ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
Washington, D.C. Ottawa, Ontario
30 SEPTEMBER 1975

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

CANADA · UNITED STATES

31 December 1975

The Honorable Henry Kissinger
The Secretary of State
Washington, D.C.

The Honourable A. Gillespie
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 eleventh Annual Report, dated 30 September 1975, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1974 to 30 September 1975.

Respectfully submitted:

For the United States

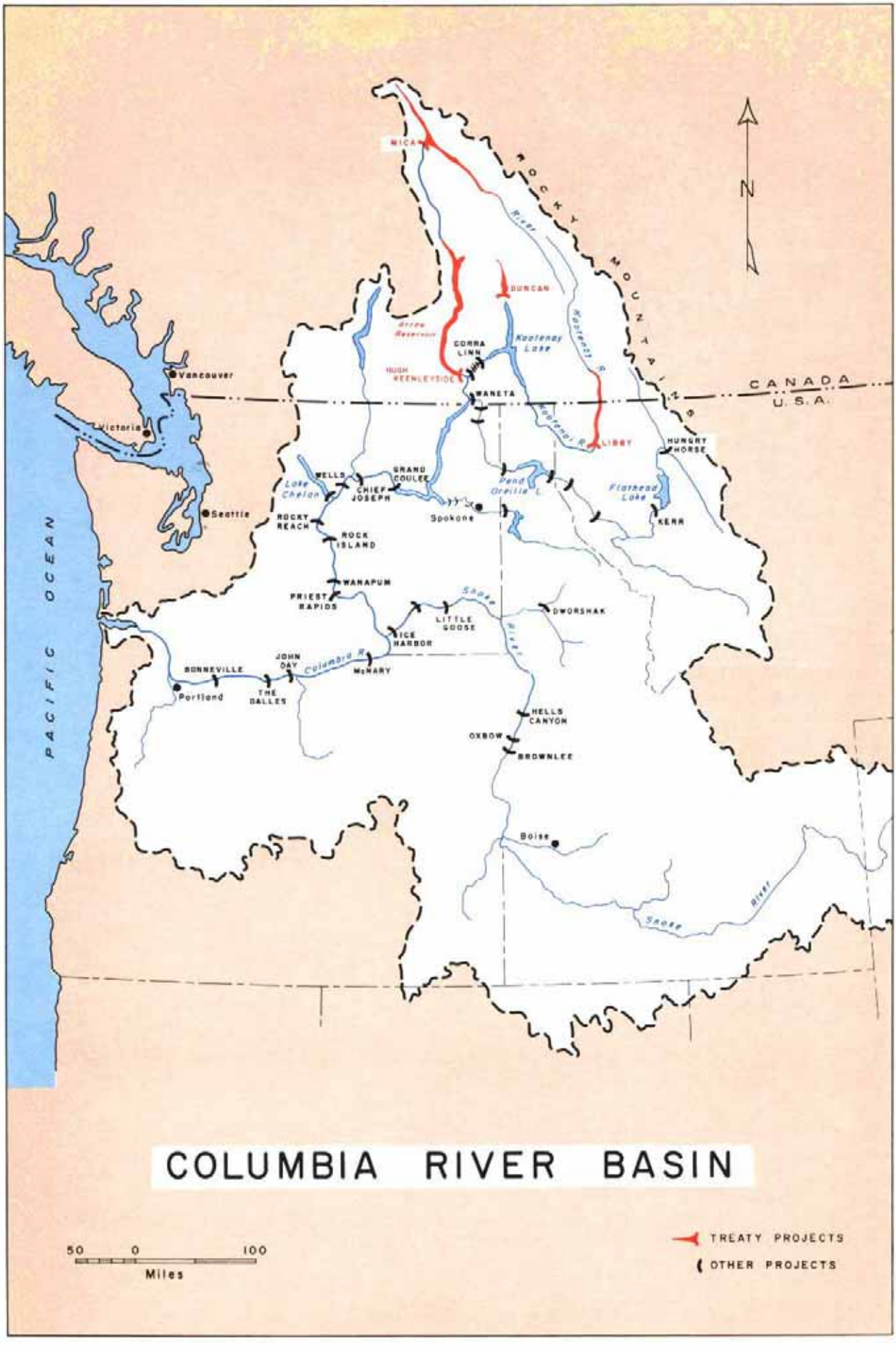
Homer B. Willis, Chairman

J. Emerson Harper

For Canada

G.M. MacNabb, Chairman

B.E. Marr



COLUMBIA RIVER BASIN

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PERMANENT ENGINEERING BOARD

Washington, D.C. **Ottawa, Canada**

30 September 1975

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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 eleventh 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.

Two Board meetings and one meeting of the Board with the Entities were held during the reporting period. The Board also inspected the Libby, Arrow and Mica projects during the latter part of August 1975.

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. Reservoir operations contributed only minor flood control benefits in Canada and the United States because of low runoff conditions.

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. Downstream power benefits are being calculated by the Entities as required by the Treaty.

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 1974 to 30 September 1975, 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 also 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.

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.

HUGH KEENLEYSIDE DAM

The dam at the outlet of Arrow Lakes reservoir.

Columbia River, British Columbia

Features of the Treaty and Related Documents

The essential features 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.

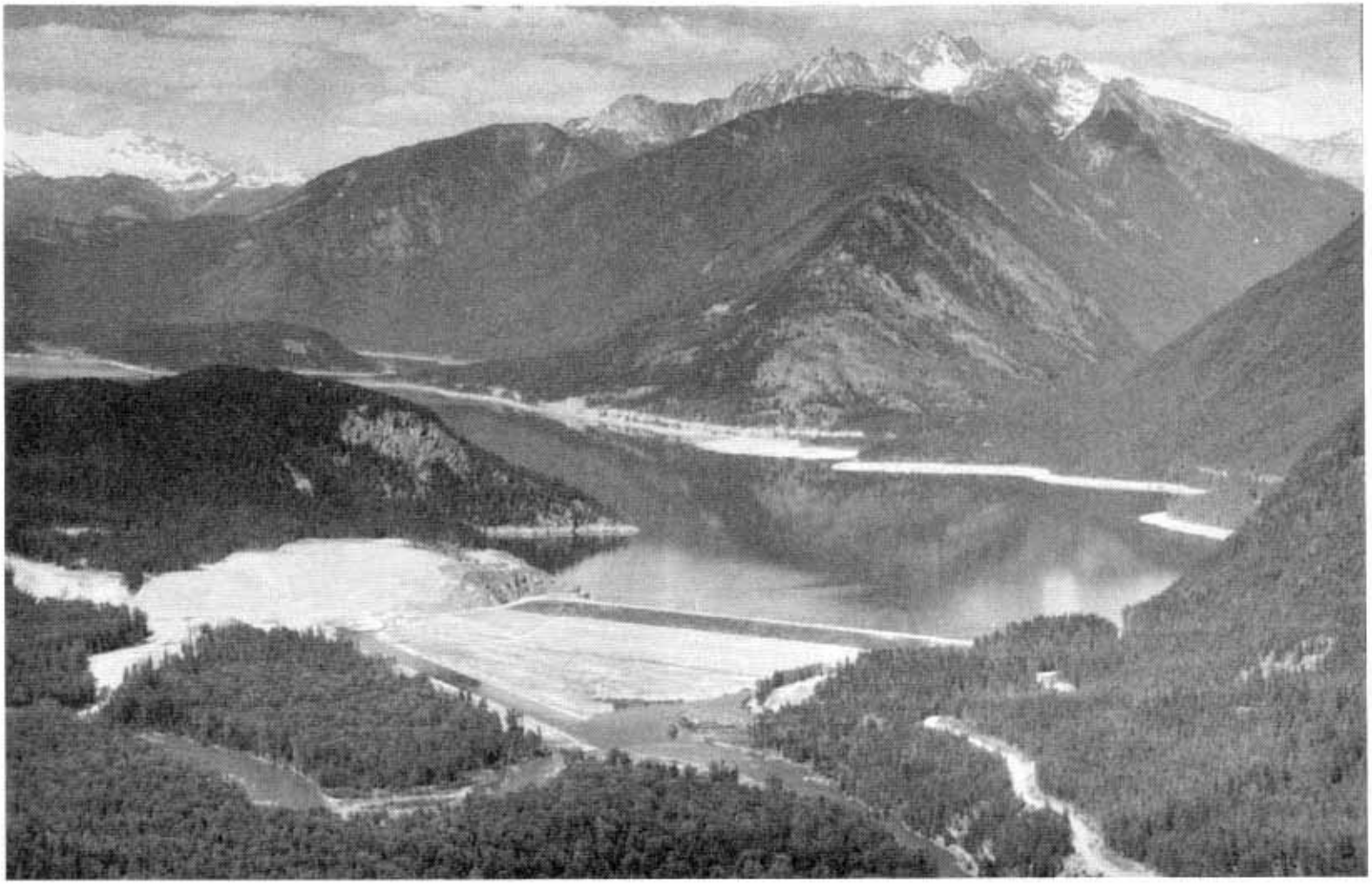
(f) Both Canada and the United States have the right to make diversions of water for consumptive uses and, in addition, after September 1984 Canada has the option of making for power purposes specific diversions of the Kootenay River into the headwaters of the Columbia River.

(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



DUNCAN DAM

The completed dam and reservoir.

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. 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 the Board members, alternate members and secretaries are shown in Appendix A. It is noted that Mr. Alex Shwaiko has replaced Mr. Fred L. Thrall as an alternate member on the United States Section of the Board.

Duties and Responsibilities of the Board

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

(a) assembling records of the flows of the Columbia River and the Kootenay River at the Canada-United States of America boundary;

(b) reporting to Canada and the United States of America whenever there is substantial deviation from the hydroelectric and flood control operating plans and if appropriate including in the report recommendations for remedial action and compensatory adjustments;

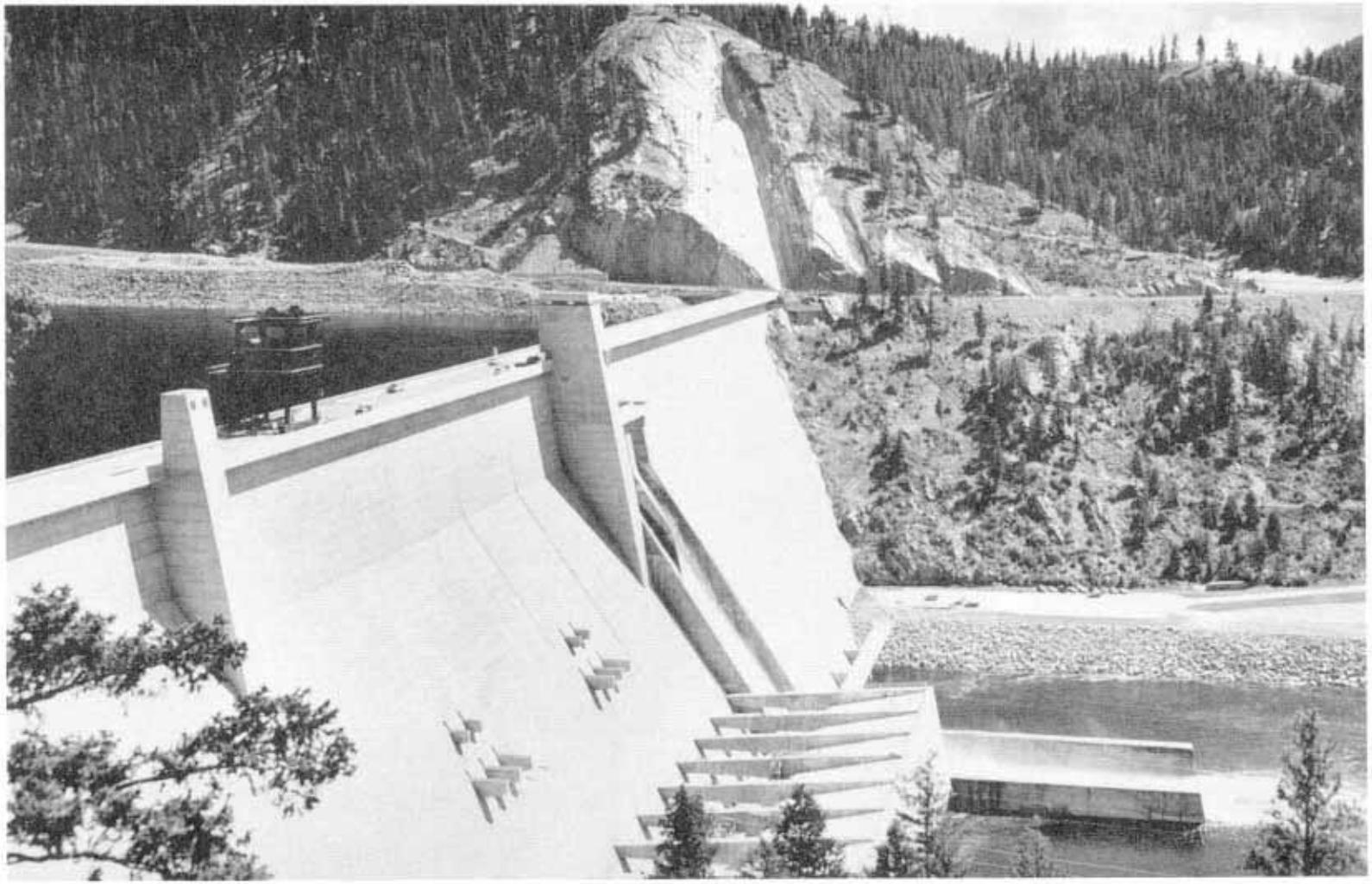
(c) assisting in reconciling differences concerning technical or operational matters that may arise between the entities;

(d) making periodic inspections and requiring reports as necessary from the entities with a view to ensuring that the objectives of the Treaty are being met;

(e) making reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty and making special reports concerning any matter which it considers should be brought to their attention;

(f) investigating and reporting with respect to any other matter coming within the scope of the Treaty at the request of either Canada or the United States of America;

(g) consulting with the entities in the establishment and operation of a hydro-meteorological system as required by Annex A of the Treaty.



LIBBY DAM

The dam and powerhouse.

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. 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. It is noted that Mr. J. W. Wilson has replaced Mr. W. D. Kennedy as Chairman of the Canadian Entity and that Major General Wesley E. Peel has replaced Major General Richard E. McConnell as member of the United States Entity.

VISITOR CENTRE at Libby Dam, opened.

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.

MICA DAM Columbia River, British Columbia

Outlet works discharges are limited in winter due to fog and spray which interfere with powerhouse construction.

ACTIVITIES OF THE BOARD

Meetings

The first meeting of the Board during the report year was held in Portland, Oregon on 26 November 1974 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. The second meeting of the Board was held in Castlegar, B.C. on 24 August 1975. The Board attended dedication ceremonies at Libby Dam and inspected the Libby project on 24 August 1975. On 25 and 26 August the Board visited the Arrow, Kootenay Canal and Mica projects.

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 1973 to 30 September 1974

- Columbia River Treaty Hydroelectric Operating Plan – Assured Operating Plan for Operating Year 1979-80, plus a copy of the Entities' agreement on this document

- Detailed Operating Plan for Columbia River Treaty Storage 1 July 1974 through 31 July 1975, plus a copy of the Entities' agreement on this document

- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1979-80, plus a copy of the Entities' agreement on this document

- Columbia River Treaty Hydrometeorological System Plan for Exchange of Operational Hydromet Data dated 31 December 1974, plus a copy of the Entities' agreement on this document

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 1975 through 31 July 1976, plus a copy of the Entities' agreement on this document

- Columbia River Treaty Hydroelectric Operating Plan — Assured Operating Plan for Operating Year 1980-81, plus a copy of the Entities' agreement on this document

- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1980-81, 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 1974 to 30 September 1975

- Columbia River Treaty Hydrometeorological System Treaty Facilities, September 1975

- Columbia River Treaty Hydrometeorological Supporting Facilities, September 1975.

Report to Governments

The tenth Annual Report of the Board was submitted to the two governments on 31 December 1974.

TREATY TOWER
commemorative sculpture
at Libby Dam.

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 primarily in the United States 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. When the powerhouse at Mica dam and the Canal Plant on the Kootenay River, both currently under construction, are completed, the power benefits in Canada will increase substantially.

The locations of the four 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.

SLUICEWAYS
operating at
Hugh Keenleyside Dam.

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 3 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 and reservoir.

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 with a storage capacity of 20,000,000 acre-feet. The project will utilize 12,000,000 acre-feet of live storage of which 7,000,000 acre-feet are committed under the Treaty. Several years will be required to completely fill the reservoir.

Work is proceeding on construction of the underground power generating facilities at this site. The first two of the initial four generators are expected to be in service in 1976. There will be space for a total of six 435,000 kw units with a total capacity of 2,610,000 kw.

The dam is shown in the picture on page 13 and project data are shown in Table 3 of Appendix D.

DRAFT TUBE ELBOW
for Unit No. 1
at Mica powerhouse.

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 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 river bed 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.

Construction of the dam has been completed, and work during 1975 was devoted primarily to completing the powerhouse, visitors' accommodations, and the selective withdrawal system.

The powerhouse structure is complete and installation of generation facilities is continuing. Unit 1 was completed in August 1975 and Unit 2 is scheduled to be on-line in October 1975. Units 3 and 4 are scheduled for completion in January 1976 and April 1976, respectively. Space is also being provided for four additional units which are currently scheduled for the mid-1980's.

The visitors' accommodations contract is scheduled for completion in November 1975. The relocation of Montana State Highway 37 along the east bank of Lake Koocanusa was completed in 1975, and construction of an additional portion of Montana State Highway 37 downstream of the dam is scheduled for the spring of 1976.

Work on the selective withdrawal system, which will permit the regulation of water quality by selecting the level in the reservoir from which water is drawn for power discharges, is now about 85% complete. This feature is scheduled for completion by January 1976.

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

LIBBY DAM DEDICATION
Spilling stops as
water is diverted
to generators.
24 August 1975.

Libby Project in Canada

Nearly half of the 90-mile length of Lake Koocanusa, when full, is in Canada. Procurement and preparation of the land required for the portion of the reservoir in Canada is, in accordance with the terms of the Treaty, the obligation of the Canadian Government. By subsequent agreement between Canada and the Province of British Columbia in 8 July 1963, British Columbia undertook responsibility for these flowage costs in Canada.

Storage of water to refill Lake Koocanusa commenced early in May and on 19 May 1975 storage commenced in the Canadian portion of the reservoir. The reservoir reached its maximum elevation for the year of 2455.5 feet on 9 September, slightly below the normal full pool elevation of 2459 feet.

CAMPGROUND at Surveyor's Lake on shores of Lake Koocanusa in Canada.

The British Columbia Forest Service is continuing with a program of piling and burning debris collected on the shores of the reservoir. All new roads, bridges and modifications to the Canadian Pacific Railway track between Fort Steele and Wardner made necessary by the project were completed in 1972.

The Fish and Wildlife Branch of the Provincial Department of Recreation and Conservation has installed fish screens in Linklater and Plumbob Creeks as a contribution to the United States fish-tagging program for the reservoir. The Parks Branch of the same Department is proceeding with development of waterfront parks and recreational facilities at Kikomun Creek and Wardner and is studying the possibility of other recreational areas around the perimeter of the reservoir.

Hydrometeorological Network

One of the responsibilities assigned to the Entities by the Treaty is the establishment and operation, in consultation with the Permanent Engineering Board, of a hydrometeorological system to obtain data for detailed programming of flood control and power operation. This system includes snow courses, meteorological stations and streamflow gauges.

In developing the hydrometeorological network the Entities, with the concurrence of the Board, adopted a document which defines the Columbia River Treaty Hydrometeorological System Network and sets forth a method of classifying facilities into those required as part of the Treaty System and those of value as Supporting Facilities. The Columbia River Treaty Hydrometeorological Committee, formed by the Entities, makes recommendations on establishing the Treaty Hydrometeorological System.

During this report year the Entities, with the concurrence of the Board, adopted a revised plan for exchange of operational hydrometeorological data. The Entities, after the end of this report year, provided the Board with revised documents which list the Treaty System and Supporting Facilities for the hydrometeorological network.

CORRA LINN DAM
and forebay
with canal for
Kootenay Canal project.

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.

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 1975. A detailed operating plan for the operating year ending 31 July 1976 was forwarded to the Board after the end of this report year. The detailed operating plan to 31 July 1976 is the first to include operation of the Libby project.

The operating plan for operating year 1979-80, received by the Board early in the report year, is the fourth to include generation at the Mica project. This operating plan is based on the operation of the system for optimum generation in both countries. The Board has reviewed this plan and concludes that it is consistent with the terms of the Treaty and does not depart substantially from previous plans. The operating plan for 1980-81 was provided to the Board after the end of the report year.

RUNNER and shaft for Mica turbine.

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.

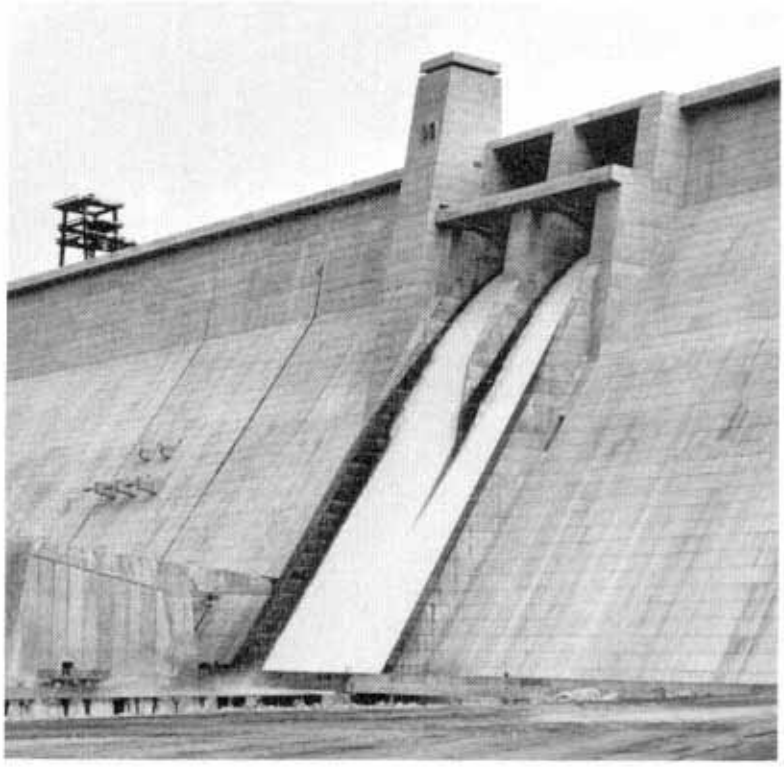
In this report year the Entities provided the Board with a copy of their agreed document outlining downstream power benefits resulting from Canadian storage for the operating year 1979-80. The Board has completed its review of this document and concludes that it meets the requirements of the Treaty. 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. This material facilitated review of the documents by the Board. A report on determination of downstream power benefits for the operating year 1980-81 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.

LIBBY DAM SPILLWAY
and Treaty Tower.



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.

OPERATION

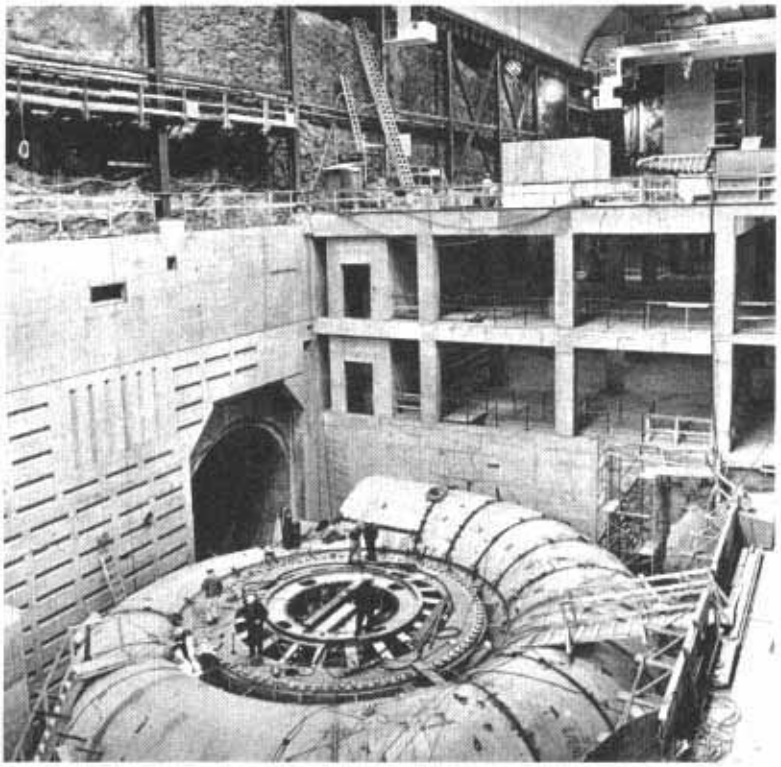
General

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 the "Columbia River Treaty Flood Control Operating Plan", the "Detailed Operating Plan for Columbia River Treaty Storage 1 July 1974 through 31 July 1975", the "Detailed Operating Plan for Columbia River Treaty Storage 1 August 1975 through 31 July 1976", the "Hydroelectric Operating Plans for Canadian Storage during the Operating Years 1969-70 through 1974-75", and the "Columbia River Treaty Hydroelectric Operating Plan for Canadian Storage 1975-76 Operating Year".

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. After the very large freshet in 1974, all storage in Canada committed under the Treaty and other reservoirs in the Pacific Northwest were full. Generally favourable weather and streamflow conditions occurred throughout this report year.



SCROLL CASE
for Unit No. 1
at Mica powerhouse.

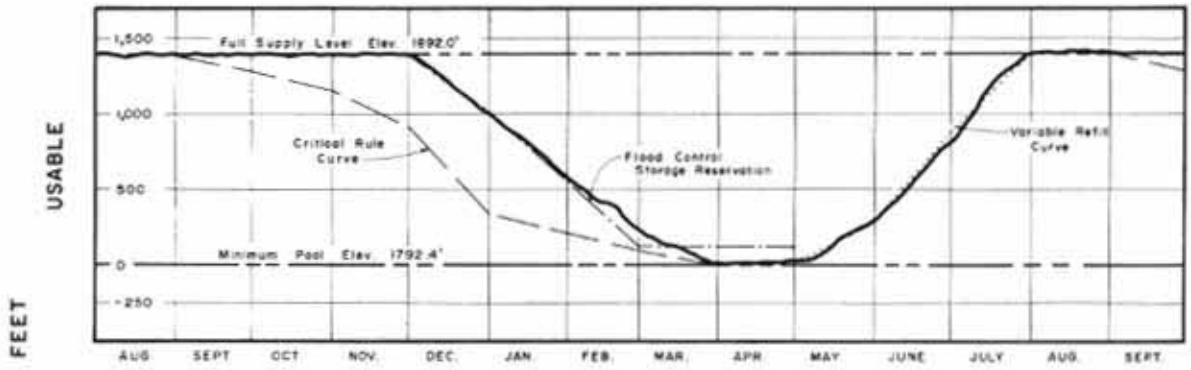
Although runoff conditions were slightly below average for the September through April period, power loads in the United States Northwest were less than expected and power operations were routine. Surplus hydroelectric energy was available in the Bonneville Power Administration system from mid-February through July. The 1975 freshet was about average and Treaty storage in the Duncan, Arrow and Mica projects was filled. There was, however, no surplus water in the system which would permit an increase in accumulation of dead storage in the Mica reservoir.

Operation of the reservoirs is illustrated on pages 32 and 33 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

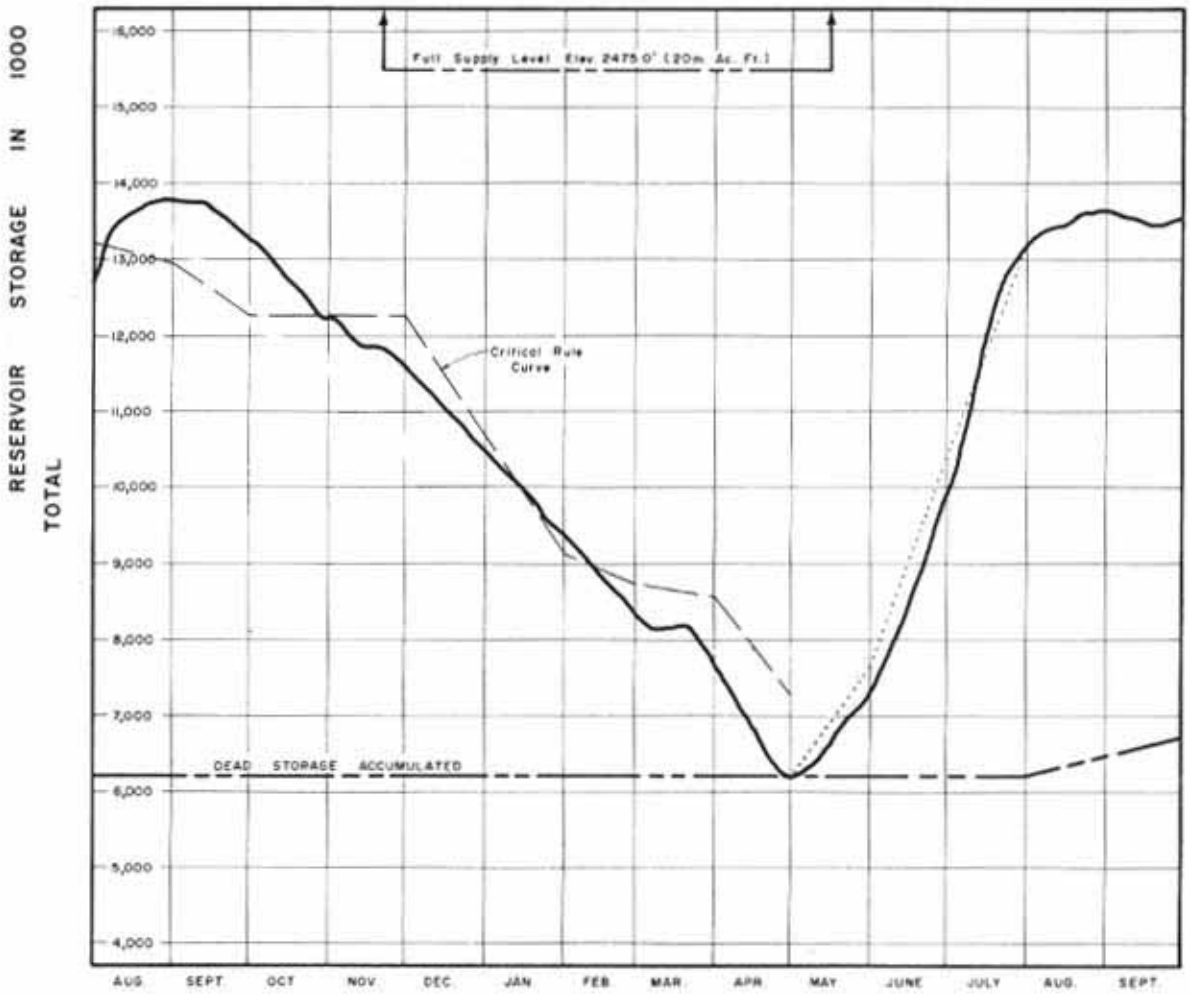
maximum month-end reservoir levels which will permit evacuation of the reservoir to control the forecasted freshet. The Critical Rule Curve shows minimum month-end reservoir levels which should be maintained to enable the anticipated power demands to be met under adverse water supply conditions. The 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 full pool elevation, 1892 feet, and was maintained at this elevation until the end of November. From December 1974 through March 1975 storage releases were closely coordinated with releases from Libby to ensure compliance with the International Joint Commission's Order on Kootenay Lake while evacuating the required storage space. During April releases from Duncan were kept below 700 cfs to assist in studies on the fish population below the reservoir. The reservoir was held below elevation 1798 feet until 6 May 1975 when reservoir discharges were reduced to 100 cfs and storing commenced. The reservoir reached full pool elevation of 1892 feet on 1 August 1975 and this elevation was maintained throughout the remainder of the report year.

The Arrow reservoir at the beginning of the report year was at elevation 1430 feet. Downstream power requirements and below average inflows resulted in a continuing drop in reservoir levels of about eight feet per month through February 1975. During the second half of March the level fell about five feet in one week. Drafting of reservoir storage was complete by the end of March and storing commenced during the first week in May.

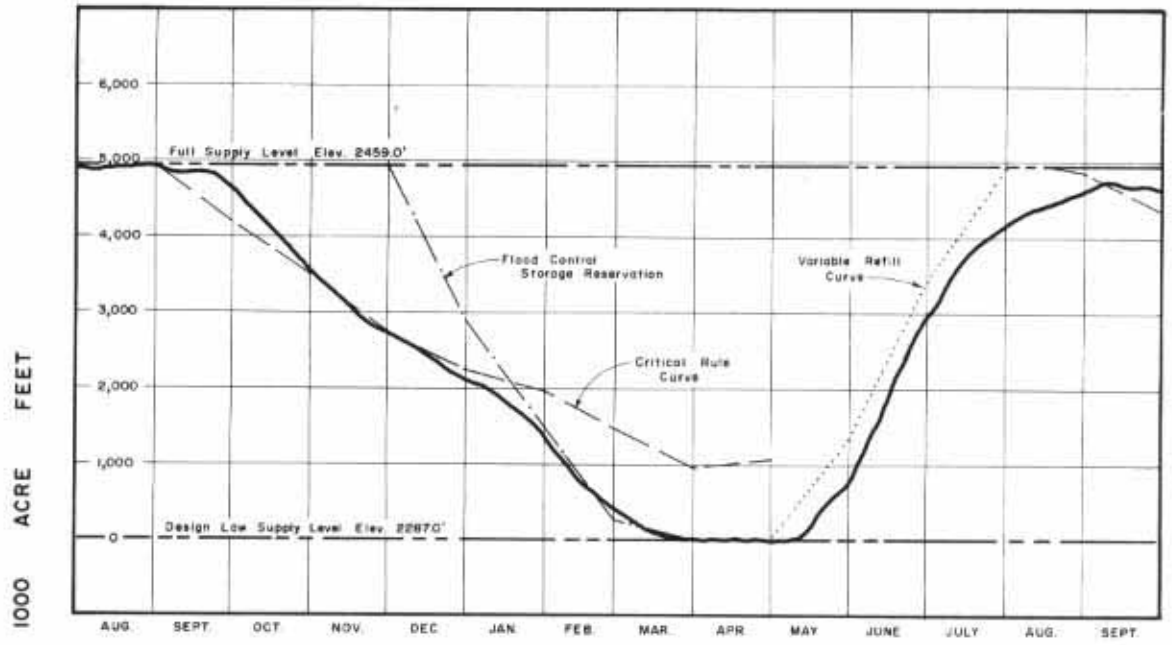


DUNCAN RESERVOIR

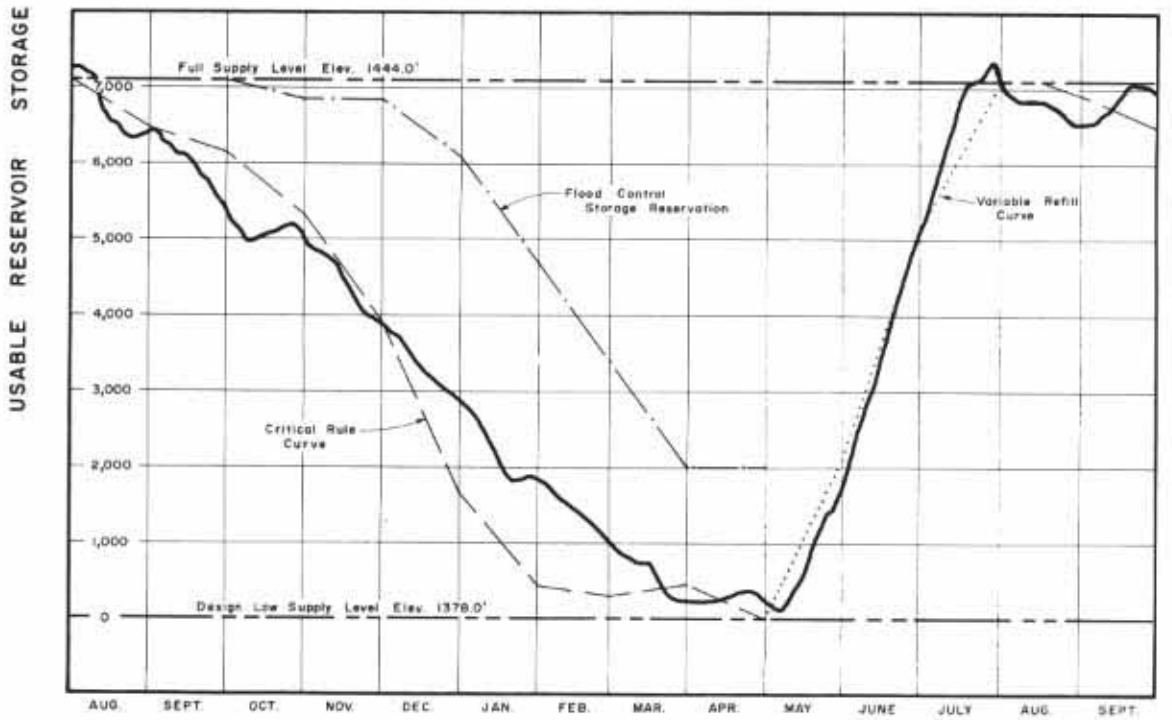


MICA RESERVOIR

HYDROGRAPHS – Duncan and Mica reservoir levels for the 14-month period ending 30 September 1975.



LIBBY RESERVOIR



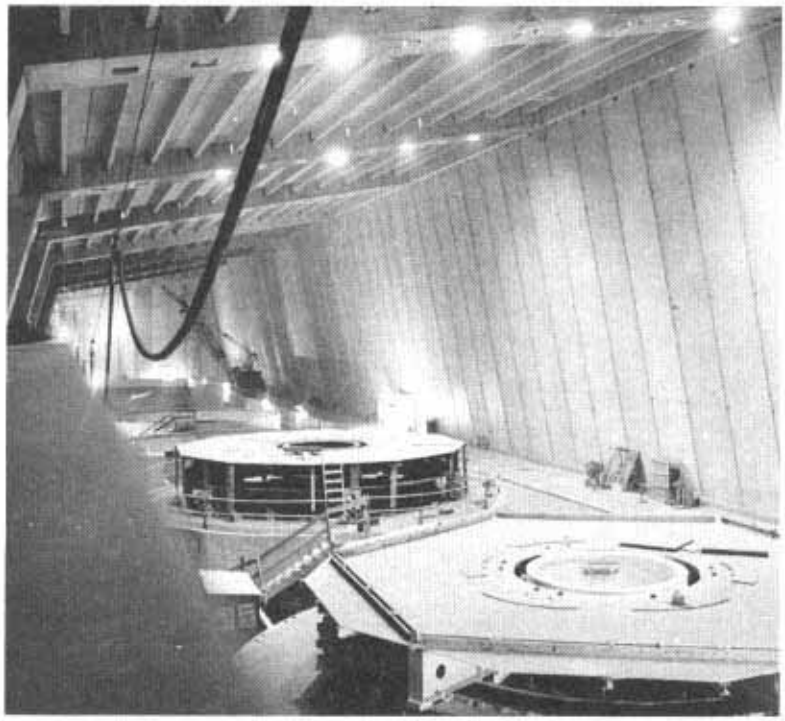
ARROW RESERVOIR

HYDROGRAPHS — Libby and Arrow reservoir levels for the 14-month period ending 30 September 1975.

After this only minimum releases were provided until mid-July when discharges were increased for power purposes. A temporary surcharge was made on the reservoir to elevation 1446.1 feet at the end of July in order to compensate for anticipated involuntary storage at Mica Dam due to discharge limitations. Favourable streamflow conditions enabled Arrow reservoir to remain nearly full until the end of September. On 30 September 1975 the water surface was at elevation 1443.2 feet.

At the beginning of the report year McNaughton Lake, the reservoir behind Mica Dam, was at elevation 2402 feet; the 7 million acre-feet of Treaty storage was full and about 6.2 million acre-feet of water was in dead storage. Discharges throughout the winter were held as high as could be tolerated for construction of the powerhouse. In March discharges were reduced to conserve water for possible transfer to dead storage but low inflows and high demands made it necessary to resume high rates of discharge at the end of March. The minimum reservoir level was 2281.6 feet on 30 April 1975. During the refill period outflows were reduced to 1,000 cfs. By the end of July the requirement to fill the Treaty storage and to meet downstream power needs had used all available water and the amount in dead storage remained at the 6.2 maf accumulated during the previous year.

In August and September 1975, in accordance with the provisions of the Program for Initial Filling of Mica Reservoir, dated 26 July 1967, the Canadian Entity delivered electric energy to the United States in lieu of equivalent water releases from McNaughton Lake. This measure increased the dead storage reserve by 0.5 maf to 6.7 maf by 30 September 1975. The water level on that date was at elevation 2405.8 feet.



LIBBY POWERHOUSE
Interior.

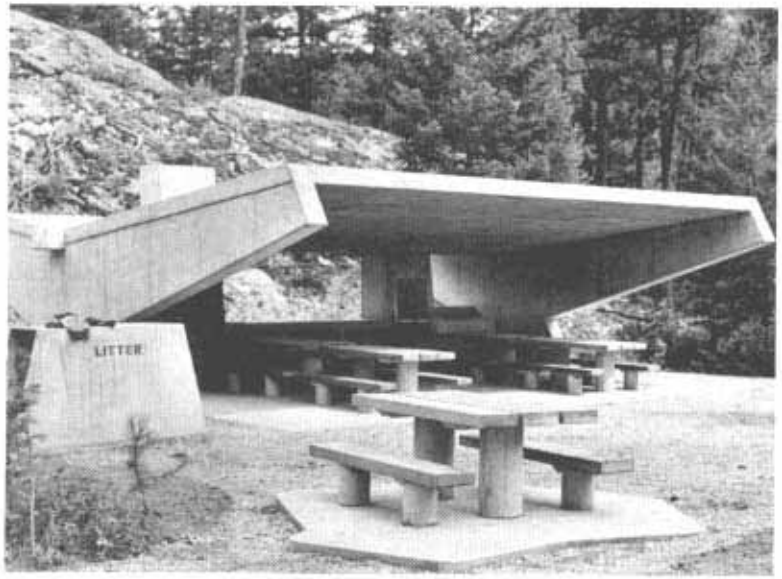
Lake Koocanusa, the reservoir created by Libby Dam, was at elevation 2453 feet on 1 October 1974, having reached its normal full pool elevation of 2459 feet for the first time in July 1974. Drafting of storage water for downstream power generation and flood control evacuation which began in September continued at a high rate during October and November. By the end of November, Libby outflows were being regulated to lesser amounts to provide a uniform rate of drawdown of the reservoir. Libby and Duncan outflows were coordinated from 1 December 1974 through March 1975 to maintain Kootenay Lake levels consistent with the International Joint Commission rule curve and to evacuate both reservoirs.

The low water elevation of 2287 feet required for flood control was reached by 1 April. Reservoir refill started on 8 May and the maximum reservoir elevation for the year, 2455.5 feet, was reached on 9 September. By the end of the month the water surface was at elevation 2453.0 feet.

Flood Control Operation

Operation for flood control during the 1975 freshet was in accordance with the Entity document "Columbia River Treaty Flood Control Operating Plan". Storage space at the Duncan, Arrow, Mica and Libby projects was provided prior to the freshet in accordance with that plan. Storing commenced early in May and continued until after the peak of the freshet was reached late in June. This about average freshet was controlled to well below damaging discharges.

SOUSE GULCH
picnic shelter
on Lake Koocanusa
in Montana.



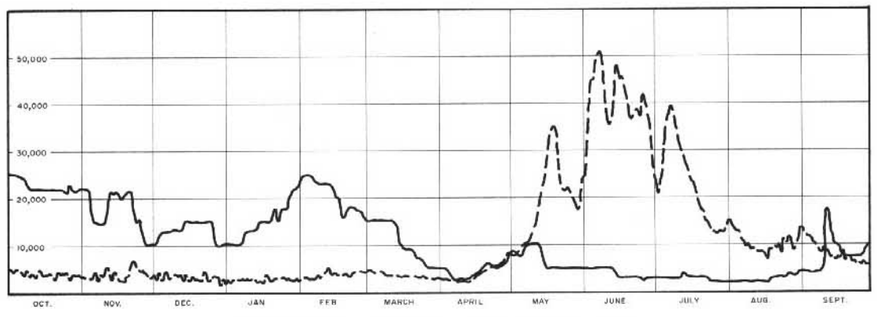
BENEFITS

Flood Control Provided

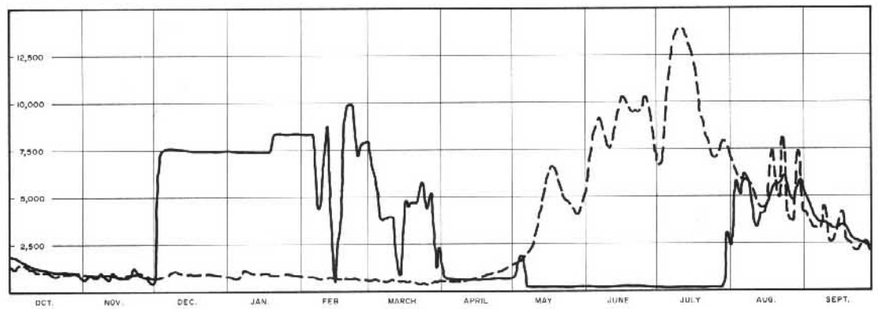
Without regulation by upstream reservoirs the 1975 freshet would have produced an average April through August runoff volume and peak discharge at The Dalles, Oregon, and would have caused little flood damage. In Canada, even without the four storage projects constructed as a result of the Treaty, the 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 six 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 nine 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 by hydrographs which show both the actual discharges and the pre-project flows that would have occurred if the dams had not been built. It is noted that the pre-project hydrograph 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.

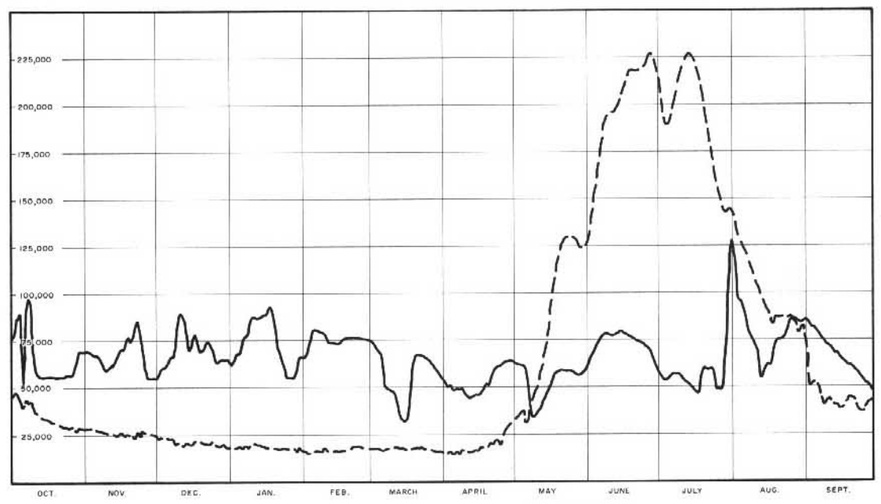
The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon from about 670,000 cfs to 423,000 cfs. The corresponding reduction in peak stage at Vancouver, Washington was about nine feet. The unregulated freshet would have been more than bank



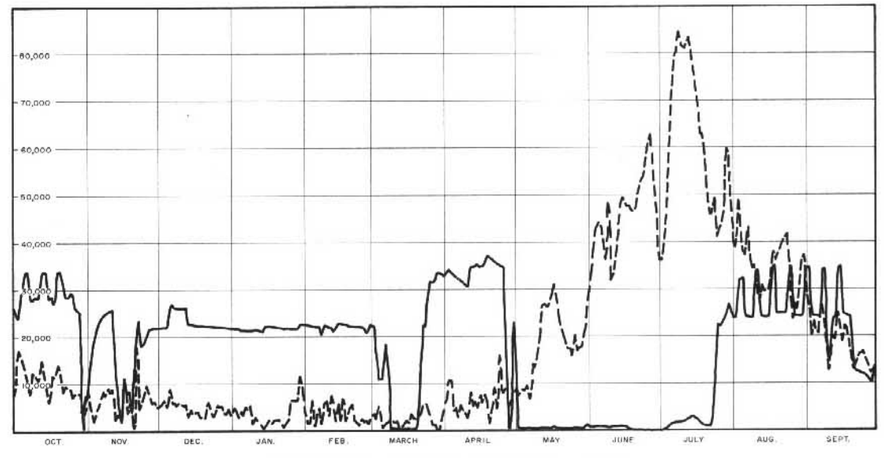
KOOTENAI RIVER AT LIBBY DAM



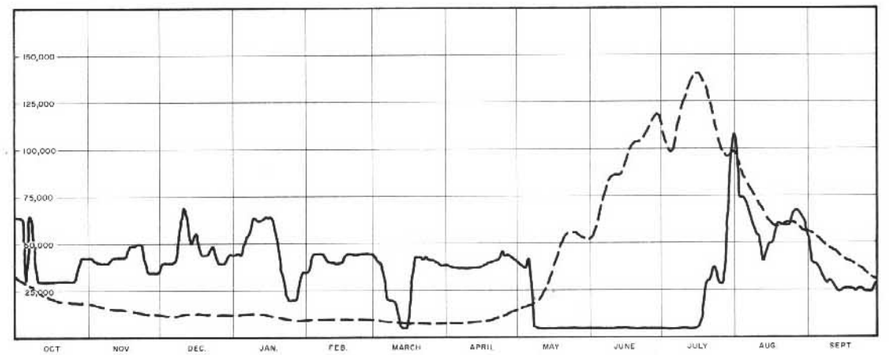
DUNCAN RIVER AT DUNCAN DAM



COLUMBIA RIVER AT BIRCHBANK



COLUMBIA RIVER AT MICA DAM



COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM

LEGEND

Observed Flows

Pre - Project Flows

HYDROGRAPHS – Observed and pre-project flows for year ending 30 September 1975.

full at Vancouver but three feet below major flood stage. The Duncan, Arrow, Mica and Libby projects contributed about 40 percent of the total effective storage in the Columbia River system during the peak runoff month of June 1975. The regulation by the Treaty storage projects during the 1975 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.

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 for a 30-year period. No additional downstream power benefits were realized during the year from the operation of Treaty dams 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, are retained wholly within Canada and the benefits from Libby in the United States are not shareable under 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 the Entities, and the flood control operating plan for Treaty reservoirs.

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 regulation by the Treaty storage projects during the 1975 freshet period contributed only minor flood control benefits in Canada and the United States because of low runoff conditions.

4. Finally, the Board concludes that the objectives of the Treaty are being met.

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

United States	Canada
Members	
Mr. Homer B. Willis, Chairman Chief, Engineering Division, Civil Works Directorate, Office, Chief of Engineers, U.S. Army, Washington, D.C.	Mr. G. M. MacNabb, Chairman Deputy Minister, Department of Energy, Mines and Resources, Ottawa, Ontario
Mr. C. King Mallory Deputy Assistant Secretary for Energy and Minerals, U.S. Department of the Interior, Washington, D.C.	Mr. B.E. Marr Deputy Minister of Water Resources, Department of Lands, Forests and Water Resources, Victoria, B.C.
Alternates	
Mr. Alex Shwaiko [1)] Acting Chief, Planning Division, Civil Works Directorate, Office, Chief of Engineers, U.S. Army, Washington, D.C.	Mr. E.M. Clark Regional Director, Pacific and Yukon Region, Inland Waters Directorate, Department of the Environment, Vancouver, B.C.
Mr. J. Emerson Harper Assistant and Power Engineering Advisor, Office of the Assistant Secretary for Energy and Minerals, Department of the Interior, Washington, D.C.	Mr. H.M. Hunt Chief, Power and Special Projects Division, Water Resources Service, Department of Lands, Forests and Water Resources, Victoria, B.C.
Secretaries	
Mr. Walter W. Duncan Assistant Chief, Hydrologic Engineering Branch, Civil Works Directorate, Office, Chief of Engineers, U.S. Army, Washington, D.C.	Mr. E.M. Clark Regional Director, Pacific and Yukon Region, Inland Waters Directorate, Department of the Environment, Vancouver, B.C.

1) Vice Mr. Fred L. Thrall as of November 1974.

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

United States

Mr. Donald P. Hodel, Chairman

Administrator, Bonneville
Power Administration,
Department of the Interior,
Portland, Oregon

Major General Wesley E. Peel [2]

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

Canada

Mr. J.W. Wilson, Chairman [1]

Director,
B.C. Hydro and Power
Authority,
Vancouver, B.C.

1) Vice Mr. W.D. Kennedy as of 1 August 1975.

2) Vice Major General Richard E. McConnell as of July 1975.

APPENDIX C

RECORD OF FLOWS

AT THE

INTERNATIONAL BOUNDARY

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	77,700	69,500	56,000	61,700	65,600	74,800	50,500	61,700	63,600	54,000	113,000	55,300
2	87,600	69,800	59,900	63,600	69,300	72,400	49,500	61,100	67,400	52,500	95,300	49,600
3	86,500	68,600	60,100	67,200	76,900	69,300	50,500	61,200	70,600	52,100	95,100	51,000
4	90,700	67,100	60,300	67,000	80,500	68,500	47,700	61,300	72,300	53,900	95,100	52,700
5	49,900	67,200	62,900	70,900	80,800	63,500	48,300	58,900	74,100	55,500	90,700	51,500
6	92,100	66,000	66,000	76,700	80,300	51,400	49,200	48,100	77,500	56,100	81,700	48,200
7	98,000	63,200	65,800	76,700	79,700	49,100	47,900	32,700	78,300	56,000	78,000	42,100
8	96,600	60,000	70,800	79,800	79,400	48,700	49,600	33,500	77,900	56,200	75,600	39,400
9	72,200	58,800	85,300	86,900	78,400	47,500	46,200	34,800	76,900	54,300	71,600	41,200
10	59,200	60,300	89,800	87,500	74,200	47,400	44,600	36,800	76,700	53,100	70,800	43,200
11	56,200	61,900	88,500	86,600	73,500	44,600	43,900	38,800	76,400	52,600	65,500	42,600
12	56,300	61,400	85,400	86,200	73,800	37,400	44,200	41,300	78,300	51,600	53,500	39,700
13	55,800	64,200	74,100	87,300	73,600	32,200	45,300	44,200	78,600	50,900	56,900	40,500
14	56,400	68,800	69,000	88,300	72,800	31,300	45,500	47,000	79,500	49,300	60,800	39,800
15	56,200	70,500	74,300	88,100	72,800	31,300	45,000	50,600	79,000	47,000	61,800	37,800
16	55,900	70,100	78,900	88,800	74,000	34,300	47,600	54,700	77,800	45,900	61,100	38,900
17	56,000	73,500	72,900	93,100	76,000	48,100	48,800	56,900	77,300	45,800	65,800	40,200
18	56,000	77,300	68,800	89,300	75,200	64,900	51,900	57,500	76,800	54,300	71,900	42,000
19	55,900	74,600	68,700	79,700	75,900	66,700	50,200	58,300	75,600	60,300	74,400	44,700
20	55,900	75,000	69,600	71,700	76,200	66,800	52,900	58,700	75,200	58,800	73,800	43,700
21	56,000	82,300	73,900	68,700	75,900	66,400	57,700	58,200	74,600	58,100	74,400	43,100
22	55,400	86,700	74,200	64,400	75,800	65,900	60,200	57,900	74,300	60,200	76,500	38,700
23	56,700	80,000	72,800	57,600	76,300	65,500	60,000	58,500	72,900	55,400	77,000	37,000
24	56,400	75,700	69,700	54,400	75,700	64,700	60,700	58,100	70,600	47,800	84,100	36,200
25	56,100	63,100	63,100	55,300	75,800	64,000	62,300	57,700	70,100	48,900	86,100	36,600
26	56,600	55,600	63,200	55,100	75,500	62,200	62,400	56,600	70,300	47,000	85,100	40,700
27	61,300	54,600	64,500	54,800	75,300	60,800	63,700	56,000	67,900	51,200	84,900	42,000
28	69,700	54,700	65,100	58,600	75,100	59,400	63,800	55,300	65,200	68,900	78,300	41,500
29	69,300	54,900	64,200	65,300		57,100	63,000	56,100	62,700	97,700	81,800	45,300
30	69,700	54,500	64,400	66,100		54,600	62,700	57,900	57,800	120,000	83,500	48,500
31	68,600		62,000	65,700		52,500		60,100		128,000	74,600	
Mean	66,000	67,000	69,800	73,000	75,500	55,600	52,500	52,600	73,200	59,500	77,400	43,100

COLUMBIA RIVER AT BIRCHBANK, B.C. – Daily discharges for the year ending 30 September 1975 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	17,900	25,000	11,800	11,500	26,900	17,200	7,000	18,400	34,800	10,000	4,020	6,150
2	11,900	25,000	11,700	11,400	27,900	17,500	6,750	18,600	36,300	10,700	3,930	5,840
3	20,700	25,100	11,700	11,300	27,700	18,000	6,830	19,000	38,900	11,600	3,810	5,740
4	25,800	25,100	13,900	11,300	27,900	18,400	7,000	20,800	37,000	11,900	3,680	5,570
5	27,600	18,100	14,300	11,100	28,000	18,800	5,930	20,800	36,300	11,400	3,620	5,260
6	27,600	16,900	14,300	11,200	27,900	18,800	4,560	21,400	35,500	10,800	3,570	5,170
7	27,500	16,800	14,300	11,300	26,500	18,800	4,440	22,500	33,700	10,600	3,620	5,140
8	27,500	16,900	14,200	12,800	25,800	18,700	4,350	24,200	29,700	9,880	3,670	5,220
9	25,100	16,700	14,200	12,800	25,800	18,500	4,290	26,700	26,800	9,630	3,650	5,210
10	24,900	16,500	14,300	13,000	25,700	18,600	4,160	30,000	24,900	9,160	3,690	9,740
11	24,800	16,300	14,400	12,900	25,600	18,600	4,160	33,500	25,200	8,440	3,540	15,900
12	24,800	21,100	14,300	12,800	26,400	18,600	4,360	35,600	26,200	8,800	3,560	17,100
13	24,800	24,600	14,300	12,700	26,800	18,800	4,700	36,500	27,300	8,500	3,750	11,800
14	25,000	24,200	15,900	15,500	26,900	16,700	5,240	33,700	25,000	7,700	3,370	10,600
15	24,900	24,500	16,500	15,900	25,400	12,200	6,150	36,300	22,900	8,000	3,630	10,500
16	25,000	24,700	16,600	16,000	23,900	11,300	7,310	39,800	21,900	7,480	3,340	10,300
17	25,000	23,600	16,600	16,000	23,700	11,300	8,320	39,300	20,300	7,070	3,460	8,510
18	24,900	23,200	16,600	16,000	23,200	11,500	9,390	37,200	18,700	6,820	3,540	8,340
19	25,100	23,500	16,600	16,100	19,500	11,800	10,400	37,900	18,200	6,580	5,030	8,410
20	25,000	25,100	16,700	16,100	18,100	11,800	11,700	32,800	17,700	6,370	4,500	8,310
21	25,000	28,000	17,100	19,600	20,500	11,800	12,500	28,800	18,000	6,200	4,150	8,170
22	24,900	30,700	17,800	20,000	20,600	10,400	12,600	26,900	16,800	6,100	4,010	7,980
23	25,000	22,900	17,600	19,800	20,700	9,450	12,400	26,900	15,700	5,350	4,730	7,880
24	24,900	19,600	17,200	19,800	20,800	9,260	12,700	27,200	16,700	4,490	5,280	7,820
25	24,900	18,500	17,200	19,700	20,000	9,040	13,100	24,500	16,200	4,410	5,380	7,900
26	24,500	18,100	17,000	18,900	19,400	7,990	14,700	22,000	14,400	4,310	5,580	8,120
27	25,100	13,300	13,600	19,500	19,600	7,200	16,400	21,000	13,400	4,190	5,500	8,200
28	24,900	12,000	11,800	23,600	18,200	7,000	17,500	21,700	12,400	3,890	4,770	9,900
29	24,400	11,800	11,400	23,900		6,890	17,600	24,300	11,500	3,880	4,960	10,100
30	24,900	11,800	11,300	23,800		7,080	18,000	28,600	10,500	4,070	5,350	10,100
31	25,100		11,300	24,600		7,020		32,700		4,020	6,120	
Mean	24,500	20,700	14,700	16,200	23,900	13,500	9,150	28,100	23,400	7,500	4,220	8,500

KOOTENAI RIVER AT PORTHILL, IDAHO – Daily discharges for the year ending 30 September 1975 in cubic feet per second.

APPENDIX D

PROJECT INFORMATION

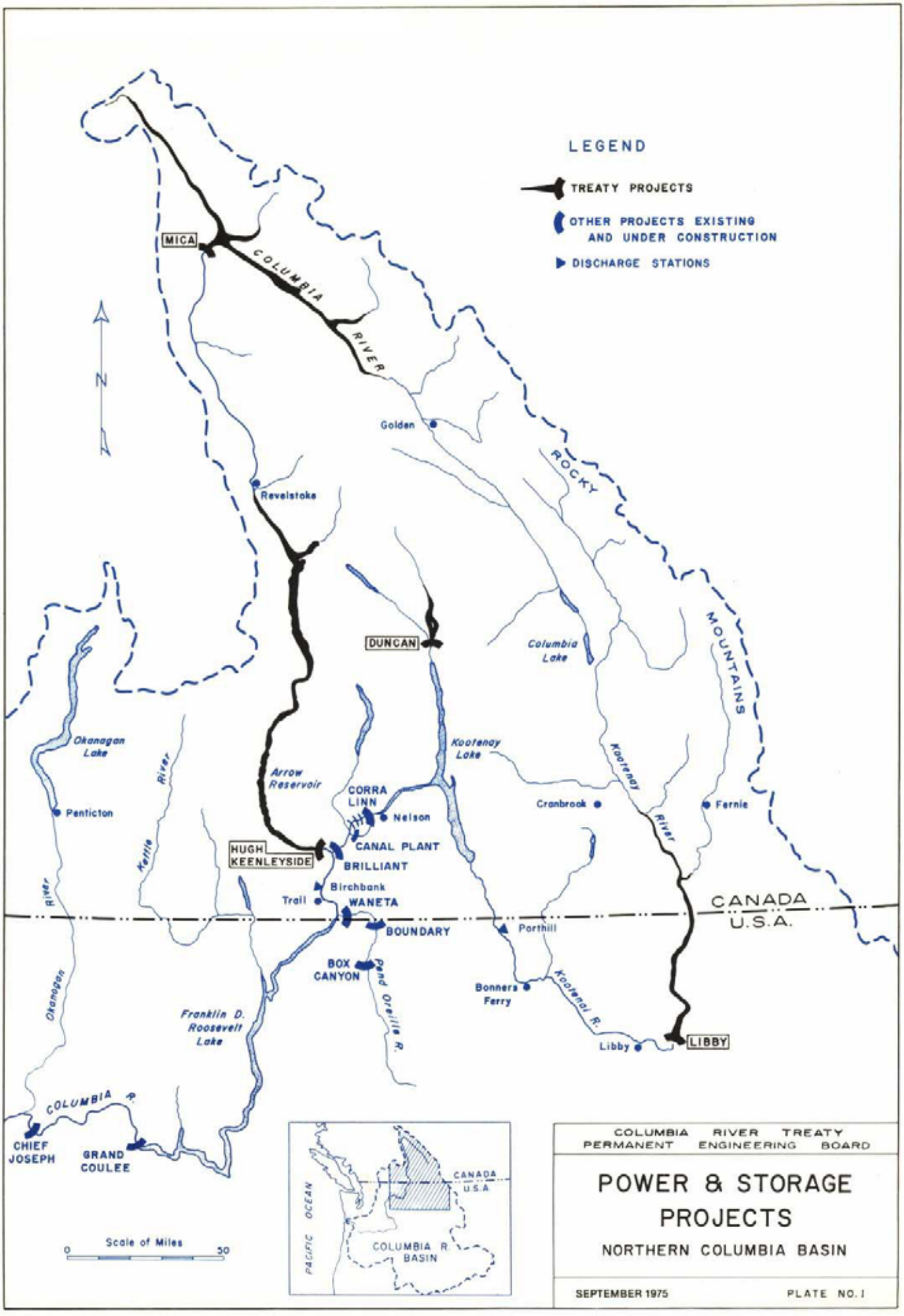

LEGEND
TREATY PROJECTS
OTHER PROJECTS EXISTING AND UNDER CONSTRUCTION
DISCHARGE STATIONS
MICA
COLUMBIA RIVER
N
Golden
Revelstoke
ROCKY MOUNTAINS
DUNCAN
Columbia Lake
Okanagan Lake
Arrow Reservoir
Kootenay Lake
Kootenay River
CORRA LINN
Nelson
Cranbrook
Fernie
Penticton
Kettle River
HUGH KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
Trail
WANETA
CANADA
U.S.A.
BOUNDARY
Porthill
Okanogan River
BOX CANYON
Pend Oreille R.
Bonners Ferry
Kootenai R.
Franklin D. Roosevelt Lake
Libby
LIBBY
COLUMBIA R.
CHIEF JOSEPH
GRAND COULEE
Scale of Miles
0
30
PACIFIC OCEAN
CANADA
U.S.A.
COLUMBIA R. BASIN
COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
POWER & STORAGE PROJECTS
NORTHERN COLUMBIA BASIN
SEPTEMBER 1975
PLATE NO. I

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	18,432 acres
Total Storage Capacity	1,432,500 ac-ft
Usable Storage Capacity	1,400,000 ac-ft
Treaty Storage Commitment	1,400,000 ac-ft
Dam, Earthfill	
Crest Elevation	1,907 feet
Length	2,600 feet
Approximate height above riverbed	130 feet
Spillway – Maximum Capacity	47,700 cfs
Discharge Tunnels – Maximum Capacity	20,000 cfs
Power Facilities	
None	

TABLE 2

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	128,000 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	
Relocations carried out:	
Canadian Pacific Railway	3.5 miles
Highways 6 and 23	110 miles

TABLE 3

MICA PROJECT

Mica Dam and McNaughton 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	105,600 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 435 mw	2,610 mw
First power planned for	1976
Present undertaking	
4 units at 435 mw	1,740 mw
Head at full pool	600 feet
Maximum Turbine Discharge	
of 4 units at full pool	40,000 cfs
Relocations carried out:	
Big Bend Highway between Revelstoke and Mica Project	90 miles
Canadian Pacific Railway	7.7 miles

TABLE 4

LIBBY PROJECT

Libby Dam and Lake Koocanusa

Storage Project	
Construction began	1966
Storage became fully operational	17 April 1973
Reservoir	
Normal Full Pool Elevation	2,459 feet
Normal Minimum Pool Elevation	2,287 feet
Surface Area at Full Pool	46,500 acres
Total Storage Capacity	5,809,000 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
Present undertaking	
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
Relocations carried out:	
Burlington Northern Railroad	59 miles
Montana State Highway 37	52 miles
Forest Development Road	50 miles
Forest Development Road Connections	16 miles
British Columbia Highways	29 miles
Canadian Pacific Railway	15 miles