removal of a gravel bar near Libby townsite. The 5,000 cfs spill resumed on 18 January but was terminated on 26 January when it became apparent the water supply forecast would decrease. Draft continued in February and the lake level was at elevation 2356.6 feet on 28 February, about 5.2 feet above its variable refill curve. The outflow in early March was reduced to 4,000 cfs and later to 3,000 cfs when the 1 March water supply forecast revealed a decreasing volume inflow forecast and less than 95% confidence of refill. The lake continued to draft slowly because of low inflows and reached its lowest elevation of the year, 2349.70 feet, on 14 March 1981. At that time the lake was about 1.7 feet below the 31 March variable refill curve.

Refill Period. Inflows to Libby began increasing in the latter part of April and generally fluctuated between 17,000 cfs and 35,000 cfs until 1 June, before a definite recession was observed. The seasonal peak was reached on 27 May with a daily average inflow of 69,700 cfs.

Libby outflow was 3,000 cfs from mid-March through 27 May by which time the lake had filled to elevation 2412.7 feet. Releases were then gradually increased and by 1 June were at 13,000 cfs. This continued through the month of June with the exception of a few days at the end of the month when the outflow was increased to full powerhouse capacity. With the continuing high inflows there was concern about water quality and the effects on fish, should the lake fill and have large amounts of spill in July. For this reason, and to maintain some flood control space, the project began spilling (8,000 cfs) on 2 July. The inflow to Libby rose to 44,000 cfs, the second peak of the year, on 6 July and outflows were increased accordingly and reached a maximum of 40,000 cfs on 7 and 8 July. The reservoir was controlled to fill slowly throughout the month. Libby Reservoir reached elevation 2458.9 feet on 26 July and was at full pool, elevation 2459.0 feet, on 31 July 1981. Spill at Libby was terminated on 3 August as inflows receded below the hydraulic capacity.

E. KOOTENAY LAKE

Storage Evacuation Period. Kootenay Lake was at elevation 1743.5 feet on 31 July 1980 as shown on Chart 9. The lake level was then maintained near elevation 1743.0 feet until 4 September when inflow increased due to higher releases from Duncan Reservoir. As a result, Kootenay Lake filled to elevation 1745.1 feet by 3 October. During this period, Kootenay Lake outflow was regulated to maintain full turbine capacity (18,000 cfs) at Brilliant.

During October and November, Kootenay Lake was held close to elevation 1745.0 feet with the outflow varying between 16,000 cfs and 25,000 cfs. Brilliant began to spill in late October.

Kootenay Lake outflow increased to 38,000 cfs in December to discharge the storage releases from Duncan and Libby reservoirs. Later in the month, the outflow was further increased to 40,000 cfs to discharge the unusually high local inflow produced by the mild weather and heavy rainfalls.

Maintaining the high discharge, Kootenay Lake was drafted to elevation 1744.3 feet by 5 January 1981. Following the International Joint Commission Rule Curve closely, Kootenay Lake continued to draft through February, March and early April and reached its normal low elevation of 1738.0 feet on 17 April.

Refill Period. Kootenay Lake began refilling as inflow increased in late April. Inflow in May was well above average causing Kootenay Lake to fill quickly to elevation 1747.4 feet by 31 May. The high lake level increased the discharge capability of the lake allowing the outflow to be increased from 18,000 cfs to 58,000 cfs during the month.

Kootenay Lake remained close to elevation 1747.5 feet for most of June until high snowmelt and heavy rainfalls combined with high discharges from Libby and Duncan Reservoirs raised its level to a peak elevation of 1749.5 feet on 10 July. Inflow dropped off later in the month, and Kootenay Lake was drafted slightly to elevation 1748.4 feet by 31 July. Kootenay Lake reached elevation 1743.32 feet as measured at the Nelson gauge on 31 August 1981.

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 1980-81 Detailed Operating Plan designed to achieve optimum power generation in Canada and in the United States of America in accordance with paragraph 7, Annex A of the Treaty. In 1964, the Canadian Entitlement to downstream power benefits for the 1980-81 Operating Year was purchased by Columbia Storage Power Exchange (CSPE) and exchanged with BPA for specified amounts of power and energy. 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 1980-81 Operating Year.

The generation at downstream projects in the United States, delivered under the Canadian Entitlement Exchange Agreement was 583 average megawatts at rates up to 1311 megawatts from 1 August 1980 through 31 March 1981, and 545 average megawatts at rates up to 1297 megawatts from 1 April 1981 through 31 July 1981. During the period 1 April 1980 through 31 March 1981, the CSPE participants assigned 68 average megawatts at rates up to 150 megawatts to Pacific Southwest utilities. Beginning 1 April 1981, the assignment was 64 average megawatts at rates up to 150 megawatts. CSPE power not assigned to Pacific Southwest utilities was used to meet Pacific Northwest loads.

Review of 1980-81 Power Operations. Coordinated System reservoirs filled to 98 percent of their normal full contents on 31 July 1980.

The Hanford Generating Plant (HGP) did not return to service on 1 August 1980 as planned due to a construction strike, but did finally return to service on 20 March 1981. The plant was taken out of service again on 4 May for summer maintenance and refueling. During this period the plant produced a total of 491,129 megawatt-hours.

As a result of low natural streamflow conditions on the Columbia River during August (the second lowest in the past 56-year of record at The Dalles), reservoirs were drafted 2.1 billion kilowatt-hours below rule curves by 31 August. About 0.6 billion kilowatt-hours of the reservoir deficiency was from provisional draft for production of Advance Energy for BPA's industrial customers.

By 30 November, reservoirs recovered to their rule curves as natural streamflow conditions improved. Also, all of the energy that had been stored with B. C. Hydro during the spring fish migration was returned by the end of November (approximately 0.7 billion kilowatt-hours).

On 11 December, BPA restored secondary energy deliveries to its non-firm industrial loads and made an equivalent amount of secondary energy available for sale to Pacific Northwest investor-owned utilities. During the period 29 September through 10 December, the non-firm portion of BPA's industrial load was served with non-Federal energy purchases. Also, the industries' share of the Hanford project was re-instated following termination of the construction strike in November. Some of this energy was advanced to the industries during late November and early December.

As a result of heavy precipitation and record-setting warm temperatures during December, Coordinated System reservoirs were 4.9 billion kilowatt-hours above rule curves by 31 December 1980. All major Federal reservoirs except Hungry Horse filled to the maximum content permitted by their flood control limits.

December's extremely high streamflows forced BPA to offer surplus energy to the Pacific Southwest utilities beginning on the 26th. This surplus condition continued through the early morning of 5 January 1981, and again during the four day period of 9-12 January. Federal System surplus sales to California during the 26 December - 12 January period totalled 790,665 megawatt-hours.

About 50,000 megawatt-hours of surplus energy was also delivered to Pacific Southwest utilities during February that could not be conserved in reservoirs. BPA continued to supply secondary energy to all of its Pacific Northwest customers and Direct Service Industries through 27 March 1981. From 28 March through 27 April 1981, BPA delivered Special Advance Energy to the Direct Service Industries from provisional releases from Grand Coulee Reservoir.

Operations for the juvenile fish out-migration began 28 April. Secondary energy deliveries to Pacific Northwest and Pacific Southwest customers of BPA were resumed concurrently with the start of the fish operation. BPA also began to store excess energy in B. C. Hydro reservoirs resulting from the over-generation on the Federal System.

Precipitation during May, June, and July was 170, 143, and 163 percent of normal, respectively, over the Columbia River Basin above The Dalles. As a result, the actual January-July volume runoff of the Columbia River at The Dalles was 103.5 million acre-feet, or 21.6 MAF higher than the 1 April probable runoff forecast. All major reservoirs were full on 31 July 1981, the date that reservoirs are programmed to refill.

Northwest utilities sold a record 2,628,029 megawatt-hours of surplus energy to California during May, including Federal surplus sales of 944,964 megawatt-hours. During June and July, Federal sales on the Pacific Intertie totalled 2,440,389 and 2,458,709 megawatt-hours, respectively, the highest monthly amounts since the Intertie began operations. During the first seven months of 1981, BPA sold nearly 6.5 million megawatt-hours of surplus energy to California utilities. Pacific Northwest generating utilities sold 10.75 million megawatt-hours to California during the same period. It is estimated that the total surplus sales to California saved nearly $1 billion in oil purchases by the Pacific Southwest utilities.

B. FLOOD CONTROL

Flood control during the spring runoff was provided by operation of the Treaty projects and other storage reservoirs in the Columbia Basin. Above normal rainfall, in addition to snowmelt, caused peak flows in June. The result was a faster and earlier fill this year. The Treaty projects were operated for flood control in accordance with existing agreements, which specify outflows. The unregulated peak at The Dalles was 579,000 cfs on 10 June 1981, which is 5.7 feet above bankfull capacity at Vancouver, Washington. The maximum observed daily discharge during the spring runoff at The Dalles was 436,400 cfs on 10 June. The maximum observed stage at Vancouver was 16.9 feet, 0.9 feet above bankfull stage. The observed and unregulated hydrographs for 1 July 1980 through 31 July 1981 at The Dalles are shown on the summary hydrograph on Chart 12 for comparison with historical flows. On Chart 13, the effects on streamflows at The Dalles by Mica, Arrow, Duncan and Libby regulation are separated from the other major storage projects in the basin.

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 apparent delayed filling of Arrow Reservoir depicted on Chart 14 is accounted for by temporary retention of some Arrow treaty storage in other upstream projects.

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 be adverse to 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 for the Preparation and Use of Hydroelectric Operating Plans dated May 1979, together with the Columbia River Treaty Flood Control Operating Plan dated October 1972, establish the general criteria of operations.

The Assured Operating Plan dated September 1975 established Operating Rule Curves for Duncan, Arrow and Mica during the 1980-81 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 September 1980 established data and criteria for determining the Operating Rule Curves for use in actual operations. At the request of the U. S. Entity, these criteria included the Critical Rule Curves for Duncan, Arrow, and Mica from the 1980-81 Pacific Northwest Coordination Agreement final regulation. The Variable Refill Curves and flood control requirements subsequent to 1 January 1981 were determined on the basis of seasonal volume runoff forecasts during actual operation.

B. POWER OPERATION

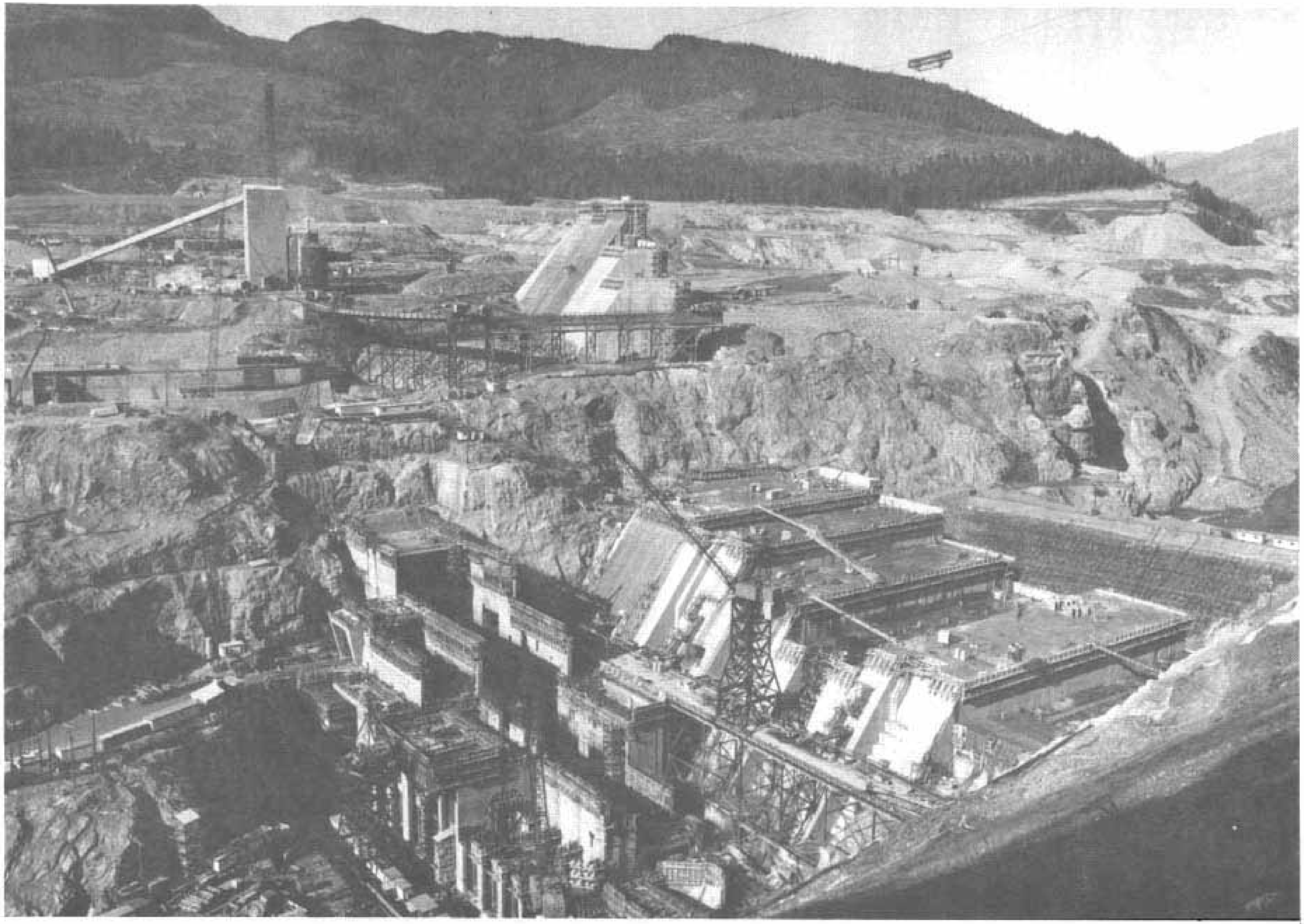
Consistent with all Detailed Operating Plans prepared since the installation of generation at Mica, the 1980-81 Detailed Operating Plan was designed to achieve optimum power generation at site in Canada and downstream in Canada and the United States, consistent with project operating limits and flood 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 and Canada 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

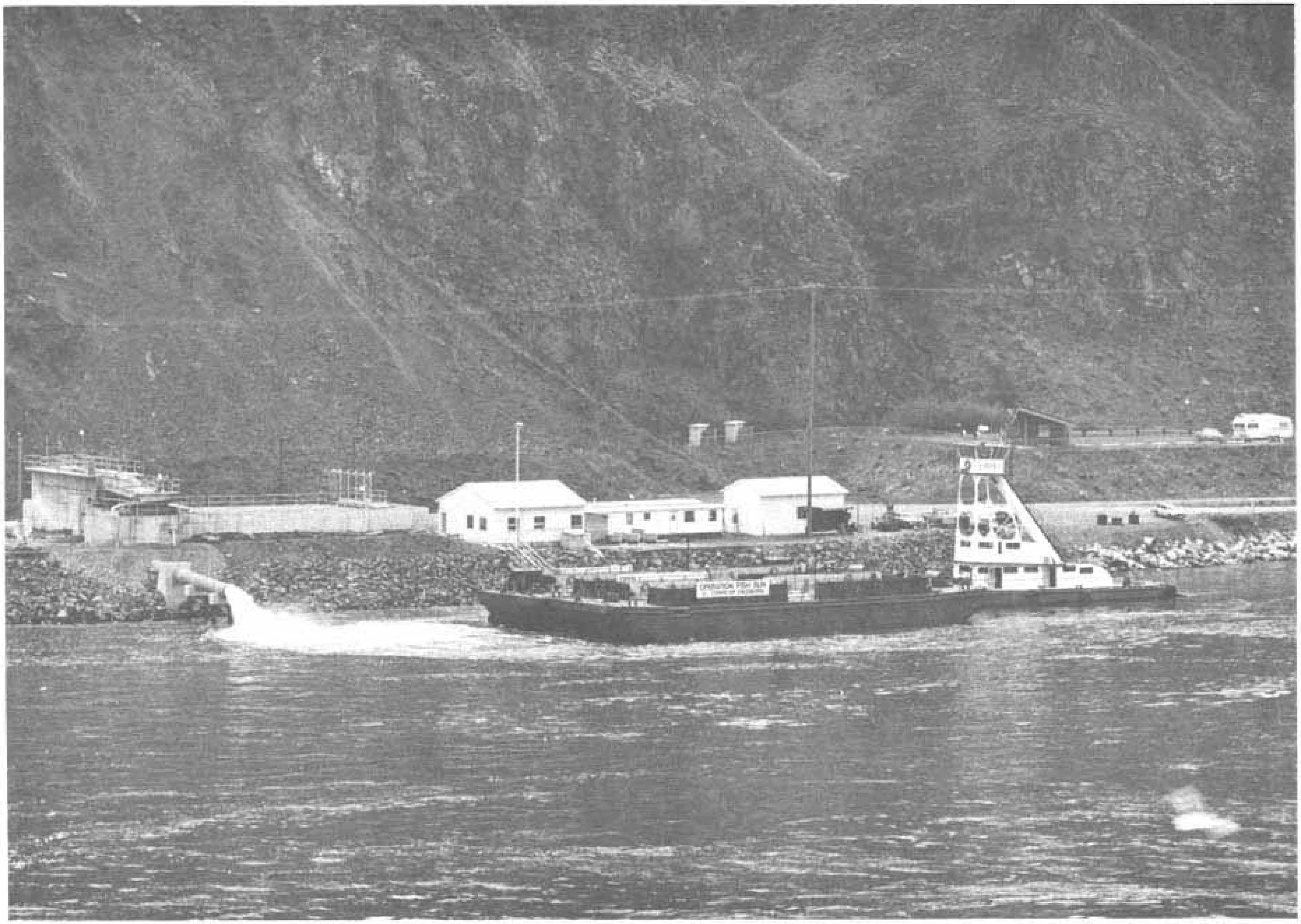
The Flood Control Operating Plan was designed to minimize flood damage both in Canada and in the United States. The flood control operation during the drawdown period consisted of evacuating and holding available storage space, consistent with refill criteria, sufficient to control the flood that could 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 the 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 view from the left bank showing construction of B.C. Hydro's Revelstoke project as of 16 October 1981. The concrete portion of the dam shown in the picture will be adjoined by an earth-filled wing dam which will extend on the right bank. Ultimate capacity of the project will by 2700 MW.

(B.C. Hydro photo)



Two specially outfitted barges await their loads of juvenile salmon and steelhead at the fish handling facilities at Lower Granite Lock and Dam. Barging from Lower Granite, Little Goose, and McNary Dams accounted for the transportation of 5.2 million juveniles past Lower Snake and Columbia River Dams for release below Bonneville Dam. The total transportation effort from the three dams with trucking included was 8.3 million juvenile fish.

(Corps of Engineers photo)

The second powerhouse at Bonneville Dam was about 98% complete on July 31, 1981. The first of eight 66.5 MW generating units become commercially available on May 22, 1981. All generating units are scheduled to be completed by late summer of 1982.

(Corps of Engineers photo)

Table 1

Unregulated Runoff Volume Forecasts
Millions of Acre-Feet
1981

Forecast Date - 1st of	DUNCAN Most Probable 1 Apr - 31 Aug	ARROW Most Probable 1 Apr - 31 Aug	MICA Most Probable 1 Apr - 31 Aug	LIBBY Most Probable 1 Apr - 31 Aug	UNREGULATED RUNOFF COLUMBIA RIVER AT THE DALLES, OREGON Most Probable 1 Jan - 31 Jul
January	2.38	26.0	12.7	7.89	106.0
February	1.93	22.10	11.20	6.26	84.7
March	2.04	22.50	11.20	6.28	84.5
April	1.94	21.60	10.80	5.75	81.9
May	2.05	22.30	10.90	5.86	83.2
June	2.16	23.70	11.50	6.47	95.9
July	2.28	24.80	11.70	7.27	101.0
Actual	2.15	24.35	11.81	7.36	103.5

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 REFILL CURVE

1981

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUNE 1
1. PROBABLE FEB 1 - JULY 31 INFLOW, KSFD 1/		5238.3	4609.2	4638.5	4555.9	4606.2	4971.4
2. 95% FORECAST ERROR, KSFD		716.0	544.7	500.5	490.0	478.8	475.3
3. 95% CONFIDENCE FEB 1 - JULY 31 INFLOW, KSFD 2/		4522.3	4064.5	4138.0	4065.9	4127.4	4496.1
4. OBSERVED FEB 1 - DATE INFLOW, KSFD		0.0	0.0	152.2	289.1	539.9	1674.5
5. 95% CONFIDENCE DATE - JULY 31 INFLOW, KSFD 3/		4522.3	4064.5	3985.8	3776.8	3587.5	2821.6
ASSUMED FEB 1 - JULY 31 INFLOW, % VOLUME		100.0					
ASSUMED FEB 1 - JULY 31 INFLOW, KSFD 4/		4522.3					
MIN FEB 1 - JULY 31 OUTFLOW, KSFD		2180.0					
MIN JAN 31 RESERVOIR CONTENT, KSFD 5/	1408.1	1186.9					
MIN JAN 31 RESERVOIR ELEVATION, FT. 6/	2426.6	2421.8					
JAN 31 VARIABLE REFILL CURVE, FT. 7/		2421.8					
ASSUMED MAR 1 - JULY 31 INFLOW, % VOLUME		97.8	97.8				
ASSUMED MAR 1 - JULY 31 INFLOW, KSFD 4/		4422.8	3975.1				
MIN MAR 1 - JULY 31 OUTFLOW, KSFD		1760.0	1760.0				
MIN FEB 28 RESERVOIR CONTENT, KSFD 5/	1008.1	866.4	1314.1				
MIN FEB 28 RESERVOIR ELEVATION, FT. 6/	2417.7	2414.5	2424.6				
FEB 28 VARIABLE REFILL CURVE, FT. 7/		2414.5	2417.7				
ASSUMED APR 1 - JULY 31 INFLOW, % VOLUME		95.4	95.4	97.6			
ASSUMED APR 1 - JULY 31 INFLOW, KSFD 4/		4314.3	3877.5	3890.1			
MIN APR 1 - JULY 31 OUTFLOW, KSFD		1295.0	1295.0	1295.0			
MIN APR 30 RESERVOIR CONTENT, KSFD 5/	630.1	509.9	946.7	934.1			
MIN MAR 31 RESERVOIR ELEVATION, FT. 6/	2409.0	2406.2	2416.3	2416.0			
MAR 31 VARIABLE REFILL CURVE, FT. 7/		2406.2	2409.0	2409.0			
ASSUMED MAY 1 - JULY 31 INFLOW, % VOLUME		91.0	91.0	93.1	95.4		
ASSUMED MAY 1 - JULY 31 INFLOW, KSFD 4/		4115.3	3698.7	3710.8	3603.1		
MIN MAY 1 - JULY 31 OUTFLOW, KSFD		920.0	920.0	920.0	920.0		
MIN APR 30 RESERVOIR CONTENT, KSFD 5/	401.8	333.9	750.5	738.4	846.1		
MIN APR 30 RESERVOIR ELEVATION, FT. 6/	2403.6	2402.0	2411.8	2411.5	2414.0		
APR 30 VARIABLE REFILL CURVE, FT. 7/		2402.0	2403.6	2403.6	2403.6		
ASSUMED JUNE 1 - JULY 31 INFLOW, % VOLUME		74.1	74.1	75.8	77.7	81.5	
ASSUMED JUNE 1 - JULY 31 INFLOW, KSFD 4/		3351.0	3011.8	3021.2	2934.6	2923.8	
MIN JUNE 1 - JULY 31 OUTFLOW, KSFD		610.0	610.0	610.0	610.0	610.0	
MIN MAY 31 RESERVOIR CONTENT, KSFD 5/	935.6	788.2	1127.4	1118.0	1204.6	1215.4	
MIN MAY 31 RESERVOIR ELEVATION, FT. 6/	2416.1	2412.7	2420.4	2420.2	2422.2	2422.4	
MAY 31 VARIABLE REFILL CURVE, FT. 7/		2412.7	2416.1	2416.1	2416.1	2416.1	
ASSUMED JULY 1 - JULY 31 INFLOW, % VOLUME		36.9	36.9	37.8	38.7	40.6	49.8
ASSUMED JULY 1 - JULY 31 INFLOW, KSFD 4/		1668.7	1499.8	1506.6	1461.6	1456.5	1405.2
MIN JULY 1 - JULY 31 OUTFLOW, KSFD		310.0	310.0	310.0	310.0	310.0	310.0
MIN JUNE 30 RESERVOIR CONTENT, KSFD 5/	2317.1	2170.5	2339.4	2332.6	2377.6	2382.7	2434.0
MIN JUNE 30 RESERVOIR ELEVATION, FT. 6/	2445.9	2442.9	2446.4	2446.2	2447.1	2447.2	2448.3
JUNE 30 VARIABLE REFILL CURVE, FT. 7/		2442.9	2445.9	2445.9	2445.9	2445.9	2445.9
JULY 31 VARIABLE REFILL CURVE, FT. 7/	2469.8	2469.8	2469.8	2469.8	2469.8	2469.8	2469.8
MICA ACCUMULATED DEAD STORAGE, KSFD	6313.0	6313.0	6313.0	6313.0	6313.0	6313.0	6313.0

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ FULL CONTENT (3529.2) PLUS PRECEDING LINE LESS LINE PRECEDING THAT (USABLE STORAGE)
6/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE DATED 25 MARCH 1974
(FOOTNOTE 5 PLUS ACCUMULATED DEAD STORAGE)
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED BY ADDING
DEAD STORAGE TO INITIAL (BASE ENERGY CONTENT CURVE) CONTENTS

6039/3

Table 3
Arrow Lakes Reservoir Computation Form

95 PERCENT CONFIDENCE FORECAST AND VARIABLE REFILL CURVE

1981

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUNE 1
		TOTAL	LOCAL	LOCAL	LOCAL	LOCAL	TOTAL
1. PROBABLE FEB 1 - JULY 31 INFLOW, KSFD 1/		11293.4	4774.0	5182.9	5295.9	5582.8	9990.3
2. 95% FORECAST ERROR, KSFD		1525.7	775.9	727.7	561.3	506.2	827.1
3. 95% CONFIDENCE FEB 1 - JULY 31 INFLOW, KSFD 2/		9767.7	3998.1	4455.2	4734.6	5076.6	9163.2
4. OBSERVED FEB 1 - DATE INFLOW, KSFD		0.0	0.0	322.5	619.8	1058.7	3433.0
5. 95% CONFIDENCE DATE - JULY 31 INFLOW, KSFD 3/		9767.7	3998.1	4132.7	4114.8	4017.9	5730.2
ASSUMED FEB 1 - JULY 31 INFLOW, % VOLUME		100.0					
ASSUMED FEB 1 - JULY 31 INFLOW, KSFD 4/		9767.7					
MIN FEB 1 - JULY 31 OUTFLOW, KSFD		1454.0					
MICA REFILL REQUIREMENTS, KSFD 5/		2342.3					
MIN JAN 31 RESERVOIR CONTENT, KSFD 6/	2077.0	527.0*					
MIN JAN 31 RESERVOIR ELEVATION, FT. 7/	1419.6	1390.1					
JAN 31 VARIABLE REFILL CURVE, FT. 8/		1390.1					
ASSUMED MAR 1 - JULY 31 INFLOW, % VOLUME		97.5	97.3				
ASSUMED MAR 1 - JULY 31 INFLOW, KSFD 4/		9523.5	3890.2				
MIN MAR 1 - JULY 31 OUTFLOW, KSFD		1314.0	2470.9				
MICA REFILL REQUIREMENTS, KSFD 5/		2662.8	1760.0				
MIN FEB 28 RESERVOIR CONTENT, KSFD 6/	1454.0	336.6*	400.3				
MIN FEB 28 RESERVOIR ELEVATION, FT. 7/	1408.4	1385.9	1387.3				
FEB 28 VARIABLE REFILL CURVE, FT. 8/		1385.9	1387.3				
ASSUMED APR 1 - JULY 31 INFLOW, % VOLUME		94.7	94.1	96.8			
ASSUMED APR 1 - JULY 31 INFLOW, KSFD 4/		9250.0	3762.2	4000.5			
MIN APR 1 - JULY 31 OUTFLOW, KSFD		1159.0	2315.9	3223.7			
MICA REFILL REQUIREMENTS, KSFD 5/		3019.3	1295.0	1295.0			
MIN MAR 31 RESERVOIR CONTENT, KSFD 6/	1342.6	21.5*	838.3	1507.8			
MIN MAR 31 RESERVOIR ELEVATION, FT. 7/	1406.3	1378.5	1396.5	1409.4			
MAR 31 VARIABLE REFILL CURVE, FT. 8/		1378.5	1396.5	1406.3			
ASSUMED MAY 1 - JULY 31 INFLOW, % VOLUME		89.0	87.2	89.7	92.7		
ASSUMED MAY 1 - JULY 31 INFLOW, KSFD 4/		8693.2	3486.3	3707.0	3814.4		
MIN MAY 1 - JULY 31 OUTFLOW, KSFD		1009.0	2020.8	2750.9	2965.0		
MICA REFILL REQUIREMENTS, KSFD 5/		3195.3	920.0	920.0	920.0		
MIN APR 30 RESERVOIR CONTENT, KSFD 6/	1439.9	0.0	1194.1	1703.5	1810.2		
MIN APR 30 RESERVOIR ELEVATION, FT. 7/	1408.2	1377.9	1403.5	1413.0	1414.9		
APR 30 VARIABLE REFILL CURVE, FT. 8/		1377.9	1403.5	1408.2	1408.2		
ASSUMED JUNE 1 - JULY 31 INFLOW, % VOLUME		68.7	63.9	65.7	67.9	73.3	
ASSUMED JUNE 1 - JULY 31 INFLOW, KSFD 4/		6710.4	2554.8	2715.2	2793.9	2945.1	
MIN JUNE 1 - JULY 31 OUTFLOW, KSFD		854.0	1707.5	2044.6	2143.5	1990.7	
MICA REFILL REQUIREMENTS, KSFD 5/		2741.1	610.0	610.0	610.0	610.0	
MIN MAY 31 RESERVOIR CONTENT, KSFD 6/	2180.8	464.2	2122.3	2299.0	2319.2	2015.2	
MIN MAY 31 RESERVOIR ELEVATION, FT. 7/	1421.4	1388.7	1420.4	1423.4	1423.8	1418.6	
MAY 31 VARIABLE REFILL CURVE, FT. 8/		1388.7	1420.4	1421.4	1421.4	1418.6	
ASSUMED JULY 1 - JULY 31 INFLOW, % VOLUME		31.9	27.5	28.2	29.2	31.5	46.4
ASSUMED JULY 1 - JULY 31 INFLOW, KSFD 4/		3115.9	1099.5	1165.4	1201.5	1265.6	2658.8
MIN JULY 1 - JULY 31 OUTFLOW, KSFD		434.0	912.5	1249.6	1348.5	1195.7	1033.9
MICA REFILL REQUIREMENTS, KSFD 5/		1358.7	310.0	310.0	310.0	310.0	1212.1
MIN JUNE 30 RESERVOIR CONTENT, KSFD 6/	3415.3	2256.4	3082.6	3353.8	3416.6	3199.7	3166.8
MIN JUNE 30 RESERVOIR ELEVATION, FT. 7/	1441.5	1422.7	1436.3	1440.5	1441.5	1438.1	1437.6
JUNE 30 VARIABLE REFILL CURVE, FT. 8/		1422.7	1436.3	1440.5	1441.5	1438.1	1437.6
JULY 31 VARIABLE REFILL CURVE, FT. 8/	1444.0	1444.0	1444.0	1444.0	1444.0	1444.0	1444.0

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ FOR ARROW TOTAL, MICA FULL CONTENT - VARIABLE REFILL CURVE FROM MICA VRC COMPUTATION FORM
FOR ARROW LOCAL, MICA MINIMUM POWER DISCHARGES
6/ FOR ARROW TOTAL, FULL CONTENT (3579.6 KSFD) PLUS TWO PRECEDING LINES LESS LINE PRECEDING THAT. FOR ARROW LOCAL, FULL CONTENT (3579.6) LESS PRECEDING LINE PLUS LINE PRECEDING THAT LESS LINE PRECEDING THAT
7/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE DATED 28 FEBRUARY 1974
8/ LOWER OF THE ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR (INITIAL, WHICH IS THE BASE ENERGY CONTENT CURVE)
* LOWER LIMIT, BASED ON 1936-37 HYDRO CONDITION

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Table 4

Duncan Reservoir Computation Form

95 PERCENT CONFIDENCE FORECAST AND VARIABLE REFILL CURVE

1981

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUNE 1
1. PROBABLE FEB 1 - JULY 31 INFLOW, KSFD 1/		1007.1	829.1	882.8	853.1	893.7	958.0
2. 95% FORECAST ERROR, KSFD		155.0	120.4	116.1	108.4	97.3	94.9
3. 95% CONFIDENCE FEB 1 - JULY 31 INFLOW, KSFD 2/		852.1	708.7	766.7	744.7	796.4	863.1
4. OBSERVED FEB 1 - DATE INFLOW, KSFD		0.0	0.0	25.1	51.5	99.9	334.8
5. 95% CONFIDENCE DATE - JULY 31 INFLOW, KSFD 3/		852.1	708.7	741.6	693.2	696.5	528.3
ASSUMED FEB 1 - JULY 31 INFLOW, % VOLUME		100.0					
ASSUMED FEB 1 - JULY 31 INFLOW, KSFD 4/		852.1					
MIN FEB 1 - JULY 31 OUTFLOW, KSFD		18.1					
MIN JAN 31 RESERVOIR CONTENT, KSFD 5/	377.6	209.1*					
MIN JAN 31 RESERVOIR ELEVATION, FT. 6/	1853.0	1830.3					
JAN 31 VARIABLE REFILL CURVE, FT. 7/		1830.3					
ASSUMED MAR 1 - JULY 31 INFLOW, % VOLUME		97.8	97.8				
ASSUMED MAR 1 - JULY 31 INFLOW, KSFD 4/		833.3	693.1				
MIN MAR 1 - JULY 31 OUTFLOW, KSFD		15.3	115.8				
MIN FEB 28 RESERVOIR CONTENT, KSFD 5/	302.9	110.9*	128.5				
MIN FEB 28 RESERVOIR ELEVATION, FT. 6/	1843.3	1815.4	1818.3				
FEB 28 VARIABLE REFILL CURVE, FT. 7/		1815.4	1818.3				
ASSUMED APR 1 - JULY 31 INFLOW, % VOLUME		95.4	95.4	97.5			
ASSUMED APR 1 - JULY 31 INFLOW, KSFD 4/		812.9	676.1	723.1			
MIN APR 1 - JULY 31 OUTFLOW, KSFD		12.2	112.7	185.9			
MIN APR 30 RESERVOIR CONTENT, KSFD 5/	303.0	2.3*	142.4	168.6			
MIN MAR 31 RESERVOIR ELEVATION, FT. 6/	1843.3	1794.8	1820.4	1824.4			
MAR 31 VARIABLE REFILL CURVE, FT. 7/		1794.8	1820.4	1824.4			
ASSUMED MAY 1 - JULY 31 INFLOW, % VOLUME		90.3	90.3	92.2	94.6		
ASSUMED MAY 1 - JULY 31 INFLOW, KSFD 4/		769.4	639.9	683.7	655.8		
MIN MAY 1 - JULY 31 OUTFLOW, KSFD		9.2	85.0	140.2	156.4		
MIN APR 30 RESERVOIR CONTENT, KSFD 5/	236.5	0.0	150.9	162.3	206.4		
MIN APR 30 RESERVOIR ELEVATION, FT. 6/	1834.2	1794.2	1821.7	1823.4	1829.9		
APR 30 VARIABLE REFILL CURVE, FT. 7/		1794.2	1821.7	1823.4	1829.9		
ASSUMED JUNE 1 - JULY 31 INFLOW, % VOLUME		70.5	70.5	72.0	73.9	78.1	
ASSUMED JUNE 1 - JULY 31 INFLOW, KSFD 4/		600.7	499.6	533.9	512.3	544.0	
MIN JUNE 1 - JULY 31 OUTFLOW, KSFD		6.1	56.4	93.0	103.7	87.1	
MIN MAY 31 RESERVOIR CONTENT, KSFD 5/	343.8	111.2	262.6	264.9	297.2	248.9	
MIN MAY 31 RESERVOIR ELEVATION, FT. 6/	1848.6	1815.5	1837.8	1838.1	1842.5	1835.9	
MAY 31 VARIABLE REFILL CURVE, FT. 7/		1815.5	1837.8	1838.1	1842.5	1835.9	
ASSUMED JULY 1 - JULY 31 INFLOW, % VOLUME		33.3	33.3	34.0	34.9	36.9	47.2
ASSUMED JULY 1 - JULY 31 INFLOW, KSFD 4/		283.7	236.0	252.1	241.9	257.0	249.4
MIN JULY 1 - JULY 31 OUTFLOW, KSFD		3.1	28.6	47.2	52.7	44.3	35.3
MIN JUNE 30 RESERVOIR CONTENT, KSFD 5/	560.6	425.2	498.5	500.9	516.6	493.1	491.7
MIN JUNE 30 RESERVOIR ELEVATION, FT. 6/	1875.3	1859.0	1867.9	1868.2	1870.1	1867.3	1867.1
JUNE 30 VARIABLE REFILL CURVE, FT. 7/		1859.0	1867.9	1868.2	1870.1	1867.3	1867.1
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 21 FEBRUARY 1973
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR (INITIAL, WHICH IS THE BASE ENERGY CONTENT CURVE)
* LOWER LIMIT, BASED ON 1936-37 HYDRO CONDITIONS

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Table 5
Libby Reservoir Computation Form

95 PERCENT CONFIDENCE FORECAST AND VARIABLE REFILL CURVE

1981

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUNE 1
1. PROBABLE JAN 1 - JULY 31 INFLOW, KSFD		3924.9	3331.3	3228.5	2998.7	3067.6	3394.9
2. 95% FORECAST ERROR, KSFD		877.2	598.8	546.6	495.1	414.7	348.4
3. OBSERVED JAN 1 - DATE INFLOW, KSFD		0.0	142.4	240.3	368.5	614.3	1696.8
4. 95% CONFIDENCE DATE - JULY 31 INFLOW, KSFD 1/		3047.7	2590.1	2441.6	2135.1	2038.6	1349.7
ASSUMED FEB 1 - JULY 31 INFLOW, % VOLUME		96.94					
ASSUMED FEB 1 - JULY 31 INFLOW, KSFD 2/		2954.4					
FEB MINIMUM FLOW REQUIREMENTS, CFS 3/		3000.0					
MIN FEB 1 - JULY 31 OUTFLOW, KSFD 4/		543.0					
MIN JAN 31 RESERVOIR CONTENT, KSFD 5/		75.9					
MIN JAN 31 RESERVOIR ELEVATION, FT. 6/		2296.3					
JAN 31 VARIABLE REFILL CURVE, FT. 7/		2367.6					
BASE ENERGY CONTENT CURVE, FT.	2403.1						
LOWER LIMIT FOR VARIABLE REFILL CURVE, FT.	2367.6						
ASSUMED MAR 1 - JULY 31 INFLOW, % VOLUME		94.17	97.14				
ASSUMED MAR 1 - JULY 31 INFLOW, KSFD 2/		2870.0	2516.0				
MAR MINIMUM FLOW REQUIREMENTS, CFS 3/		3000.0	3000.0				
MIN MAR 1 - JULY 31 OUTFLOW, KSFD 4/		459.0	463.4				
MIN FEB 28 RESERVOIR CONTENT, KSFD 5/		76.3	434.7				
MIN FEB 28 RESERVOIR ELEVATION, FT. 6/		2296.4	2335.2				
FEB 28 VARIABLE REFILL CURVE, FT. 7/		2345.4	2345.4				
BASE ENERGY CONTENT CURVE, FT.	2401.7						
LOWER LIMIT FOR VARIABLE REFILL CURVE, FT.	2345.4						
ASSUMED APR 1 - JULY 31 INFLOW, % VOLUME		90.79	93.66	96.42			
ASSUMED APR 1 - JULY 31 INFLOW, KSFD 2/		2767.0	2425.8	2354.2			
APR MINIMUM FLOW REQUIREMENTS, CFS 3/		3000.0	3000.0	3000.0			
MIN APR 1 - JULY 31 OUTFLOW, KSFD 4/		366.0	370.4	480.2			
MIN MAR 31 RESERVOIR CONTENT, KSFD 5/		86.3	431.9	613.3			
MIN MAR 31 RESERVOIR ELEVATION, FT. 6/		2297.6	2335.0	2351.4			
MAR 31 VARIABLE REFILL CURVE, FT. 7/		2300.8	2335.0	2351.4			
BASE ENERGY CONTENT CURVE, FT.	2400.4						
LOWER LIMIT FOR VARIABLE REFILL CURVE, FT.	2300.8						
ASSUMED MAY 1 - JULY 31 INFLOW, % VOLUME		81.71	84.29	86.77	90.00		
ASSUMED MAY 1 - JULY 31 INFLOW, KSFD 2/		2490.3	2183.2	2118.6	1921.6		
MAY MINIMUM FLOW REQUIREMENTS, CFS 3/		3000.0	3036.0	3936.0	4200.0		
MIN MAY 1 - JULY 31 OUTFLOW, KSFD 4/		276.0	279.3	362.1	386.4		
MIN APR 30 RESERVOIR CONTENT, KSFD 5/		273.0	583.5	730.8	952.1		
MIN APR 30 RESERVOIR ELEVATION, FT. 6/		2319.0	2348.8	2360.9	2376.9		
APR 30 VARIABLE REFILL CURVE, FT. 7/		2319.0	2348.8	2360.9	2376.9		
BASE ENERGY CONTENT CURVE, FT.	2399.0						
LOWER LIMIT FOR VARIABLE REFILL CURVE, FT.	2287.0						
ASSUMED JUNE 1 - JULY 31 INFLOW, % VOLUME		52.75	54.42	56.02	58.10	64.56	
ASSUMED JUNE 1 - JULY 31 INFLOW, KSFD 2/		1607.7	1409.5	1367.8	1240.5	1316.1	
JUNE MINIMUM FLOW REQUIREMENTS, CFS 3/		3000.0	3036.0	3936.0	4200.0	3972.0	
MIN JUNE 1 - JULY 31 OUTFLOW, KSFD 4/		183.0	185.2	240.1	256.2	231.3	
MIN MAY 31 RESERVOIR CONTENT, KSFD 5/		1062.7	1263.0	1359.6	1503.0	1402.5	
MIN MAY 31 RESERVOIR ELEVATION, FT. 6/		2384.4	2397.0	2402.8	2411.2	2405.4	
MAY 31 VARIABLE REFILL CURVE, FT. 7/		2384.4	2397.0	2402.8	2411.2	2405.4	
BASE ENERGY CONTENT CURVE, FT.	2423.9						
LOWER LIMIT FOR VARIABLE REFILL CURVE, FT.	2287.0						
ASSUMED JULY 1 - JULY 31 INFLOW, % VOLUME		18.97	19.57	20.15	20.90	23.22	35.97
ASSUMED JULY 1 - JULY 31 INFLOW, KSFD 2/		578.1	506.9	492.0	446.2	473.4	485.5
JULY MINIMUM FLOW REQUIREMENTS, CFS 3/		3000.0	3036.0	3936.0	4200.0	3972.0	3360.0
MIN JULY 1 - JULY 31 OUTFLOW, KSFD 4/		93.0	94.1	122.0	130.2	117.6	104.2
MIN JUNE 30 RESERVOIR CONTENT, KSFD 5/		2002.2	2074.5	2117.3	2171.3	2131.5	2106.0
MIN JUNE 30 RESERVOIR ELEVATION, FT. 6/		2436.4	2439.9	2442.0	2444.6	2442.7	2441.5
JUNE 30 VARIABLE REFILL CURVE, FT. 7/		2436.4	2439.9	2442.0	2444.6	2442.7	2441.5
BASE ENERGY CONTENT CURVE, FT.	2450.1						
LOWER LIMIT FOR VARIABLE REFILL CURVE, FT.	2287.0						
JULY 31 VARIABLE REFILL CURVE, FT.		2459.0	2459.0	2459.0	2459.0	2459.0	2459.0
JAN 1 - JULY 31 FORECAST - EARLYBIRD, MAF 8/		105.0	89.4	82.2	78.6	83.4	87.0
AT THE DALLES - OFFICIAL, MAF		106.0	84.7	84.5	81.9	83.2	95.9

1/ LINE 1 - LINE 2 - LINE 3
2/ PRECEDING LINE X LINE 4
3/ BASED ON POWER DISCHARGE REQUIREMENTS DETERMINED FROM 8/
4/ CUMULATIVE MINIMUM OUTFLOW (DATE TO JULY) FROM 3/
5/ FULL CONTENT (2487.3 KSFD) PLUS OUTFLOW MINUS INFLOW (2487.3 + 4/ - 2/)
6/ ELEVATION CORRESPONDING TO 5/ FROM NWPP STORAGE VS ELEVATION TABLE
7/ ELEVATION FROM 6/, BUT < BASE ECC AND > LOWER LIMIT
8/ USED TO CALCULATE THE POWER DISCHARGE REQUIREMENT FOR 3/

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Computation of Initial Controlled Flow Columbia River at The Dalles 1 May 1981

1 May Forecast of May - August Unregulated Runoff Volume, MAF		56.8
Less Estimated Depletions, MAF		1.5
Less Upstream Storage Corrections, MAF		
Mica	5.9	
Arrow	3.0	
Libby	3.4	
Duncan	1.0	
Hungry Horse	0.6	
Flathead Lake	0.2	
Noxon	0.0	
Pend Oreille Lake	0.2	
Grand Coulee	2.0	
Brownlee	0.0	
Dworshak	0.1	
John Day	0.2	
TOTAL	16.6	16.6
Forecast of Adjusted Residual Runoff Volume, MAF		38.7
Computed Initial Controlled Flow From Chart 1 of Flood Control Operating Plan, KCFS		230.0

Chart 1
Seasonal Precipitation
Columbia River Basin
October 1980 - April 1981
Percent of 1963 - 1977 Average

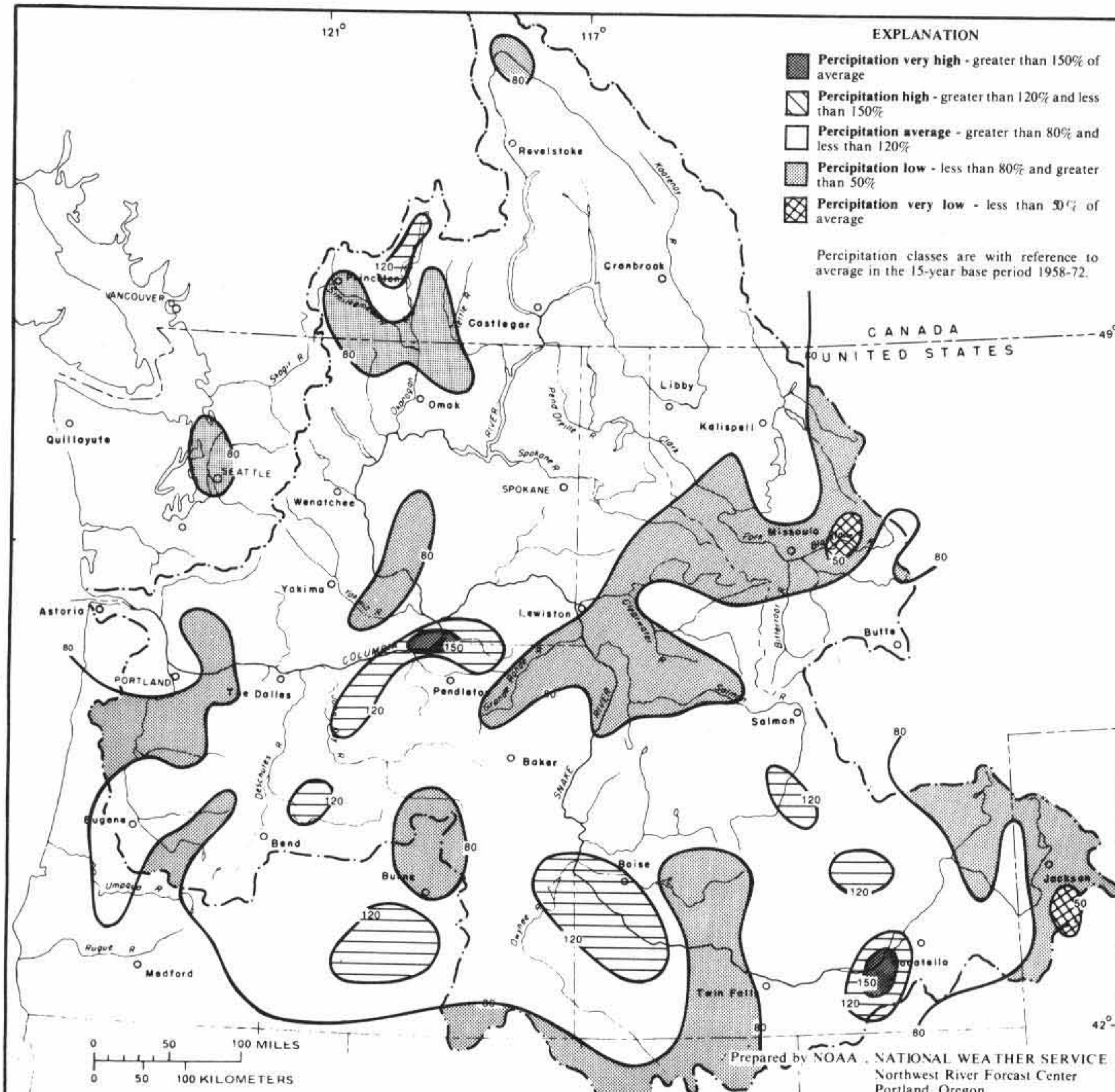


Chart 2

Winter Season

Temperature and Precipitation Indexes 1980 - 81

Columbia River Basin above The Dalles

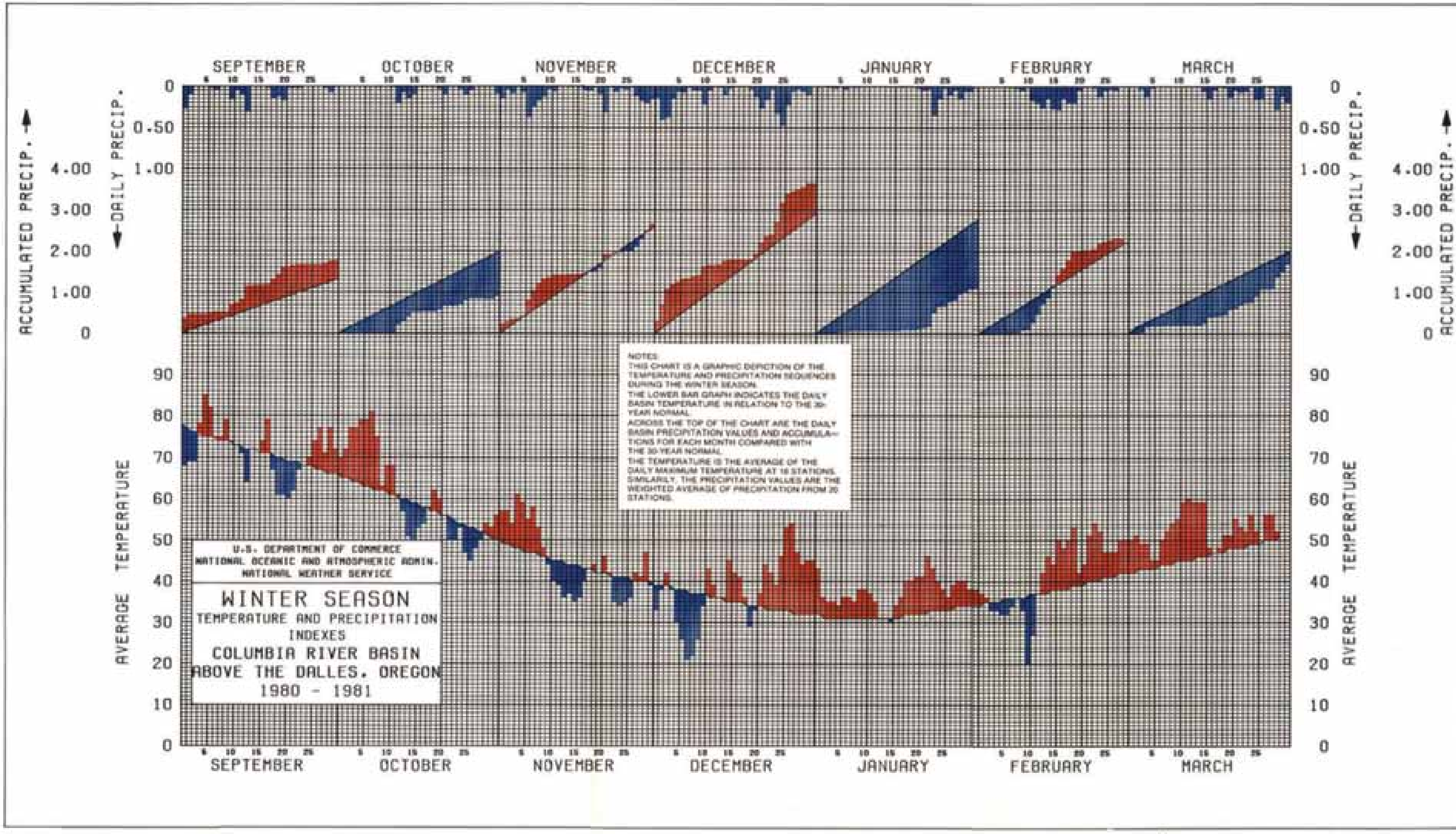


Chart 3

Snowmelt Season
Temperature and Precipitation Indexes 1981
Columbia River Basin above The Dalles

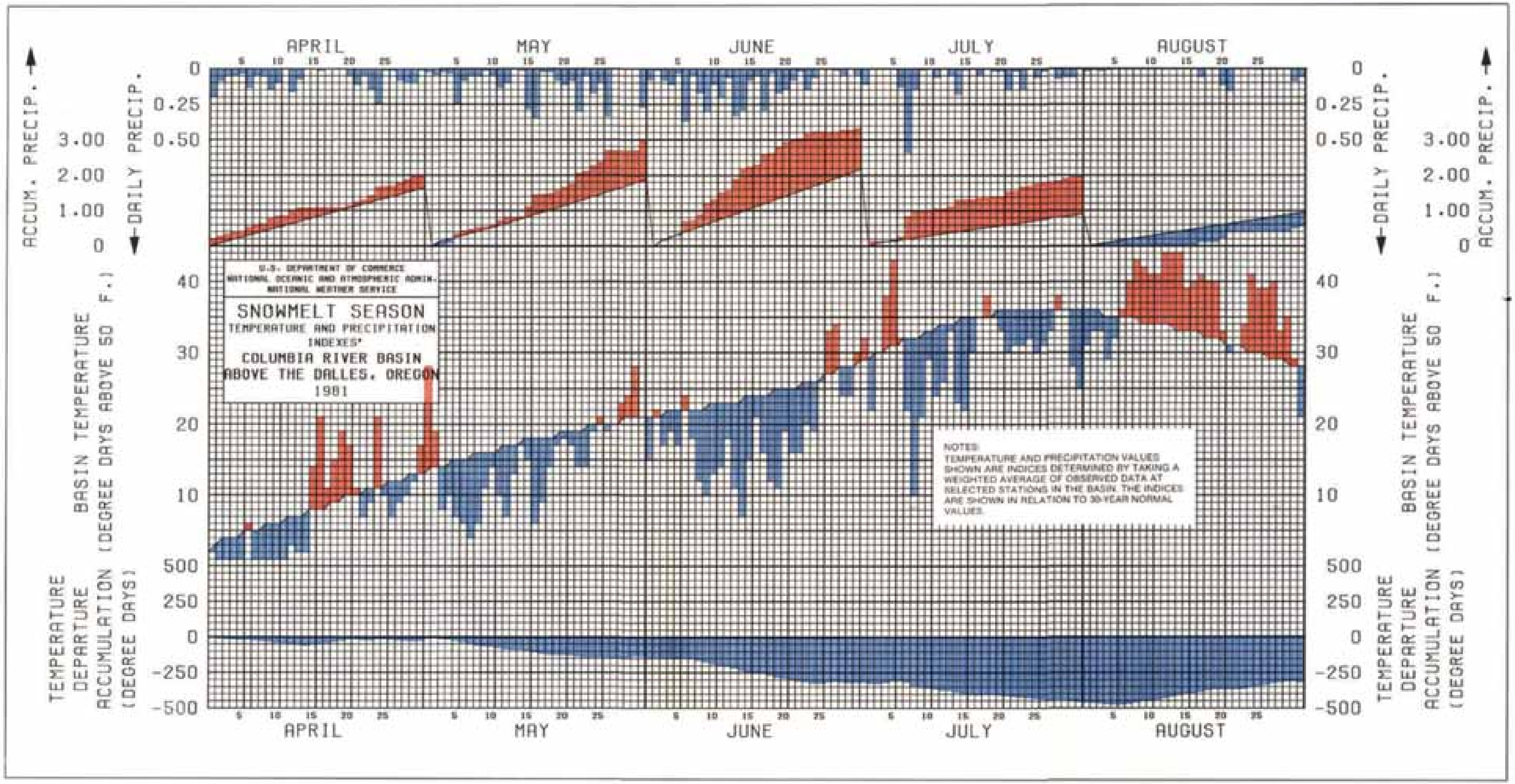


Chart 4

Snowmelt Season
Temperature and Precipitation Indexes 1981
Columbia River Basin at Canada

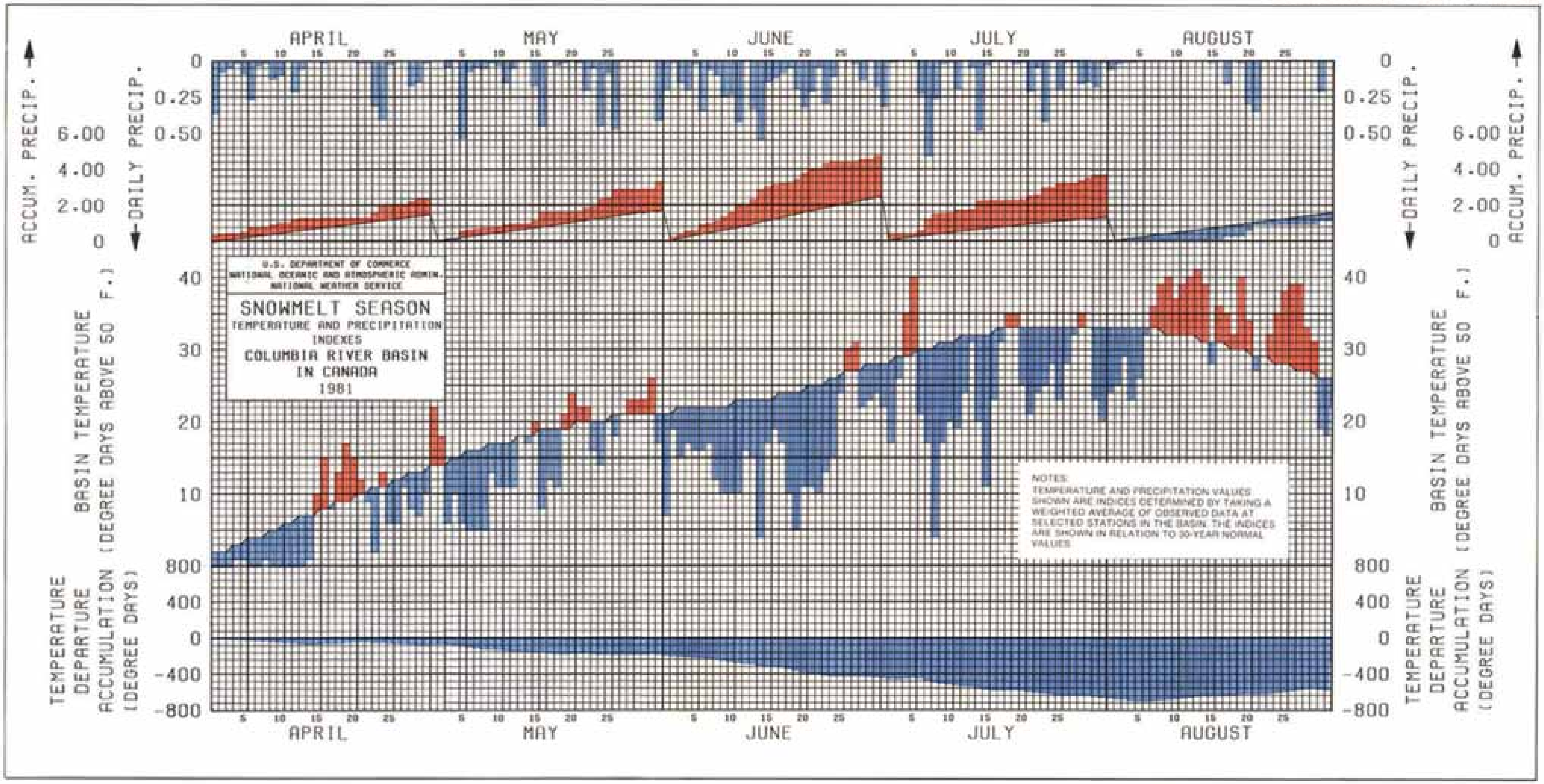
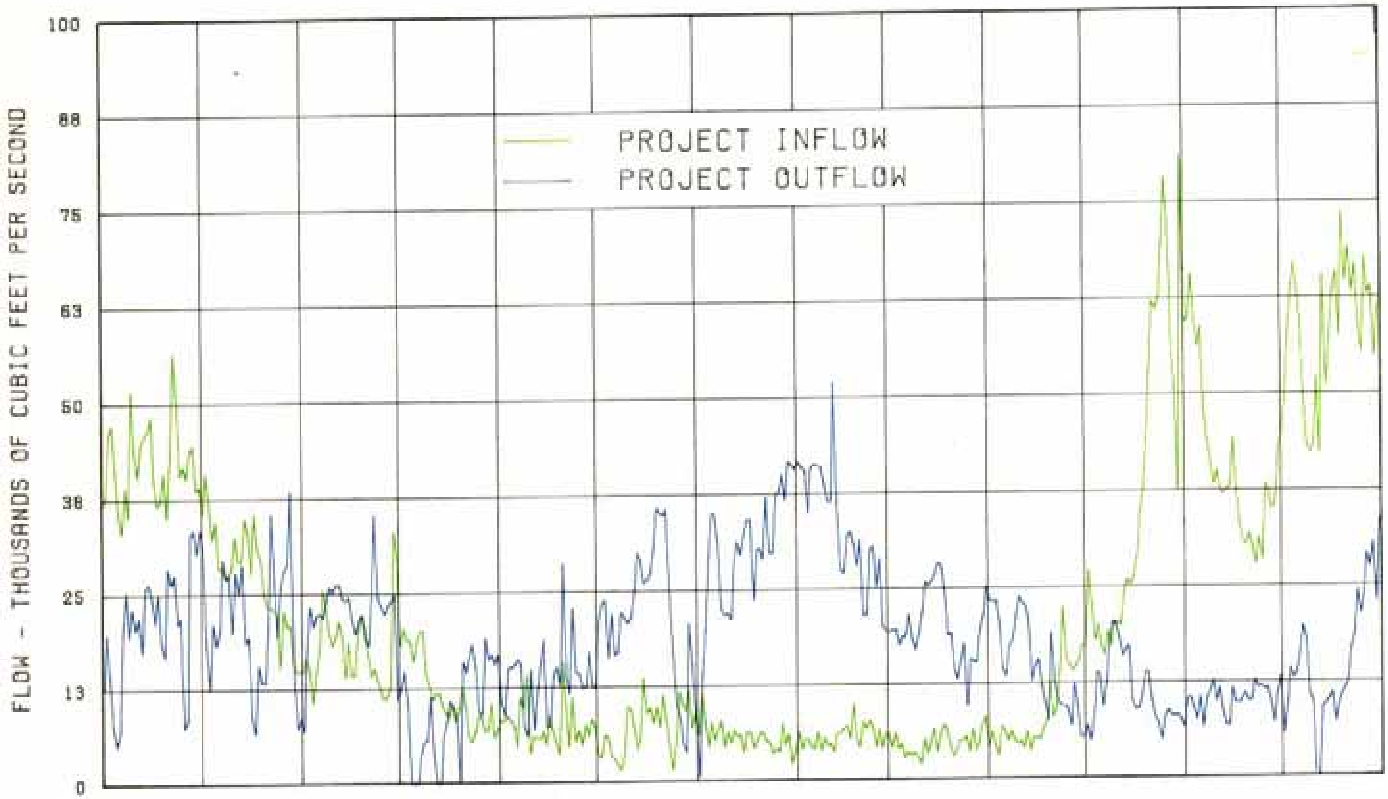


Chart 5

Regulation of Mica
1 July 1980 - 31 July 1981



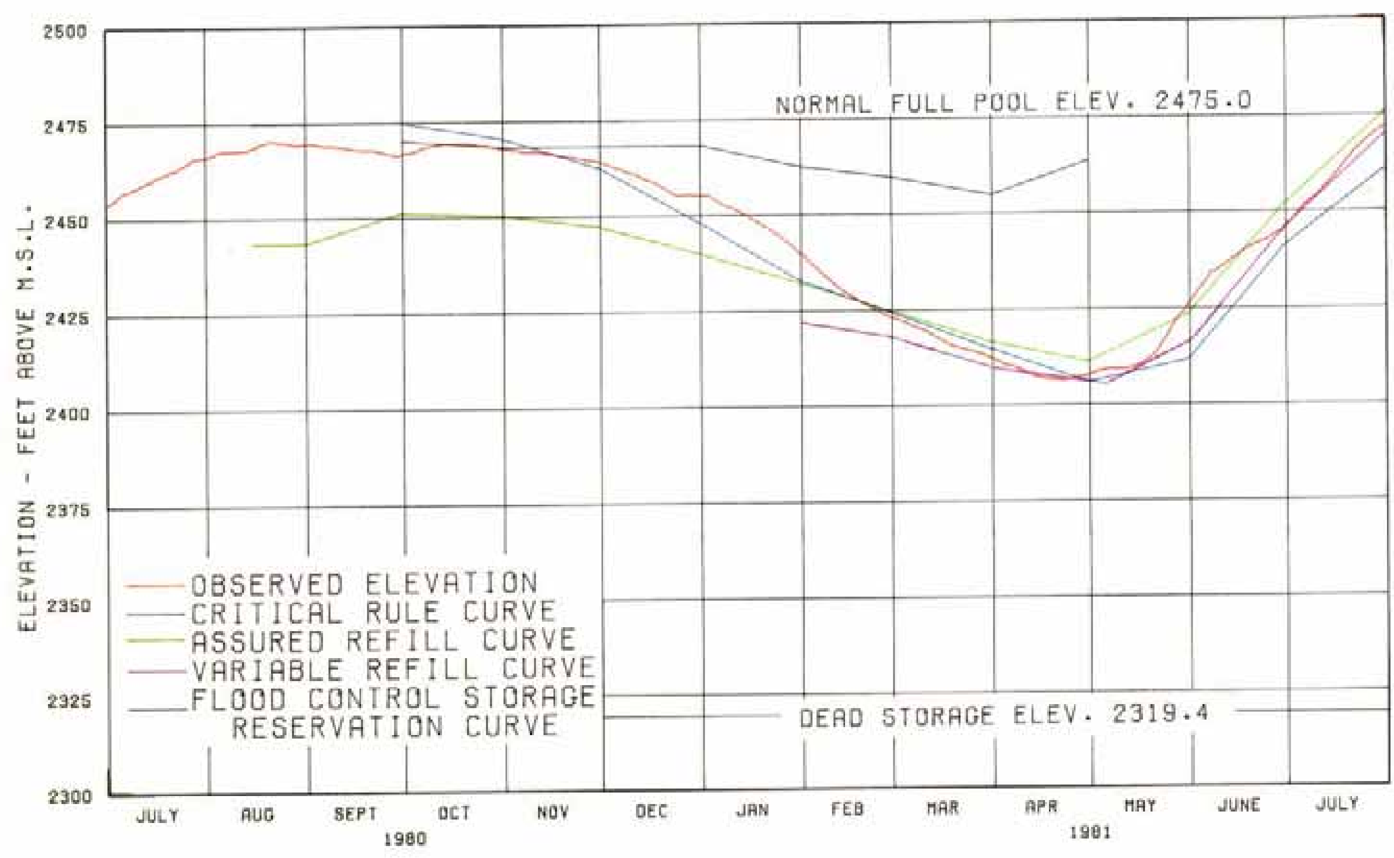
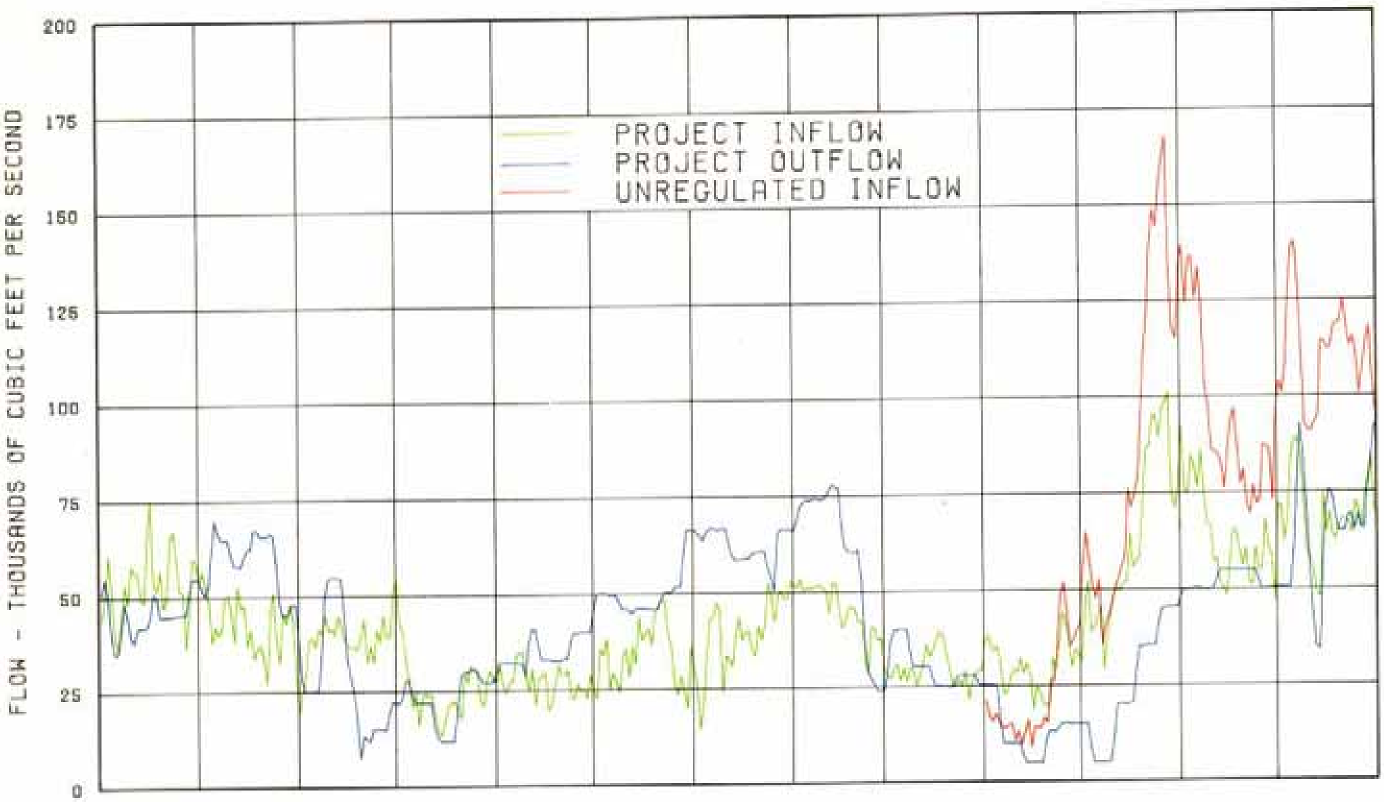


Chart 6

Regulation of Arrow
1 July 1980 - 31 July 1981



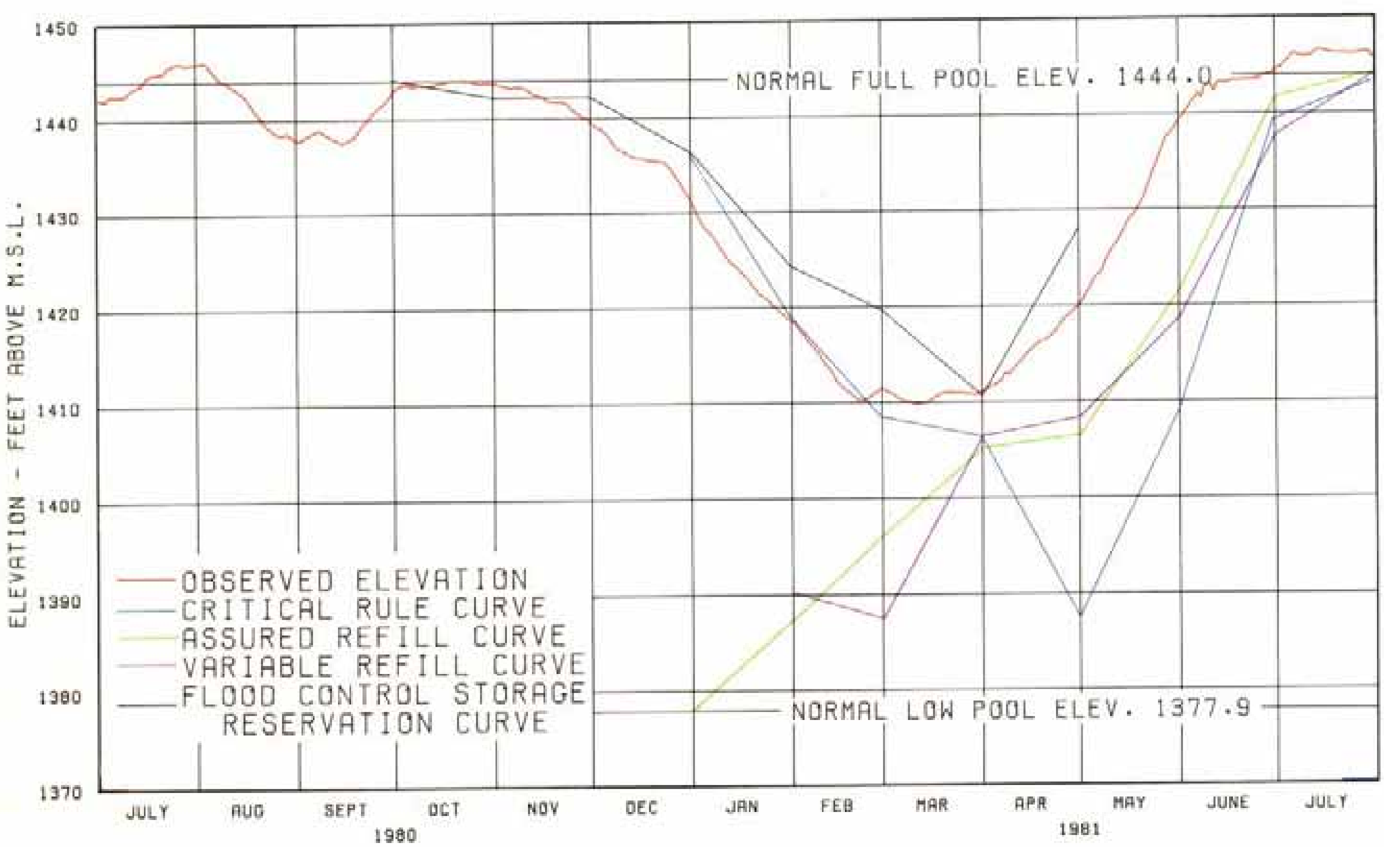
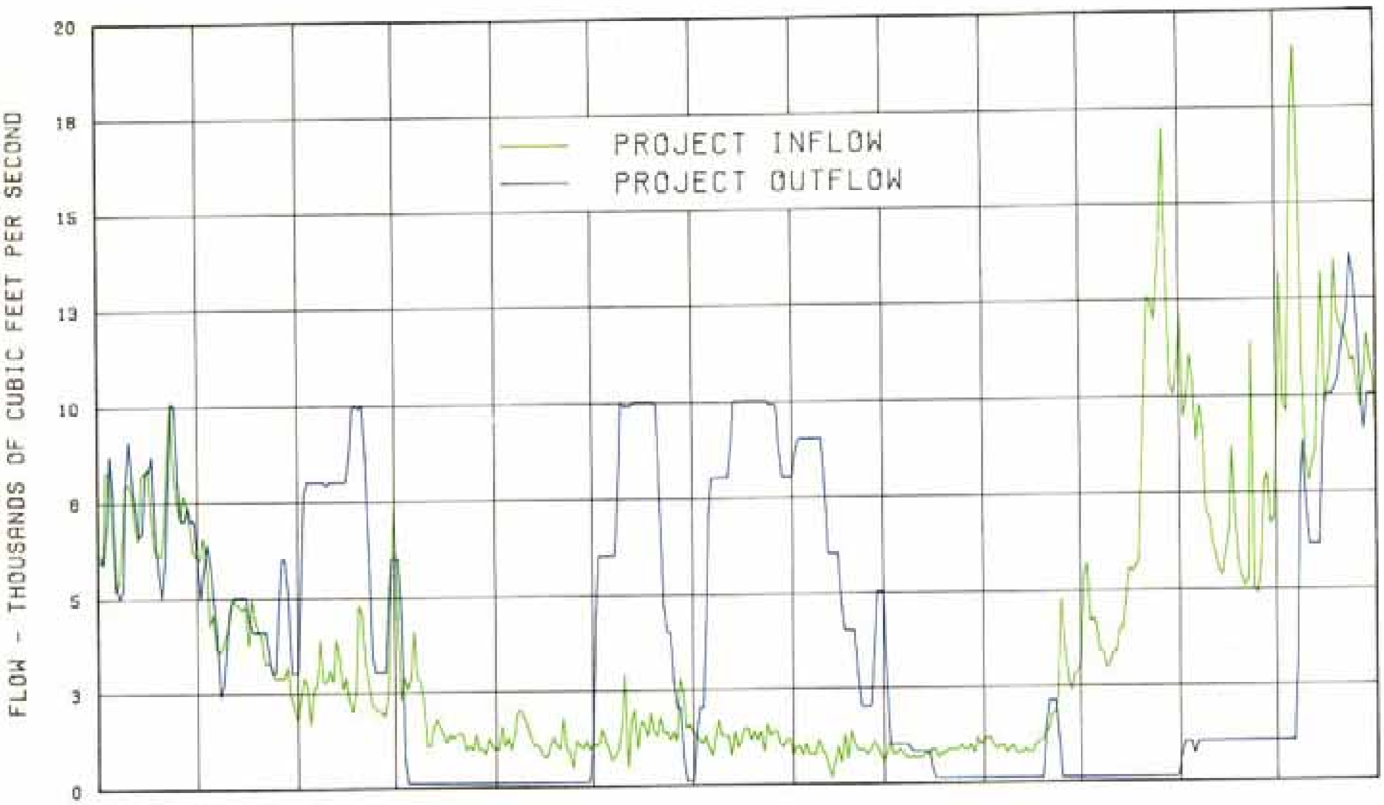


Chart 7
Regulation of Duncan
1 July 1980 - 31 July 1981



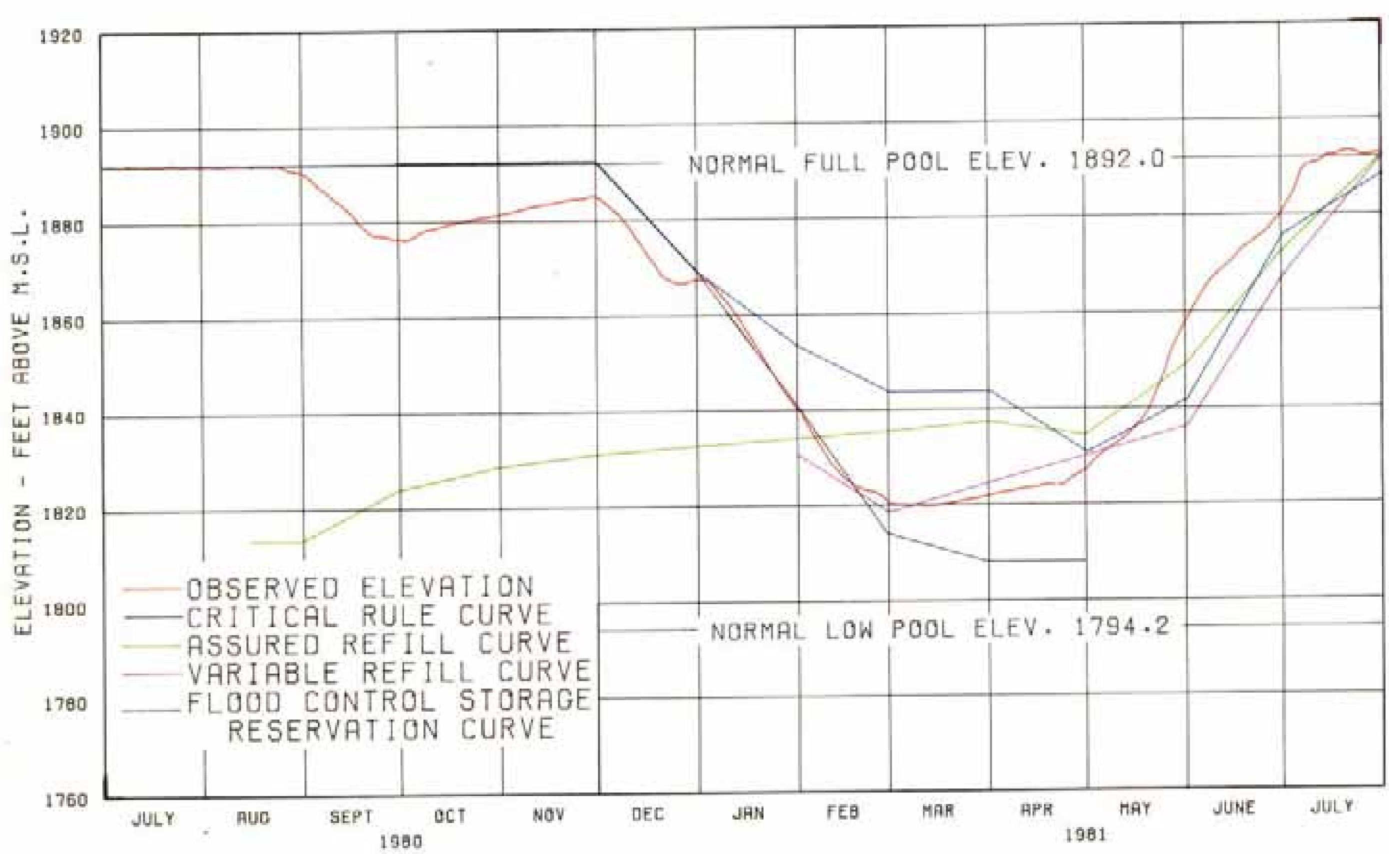


Chart 8

Regulation of Libby
1 July 1980 - 31 July 1981

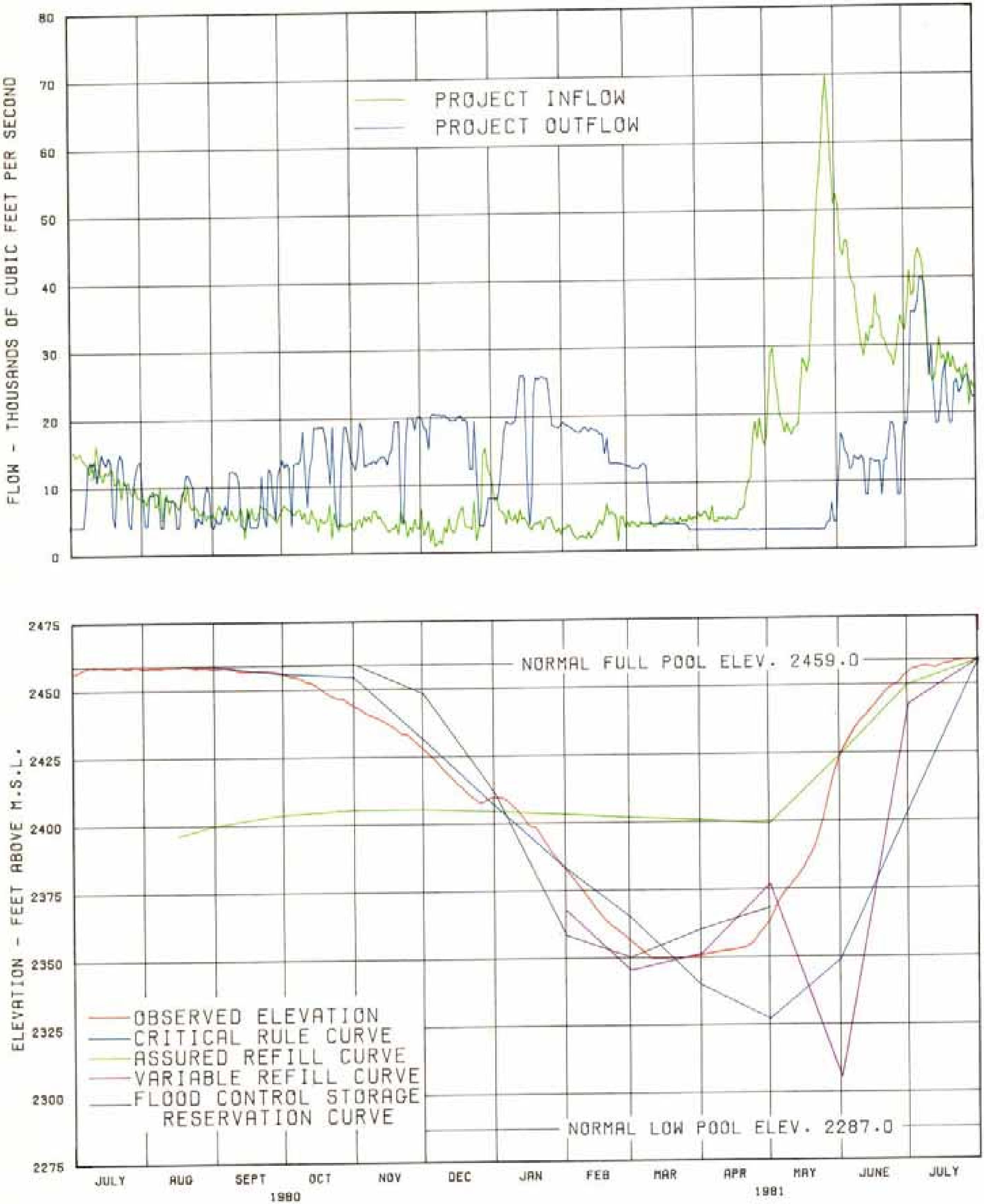


Chart 9

Regulation of Kootenay Lake
1 July 1980 - 31 July 1981

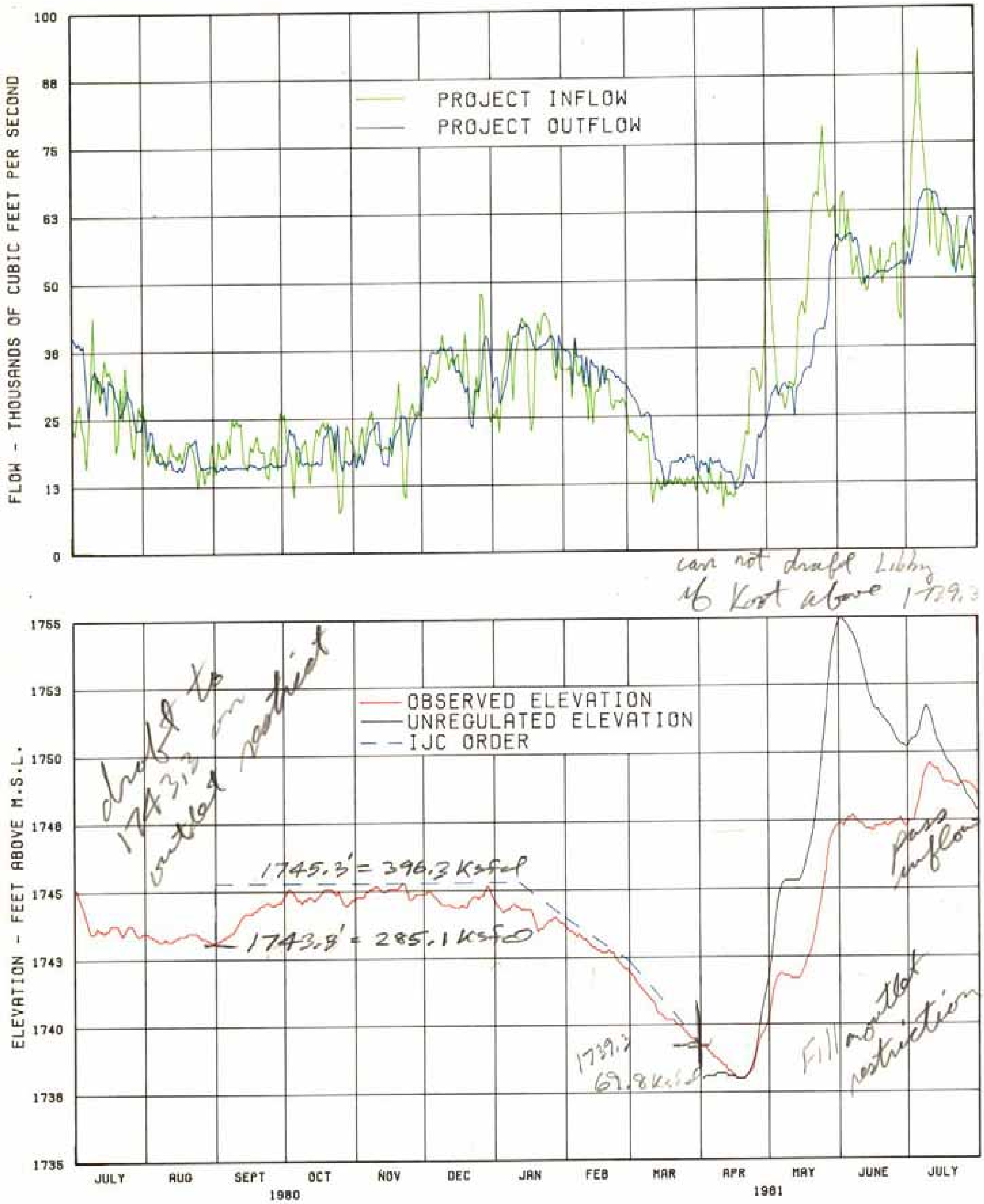


Chart 10

Columbia River at Birchbank 1 July 1980 - 31 July 1981

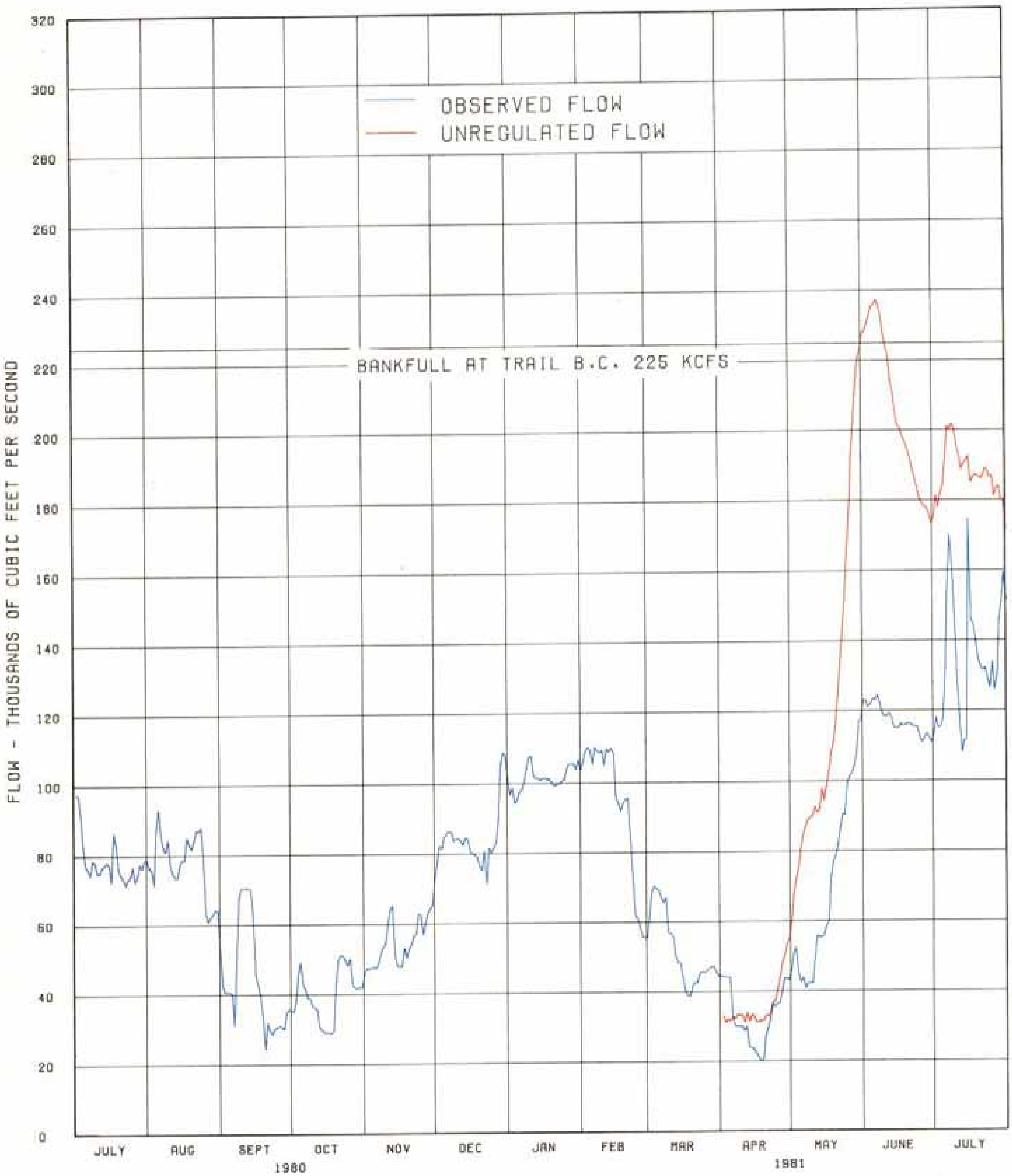
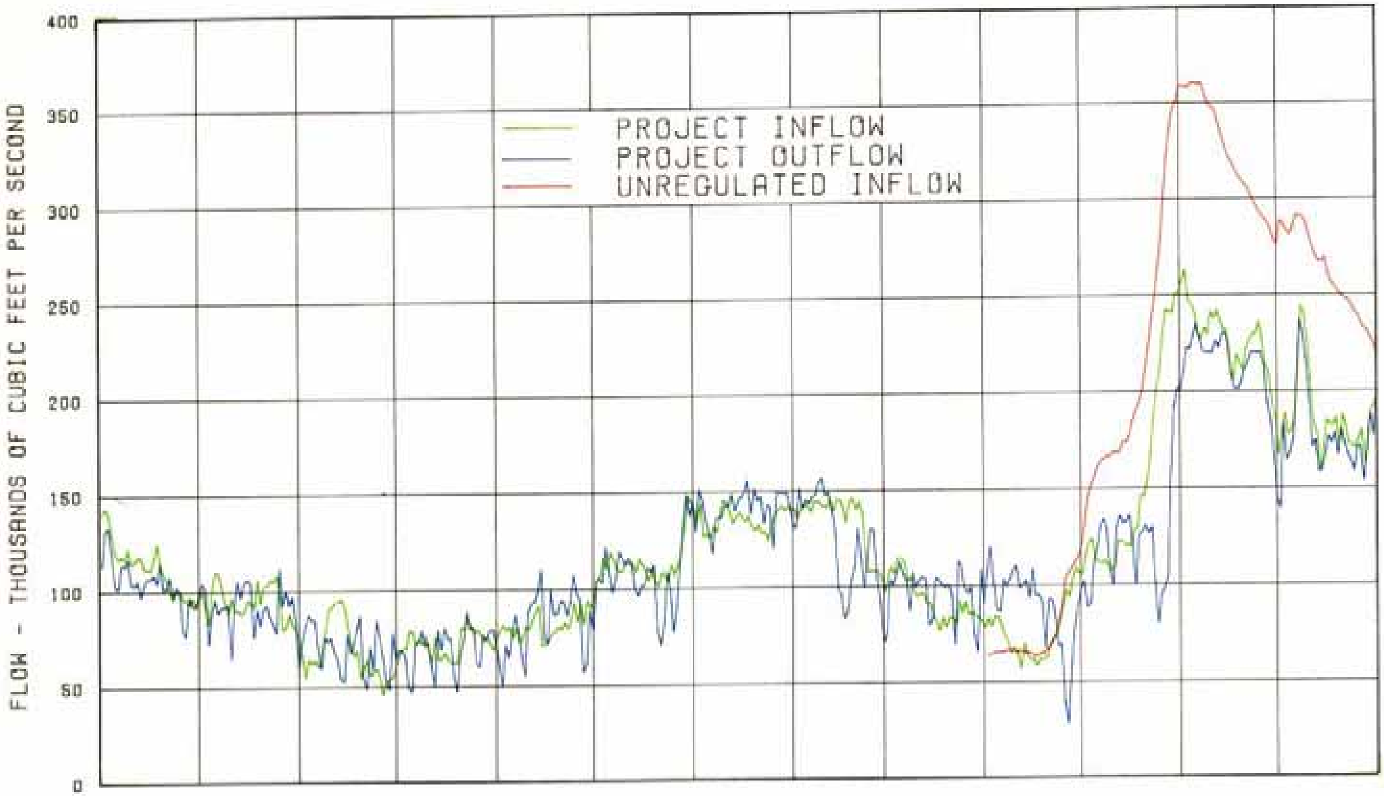


Chart 11

Regulation of Grand Coulee
1 July 1980 - 31 July 1981



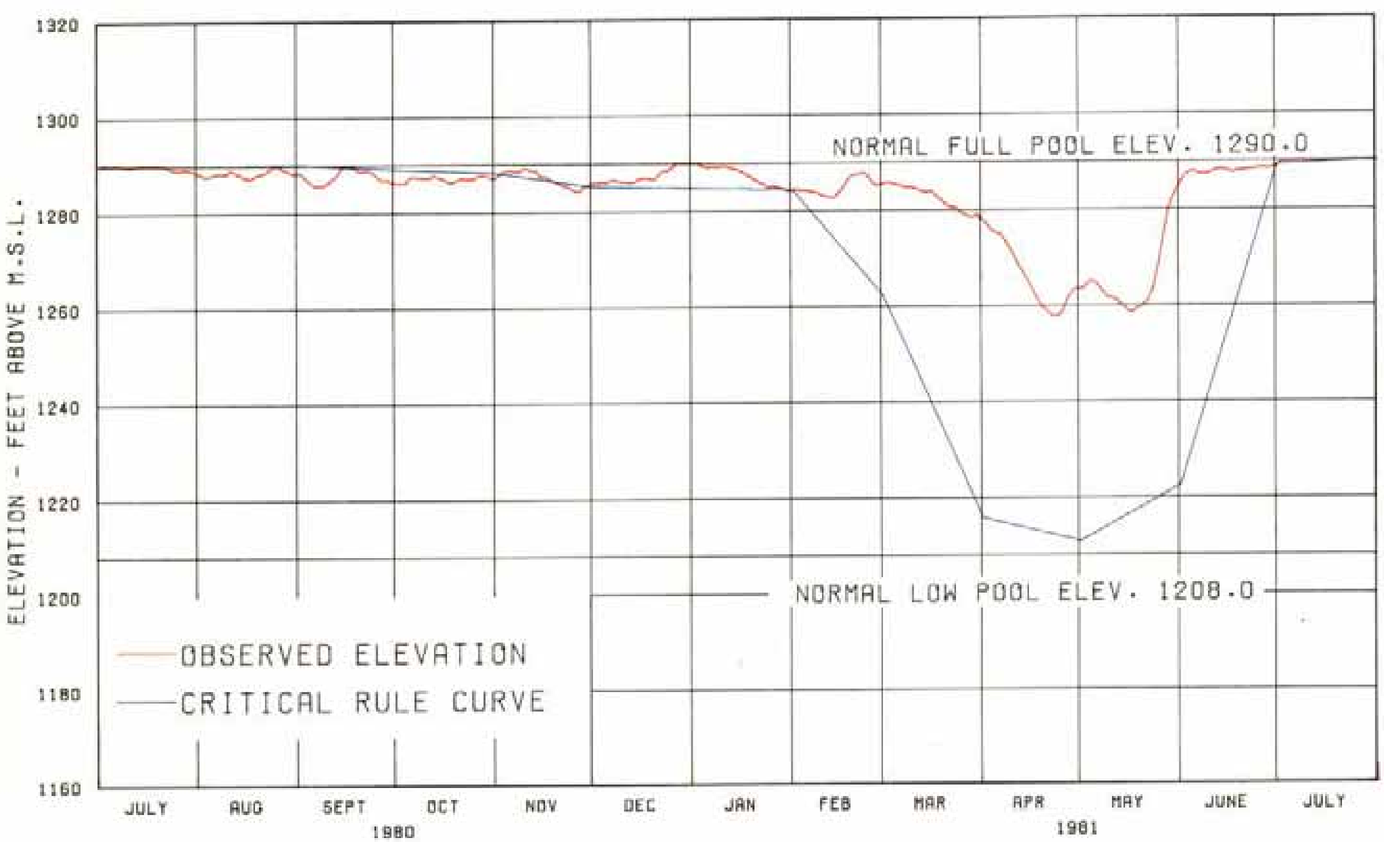


Chart 12

Columbia River at The Dalles
1 July 1980 - 31 July 1981

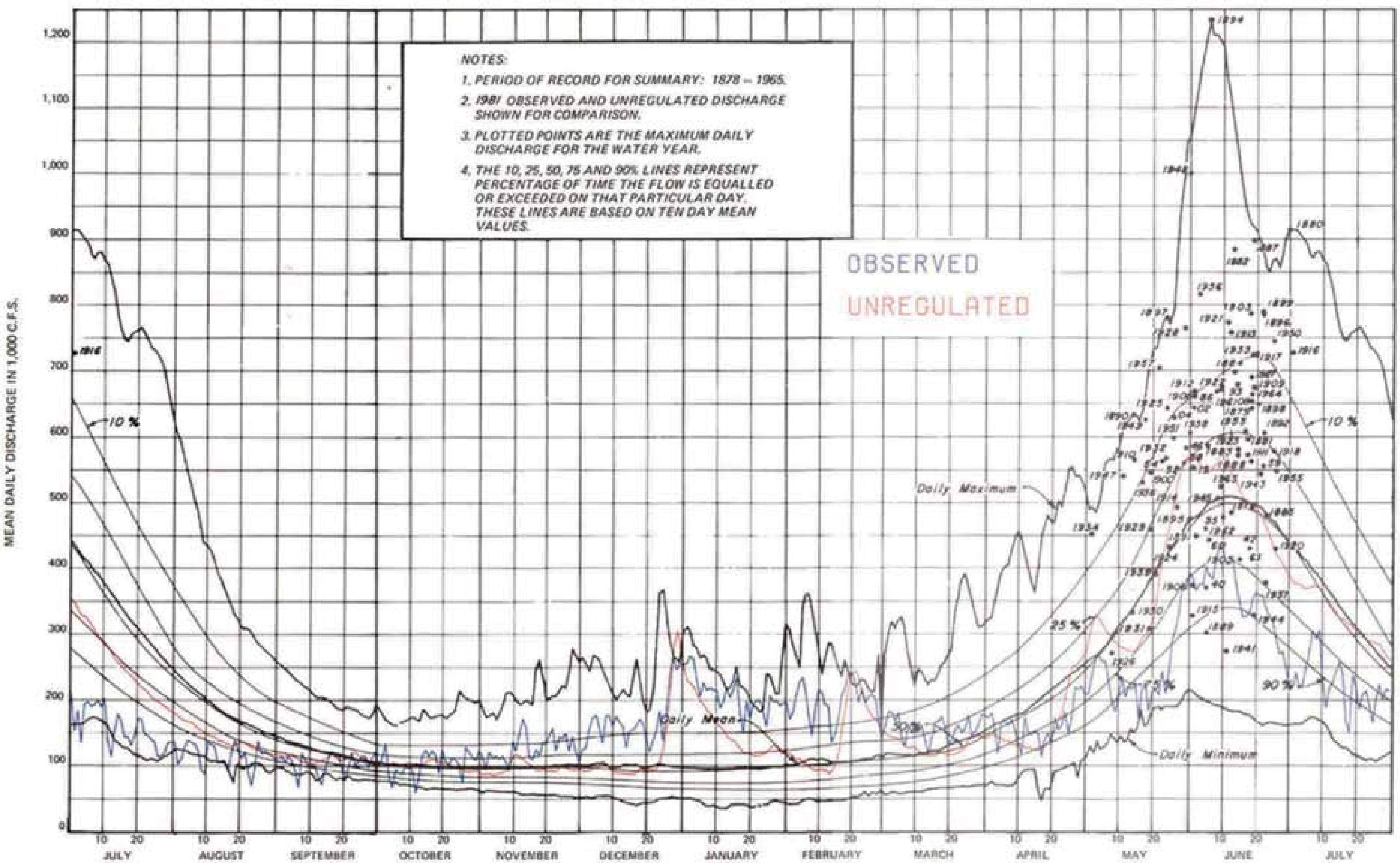


Chart 12

Columbia River at The Dalles
1 July 1980 - 31 July 1981

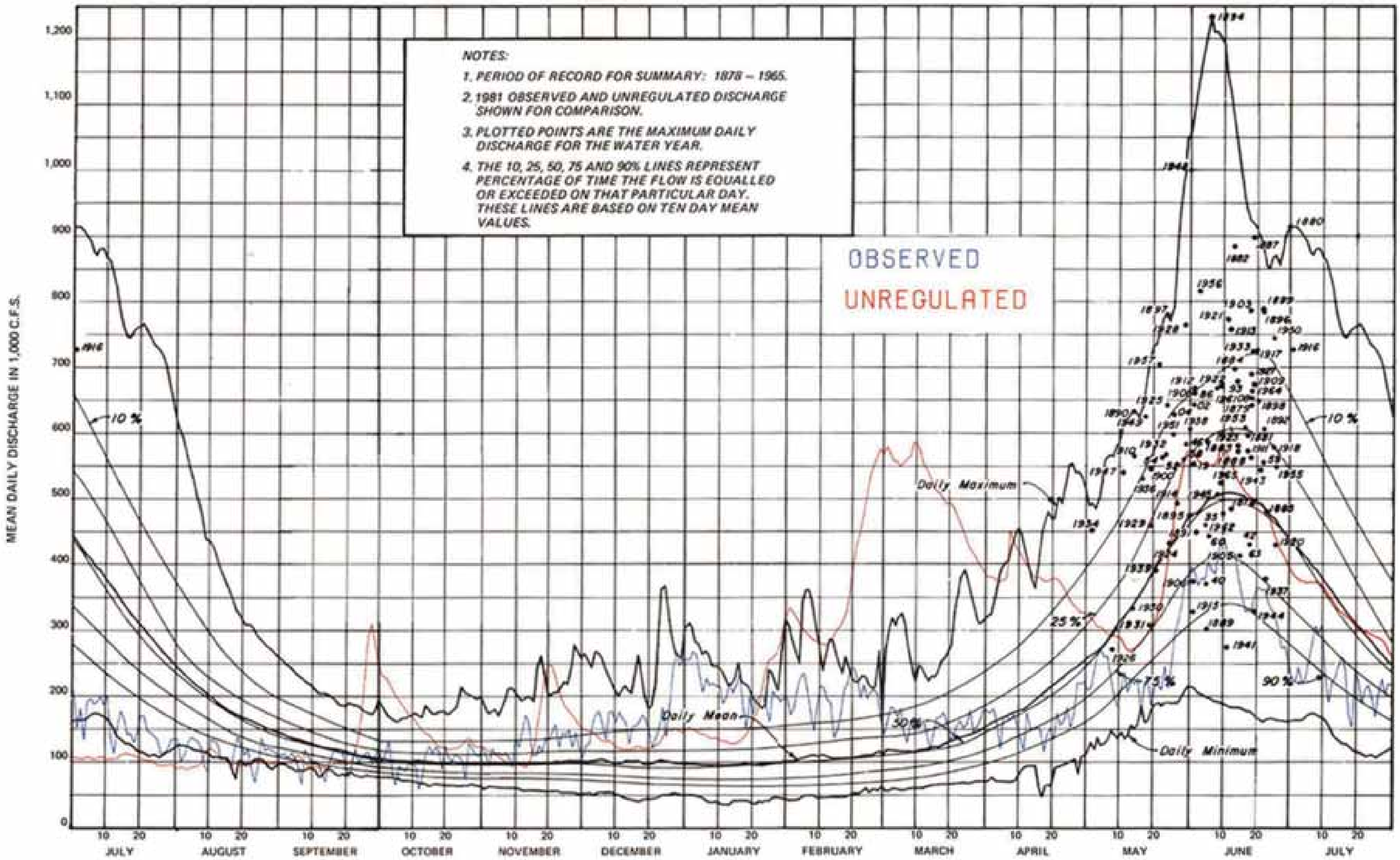


Chart 13

Columbia River at The Dalles
1 April 1981 - 31 July 1981

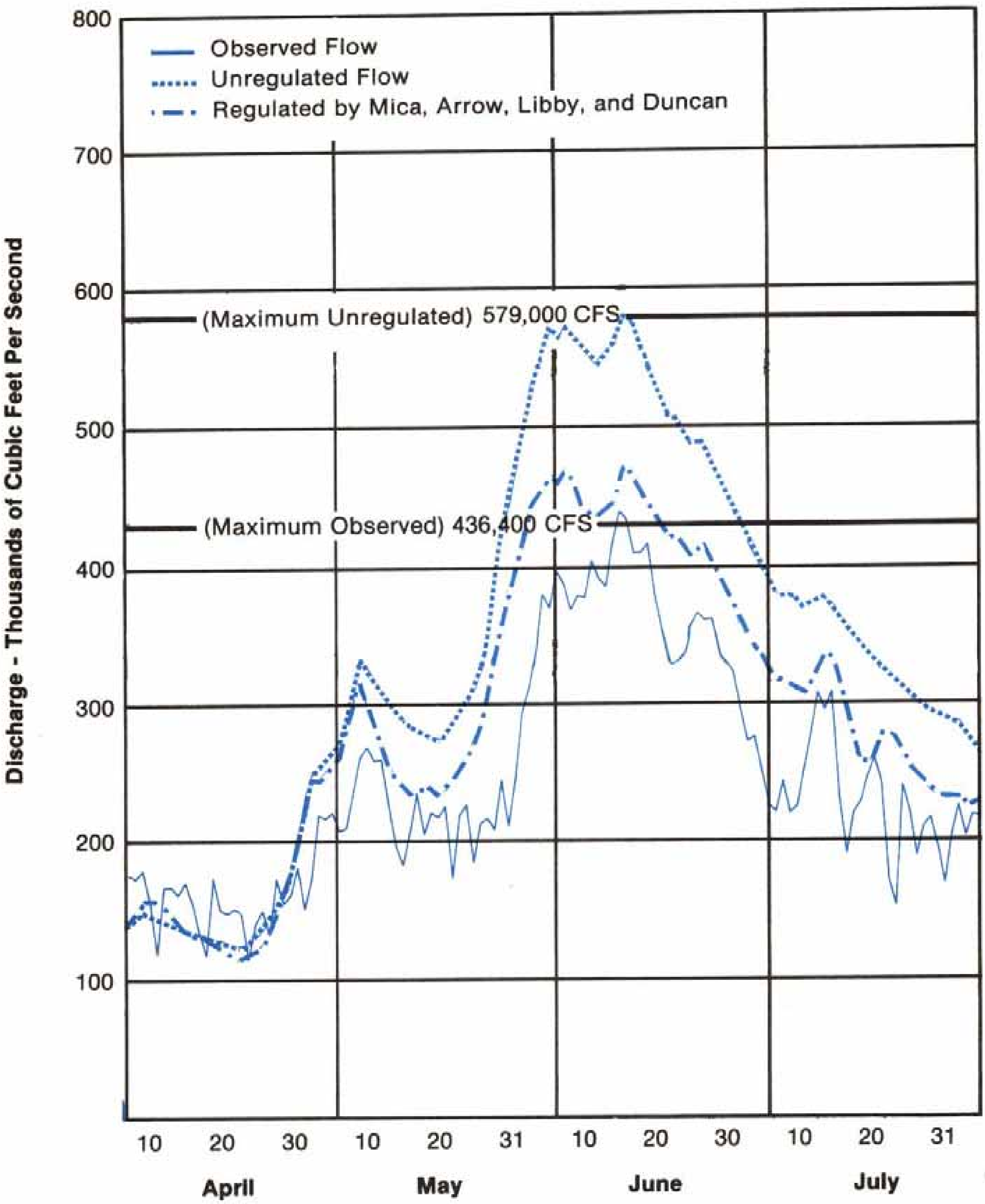
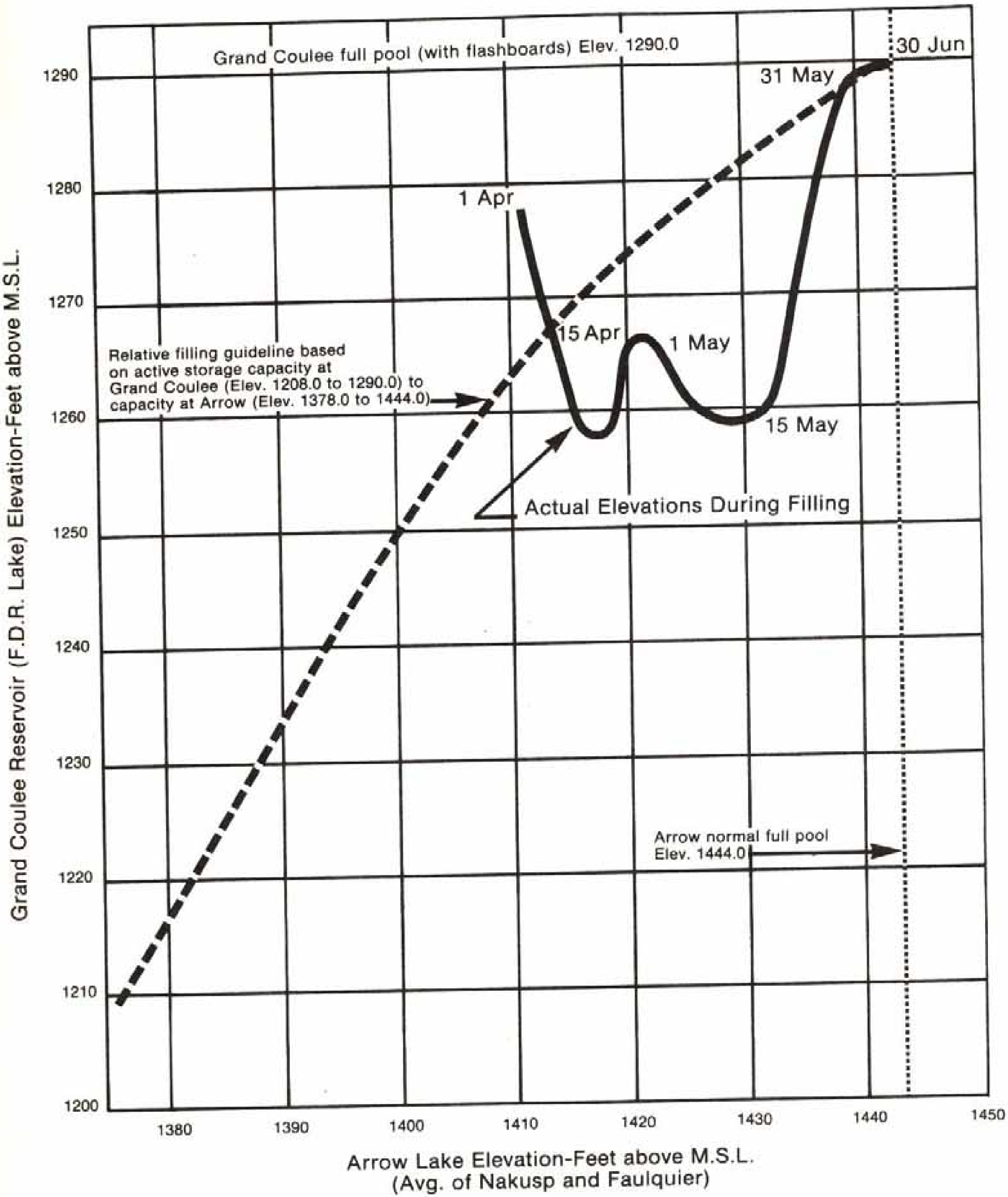


Chart 14

1981 Relative Filling Arrow and Grand Coulee



REFERENCES

The following documents governed the operation of the Columbia Treaty Projects during the period 1 August 1980 through 31 July 1981:

1. "Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans dated 1 May 1979.

2. "Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operation Year 1980-81", dated September 1975.

3. "Detailed Operating Plan for Columbia River Treaty Storage - August 1980 through 31 July 1981", dated September 1980.

4. "Columbia River Treaty Flood Control Operating Plan", dated October 1972.