

ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

Washington, D.C.

Ottawa, Ontario

30 SEPTEMBER 1982



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 1982

The Honorable George P. Schultz
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 eighteenth Annual Report, dated 30 September 1982, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1981 to 30 September 1982.

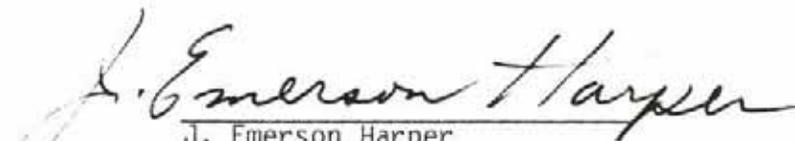
Respectfully submitted:

For the United States

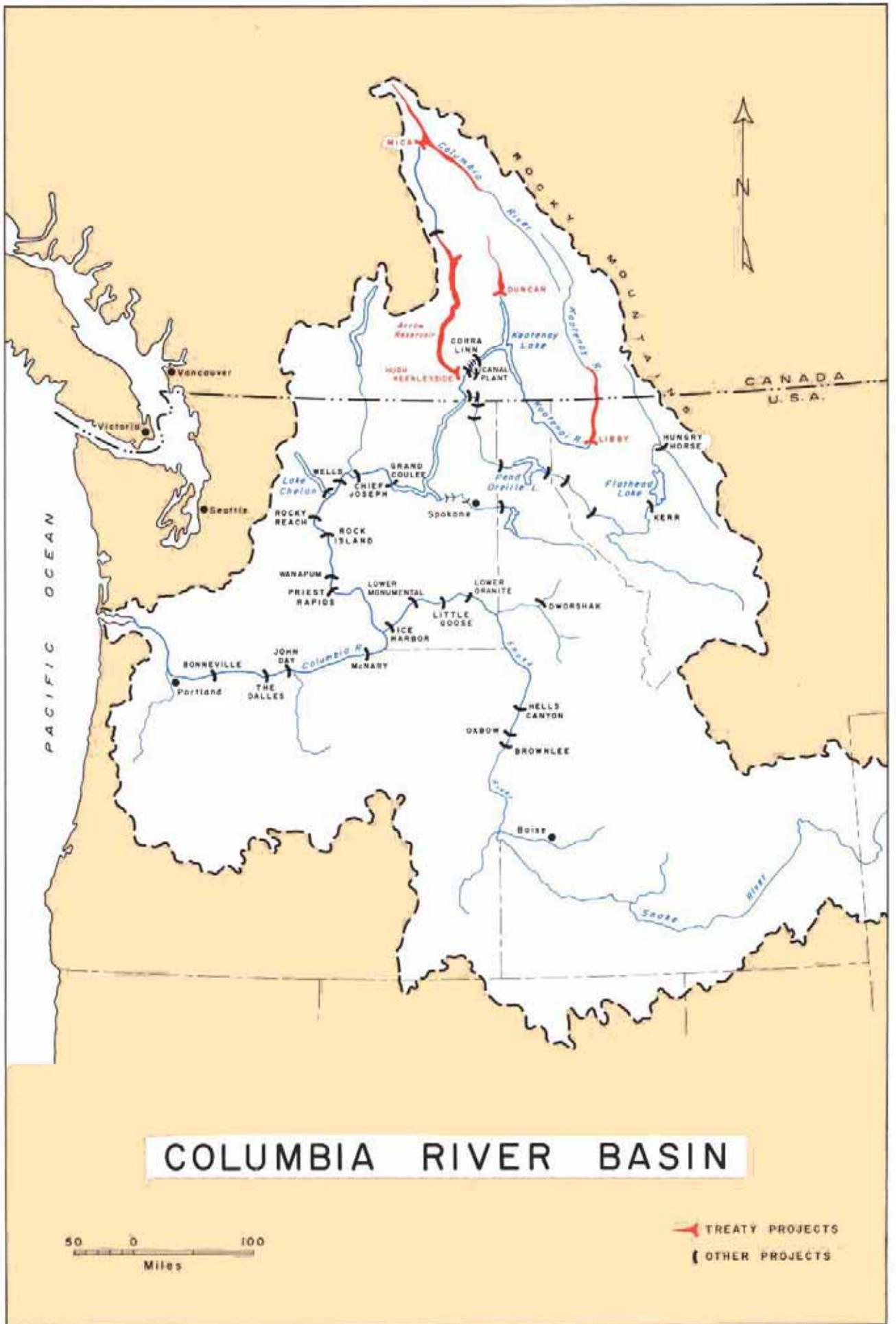
For Canada


Lloyd A. Duscha, Chairman


G.M. MacNabb, Chairman


J. Emerson Harper


B.E. Marr



COLUMBIA RIVER BASIN

50 0 100
Miles

▲ TREATY PROJECTS
┌ OTHER PROJECTS

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

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SUMMARY

The eighteenth 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 the 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 Arrow reservoir 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 26-33)

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)

A recent proposal by the Northwest Power Planning Council to commit Treaty storage in Canada for fisheries purposes in the United States may conflict with the terms of the Treaty. (Page 23)

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 1981 to 30 September 1982, 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.



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

Kootenai River, Montana

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.

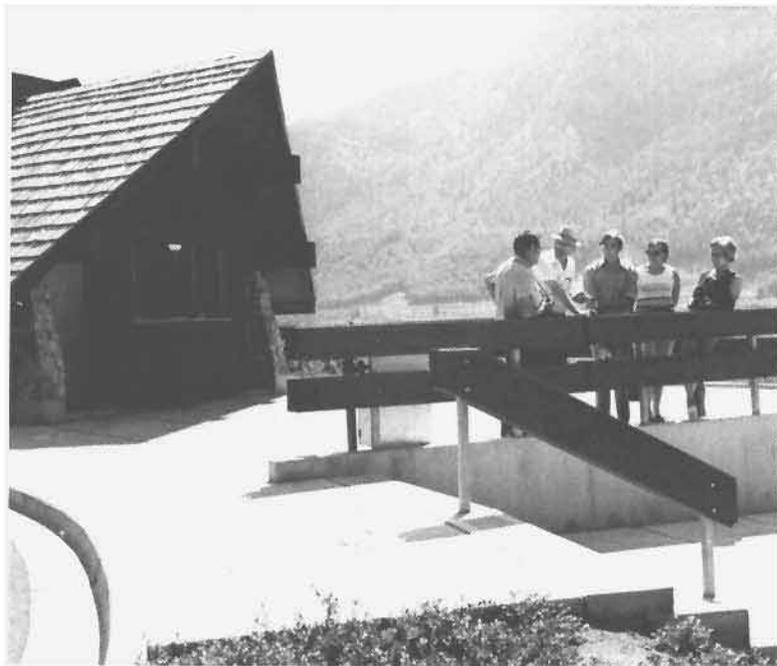
- (g) Differences arising under the Treaty which cannot be resolved by the two countries may be referred by either to the International Joint Commission or to arbitration by an appropriate tribunal as specified by the Treaty.

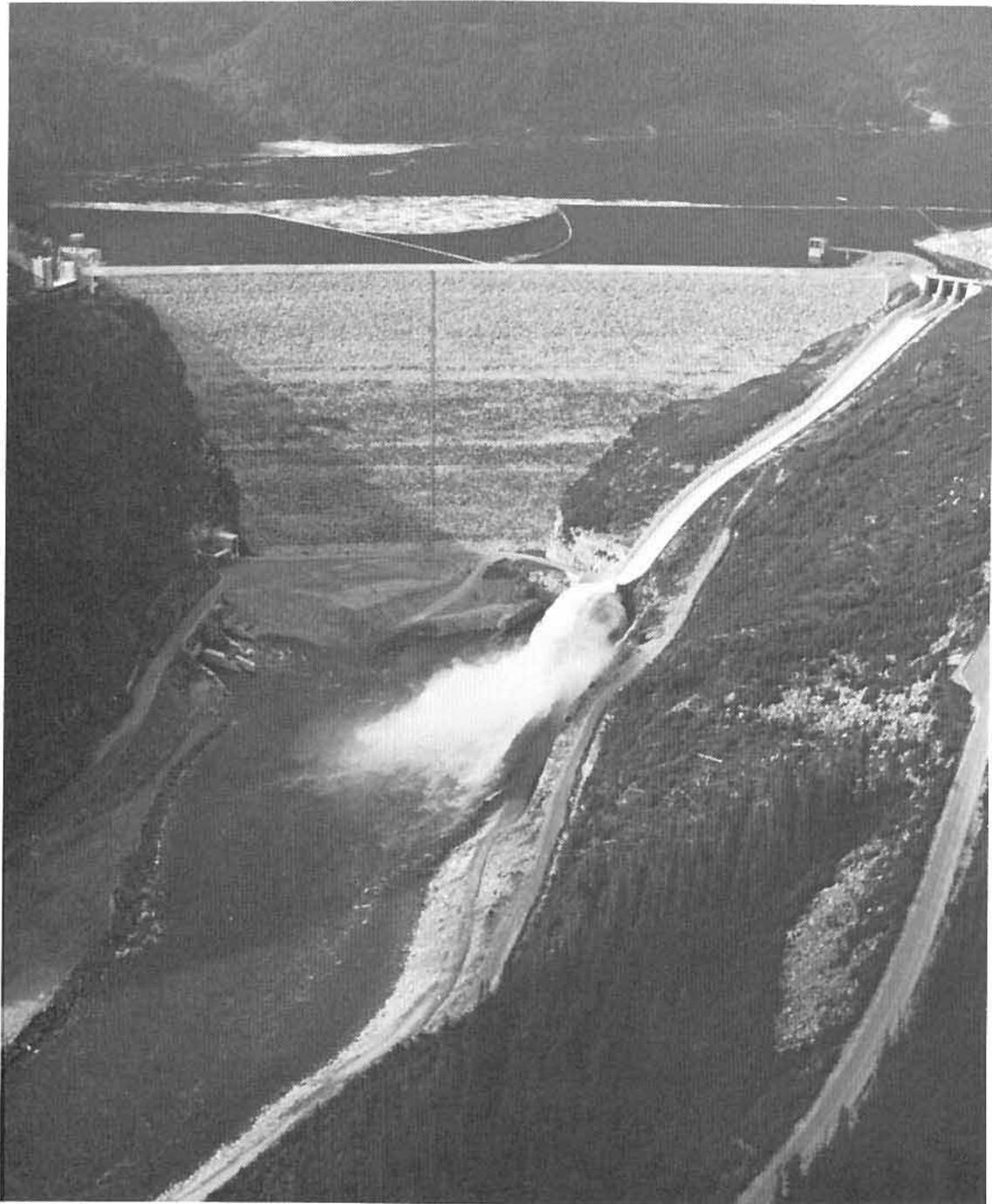
- (h) The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964.

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

INFORMATION CENTRE
at Hugh Keenleyside Dam,
British Columbia.





MICA DAM
The earth dam with spillway in operation during 1981.

Columbia 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

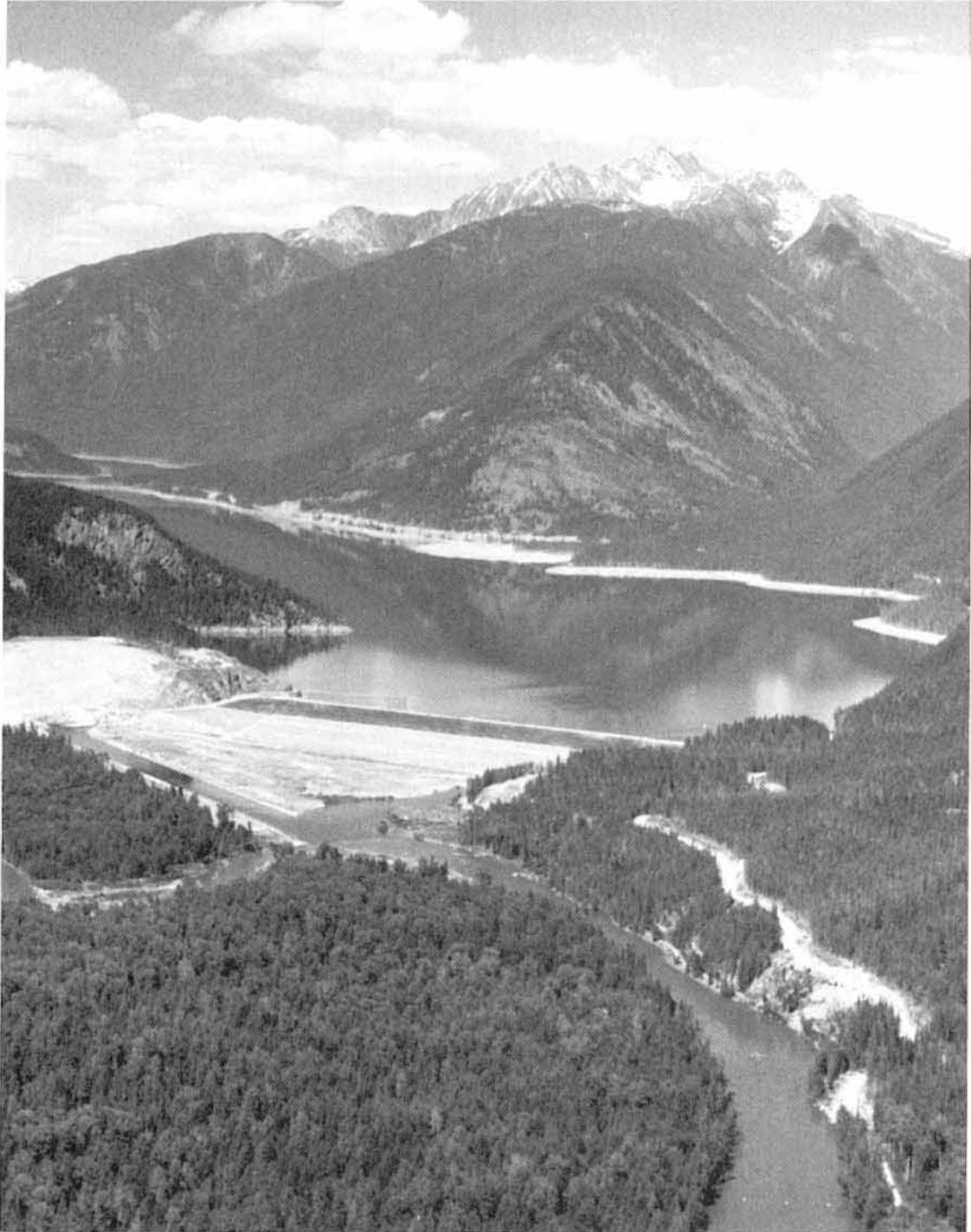
Pursuant to Executive Order No. 11177 dated 16 September 1964 the Secretary of the Army and the Secretary of the Interior on 7 December 1964 appointed two members and two alternate members to form the United States Section of the Permanent Engineering Board. Pursuant to the Department of Energy Organization 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.



DUNCAN DAM

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

Duncan River, British Columbia

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

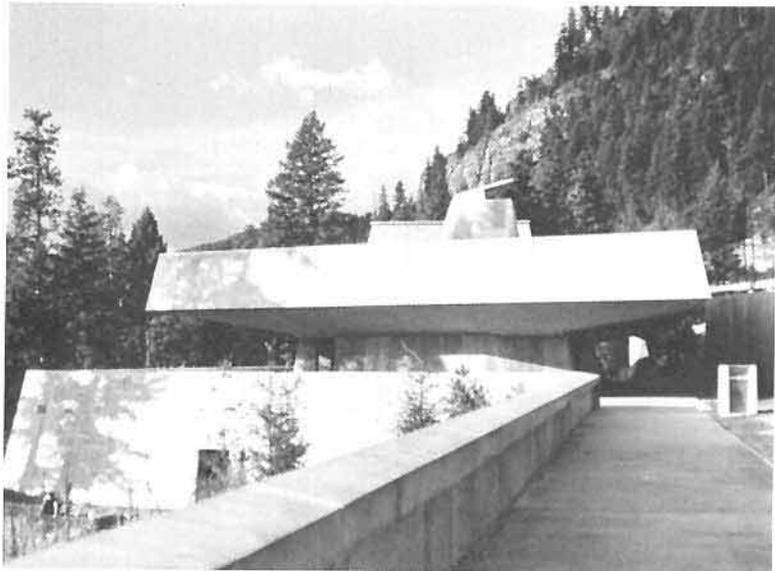
In addition to the powers and duties specified elsewhere in the Treaty and related documents the Treaty requires that the entities be responsible for:

- (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.

VISITOR CENTRE
at Libby Dam,
Montana.



ACTIVITIES OF THE BOARD

Meetings

The Board met in Seattle, Washington on 20 November 1981 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 1980 to 30 September 1981
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1986-87, plus a copy of the Entities' agreement on this document
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1981 through 31 July 1982, plus a copy of the Entities' agreement on this document

- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1986-87, plus a copy of the Entities' agreement on this document
- Limitation on Dependable Hydroelectric Capacity Credit Resulting from Canadian Storage, dated 21 January 1982.

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

Report to Governments

The seventeenth Annual Report of the Board was submitted to the two governments on 31 December 1981.



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. Completion of the Canal Plant on the Kootenay River in 1976 and installation of generators at Mica Dam during 1976 and 1977 have caused the power benefits in Canada to increase substantially. Completion of the Revelstoke project, now under construction, will result in a further substantial increase in power benefits in Canada. By 1985 some 4,000 megawatts of generation in Canada that would otherwise not have been installed will be benefiting from the operation of Treaty storage. This will be the installed capacity at Mica and Revelstoke on the Columbia River and at the Canal Plant on the Kootenay River. 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 into the headwaters of the Columbia River commencing in 1984. British Columbia Hydro and Power Authority has completed engineering feasibility and detailed environmental studies of the potential diversion at Canal Flats. These are now being assessed.

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 of 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 9.

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 has no associated power facilities, however, installation of generators is now being considered.

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 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 6 and project data are shown in Table 3 of Appendix D.

REVELSTOKE DAM
under construction
downstream from
Mica Dam.



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 5,809,000 acre-feet, of which 4,934,000 acre-feet are usable for flood control and power purposes. The present installed capacity at the Libby powerhouse is 420 megawatts.

During the year, work at the Libby Project covered renovations to the outlet works, minor site improvements and a start on installation of a rock slide detection system. Installation of the turbines for the four additional units in the main dam was essentially complete by September 1982. However, current planning now provides for completion of only one generating unit, late in 1983. There has been no construction activity on the reregulating dam since that project was halted by Court Order late in 1978. Further construction on the reregulating dam must wait legal and legislative resolution of the matter.

SPORT FISHING
Arrow Reservoir
in British Columbia.



The Libby project is shown in the picture on page 2 and project data are shown in Table 4 of Appendix D.

Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 42-mile portion of Lake Koochanusa in Canada. 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. During the report year a program of debris removal from the reservoir was undertaken, and the old highway bridge at Wardner was removed.

LIBBY DAM
downstream face.
Visitor's centre
is in foreground.



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 hydro-meteorological 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 Hydro-meteorological 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 Hydro-meteorological 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. A revised plan for exchange of operational data and a new listing of Treaty hydro-meteorological facilities have been drafted by the Entities. Changes in these documents continue to be required as a result of the increasing use of satellite telemetry for network automation, and the implementation of computerized data exchange and processing facilities. These documents therefore are still in draft form.

Progress is being made in automating the collection and processing of hydro-meteorological data in the Columbia River system. The "Columbia River Operational Hydromet System", a computer system that has capability for direct input of data from other computer terminals and for the retrieval of data reports, is in operation in Portland, Oregon. A data processing computer has been installed at British Columbia Hydro and Power Authority's Burnaby Mountain System Control Centre to facilitate data exchange between the Entities. Telemetry from hydrometeorological stations in the Canadian drainages is gradually being converted from conventional VHF/UHF to satellite telemetry, using

the GOES weather satellite system. All Canadian data is now being transmitted direct to the computer 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.

The Entities have reverted to the use of the 30-year record for developing Assured Operating Plans. This practice will continue unless the two governments agree on a change to paragraph 8 of the Protocol to the Treaty. It is noted that the Entities' document "Columbia River Treaty, Principles and Procedures for Preparation and Use of Hydro-electric Operating Plans", dated 1 May 1979, has not yet been revised to delete references to use of streamflow records longer than the 30 years in developing Assured Operating Plans.

The Assured Operating Plan for operating year 1986-87, 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 1982. A Detailed Operating Plan for the operating year ending 31 July 1983 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 Board has become aware of the Northwest Power Planning Council's view, as presented in a draft report entitled "Fish and Wildlife Program", that Treaty storage in Canada can be used for fisheries purposes in the United States. The Board is concerned that this could conflict with the terms of the Treaty and that such proposals are being made without adequate consultation with the Board. The Board is currently reviewing these concerns.

NAVIGATION LOCK
Serving pleasure boats
at Hugh Keenleyside Dam.



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 1986-87. 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 1987-88 was received from the Entities after the end of the report year.

The report "Limitation on Dependable Hydroelectric Capacity Credit Resulting from Canadian Storage", 21 January 1982, received during the year is under review by the Board.

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 the Kootenai River at Porthill, Idaho, and for the Columbia River at Birchbank, British Columbia, Plate 1, are tabulated in Appendix C for this report year.

KOOCANUSA BRIDGE
crosses the reservoir
created by Libby Dam,
Montana.



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 1981 through 31 July 1982
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1982 through 31 July 1983
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1981-82
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1982-83.

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

- Arrow Lakes Storage Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration dated 24 June 1981.

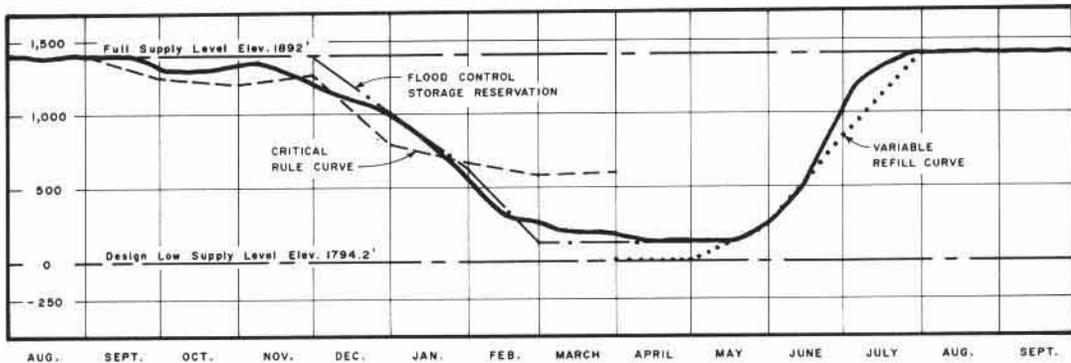
Power Operation

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 1981 freshet and by the beginning of this report year only a small amount of Treaty storage had been drafted. Above average inflows throughout the winter contributed to near record sales of secondary energy in the United States from early December through July. Heavy rains in mid-February required flood control operation of the system for several weeks to alleviate their effect on mid and lower Columbia River stages.

The 1982 freshet was above average; however, flood control was provided by normal refill schedules. After the freshet, drafting of Treaty storage for power was not required and Treaty reservoirs remained full to the end of this report year.

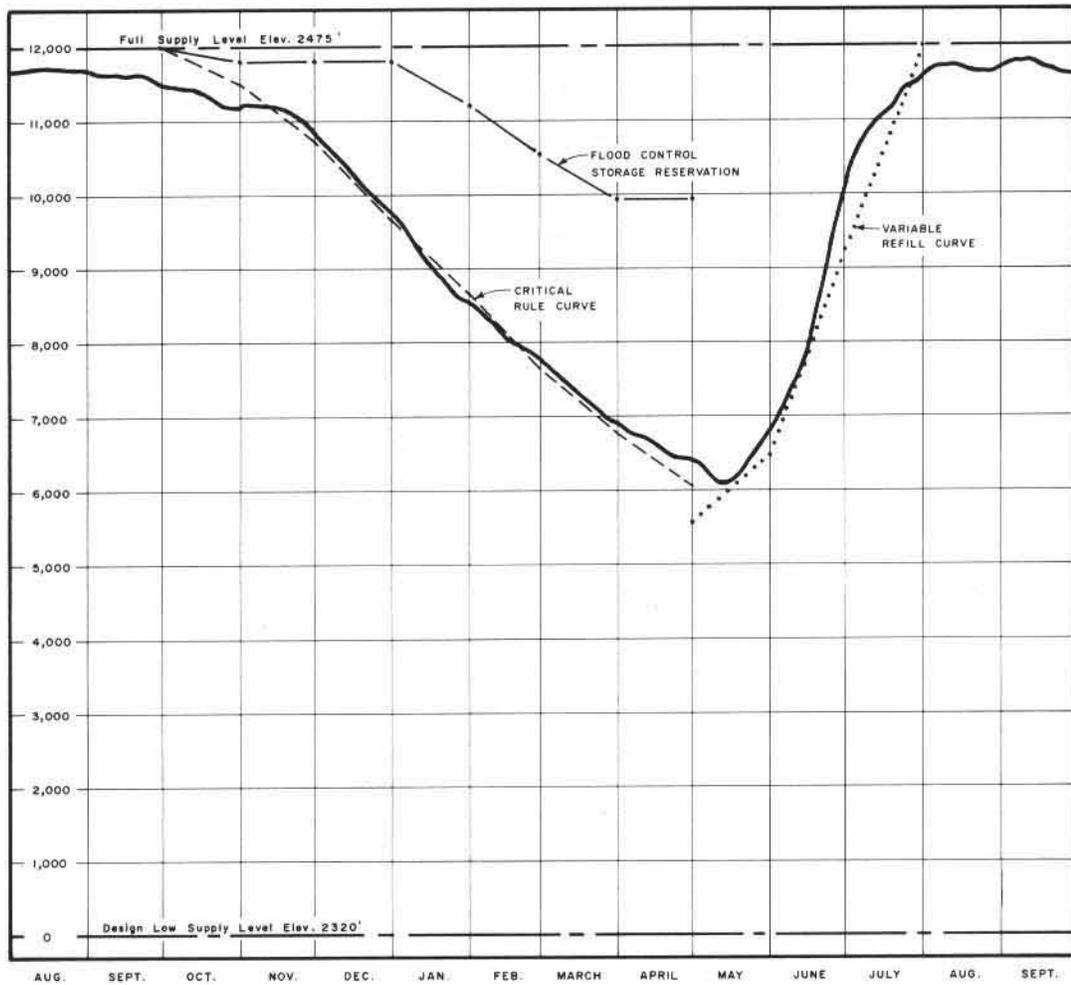
Operation of the reservoirs is illustrated on pages 28 and 29 by hydrographs which show actual reservoir levels and some of the more important rule curves which govern operation of the Treaty storages. The Flood Control Storage Reservation curve specifies maximum month-end reservoir levels which will 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.



FEET

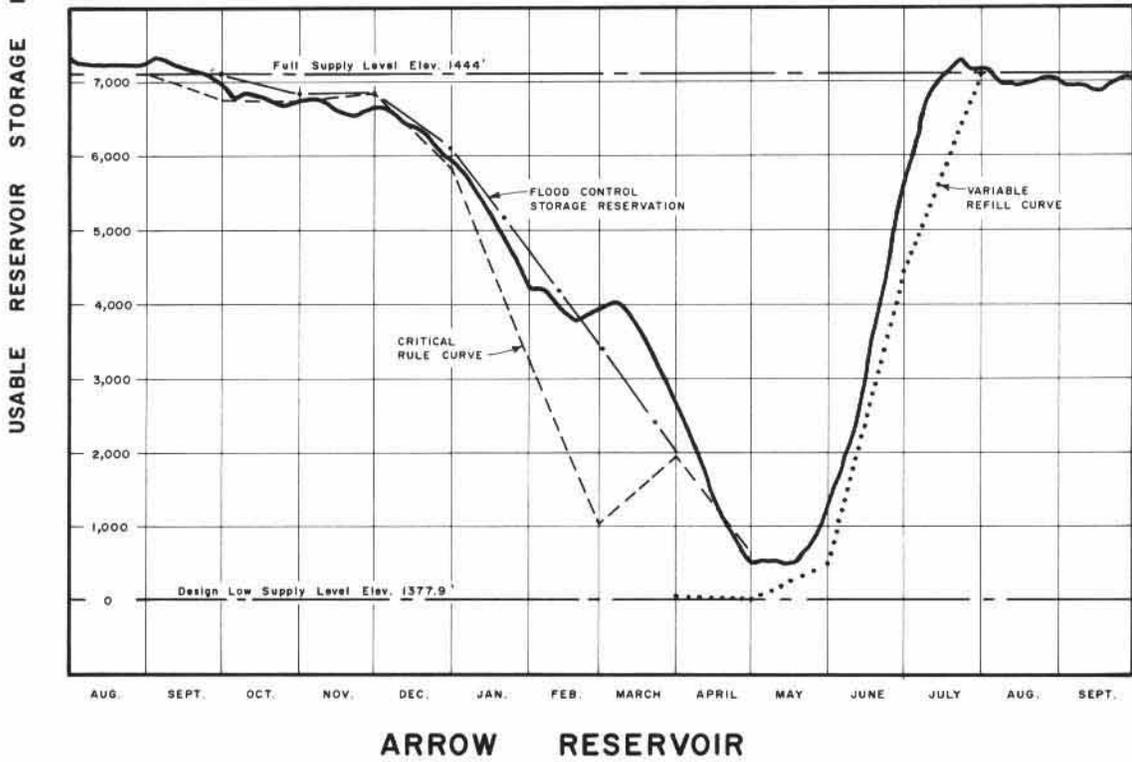
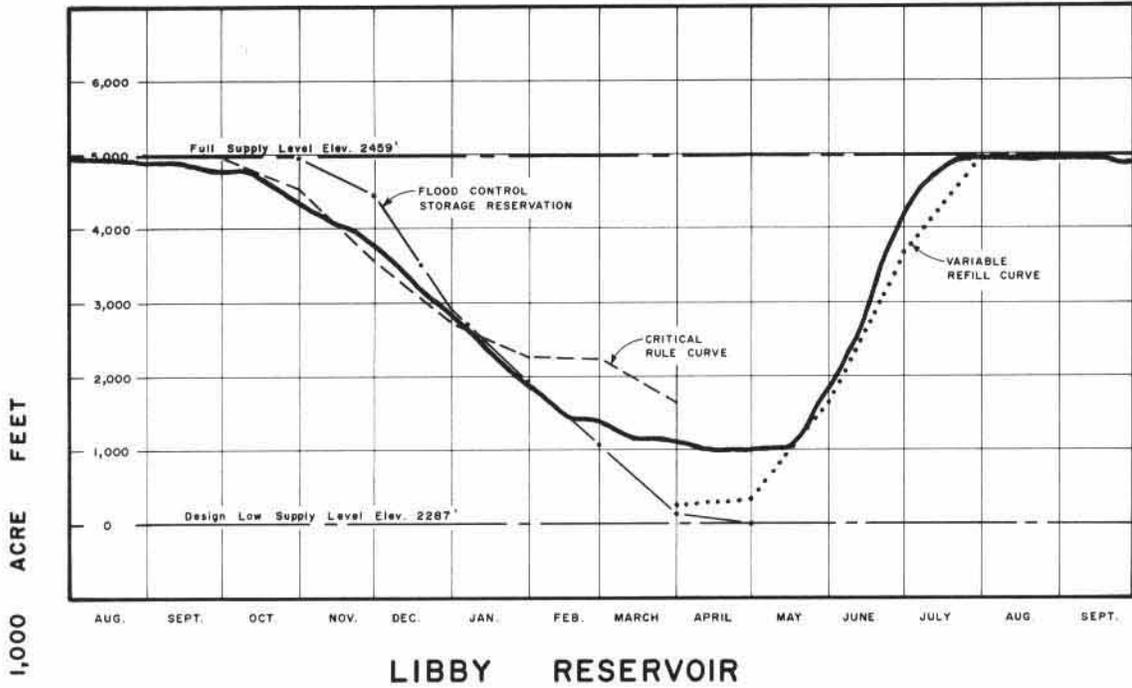
DUNCAN RESERVOIR

USABLE RESERVOIR STORAGE IN 1,000 ACRE FEET



MICA RESERVOIR

HYDROGRAPHS — Duncan and Mica reservoir levels for the 14-month period ending 30 September 1982.



HYDROGRAPHS — Libby and Arrow reservoir levels for the 14-month period ending 30 September 1982.

At the beginning of the report year the Duncan reservoir was at elevation 1886.9 feet, five feet below full pool. Throughout the draft season releases were scheduled in conjunction with Libby discharges to control Kootenay Lake inflow and minimize spill at Kootenay River hydroelectric plants. The elevation required by the Flood Control Rule Curve, 1807.8 feet, was reached on 13 April 1982. Filling commenced in mid-May and the reservoir filled on 28 July. It was held full at elevation 1892 feet to the end of the report year.

The Arrow reservoir was at elevation 1442.8 feet, 1.2 feet below full pool at the beginning of this report year. The contents included one foot of water held by British Columbia Hydro and Power Authority for Bonneville Power Administration under a special agreement. This water was released in December. Drafting of Treaty storage was generally in conformance with Flood Control Rule Curve requirements until 14 May when the lowest elevation of the year, 1382.9 feet, was reached. From 17 February to 7 March Arrow discharges were controlled in response to daily requests by the United States Entity for flood control operations on the lower Columbia River.

Refilling of Arrow reservoir began 19 May 1982 and reached its peak elevation of 1445.4 on 22 July. From early August the reservoir remained near its full pool elevation of 1444 feet. On 30 September the reservoir elevation was 1443.7 feet.

Treaty storage in the Mica reservoir had been refilled at the beginning of the report year. The reservoir elevation itself was 2469.6 feet, about five feet below normal full pool elevation. Drafting of Treaty storage commenced in October. From November to mid-April discharges were in accordance with British Columbia Hydro and Power Authority's generating needs and downstream United States' requirements. Discharges at Mica were reduced during the latter part of February for flood control on the lower Columbia. The reservoir reached elevation 2413.3 feet on 11 May 1982, its minimum for the report year.

Mica reservoir began to refill on 11 May. After 27 June discharges were controlled to meet refill criteria and to limit flows to 75,000 cfs at the Revelstoke construction site.

During July and the first half of August spilling occurred because project outflows exceeded the British Columbia Hydro system load requirements. The peak elevation, 2473.1 feet, occurred 10 September 1982. Treaty storage remained full and on 30 September the Mica reservoir was at elevation 2470.8 feet.

At the beginning of this report year Libby reservoir was at elevation 2455.9 feet, three feet below normal full pool elevation. Drafting began in late September and was continued to meet power and flood control requirements until the reservoir reached its lowest elevation for the year, 2342.1 feet on 24 April 1982. After mid-February drafting was curtailed as necessary to avoid exceeding the International Joint Commission rule curve for Kootenay Lake. The reservoir refilled 26 July and remained near its full pool elevation of 2459 feet until late September. At year end the reservoir elevation was 2457.9 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 17 February 1982. Operations were on a daily basis until 10 April to reduce flooding and allow evacuation of space filled during the flood control operations.

Flood control during the 1982 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

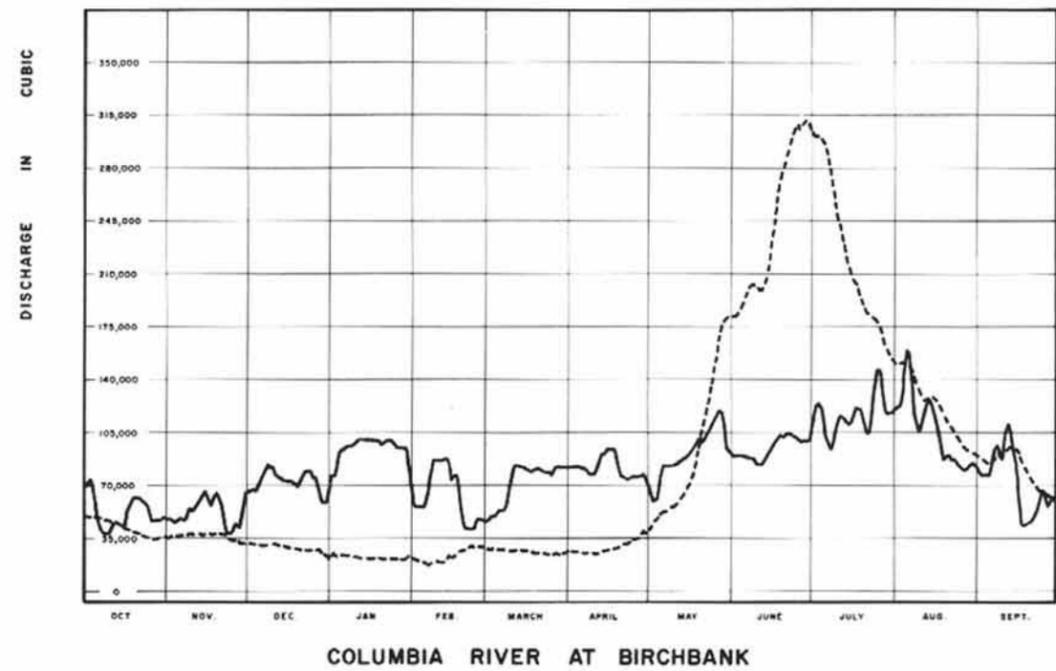
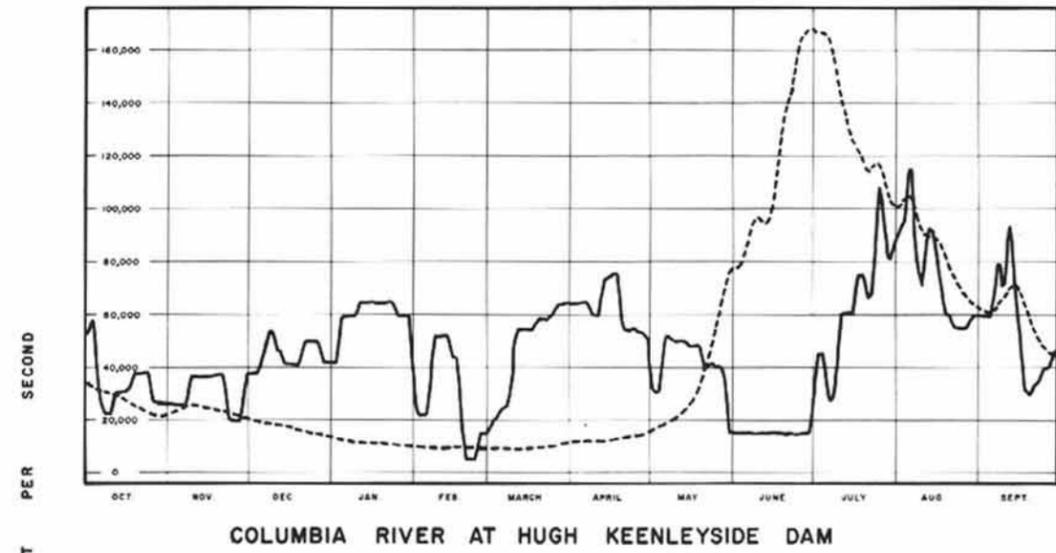
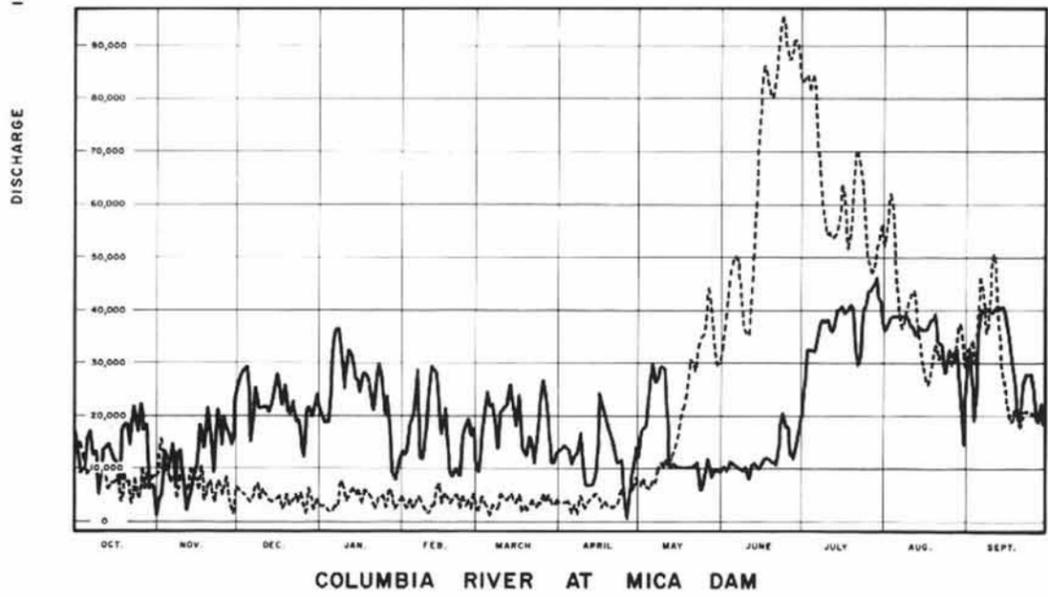
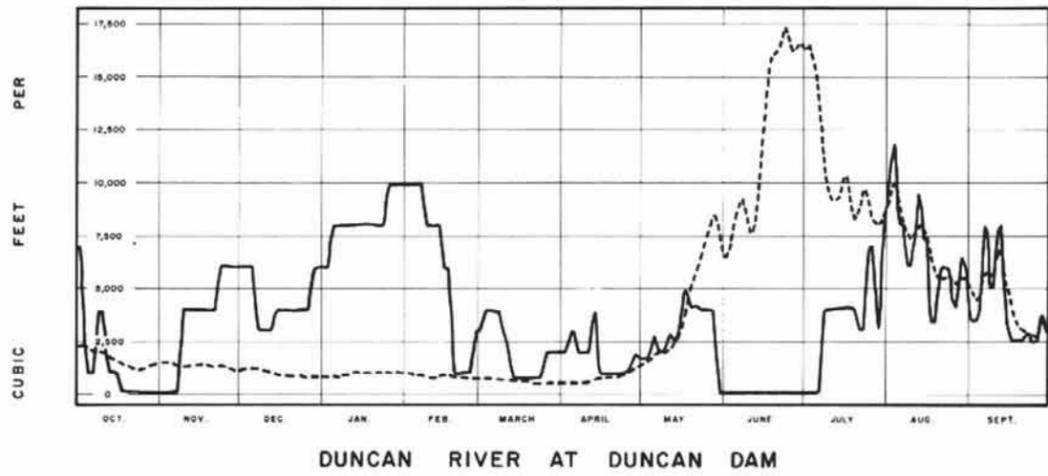
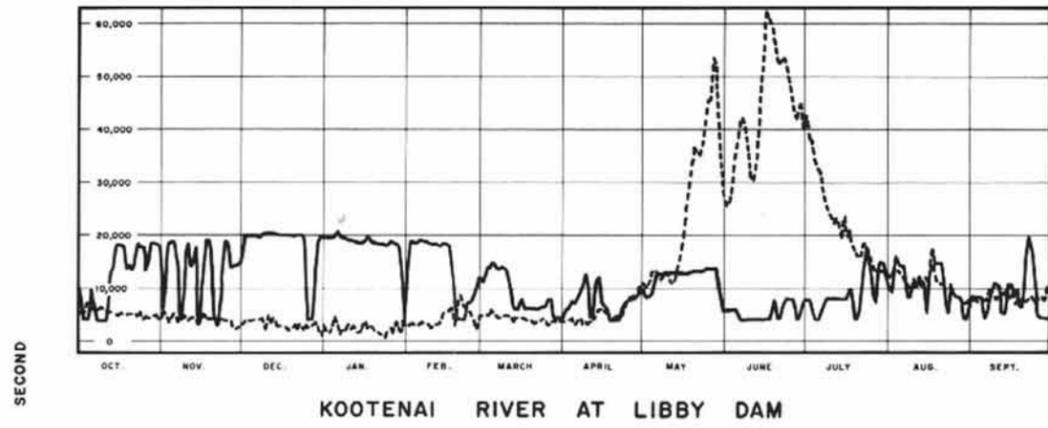
Flood Control Provided

Without regulation by upstream reservoirs the 1982 freshet would have produced an above average peak discharge at Trail, British Columbia and 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 eight feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by thirteen and one-half 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 750,000 cfs to 422,000 cfs. Regulation by the Treaty storage projects during the 1982 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.



LEGEND

- Observed Flows
- - - Pre-Project Flows

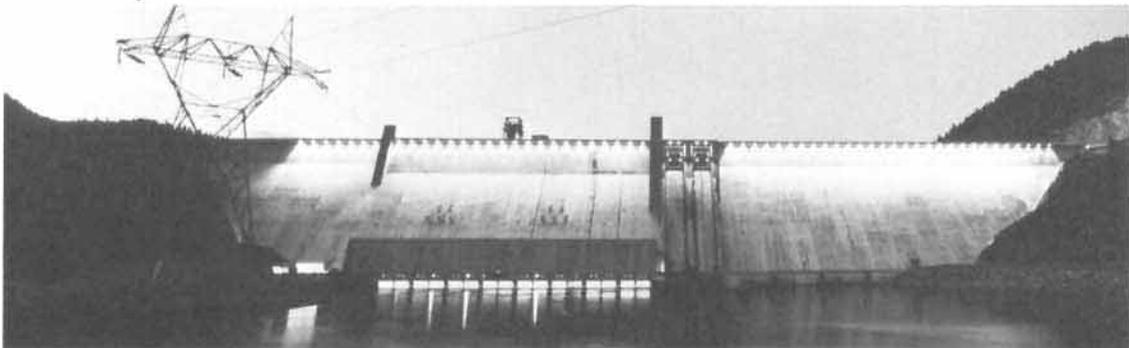
HYDROGRAPHS — Observed and pre-project flows for year ending 30 September 1982.

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. 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, which had an above average freshet, no such arrangements were requested for fishery purposes.



LIBBY DAM and powerhouse at night.

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. The above average 1982 freshet was regulated by the Treaty storage projects to avoid flood damages in both Canada and the United States.
4. A proposal by the Northwest Power Planning Council to commit Treaty storage in Canada for fisheries purposes in the United States may conflict with the terms of the Treaty.
5. The objectives of the Treaty are being met.

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Power Administration,
Department of Energy,
Portland, Oregon

Brigadier General James W. van Loben Sels

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Corps of Engineers,
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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.	Sept.
1	14,300	16,800	19,700	21,500	15,800	17,100	9,000	22,700	23,500	17,200	10,700	8,600
2	9,950	9,740	21,700	21,700	19,800	16,900	10,200	22,700	24,300	18,900	11,600	8,520
3	6,300	19,400	22,100	21,800	20,100	18,600	10,700	24,900	25,600	15,700	15,200	8,610
4	6,000	20,600	22,000	21,800	19,300	18,900	11,500	26,500	26,400	13,400	15,500	8,960
5	6,130	20,600	22,100	21,900	19,200	19,900	10,900	27,400	25,400	12,600	15,400	7,780
6	11,600	20,700	22,900	21,500	19,300	19,800	11,900	27,000	23,300	12,200	15,200	5,350
7	8,230	16,600	23,400	21,400	19,400	18,700	13,000	26,400	21,300	13,800	14,400	7,860
8	6,070	6,860	22,700	21,600	19,400	18,100	15,000	26,700	19,600	14,100	9,690	8,890
9	6,100	6,700	23,200	21,200	19,400	18,100	16,400	26,800	19,300	13,900	9,520	10,600
10	6,130	18,000	23,900	21,500	19,200	20,800	12,200	26,200	19,700	13,500	11,900	10,600
11	6,250	17,000	24,200	21,500	19,000	20,900	8,100	26,100	21,100	13,000	11,400	10,500
12	6,510	15,500	23,600	21,500	19,300	19,300	10,700	26,800	22,500	12,700	13,100	6,170
13	13,800	19,400	23,000	21,300	19,100	15,800	20,100	28,400	24,100	12,500	11,200	6,580
14	17,700	16,800	22,900	21,300	19,700	14,100	22,000	30,500	25,000	12,200	11,800	10,700
15	19,600	7,580	23,000	21,000	23,600	13,800	19,200	33,300	26,400	12,300	8,050	10,800
16	19,900	7,110	22,800	21,300	27,600	14,900	16,900	36,300	26,400	12,200	13,400	10,700
17	20,100	19,000	22,700	21,300	29,200	13,000	14,600	38,600	25,400	14,000	14,700	9,630
18	16,900	21,300	22,800	21,300	24,000	12,300	12,100	41,900	25,900	12,000	15,000	9,900
19	15,500	21,700	23,000	20,900	18,400	11,800	11,300	42,600	24,300	8,090	14,900	6,630
20	18,100	11,700	23,000	20,600	14,600	11,500	10,600	40,000	20,800	7,590	14,900	8,170
21	15,300	6,480	23,100	20,700	22,000	10,500	10,200	39,000	19,500	10,200	13,800	17,500
22	16,000	6,230	23,000	20,800	24,100	10,300	10,500	39,800	21,700	14,900	8,950	21,200
23	19,500	6,770	22,600	20,500	19,700	10,600	13,500	41,600	21,300	19,700	6,810	21,700
24	19,400	18,500	22,400	20,600	18,600	10,700	16,700	42,000	20,300	17,300	11,000	13,300
25	16,600	21,200	18,800	21,100	16,800	10,600	19,400	43,400	19,500	14,500	9,090	7,050
26	15,200	18,000	8,180	20,900	16,300	11,600	19,800	45,200	18,300	10,100	8,880	6,150
27	18,400	16,400	6,830	20,600	16,400	11,500	20,000	42,800	16,700	10,300	8,740	5,810
28	20,200	15,800	7,120	20,700	17,500	9,050	21,000	38,500	16,000	15,500	8,420	5,700
29	20,500	15,800	18,700	20,700	20,700	8,890	23,900	29,800	17,300	15,900	5,340	5,870
30	20,500	16,100	21,300	16,700	16,700	8,910	23,800	24,700	17,300	15,500	5,230	5,700
31	20,700		21,300	7,580		8,870		23,400		13,600	8,430	
Mean	14,100	15,200	20,900	20,600	19,900	14,400	14,800	32,600	21,900	13,500	11,400	9,520

KOOTENAI RIVER AT PORTHILL, IDAHO — Daily discharges for the year ending 30 September 1982 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	69,600	47,400	66,000	77,100	55,300	47,300	81,700	58,800	89,100	123,000	122,000	76,700
2	70,700	48,400	66,700	76,600	56,400	49,600	81,500	59,200	89,100	124,000	124,000	76,400
3	74,100	46,100	67,700	83,700	56,100	50,100	82,600	61,100	88,900	122,000	136,000	76,200
4	67,900	45,600	66,400	93,500	55,900	50,500	82,000	75,600	89,000	113,000	159,000	76,400
5	52,500	47,400	70,400	95,000	56,100	54,100	80,800	83,700	88,600	101,000	157,000	82,000
6	41,800	48,700	77,100	95,900	63,100	53,600	81,700	83,600	88,600	97,300	137,000	95,300
7	38,800	46,900	79,400	96,900	78,800	54,100	80,300	83,600	87,700	93,000	118,000	97,600
8	36,800	48,000	84,000	97,200	86,700	58,200	77,000	83,700	85,600	98,200	110,000	87,800
9	36,700	54,900	81,800	96,600	86,500	67,900	77,000	83,900	83,400	108,000	104,000	86,700
10	36,600	53,100	82,400	99,200	86,200	78,000	76,900	84,500	82,600	116,000	109,000	102,000
11	40,900	54,400	76,700	101,000	86,600	83,200	83,400	86,000	83,800	115,000	121,000	111,000
12	45,400	57,400	75,900	100,000	87,000	82,900	91,200	87,200	86,500	113,000	126,000	104,000
13	45,600	60,500	73,600	99,800	88,400	82,700	90,900	88,100	90,000	110,000	127,000	89,200
14	43,100	62,700	72,300	99,500	85,400	82,200	94,500	89,400	92,400	110,000	120,000	76,700
15	42,700	66,800	72,500	99,100	73,100	81,100	94,300	91,700	96,200	114,000	114,000	63,400
16	43,100	60,100	71,600	99,000	76,500	79,700	94,300	94,100	99,400	121,000	107,000	44,600
17	55,100	55,600	71,400	99,400	77,500	78,800	94,400	96,800	101,000	120,000	96,400	41,900
18	58,500	62,900	71,400	99,200	62,900	80,000	87,200	101,000	103,000	120,000	86,000	44,100
19	62,100	65,700	69,200	98,800	49,600	81,500	77,500	102,000	102,000	116,000	87,400	44,300
20	61,900	60,000	71,000	97,100	42,100	80,900	75,400	97,700	104,000	104,000	89,600	46,300
21	61,700	56,400	76,900	98,900	41,100	80,000	74,300	103,000	105,000	104,000	86,700	49,400
22	59,700	46,300	80,100	99,500	40,700	78,700	73,900	105,000	104,000	112,000	86,500	52,800
23	58,300	37,200	79,900	99,900	40,900	78,700	75,500	109,000	102,000	131,000	84,500	62,400
24	57,300	37,900	80,300	97,800	42,000	79,100	75,900	111,000	101,000	146,000	83,200	67,400
25	49,100	39,000	74,900	95,100	48,400	77,000	75,400	116,000	100,000	146,000	79,500	63,800
26	45,700	44,900	74,000	95,300	48,000	82,900	75,700	120,000	97,700	132,000	79,700	55,500
27	46,600	44,400	64,900	94,500	46,700	82,300	76,500	117,000	98,600	119,000	81,200	58,000
28	46,800	42,100	58,500	94,400	46,000	82,100	77,700	106,000	98,100	116,000	84,500	61,800
29	47,200	55,900	58,300	94,600		82,200	73,900	93,200	99,600	117,000	84,800	52,300
30	48,700	66,100	58,700	77,800		81,700	65,800	92,200	115,000	118,000	82,600	39,400
31	49,200		64,600	60,200		81,800		89,800		121,000	79,400	
Mean	51,400	52,100	72,200	94,000	63,000	73,000	81,000	92,100	95,100	116,000	105,000	69,500

COLUMBIA RIVER AT BIRCHBANK, B.C. — Daily discharges for the year ending 30 September 1982 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

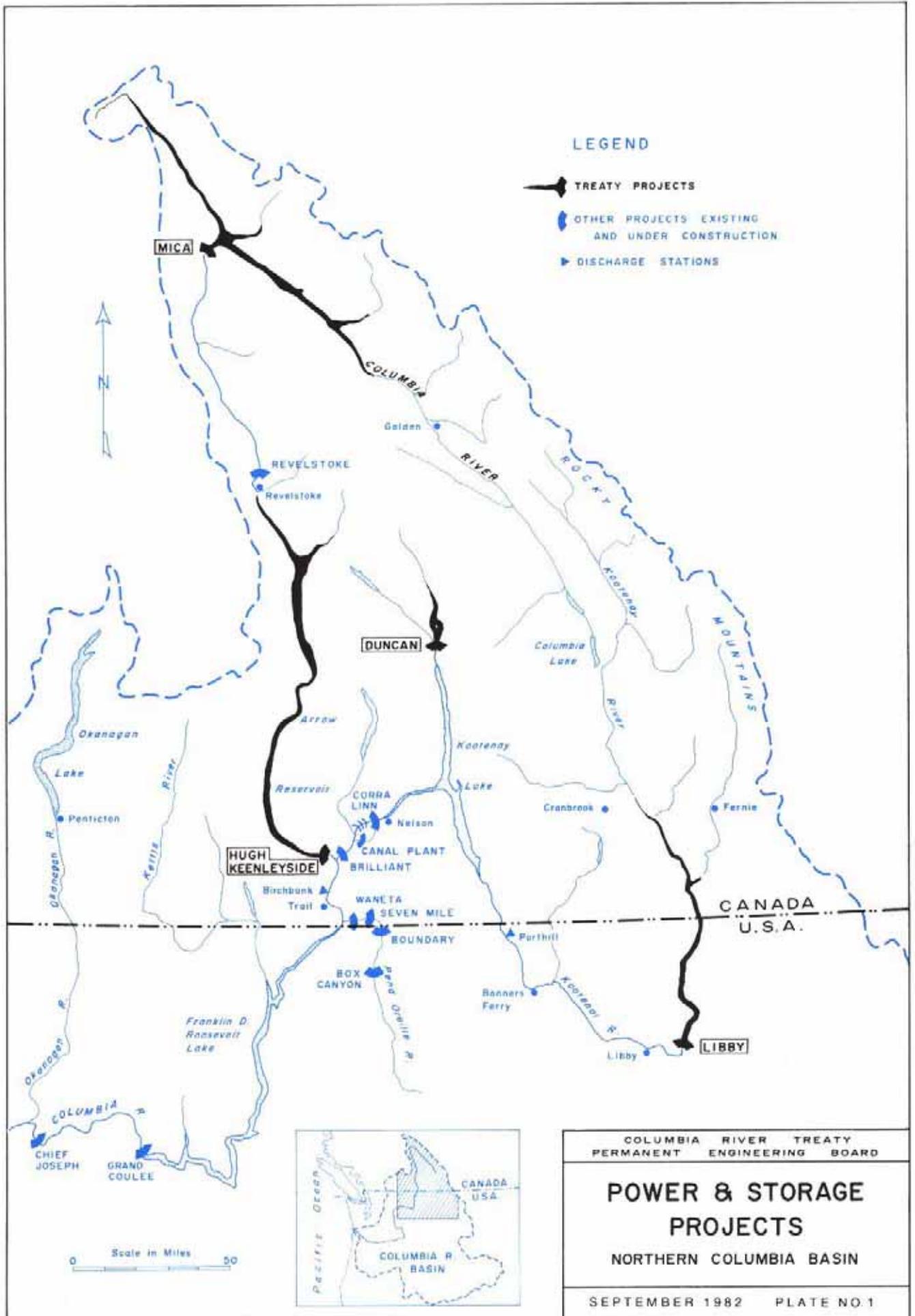
Table No. 2

Mica Project

Table No. 3

Libby Project

Table No. 4



0 Scale in Miles 50



TABLE 1

DUNCAN PROJECT

Duncan 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	

ARROW PROJECT

Hugh 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 Kooconusa

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	5,809,000 ac-ft
Usable Storage Capacity	4,934,000 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	
Designed 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