



COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD
C A N A D A • U N I T E D S T A T E S

CANADIAN SECTION

G.M. MacNABB, Chairman
B.E. Marr, Member

UNITED STATES SECTION

L.A. DUSCHA, Chairman
J.E. Harper, Member

31 December 1983

The Honorable George P. Shultz
The Secretary of State
Washington, D.C.

The Honourable J. Chretien
Minister of Energy, Mines and
Resources
Ottawa, Ontario

Gentlemen:

Reference is made to the Treaty between the United States of America and Canada, relating to co-operative development of the water resources of the Columbia River basin, signed at Washington, D.C., on 17 January 1961.

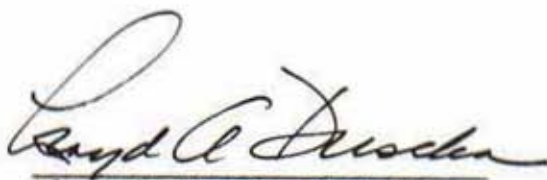
In accordance with the provisions of Article XV paragraph 2(e), there is submitted herewith the nineteenth Annual Report, dated 30 September 1983, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1982 to 30 September 1983.

Respectfully submitted:

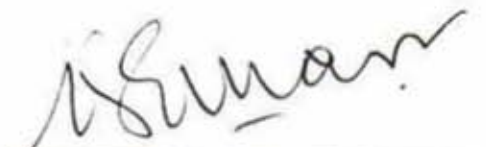
For the United States

For Canada


Lloyd A. Duscha, Chairman


G.M. MacNabb, Chairman


J. Emerson Harper


B.E. Marr



**ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA**

**COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD**

Washington, D.C.

Ottawa, Ontario

30 September 1983

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Photographs supplied by the British Columbia Hydro and
Power Authority, the Government of British Columbia,
and the Corps of Engineers, U.S. Army.

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SUMMARY

The nineteenth Annual Report of the Permanent Engineering Board is submitted to the Governments of the United States and Canada in compliance with Article XV of the Columbia River Treaty of 17 January 1961. The status of projects, progress of Entity studies, operation of Duncan, Arrow, Mica and Libby reservoirs, and the resulting benefits are described.

The Duncan, Arrow, Mica and Libby storage projects were operated throughout the year in accordance with the objectives of the Treaty and the terms of operating plans developed by the Entities. A special agreement for using additional storage in the reservoirs at Arrow and Mica did not conflict with Treaty operations. Although reservoir operations reduced peak freshet flows, the unregulated peaks would not have caused major flood damages in either country. (Pages 26-32)

Studies pertaining to development of the hydrometeorological network and power operating plans are being continued by the Entities to ensure operation of the projects in accordance with the terms of the Treaty. Annual calculations of downstream power benefits are proceeding satisfactorily. (Pages 21-24)

The Northwest Power Planning Council's "Columbia River Basin Fish and Wildlife Program" which advocates the use of Canadian Treaty storage for fisheries purposes in the United States cannot be considered in developing Assured Operating Plans as it contradicts Treaty requirements for optimum operation for power and flood control benefits. (Page 23)

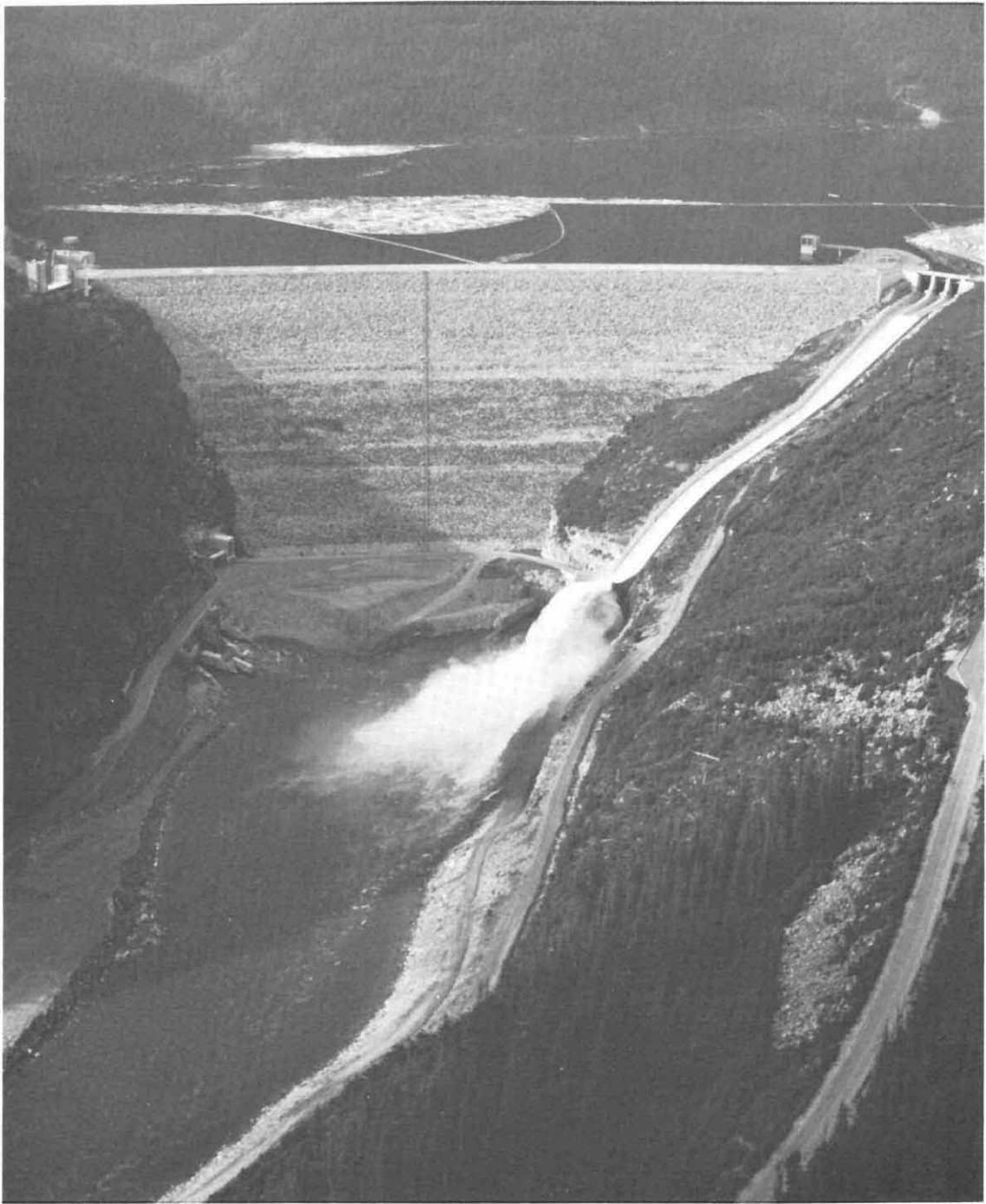
The Board has some reservations about the practice of the Entities of updating streamflow records for the development of Assured Operating Plans. This practice will be reviewed. (Page 22)

The Board concludes that the objectives of the Treaty are being met.

INTRODUCTION

The Columbia River Treaty, which provides for co-operative development of the water resources of the Columbia River basin, was signed in Washington, D.C. on 17 January 1961 by representatives of the United States and Canada. Article XV of the Treaty established a Permanent Engineering Board and specified that one of its duties would be to "make reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty. . ."

This Annual Report, which covers the period 1 October 1982 to 30 September 1983, describes activities of the Board, progress being achieved by both countries under the terms of the Treaty, operation of the Treaty projects, and the resulting benefits. The report states that, in the opinion of the Board, the objectives of the Treaty are being met. Summaries of the essential features of the Treaty and of the responsibilities of the Board and of the Entities are included.



MICA DAM
Columbia River, British Columbia
The earth dam with spillway in operation. The underground powerhouse is at the left.

THE COLUMBIA RIVER TREATY

General

The Columbia River Treaty was signed in Washington, D.C. on 17 January 1961 and was ratified by the United States Senate in March of that year. In Canada ratification was delayed. Further negotiations between the two countries resulted in formal agreement by an exchange of notes on 22 January 1964 to a Protocol to the Treaty and to an Attachment Relating to Terms of Sale. The Treaty and related documents were approved by the Canadian Parliament in June 1964.

The Canadian Entitlement Purchase Agreement was signed on 13 August 1964. Under the terms of this agreement Canada's share of downstream power benefits resulting from the first thirty years of scheduled operation of each of the storage projects was sold to a group of electric utilities in the United States known as the Columbia Storage Power Exchange.

On 16 September 1964 the Treaty and Protocol were formally ratified by an exchange of notes between the two governments. The sum of \$253.9 million (U.S. funds) was delivered to the Canadian representatives as payment in advance for the Canadian entitlement to downstream power benefits during the period of the Purchase Agreement. On the same date at a ceremony at the Peace Arch Park on the International Boundary the Treaty and its Protocol were proclaimed by President Johnson, Prime Minister Pearson, and Premier Bennett of British Columbia.

Features of the Treaty and Related Documents

The essential undertakings of the Treaty are as follows:

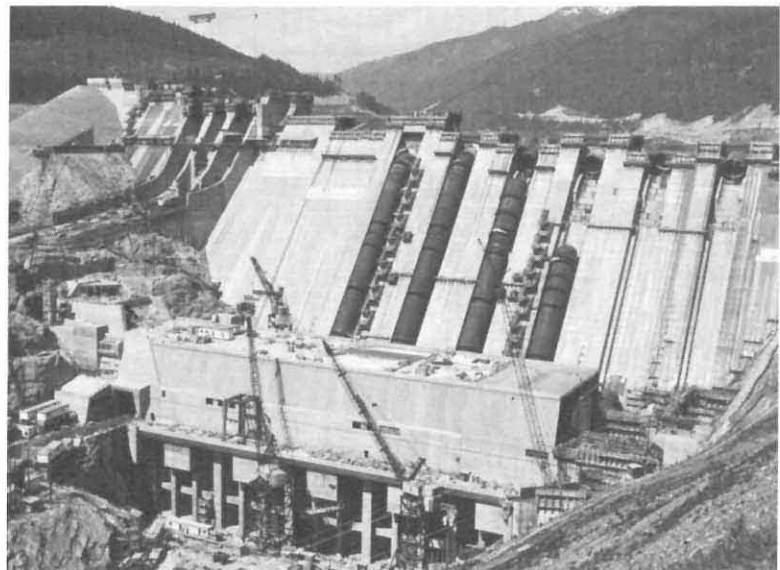
- (a) Canada will provide 15.5 million acre-feet of usable storage by constructing dams near Mica Creek, the outlet of Arrow Lakes and Duncan Lake, in British Columbia.
- (b) The United States will maintain and operate hydroelectric power facilities included in the base system and any new main-stem projects to make the most effective use of improved stream flow resulting from operation of the Canadian storage. Canada will operate the storage in accordance with procedures and operating plans specified in the Treaty.
- (c) The United States and Canada will share equally the additional power generated in the United States as a result of river regulation by upstream storage in Canada.
- (d) On commencement of the respective storage operations the United States will make payments to Canada totalling \$64.4 million (U.S. funds) for flood control provided by Canada.
- (e) The United States has the option of constructing a dam on the Kootenai River near Libby, Montana. The Libby reservoir would extend some 42 miles into Canada and Canada would make the necessary Canadian land available for flooding.
- (f) Both Canada and the United States have the right to make diversions of water for consumptive uses and, in addition, after September 1984 Canada has the option of making for power purposes specific diversions of the Kootenay River into the headwaters of the Columbia River.

- (g) Differences arising under the Treaty which cannot be resolved by the two countries may be referred by either to the International Joint Commission or to arbitration by an appropriate tribunal as specified by the Treaty.
- (h) The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964.

The Protocol of January 1964 amplified and clarified certain terms of the Columbia River Treaty. The Attachment Relating to Terms of Sale signed on the same date established agreement that under certain terms Canada would sell in the United States its entitlement to downstream power benefits for a 30-year period. The Canadian Entitlement Purchase Agreement of 13 August 1964 provided that the Treaty storages would be operative for power purposes on the following dates:

Duncan storage	1 April 1968
Arrow storage	1 April 1969
Mica storage	1 April 1973

REVELSTOKE DAM
under construction downstream
from Mica Dam.





DUNCAN DAM
The earth dam and Duncan Lake. Discharge tunnels are to the left of the dam.

Duncan River, British Columbia

PERMANENT ENGINEERING BOARD

General

Article XV of the Columbia River Treaty established a Permanent Engineering Board consisting of two members to be appointed by Canada and two members by the United States. Appointments to the Board were to be made within three months of the date of ratification. The duties and responsibilities of the Board were also stipulated in the Treaty and related documents.

Establishment of the Board

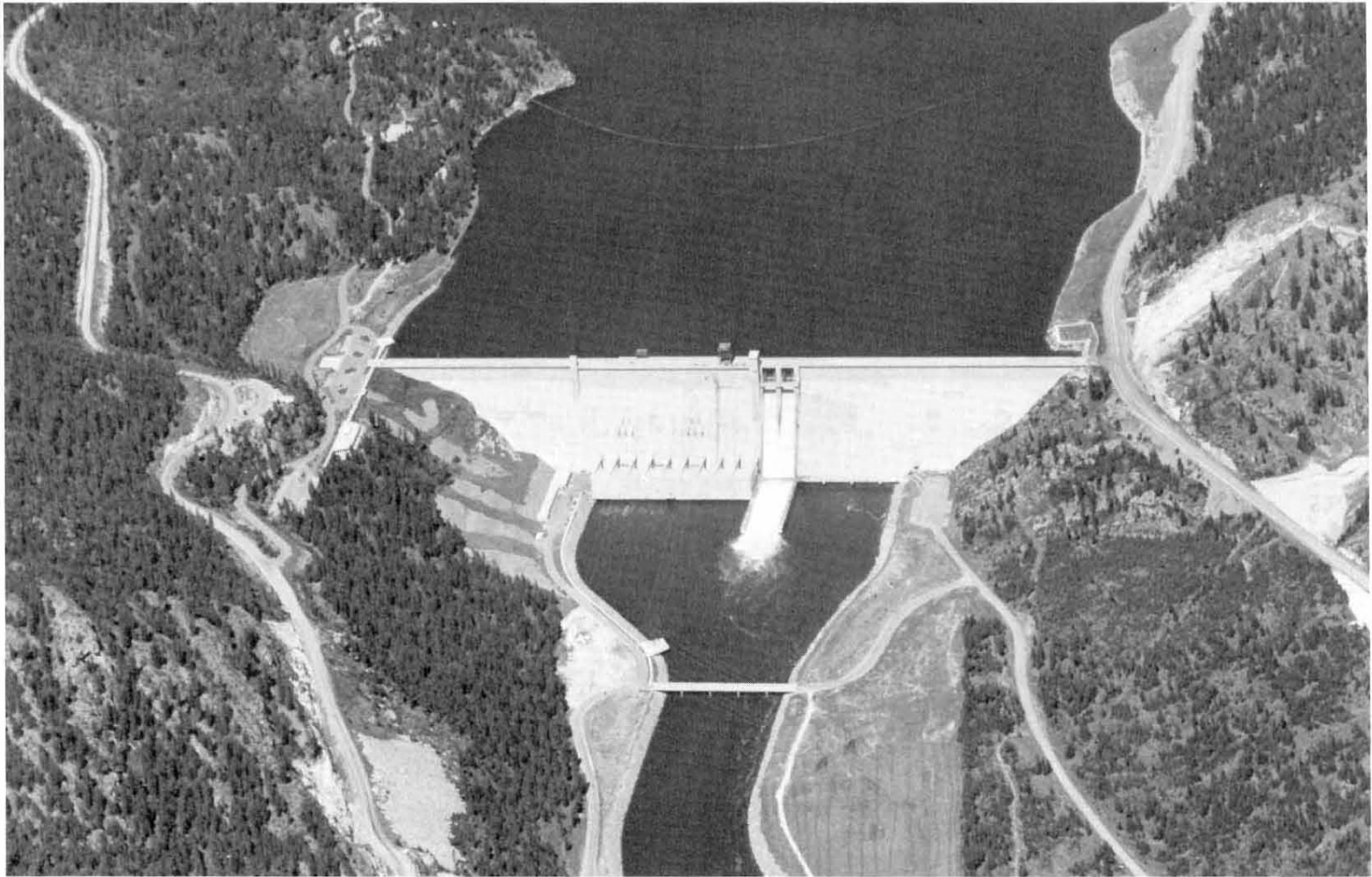
Pursuant to Executive Order No. 11177 dated 16 September 1964 the Secretary of the Army and the Secretary of the Interior on 7 December 1964 appointed two members and two alternate members to form the United States Section of the Permanent Engineering Board. Pursuant to the Department of Energy Organization Act of 4 August 1977 the appointments to the United States Section of the Board are now made by the Secretary of the Army and the Secretary of Energy. The members of the Canadian Section of the Board were appointed by Order in Council P.C. 1964-1671 dated 29 October 1964. Each member was authorized to appoint an alternate member. On 11 December 1964 the two governments announced the composition of the Board.

The names of Board members, alternate members and secretaries are shown in Appendix A.

Duties and Responsibilities of the Board

The general duties and responsibilities of the Board to the governments, as set forth in the Treaty and related documents, include:

- (a) assembling records of the flows of the Columbia River and the Kootenay River at the Canada-United States of America boundary;
- (b) reporting to Canada and the United States of America whenever there is substantial deviation from the hydroelectric and flood control operating plans and if appropriate including in the report recommendations for remedial action and compensatory adjustments;
- (c) assisting in reconciling differences concerning technical or operational matters that may arise between the entities;
- (d) making periodic inspections and requiring reports as necessary from the entities with a view to ensuring that the objectives of the Treaty are being met;
- (e) making reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty and making special reports concerning any matter which it considers should be brought to their attention;
- (f) investigating and reporting with respect to any other matter coming within the scope of the Treaty at the request of either Canada or the United States of America;
- (g) consulting with the entities in the establishment and operation of a hydro-meteorological system as required by Annex A of the Treaty.



LIBBY DAM
The dam and reservoir, Lake Kootenai. The powerhouse is at the left of the spillway.

Kootenai River, Montana

ENTITIES

General

Article XIV(1) of the Treaty provides for the designation by Canada and the United States of entities which are empowered and charged with the duty of formulating and executing the operating arrangements necessary to implement the Treaty. Provision is made for either government to designate one or more entities. The powers and duties of the entities are specified in the Treaty and related documents.

Establishment of the Entities

Executive Order No. 11177, previously referred to, designated the Administrator of the Bonneville Power Administration, Department of the Interior, and the Division Engineer, North Pacific Division, Corps of Engineers, Department of the Army, as the United States Entity with the Administrator to serve as Chairman. Pursuant to the Department of Energy Organization Act of 4 August 1977 these appointments are now made by the Secretary of the Army and the Secretary of Energy. Order in Council P.C. 1964-1407 dated 4 September 1964 designated the British Columbia Hydro and Power Authority as the Canadian Entity for the purposes of the Treaty.

The names of the members of the two entities are shown in Appendix B.

Powers and Duties of the Entities

In addition to the powers and duties specified elsewhere in the Treaty and related documents the Treaty requires that the entities be responsible for:

- (a) co-ordination of plans and exchange of information relating to facilities to be used in producing and obtaining the benefits contemplated by the Treaty,
- (b) calculation of and arrangements for delivery of hydroelectric power to which Canada is entitled for providing flood control,
- (c) calculation of the amounts payable to the United States of America for standby transmission services,
- (d) consultation on requests for variations made pursuant to Articles XII(5) and XIII(6),
- (e) the establishment and operation of a hydrometeorological system as required by Annex A,
- (f) assisting and co-operating with the Permanent Engineering Board in the discharge of its functions,
- (g) periodic calculation of accounts,
- (h) preparation of the hydroelectric operating plans and the flood control operating plans for the Canadian storage together with determination of the downstream power benefits to which Canada is entitled,
- (i) preparation of proposals to implement Article VIII and carrying out any disposal authorized or exchange provided for therein,

- (j) making appropriate arrangements for delivery to Canada of the downstream power benefits to which Canada is entitled including such matters as load factors for delivery, times and points of delivery, and calculation of transmission loss,
- (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.

Article XIV(4) of the Treaty provides that the two governments may, by an exchange of notes, empower or charge the entities with any other matter coming within the scope of the Treaty.

TREATY TOWER
on Libby Dam
in Montana.



ACTIVITIES OF THE BOARD

Meetings

The Board met in Vancouver, British Columbia on 3 December 1982 to review progress under the Treaty and to discuss preparation of the Board's Annual Report. The Board met with the Entities on the same day to discuss Entity studies and general progress.

Reports Received

Throughout the report year the Canadian Entity provided the Board with weekly reports on operation of the Canadian storage reservoirs and with daily flow forecasts during the freshet season for the northern part of the Columbia River basin. The United States Entity provided monthly reports on the operation of the Libby storage reservoir. The Entities also provided copies of computer printouts of studies for the Assured Operating Plan and downstream power benefit calculations, and the following documents and reports:

- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1981 to 30 September 1982
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1987-88, plus a copy of the Entities' agreement on this document
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1982 through 31 July 1983, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1987-88, plus a copy of the Entities' agreement on this document

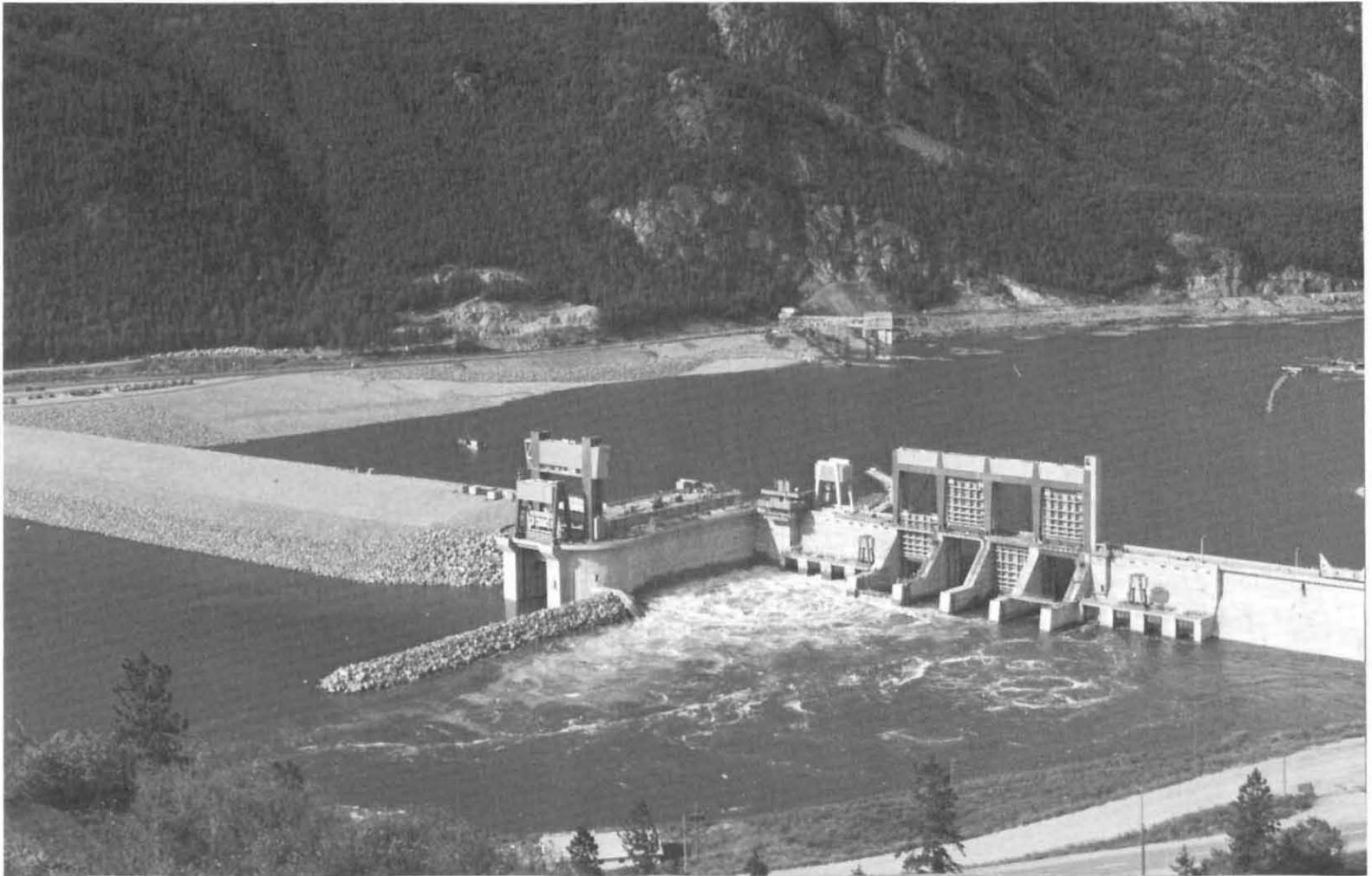
- An agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration to provide extra storage in Arrow Lakes reservoir and in Kinbasket Lake in 1983, dated 9 June 1983.

Subsequent to the end of this report year the Board received the following documents and reports from the Entities:

- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1983 through 31 July 1984, plus a copy of the Entities' agreement on this document
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1988-89, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1988-89, plus a copy of the Entities' agreement on this document
- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1982 to 30 September 1983
- Columbia River Treaty, Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans, May 1983, plus a copy of the Entities' agreement on this document
- An agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration on interim operating procedures to facilitate initial filling of the reservoir at the Revelstoke project, dated 9 September 1983
- Hydrometeorological Committee Documents (undated) by the Columbia River Treaty Hydrometeorological Committee.

Report to Governments

The eighteenth Annual Report of the Board was submitted to the two governments on 31 December 1982.



HUGH KEENLEYSIDE DAM
Concrete spillway and discharge works with navigation lock and earth dam.

Columbia River, British Columbia

PROGRESS

General

The results achieved under the terms of the Treaty include construction of the Treaty projects, progress in developing the hydrometeorological network, power and flood control operating plans, and the annual calculation of downstream power benefits. The three Treaty storage projects in British Columbia, the Duncan, Arrow and Mica projects, produce power and flood control benefits in both Canada and the United States. The Libby storage project in Montana is in operation and provides power and flood control benefits in both countries. In the United States increased flow regulation provided by Treaty projects has facilitated the installation of additional generating capacity at existing plants on the Columbia River. In Canada completion of the Canal Plant on the Kootenay River in 1976 and installation of generators at Mica Dam during 1976 and 1977 have caused power benefits to increase substantially. Completion of the Revelstoke Project in 1984 will result in a further substantial increase in power benefits in Canada. This amounts to some 4,000 megawatts of generation in Canada that may not have been installed without the Treaty. In addition, the installation of generating capacity at Hugh Keenleyside Dam and at the Murphy Creek Site near Trail, British Columbia is now being considered.

The Treaty provides Canada with the option of diverting the Kootenay River at Canal Flats into the headwaters of the Columbia River commencing in 1984. Although British Columbia Hydro and Power Authority has completed engineering feasibility and detailed environmental studies of the potential diversion some further studies are needed before the project could proceed.

The locations of the above projects are shown on Plate 1 in Appendix D.

Status of the Treaty Projects

Duncan Project

Duncan Dam, the smallest Treaty project, was scheduled by the Sales Agreement for operation by 1 April 1968 and was the first of the Treaty projects to be completed. It became fully operational on 31 July 1967, well in advance to Treaty requirements.

The earthfill dam, about 130 feet high, is located on the Duncan River a few miles north of Kootenay Lake. The reservoir behind the dam extends for about 27 miles and provides 1,400,000 acre-feet of usable storage which is all committed under the Treaty. There are no power facilities included in this project which is shown in the picture on page 6.

Characteristics of the project are shown in Table 1 of Appendix D.

Arrow Project

The Hugh Keenleyside Dam, at the outlet of the Arrow Lakes, was the second Treaty project to be completed. It became operational on 10 October 1968 well ahead of the date of 1 April 1969 scheduled by the Sales Agreement. The project at present has no associated power facilities, however, installation of generators is now under active consideration.

The dam consists of two main components: a concrete gravity structure which includes the spillway, low-level outlets and navigation lock and an earthfill section which rises 170 feet above the riverbed. The reservoir, about 145 miles long, includes both the Upper and Lower Arrow Lakes, and provides 7,100,000 acre-feet of Treaty storage.

The project is shown in the picture on page 15 and project data are shown in Table 2 of Appendix D.

MICA DAM
and forebay,
British Columbia.



Mica Project

Mica Dam, the largest of the Treaty projects, was scheduled by the Sales Agreement for initial operation on 1 April 1973. The project was declared operational and commenced storing on 29 March 1973.

Mica Dam is located on the Columbia River about 85 miles north of Revelstoke, British Columbia. The earthfill dam rises more than 800 feet above its foundation and creates a reservoir 135 miles long, Kinbasket Lake, with a storage capacity of 20,000,000 acre-feet. The project utilizes 12,000,000 acre-feet of live storage of which 7,000,000 acre-feet are committed under the Treaty.

The underground powerhouse has space for a total of six 434 megawatt units with a total capacity of 2,604 megawatts. The first two generators were placed in service late in 1976 and the last of the initial four units commenced operation in October 1977.

The project is shown in the picture on page 2 and project data are shown in Table 3 of Appendix D.

Libby Project in the United States

Libby Dam is located on the Kootenai River 17 miles northeast of the town of Libby, Montana. Construction began in the spring of 1966, storage has been fully operational since 17 April 1973, and commercial generation of power began on 24 August 1975, coincident with formal dedication of the project. The concrete gravity dam rises 370 feet above the riverbed and creates Lake Kootenai which is 90 miles long and extends 42 miles into Canada. Lake Kootenai has a gross storage of 5,869,000 acre-feet, of which 4,980,000 acre-feet are usable for flood control and power purposes. The Libby powerhouse now has four units with a total installed capacity of 420 megawatts.

Work on the Libby project during the report year included site restoration work, a circuit breaker blast barrier and the installation of a rock slide detection system, all of which were completed in November 1982.

Construction of the Libby Additional Units project was initiated during fiscal year 1978. Turbines for the four additional units in the main dam have been installed. Congressional

CONTROL ROOM
for generators
at Libby Dam.



restrictions imposed in the 1982 Appropriations Act provide for completion of only one of the four additional units. One generator is being installed and power from that unit is scheduled to be on line in October 1984.

There has been no construction activity on the Reregulating Dam since that project was halted by court order in September 1978.

The Libby project is shown in the picture on page 9 and project data are shown in Table 4 of Appendix D.

RECREATION PONDS
at Kikomun Park
on shore of Lake Koocanusa
in British Columbia.



Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 42-mile portion of Lake Koocanusa in Canada. Funded by British Columbia Hydro and Power Authority and coordinated by the Province of British Columbia's Ministry of Environment, fishery and wildlife studies are being continued and a program of property fencing is underway to maintain control of livestock because of continuing reservoir bank sloughing.

Hydrometeorological Network

One of the responsibilities assigned to the Entities by the Treaty is the establishment and operation, in consultation with the Permanent Engineering Board, of a hydrometeorological system to obtain data for detailed programming of flood control and power operation. This system includes snow courses, meteorological stations and streamflow gauges. The Columbia River Treaty Hydrometeorological Committee, formed by the Entities, makes recommendations on further development of the Treaty Hydrometeorological System.

In developing the hydrometeorological network the Entities, with the concurrence of the Board, adopted a document in 1976 which defines the Columbia River Treaty Hydrometeorological System Network and sets forth a method of classifying facilities into those required as part of the Treaty System and those of value as Supporting Facilities.

During the 1976-77 report year the Entities, with the concurrence of the Board, adopted a plan for exchange of operational hydrometeorological data. That plan is still in force. Revised Hydrometeorological Committee Documents were received after the end of the report year. These documents incorporate the increasing use of satellite telemetry for network automation as well as computerized data exchange and processing facilities.

Progress continues to be made in automating the collection and processing of hydrometeorological data in the Columbia River system. The hydrometeorological network in the Canadian portion of the basin is expected to be fully automated by October 1984. In the United States, the Columbia Basin teletype network has been upgraded and now operates as an extension of the Columbia River Operational Hydromet System, a computer system that has capability for direct input of data from other computer terminals and for retrieval of data reports. This system is located in Portland, Oregon. British Columbia Hydro and Power Authority's data processing computer at the Burnaby Mountain System Control Centre is linked by permanent microwave channel to the centre in Portland.

Power Operating Plans

The Treaty and related documents provide that the Entities are to agree annually on operating plans and on the resulting downstream power benefits for the sixth succeeding year of operation. These operating plans, prepared five years in advance, are called Assured Operating Plans. They represent the basic operating commitment of the Canadian Entity, and provide the Entities with a basis for system planning. At the beginning of each operating year, a Detailed Operating Plan is prepared on the basis of current resources and loads to obtain results that may be more advantageous to both countries than those which would be obtained by operating in accordance with the Assured Operating Plan.

The Entities have agreed with the Board's view, as noted in the Board's annual report to 30 September 1981, that Canada's commitment to operate under an Assured Operating Plan is tied directly to the benefits produced by that plan. Therefore, the period of streamflow records used to calculate downstream power benefits and to develop such plans must be identical.

Paragraph 8 of the Protocol to the Treaty stipulates that a specific 30-year record of streamflows be used for calculating downstream power benefits. The Board notes that the Entities are using this record for part of the downstream benefit calculations but have updated and extended the record for general use and are using this updated record for the specified 30-year period to develop Assured Operating Plans. The Board has some reservations about the updating of these records and intends to review this procedure.

The document "Columbia River Treaty, Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans" has been revised to recognize use of the updated record for the 30-year period.

The Assured Operating Plan for operating year 1987-88, received by the Board early in the report year, includes generation at the Mica and Revelstoke projects in Canada and is based on the operation of the system for optimum generation in both countries.

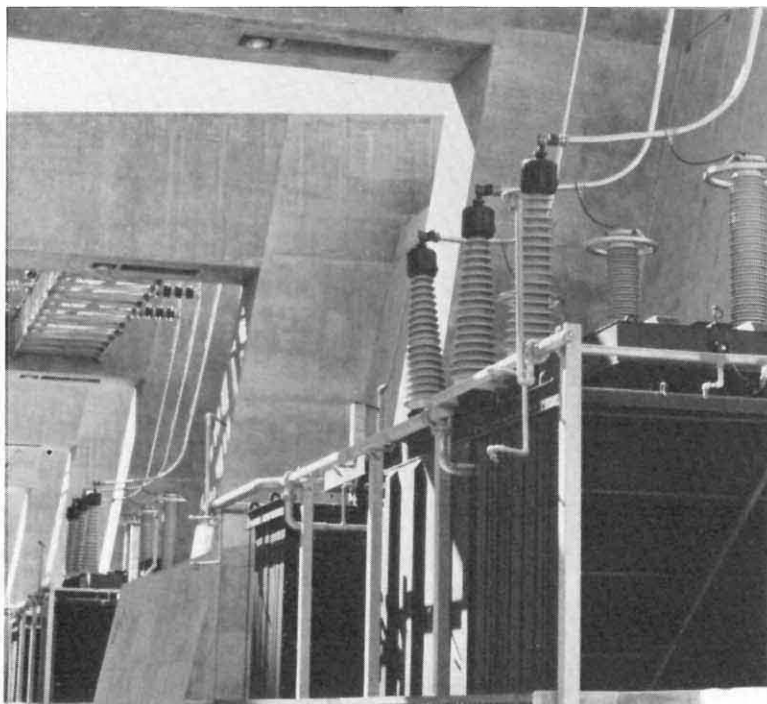
Early in this report year the Entities provided the Board with a Detailed Operating Plan for Canadian storage for the operating year ending 31 July 1983. A Detailed Operating

Plan for the operating year ending 31 July 1984 was forwarded to the Board after the end of the report year. These plans contain criteria for operating the Arrow, Duncan, Mica and Libby reservoirs.

The Northwest Power Planning Council was established by Act of Congress in 1980 to prepare a program for improvement of fish and wildlife in the Columbia River Basin and to develop a conservation and electric power plan for the Pacific Northwest. The Council, on 15 November 1982, adopted the "Columbia River Basin Fish and Wildlife Program" which advocates the use of Canadian Treaty storage for fisheries purposes in the United States.

The Board does not agree that use of Canadian storage could be considered for fishery purposes in developing the Assured Operating Plans as it contradicts Treaty requirements for optimum operation for power and flood control benefits. The Board notes however that the Entities could, by agreement, provide water for fish migration under detailed operating arrangements providing this does not conflict with Treaty requirements. Such arrangements must not result in any decrease to Canadian downstream power or flood control benefits. The Board has advised the Entities of this position.

TRANSFORMERS
at Libby Dam,
Montana.



Annual Calculation of Downstream Benefits

The general requirements for determination of assured operating plans and downstream power benefits are summarized in the first paragraph of the preceding section.

In this report year the Entities provided the Board with a copy of their agreed document outlining downstream power benefits resulting from Canadian storage for the operating year 1987-88. The Board has completed its review of this document and concludes that it meets the requirements of the Treaty. Copies of the three computer studies used in the final calculations for the determination of downstream benefits, and which also provide the basis of the hydroelectric operating plan, were forwarded to the Board by the Entities. A report on determination of downstream power benefits for the operating year 1988-89 was received from the Entities after the end of the report year.

The report "Limitation on Dependable Hydroelectric Capacity Credit Resulting from Canadian Storage", prepared for the United States Entity was reviewed by the Board. Comments were provided to the Entities for consideration in further review of the report.

Flood Control Operating Plans

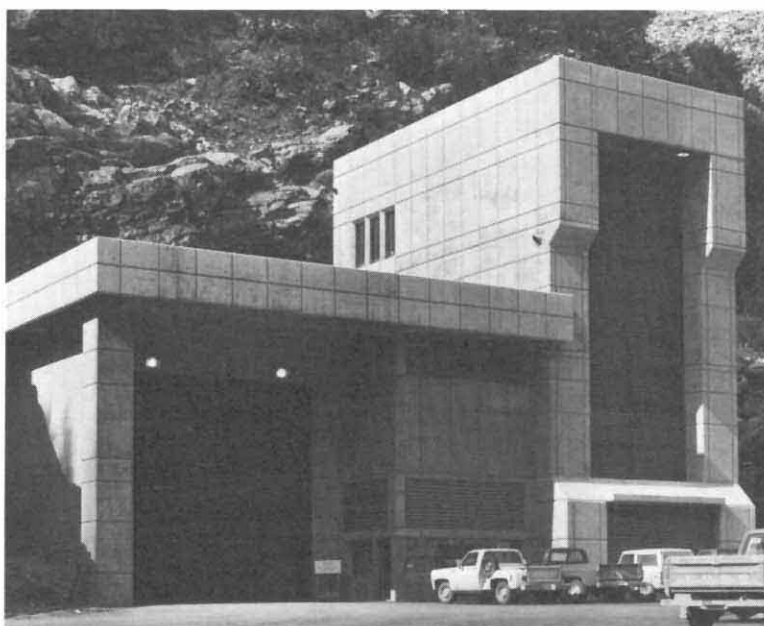
The Treaty provides that Canadian storage reservoirs will be operated by the Canadian Entity in accordance with operating plans designed to minimize flood damage in the United States and Canada.

The "Columbia River Treaty Flood Control Operating Plan" defines flood control operation of the Duncan, Arrow, Mica and Libby reservoirs. This plan was received from the Entities and reviewed by the Board in the 1972-73 report year.

Flow Records

Article XV (2)(a) of the Treaty specified that the Permanent Engineering Board shall assemble records of flows of the Columbia and Kootenay Rivers at the Canada-United States of America boundary. Actual recorded flows for this report year are tabulated in Appendix C for the Kootenai River at Porthill, Idaho, and for the Columbia River at Birchbank, British Columbia, Plate 1.

ENTRANCE
to underground
powerhouse
at Mica Dam.



OPERATION

General

The Columbia River Treaty Operating Committee was established by the Entities to develop operating plans for the Treaty storages and to direct operation of these storages in accordance with the terms of the Entity agreements.

During the report year the Treaty storage in Canada was operated by the Canadian Entity in accordance with:

- Columbia River Treaty Flood Control Operating Plan
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1982 through 31 July 1983
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1983 through 31 July 1984
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1982-83
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1983-84.

In addition, a special agreement was in effect during this period:

- Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration dated 9 June 1983 providing extra storage in Arrow Lakes reservoir and in Kinbasket Lake in 1983.

Power Operation

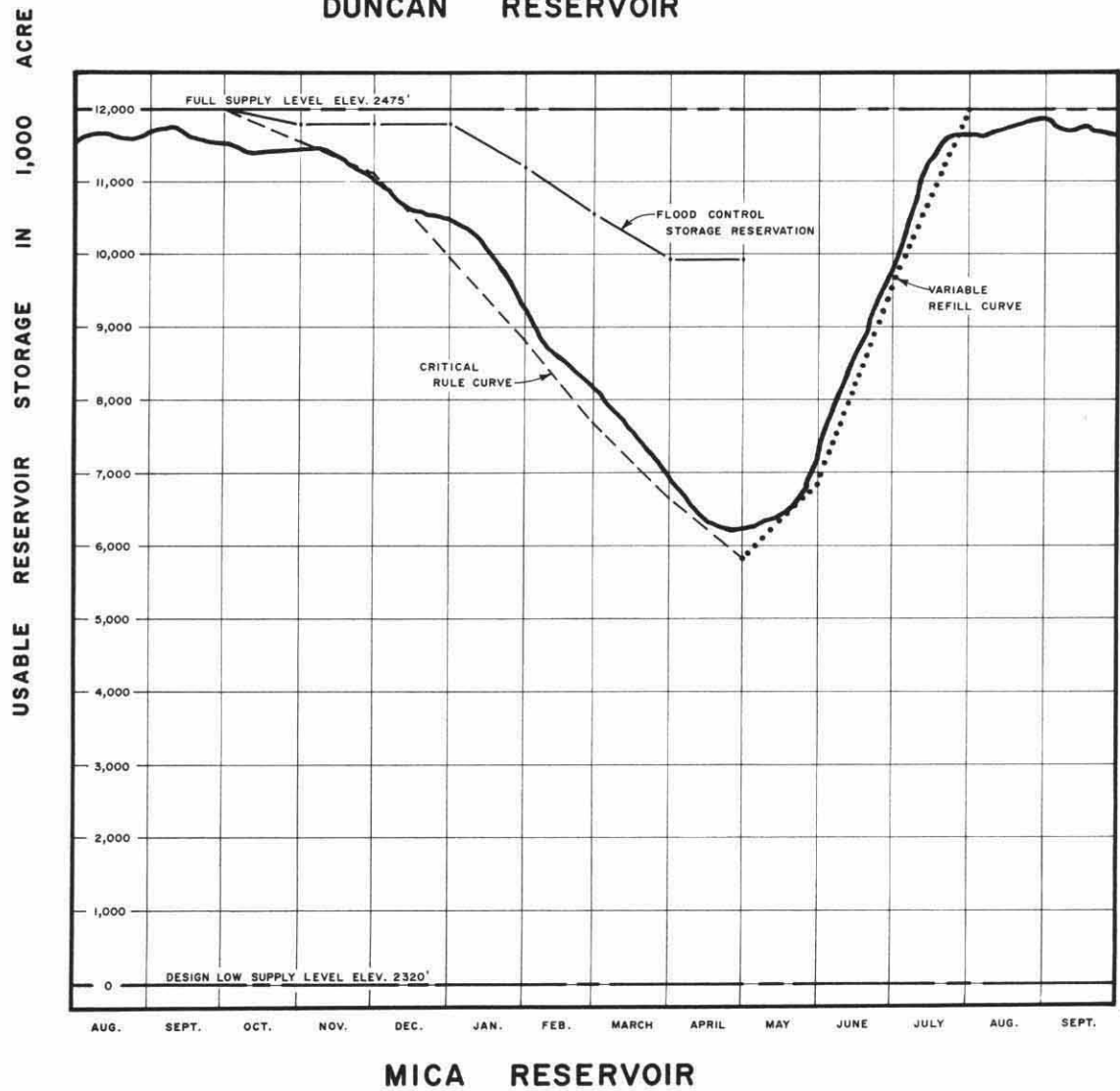
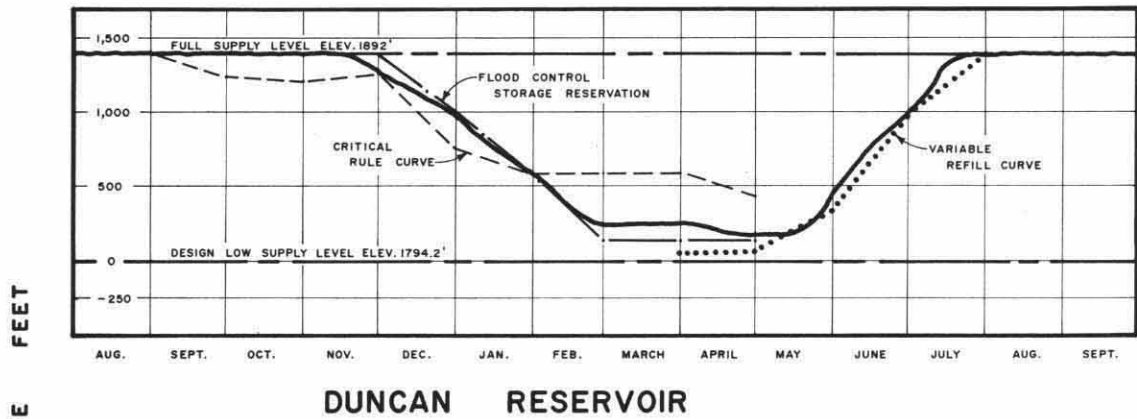
The three Canadian Treaty reservoirs, Duncan, Arrow and Mica, and the Libby reservoir in the United States were in full operation throughout this report year.

All power reservoirs in the Columbia River System filled in the 1982 freshet. At the beginning of this report year Canadian Treaty Storages were full and Libby reservoir was nearly full. Near average inflows and decreased load growth in the Pacific Northwest contributed to sales of secondary energy in United States markets during the report year. Heavy rains in late February required flood control operation of the system for several weeks to alleviate their effect on mid and lower Columbia River stages.

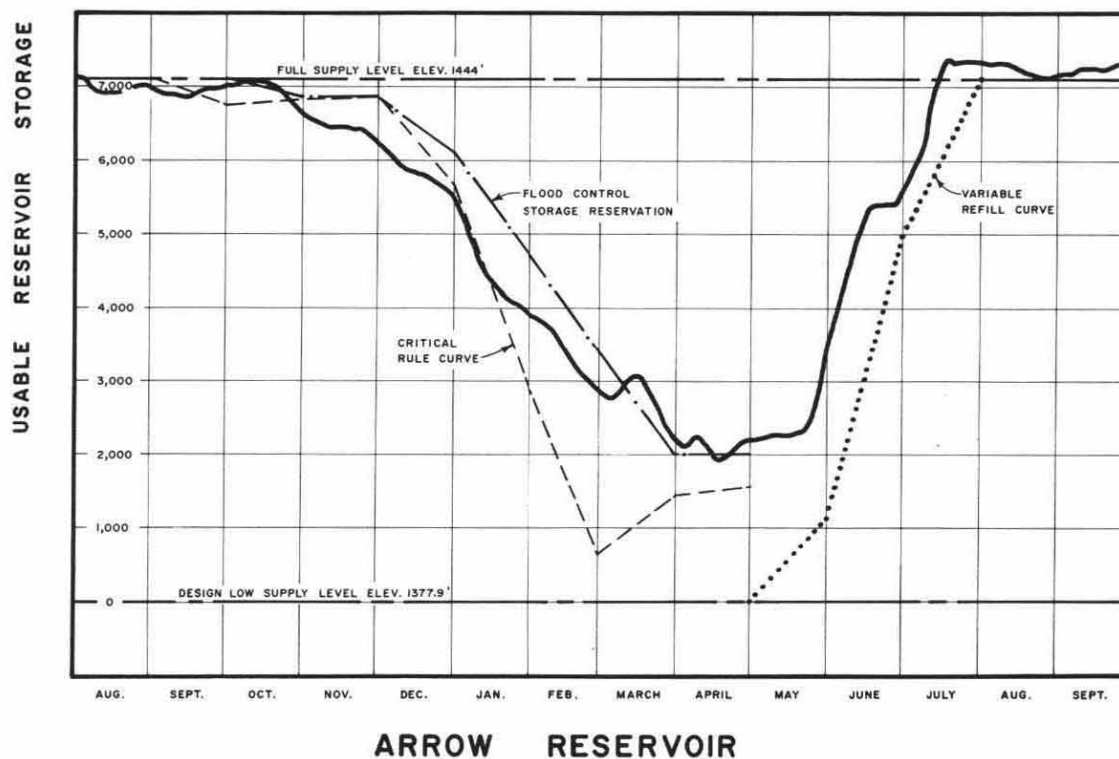
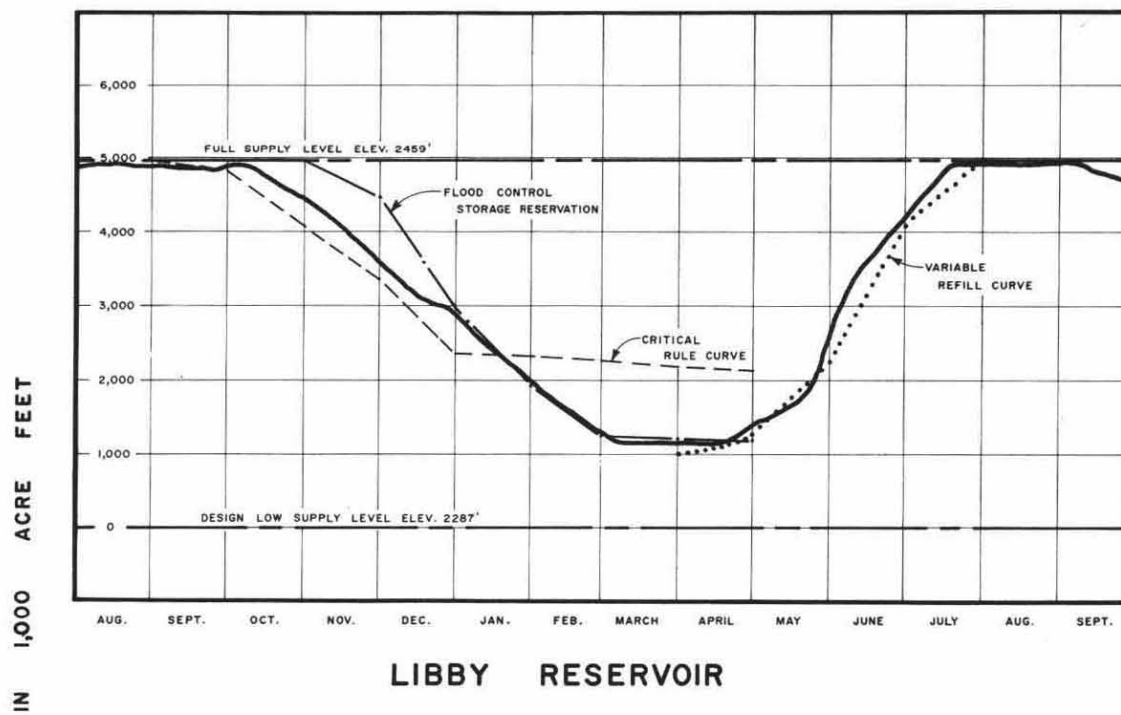
The 1983 freshet volume was slightly above average, although in the Canadian portion of the basin precipitation in July was the highest on record. In spite of the high inflows in Canada, downstream flood control was provided by normal refill schedules. After the freshet, little drafting of Treaty storage for power was required and most Treaty reservoirs were full at the end of this report year.

In the United States during the period from mid April to mid June reservoirs were operated to assist juvenile fish downstream migration in the Snake and Columbia Rivers.

Operation of the reservoirs is illustrated on pages 28 and 29 by hydrographs which show actual reservoir levels and some of the more important rule curves which govern operation of the Treaty storages. The Flood Control Storage Reservation curve specifies maximum month-end reservoir levels which will permit evacuation of the reservoir to control the forecasted freshet. The Critical Rule Curve shows minimum month-end reservoir levels which should be maintained to enable the anticipated power demands to be met under adverse water supply conditions. The Variable Refill Curve shows reservoir elevations necessary to ensure refilling the reservoir by the end of July with a reasonable degree of confidence. Similar rule curves which apply to operation of the combined Canadian Treaty storages have also been provided to the Board.



HYDROGRAPHS — Duncan and Mica reservoir levels for the 14-month period ending 30 September 1983.



HYDROGRAPHS — Libby and Arrow reservoir levels for the 14-month period ending 30 September 1983.

At the beginning of the report year the Duncan reservoir was full at elevation 1892 feet. Throughout the draft season releases for power and flood control drawdown requirements were scheduled in conjunction with Libby discharges to control Kootenay Lake inflow and minimize spill at Kootenay River hydroelectric plants. Minimum reservoir elevation for the year was 1812.4 feet on 28 April 1983. Filling commenced in mid-May and the reservoir filled on 24 July. It was held at or near full to the end of the report year and on 30 September 1983 the reservoir elevation was 1891.5 feet.

The Arrow reservoir was near normal full pool at elevation 1443.7 feet at the beginning of this report year. Drafting of Treaty storage was generally in conformance with Flood Control Rule Curve requirements. However, by special arrangement, storage space was utilized at the end of December 1982 to temporarily store water surplus to generating requirements in the northwest United States. Also, following heavy rains in the United States during February, storage of water to control downstream flooding caused reservoir levels to exceed the evacuation target levels.

Refill began late in April and the reservoir reached full pool elevation of 1444 feet on 16 July. Storing continued in accordance with a special agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration to utilize non-Treaty storage space up to elevation 1446 feet which was reached on 19 July. The reservoir then remained above its normal full pool elevation and was at elevation 1446 feet at the end of the report year.

Treaty storage in the Mica reservoir was full at the beginning of the report year. The reservoir elevation was 2470.8 feet, about four feet below normal full pool elevation. Drafting of Treaty storage commenced in October. From November through April discharges were in accordance with British Columbia Hydro and Power Authority's generating needs and downstream United States' requirements.

Mica reservoir began to refill in May. In early July, after heavy rains, project discharges were controlled to meet requirements at the Revelstoke construction site. Treaty storage space was filled on 15 July.

During the latter part of July and most of August water was spilled at Mica to meet the need to maintain some storage space to protect construction underway at the Revelstoke project. During the period 15 to 24 July about 167,000 acre-feet of water was stored in non-Treaty storage space under a special agreement. The peak elevation, 2474.3 feet, occurred 2 September 1983. Treaty storage remained full and on 30 September the Mica reservoir was at elevation 2472 feet.

At the beginning of this report year Libby reservoir was nearly full at elevation 2457.9 feet, one foot below normal full pool. Drafting began in September and was continued to meet power and flood control requirements until the reservoir reached its lowest elevation for the year, 2348.3 feet on 15 April 1983. Early in March drafting was reduced to avoid exceeding the International Joint Commission rule curve for Kootenay Lake. The reservoir refilled 7 August and remained near its full pool elevation of 2459 feet until late September. At year end the reservoir elevation was 2453.2 feet.

Flood Control Operation

Because heavy rains caused high flows in the mid and lower Columbia River, Treaty projects were put under flood control operation on 22 February 1983. Operations were on a daily basis until 25 March to reduce flooding in the United States and allow evacuation of space filled during these flood control operations.

Flood control during the 1983 spring runoff was provided by the normal refill operation of the Treaty projects and other storage reservoirs in the Columbia River basin. Operation during the freshet was in accordance with the Entities' document "Columbia River Treaty Flood Control Operating Plan" and the freshet was controlled to well below damaging levels.

BENEFITS

Flood Control Provided

Without regulation by upstream reservoirs the 1983 freshet would have produced an about average peak discharge at Trail, British Columbia and an above average peak discharge at The Dalles, Oregon, but would not have caused major flood damage in either country.

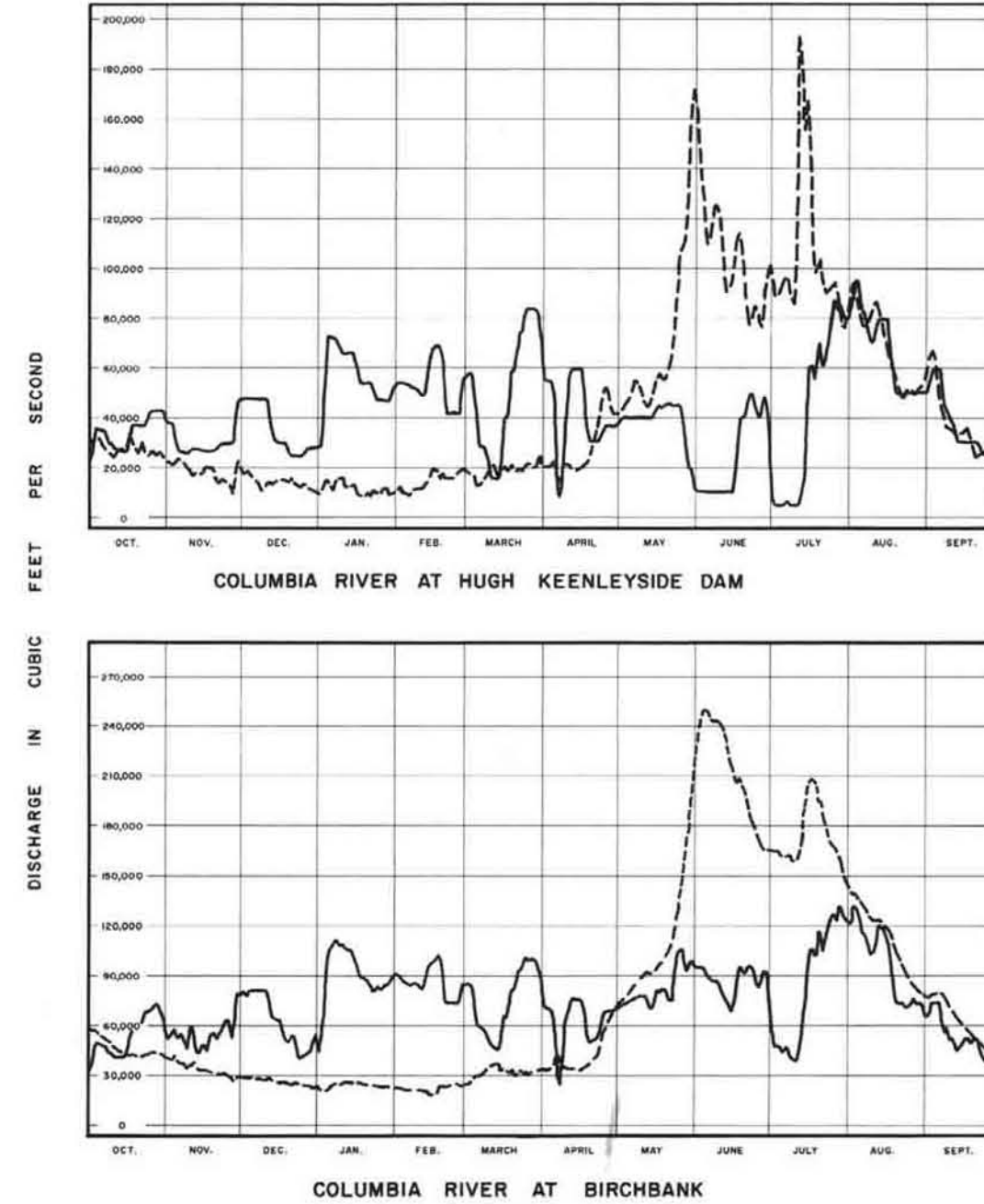
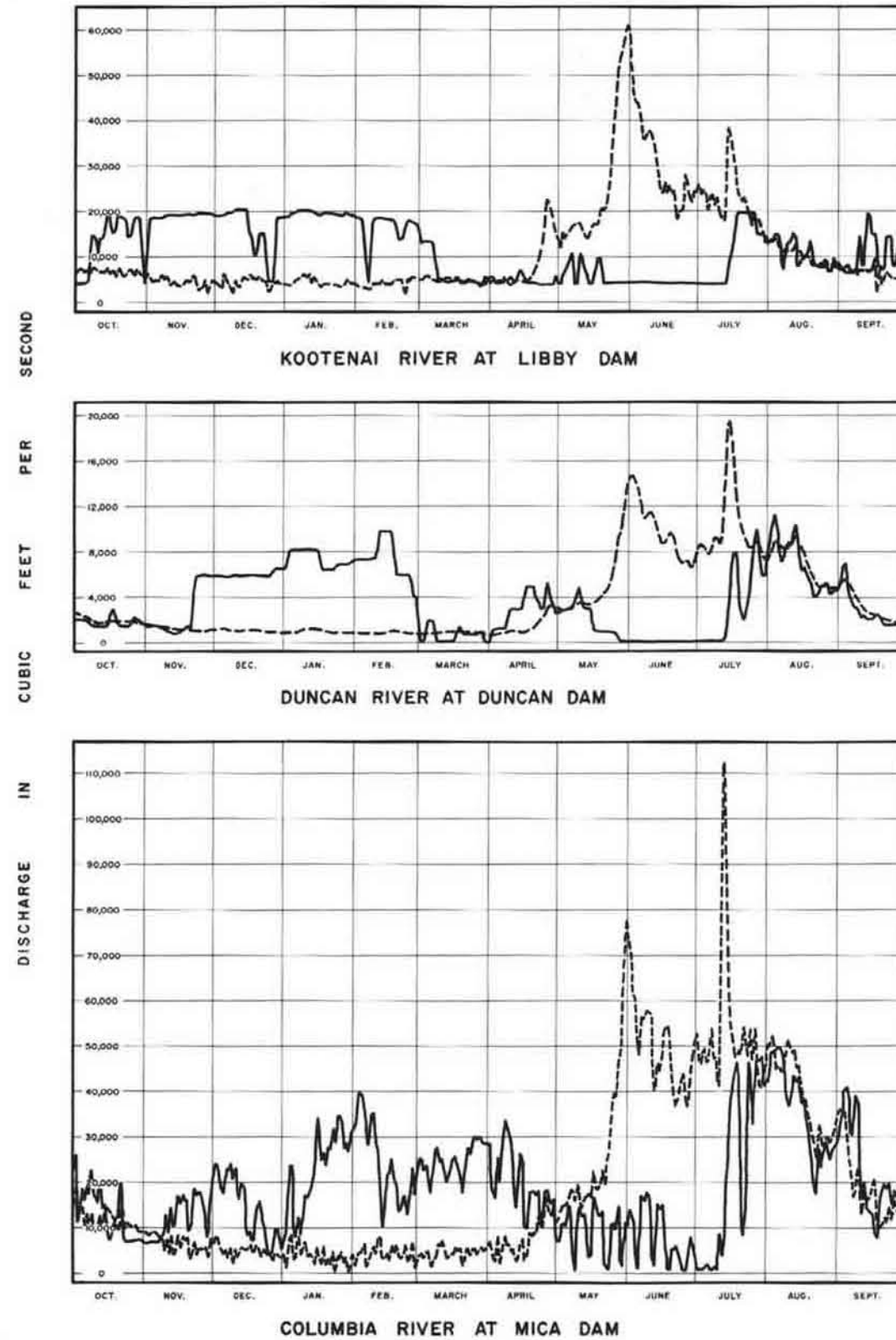
It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about six and one half feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by about eleven feet. The effect of storage in the Duncan, Arrow, Mica and Libby reservoirs on flows at the sites and on flows of the Columbia River at Birchbank is illustrated on page 33 by hydrographs which show both the actual discharges and the flows that would have occurred if the dams had not been built. It is noted that the hydrograph showing pre-project conditions for Birchbank has been computed on the assumption that the effects of Duncan, Arrow, Mica and Libby regulation and of the regulation provided by the Corra Linn development on Kootenay Lake have been removed.

The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon from about 723,000 cfs to 402,000 cfs. Regulation by the Treaty storage projects during the 1983 freshet period contributed minor flood control benefits in Canada and the United States.

All payments required by Article VI(1) as compensation for flood control provided by the Canadian Treaty storage projects have been made by the United States to Canada; the final payment was made on 29 March 1973 when the Mica project was declared operational.

Power Benefits

Downstream power benefits in the United States which arise from operation of the Canadian Treaty Storage were pre-determined and the Canadian one-half share was sold in the United States under the terms of the Canadian Entitlement Purchase Agreement.



LEGEND
 — Observed Flows
 - - - Pre-Project Flows

HYDROGRAPHS — Observed and pre-project flows
 for year ending 30 September 1983.

The United States Entity delivered capacity and energy to Columbia Storage Power Exchange participants as purchasers of the Canadian Entitlement. No additional downstream power benefits were realized during the year from the operation of Treaty storage other than the added generation made possible on the Kootenay River in Canada and additional generation in the United States system resulting from regulation provided by Libby. The Kootenay River benefits in Canada, under Article XII of the Treaty, and generation at the Mica project are retained wholly within Canada while the benefits from Libby in the United States are not shareable under the Treaty.

Other Benefits

In previous report years, by agreement between the Entities, streamflows have been regulated for non-power purposes such as accommodating construction in river channels and providing water to assist the downstream migration of juvenile fish in the United States. These arrangements were supplemental to Treaty operating plans. In this report year similar arrangements were made.

SPORT FISHING
on Arrow Reservoir
in British Columbia.



CONCLUSIONS

1. The Duncan, Arrow, Mica and Libby projects have been operated in conformity with the provisions of the Treaty, the detailed operating plans developed by the Entities, the flood control operating plan for Treaty reservoirs, and a special agreement for using additional storage in Arrow reservoir. Operation under this agreement did not conflict with normal Treaty operations.
2. Entity evaluations pertaining to development of the hydrometeorological network, power operating plans, and the annual calculation of downstream power benefits are proceeding satisfactorily.
3. Treaty storage projects were regulated to avoid what otherwise would have been moderate flood damages in the United States from the above average freshet and high flows in February.
4. The Northwest Power Planning Council's "Columbia River Basin Fish and Wildlife Program" which advocates the use of Canadian Treaty storage for fisheries purposes in the United States cannot be considered in developing Assured Operating Plans as it contradicts Treaty requirements for optimum operation for power and flood control benefits.
5. The Board has some reservations about the practice of the Entities of updating streamflow records for the development of Assured Operating Plans. This practice will be reviewed.
6. The objectives of the Treaty are being met.

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	<u>Alternates</u>	
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Mr. Thomas L. Weaver Assistant Administrator for Engineering, Western Area Power Administration, Department of Energy, Golden, Colorado		Mr. H.M. Hunt Head, Power and Special Projects Section, Ministry of Environment, Victoria, B.C.
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Power Administration,
Department of Energy,
Portland, Oregon

Brigadier General James W. van Loben Sels

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

Canada

Mr. R.W. Bonner, Chairman

Chairman, British Columbia
Hydro and Power Authority,
Vancouver, B.C.

RECORD OF FLOWS
AT THE
INTERNATIONAL BOUNDARY

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.
1	5,610	6,320	21,300	19,100	21,000	20,200	10,600	15,800	25,700	9,440	15,400	9,030
2	5,480	17,500	20,700	19,000	20,900	18,500	10,200	16,000	26,300	9,440	15,700	7,750
3	5,860	20,000	21,600	19,100	20,700	18,800	8,970	18,100	24,600	9,600	16,200	7,940
4	5,760	20,500	24,600	20,500	20,400	19,200	8,680	18,900	22,500	9,350	16,400	7,180
5	5,510	20,600	24,700	20,700	13,500	19,500	8,540	20,300	20,800	8,860	16,400	7,290
6	5,640	20,900	23,900	21,200	9,510	19,300	8,450	22,900	19,400	8,680	14,600	7,190
7	5,920	21,100	22,800	21,500	7,230	19,100	9,890	23,900	18,600	8,520	10,100	7,270
8	14,300	21,000	22,100	22,700	16,900	14,500	9,250	19,700	18,200	8,370	8,940	7,290
9	14,500	20,800	21,900	24,700	18,600	12,000	8,610	18,600	17,900	7,880	14,400	8,000
10	14,500	20,500	21,700	24,700	19,600	13,300	8,580	22,200	17,300	7,560	14,200	13,900
11	11,300	20,600	21,100	25,200	19,800	15,400	8,380	22,800	17,200	7,270	15,300	9,170
12	13,800	20,600	21,200	25,100	19,900	15,600	8,330	19,500	15,600	7,120	16,000	8,840
13	14,800	20,500	21,500	24,300	20,500	14,400	9,460	17,200	14,100	7,600	14,300	17,400
14	18,200	20,600	21,400	23,800	20,600	14,200	10,900	15,200	13,300	11,800	10,100	19,500
15	19,400	20,500	21,700	22,900	20,400	14,000	10,100	15,500	13,100	15,300	9,480	16,900
16	16,900	20,900	20,700	22,200	20,500	13,300	9,050	16,400	12,600	16,500	10,700	15,500
17	15,500	21,100	17,800	22,100	20,500	12,700	8,140	19,100	12,100	19,200	10,800	15,000
18	15,500	21,500	14,900	22,000	21,400	12,200	8,680	23,400	11,700	23,800	10,800	9,420
19	18,300	21,800	12,000	21,800	19,100	11,500	9,690	24,400	11,400	24,200	12,900	8,610
20	19,500	21,700	14,100	21,800	17,300	10,400	11,300	21,100	10,800	24,500	12,900	7,950
21	19,800	21,800	16,400	21,600	17,300	9,920	13,200	21,700	10,200	24,200	9,320	8,100
22	20,000	21,500	16,600	21,500	17,900	10,200	15,300	23,400	9,720	23,900	8,820	13,900
23	17,800	21,300	16,500	21,300	20,800	9,380	17,300	25,200	10,500	23,500	8,360	14,900
24	16,800	21,300	11,800	21,400	21,800	9,110	22,300	28,000	11,400	23,200	8,860	14,600
25	16,500	21,300	6,790	21,300	22,400	8,950	26,400	30,500	11,100	23,300	8,930	9,020
26	19,200	21,300	6,350	21,100	22,700	8,740	25,200	32,400	10,200	22,200	8,710	8,430
27	20,500	21,000	6,360	21,400	22,700	8,280	22,000	32,300	9,960	18,700	9,880	11,700
28	20,700	21,000	15,000	21,800	22,600	8,070	19,200	31,600	10,300	17,900	8,380	11,800
29	20,900	21,200	18,400	21,800		7,960	17,500	31,400	9,900	17,800	7,620	11,600
30	15,700	21,100	18,900	21,600		9,910	17,700	31,500	9,600	17,100	10,300	11,600
31	6,320		19,200	21,400		9,440		29,300		15,700	9,480	
Mean	14,200	20,400	18,200	22,000	19,200	13,200	12,700	22,800	14,900	15,200	11,800	10,900

KOOTENAI RIVER AT PORTHILL, IDAHO — Daily discharges for the year ending 30 September 1983 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.
1	33,300	51,900	78,800	44,100	91,800	85,800	72,000	72,400	95,700	54,400	122,000	66,400
2	41,000	53,000	81,600	50,500	91,500	85,800	71,700	73,500	96,100	47,700	123,000	67,500
3	50,100	56,200	77,700	67,100	89,300	86,200	71,300	73,800	96,400	48,700	133,000	74,900
4	49,400	58,300	81,900	88,300	86,500	82,600	70,600	74,200	94,300	48,000	132,000	74,900
5	49,100	52,300	81,900	105,000	85,800	67,100	65,300	75,600	91,800	44,500	125,000	75,200
6	48,700	55,800	81,600	108,000	84,800	58,600	51,200	75,900	90,100	46,300	116,000	76,300
7	47,700	53,300	81,900	110,000	84,000	58,600	29,000	77,700	87,600	47,700	116,000	68,200
8	44,100	48,000	81,600	113,000	86,200	58,300	23,100	78,000	86,900	44,500	112,000	56,500
9	44,100	45,600	81,600	109,000	86,500	56,200	47,000	78,000	87,900	39,600	104,000	60,000
10	42,400	59,300	81,600	108,000	84,800	50,900	60,000	78,800	83,300	39,900	103,000	52,300
11	40,600	60,000	81,900	110,000	82,600	47,700	72,700	77,300	81,200	39,600	105,000	53,000
12	41,000	51,900	74,200	106,000	83,000	47,000	77,000	78,800	77,700	45,600	111,000	50,500
13	40,600	43,400	65,000	106,000	88,600	45,900	77,000	72,700	75,200	54,700	122,000	44,500
14	40,600	44,500	63,900	106,000	96,800	45,200	77,000	70,600	71,700	75,200	120,000	47,000
15	42,000	49,100	63,200	104,000	98,200	50,500	77,000	74,200	68,500	91,500	118,000	49,100
16	48,400	48,000	63,900	96,800	98,900	65,700	76,600	82,300	73,500	107,000	114,000	53,000
17	52,600	44,800	57,200	90,800	100,000	64,600	71,300	80,200	85,100	108,000	106,000	53,000
18	59,300	52,600	51,900	89,700	104,000	69,200	57,200	82,600	96,400	102,000	90,100	53,000
19	58,300	55,800	49,800	88,600	97,800	80,900	50,500	81,600	94,300	103,000	78,400	49,800
20	59,700	55,800	51,200	87,600	84,400	80,900	50,500	82,300	92,500	118,000	74,200	54,400
21	59,700	52,300	54,000	87,600	74,500	83,700	51,900	77,000	92,200	105,000	73,800	53,300
22	60,400	55,100	54,000	83,000	73,500	93,600	52,600	75,200	96,800	107,000	74,500	51,600
23	67,500	57,600	47,300	80,500	73,800	94,300	54,000	91,800	95,700	115,000	73,500	43,100
24	69,600	62,500	40,300	83,000	73,800	97,100	61,800	102,000	93,600	121,000	71,300	39,600
25	69,900	63,200	40,300	84,400	73,500	102,000	68,500	107,000	85,800	127,000	72,400	39,600
26	68,900	63,900	41,700	81,900	73,100	99,600	69,600	107,000	83,700	128,000	74,500	39,600
27	73,100	52,300	42,400	83,300	79,800	101,000	69,200	99,900	86,500	124,000	77,000	42,700
28	73,800	60,700	43,800	85,100	86,500	101,000	69,200	92,900	94,300	133,000	73,800	41,000
29	69,900	79,500	44,100	84,800		99,900	70,300	97,500	91,100	130,000	74,900	39,900
30	67,100	80,200	51,200	87,900		97,100	69,600	100,000	74,200	125,000	74,200	39,600
31	59,300		55,100	91,100		80,900		96,100		123,000	66,700	
Mean	53,900	55,600	62,800	91,000	86,200	75,400	62,800	83,400	87,300	85,300	97,800	53,700

COLUMBIA RIVER AT BIRCHBANK, B.C. — Daily discharges for the year ending 30 September 1983 in cubic feet per second.

PROJECT INFORMATION

Power and Storage Projects,
Northern Columbia Basin

Plate No. 1

Project Characteristic Data

Duncan Project

Table No. 1

Arrow Project

Table No. 2

Mica Project

Table No. 3

Libby Project

Table No. 4

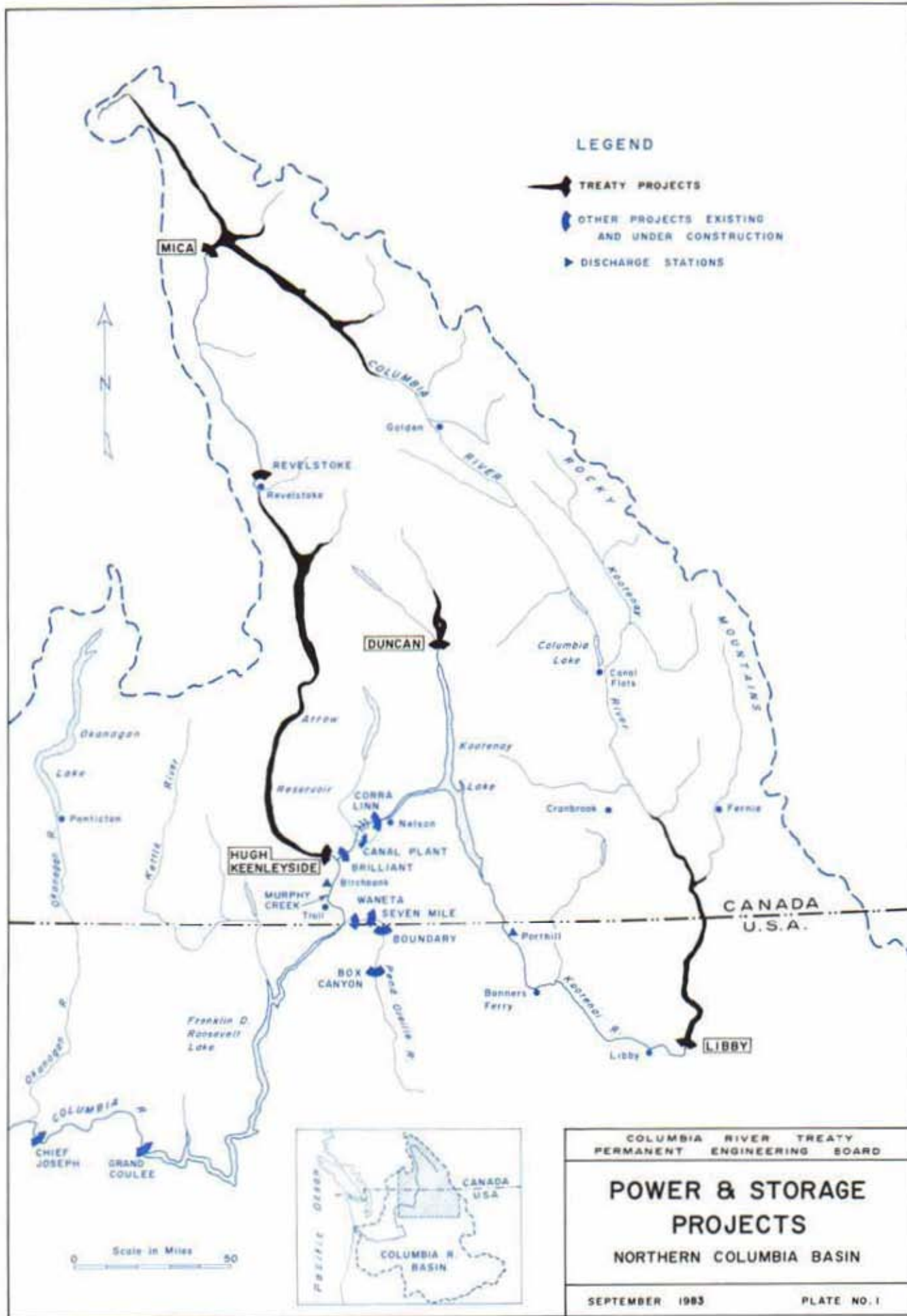


TABLE 1

DUNCAN PROJECTDuncan Dam and Duncan Lake

Storage Project

Construction began	17 September 1964
Storage became fully operational	31 July 1967

Reservoir

Normal Full Pool Elevation	1,892 feet
Normal Minimum Pool Elevation	1,794.2 feet
Surface Area at Full Pool	18,000 acres
Total Storage Capacity	1,432,500 ac-ft
Usable Storage Capacity	1,400,000 ac-ft
Treaty Storage Commitment	1,400,000 ac-ft

Dam, Earthfill

Crest Elevation	1,907 feet
Length	2,600 feet
Approximate height above riverbed	130 feet
Spillway — Maximum Capacity	47,700 cfs
Discharge Tunnels — Maximum Capacity	20,000 cfs

Power Facilities

None

TABLE 2ARROW PROJECTHugh Keenleyside Dam and Arrow Lakes

Storage Project

Construction began	March 1965
Storage became fully operational	10 October 1968

Reservoir

Normal Full Pool Elevation	1,444 feet
Normal Minimum Pool Elevation	1,377.9 feet
Surface Area at Full Pool	130,000 acres
Total Storage Capacity	8,337,000 ac-ft
Usable Storage Capacity	7,100,000 ac-ft
Treaty Storage Commitment	7,100,000 ac-ft

Dam, Concrete Gravity and Earthfill

Crest Elevation	1,459 feet
Length	2,850 feet
Approximate height above riverbed	170 feet
Spillway — Maximum Capacity	240,000 cfs
Low Level Outlets — Maximum Capacity	132,000 cfs

Power Facilities

None

TABLE 3

MICA PROJECTMica Dam and Kinbasket Lake

Storage	
Construction began	September 1965
Storage became fully operational	29 March 1973
Reservoir	
Normal Full Pool Elevation	2,475 feet
Normal Minimum Pool Elevation	2,320 feet
Surface Area at Full Pool	106,000 acres
Total Storage Capacity	20,000,000 ac-ft
Usable Storage Capacity	
Total	12,000,000 ac-ft
Commitment to Treaty	7,000,000 ac-ft
Dam, Earthfill	
Crest Elevation	2,500 feet
Length	2,600 feet
Approximate height above foundation	800 feet
Spillway — Maximum Capacity	150,000 cfs
Outlet Works — Maximum Capacity	37,400 cfs
Power Facilities	
Designed ultimate installation	
6 units at 434 mw	2,604 mw
Power commercially available	December 1976
Presently installed	
4 units at 434 mw	1,736 mw
Head at full pool	600 feet
Maximum Turbine Discharge	
of 4 units at full pool	38,140 cfs

TABLE 4

LIBBY PROJECTLibby Dam and Lake Koocanusa

Storage Project

Construction began	1966
Storage became fully operational	17 April 1973

Reservoir

Normal Full Pool Elevation	2,459 feet
Normal Minimum Pool Elevation	2,287 feet
Surface Area at Full Pool	46,500 acres
Total Storage Capacity	5,869,000 ac-ft
Usable Storage Capacity	4,980,000 ac-ft

Dam, Concrete Gravity

Deck Elevation	2,472 feet
Length	3,055 feet
Approximate height above riverbed	370 feet
Spillway — Maximum Capacity	145,000 cfs
Low Level Outlets — Maximum Capacity	61,000 cfs

Power Facilities

Digned ultimate installation	
8 units at 105 mw	840 mw
Power commercially available	24 August 1975
Presently installed	
4 units at 105 mw	420 mw
Head at full pool	352 feet
Maximum Turbine Discharge	
of 4 units at full pool	19,625 cfs