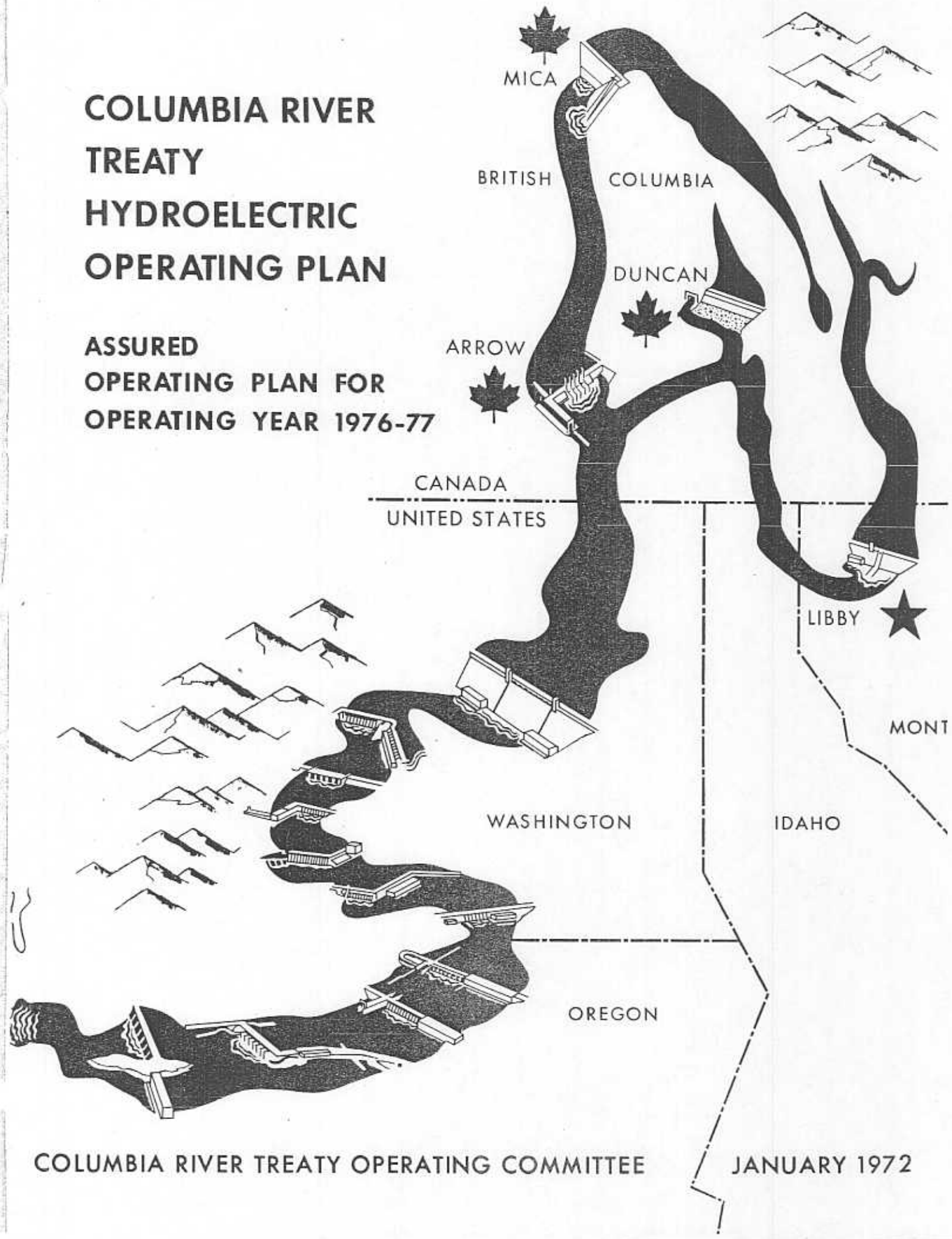
COLUMBIA RIVER TREATY HYDROELECTRIC OPERATING PLAN

ASSURED OPERATING PLAN FOR OPERATING YEAR 1976-77



COLUMBIA RIVER TREATY OPERATING COMMITTEE

JANUARY 1972

COLUMBIA RIVER TREATY

AGREEMENT

on

HYDROELECTRIC OPERATING PLAN FOR CANADIAN STORAGE

OPERATING YEAR 1976-77

The Columbia River Treaty between the United States and Canada requires that hydroelectric operating plans be agreed in advance by the Entities for the operation of the storages provided in the Treaty. The Canadian Entity and the United States Entity herewith agree that the Canadian storages will be operated in accordance with the attached "Columbia River Treaty Operating Plan, Assured Operating Plan for Operating Year 1976-77," dated January 1972.

Ray G. Williston
Chairman
Canadian Entity

March 21, 1972
(Date signed)

H. R. Richmond
Chairman
United States Entity

MAR 16 1972
(Date signed)

COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN

Assured Operating Plan for
Operating Year 1976-77

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COLUMBIA RIVER TREATY
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INTRODUCTION

The Treaty between Canada and the United States of America relating to the cooperative development of the water resources of the Columbia River Basin requires that each year an Assured Operating Plan be agreed by the Entities for the operation of the Columbia River Treaty Storage in Canada during the sixth succeeding year. This plan will provide to the Entities information for the sixth succeeding year for planning the power systems in their respective countries which are dependent on or coordinated with the operation of the Canadian storage projects. The data assumed for this Assured Operating Plan will undergo review by the Entities immediately prior to the 1976-77 operating year and such data may be revised to reflect data and criteria current at that time. Should the Entities fail to agree on such revisions, then this Assured Operating Plan will form the basis for the Detailed Operating Plan for 1976-77.

This Assured Operating Plan was prepared in accordance with the Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage[1/]. It is based on criteria contained in Annex A and Annex B of the Columbia River Treaty[2/], Article VII of the Protocol[3/], and Section B.1. of the Terms of Sale[4/]. Other necessary operating criteria reflected in this plan are the Program for the Initial Filling of Mica[5/] and the draft, Columbia River Treaty Flood Control Operating Plan[6/].

The Assured Operating Plan consists of:

(a) The Operating Rule Curve for the whole of the Canadian Treaty Storage, including the Critical Rule Curve, Assured Refill Curve, Variable Refill Curves, and the individual project Flood Control Storage Reservation Curves.

(b) Operating Rules, which specifically designate criteria for operation of the Canadian Treaty Projects in accordance with the principles contained in the above references.

A 30-year System Regulation Study[7/] was utilized to develop and test the operating rules and rule curves. It contains the agreed-upon operating constraints such as maximum and minimum project elevations and discharges.

SYSTEM REGULATION STUDIES

System Regulation Studies for the Assured Operating Plan were based on 1976-77 estimated loads and resources in British Columbia and in the United States Pacific Northwest System. Historical flows for the period July 1928 through June 1958, modified to estimated 1976-77 conditions[8/], were used. This plan is the first to reflect the installation of generators at Mica project; therefore, in accordance with Annex A, Paragraph 7 of the Treaty, the System Regulation Studies reflect Canadian storage operation for optimum generation in both Canada and the United States. The Critical Rule Curve for these studies was determined from Bonneville Power Administration Study 77-41. The study indicated a 42-1/2 month critical period resulting from the low flows during the period from 16 August 1928 through February 1932. It was assumed that all reservoirs, both in the United States and Canada, were full at the beginning of the critical period.

In the studies Mica and Arrow storages were operated for power purposes, as if they were a single reservoir; however, individual project flood control criteria were followed. Although only 7.0 million acre-feet of storage contents at Mica is committed for power operation purposes under the Treaty, the study is based on a full storage content of 20 million acre-feet to test compatibility with flood control parameters. Flood Control and Variable Refill Criteria are based on simulated forecasts[9/]; i.e., forecasts that would have been made at each date with the information then available.

OPERATING RULE CURVES

The operation of Canadian storage during the 1976-77 Operating Year shall be guided by an Operating Rule Curve for the whole of Canadian storage, and by Flood Control Storage Reservation Curves for the individual projects. The Operating Rule Curve is derived from the various curves described below. These curves are first determined for the individual Canadian storages and then summed to obtain the values for the whole of usable Canadian storage given by the composite tables included in this Plan. This is in accordance with the provision of Article VII(2) of the Protocol.

(a) Critical Rule Curve. The Critical Rule Curve indicates the end-of-month storage content of Canadian storage during the critical period. It is designed to protect the ability of the United States system to serve firm load and to protect the firm level of Mica generation with the occurrence of flows no worse than those during the most adverse historical streamflow period. A tabulation of the Composite Critical Rule Curve for the whole of Canadian storage is included as Table 1.

(b) Refill Curve. The Refill Curve is a guide to operation of Canadian storage which defines the normal limit of storage draft for secondary energy in order to provide a high probability of refilling the storage. In general, the Operating Plan does not permit serving secondary loads at the risk of refilling storages and thereby jeopardzing the firm load carrying capability of the system or the Mica generating plant during subsequent years. The end of the refill period is considered to be 31 July.

The Refill Curve is, in turn, defined by two curves as discussed below. In each case, adjustment should be made for water required for refill of upstream reservoirs when applicable.

(1) Assured Refill Curve. The Assured Refill Curve indicates the end-of-month storage content required to assure refill of Canadian storage based on the second-lowest historical volume of inflow for the whole or remaining portion of the refill period. A tabulation of the composite Assured Refill Curve for the whole of Canadian storage is included as Table 2.

(2) Variable Refill Curve. The Variable Refill Curve gives end-of-month storage contents for the period January through July required to refill Canadian storage based on forecast inflow volume and specified Power Discharge Requirements during the refill period. In the system regulation studies the Power Discharge Requirement was made a function of the natural January-July runoff volume at The Dalles, Oregon. In those years when this volume was lower than 90 million acre-feet, the discharge used was that required to meet firm loads while refilling, in accordance with the requirements of

Principles and Procedures. In years when the runoff volume at The Dalles exceeded 90 million acre-feet the Power Discharge Requirement was the project minimum outflow. The following are the Power Discharge Requirements used in computing the Variable Refill Curves:

Project	Power Discharge Requirement, c.f.s., for Jan-July Volume at The Dalles Less Than 90 m.a.f.	Power Discharge Requirement, c.f.s., for Jan-July Volume at The Dalles Exceeding 90 m.a.f.
Arrow	30,200	5,000
Duncan	1,000	100
Mica	21,000	3,000

Composite Variable Refill Curves for the whole of Canadian storage for the 30 years of historical record are recorded as Table 3. These illustrate the probable range of these curves based on historical conditions. In the actual operation in 1976-77, the Variable Refill Curve for each project will be based on the at-site inflow forecast reduced by upstream storage refill requirements and volume release determined from the Power Discharge Requirements given above.

(c) Flood Control Storage Reservation Curve. The Flood Control Storage Reservation Curves[10/] give end-of-month storage content to which each individual Canadian storage project shall be evacuated for flood control and other requirements during the Storage Evacuation Period. During the Flood Control Refill Period the flood control curves used in the studies were developed from daily system regulation studies. They reflect the use of simulated runoff forecasts. Flood control curves for the thirty-year study period are shown on Tables 4, 5, and 6. Tables 5 and 6 reflect an assumed transfer of 2 million acre-feet of storage space from Arrow to Mica. In actual operation, the Flood Control Storage Reservation Curves will be based on the Flood Control Operating Plan, using the latest forecast of runoff available at that time.

(d) Definition of Operating Rule Curve. Prior to 1 January, the Operating Rule Curve is defined by the Critical Rule Curve or the Assured Refill Curve, whichever is higher. The Critical Rule Curve for the first year of the critical period is used in the foregoing determination. Beginning 1 January, the Operating Rule Curve is defined by first determining the higher of the Critical Rule Curve and the Assured Refill Curve; the Operating Rule Curve is the lower of the above-determined value or the Variable Refill Curve. Also, in all periods the Operating Rule Curve meets all requirements for flood control operation. Composite Operating Rule Curves for the whole of Canadian storage for all 30 years of historical record are included as Table 7 to illustrate the probable future range of these curves based on historical conditions.

OPERATING RULES

The following rules, used in the System Regulation Study, will apply to the operation of Canadian storage in the 1976-77 Operating Year.

(a) The whole of the Canadian storage may be drafted to its Operating Rule Curve as required to produce optimum generation in Canada and the United States in accordance with Annex A, Paragraph 7 of the Treaty, subject to project physical characteristics and operating constraints.

(b) The whole of the Canadian storage will not be drafted below its Operating Rule Curve unless:

(1) Reservoir storage in the United States system has been drafted to its refill curve.

(2) Deliveries of secondary energy in the United States are discontinued.

(3) Committed firm thermal and miscellaneous resources not displaced by surplus firm hydro resources are in operation or other replacement energy has been secured from sources other than those committed.

(c) When the conditions of (b) above are met, and it is necessary to draft additional storage to produce optimum generation as determined by the Critical Period System Regulation study, the whole of the Canadian storage and reservoir storage in the United States system will be drafted proportionately between its Operating Rule Curve or Energy Content Curve, respectively, and its Critical Rule Curve. The proportionate draft will be made, if necessary, first to the first year Critical Rule Curve, then between the first and second year Critical Rule Curve, the second and third year Critical Rule Curve, etc. When it is necessary to operate the whole of the Canadian storage and the United States reservoir storage below their lowest Critical Rule Curves, each shall be operated proportionately between its lowest Critical Rule Curve and its normal minimum content. However, Mica Reservoir will continue to be operated in coordination with Arrow, so as to optimize generation at site as well as downstream in the United States.

(d) Each project will be operated on or below the storage content defined by its Flood Control Storage Reservation Curve, unless such content is below that indicated by the Variable Refill Curve.

(e) Mica project will be operated to the following monthly average outflows except as qualified in (1) to (6) below:

July	8,000 cfs minimum
August	20,000 cfs, or inflow if reservoir is full
September	10,000 cfs, or inflow if reservoir is full
October-November	15,000 cfs
December-February	21,000 cfs
March	8,000 cfs minimum
April-June	8,000 cfs - 15,000 cfs

(1) March and July monthly average outflows will be adjusted to allow the Mica reservoir to reach stipulated rule curve elevations subject to the 8,000 cfs minimum release.

(2) Mica monthly average outflows will be increased in the months from October to June if required to avoid violation of the Flood Control Storage Reservation Curve.

(3) If the end-of-month storage content at the Arrow project is:

-- below 500 KSFD in any month from October through January, then the Mica monthly average outflow in the following month will be increased by 5,000 cfs over that specified in (e) above.

-- below 100 KSFD in any month from October through January, then the Mica monthly average outflow in the following month will be increased by 10,000 cfs over that specified in (e) above.

(4) Mica monthly average outflows will be increased in the months of April through June from 8,000 cfs to the extent the additional generation is usable in the B.C. Hydro Integrated System up to a maximum outflow of 15,000 cfs.

(5) Storage releases from Mica in excess of 7 million acre-feet will be made at the discretion of the Canadian Section of the Operating Committee.

(6) Mica monthly average outflows will be increased during the months of July through September in abnormally low streamflow years in order to maintain the Arrow Reservoir above the following storage contents:

31 July	1,000 KSFD
31 August	1,000 KSFD
30 September	900 KSFD

The operating rules set forth above are designed to produce optimum generation in Canada and in the United States, as required by Annex A of the Treaty, when gross Mica storage content on 31 July 1976 is 15 million acre-feet or more. If the storage content filled by 31 July 1976 is less than 15 million acre-feet, some modification of the rules may be necessary to ensure adequate and complete drafting of Canadian storage in Mica Reservoir to meet United States power requirements. In that event, such modified operating rules will be included in the 1976-77 Detailed Operating Plan.

IMPLEMENTATION

The Entities have agreed that each year a Detailed Operating Plan will be prepared for the immediately succeeding operating year. Such Detailed Operating Plans are made under the authority of Article XIV 2.(k) of the Columbia River Treaty which states " . . . the powers and the duties of the Entities include:

(k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in Annexes A and B."

The Detailed Operating Plan for 1976-77 will reflect the latest available load, resource and other pertinent data to the extent the Entities agreed these data should be included in the plan. Beginning on 1 January 1976 the Assured Operating Plan contained herein will be reviewed and the data and criteria updated, as agreed by the Entities, to form the basis for a Detailed Operating Plan for the 1976-77 Operating Year. Failing agreement on updating the Assured Operating Plan, the Detailed Operating Plan will include all data and criteria given in this Assured Operating Plan. Actual operation during the 1976-77 Operating Year shall be guided by the Detailed Operating Plan.

The operating rules to be used in implementation of the Detailed Operating Plan are generally the same as the operating rules described in this document.

The values used in the study to define the various rule curves were month-end values only. In actual day-to-day operation it is necessary to operate in such a manner during the course of each month that these month-end values can be observed in accordance with the operating rules. Because of the normal variation of power load and streamflow during any month, straight line interpolation between the month-end points should not be assumed.

During the storage drawdown season, Canadian storage should not be drafted below its month-end point at any time during the month unless it can be conservatively demonstrated that sufficient inflow is available, in excess of the minimum outflow required to serve power demand, to refill the reservoir to its end-of-month value as required. During the storage evacuation and refill season, operation will be consistent

with the Flood Control Operating Plan. When refill of Canadian storage is being guided by Variable Refill Curves, such curves will be computed on a day-by-day basis using the residual volume-of-inflow forecasts depleted by the volume required for minimum outflow from each day through the end of the refill season.

REFERENCES

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

2/ Treaty between Canada and the United States of America relating to Cooperative Development of the Water Resources of the Columbia River Basin dated 17 January 1961.

3/ Protocol -- Annex to Exchange of Notes dated 22 January 1964.

4/ Terms of Sale -- Attachment to Exchange of Notes dated 22 January 1964.

5/ Program for Initial filling of Mica Reservoir, dated 26 July 1967.

6/ Columbia River Treaty Flood Control Operating Plan, dated December 1971 (draft).

7/ BPA Hydroelectric Power Planning Program, 77-41 Assured Operating Plan 30-Year Study, dated 27 January 1972.

8/ Extension of Modified Flows through 1958, Water Management Subcommittee of CBIAC, dated June 1960.

9/ Volume Forecasts for Reservoir Regulation Studies, 1929-1965, Cooperative Columbia River Forecasting Unit, dated July 1967.

10/ Summary of End-of-Month Reservoir Storage Requirement from Columbia River Flood Regulation Studies 004 dated 2 April 1970.

TABLE 1

COLUMBIA RIVER TREATY
COMPOSITE CRITICAL RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1976-77 OPERATING YEAR

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1ST YR	7814.6	7444.7	7110.0	6904.0	6787.2	5504.2	3823.7	2014.6	1999.2	1298.5	2759.9	6192.8
2ND YR	7367.4	6552.3	5851.9	4966.6	4127.3	2889.8	1738.5	1000.2	519.0	1080.3	2690.0	3975.8
3RD YR	5654.0	5219.4	4951.5	4387.0	3680.4	2456.2	1690.1	875.1	81.2	-30.5	1654.2	2279.1
4TH YR	2785.1	2346.5	2264.9	2040.0	1543.3	542.7	0.0	-166.5	0.0	0.0	0.0	0.0

TABLE 2

COLUMBIA RIVER TREATY
COMPOSITE ASSURED REFILL CURVE
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1976-77 OPERATING YEAR

JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
0.0	3.0	137.9	342.2	463.5	522.7	6135.8	5348.1	5135.1	4411.8	5920.0	7119.6	7814.6

TABLE 3

COLUMBIA RIVER TREATY
COMPOSITE VARIABLE REFILL CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1976-77 OPERATING YEAR

FLOW YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29							7173.4	7461.7	6697.5	5992.7	6172.8	7155.4	7814.6
1929-30							5921.8	6122.8	3201.8	2818.4	4218.0	6015.8	,,
1930-31							7554.5	7467.1	6648.0	5902.2	6263.5	7602.6	,,
1931-32							391.5	290.4	0.0	7.3	2703.9	5193.4	,,
1932-33							231.6	0.0	8.6	3.0	1306.6	4760.8	,,
1933-34							0.0	,,	.7	29.2	327.4	4680.3	,,
1934-35							,,	,,	0.0	0.0	438.9	4141.6	,,
1935-36							6590.8	5791.6	4339.4	2735.0	3961.6	6960.1	,,
1936-37							7665.6	7589.4	6053.8	6228.6	6134.3	7156.6	,,
1937-38							0.0	0.0	0.0	165.3	1971.4	5384.6	,,
1938-39							6221.3	4947.7	3225.6	2968.6	4317.1	6644.3	,,
1939-40							7038.5	7163.5	5615.5	5134.0	5807.0	7216.6	,,
1940-41							6288.6	5605.2	4665.9	4508.5	5904.1	7058.3	,,
1941-42							92.6	1243.1	1931.9	2388.4	3902.9	5818.9	,,
1942-43							398.6	797.2	995.7	1222.6	2972.9	5476.3	,,
1943-44							7515.5	7312.6	6380.6	5486.5	5851.9	7033.3	,,
1944-45							7544.1	7231.0	5324.0	4560.1	4894.4	6716.1	,,
1945-46							430.9	0.0	0.0	0.0	1087.5	5067.7	,,
1946-47							234.3	,,	15.5	99.2	2101.3	5477.2	,,
1947-48							1033.4	1449.3	381.1	737.3	1878.6	5343.4	,,
1948-49							1165.0	2145.0	1315.5	1986.9	3632.4	6543.7	,,
1949-50							1250.8	1133.3	780.8	1021.2	2539.9	5250.0	,,
1950-51							135.0	0.0	0.0	0.0	1403.6	4868.0	,,
1951-52							524.7	317.0	258.3	769.2	2711.9	5768.1	,,
1952-53							3549.0	1339.0	1341.0	1721.7	2987.6	5821.3	,,
1953-54							1818.4	920.2	9.6	273.4	1505.3	4821.7	,,
1954-55							1181.9	1636.0	1688.8	1711.4	2943.1	5170.3	,,
1955-56							0.0	0.0	0.0	0.0	1241.5	5193.1	,,
1956-57							82.3	45.3	,,	,,	2057.6	6122.5	,,
1957-58							1314.3	1119.3	1029.7	1712.9	3292.7	6649.9	,,

TABLE 4

FLOOD CONTROL STORAGE RESERVATION CURVES
DUNCAN
KSFD
1976-77 OPERATING YEAR

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29	679.1	679.1	679.1	679.1	679.1	477.4	275.8	174.9	306.0	295.9	374.1	619.1	679.1
1929-30	,,	,,	,,	,,	,,	,,	336.3	306.0	311.1	320.6	342.8	532.4	,,
1930-31	,,	,,	,,	,,	,,	,,	341.3	185.0	245.5	240.5	393.7	630.2	,,
1931-32	,,	,,	,,	,,	,,	,,	245.5	38.8	38.8	38.8	212.7	534.4	,,
1932-33	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	130.6	529.9	,,
1933-34	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	205.7	511.7	,,
1934-35	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	123.0	441.6	,,
1935-36	,,	,,	,,	,,	,,	,,	285.8	149.7	149.7	132.1	350.4	639.9	,,
1936-37	,,	,,	,,	,,	,,	,,	386.7	280.8	205.2	220.8	332.7	549.5	,,
1937-38	,,	,,	,,	,,	,,	,,	245.5	38.8	38.8	38.8	170.4	477.9	,,
1938-39	,,	,,	,,	,,	,,	,,	,,	104.3	,,	,,	246.5	433.1	,,
1939-40	,,	,,	,,	,,	,,	,,	,,	144.7	164.8	165.0	355.9	603.9	,,
1940-41	,,	,,	,,	,,	,,	,,	,,	79.1	,,	235.4	365.5	586.8	,,
1941-42	,,	,,	,,	,,	,,	,,	,,	38.8	,,	205.2	363.0	585.3	,,
1942-43	,,	,,	,,	,,	,,	,,	,,	,,	38.8	38.8	124.5	324.7	647.9
1943-44	647.9	,,	,,	,,	,,	,,	301.0	159.8	235.4	262.7	396.8	626.2	679.1
1944-45	679.1	,,	,,	,,	,,	,,	331.2	185.0	190.1	104.3	209.7	389.7	671.0
1945-46	671.0	,,	,,	,,	,,	,,	245.5	38.8	38.8	49.4	287.9	605.0	679.1
1946-47	679.1	,,	,,	,,	,,	,,	,,	,,	,,	59.5	269.2	561.6	,,
1947-48	,,	,,	,,	,,	,,	,,	,,	,,	,,	38.8	231.9	603.0	,,
1948-49	,,	,,	,,	,,	,,	,,	,,	139.6	,,	58.0	283.8	497.1	677.6
1949-50	677.6	,,	,,	,,	,,	,,	250.6	38.8	,,	38.8	96.3	430.0	679.1
1950-51	679.1	,,	,,	,,	,,	,,	245.5	,,	,,	43.8	235.4	472.9	,,
1951-52	,,	,,	,,	,,	,,	,,	,,	,,	,,	59.0	236.4	507.7	,,
1952-53	,,	,,	,,	,,	,,	,,	386.7	149.7	174.9	116.4	215.3	490.0	,,
1953-54	,,	,,	,,	,,	,,	,,	311.1	38.8	38.8	38.8	197.1	491.0	,,
1954-55	,,	,,	,,	,,	,,	,,	290.9	159.8	159.8	134.6	188.0	532.9	,,
1955-56	,,	,,	,,	,,	,,	,,	245.5	0.0	0.0	0.0	211.7	550.5	,,
1956-57	,,	,,	,,	,,	,,	,,	250.6	38.8	38.8	42.3	330.7	612.5	,,
1957-58	,,	,,	,,	,,	,,	,,	285.8	94.3	74.1	69.1	331.7	679.1	,,

TABLE 5

FLOOD CONTROL STORAGE RESERVATION CURVES
ARROW
KSFO
1976-77 OPERATING YEAR

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29	3602.3	3602.3	3602.3	3476.3	3602.3	3098.1	2920.8	2770.4	3098.1	3098.1	3098.1	3602.3	3602.3
1929-30	,,	,,	,,	,,	,,	,,	2493.1	2493.1	1636.0	1636.0	1636.0	3098.1	,,
1930-31	,,	,,	,,	,,	,,	,,	2997.3	3098.1	3098.1	3098.1	3098.1	3602.3	,,
1931-32	,,	,,	,,	,,	,,	,,	2392.3	1726.8	1031.0	1031.0	1701.6	,,	,,
1932-33	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1247.8	2997.3	,,
1933-34	,,	,,	,,	,,	,,	,,	,,	,,	,,	1701.6	2275.3	3602.3	,,
1934-35	,,	,,	,,	,,	,,	,,	,,	,,	,,	1031.0	1061.3	2856.1	,,
1935-36	,,	,,	,,	,,	,,	,,	3098.1	2215.8	,,	,,	1671.3	3148.5	,,
1936-37	,,	,,	,,	,,	,,	,,	,,	3098.1	2544.4	3047.7	3047.7	3602.3	,,
1937-38	,,	,,	,,	,,	,,	,,	2392.3	1726.8	1031.0	1031.0	1217.6	3062.9	,,
1938-39	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2049.5	2261.2	,,
1939-40	,,	,,	,,	,,	,,	,,	2518.3	2604.0	1081.5	1081.5	1822.6	2866.2	,,
1940-41	,,	,,	,,	,,	,,	,,	2392.3	1726.8	3098.1	3098.1	3098.1	3602.3	,,
1941-42	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1942-43	,,	,,	,,	,,	,,	,,	,,	,,	1031.0	1031.0	1031.0	2170.5	,,
1943-44	,,	,,	,,	,,	,,	,,	2846.0	3098.1	3098.1	3098.1	3098.1	3602.3	,,
1944-45	,,	,,	,,	,,	,,	,,	2836.0	2805.7	1636.0	2341.9	2341.9	,,	,,
1945-46	,,	,,	,,	,,	,,	,,	2392.3	1726.8	1031.0	1031.0	1736.9	3587.2	,,
1946-47	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1913.3	3602.3	,,
1947-48	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1857.9	,,	,,
1948-49	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	2286.4	3526.7	,,
1949-50	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1797.4	3602.3	,,
1950-51	,,	,,	,,	,,	,,	,,	,,	,,	22.7	68.1	1343.6	2896.5	,,
1951-52	,,	,,	,,	,,	,,	,,	,,	,,	1031.0	1031.0	1404.1	2951.9	,,
1952-53	,,	,,	,,	,,	,,	,,	3098.1	,,	,,	,,	1177.3	2699.8	,,
1953-54	,,	,,	,,	,,	,,	,,	2392.3	,,	,,	,,	1056.3	1439.4	,,
1954-55	,,	,,	,,	,,	,,	,,	2554.5	2820.8	1686.5	2190.6	2190.6	3602.3	,,
1955-56	,,	,,	,,	,,	,,	,,	2392.3	879.8	22.7	229.4	1333.5	2765.4	,,
1956-57	,,	,,	,,	,,	,,	,,	,,	1726.8	1031.0	1207.5	2392.3	3602.3	,,
1957-58	,,	,,	,,	,,	,,	,,	,,	,,	,,	1031.0	2039.4	,,	,,

TABLE 6

FLOOD CONTROL STORAGE RESERVATION CURVES
MICA
KSFD
1976-77 OPERATING YEAR

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29	3533.2	3533.2	3533.2	3432.4	3432.4	3432.4	3260.9	3235.7	3432.4	3432.4	3533.2	3533.2	3533.2
1929-30	"	"	"	"	"	"	3150.0	3089.5	2776.9	2742.7	2710.4	"	"
1930-31	"	"	"	"	"	"	3356.7	3432.4	3432.4	3398.1	3533.2	"	"
1931-32	"	"	"	"	"	"	3114.7	2802.2	2484.5	2484.5	3063.8	"	"
1932-33	"	"	"	"	"	"	"	"	"	"	2558.1	"	"
1933-34	"	"	"	"	"	"	"	"	"	"	3533.2	"	"
1934-35	"	"	"	"	"	"	"	"	"	"	2572.3	"	"
1935-36	"	"	"	"	"	"	3412.2	2968.5	"	2542.5	3401.6	"	"
1936-37	"	"	"	"	"	"	3432.4	3432.4	3104.7	3163.1	3295.7	"	"
1937-38	"	"	"	"	"	"	3114.7	2802.2	2484.5	2484.5	2682.7	"	"
1938-39	"	"	"	"	"	"	"	"	"	"	3379.9	"	"
1939-40	"	"	"	"	"	"	3145.0	3104.7	"	2550.1	2877.8	"	"
1940-41	"	"	"	"	"	"	3114.7	2802.2	"	2766.9	3296.7	"	"
1941-42	"	"	"	"	"	"	"	"	2877.8	2880.3	3360.8	"	"
1942-43	"	"	"	"	"	"	3291.2	"	2484.5	2484.5	2745.7	"	"
1943-44	"	"	"	"	"	"	3286.2	3432.4	3432.4	3432.4	3521.6	"	"
1944-45	"	"	"	"	"	"	3114.7	3255.9	3039.1	2737.1	3001.8	"	"
1945-46	"	"	"	"	"	"	"	2802.2	2484.5	2484.5	2976.1	"	"
1946-47	"	"	"	"	"	"	"	"	"	"	3206.5	"	"
1947-48	"	"	"	"	"	"	"	"	"	"	3197.4	"	"
1948-49	"	"	"	"	"	"	"	"	"	"	3194.4	"	"
1949-50	"	"	"	"	"	"	"	"	"	"	2484.5	"	"
1950-51	"	"	"	"	"	"	"	"	"	"	2996.8	"	"
1951-52	"	"	"	"	"	"	"	"	"	"	3196.9	"	"
1952-53	"	"	"	"	"	"	3432.4	"	"	"	2762.3	"	"
1953-54	"	"	"	"	"	"	3114.7	"	"	"	2989.2	"	"
1954-55	"	"	"	"	"	"	3200.4	3276.1	3190.4	2787.0	2916.1	"	"
1955-56	"	"	"	"	"	3029.0	2071.1	1113.2	54.4	0.0	655.4	2302.5	"
1956-57	"	"	"	"	"	3432.4	3114.7	2802.2	2484.5	2484.5	3533.2	3533.2	"
1957-58	"	"	"	"	"	"	"	"	"	"	3357.2	"	"

TABLE 7

COLUMBIA RIVER TREATY
COMPOSITE OPERATING RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1976-77 OPERATING YEAR

FLOW YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
1928-29	7814.6	7444.7	7110.0	6904.0	6556.0	5504.2	5425.7	4972.3	4977.4	4127.6	5493.2	6957.3	7814.6
1929-30	,,	,,	,,	,,	,,	,,	4623.1	4622.5	3064.3	2699.3	3998.8	5929.8	,,
1930-31	,,	,,	,,	,,	,,	,,	5682.9	4982.4	4916.9	4072.2	5570.2	7092.2	,,
1931-32	,,	,,	,,	,,	,,	,,	391.5	290.4	0.0	7.3	2261.0	5193.4	,,
1932-33	,,	,,	,,	,,	,,	,,	231.6	0.0	8.6	3.0	1212.4	4760.0	,,
1933-34	,,	,,	,,	,,	,,	,,	0.0	,,	.7	29.2	256.9	4650.9	,,
1934-35	,,	,,	,,	,,	,,	,,	,,	,,	0.0	0.0	438.9	4141.6	,,
1935-36	,,	,,	,,	,,	,,	,,	5343.4	4365.7	3451.0	2648.7	3943.8	6715.0	,,
1936-37	,,	,,	,,	,,	,,	,,	5808.9	5078.2	4876.6	4052.5	5576.1	7020.1	,,
1937-38	,,	,,	,,	,,	,,	,,	0.0	0.0	0.0	165.3	1447.8	5327.9	,,
1938-39	,,	,,	,,	,,	,,	,,	4886.1	3828.1	2916.3	2477.9	3987.1	5431.1	,,
1939-40	,,	,,	,,	,,	,,	,,	5093.0	4780.9	3653.4	3269.5	4374.2	6433.6	,,
1940-41	,,	,,	,,	,,	,,	,,	4967.0	3838.1	4521.7	3915.1	5659.3	6938.4	,,
1941-42	,,	,,	,,	,,	,,	,,	92.6	1190.0	1876.8	2251.5	3775.4	5818.9	,,
1942-43	,,	,,	,,	,,	,,	,,	398.6	797.2	978.5	1116.1	1939.7	4557.3	7783.4
1943-44	7783.4	,,	,,	,,	,,	,,	5471.1	4957.2	4906.8	4094.4	5653.5	6994.6	7814.6
1944-45	7814.6	,,	,,	,,	,,	,,	5491.4	4982.4	4233.2	3936.0	4692.3	6684.6	7806.5
1945-46	7806.5	,,	,,	,,	,,	,,	430.9	0.0	0.0	0.8	1087.5	5067.7	7814.6
1946-47	7814.6	,,	,,	,,	,,	,,	234.3	,,	15.5	83.7	2101.3	5477.2	,,
1947-48	,,	,,	,,	,,	,,	,,	1033.4	1425.0	381.1	728.3	1878.6	5343.4	,,
1948-49	,,	,,	,,	,,	,,	,,	1165.0	2116.5	1290.9	1616.6	3632.4	6509.7	7813.1
1949-50	7813.1	,,	,,	,,	,,	,,	1250.8	1071.3	718.7	994.1	2416.5	5231.9	7814.6
1950-51	7814.6	,,	,,	,,	,,	,,	135.0	0.0	0.0	0.0	1403.6	4868.0	,,
1951-52	,,	,,	,,	,,	,,	,,	524.7	317.0	258.3	769.2	2408.2	5692.7	,,
1952-53	,,	,,	,,	,,	,,	,,	3490.0	1241.8	1251.5	1607.1	2336.8	5485.2	,,
1953-54	,,	,,	,,	,,	,,	,,	1775.7	898.3	9.6	273.4	1505.3	3697.8	,,
1954-55	,,	,,	,,	,,	,,	,,	1181.9	1550.4	1609.9	1607.9	2863.0	5170.3	,,
1955-56	,,	,,	,,	,,	,,	,,	0.0	0.0	0.0	0.0	1241.5	5193.1	,,
1956-57	,,	,,	,,	,,	,,	,,	82.3	38.8	,,	,,	2057.6	6122.5	,,
1957-58	,,	,,	,,	,,	,,	,,	1314.3	1043.5	964.4	1486.5	3278.3	6648.0	,,

C O L U M B I A R I V E R T R E A T Y

AGREEMENT

on

DETERMINATION OF DOWNSTREAM POWER BENEFITS

RESULTING FROM CANADIAN STORAGE

FOR OPERATING YEAR 1976-77

The Columbia River Treaty between Canada and the United States requires that the downstream power benefits resulting from operating plans agreed to by the Entities will be determined in advance by the Entities. The determination of downstream power benefits for the operating year 1976-77 is covered in the attached report, dated January 31, 1972, and is agreed to by the United States Entity and the Canadian Entity.

Ray G. Williston
Chairman
Canadian Entity

March 21, 1972
(Date signed)

H. R. Richmond
Chairman
United States Entity

MAR 16 1972
(Date signed)

DETERMINATION OF DOWNSTREAM POWER BENEFITS RESULTING FROM CANADIAN STORAGE
FOR OPERATING YEAR 1976-77
January 31, 1972

I. Introduction.

The Treaty between Canada and the United States of America and related documents relating to the cooperative development of the water resources of the Columbia River Basin requires that downstream power benefits from Canadian storage be determined in advance by the two entities. The purpose of this report is to set out the results of downstream power benefit computations for the sixth succeeding year, 1976-77, and for the storages for which the Assured Operating Plan was developed.

The procedures followed in the benefit studies are those provided in Annex A, Paragraph 7; in Annex B of the Treaty; in Articles VIII, IX, and X of the Protocol; and in the document, "Procedures for the Determination of Downstream Power Benefits Resulting from Canadian Storage," dated September 9, 1968.

The Canadian Entitlement Benefits were computed as follows:

Step I — based on the total U.S. planned hydro and thermal system with 15-1/2 maf of Canadian storage operated for optimum generation in both countries (77-41 study).

Step II — based on the U.S. base hydro and thermal system with 15-1/2 maf of Canadian storage operated for optimum generation in both countries (77-42 study).

Step III — based on the U.S. base hydro and thermal system operated for optimum generation in U.S. (77-13 study).

II. Results of Study.

The Canadian Entitlement, which is one-half the total computed downstream power benefits, was computed to be:

Dependable Capacity = 1,424 mw

Average Annual Energy = 725 mw

III. Computation of Entitlement.

The following Tables and Charts are attached and summarize the study.

Table 1. Computation of Canadian Entitlement

The essential elements used in the computation of the Canadian Entitlement as provided in Paragraph 2 and 3 of Annex B are shown in this table.

Table 2. Summary of Power Regulations for the Computation of Canadian Entitlement to Downstream Benefits

This table summarizes the Step I, II, and III regulations by projects.

Table 3. Determination of Load Shape for Steps II and III, Canadian Entitlement Computation

The load shape for Steps II and III carry the same ratio between each month and the annual average as does the Pacific Northwest area load. The Northwest area firm loads on this table were based on the current forecast data. The Grand Coulee pumping load is also included in this estimate.

The firm load for Steps II and III is computed as follows:

(1) Estimate the hydro nominal prime power for the critical period;

(2) Add the thermal from Step I less reserve;

(3) Multiply (2) by the ratio of the area annual average firm load to the area critical period firm load to obtain the annual average firm load for Steps II and III (the ratios used in this study were 0.98808 and 0.96110, respectively);

(4) Pro rate the average annual Step II or III load determined in (3) by months in the ratio that each monthly area load bears to the annual average area load; and

(5) Subtract the thermal in each month to obtain the monthly firm hydro load. The average annual hydro load for Steps II and III also becomes the firm energy considered usable according to Annex B, Paragraph 3(a).

Chart 1 & 2. Secondary Energy Duration Curve, Steps II and III

These charts are duration curves of the secondary energy for Steps II and III. The secondary energy is the capability each month which exceeds the firm hydro loads shown in Table 3. The usable secondary energy shown in average megawatts for each step is computed in accordance with Annex B, Paragraphs 3 (b) and 3 (c). The "other usable secondary" was computed on the basis of 40% of the remainder after thermal replacement. The thermal replacement was limited to the existing and scheduled thermal energy capability after allowance for reserve, except when an energy surplus condition occurs; then the thermal replacement must not exceed the total of the thermal energy capability and the estimated interruptible load.

Thermal Energy Capability - mw	3,812
Less 5% Reserve - mw	191
Less Minimum Thermal Generation	1,621
Thermal Replacement - mw	2,000

The following tabulation shows the ordinate values for usable secondary energy:

	Step II	Step III
Thermal Replacement	2,000	2,000
Other	1,440	2,189
Total - mw	3,440	4,189

TABLE 1

COMPUTATION OF CANADIAN ENTITLEMENT

Generation Figures are in Average Megawatts; Load Factors, in Percent

Determination of Dependable Capacity Credited to Canadian Storage

Critical Period Average Rate of Generation with Canadian Storage, Step II	8,952
Critical Period Average Rate of Generation without Canadian Storage, Step III	6,958
Gain Due to Canadian Storage	1,994
Estimated Average Critical Period Load Factor -- Percent	70.019
Dependable Capacity Gain 1/	2,848
Canadian Share of Dependable Capacity	1,424

Determination of Increase in Average Annual Usable Energy

Step II (with Canadian Storage)

Annual Firm Hydro Energy	8,821
Thermal Replacement Energy	1,077
Other Usable Secondary Energy	517
System Annual Average Usable Energy	10,415

Step III (without Canadian Storage)

Annual Firm Hydro Energy	6,610
Thermal Replacement Energy	1,418
Other Usable Secondary Energy	937
System Annual Average Usable Energy	8,965

Average Annual Usable Energy Gain	1,450
Canadian Share of Average Annual Energy Gain	725

1/ Dependable capacity gain credited to Canadian storage equals gain in critical period average rate of generation divided by the estimated average critical period load factor.

SUMMARY OF POWER REGULATIONS FOR 1976-77
FOR THE COMPUTATIONS OF CANADIAN ENTITLEMENT
TO DOWNSTREAM BENEFITS

TABLE 2

PROJECTS:	BASIC DATA		STEP I			STEP II				STEP III			
	Number of Units	Nominal Installed Peaking Capacity mw	Usable Storage 1000 AF	January Peaking Capability mw	Critical Period Average Generation mw	Usable Storage 1000 AF	January Peaking Capability mw	Critical Period Average Generation mw	Average Annual Generation mw	Usable Storage 1000 AF	January Peaking Capability mw	Critical Period Average Generation mw	Average Annual Generation mw
CANADIAN													
Mica			7,008			7,008							
Arrow			7,145			7,145							
Duncan			1,347			1,347							
Subtotal			15,500			15,500							
BASE SYSTEM FEDERAL													
Hungry Horse	4	328	3,161	160	102	3,008	230	115	102	3,008	278	212	101
Albeni Falls	3	49	1,155	24	23	1,155	20	22	22	1,155	23	25	24
Grand Coulee	21+2	4,283	9,232	3,989	2,029	5,072	4,211	1,812	2,338	5,072	4,035	1,264	2,141
Chief Joseph	16-19	1,389		1,389	1,024		1,389	943	1,170		1,389	664	1,037
Ice Harbor	6	693		693	219		693	225	304		693	171	304
McNary	14	1,127		1,127	648		1,127	594	764		1,127	429	714
John Day	16	2,484	535	2,484	922		2,484	927	1,271		2,484	678	1,234
The Dalles	22	1,943		1,943	733		1,943	709	959		1,943	531	934
Bonneville	10	574		574	566		574	558	663		574	470	546
Subtotal		12,870	10,083	12,383	6,266	9,235	12,671	5,905	7,491	9,235	12,546	4,452	7,055
BASE SYSTEM NON-FEDERAL													
Kootenay Lake (Canadian)			787			427				427			
Kerr	3	185	1,219	172	114	1,219	176	104	122	1,219	179	151	122
Thompson Falls	6	40		40	35		35	37	32		38	37	31
Noxon Rapids	4	430	231	426	174		430	160	217		430	179	218
Cabinet Gorge	4	230		230	112		230	99	129		230	111	129
Box Canyon	4	71		71	47		71	46	50		71	52	49
Coeur d'Alene & Long Lake			327			223				223			
Wells	10	820		820	440		820	411	517		820	287	475
Chelan	2	54	677	50	38	676	51	38	46	676	52	49	45
Rocky Reach	11	1,291		1,291	646		1,291	607	771		1,291	426	717
Rock Island	10	159		155	155		157	156	150		158	124	140
Wanapum	10	986		986	560		986	525	661		986	365	599
Priest Rapids	10	912		912	528		912	496	632		912	356	565
Brownlee	4	450	980	450	226	974	450	256	262	974	450	254	259
Oxbow	4	220		220	94		220	112	119		220	115	119
Subtotal		5,848	4,221	5,823	3,169	3,519	5,829	3,047	3,608	3,519	5,837	2,506	3,468
TOTAL BASE SYSTEM HYDRO		18,718	29,804	18,206	9,435	28,254	18,500	8,952	11,189	12,754	18,383	6,958	10,503
ADDITIONAL STEP I PROJECTS													
Libby	4	483	4,965	201	189								
Boundary	4	650		650	361								
Spokane River Plants		153		147	89								
Hells Canyon	3	450		450	179								
Dworshak	3	460	2,015	407	160								
Lewiston	2	6		6	6								
Lower Granite	3	466		466	218								
Little Goose	3	466		466	214								
Lower Monumental	3	466		466	218								
Pelton and Round Butte		454	274	423	132								
Subtotal		4,054	7,254	3,682	1,766								
Independent Resources		4,855	8,489	3,679	1,718								
TOTAL HYDRO RESOURCES		27,427	45,547	25,567	12,919								
MISCELLANEOUS CONTRACTS				54	16								
THERMAL RESOURCES													
Existing Thermal Plants				401	255								
Centralia #1 & #2				1,400	1,260								
Trojan				1,130	1,017								
Jim Bridger 1, 2 & 3				1,500	1,280								
TOTAL THERMAL RESOURCES				4,431	3,812								
TOTAL IMPORTS				70	472								
TOTAL RESOURCES (HYDRO AND THERMAL)				30,122	17,219								
RESERVES 1/				-2,156	-191								
RESOURCES AVAILABLE FOR LOAD				27,966	17,028								
ESTIMATED LOAD													
Pacific Northwest Area				26,952	16,659								
SYSTEM LOAD				26,952	16,659								
SURPLUS OR (DEFICIT)				1,014	369								
CRITICAL PERIOD													
Starts :				August 16, 1928			September 1943				September 16, 1936		
Ends :				February 1932			April 1945				April 15, 1937		
Length (Months):				42-1/2 Months			20 Months				7 Months		
STUDY IDENTIFICATION				77-41			77-42				77-13		

1/ Peak reserves are 8% of peak load; energy reserves are 5% of thermal plant energy capability not including NPR.

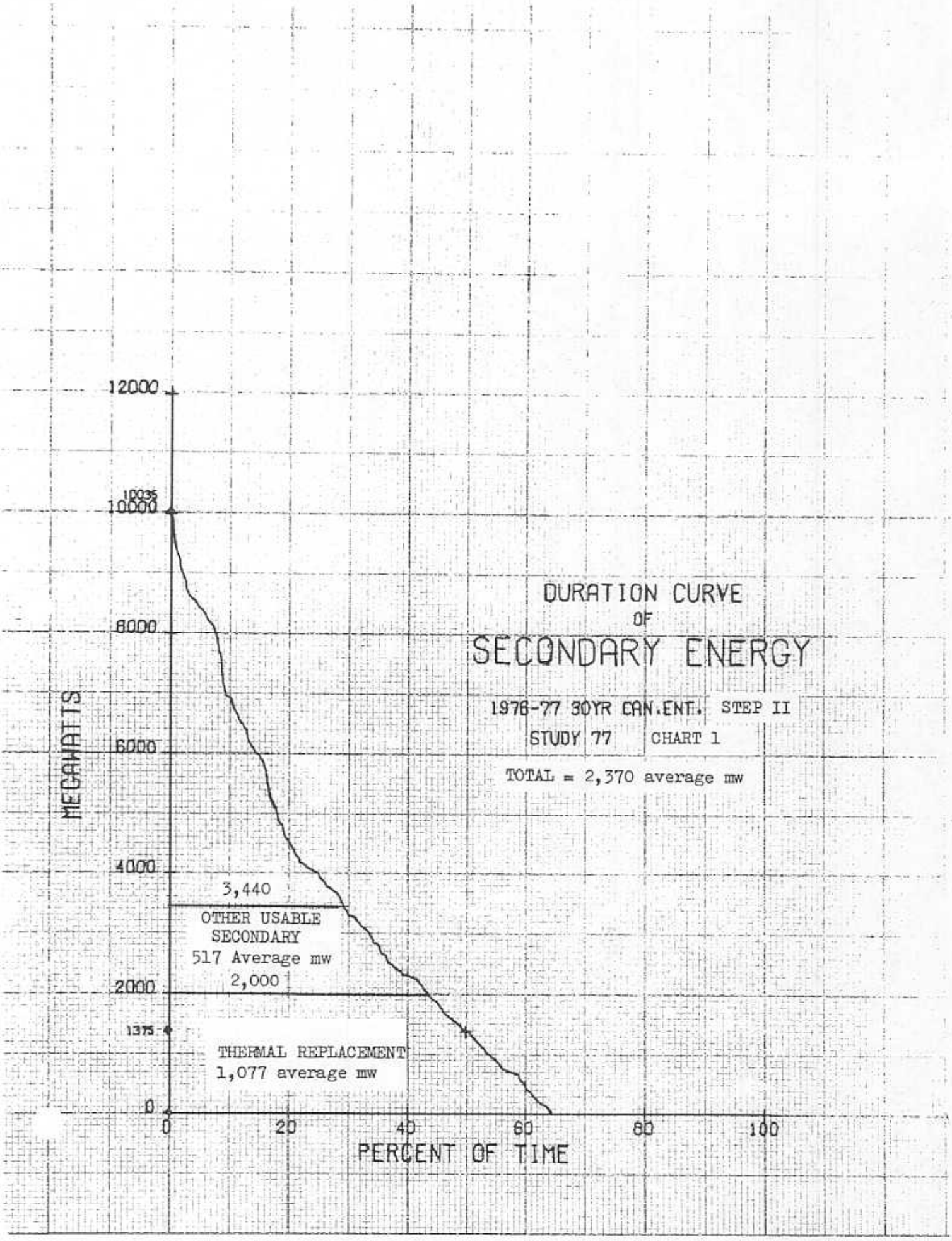
DETERMINATION OF LOAD SHAPE FOR STEP II AND III
1976-77 CANADIAN ENTITLEMENT COMPUTATIONS

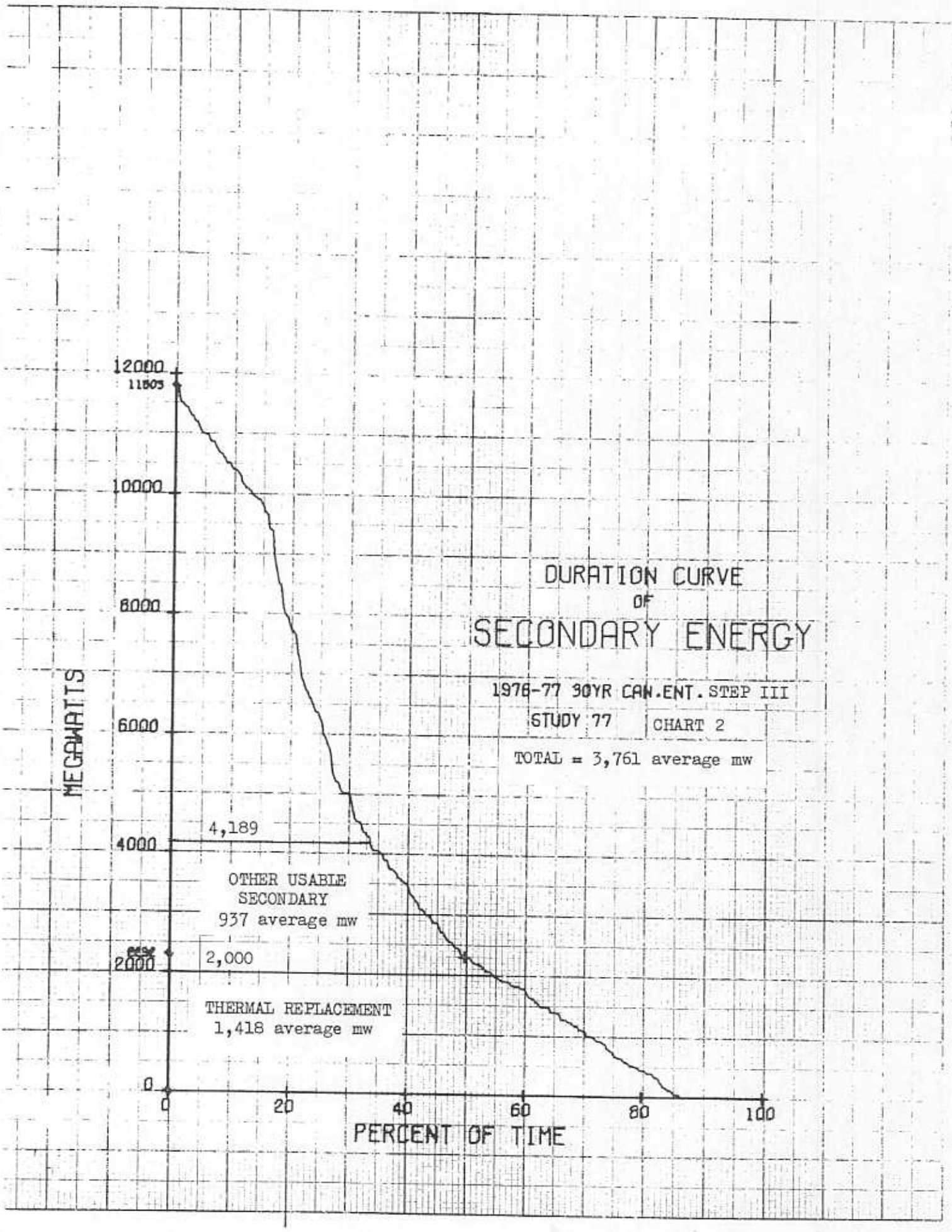
	Pacific Northwest Area Load			Step II			Step III		
	Peak	Avg.	Load Factor %	Total Firm Load 1/	Thermal Firm Load	Hydro Firm Load 1/	Total Firm Load 1/	Thermal Firm Load	Hydro Firm Load
July	21,168 *	15,386	72.68	10,038	2,000	8,038	7,987	2,000	5,987
Aug. 1-15	21,490 *	15,479	72.03	10,099	2,000	8,099	8,035	2,000	6,035
Aug. 16-31	21,444 *	15,468	72.13	10,092	2,000	8,092	8,029	2,000	6,029
Sept. 1-15	21,692 *	15,323	70.64	9,997	2,000	7,997	7,954	2,000	5,954
Sept. 16-30	21,692 *	15,290	70.49	9,996	2,000	7,996	7,937	2,000	5,937
October	22,993 *	15,843	68.90	10,337	2,000	8,337	8,224	2,000	6,224
November	24,804 *	16,990	68.50	11,085	2,000	9,085	8,819	2,000	6,819
December	26,714 *	18,200	68.13	11,874	2,000	9,874	9,447	2,000	7,447
January	26,952 *	18,841	69.91	12,293	2,000	10,293	9,780	2,000	7,780
February	25,429 *	18,005	70.80	11,747	2,000	9,747	9,346	2,000	7,346
March	24,372 *	17,097	70.15	11,155	2,000	9,155	8,875	2,000	6,875
Apr. 1-15	23,313 *	16,399	70.34	10,699	2,000	8,699	8,512	2,000	6,512
Apr. 16-30	23,314 *	16,378	70.25	10,686	2,000	8,686	8,501	2,000	6,501
May	23,174 *	15,824	68.28	10,324	2,000	8,324	8,214	2,000	6,214
June	22,268 *	15,755	70.75	10,279	2,000	8,279	8,178	2,000	6,178
Crit. Period Avg.		16,659	70.019	10,952	2,000	8,952	8,958	2,000	6,958
Annual Average		16,586		10,821	2,000	8,821	8,610	2,000	6,610
January Peak	26,952 *								
Step I Critical Period	Aug. 16, 1928 - Feb. 29, 1932 (42-1/2 Months)			Critical Period Sept. 1943 - Apr. 1945 (20 Months)			Critical Period Sept. 16, 1936 - Apr. 15, 1937 (7 Months)		

1/ Total firm load of Step II and Step III systems, computed for each system to have an average energy load equivalent to the average energy capability within the critical period and to bear a constant ratio, month by month, to the Pacific Northwest Area Load.

* Figures so marked are peak megawatts. All other figures are monthly or semi-monthly energy in average megawatts.

TABLE 3


DURATION CURVE
OF
SECONDARY ENERGY
1976-77 30YR CAN.ENT. STEP II
STUDY 77 CHART 1
TOTAL = 2,370 average mw
MEGAWATTS
12000
10000
8000
6000
4000
2000
0
10035
3,440
OTHER USABLE
SECONDARY
517 Average mw
2,000
1375
THERMAL REPLACEMENT
1,077 average mw
0
20
40
60
80
100
PERCENT OF TIME


12000
11503
10000
8000
6000
4000
2000
0
MEGAWATTS
DURATION CURVE
OF
SECONDARY ENERGY
1976-77 30YR CAN.ENT. STEP III
STUDY 77
CHART 2
TOTAL = 3,761 average mw
4,189
OTHER USABLE
SECONDARY
937 average mw
2,000
THERMAL REPLACEMENT
1,418 average mw
0
20
40
60
80
100
PERCENT OF TIME

Ken Ennis

UNITED STATES ENTITY

COLUMBIA RIVER TREATY

Address reply to:
THE CHAIRMAN

P.O. Box 3621

Portland, Oregon 97208

CHAIRMAN:
Administrator,
Bonneville Power Administration
Department of The Interior

MEMBER:
Division Engineer,
North Pacific Division
Corps of Engineers
Department of the Army

February 15, 1972

Memorandum

To: Bernard Goldhammer and Gordon H. Fernald, Coordinators
Columbia River Treaty

From: H. M. McIntyre, Chairman
Columbia River Treaty Operating Committee

Subject: Downstream Power Benefits for 1976-77 Operating Year

Introduction

Power generation at Mica is scheduled for 1976-77 and the 1976-77 Assured Operating Plan has been designed in accordance with Annex A, paragraph 7, to achieve optimum power generation at-site in Canada and downstream in the United States of America. This change in operation of Canadian storage from that featured in the 1975-76 AOP is recognized in Annex A, paragraph 7, and is subject to certain limits set out in that paragraph. On 16 November 1971, the Entities agreed that the provisions of Annex A, paragraph 7, would be observed for 1976-77 and all ensuing operating years by following the procedure set out in the document, "Operating Plans with Mica Generation," dated 15 November 1971.

The Operating Committee was instructed accordingly and this document sets out the results of the studies carried out by the Committee to insure that the changed operation of Canadian storage falls within the limits allowed by Annex A, paragraph 7.

The "Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1976-77" is attached.

Measurement of Change

The measurement of change of operation laid down in Annex A, paragraph 7, and in the document "Operating Plans with Mica Generation" dated 15 November 1971, is in terms of reduction, if any, in downstream power benefits determined in accordance with the Treaty.

Results of Studies

In accordance with Annex B, paragraph 5, of the Treaty, the downstream power benefits (Canadian Entitlement) for the operating year 1976-77 were determined on the basis of the Assured Operating Plan for that year and have been established as:

Dependable Capacity	:	1,424 mw
Average Annual Energy	:	725 mw

The above figures were derived from Study 8 (15½ maf operated for optimum generation in U.S. and Canada) and Study 5 as set out in the document dated 15 November 1971.

In accordance with paragraph 8 of that document, the minimum permitted downstream power benefits for 1976-77 are represented by the quantity Z derived from present year's Study 3 (15 maf operated for optimum generation in U.S.) and Study 5. The committee found these figures (Canadian Entitlement) to be:

Dependable Capacity	:	1,402 mw
Average Annual Energy	:	708 mw

The change of operation of Canadian storage is therefore within the permitted range.

In accordance with paragraph 7 of the document, Operating Plans with Mica generation, dated 15 November 1975, the Operating Committee also compared the capacity and the energy derived from Study 2 and Study 5 (15½ maf operated for optimum generation in the U.S.) with the measured downstream power benefits associated with the 1976-77 AOP.

The figures from Study 2 and Study 5 (Canadian Entitlement) were as follows:

Dependable Capacity	:	1,425 mw
Average Annual Energy	:	717 mw

The Committee considers that the comparison indicates no significant differences between the two measurements and therefore no compensation is due in respect of reduction of the Canadian Entitlement under paragraph A 4 of the Terms of Sale dated 22 January 1964.

With the submission of this paper, the Committee considers that it has completed all eight of the studies it was required to do in connection with the 1976-77 AOP and associated determination of downstream power benefits.

However, our examination of what happened to the actual planned system (Step I system) for 1976-77 indicated there would be small losses with the Mica storage operation. The January peak loss amounted to 40 megawatts and the firm energy loss to about 8 average megawatts. There were indications also that there would be small reductions in the average annual usable energy. These amounts of losses are almost insignificant when compared to the total system peak resources available for load of nearly 28,000 megawatts and 17,028 average megawatts of firm energy generation.

H. M. McIntyre
Chairman, Operating Committee
Columbia River Treaty

Enclosure

cc:
Operating Committee members
H. Kropitzer, Sec., U.S. Entity - AD

UNITED STATES GOVERNMENT

Memorandum

DATE : October 1, 1971

In reply refer to : PRC

TO : H. M. McIntyre, Chief
Branch of Power Resources - PR

FROM : Hugh H. Kasai, Hydraulic Engineer
Power Capabilities Section - PRC

SUBJECT: Determination of Loss in Downstream Power Benefits Resulting from a 3 MAF Reduction in Canadian Storage

The downstream power benefit study in which Canadian Storage is reduced 3 maf, from 15.5 maf to 12.5 maf, has been completed using the 1976-77 operating year. The procedures used in this benefit study were consistent with the previously completed 15.5 maf and 15.0 maf benefit studies.

The Canadian Shares of the Dependable Capacity and Average Annual Energy Gains are one-half the total computed downstream power benefits as determined by the Step 2 and Step 3 studies. For 15.5 maf and 12.5 maf, these gains and the losses due to the 3 maf reduction are as follows:

	Canadian Share of Gains	
	Dependable Capacity MW	Average Annual Energy MW
15.5 maf	1,425	717
12.5 maf	1,299	674
Loss Due to 3.0 maf	126	43

With the 3 maf reduction in Canadian storage, both Mica and Arrow become "annual reservoirs." For this reason, in determining the critical period, both the one-year period, 1936-37, and the two-year period, 1943-45, were studied. The prime power for the one-year critical period was approximately 194 average megawatts greater than that for the twenty months of the two-year period.

PRC:HHKasai:cr 10/1/71