

ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

Washington, D.C.

Ottawa, Ontario

30 SEPTEMBER 1980



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 1980

The Honorable Edmund S. Muskie
The Secretary of State
Washington, D.C.

The Honourable M. Lalonde
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 sixteenth Annual Report, dated 30 September 1980, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1979 to 30 September 1980.

Respectfully submitted:

For the United States

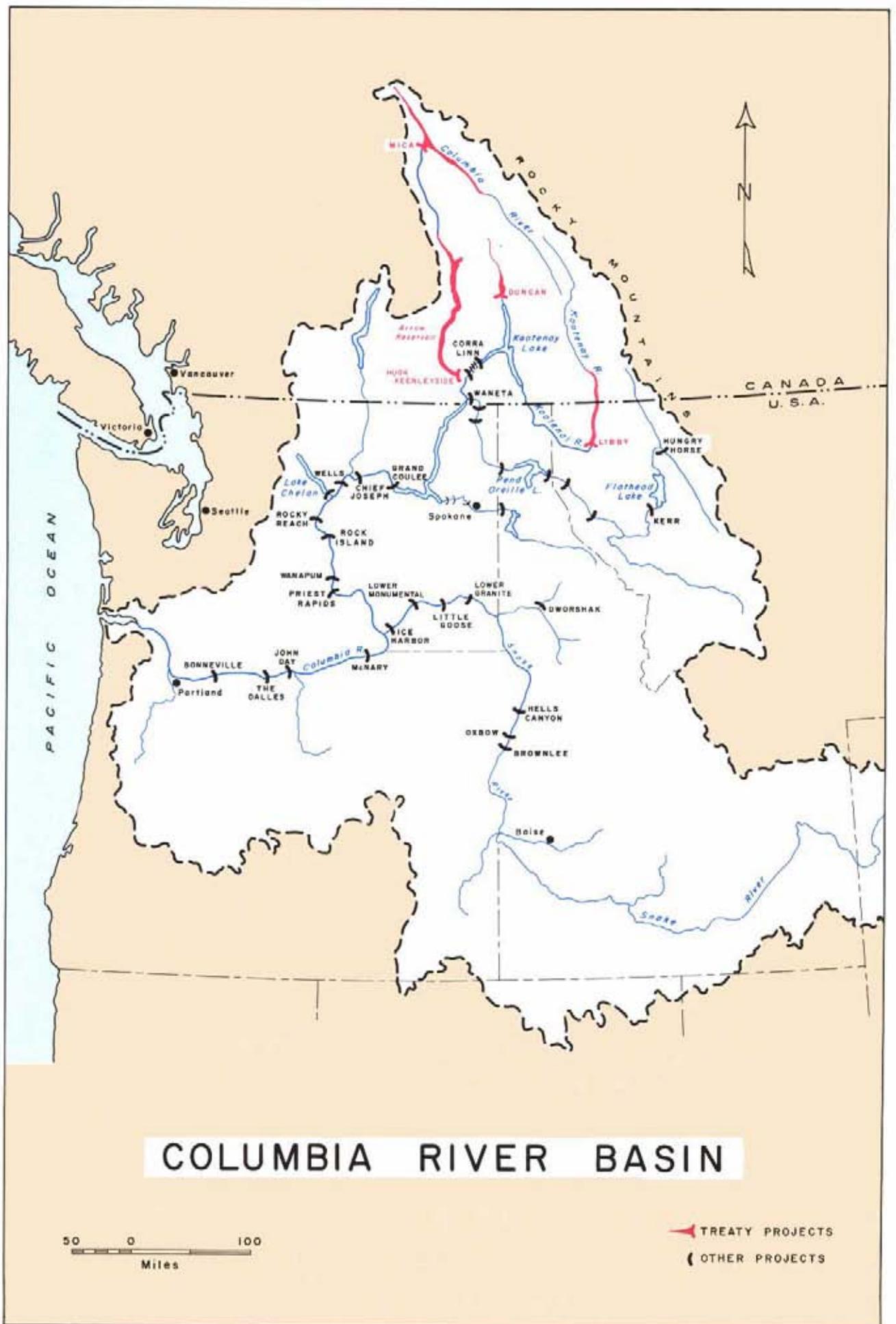
Lloyd A. Duscha, Chairman

For Canada

G.M. MacNabb, Chairman

J. Emerson Harper

B.E. Marr



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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 sixteenth 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. Although reservoir operations reduced peak freshet flows the unregulated peaks would not have caused any significant flood damages in either country.

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. The Board has advised the Entities that their use of a 40-year period of streamflow record for the development of Assured Operating Plans be discontinued for the reasons mentioned in this report (page 22). The Entities have agreed to this request.

Subject to final verification of recent Entity studies (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 1979 to 30 September 1980, 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, subject to the one caveat noted in the Summary 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.



HUGH KEENLEYSIDE DAM
Earth dam at the outlet of Arrow Lakes with navigation lock and discharge works.

Columbia River, British Columbia

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.

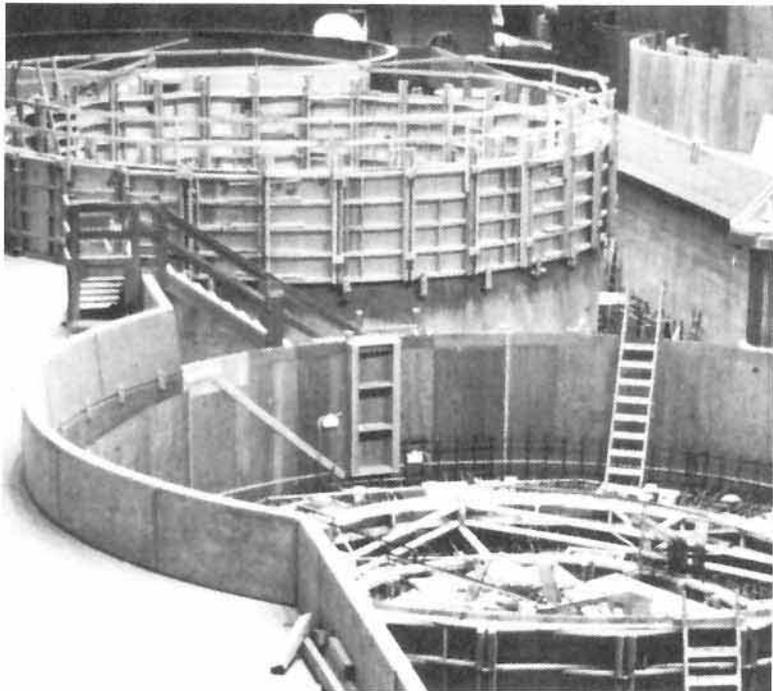
(g) Differences arising under the Treaty which cannot be resolved by the two countries may be referred by either to the International Joint Commission or to arbitration by an appropriate tribunal as specified by the Treaty.

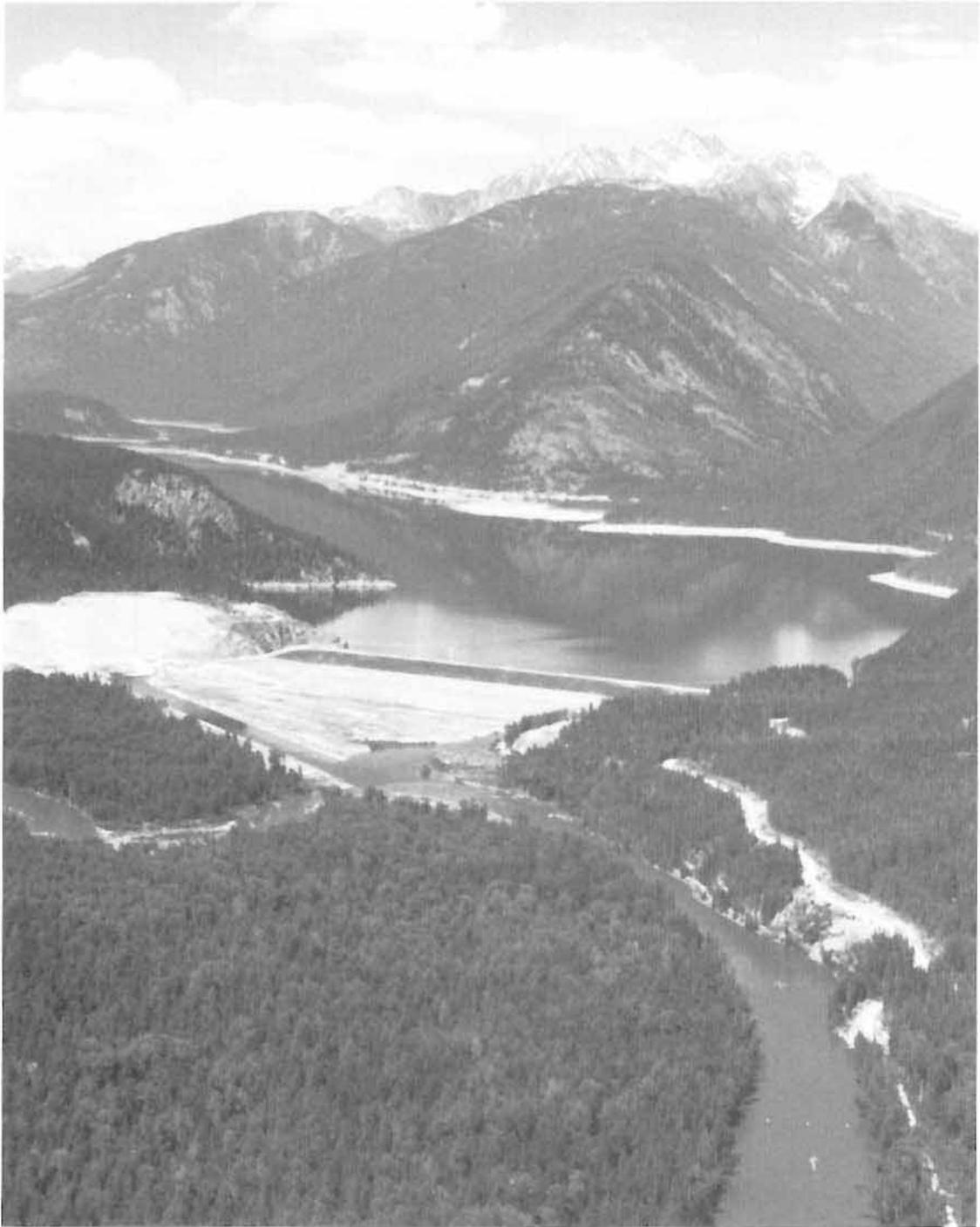
(h) The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964.

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

TURBINE INSTALLATION
for additional units
at Libby powerhouse
nearing completion.





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

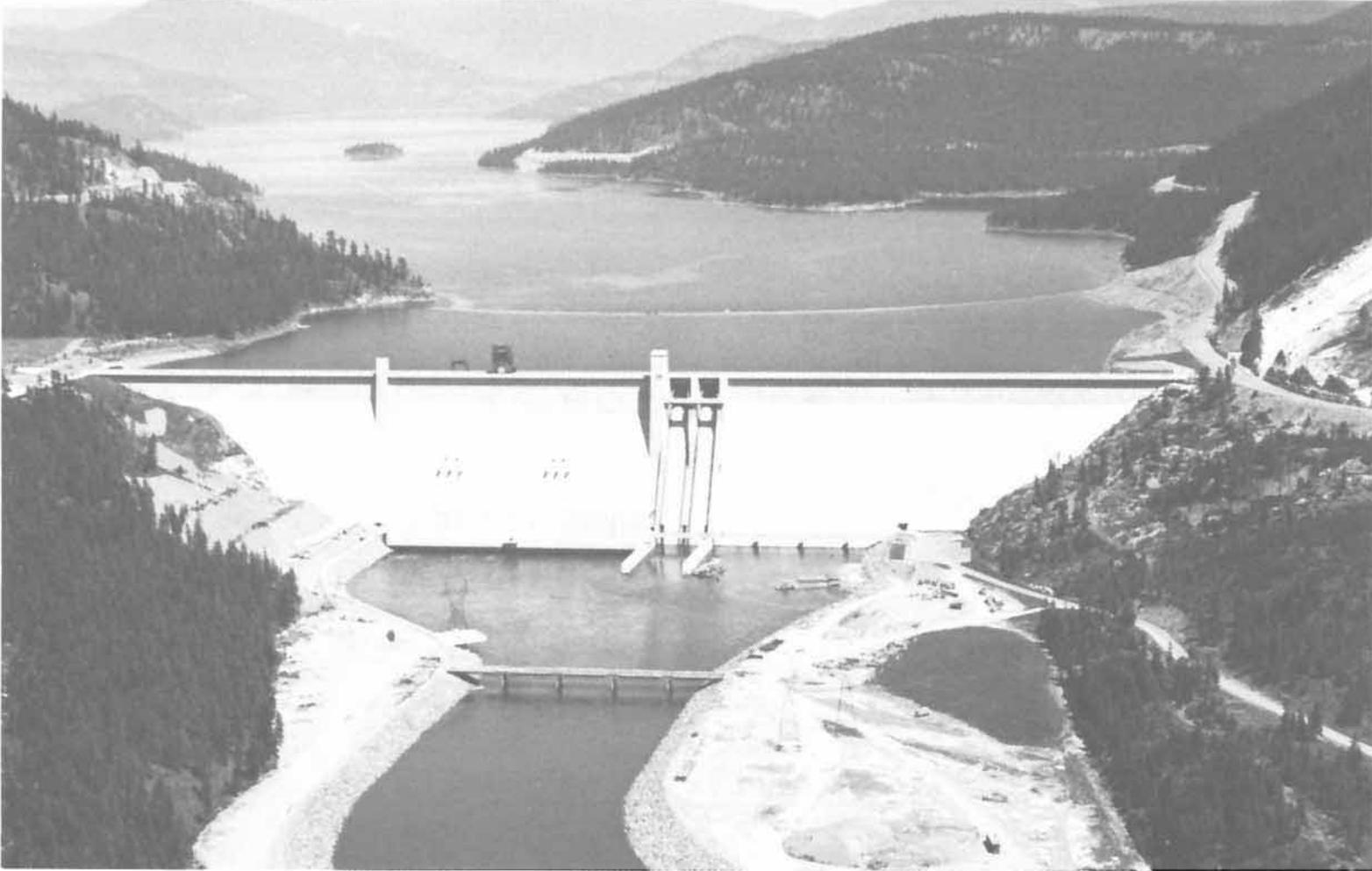
Pursuant to Executive Order No. 11177 dated 16 September 1964 the Secretary of the Army and the Secretary of the Interior on 7 December 1964 appointed two members and two alternate members to form the United States Section of the Permanent Engineering Board. Pursuant to the Department of Energy Organization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

REVELSTOKE PROJECT
construction progress:
site of main dam dry
between cofferdams.



ACTIVITIES OF THE BOARD

Meetings

The Board met in Portland, Oregon on 27 November 1979 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 1978 to 30 September 1979
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1984-85, plus a copy of the Entities' agreement on this document
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1979 through 31 July 1980, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1984-85, plus a copy of the Entities' agreement on this document

- Draft report of the Columbia River Treaty Hydrometeorological Committee which includes revised listings of Treaty and Support Facilities and a revised Plan for Exchange of Data
- Arrow Lakes Storage Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration dated 17 June 1980
- Mica Storage Arrangement between British Columbia Hydro and Power Authority and Bonneville Power Administration, plus a copy of the Entities' Agreement to Enhance Filling of Mica Reservoir dated 3 July 1980.

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 1980 through 31 July 1981, plus a copy of the Entities' agreement on this document
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1985-86, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1985-86, 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 1979 to 30 September 1980.

Report to Governments

The fifteenth Annual Report of the Board was submitted to the two governments on 31 December 1979.



MICA DAM
The earth dam with the spillway in use.

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, are now in operation and supply power benefits 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.

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 is currently studying both the engineering and environmental aspects of the potential diversion at Canal Flats.

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 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 has no associated power facilities.

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 2 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 dam is shown in the picture on page 15 and project data are shown in Table 3 of Appendix D.

SPAWNING CHANNEL
for Kokanee
on Mackenzie Creek
south of Revelstoke.



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 Koocanusa which is 90 miles long and extends 42 miles into Canada. Lake Koocanusa 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.

Construction of the Libby Additional Units and Reregulating Dam project was initiated in 1978. A contract for the manufacture and installation of the turbines for the four additional units in the main dam was 91% complete by September 1980. The first generator is scheduled for delivery in May 1982. Installation and start-up of all four generating units is expected to be completed by January 1984. 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.

REXFORD BENCH
CAMPGROUND
in Montana was
completed in 1980.



The Libby project is shown in the picture on page 9 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, parks facilities are being enhanced and potential sites studied for future development; fishery and wildlife studies are being continued. 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 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 are anticipated as a result of the increasing use of satellite telemetry for network automation, and the implementation of computerized data exchange and processing facilities.

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 being installed at British Columbia Hydro and Power Authority's Burnaby Mountain System Control Centre will 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. Converted stations will then be directly accessible by the United States Entity.

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 Assured Operating Plan for operating year 1984-85, received by the Board early in the report year, includes generation at the Mica project and is based on the operation

of the system for optimum generation in both countries. However, during its review of this plan at its November 1979 meeting the Board became aware that the Entities, starting with the Assured Operating Plan for 1980-81, had decided to use a 40-year period of streamflow record for their analysis rather than the 30-year period specified by the Protocol to the Treaty. While the Protocol reference is to streamflow records employed to calculate downstream power benefits, the Board's view is that Canada's commitment to operate under an assured plan is tied directly to the benefits produced by that plan; therefore the streamflow records used must be identical.

The Board expressed its concern to the Entities at their joint meeting in November of 1979. No agreement was reached, or necessarily sought at that meeting; however the Entities noted that the action had been taken in an effort to keep the Assured Operating Plans as current and realistic as possible and that little difference, if any, resulted from the change of the streamflow record.

Shortly after the end of the current reporting year, the Board received from the Entities the Assured Operating Plan for 1985-86 and noted that the 40-year streamflow period was still being utilized. The matter was raised again with the Entities at a meeting in November of 1980. As a result studies have been carried out by the Entities which indicate that for the years in question the adoption of the longer period of streamflow has no impact on the Canadian Entity's commitment to operate under the Treaty. Subject to verification of these studies the Board does not propose that a detailed recalculation of the existing Assured Operating Plans be made. In addition, development of Assured Operating Plans will revert to the use of the 30-year record of streamflow.

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 1980. A Detailed Operating Plan for the operating year ending 31 July 1981 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.

A report by the Entities on revised Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans has been reviewed by the Board. The Board concludes that, subject to modification of the references to the use of different periods of streamflow for developing operating plans and for calculating downstream power benefits, this improved documentation will be consistent with Treaty objectives.

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 1984-85. 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 1985-86 was received from the Entities after the end of the report year.

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.

FISH HATCHERY
at Murray Springs, Montana
completed October 1979.



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 1979 through 31 July 1980
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1980 through 31 July 1981
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1979-80
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1980-81.

In addition, two special agreements were in effect during this period:

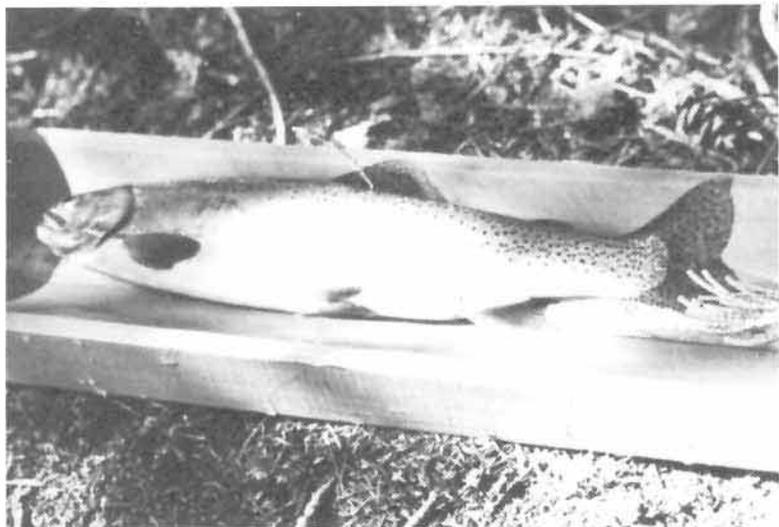
- Arrow Lakes Storage Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration dated 17 June 1980

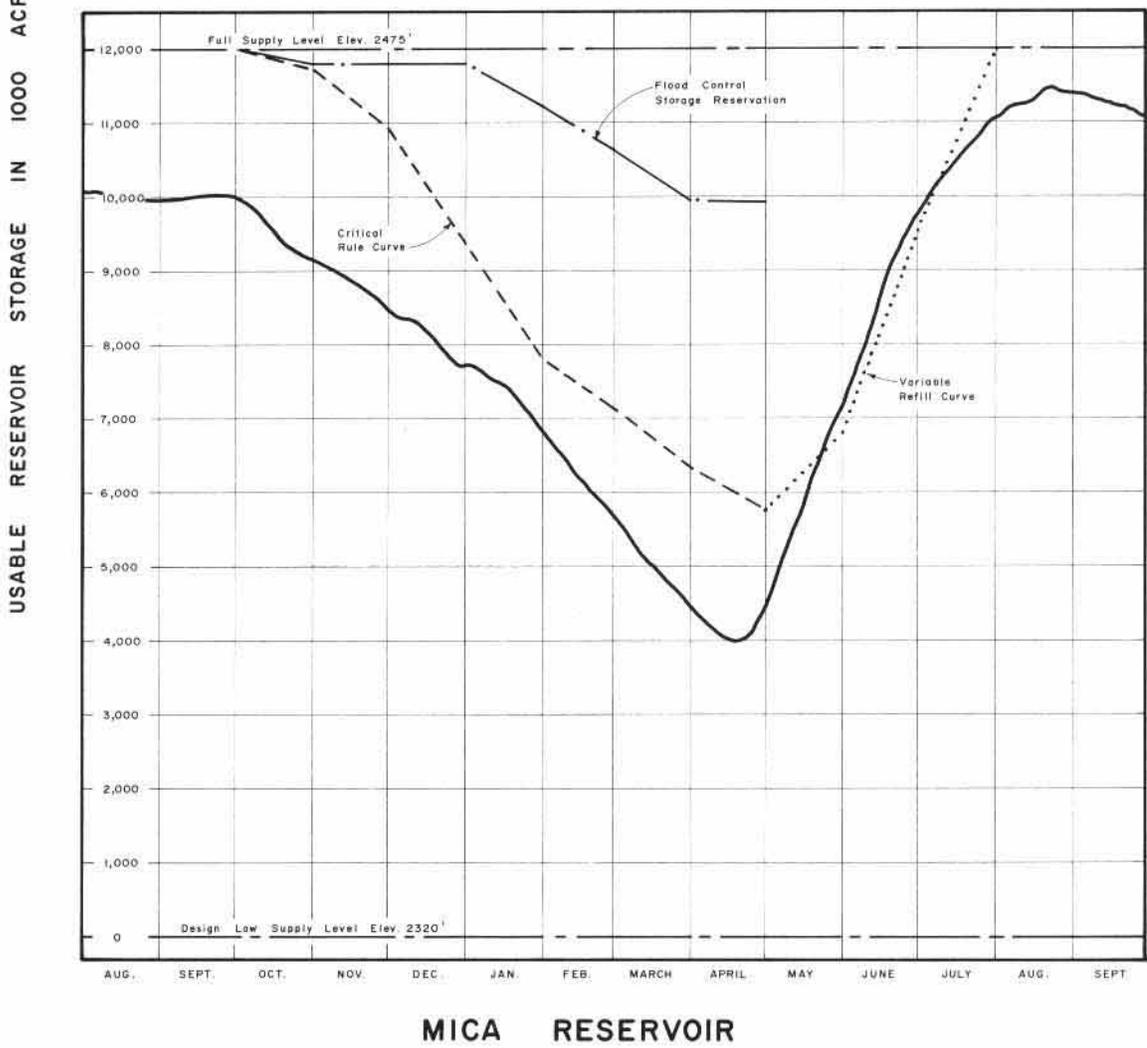
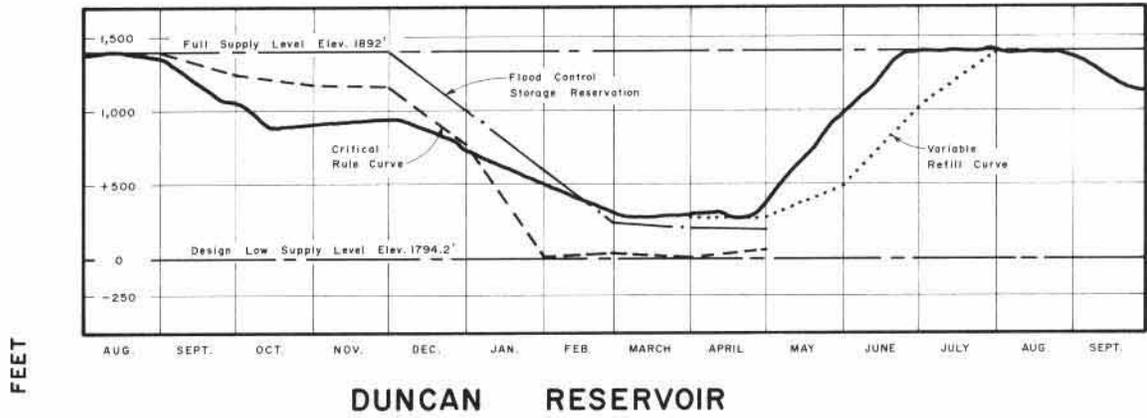
- Mica Storage Arrangement between British Columbia Hydro and Power Authority and Bonneville Power Administration, plus a copy of the Entities' Agreement to Enhance Filling of Mica Reservoir dated 3 July 1980.

Power Operation

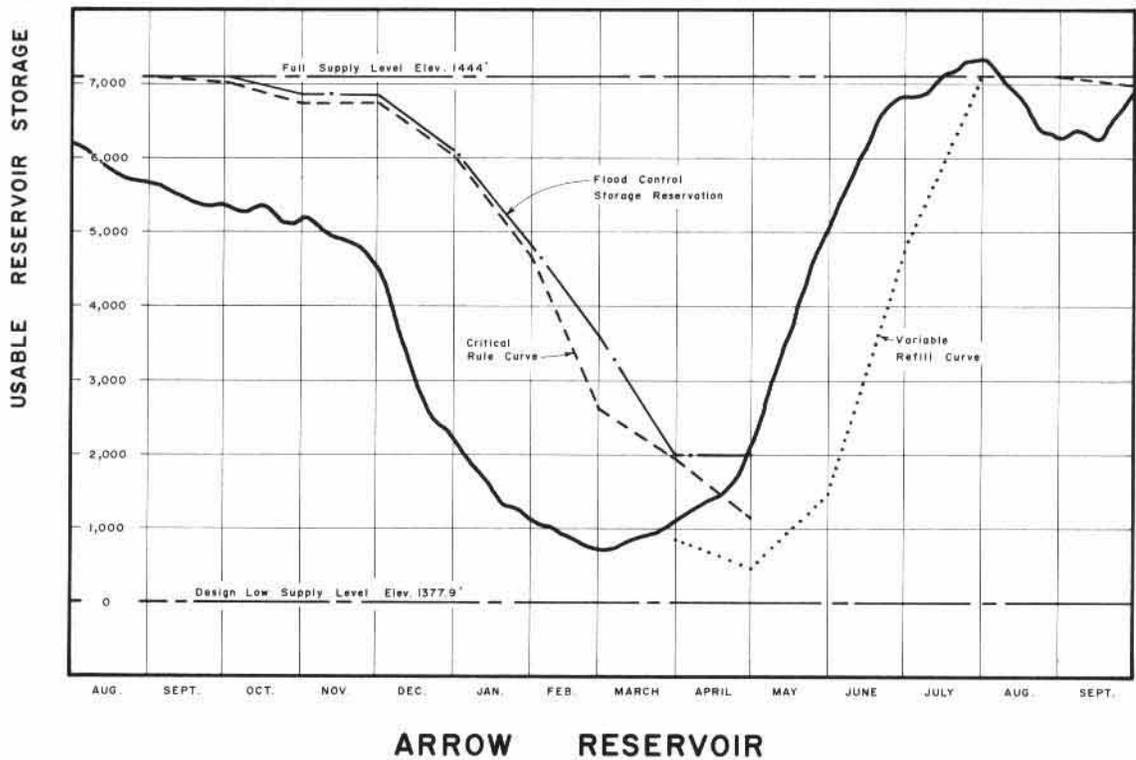
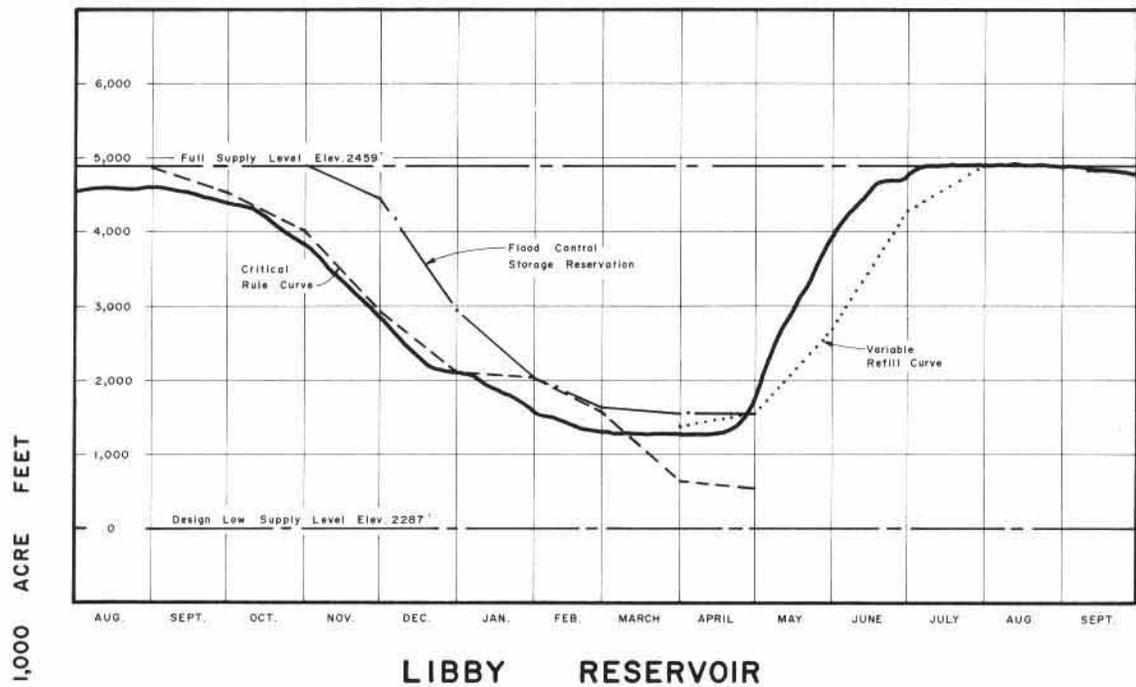
The three Canadian Treaty reservoirs, Duncan, Arrow and Mica, and the Libby reservoir in the United States were in full operation throughout this report year. All reservoirs in the Columbia River System did not fill during the 1979 freshet and at the beginning of this report year there was a storage energy deficit of five billion kilowatt hours. This deficit increased until the end of 1979 because precipitation was low and thermal plant outages exceeded expectations. In January the freshet volume forecast, although below normal, permitted adjustment of rule curves and the deficit was reduced to one billion kilowatt hours at month's end. Freshet runoff came early and most reservoirs in the system filled by 31 July 1980. Below average inflows after the freshet contributed to a system storage energy deficit of 1.5 billion kilowatt hours at the end of the report year.

CUT-THROAT TROUT tagging program in Lake Koocanusa area, British Columbia.





HYDROGRAPHS — Duncan and Mica reservoir levels for the 14-month period ending 30 September 1980.



HYDROGRAPHS — Libby and Arrow reservoir levels for the 14-month period ending 30 September 1980.

Extra releases to assist downstream migration of fish in the United States during the first part of the freshet caused secondary energy to be generated and a portion of this was stored in British Columbia Hydro and Power Authority's Williston Lake reservoir.

The 1980 freshet, although less than average, exceeded the volume forecast thereby permitting the use of extra storage in the Arrow Lakes reservoir under a special agreement. The Agreement to Enhance Mica Filling, which permitted Mica reservoir to fill earlier, also resulted from this condition.

The eruption of Mount St. Helens on 18 May 1980 sent massive amounts of mud and debris into the lower Columbia River and some tributaries. There was no effect on operation of Treaty projects.

Operation of the reservoirs is illustrated on pages 27 and 28 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.

At the beginning of the report year the Duncan reservoir was at elevation 1871.8 feet, 20 feet below full pool. Throughout the draft season releases were scheduled in conjunction with Libby discharges to minimize spill at Kootenay River hydroelectric plants. The minimum reservoir elevation for the year was 1819.7 feet on 9 March 1980. In late April outflows were reduced to minimum and the reservoir filled on 28 June. Drafting began on 25 August and at the end of the report year the reservoir elevation was 1876.3 feet.

The Arrow reservoir was at elevation 1430.1 feet, about 14 feet below normal full pool, at the beginning of this report year. Discharges were modified during the period 14 October to 3 November to facilitate sewer construction near Trail, British Columbia. During December the reservoir was drafted heavily to meet United States' power requirements. Drawdown continued until 3 March 1980 when the reservoir reached elevation 1386.7 feet, its minimum for the year. Filling began in early March and as a result of the early runoff, Treaty storage space was filled by 16 June. The extra two feet of storage authorized by the Arrow Lakes Storage Agreement filled with water surplus to United States' requirements by 22 June. Storage was drafted during August but partially refilled in September and the reservoir elevation was 1442.3 feet on 30 September. The United States' share, half of the extra storage, was still held in the reservoir at that date.

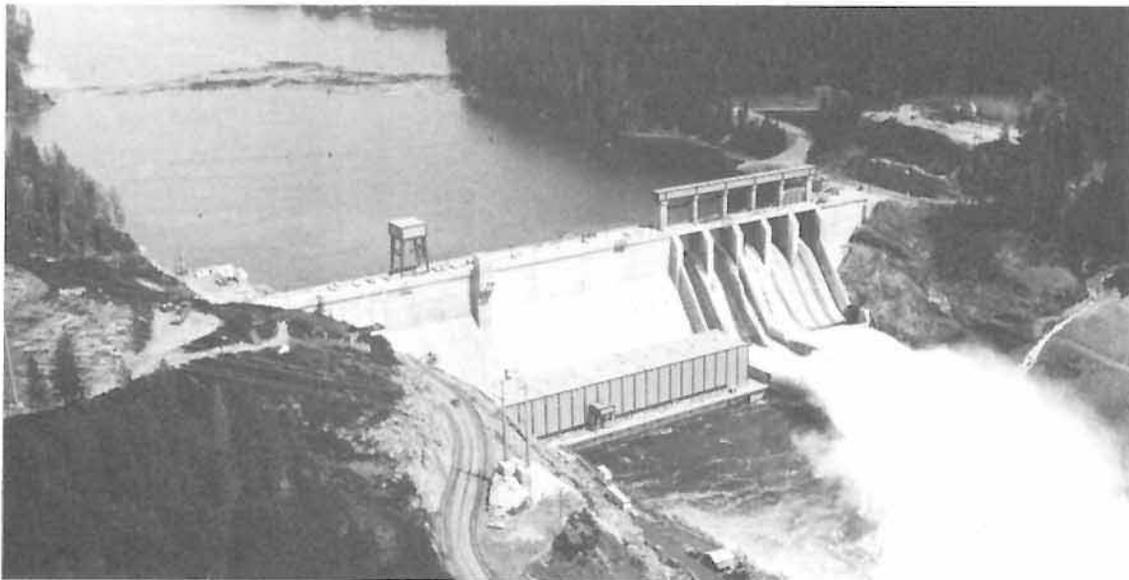
The Mica reservoir, formerly known as McNaughton Lake, has been renamed Kinbasket Lake. At the beginning of the report year its elevation was 2455.6 feet, about 19 feet below normal full pool elevation. In October, discharges to meet British Columbia Hydro and Power Authority's generating needs exceeded Detailed Operating Plan requirements. These, along with earlier high discharges to help maintain water levels in Arrow Lakes during the summer of 1979, created an imbalance in Treaty storage between Mica and Arrow reservoirs. This imbalance was rectified by the end of January 1980 as a result of operating Mica below target releases. Mica generation was subsequently

COLUMBIA RIVER
near Radium, B.C.
on Kootenay Diversion route
would not change
appreciably.



increased to meet Canadian needs and the reservoir's lowest elevation, 2387.4 feet, was reached on 18 April. High streamflows in May and June permitted the reservoir to fill rapidly. Between 17 June and 6 July Bonneville Power Administration's surplus generation was stored under the Mica Storage Arrangement. The resulting 112,900 second-foot days of storage was returned by 8 August. Treaty storage space at Mica was filled by 5 August and remained full through 30 September. About three feet of non-Treaty storage was drafted in September and the month-end elevation of the reservoir was 2466.5 feet.

At the beginning of this report year Libby reservoir was at elevation 2446.7 feet. High discharges were needed to meet power requirements up to the end of December and drafting continued until the reservoir reached its lowest elevation for the year, 2353.2 feet on 9 April. The reservoir filled rapidly and some spilling was required in mid-June to adhere to the flood control rule curve. On 6 July the level was one-half foot below full pool elevation and remained at that level through July and August. On 30 September the reservoir was at elevation 2456.0 feet.



SEVEN MILE DAM on Pend d'Oreille River began operation in 1980.

Flood Control Operation

Operation for flood control during the 1980 freshet was in accordance with the Entities' document "Columbia River Treaty Flood Control Operating Plan" and the required storage space was provided in all reservoirs prior to the freshet. The freshet was controlled to well below damaging levels by regulating discharges for power purposes and for the best operation to refill.

BENEFITS

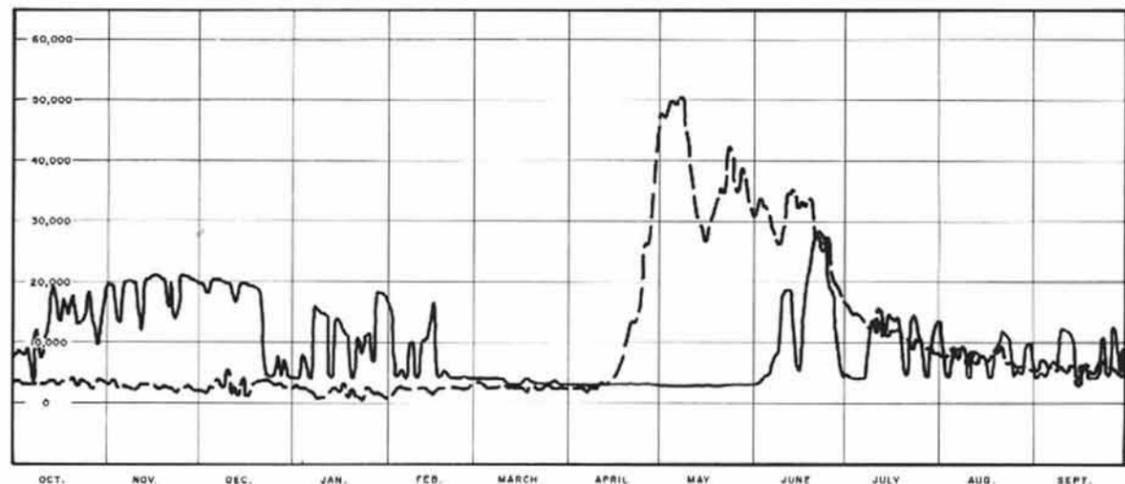
Flood Control Provided

Without regulation by upstream reservoirs the 1980 freshet would have produced a less than average peak discharge at The Dalles, Oregon, and would have caused little flood damage. In Canada, even without the four storage projects constructed as a result of the Treaty, the peak discharge of the Columbia River at Trail would not have reached damaging levels.

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about five feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by more than 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 34 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.

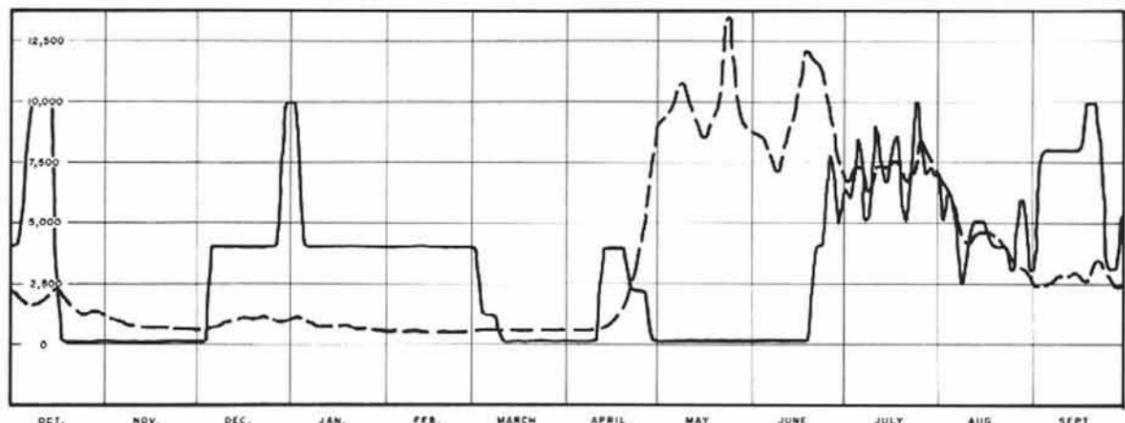
The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon from about 544,000 cfs to 338,000 cfs. Regulation by the Treaty storage projects during the 1980 freshet period contributed only minor flood control 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.

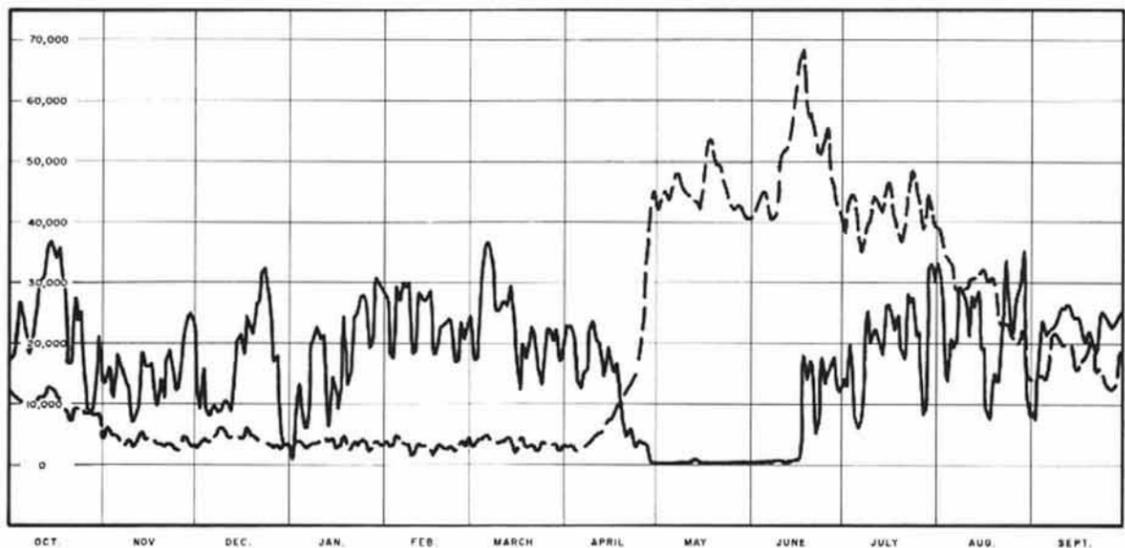


KOOTENAI RIVER AT LIBBY DAM

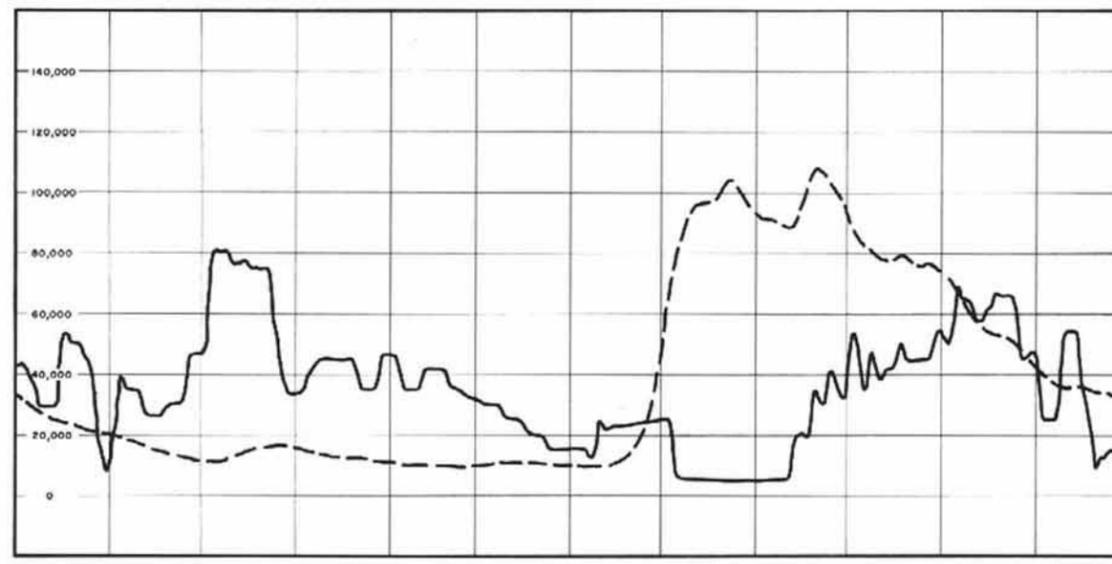
DISCHARGE IN CUBIC FEET PER SECOND



DUNCAN RIVER AT DUNCAN DAM



COLUMBIA RIVER AT MICA DAM



COLUMBIA RIVER AT HIGH KEENLEYSIDE DAM



COLUMBIA RIVER AT BIRCHBANK

LEGEND
 ———— Observed Flows
 - - - - - Pre-Project Flows

HYDROGRAPHS— Observed and pre-project flows for year ending 30 September 1980.

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.

Some additional power benefits were realized in 1980 through the use of non-Treaty storage under the Arrow Lakes Storage Agreement. These were shared by British Columbia Hydro and Power Authority and Bonneville Power Administration. There was also some extra benefit obtained by the use of the Agreement to Enhance Mica Filling. These operations were outside the Treaty and did not conflict with Treaty operations. The effects benefited both countries.

Other Benefits

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 supplement Treaty operating plans and have not created conflicts with operations under those plans. The effects have been beneficial in both countries in accordance with the intent of the Treaty.

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, and the flood control operating plan for Treaty reservoirs. Special operating arrangements have accommodated other interests without harming system operation and were consistent with the intent of the Treaty.
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. Regulation by the Treaty storage projects during the 1980 freshet period contributed only minor flood control benefits in Canada and the United States because of below average runoff conditions.
4. Subject to final verification that the use of a longer period of streamflow record for Assured Operating Plans has not affected operating commitments, and acknowledging the Entities' commitment to revert to the use of the 30-year streamflow record, the Board concludes that the objectives of the Treaty are being met.

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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	60,700	44,500	66,700	50,000	74,100	44,600	30,400	80,600	59,600	94,000	78,900	44,400
2	60,700	42,400	81,200	50,000	76,900	44,100	28,000	81,600	59,900	98,600	74,300	40,200
3	60,700	54,400	93,600	52,900	68,300	43,100	24,300	83,200	59,100	94,500	71,000	40,100
4	59,000	59,300	107,400	56,100	56,200	44,100	25,300	76,600	58,300	84,300	82,500	39,700
5	56,900	53,300	113,000	56,500	52,500	43,900	24,700	66,600	55,800	76,600	91,200	39,800
6	54,700	52,300	106,300	58,900	52,200	43,900	22,300	68,600	55,900	76,600	86,200	39,800
7	50,100	52,300	110,500	61,800	52,400	43,400	20,500	72,700	56,300	75,100	83,500	45,800
8	45,600	54,400	110,500	61,600	52,300	43,100	20,200	73,000	55,800	74,700	80,200	63,100
9	45,600	59,700	108,400	61,600	52,800	40,700	24,400	81,200	55,100	77,200	80,200	70,300
10	44,100	59,700	104,500	61,500	55,500	38,500	32,000	83,200	57,000	75,400	77,200	70,500
11	45,600	55,800	104,500	61,500	58,900	39,000	35,500	81,700	58,000	73,600	74,000	70,800
12	45,600	48,000	105,600	61,400	56,500	39,200	33,600	80,300	62,800	76,300	73,600	70,600
13	45,600	44,800	104,900	61,100	54,800	38,600	34,700	75,900	70,900	76,500	73,200	70,300
14	53,000	47,000	104,900	61,000	54,200	39,600	35,000	70,900	70,000	74,300	75,500	63,300
15	65,300	47,700	104,200	64,400	56,100	42,600	39,000	70,900	70,700	74,400	77,900	50,900
16	70,600	45,900	97,800	68,600	58,700	41,200	38,500	69,900	70,700	71,900	77,800	44,900
17	71,300	47,000	99,900	69,800	58,900	36,000	41,200	69,300	67,800	84,400	82,100	40,000
18	68,500	51,600	101,400	69,800	61,400	33,800	44,100	69,000	76,600	84,600	83,900	36,300
19	68,200	54,400	101,400	69,800	63,800	33,100	44,900	68,800	84,700	77,700	82,400	27,700
20	68,200	55,800	98,900	65,300	59,900	34,600	49,700	67,300	86,000	74,300	83,500	28,700
21	68,500	55,400	96,400	60,800	58,800	37,600	52,000	67,600	80,400	73,700	86,500	31,500
22	67,500	48,400	93,900	59,000	58,800	37,800	52,300	70,800	76,700	70,700	86,900	28,100
23	67,500	51,200	84,000	51,800	55,500	35,800	53,500	70,100	79,600	71,700	87,200	30,900
24	67,100	48,700	73,100	51,700	52,900	30,500	58,200	67,700	85,000	72,500	82,400	31,000
25	64,300	55,400	61,100	51,700	46,400	28,700	61,000	65,000	89,200	76,300	67,700	31,400
26	51,600	68,500	53,000	51,800	44,800	28,600	63,500	62,700	83,300	74,000	60,500	31,600
27	38,500	72,700	53,300	57,100	44,700	29,900	68,700	63,600	78,800	73,700	61,000	30,500
28	34,100	71,300	50,500	62,800	44,700	32,700	73,300	61,000	77,400	74,400	61,500	33,100
29	27,400	69,900	48,700	62,900	44,700	30,000	83,500	61,200	76,300	77,600	64,000	36,300
30	22,700	67,500	49,100	63,700		29,900	82,300	61,900	79,900	77,200	63,700	36,000
31	28,900		49,400	71,400		29,800		60,800		77,400	56,500	
Mean	54,100	54,600	88,300	60,300	56,100	37,400	43,200	71,100	69,900	77,900	76,400	43,900

COLUMBIA RIVER AT BIRCHBANK, B.C. — Daily discharges for the year ending 30 September 1980 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	7,700	20,400	21,200	6,370	18,500	6,510	4,980	34,400	12,100	8,760	14,600	5,640
2	8,880	20,800	21,400	5,510	13,900	6,580	4,790	32,800	12,700	7,850	9,610	5,600
3	8,670	20,500	20,300	5,820	10,400	6,580	4,670	32,400	12,700	7,410	5,740	7,020
4	8,250	17,000	21,000	9,570	7,990	6,370	4,700	31,500	12,200	7,140	5,440	6,320
5	7,500	14,000	21,600	9,230	6,660	6,100	4,820	30,200	12,300	6,940	9,250	5,950
6	9,530	19,700	21,900	5,650	5,540	5,930	4,900	29,600	11,800	7,110	9,700	7,480
7	8,560	20,900	21,900	7,320	5,610	5,930	5,000	29,100	14,000	6,930	10,100	8,070
8	4,920	21,200	21,800	16,000	11,300	5,900	5,100	27,300	14,600	10,000	10,200	7,170
9	11,300	21,300	21,700	16,200	11,300	5,800	5,070	25,400	15,100	14,300	9,710	12,400
10	7,730	21,600	22,000	16,200	5,860	5,800	5,190	25,000	23,000	15,700	5,660	12,900
11	8,080	17,300	22,300	16,300	5,670	5,820	5,340	22,800	24,700	16,000	5,510	12,900
12	9,450	16,600	21,300	15,800	11,300	5,320	5,440	20,600	25,000	15,900	9,160	12,700
13	15,800	20,500	19,300	6,650	11,500	4,890	5,560	18,700	25,300	14,100	9,020	11,400
14	18,300	20,900	21,100	7,040	11,900	4,810	6,080	17,500	21,800	14,900	8,860	5,930
15	15,500	21,400	21,700	15,900	18,000	5,020	7,180	16,900	14,000	16,000	8,730	5,150
16	14,300	22,000	22,100	15,100	15,800	4,960	9,160	16,100	13,500	15,300	8,640	5,090
17	14,900	22,100	22,100	13,500	6,200	4,770	9,960	15,700	20,300	15,800	5,440	6,920
18	16,300	21,800	22,100	13,400	5,640	5,470	11,500	15,400	24,000	17,200	5,760	5,350
19	16,000	22,100	21,900	12,700	6,770	6,000	14,200	15,400	28,600	14,900	9,840	5,210
20	17,700	21,000	21,800	6,180	7,250	5,340	16,400	15,200	32,100	7,610	10,600	5,510
21	16,000	18,100	21,700	6,240	5,710	4,930	18,200	15,200	32,800	8,450	12,700	5,950
22	13,200	18,200	18,300	12,100	5,480	4,820	18,900	15,400	32,500	13,400	12,700	7,090
23	13,800	15,700	13,500	10,200	5,410	4,710	19,800	14,900	32,200	16,100	11,900	12,200
24	14,500	19,500	8,390	12,600	5,210	4,800	22,900	13,800	32,200	14,800	10,700	7,280
25	18,500	21,300	6,550	12,800	5,200	4,760	27,600	13,000	27,100	11,700	6,010	7,390
26	16,600	21,600	5,830	12,000	5,790	4,630	28,200	13,900	23,400	11,700	6,560	12,100
27	15,000	21,500	5,760	10,900	5,180	5,370	29,100	14,300	20,800	6,500	5,900	13,000
28	15,200	21,500	5,910	19,200	5,880	5,700	32,100	13,300	14,300	5,620	5,710	9,520
29	10,200	21,200	11,000	19,500	6,230	5,100	36,700	12,300	9,700	10,800	9,400	6,750
30	16,600	21,200	8,210	20,000		4,880	37,200	12,000	8,460	13,300	10,700	12,100
31	19,700		5,790	18,200		4,770		12,000		14,500	10,100	
Mean	12,900	20,100	17,500	12,100	8,520	5,430	13,700	20,100	20,100	11,800	8,840	8,270

KOOTENAI RIVER AT PORTHILL, IDAHO — Daily discharges for the year ending 30 September 1980 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

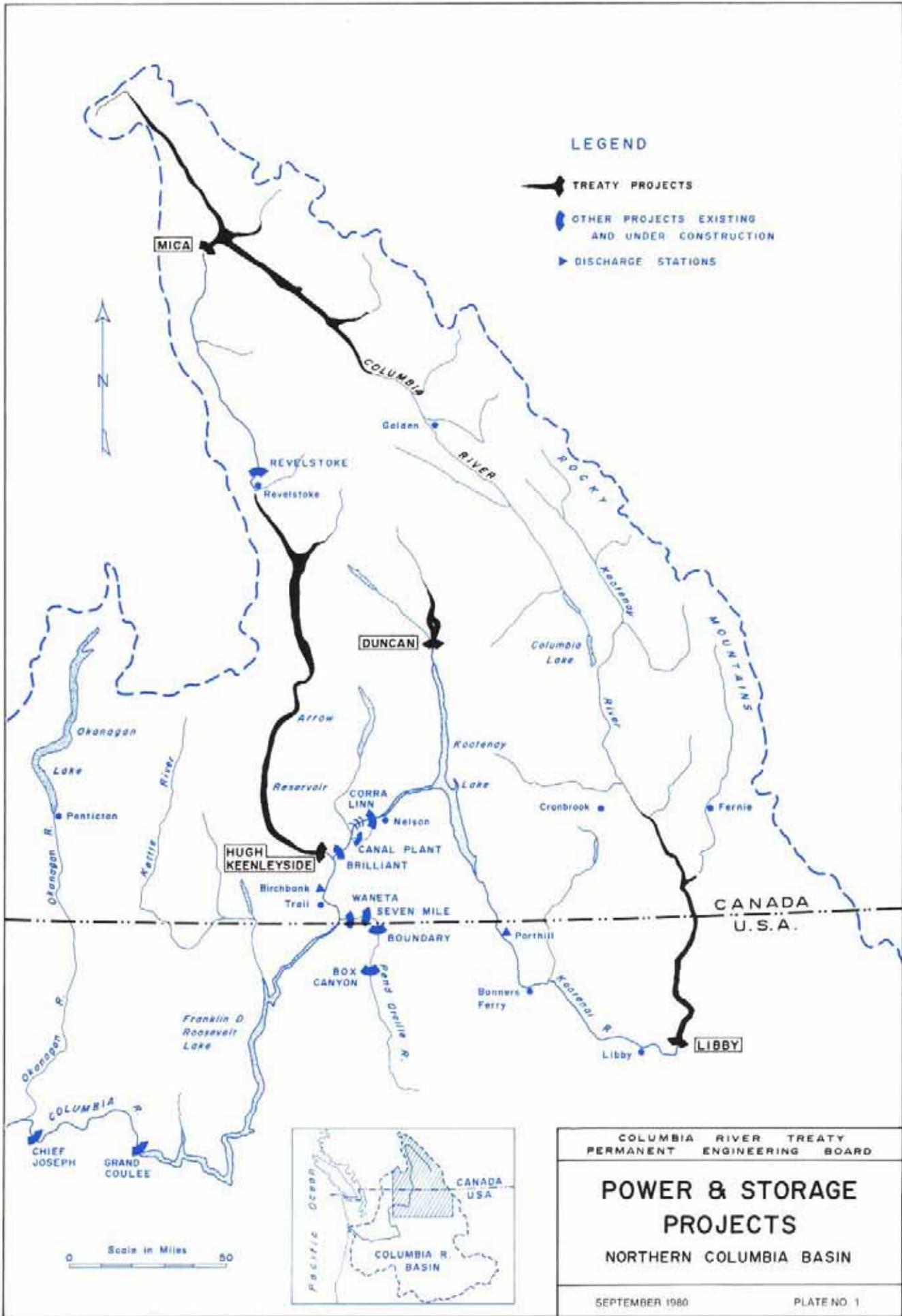
Table No. 2

Mica Project

Table No. 3

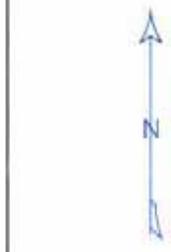
Libby Project

Table No. 4



LEGEND

-  **TREATY PROJECTS**
-  **OTHER PROJECTS EXISTING AND UNDER CONSTRUCTION**
-  **DISCHARGE STATIONS**



0 Scale in Miles 50



COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD	
<h2 style="margin: 0;">POWER & STORAGE PROJECTS</h2> <p style="margin: 0;">NORTHERN COLUMBIA BASIN</p>	
SEPTEMBER 1980	PLATE NO. 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

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 PROJECT

Mica 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 PROJECT

Libby Dam and Lake Koochanusa

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