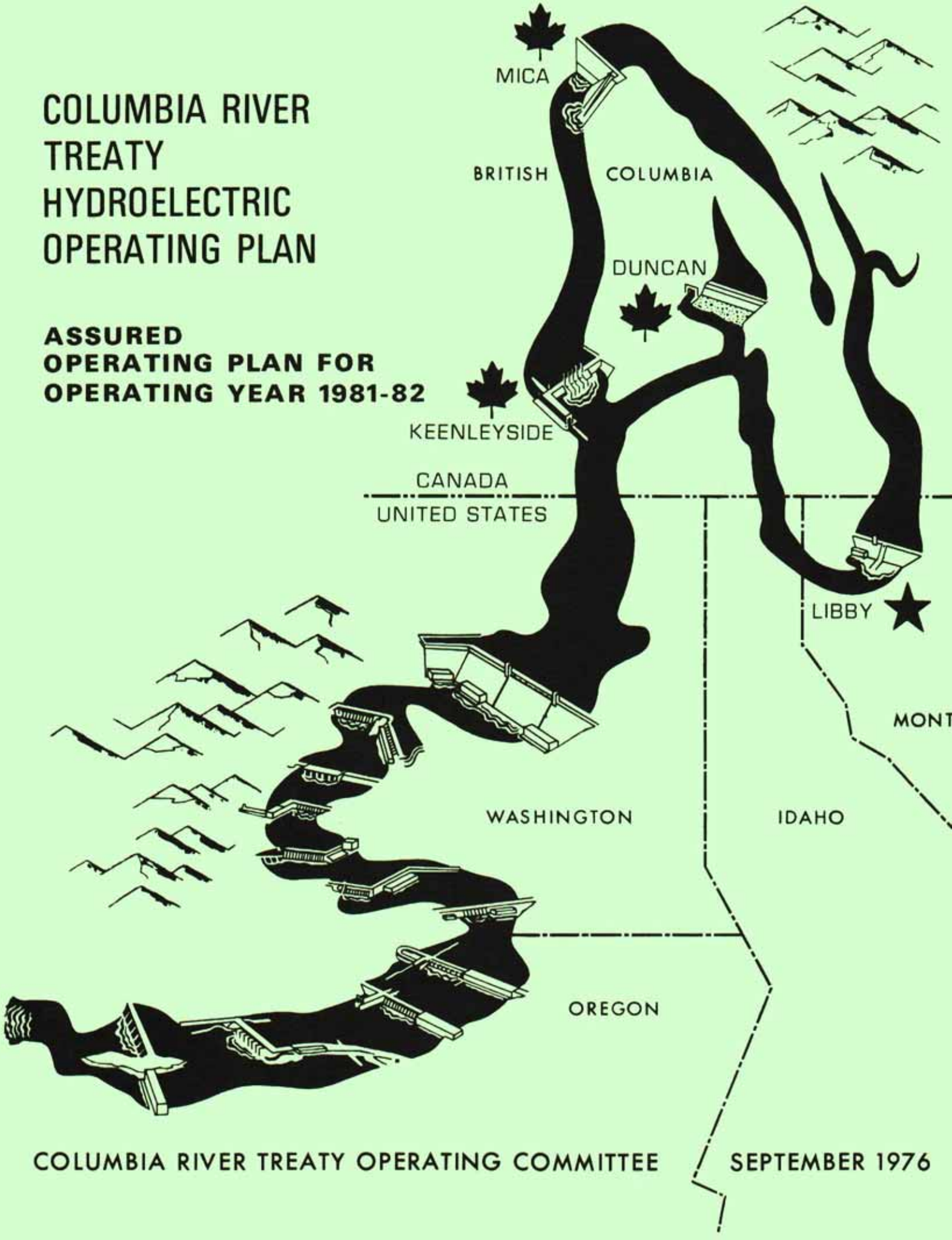
COLUMBIA RIVER TREATY HYDROELECTRIC OPERATING PLAN

ASSURED OPERATING PLAN FOR OPERATING YEAR 1981-82



COLUMBIA RIVER TREATY OPERATING COMMITTEE

SEPTEMBER 1976

COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN

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TABLE OF CONTENTS

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Operating Year 1981-82

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 1981-82 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 1981-82.

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] Terms of Sale,[4] and the Columbia River Treaty Flood Control Operating Plan.[5]

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 Upper Rule 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 40-year System Regulation Study[6] 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

In accordance with Annex A, Paragraph 7, of the Treaty, the Columbia River Operating Committee conducted system regulation studies reflecting Canadian storage operation for optimum generation in both Canada and the United States. Downstream power benefits were computed with the Canadian storage operation based on the operating rules specified herein. There is a reduction of 3.0 average megawatts of average annual usable energy in the Canadian Entitlement of downstream power benefits. This is within the limits specified by the Treaty.

System Regulation Studies for the Assured Operating Plan were based on 1981-82 estimated loads and resources in British Columbia and in the United States Pacific Northwest System. The Entities have agreed that the 1981-82 Assured Operating Plan would be based on a 40-year stream-flow period and an operating year of 1 August to 31 July. Historical

flows for the period August 1928 through July 1968, modified to estimated 1981-82 conditions,[7] were used.

The Critical Rule Curve for these studies was determined from Bonneville Power Administration Study 82-41. The study indicated a 42½-month critical period for the United States system 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, individual project flood control criteria were followed. Although only 7.0 million acre-feet of usable storage at Mica is committed for power operation purposes under the Treaty, the studies incorporate Upper Rule Curves designed to evacuate Mica storage up to the full storage of 12 million acre-feet as specified by the Columbia River Treaty Flood Control Operating Plan. Flood Control and Variable Refill Criteria are based on historical inflow volumes.

DETERMINATION OF OPTIMUM GENERATION IN CANADA AND THE UNITED STATES

In order to determine whether optimum generation in both Canada and the United States was achieved in the system regulation studies, the following three quantities were computed for both the Canadian and United States systems:

(a) firm energy capability

(b) January peaking capability

(c) average annual usable secondary energy

In the studies for the 1981-82 Assured Operating Plan the Canadian storage operation was modified to achieve a weighted sum of the three quantities that was greater than the weighted sum achieved under an

operation of Canadian storage for optimum generation in the United States alone.

The table on page 5 shows the results from the studies adopted for the 1981-82 Assured Operating Plan and from studies designed to achieve optimum generation in the United States.

The Columbia River Treaty Operating Committee agreed that for the 1981-82 Assured Operating Plan the three quantities would be assigned the following relative values:

> firm energy (Av. MW): January peaking capability (MW): average annual usable secondary energy (Av. MW) were related in the ration 3:1:2.

The three quantities were added after weighting on this basis and there was a net gain to the combined Canadian and United States systems with the study designed for optimum generation in Canada and the United States.

OPERATING RULE CURVES

The operation of Canadian storage during the 1981-82 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

COMPARISON OF STUDY RESULTS

	Optimum Generation in Canada and the United States Study No. 82-41	Optimum Generation in the United States Study No. 82-11	Loss	Gain	Net Gain
1. Firm Energy Capability (Av. MW)					
U.S. System	12,425	12,427	2	-	
Canada (Mica)	806	787	-	19	
Total (Av. MW)	13,231	13,214	2	19	17
2. January Peaking Capacity (MW)					
U.S. System	30,886	30,864	-	22	
Canada (Mica)	1,604	1,564	-	40	
Total (MW)	32,490	32,428	-	62	62
3. Average Annual Usable Secondary Energy (Av. MW)					
U.S. System	3,249	3,243	-	6	
Canada (Mica)	79	95	16	-	
Total (Av. MW)	3,328	3,338	16	6	(10)

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 in 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 failing to refill storages and thereby jeopardizing 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 1930-31 water year, the system's second lowest historical volume of inflow for the period January through July as measured at The Dalles, Oregon. The tabulation of the composite Assured Refill Curve for the whole Canadian storage is included as Table 2.

The curve was based on higher flows than the minimum discharge requirements for the period January through July. The schedule of outflows is the same as the Power Discharge Requirements used in computing the Variable Refill Curve discussed in (2) below when The Dalles volume runoff is at 80 million acre-feet.

(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 historical 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 80 million acre-feet, the discharge used was that required to meet firm loads while refilling at 80 million acre-feet. In years when the runoff volume at The Dalles exceeded 95 million acre-feet the Power Discharge Requirement was the project minimum outflow. For intermediate volumes the Power Discharge Requirement was interpolated linearly between the values shown below. The following are the January through July Power Discharge Requirements used in computing the Variable Refill Curves.

Power Discharge Requirements in cfs
For January through July Volume at The Dalles

	80 MAF			90 MAF			95 MAF
Project	Jan Feb Mar	Apr May Jun	Jul	Jan Feb Mar	Apr May Jun	Jul	All Periods
Mica	3,000	11,600	14,600	3,000	6,300	8,300	3,000
Arrow	5,000	17,500	34,500	5,000	9,600	14,000	5,000
Duncan	100	1,700	1,700	100	900	900	100

Composite Variable Refill Curves for the whole of Canadian storage for the 40 years of historical record are recorded in Table 3. These illustrate the probable range of these curves based on historical conditions.

In the actual operation in 1981-82, the Power Discharge Requirements will be based on the forecast of unregulated runoff at The Dalles.

(c) Upper Rule Curve. The Upper Rule Curves[8] give end-of-month storage content to which each individual Canadian storage project shall be evacuated for flood control and other requirements. The Upper Rule Curves used in the studies were based upon Flood Control Storage Reservation Diagrams contained in the Columbia River Treaty Flood Control Operating Plan and analysis of system flood control simulations. Flood control curves for the 40-year study period are shown on Tables 4, 5 and 6. Table 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. During the period 1 August through 31 December, 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, unless the Variable Refill Curve is below the above-determined value; then it is defined by the Variable Refill Curve, but in no case shall it be lower than the lowest Critical Rule Curve developed for such year during the period January 1 through March 31. The Operating Rule Curve meets all requirements for flood control operation (except as noted in paragraph (d) of the Operating Rules). Composite Operating Rule Curves for the whole of Canadian storage for all 40 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 1981-82 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, operating constraints, and the criteria for the Mica project listed in (e) below.

(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, except that Mica Reservoir will continue to be operated in accordance with (e) below, so as to optimize generation at site as well as downstream in the United States. In the event the Mica operation results in less than that project's proportional share of draft from the whole of Canadian storage, compensating drafts will be made from Arrow to the extent possible.

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

(e) Mica project will be operated to the following monthly criteria as qualified in (1) to (3) below:

Mica Project Operating Criteria

Month	Target End-of-Period Storage Content (KSFD)	Target Average Outflow (CFS)	Minimum Outflow (CFS)
August 1-15	10,121.1	N/A	10,000
August 16-31	10,121.1	N/A	10,000
September	10,121.1	N/A	10,000
October	N/A	15,000	10,000
November	N/A	18,000	10,000
December	N/A	21,000	15,000
January	N/A	21,000	15,000
Feburary	N/A	21,000	15,000
March	N/A	17,000	15,000
April 1-15	N/A	15,000	15,000
April 16-30	N/A	15,000	10,000
May	N/A	10,000	10,000
June	N/A	10,000	10,000
July	10,121.1	N/A	10,000

(N/A - not applicable)

(1) Mica monthly outflows will be increased in the months from October to June if required to avoid violation of the Upper Rule Curve.

(2) Mica monthly average outflows will be increased in the months from July to March and the month of June if the Arrow reservoir storage in the previous month is within the following limits.

Month	Arrow Reservoir End-of-Month Storage Content (KSFD)	Mica Outflow in Next Month (CFS)
August	0 - 1,000	30,000
	1,001 - 2,100	20,000
September	0 - 2,000	30,000
October	0 - 1,700	34,000
November	0 - 400	34,000
	401 - 1,500	31,000
December	0 - 2,800	34,000
January	0 - 1,300	32,000
February	0 - 300	25,000
March	-	-
April	-	-
May	0 - 500	24,000
June	0 - 1,000	34,000
	1,001 - 2,100	20,000
July	0 - 1,000	34,000
	1,001 - 2,100	20,000

If the above table indicates the Mica outflow in August should be increased, the higher outflow applies in the first half only, and the second half of August will be examined using the August 15 Arrow content and the same criteria as for the first half.

(3) Under this Assured Operating Plan, Mica storage releases in excess of the 7 million acre-feet that are required to maintain the minimum Mica outflows specified under this plan will be retained in the Arrow reservoir, subject to flood control criteria at Arrow. The total combined storage draft from Mica and Arrow will not exceed 14.1 million acre-feet unless flood control criteria will not permit the additional Mica storage releases for minimum flow purposes to be retained at Arrow.

The present British Columbia Hydro and Power Authority generation plans recommend construction of the Revelstoke project with an initial in-service date of September 1982. The Revelstoke reservoir would have a total storage content of approximately 4.0 million acre-feet. Under the present plan the filling of this reservoir would occur during the period from mid-April through June of 1982. Since the reservoir will be filled with inflow that is either excess to the needs of both the United States and Canada or from a draft of British Columbia Hydro and Power Authority's 5.0 million acre-feet in Mica, it was not necessary to include Revelstoke reservoir initial filling in this Assured Operating Plan. Any modification to the operation of Mica reservoir required to accomodate the initial filling of the Revelstoke reservoir will be included in the 1981-82 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 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 1981-82 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 1981, 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 1981-82 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 1981-82 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 Flood Control Refill Curves,[5] 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 Sales -- Attachment to Exchange of Notes dated 22 January 1964.

[5] Columbia River Treaty Flood Control Operating Plan dated October 1972.

[6] BPA Hydroelectric Power Planning Program, Assured Operating Plan 40-year System Regulation Study 82-41, dated 27 July 1976.

[7] Provisional Report on Modified Flows at Selected Sites, 1928 to 1968 for the 1970 and 2020 Level of Development, Columbia River and Coastal Basins, Columbia River Water Management Group, Revision 2, dated April 1974 and May 1974, respectively.

[8] Summary of End-of-month Reservoir Storage Requirement from Columbia River Flood Regulation Studies dated April 1973 and as updated March 1975.

COLUMBIA RIVER TREATY
COMPOSITE CRITICAL RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1981-82 OPERATING YEAR

TABLE 1

	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1ST YR	7814.6	7814.6	7566.5	7309.1	6992.6	5717.2	3823.3	2157.6	2196.8	1446.6	1885.8	2485.4	5741.0	7295.3
2ND YR	7678.8	7744.1	7340.6	7027.3	6277.6	4907.7	2725.3	1874.4	387.5	407.4	954.7	2313.3	4511.5	6564.3
3RD YR	6923.2	7093.6	6797.4	6445.5	5851.7	4103.2	2621.3	1239.1	169.5	142.9	47.0	1539.2	3249.8	4634.1
4TH YR	4895.2	4954.5	4659.5	3760.8	2399.1	1268.3	281.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

COLUMBIA RIVER TREATY
COMPOSITE ASSURED REFILL CURVE
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1981-82 OPERATING YEAR

TABLE 2

AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
37.8	122.9	797.0	1080.6	1103.2	1169.8	1226.3	1258.2	1356.8	1262.3	1273.2	2930.8	5996.8	7814.6

COLUMBIA RIVER TREATY
COMPOSITE VARIABLE REFILL CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1981-82 OPERATING YEAR

TABLE 3

FLOW YEAR	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1928-29							4763.5	4733.3	5087.1	4994.9	4982.6	5489.7	6953.4	7814.6
1929-30							2787.2	2467.2	2487.4	2697.8	2912.8	4337.2	6695.3	,,
1930-31							3163.2	2955.1	3254.5	3333.1	3411.7	4387.4	6849.8	,,
1931-32							0.0	0.0	0.0	0.0	0.0	1223.6	5172.8	,,
1932-33							,,	,,	,,	,,	,,	1192.7	4859.6	,,
1933-34							,,	,,	,,	2.7	5.3	1526.1	5690.6	,,
1934-35							681.8	518.6	488.2	588.6	688.8	2314.4	5478.4	,,
1935-36							613.8	447.3	389.0	487.4	425.8	2489.1	6152.6	,,
1936-37							4965.1	4929.1	5186.1	5200.6	5215.3	5659.5	6971.6	,,
1937-38							65.9	0.0	0.0	156.6	313.3	2168.4	5521.6	,,
1938-39							2813.8	2491.3	2641.6	2777.8	2912.3	4179.8	6957.5	,,
1939-40							2313.1	2004.3	2117.8	2352.1	2587.2	3869.6	6784.9	,,
1940-41							3777.6	3729.2	4875.2	4353.3	4631.3	5619.9	7826.3	,,
1941-42							2303.6	1957.7	1939.7	2092.2	2244.8	3559.9	6228.3	,,
1942-43							1935.5	1578.6	1527.8	1778.3	2012.7	3661.2	5967.7	,,
1943-44							5856.3	5798.4	6084.5	6022.6	5968.9	6134.9	7181.1	,,
1944-45							4948.5	4980.1	5232.0	5243.9	5255.8	5689.7	7011.8	,,
1945-46							0.0	0.0	0.0	0.0	0.0	1221.2	5366.2	,,
1946-47							,,	,,	,,	,,	,,	1905.8	5525.4	,,
1947-48							,,	,,	,,	,,	,,	1396.7	5353.2	,,
1948-49							1758.1	1398.2	1371.1	1795.1	2219.3	3781.7	6711.9	,,
1949-50							0.0	0.0	0.0	5.7	11.4	1561.2	4838.2	,,
1950-51							,,	,,	,,	79.5	159.0	1921.6	5610.1	,,
1951-52							294.1	48.4	4.3	284.2	484.1	2333.1	5737.2	,,
1952-53							976.9	649.0	637.8	834.2	1035.3	2576.1	5665.8	,,
1953-54							0.0	0.0	0.0	0.0	0.0	918.4	4791.4	,,
1954-55							168.9	11.1	,,	132.7	265.5	1933.2	4953.2	,,
1955-56							0.0	0.0	,,	0.0	0.0	1632.7	5434.1	,,
1956-57							,,	,,	,,	,,	,,	1586.8	5859.3	,,
1957-58							,,	,,	,,	,,	,,	1329.8	5491.6	,,
1958-59							,,	,,	,,	,,	,,	1869.3	4883.8	,,
1959-60							211.9	53.2	14.6	230.0	445.4	2192.6	5253.6	,,
1960-61							0.0	0.0	0.0	0.0	0.0	1137.9	5159.7	,,
1961-62							391.0	217.1	192.4	282.8	373.3	2291.8	5468.3	,,
1962-63							235.9	69.5	72.5	340.8	607.4	2405.2	5555.2	,,
1963-64							98.8	0.0	0.0	7.7	15.3	1845.2	4639.8	,,
1964-65							175.4	17.5	,,	143.9	288.0	2228.9	5445.5	,,
1965-66							235.0	73.2	54.5	154.4	254.3	1761.9	5431.2	,,
1966-67							0.0	0.0	0.0	0.0	0.0	132.5	4226.5	,,
1967-68							,,	,,	,,	,,	,,	825.9	4752.6	,,

FLOOD CONTROL STORAGE RESERVATION CURVES
DUNCAN
KSFO
1981-82 OPERATING YEAR

TABLE 4

	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1928-29	705.8	705.8	705.8	705.8	705.8	584.1	397.2	383.0	383.0	311.0	324.6	416.4	568.6	705.8
1929-30	"	"	"	"	"	"	385.7	281.3	281.3	289.9	304.0	400.8	553.8	"
1930-31	"	"	"	"	"	"	368.5	248.0	248.0	257.1	272.7	377.1	548.9	"
1931-32	"	"	"	"	"	"	272.2	65.5	65.5	80.6	108.9	281.3	609.5	"
1932-33	"	"	"	"	"	"	"	"	"	75.1	94.2	191.5	573.2	"
1933-34	"	"	"	"	"	"	"	"	"	65.5	127.8	339.8	625.5	"
1934-35	"	"	"	"	"	"	"	"	"	"	83.7	187.8	488.8	"
1935-36	"	"	"	"	"	"	"	"	"	71.1	119.5	351.9	705.8	"
1936-37	"	"	"	"	"	"	353.9	219.8	219.8	229.4	246.0	356.9	538.9	"
1937-38	"	"	"	"	"	"	272.2	65.5	65.5	77.1	83.7	217.3	542.4	"
1938-39	"	"	"	"	"	"	"	"	"	82.6	107.4	385.7	705.8	"
1939-40	"	"	"	"	"	"	"	"	"	78.1	103.8	"	"	"
1940-41	"	"	"	"	"	"	321.1	156.3	156.3	167.3	186.0	311.8	508.2	"
1941-42	"	"	"	"	"	"	302.8	121.0	121.0	131.8	155.2	291.9	483.8	"
1942-43	"	"	"	"	"	"	305.8	126.8	126.8	141.1	172.9	248.8	647.8	"
1943-44	"	"	"	"	"	"	392.7	294.4	294.4	302.5	316.6	418.4	557.6	"
1944-45	"	"	"	"	"	"	361.5	234.4	234.4	235.9	236.9	349.9	567.7	"
1945-46	"	"	"	"	"	"	272.2	65.5	65.5	75.6	95.8	322.1	647.3	"
1946-47	"	"	"	"	"	"	"	"	"	77.1	101.8	314.1	629.7	"
1947-48	"	"	"	"	"	"	"	"	"	65.5	65.5	300.4	705.8	"
1948-49	"	"	"	"	"	"	348.3	208.7	208.7	215.2	236.9	408.8	"	"
1949-50	"	"	"	"	"	"	272.2	65.5	65.5	72.1	84.7	184.8	525.3	"
1950-51	"	"	"	"	"	"	"	"	"	79.6	103.3	285.3	534.4	"
1951-52	"	"	"	"	"	"	"	"	"	65.5	67.5	92.2	255.1	"
1952-53	"	"	"	"	"	"	"	"	"	72.1	84.7	234.4	522.8	"
1953-54	"	"	"	"	"	"	"	"	"	73.1	84.2	236.9	547.5	"
1954-55	"	"	"	"	"	"	"	"	"	72.1	88.6	154.7	488.5	"
1955-56	"	"	"	"	"	"	"	26.7	26.7	26.7	26.7	239.9	578.2	"
1956-57	"	"	"	"	"	"	"	65.5	65.5	74.6	89.7	376.1	655.9	"
1957-58	"	"	"	"	"	"	"	"	"	77.1	96.3	359.4	705.8	"
1958-59	"	"	"	"	"	"	"	"	"	65.5	65.5	129.5	513.7	"
1959-60	"	"	"	"	"	"	"	"	"	"	"	161.3	545.5	"
1960-61	"	"	"	"	"	"	"	"	"	"	"	193.6	705.8	"
1961-62	"	"	"	"	"	"	"	"	"	"	78.1	"	545.5	"
1962-63	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1963-64	"	"	"	"	"	"	"	"	"	"	65.5	161.3	513.7	"
1964-65	"	"	"	"	"	"	"	"	"	"	129.5	225.3	545.5	"
1965-66	"	"	"	"	"	"	"	"	"	"	97.3	"	"	"
1966-67	"	"	"	"	"	"	"	"	"	"	65.5	193.6	577.7	"
1967-68	"	"	"	"	"	"	"	"	"	"	"	"	513.7	"

FLOOD CONTROL STORAGE RESERVATION CURVES
ARROW
KSFO
1981-82 OPERATING YEAR

TABLE 5

	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1928-29	3579.6	3579.6	3579.6	3453.6	3453.6	3075.4	3075.4	3075.4	3075.4	3088.5	3111.2	3235.8	3579.6	3579.6
1929-30	"	"	"	"	"	"	3060.8	3047.7	3033.1	3047.2	3071.9	3207.8	"	"
1930-31	"	"	"	"	"	"	3075.4	3075.4	3075.4	3088.5	3111.2	3235.8	"	"
1931-32	"	"	"	"	"	"	2364.6	1719.2	1008.3	1015.9	1126.8	2224.4	"	"
1932-33	"	"	"	"	"	"	"	"	"	1008.3	1036.6	1761.6	3834.6	"
1933-34	"	"	"	"	"	"	"	"	"	"	1784.8	2327.2	3579.6	"
1934-35	"	"	"	"	"	"	"	"	"	"	1808.3	1725.8	3834.6	"
1935-36	"	"	"	"	"	"	"	"	"	1869.9	1873.4	2134.7	3579.6	"
1936-37	"	"	"	"	"	"	2998.3	2927.7	2859.6	2869.7	2902.5	3062.5	"	"
1937-38	"	"	"	"	"	"	2364.6	1719.2	1008.3	1063.8	1278.1	1831.1	3147.5	"
1938-39	"	"	"	"	"	"	2637.8	2243.6	1805.9	1869.5	1983.4	2735.1	3579.6	"
1939-40	"	"	"	"	"	"	2849.6	2645.4	2428.0	2454.8	2536.8	2999.8	"	"
1940-41	"	"	"	"	"	"	3075.4	3075.4	3075.4	3088.5	3111.2	3235.8	"	"
1941-42	"	"	"	"	"	"	2364.6	1719.2	1008.3	1064.8	1149.5	1934.0	"	"
1942-43	"	"	"	"	"	"	"	"	"	1111.2	1321.9	1940.4	2389.3	"
1943-44	"	"	"	"	"	"	3075.4	3075.4	3075.4	3088.5	3111.2	3235.8	3579.6	"
1944-45	"	"	"	"	"	"	2641.8	2251.6	1858.8	1842.7	1908.3	2477.8	3368.4	"
1945-46	"	"	"	"	"	"	2364.6	1719.2	1008.3	1072.4	1242.3	2201.2	3579.6	"
1946-47	"	"	"	"	"	"	"	"	"	1075.4	1360.8	2147.3	"	"
1947-48	"	"	"	"	"	"	"	"	"	1036.6	1183.3	2216.8	"	"
1948-49	"	"	"	"	"	"	"	"	"	1144.5	1375.9	2496.6	"	"
1949-50	"	"	"	"	"	"	"	"	"	1103.6	1113.7	1113.7	2232.5	"
1950-51	"	"	"	"	"	"	"	"	"	1052.2	1101.1	1355.2	3338.1	"
1951-52	"	"	"	"	"	"	"	"	"	1069.9	1345.0	1792.3	3013.9	"
1952-53	"	"	"	"	"	"	"	"	"	1057.3	1172.7	1476.2	"	"
1953-54	"	"	"	"	"	"	"	"	"	"	1134.4	1628.8	1898.2	"
1954-55	"	"	"	"	"	"	"	"	"	1075.4	1090.5	1653.7	3224.7	"
1955-56	"	"	"	"	"	"	"	857.1	0.0	0.6	209.9	1367.3	2763.4	"
1956-57	"	"	"	"	"	"	"	1719.2	1008.3	1077.9	1224.1	2651.4	3579.6	"
1957-58	"	"	"	"	"	"	"	"	"	1046.7	1190.9	2242.5	"	"
1958-59	"	"	"	"	"	"	"	"	"	1008.3	1008.3	1394.8	3322.5	"
1959-60	"	"	"	"	"	"	"	"	"	"	"	1779.7	3579.6	"
1960-61	"	"	"	"	"	"	"	"	"	"	"	1651.2	"	"
1961-62	"	"	"	"	"	"	"	"	"	"	"	2036.8	3322.5	"
1962-63	"	"	"	"	"	"	2484.5	1959.1	1359.2	1359.2	1359.2	1514.3	3579.6	"
1963-64	"	"	"	"	"	"	2364.6	1719.2	1008.3	1008.3	1008.3	1265.5	3322.5	"
1964-65	"	"	"	"	"	"	"	"	"	"	"	1651.2	3579.6	"
1965-66	"	"	"	"	"	"	2528.4	2034.8	1487.8	1487.8	1487.8	2224.7	"	"
1966-67	"	"	"	"	"	"	2364.6	1719.2	1008.3	1008.3	1008.3	1394.8	3322.5	"
1967-68	"	"	"	"	"	"	2367.1	1723.8	1015.4	1015.4	1015.4	1528.6	3579.6	"

FLOOD CONTROL STORAGE RESERVATION CURVES
MICA
KSFD
1981-82 OPERATING YEAR

TABLE 6

	AUG 15	AUG 31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR 15	APR 30	MAY	JUN	JUL
1928-29	3529.2	3529.2	3529.2	3428.4	3428.4	3428.4	3406.7	3387.0	3385.3	3369.9	3388.5	3412.2	3469.7	3529.2
1929-30	,,	,,	,,	,,	,,	,,	3378.5	3332.8	3282.7	3298.2	3385.9	3353.2	3448.8	,,
1930-31	,,	,,	,,	,,	,,	,,	3428.4	3428.4	3428.4	3431.4	3437.9	3457.1	3492.9	,,
1931-32	,,	,,	,,	,,	,,	,,	3100.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1932-33	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1933-34	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1934-35	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1935-36	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1936-37	,,	,,	,,	,,	,,	,,	3353.2	3283.7	3288.5	3218.1	3238.3	3380.8	3413.2	,,
1937-38	,,	,,	,,	,,	,,	,,	3100.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1938-39	,,	,,	,,	,,	,,	,,	3213.1	3018.5	2886.7	2828.4	2873.8	3013.9	3267.5	,,
1939-40	,,	,,	,,	,,	,,	,,	3296.8	3174.3	3042.7	3057.3	3088.1	3182.3	3353.2	,,
1940-41	,,	,,	,,	,,	,,	,,	3428.4	3428.4	3428.4	3431.4	3437.9	3457.1	3492.9	,,
1941-42	,,	,,	,,	,,	,,	,,	3100.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1942-43	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1943-44	,,	,,	,,	,,	,,	,,	3428.4	3428.4	3428.4	3431.4	3437.9	3457.1	3492.9	,,
1944-45	,,	,,	,,	,,	,,	,,	3214.6	3021.5	2881.3	2832.9	2878.3	3017.5	3269.6	,,
1945-46	,,	,,	,,	,,	,,	,,	3100.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1946-47	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1947-48	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1948-49	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1949-50	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1950-51	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1951-52	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1952-53	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1953-54	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1954-55	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1955-56	,,	,,	,,	,,	,,	3025.0	2067.1	1058.8	100.9	100.9	100.9	603.7	2363.6	,,
1956-57	,,	,,	,,	,,	,,	3428.4	3100.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1957-58	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1958-59	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1959-60	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1960-61	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1961-62	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1962-63	,,	,,	,,	,,	,,	,,	3150.6	2982.8	2626.7	2654.0	2718.4	2885.9	3282.5	,,
1963-64	,,	,,	,,	,,	,,	,,	3100.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1964-65	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1965-66	,,	,,	,,	,,	,,	,,	3168.7	2936.3	2680.2	2705.9	2759.3	2923.7	3221.7	,,
1966-67	,,	,,	,,	,,	,,	,,	3108.7	2808.2	2480.5	2511.8	2577.8	2781.5	3149.6	,,
1967-68	,,	,,	,,	,,	,,	,,	3101.7	2810.3	2483.6	2514.8	2580.9	2783.5	3150.6	,,

COLUMBIA RIVER TREATY
COMPOSITE OPERATING RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1981-82 OPERATING YEAR

TABLE 7

FLOW YEAR	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1928-29	7814.6	7814.6	7566.5	7309.1	6992.6	5717.2	3823.3	2157.6	2196.8	1495.9	1273.2	2938.8	6055.2	7814.6
1929-30	,,	,,	,,	,,	,,	,,	2672.9	1811.7	,,	,,	,,	,,	,,	,,
1930-31	,,	,,	,,	,,	,,	,,	3184.3	2157.6	,,	,,	,,	,,	,,	,,
1931-32	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	0.0	0.0	1223.6	5172.8	,,
1932-33	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1192.7	4859.8	,,
1933-34	,,	,,	,,	,,	,,	,,	,,	,,	,,	2.7	5.3	1528.1	5690.6	,,
1934-35	,,	,,	,,	,,	,,	,,	757.6	518.6	488.2	588.6	688.8	2314.4	5478.4	,,
1935-36	,,	,,	,,	,,	,,	,,	689.6	447.3	389.0	487.4	425.8	2489.1	6813.5	,,
1936-37	,,	,,	,,	,,	,,	,,	3823.3	2157.6	2196.8	1495.9	1273.2	2938.8	6055.2	,,
1937-38	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	156.6	313.3	2130.2	5521.6	,,
1938-39	,,	,,	,,	,,	,,	,,	2813.0	1927.9	2129.4	1487.8	1273.2	2904.4	6055.2	,,
1939-40	,,	,,	,,	,,	,,	,,	2313.1	1790.4	2032.8	1498.8	,,	2906.7	,,	,,
1940-41	,,	,,	,,	,,	,,	,,	3763.6	2157.6	2196.8	1495.9	,,	2938.8	,,	,,
1941-42	,,	,,	,,	,,	,,	,,	2303.6	1587.8	1915.6	1461.3	1265.6	2903.9	6039.1	,,
1942-43	,,	,,	,,	,,	,,	,,	1935.5	1122.5	1520.6	1184.4	1182.5	2878.5	5948.7	,,
1943-44	,,	,,	,,	,,	,,	,,	3823.3	2157.6	2196.8	1495.9	1273.2	2938.8	6055.2	,,
1944-45	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
1945-46	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	0.0	0.0	1221.2	5366.2	,,
1946-47	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1813.7	5525.4	,,
1947-48	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1396.7	5353.2	,,
1948-49	,,	,,	,,	,,	,,	,,	1750.1	1398.2	1368.6	1433.0	1236.5	2892.2	6055.2	,,
1949-50	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	5.7	11.4	1561.2	4838.2	,,
1950-51	,,	,,	,,	,,	,,	,,	,,	,,	,,	79.5	159.0	1921.6	5610.1	,,
1951-52	,,	,,	,,	,,	,,	,,	294.2	48.4	4.3	204.2	404.1	2329.2	5737.2	,,
1952-53	,,	,,	,,	,,	,,	,,	976.9	649.0	633.0	834.2	796.3	2465.6	5665.8	,,
1953-54	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	0.0	0.0	918.4	4791.4	,,
1954-55	,,	,,	,,	,,	,,	,,	,,	11.1	,,	132.7	265.5	1933.2	4953.2	,,
1955-56	,,	,,	,,	,,	,,	,,	,,	0.0	,,	0.0	0.0	1632.7	5434.1	,,
1956-57	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1506.8	5859.3	,,
1957-58	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1329.8	5491.6	,,
1958-59	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	1889.3	4883.8	,,
1959-60	,,	,,	,,	,,	,,	,,	287.7	53.2	14.6	230.0	445.4	2192.6	5253.6	,,
1960-61	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	0.0	0.0	1137.9	5159.7	,,
1961-62	,,	,,	,,	,,	,,	,,	466.8	217.1	192.4	282.8	373.3	2291.8	5468.3	,,
1962-63	,,	,,	,,	,,	,,	,,	311.7	69.5	72.5	340.0	607.4	2485.2	5555.2	,,
1963-64	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	7.7	15.3	1045.2	4639.8	,,
1964-65	,,	,,	,,	,,	,,	,,	,,	17.5	,,	143.9	288.8	2228.9	5445.5	,,
1965-66	,,	,,	,,	,,	,,	,,	325.4	73.2	54.5	154.4	254.3	1761.9	5431.2	,,
1966-67	,,	,,	,,	,,	,,	,,	281.1	0.0	0.0	0.0	0.0	132.5	4226.5	,,
1967-68	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	825.9	4752.6	,,

DETERMINATION OF DOWNSTREAM POWER BENEFITS RESULTING FROM CANADIAN STORAGE
FOR OPERATING YEAR 1981-82
September 1976

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 require 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, 1981-82, and for the storage 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 9 September 1968.

The Canadian Entitlement Benefits were computed as follows:

Step I - based on the total U.S. planned hydro and thermal system with 15½ maf of Canadian storage operated for optimum generation in both countries (82-41 study).

Step II - based on the U.S. base hydro and thermal system with 15½ maf of Canadian storage operated for optimum generation in both countries (82-42 study).

Step III - based on the U.S. base hydro and thermal system operated for optimum generation in the U.S. (82-13 study).

In addition to the determination of downstream power benefits for the operating year 1981-82, separate determinations were carried out in accordance with the document, "Operating Plans with Mica Generation," dated 15 November 1971, which was agreed by the Entities to implement the provisions of Annex A, Paragraph 7, relating to the limit of year-to-year change in the operation of Canadian storage in operating plans designed to achieve optimum generation at-site in Canada and downstream in Canada and the United States of America.

II. Results of Study.

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

Dependable Capacity = 1,473.5 MW

Average Annual Energy = 597.5 MW

(b) One-half of the downstream power benefits determined for 15 maf of Canadian storage operated for optimum generation in the United States was computed to be:

Dependable Capacity = 1,448.5 MW

Average Annual Energy = 590.0 MW

In accordance with Paragraph 5 of the document dated 15 November 1971, the minimum permitted downstream power benefits for the 1981-82 operating year are as follows:

Dependable Capacity = 1,449 - (1,449 - 1,448.5) = 1,448.5 MW

Average Annual Energy = 559 - (561.5 - 590.0) = 587.5 MW

The above computations are based on the formula X - (Y - Z), where the quantities X, Y, and Z are defined in the 15 November 1971 document. The quantities X and Y are derived from the downstream power benefit computations set out in the 1980-81 agreement. The computed downstream power benefits exceed these amounts.

III. Effect on Canadian Entitlement.

The Canadian Entitlement to downstream power benefits was sold to the United States of America under the Canadian Entitlement Purchase Agreement dated 13 August 1964. By definition, the Canadian Entitlement for 1981-82 which was sold was that which would have been computed if the 1981-82 Assured Operating Plan had been designed to achieve optimum generation downstream in the United States alone. The Canadian Entitlement determined for the conditions above would have been:

Dependable Capacity = ½ of 2,947 MW or 1,473.5 MW

Average Annual Energy = ½ of 1,201 MW or 600.5 MW

Since the 1981-82 Assured Operating Plan was in fact designed to achieve optimum generation at-site in Canada and downstream in the United States of America, Section 7 of the Agreement requires that "any reduction in the Canadian Entitlement resulting from action taken pursuant to Paragraph 7 of Annex A of the Treaty shall be determined in accordance with Subsection (3) of Section 6 of this Agreement." The Canadian Entitlement of downstream power benefits under the 1981-82 Assured Operating Plan was determined as:

Dependable Capacity = ½ of 2,947 MW or 1,473.5 MW

Average Annual Energy = ½ of 1,195 MW or 597.5 MW

The comparison indicates a reduction in Canadian Entitlement of 3.0 average megawatts of average annual usable energy, but no reduction in

dependable capacity. This reduction would be in respect of the period 1 April 1981 through 31 March 1982 in accordance with the document, "Procedures for the Determination of Downstream Power Benefits Resulting from Canadian Storage," dated 9 September 1968.

The Entities are agreed that the United States Entity is entitled to receive during the period 1 April 1981 through 31 March 1982, from B.C. Hydro & Power Authority, 3.0 average megawatts of energy in accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement dated 13 August 1964.

IV. 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 summarized 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 and minimum thermal generation;

(3) Mulitply (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 0.98918 and 0.96242, respectively);

(4) Pro rate the average annual Step II and 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 loads for Steps II and III also become 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 percent of the remainder after thermal replacement. The thermal replacement was limited to the existing and scheduled thermal energy capability after allowance for reserve and minimum thermal generation, except when an energy surplus condition occurs; then the thermal replacement must not exceed the total of the thermal energy required to supply firm plus the estimated secondary load.

Thermal Energy Capabilty - MW	6,908 1/
Less Minimum Thermal Generation	1,900
Thermal Replacement - MW	5,008

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

	Step II	Step III
Thermal Replacement	5,008	5,008
Other	1,570	2,591
Total - MW	6,578	7,599

1/ Thermal energy capabilities are based on an annual plant factor of 60% the first full year of operation and 75% thereafter. These annual plant factors include deductions for energy reserves and scheduled maintenance.

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	9,085
Critical Period Average Rate of Generation without Canadian Storage, Step III	7,042
Gain Due to Canadian Storage	2,043
Estimated Average Critical Period Load Factor -- Percent	69.322
Dependable Capacity Gain 1/	2,947
Canadian Share of Dependable Capacity	1,473.5

Determination of Increase in Average Annual Usable Energy

Step II (with Canadian Storage)

Annual Firm Hydro Energy	8,933
Thermal Replacement Energy	2,075
Other Usable Secondary Energy	275
System Annual Average Usable Energy	11,283

Step III (without Canadian Storage)

Annual Firm Hydro Energy	6,590
Thermal Replacement Energy	2,790
Other Usable Secondary Energy	708
System Annual Average Usable Energy	10,088

Average Annual Usable Energy Gain	1,195
Canadian Share of Average Annual Energy Gain	597.5

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 1981-82
FOR THE
COMPUTATION 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			7,000			7,000							
Arrow			7,100			7,100							
Duncan			1,400			1,400							
Subtotal			15,500			15,500							
BASE FEDERAL SYSTEM													
Hungry Horse	4	328	3,161	201	97	3,008	206	115	103	3,008	280	212	101
Albeni Falls	3	49	1,155	24	24	1,155	22	23	23	1,155	23	25	24
Grand Coulee	24 + 2	6,529	5,232	6,509	2,018	5,072	6,478	1,775	2,337	5,072	5,982	1,224	2,265
Chief Joseph	27	2,412		2,412	1,088		2,412	1,001	1,330		2,412	710	1,257
Ice Harbor	6	693		693	217		693	223	303		693	170	303
McNary	14	1,127		1,127	640		1,124	591	761		1,124	429	712
John Day	16	2,484	535	2,484	925		2,484	924	1,265		2,484	682	1,230
The Dalles	22	2,018		2,018	818		2,018	795	1,039		2,018	632	1,019
Bonneville	12 - 18	963		963	596		963	578	719		963	457	684
Subtotal		16,603	10,083	16,431	6,423	9,235	16,400	6,025	7,880	9,235	15,979	4,541	7,595
BASE SYSTEM NON-FEDERAL													
Kootenay Lake (Canadian)			649			427				427			
Kerr	3	185	1,219	178	113	1,219	175	101	120	1,219	178	149	121
Thompson Falls	6	40		40	35		38	38	32		37	36	31
Noxon Rapids	5	542	231	537	148		542	138	210		542	158	211
Cabinet Gorge	4	230		230	106		230	93	124		230	106	124
Box Canyon	4	74		71	46		70	45	48		71	51	47
Coeur d'Alene & Long Lake			327			223				223			
Wells	10	842		842	438		842	409	516		842	289	475
Chelan	2	54	677	51	38	676	50	38	46	676	51	49	45
Rocky Reach	11	1,267		1,267	590		1,267	553	716		1,267	393	672
Rock Island	18	544		544	279		544	262	332		544	182	305
Wanapum	10	986		986	557		986	524	663		986	367	600
Priest Rapids	10	912		912	531		912	498	625		912	357	567
Brownlee	4	450	980	450	212	974	450	251	263	974	450	250	256
Oxbow	4	220		220	89		220	110	116		220	114	117
Subtotal		6,346	4,083	6,328	3,182	3,519	6,326	3,060	3,811	3,519	6,330	2,501	3,571
TOTAL BASE SYSTEM HYDRO		22,949	29,666	22,759	9,605	28,254	22,726	9,085	11,691	12,754	22,309	7,042	11,166
ADDITIONAL STEP I PROJECTS													
Libby	4	483	4,934	348	190								
Boundary	4	650		650	360								
Spokane River Plants		153		152	89								
Hells Canyon	3	450		450	175								
Dworshak	3	460	2,015	433	163								
Lower Granite	6	930		930	218								
Little Goose	6	930		930	218								
Lower Monumental	6	930		930	216								
Pelton and Round Butte		454	274	438	124								
Subtotal		5,440	7,223	5,261	1,753								
Independent Resources		4,862	8,553	4,178	1,734								
TOTAL HYDRO RESOURCES		32,251	45,442	32,198	13,092								
MISCELLANEOUS CONTRACTS				23	9								
THERMAL RESOURCES 1/													
Existing Thermal Plants				1,503	281								
Centralia #1 & #2				1,300	923								
Jim Bridger #1, #2, #3, & #4				2,000	1,400								
Colstrip #1 & #2				330	292								
Trojan				1,130	872								
WNP #2				1,100	760								
Colstrip #3 & #4				980	673								
Boardman Coal				500	374								
Added Thermal Requirement				2,222	1,333								
TOTAL THERMAL RESOURCES				11,065	6,908								
TOTAL IMPORTS				256	521								
ESTIMATED HYDRO MAINTENANCE				-29	-50								
TOTAL RESOURCES (HYDRO AND THERMAL)				43,513	20,480								
RESERVES 2/				-2,626	0								
RESOURCES AVAILABLE FOR LOAD				40,887	20,480								
ESTIMATED LOAD													
Pacific Northwest Area				32,823	20,480								
SURPLUS OR (DEFICIT)				8,064	0								
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				82-41			82-42				63-13		

1/ Thermal energy capabilities are based on an annual plant factor of 60% the first full year of operation and 75% thereafter. These annual plant factors include deductions for energy reserves and scheduled maintenances.

2 Peak reserves are 8% of peak load; energy reserve deductions have been included in thermal plant energy capability.

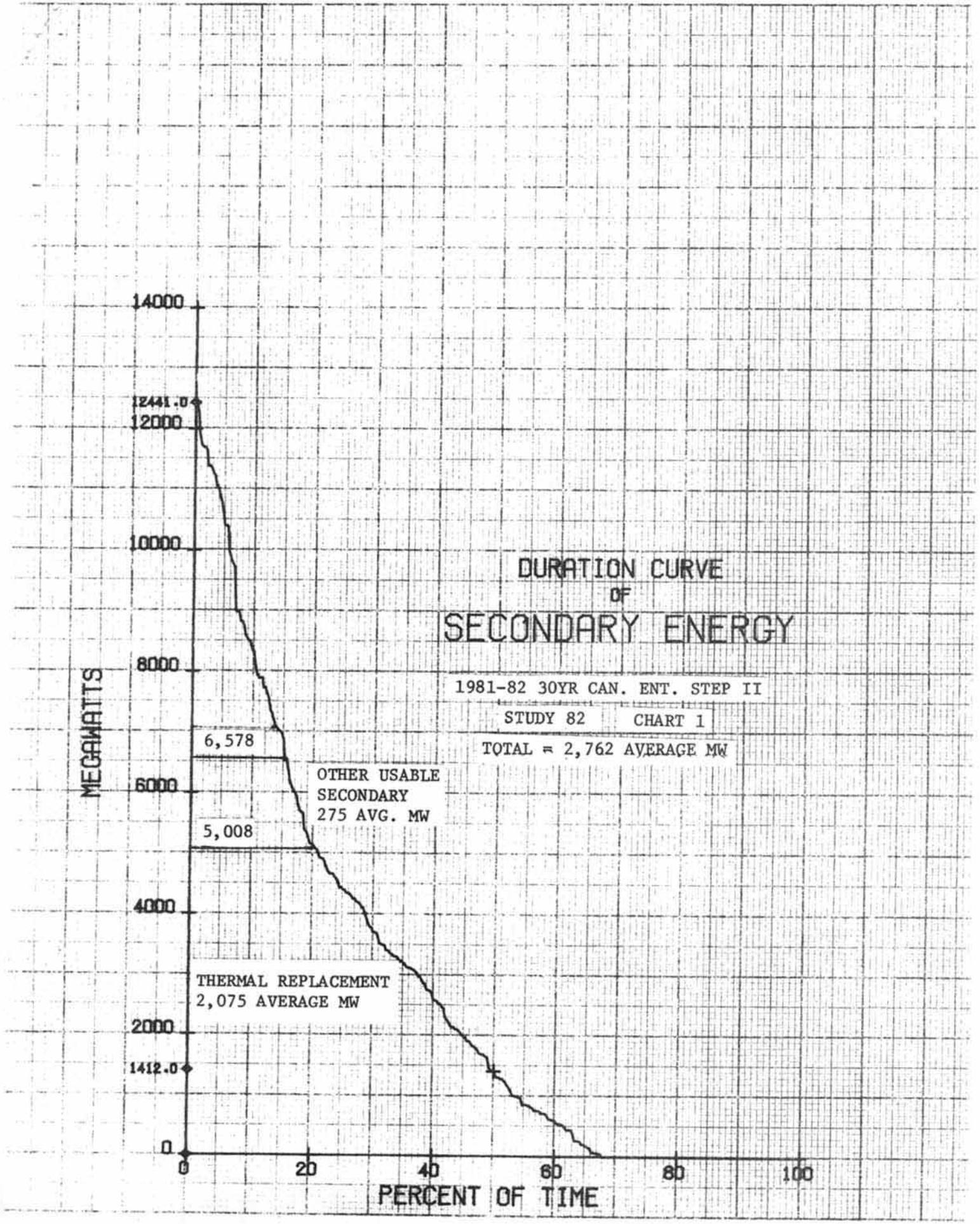
DETERMINATION OF LOAD SHAPE FOR STEP II AND III
1981-82 CANADIAN ENTITLEMENT COMPUTATIONS

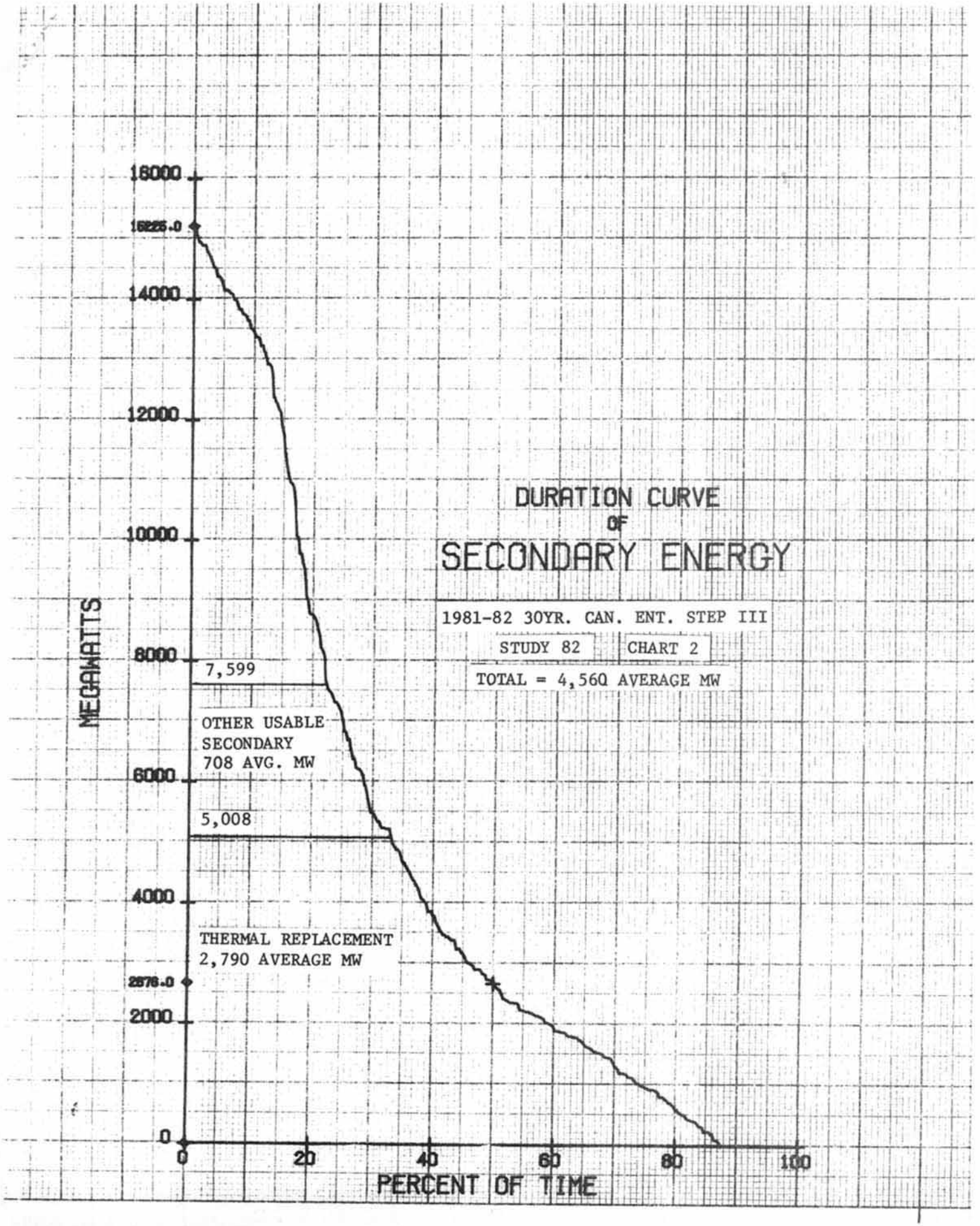
	Pacific Northwest Area Load			Step II			Step III		
	Peak	Avg.	Load Factor %	Total Firm Load 1/	Thermal Firm Load	Hydro Firm Load	Total Firm Load 1/	Thermal Firm Load	Hydro Firm Load
Aug. 1-15	27,447 *	19,146	69.76	13,094	5,008	8,086	10,894	5,008	5,886
Aug. 16-31	27,354 *	19,094	69.80	13,058	5,008	8,050	10,865	5,008	5,857
Sept. 1-15	27,637 *	18,691	67.63	12,783	5,008	7,775	10,635	5,008	5,627
Sept. 16-30	27,592 *	18,653	67.60	12,757	5,008	7,749	10,614	5,008	5,606
October	29,030 *	19,530	67.28	13,357	5,008	8,349	11,113	5,008	6,105
November	30,130 *	21,075	69.95	14,413	5,008	9,405	11,992	5,008	6,984
December	32,924 *	22,800	69.25	15,593	5,008	10,585	12,973	5,008	7,965
January	32,823 *	23,174	70.60	15,849	5,008	10,841	13,186	5,008	8,178
February	30,985 *	21,799	70.35	14,909	5,008	9,901	12,404	5,008	7,396
March	29,317 *	20,631	70.37	14,110	5,008	9,102	11,739	5,008	6,731
Apr. 1-15	28,069 *	19,799	70.54	13,541	5,008	8,533	11,266	5,008	6,258
Apr. 16-30	28,069 *	19,799	70.54	13,541	5,008	8,533	11,266	5,008	6,258
May	28,253 *	19,289	68.27	13,192	5,008	8,184	10,976	5,008	5,968
June	28,165 *	19,218	68.23	13,143	5,008	8,135	10,935	5,008	5,927
July	27,954 *	19,545	69.92	13,367	5,008	8,359	11,121	5,008	6,113
Critical Period Avg.		20,480	69.322	14,093	5,008	9,085	12,050	5,008	7,042
Annual Average		20,384		13,941	5,008	8,933	11,598	5,008	6,590
January Peak	32,823 *								
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
1981-82 30YR CAN. ENT. STEP II
STUDY 82 CHART 1
TOTAL = 2,762 AVERAGE MW
MEGAWATTS
14000
12441.0
12000
10000
8000
6000
4000
2000
1412.0
0
6,578
OTHER USABLE
SECONDARY
275 AVG. MW
5,008
THERMAL REPLACEMENT
2,075 AVERAGE MW
0
20
40
60
80
100
PERCENT OF TIME


DURATION CURVE
OF
SECONDARY ENERGY
1981-82 30YR. CAN. ENT. STEP III
STUDY 82
CHART 2
TOTAL = 4,560 AVERAGE MW
MEGAWATTS
16000
16225.0
14000
12000
10000
8000
7,599
OTHER USABLE
SECONDARY
708 AVG. MW
6000
5,008
4000
THERMAL REPLACEMENT
2,790 AVERAGE MW
2876.0
2000
0
0
20
40
60
80
100
PERCENT OF TIME