ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES
and
CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
Washington, D. C. Ottawa, Ontario
30. SEPTEMBER 1974

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD
CANADA · UNITED STATES

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

UNITED STATES SECTION
H.B. WILLIS, Chairman
C.K. MALLORY, Member

31 December 1974

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

The Honourable D.S. Macdonald
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 tenth Annual Report, dated 30 September 1974, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1973 to 30 September 1974.

Respectfully submitted:

For the United States

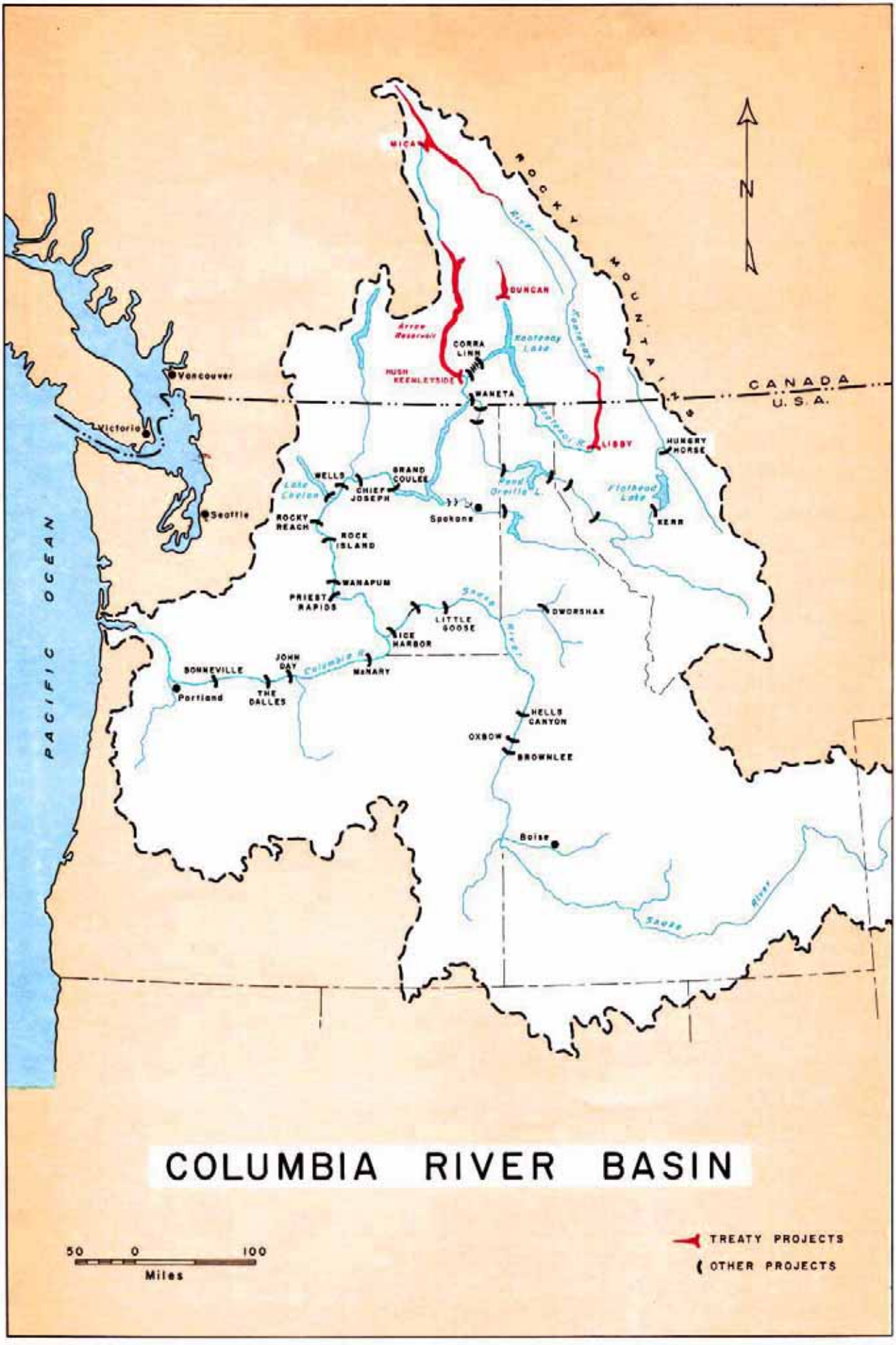
Homer B. Willis, Chairman

C. King Mallory

For Canada

G.M. MacNabb, Chairman

B.E. Marr



COLUMBIA RIVER BASIN

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to the
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PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa, Canada

30 September 1974

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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 tenth 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 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 reduced peak freshet flows and averted major flood damage in both Canada and the United States.

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 1973 to 30 September 1974, 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.

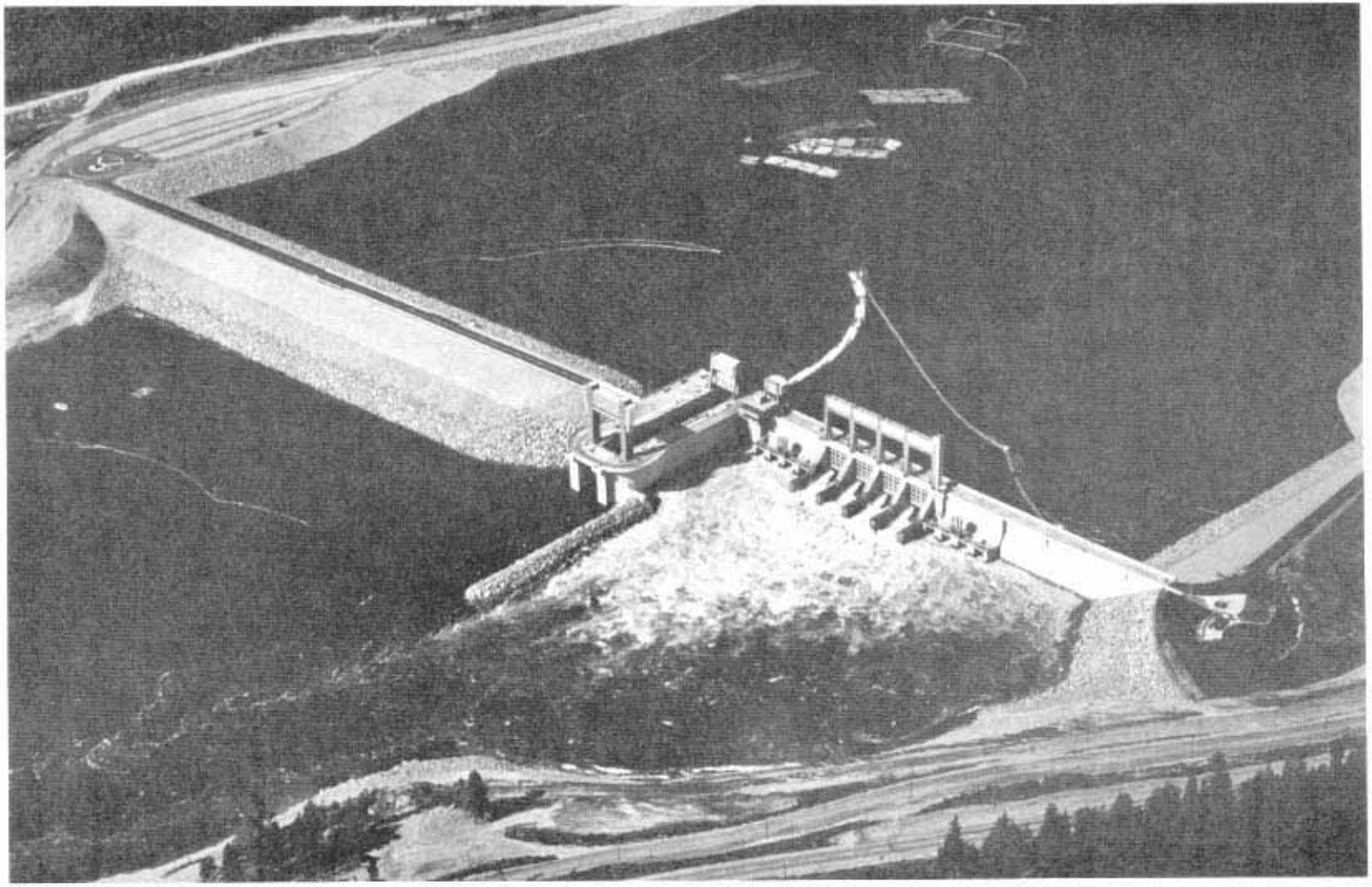
THE COLUMBIA RIVER TREATY

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 — Columbia River, British Columbia

Low level ports and sluiceways discharging during a freshet.

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.

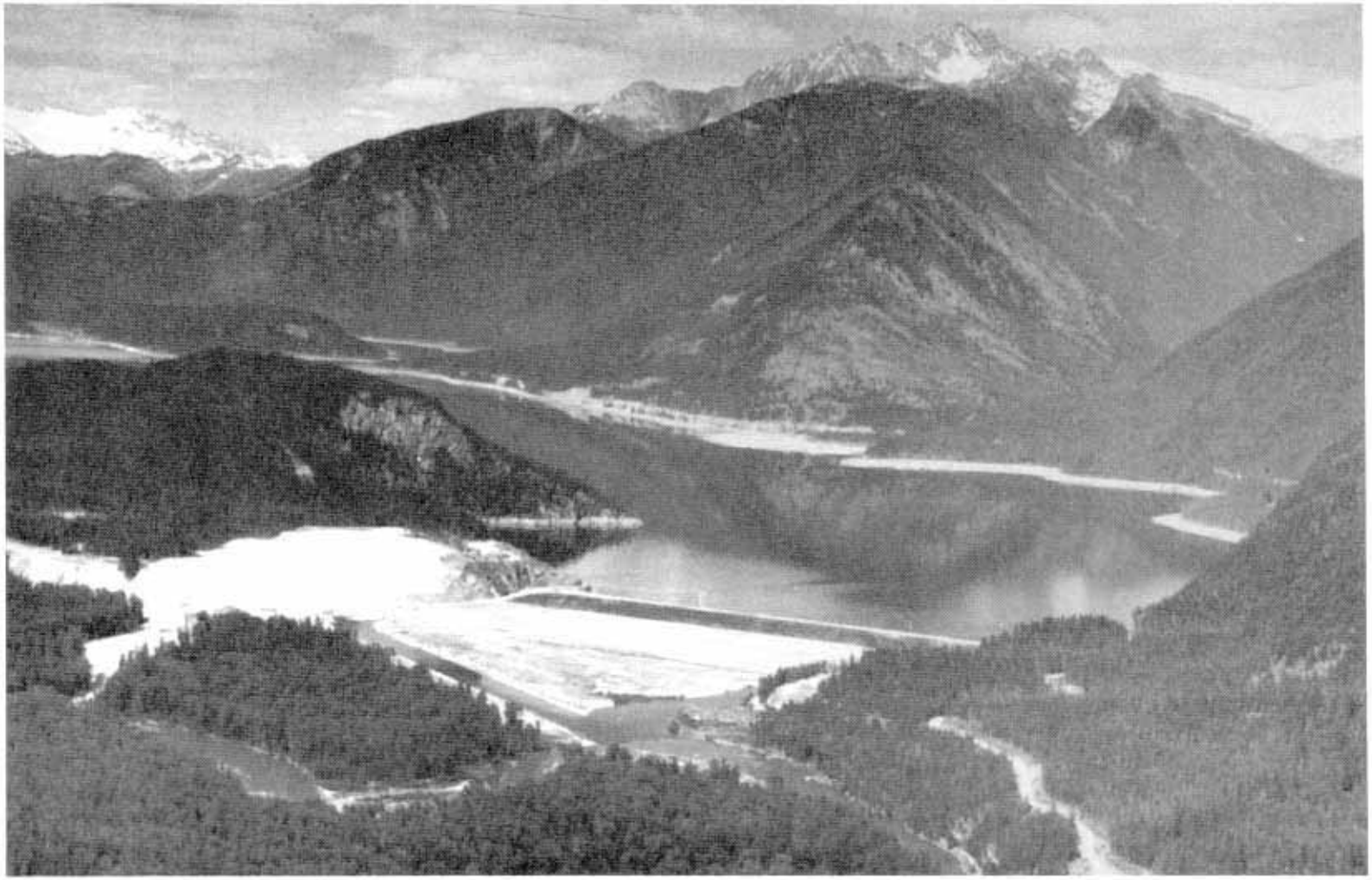
(f) Both Canada and the United States have the right to make diversions of water for consumptive uses and, in addition, after September 1984 Canada has the option of making for power purposes specific diversions of the Kootenay River into the headwaters of the Columbia River.

(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 project and the 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. B.E. Marr has replaced Mr. V. Raudsepp as a member of the Canadian Section of the Board.

DISCHARGE WORKS at Mica: low level and permanent works operating. August 1974.

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;

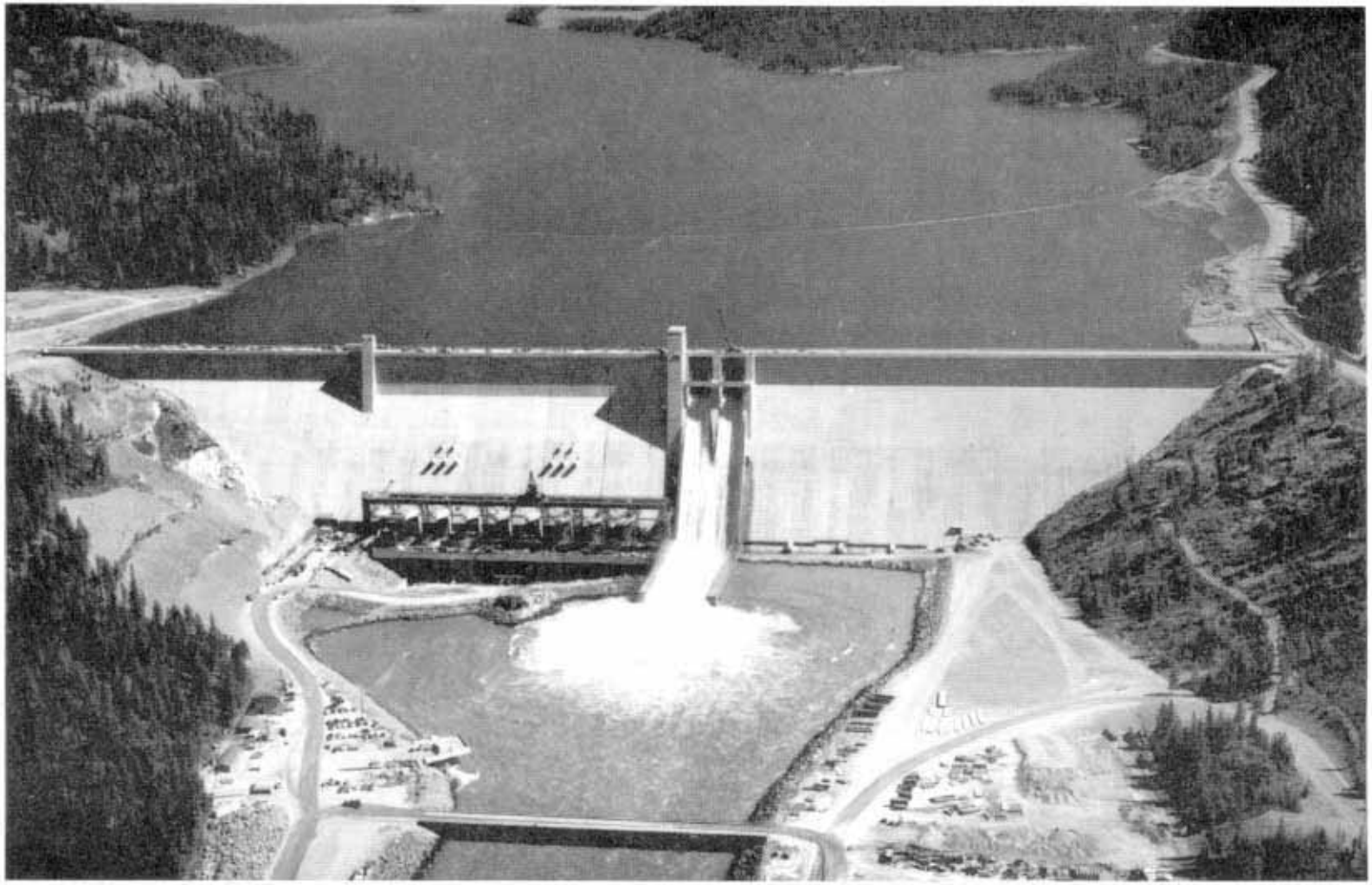
(c) assisting in reconciling differences concerning technical or operational matters that may arise between the entities;

(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

Completed and Lake Koocanusa full.

Kootenai River, Montana

September 1974.

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.

MICA PENSTOCKS,
liners being assembled
at site.
June 1974.

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,

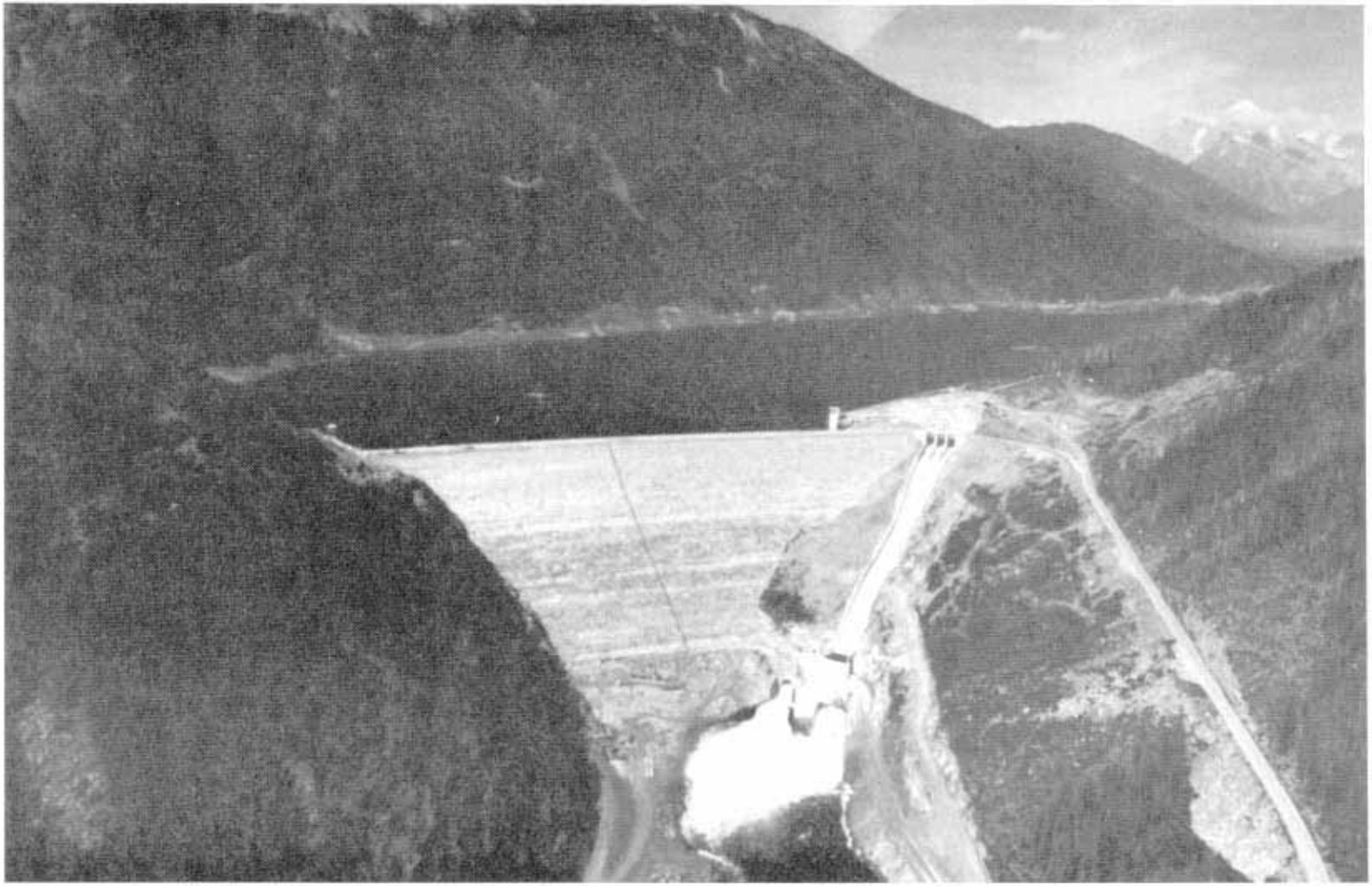
(h) preparation of the hydroelectric operating plans and the flood control operating plans for the Canadian storage together with determination of the downstream power benefits to which Canada is entitled,

(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

The dam with McNaughton Lake at its highest level this year.

Columbia River, British Columbia

August 1974.

ACTIVITIES OF THE BOARD

Meetings

The first meeting of the Board during the report year was held in Washington, D. C. on 15 October 1973 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 Ottawa, Ontario on 29 May 1974.

As construction of Treaty projects is complete the Board has decided not to continue inspecting the projects on an annual basis. The projects were not visited during this report year.

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 calculation, new storage elevation tables for the Arrow Lakes, and the following documents and reports:

- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1972 to 30 September 1973

- Report on Operation of Columbia River Treaty Projects 1 August 1972 through July 1973

- Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1978-79, plus a copy of the Entities' agreement on this document

- Detailed Operating Plan for Columbia River Treaty Storage 1 July 1973 through 31 July 1974, plus a copy of the Entities' agreement on this document

- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1978-79, plus a copy of the Entities' agreement on this document

- Amendment to Detailed Operating Plan for Columbia River Treaty Storage 1 July 1973 through 31 July 1974, an Entity agreement

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

- Semi-Annual Progress Report of the Canadian and United States Entities to the Permanent Engineering Board for the period 1 April 1973 to 30 September 1973

- Columbia Construction Progress, Mica Storage Project, Review of Construction

- Construction Progress, Final Report, October 1973 - Libby Dam and Lake Koocanusa Project.

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 July 1974 through 31 July 1975, plus a copy of the Entities' agreement on this document

- Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1979-80, 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

- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1973 to 30 September 1974.

Report to Governments

The ninth Annual Report of the Board was submitted to the two governments on 31 December 1973.

NAVIGATION LOCK
at Hugh Keenleyside Dam.

PROGRESS

General

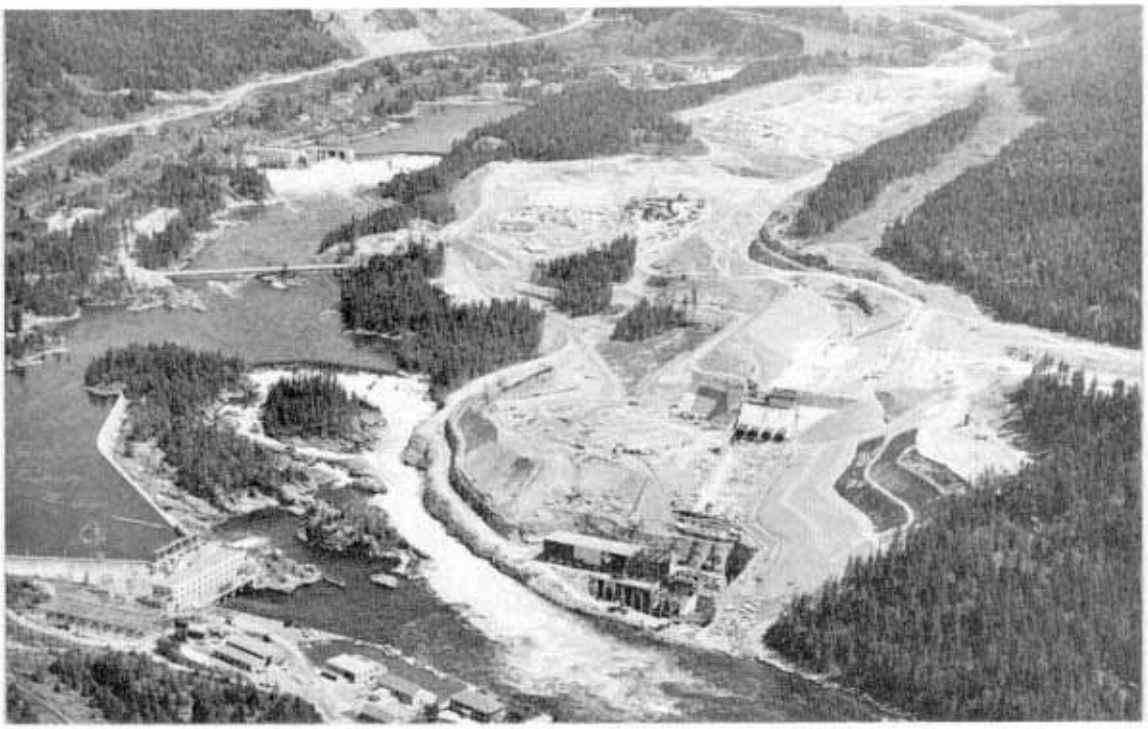
The results achieved under the terms of the Treaty include construction of the Treaty projects, progress in developing the hydrometeorological network, power and flood control operating plans, and the annual calculation of downstream power benefits. The three Treaty storage projects in British Columbia, 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.



KOOTENAY CANAL PLANT headworks and powerhouse under construction at South Slocan in British Columbia. May 1974.

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.

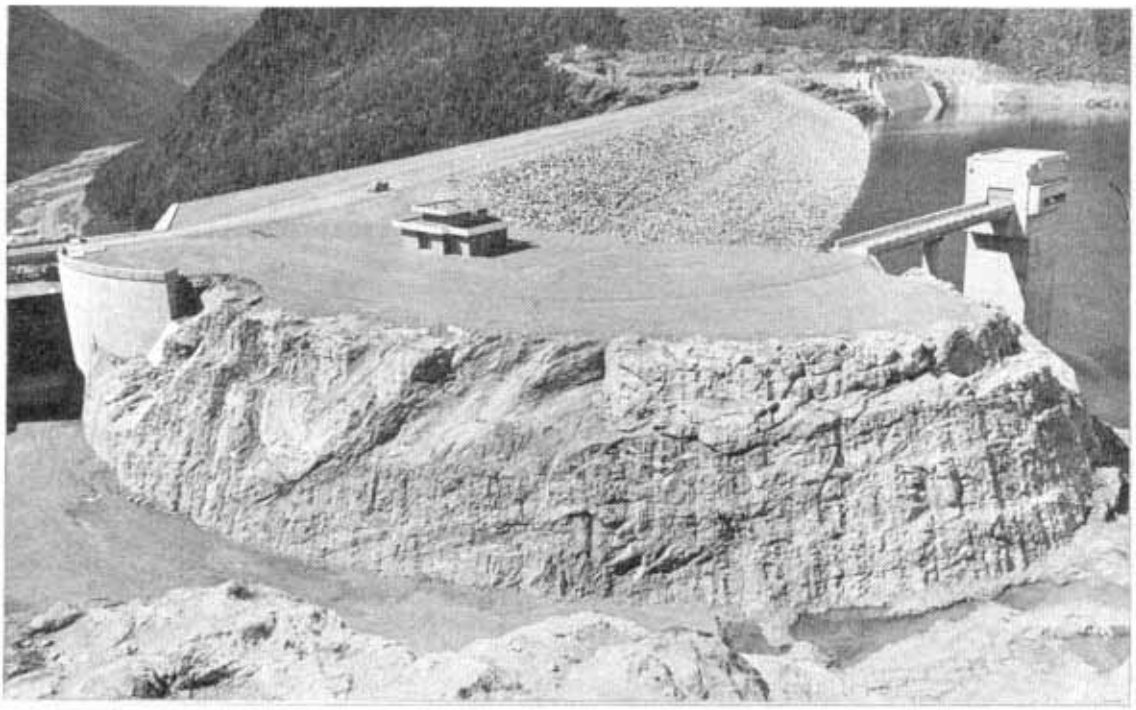
The project is shown in the picture on page 3 and project data are shown in Table 2 of Appendix D.

VISITORS' FACILITY at Libby Dam after landscape restoration.

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



MICA DAM and intake works completed. July 1974.

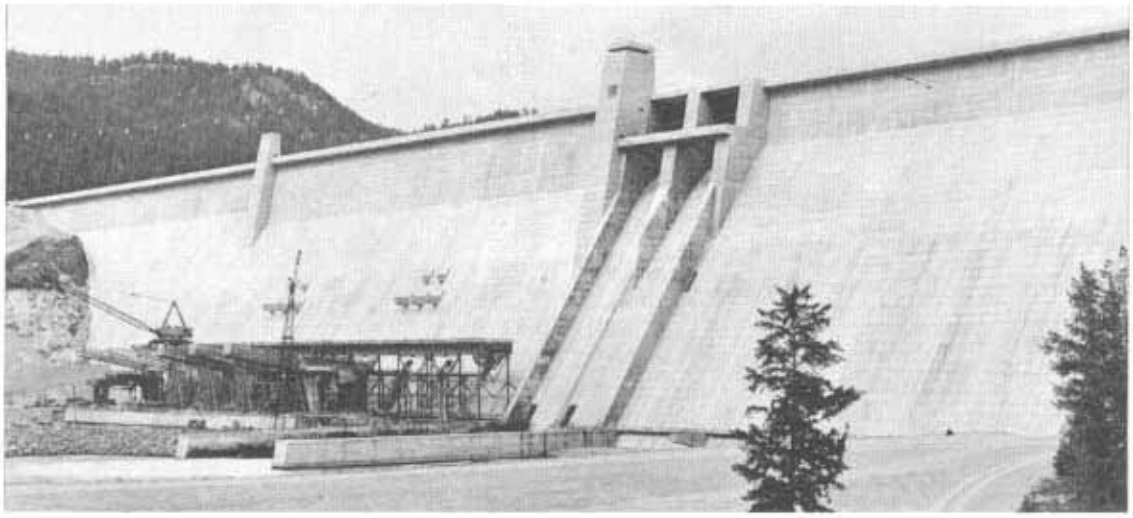
and creates a reservoir 135 miles long with a storage capacity of 20,000,000 acre-feet. The project will utilize 12,000,000 acre-feet of live storage of which 7,000,000 acre-feet are committed under the Treaty. Several years will be required to completely fill the reservoir which in 1974 reached a peak storage level of over 13,000,000 acre-feet.

Work is proceeding on construction of power generating facilities which will be located underground 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 14 and project data are shown in Table 3 of Appendix D.

Libby Project in the United States

Libby dam is located on the Kootenai River 17 miles northeast of the town of Libby, Montana. Construction began in the spring of 1966 and the project became fully operational, except for at-site power facilities, on 17 April 1973. The concrete gravity dam now 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 is usable for flood control and power purposes.



LIBBY DAM and powerhouse.

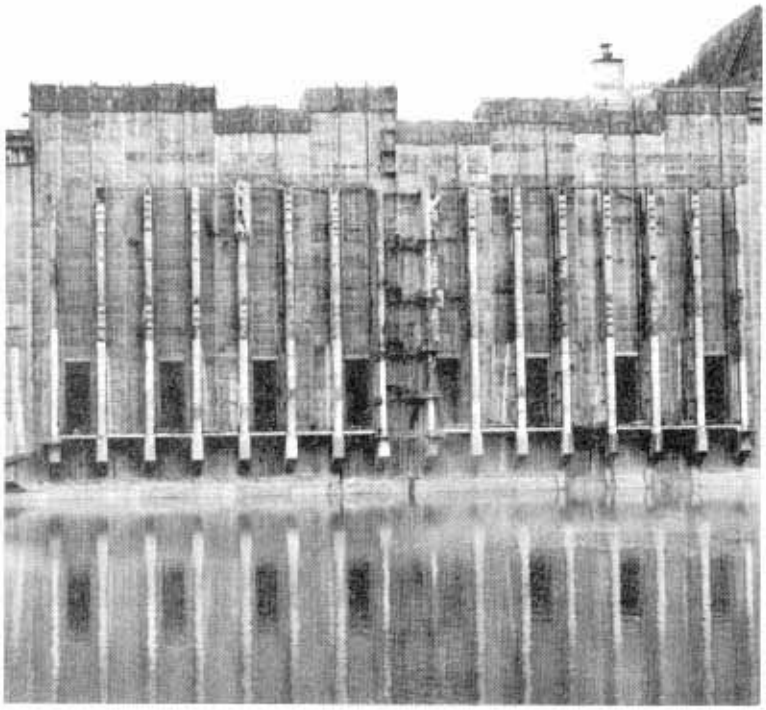
Construction on the dam is essentially complete. Work continues on the visitor facilities and historical exhibits which are scheduled for completion prior to the anticipated dedication in the summer of 1975. Work on the selective withdrawal structure is also scheduled to be completed in August 1975. This structure will allow the regulation of water quality by selecting the level in the reservoir from which the discharge water is drawn through the power units.

Powerhouse construction began in May 1974 with concrete placement continuing in the erection bay and the superstructure of units 1 through 4. It is presently estimated that the first 105,000 kw unit will be in service in July 1975 and the last of the four presently scheduled units in April 1976. Space is also being constructed for four additional units which will probably be required in 1983.

Relocation of the Burlington Northern Railroad track was completed in 1970. Construction of forest development roads was completed in September 1972. Work on the relocation of about 52 miles of Montana State Highway 37 along the east bank of Lake Koocanusa is on schedule for completion in June 1975.

The Libby project is shown in the picture on page 10 and project data are shown in Table 4 of Appendix D.

SELECTIVE WITHDRAWAL structure at Libby Dam. Construction commenced before initial filling.



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 on 8 July 1963, British Columbia undertook responsibility for these flowage costs in Canada.

KIKOMUN PARK
newly developed
at Lake Koocanusa
in British Columbia.
July 1974.

The property acquisition program is nearing completion with five settlements outstanding. Although the settlements may yet have to go to arbitration they do not constitute a legal problem insofar as reservoir operation is concerned. The British Columbia Forest Service has cleared all but ten acres of the total 9,240 acres of initially forested land and these will be cleared as soon as property acquisition has been concluded.

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 Provincial Department of Recreation and Conservation is proceeding with development of waterfront parks and recreational facilities at Kikomun Creek and Wardner. The Kikomun Park encompasses an area of 1,390 acres and has extensive day use amenities and a 60-unit campground. The campground and swimming facilities received heavy use in the summer of 1974.

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.

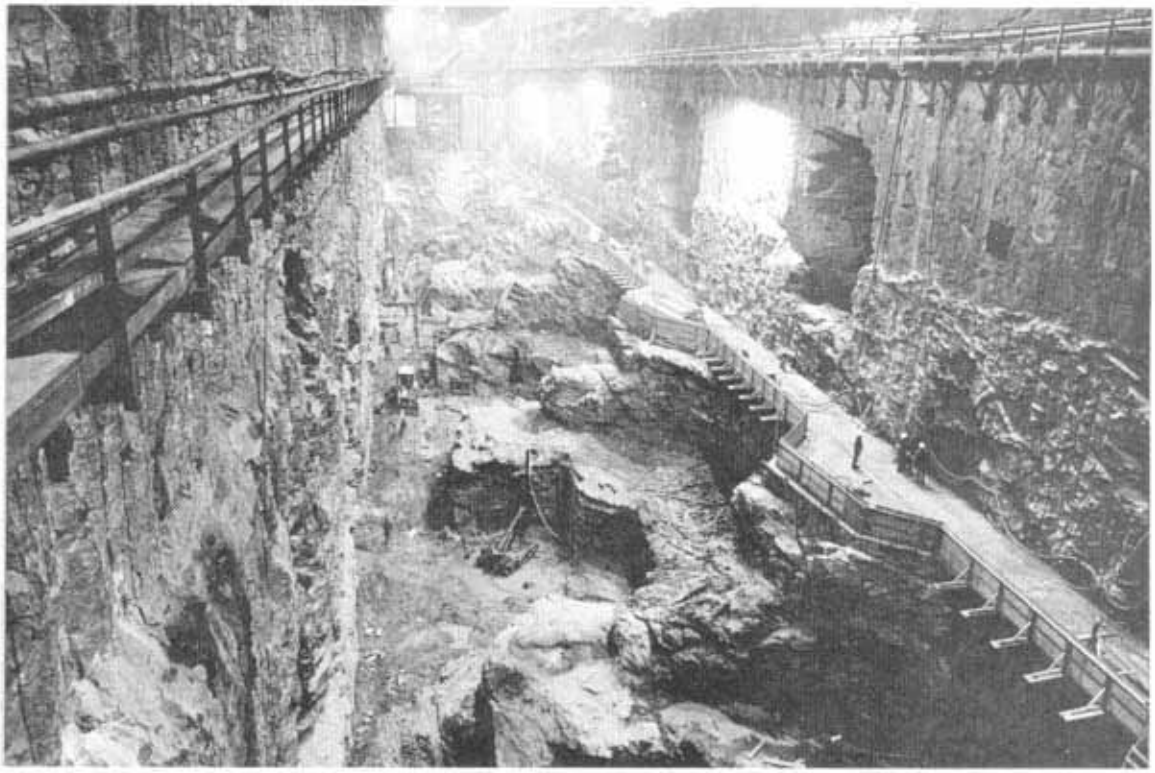
In developing the hydrometeorological network the Entities, with the concurrence of the Board, adopted a document which defines the Columbia River Treaty Hydrometeorological System Network and sets forth a method of classifying facilities into those required as part of the Treaty System and those of 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, revised the plan for exchange of operational hydrometeorological data. The Entities also revised the storage elevation tables for the Arrow Lakes. Copies were provided to the Board. A new storage elevation table for McNaughton Lake behind Mica dam has been developed and is being used in the current operating year. This new table is included in the Detailed Operating Plan for the period 1 July 1974 through 31 July 1975.

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.

The operating plan for operating year 1978-79, received by the Board early in the report year, is the third to include generation at the Mica project. This operating plan is based on the operation of the system for optimum generation in



MICA POWERHOUSE underground machine hall being excavated in the rock of the west abutment. July 1974.

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 1979-80 was provided to the Board after the end of the report year.

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 1974. A detailed operating plan for the operating year ending 31 July 1975 was forwarded to the Board after the end of this report year.

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 1978-79. 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 1979-80 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" which replaced the interim plan and which provides for flood control operation of the Duncan, Arrow, Mica and Libby reservoirs was received from the Entities early in the preceding report year.

MICA DAM
and McNaughton Lake
starting to fill.
June 1973.

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

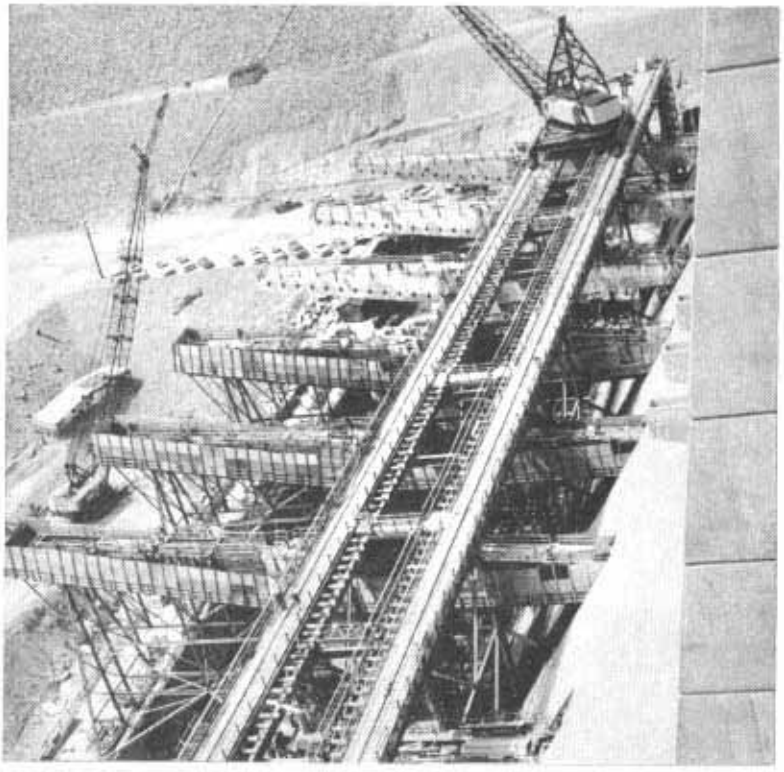
General

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 1973 through 31 July 1974", the "Amendment to Detailed Operating Plan for Columbia River Treaty Storage, 1 July 1973 through 31 July 1974", the "Detailed Operating Plan for Columbia River Treaty Storage 1 July 1974 through 31 July 1975", and the "Hydroelectric Operating Plans for Canadian Storage during the Operating Years 1969-70 through 1974-75".

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. The small freshet in 1973 followed by low inflows resulted in all these reservoirs being drafted to well below normal levels by the beginning of October 1973. As a result only limited storage was available to supplement natural streamflow for power purposes during October and the first part of November.



LIBBY POWERHOUSE construction seen from top of dam. May 1974.

In November precipitation increased thereby offsetting previous low inflow conditions. High flows throughout the remainder of the winter and the very large freshet in 1974 assured ample water supply for power operation. The Duncan, Arrow, and Libby reservoirs filled in 1974 and at Mica a considerable amount of dead storage[1] was accumulated in addition to meeting the Treaty requirements for providing live storage.[2] Drafting of Treaty storage began in September 1974.

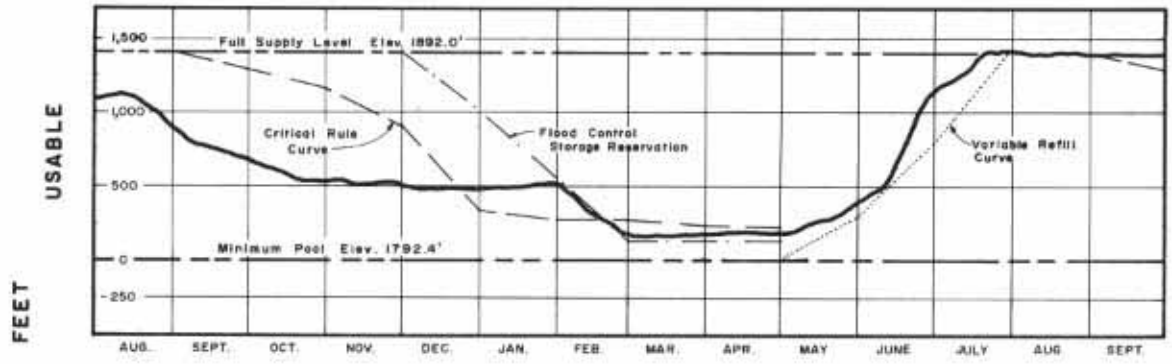
1) Dead storage is water stored in the lower part of a reservoir and not available for use in operating the reservoir.

2) Live storage is water stored in the upper part of a reservoir above the dead storage and is available for use in operating the reservoir.

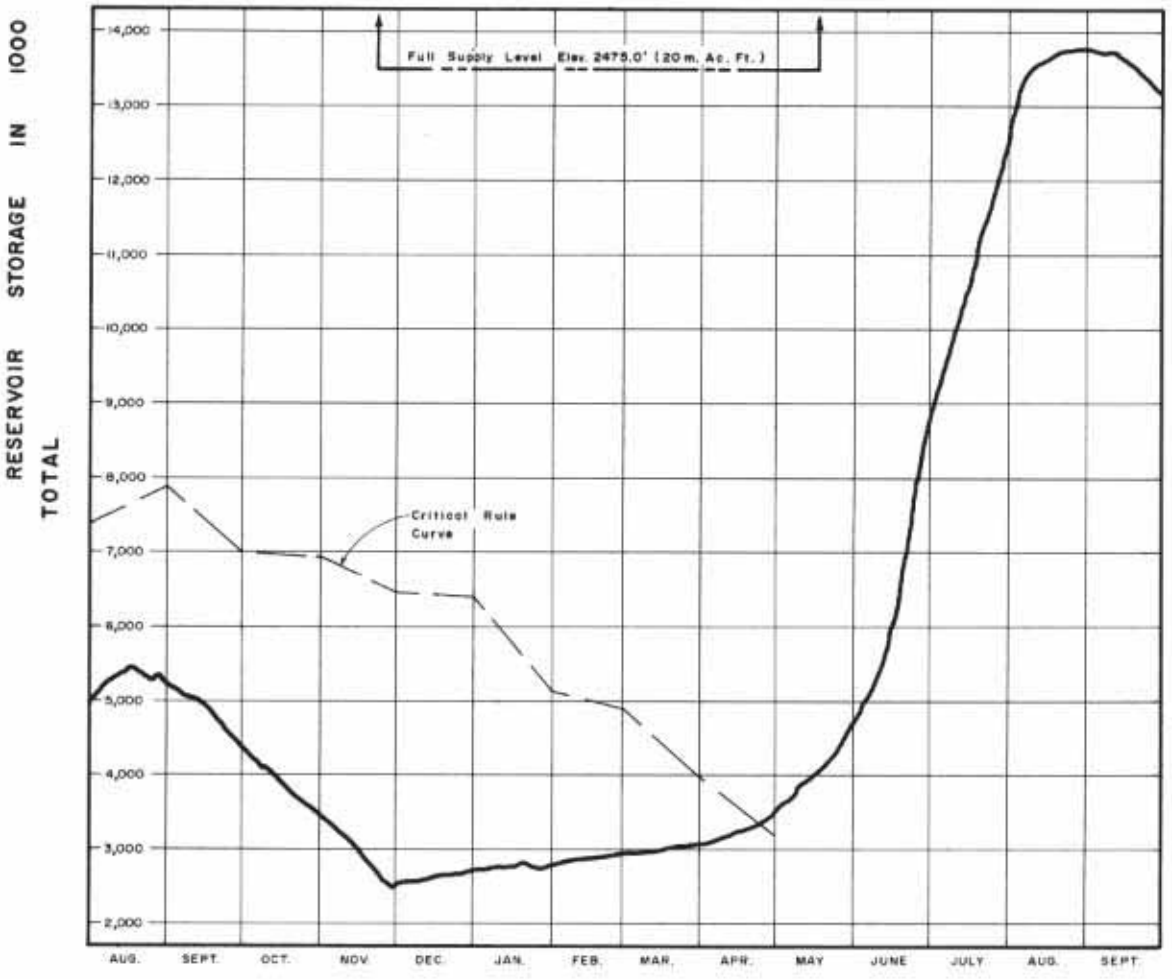
In order to assure an adequate water supply for power generation at Kootenay River plants in Canada an agreement was reached to restrict discharges from the Duncan and Libby reservoirs during the early part of this report year. This restriction resulted in a loss of head at Grand Coulee and energy was supplied by West Kootenay Power and Light Company Limited to the United States Co-ordinated System as compensation. The agreement was terminated on 30 October 1973. This agreement was the first to be made in accordance with Article XII(5) of the Treaty which provides for variation of storage operation at Libby in response to Canadian requests.

The Grand Coulee reservoir was lowered below its normal minimum pool elevation to allow, during March and April, removal of the cofferdam protecting the construction of the Third Powerhouse. This operation was taken into account in preparing the reservoir rule curves for storage operations.

Operation of the reservoirs is illustrated on pages 36 and 37 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.

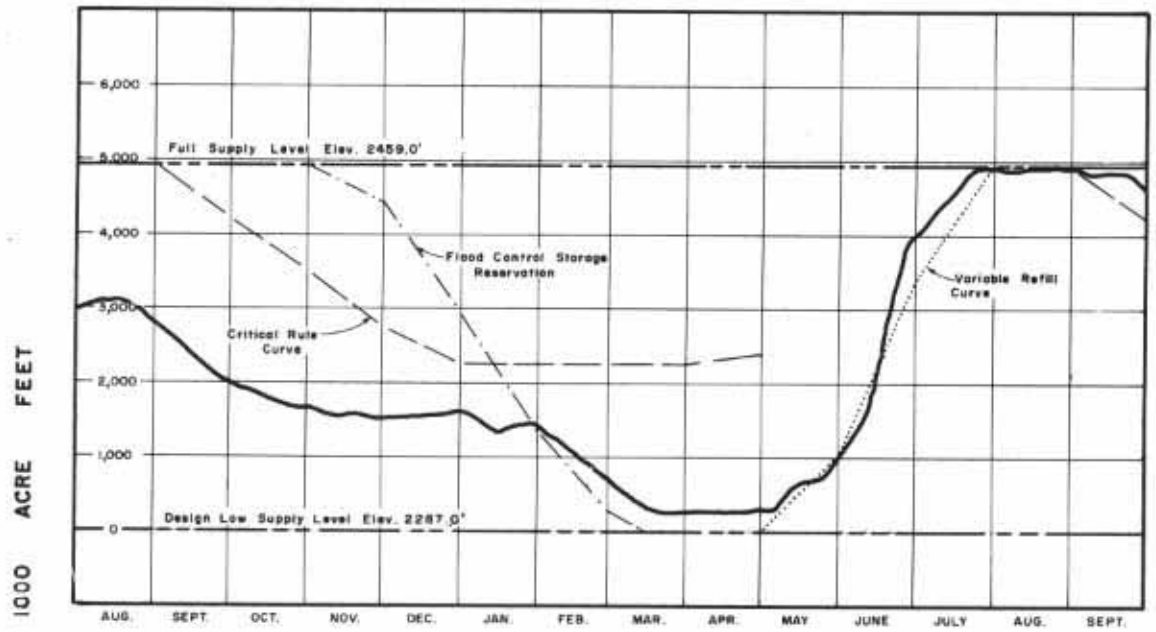


DUNCAN RESERVOIR

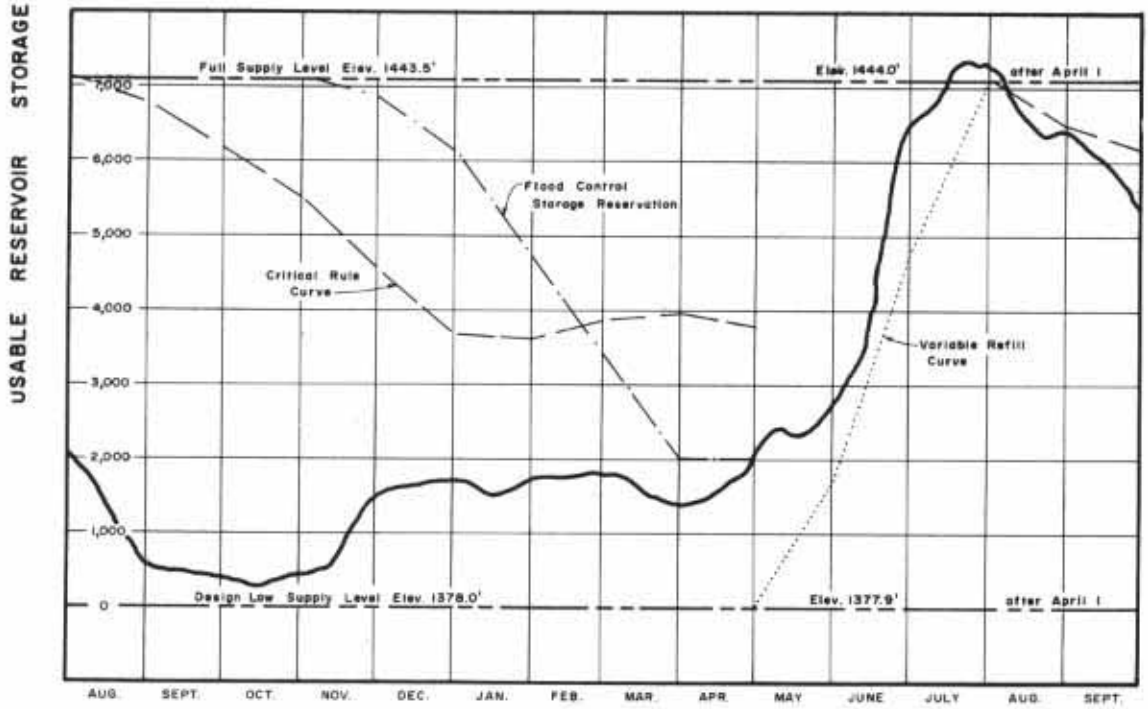


MICA RESERVOIR

HYDROGRAPHS - Duncan and Mica reservoir levels for the 14-month period ending 30 September 1974.



LIBBY RESERVOIR



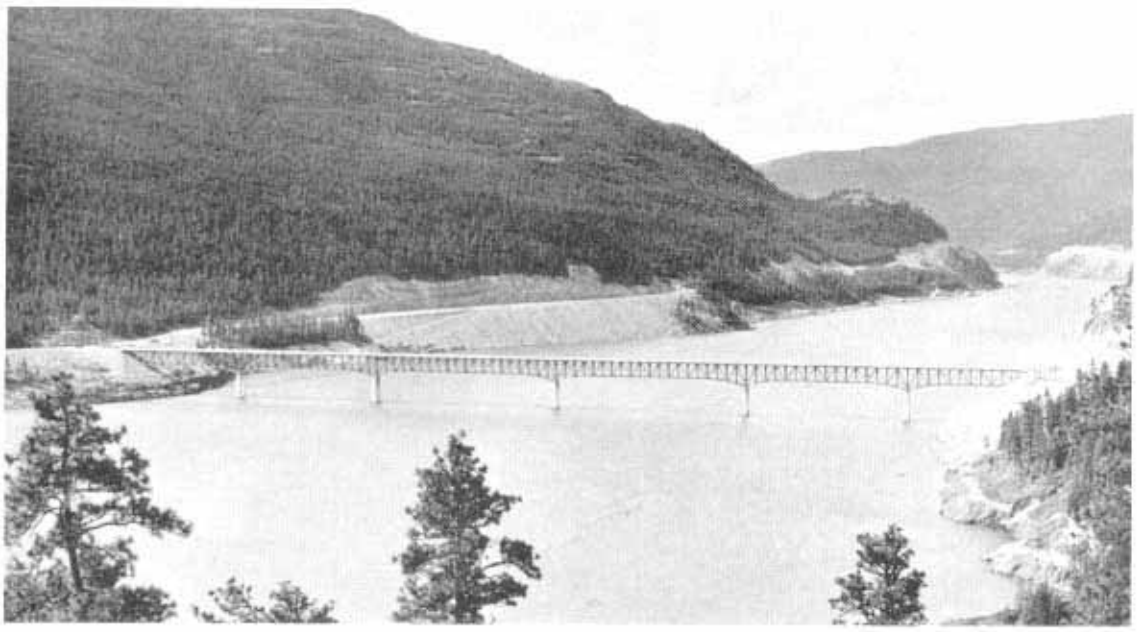
ARROW RESERVOIR

HYDROGRAPHS - Libby and Arrow reservoir levels for the 14-month period ending 30 September 1974.

At the beginning of the report year the Duncan reservoir had been drafted well below operating rule curve requirements. Drafting of storage was continued to help meet firm load demands until precipitation increased inflows early in November. Additional storage was evacuated in February to meet flood control requirements and the reservoir reached its minimum elevation of 1810.8 feet early in March. Reservoir discharges were reduced to 1,000 cfs and storing commenced on 3 May 1974. The reservoir reached full pool elevation of 1892 feet on 20 July 1974 and this elevation was maintained throughout the remainder of the report year.

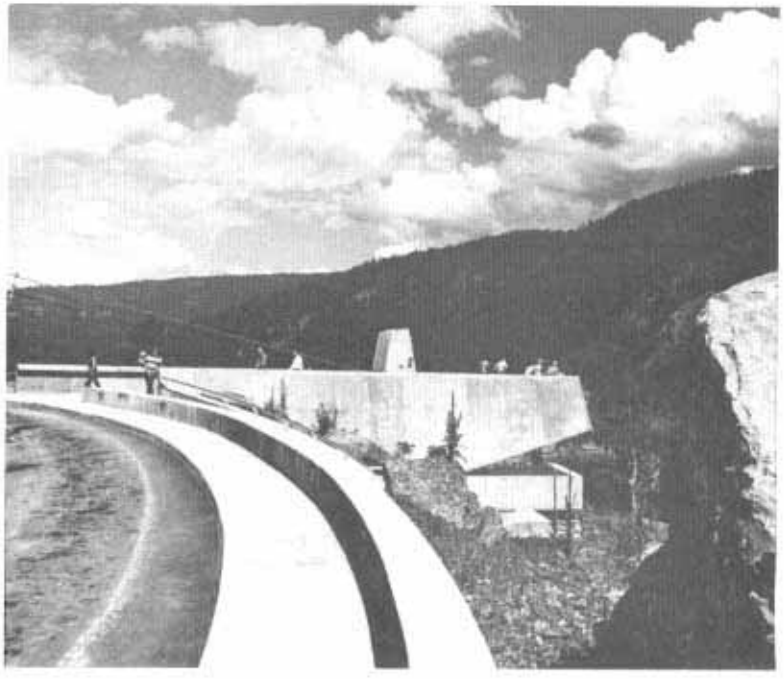
The Arrow reservoir at the beginning of the report year was at elevation 1380.7 feet and the reservoir remained at an elevation of approximately 1381 feet until early November. As a result of increased inflows throughout the system, maximum discharges from Mica, and only minimum release requirements from Arrow, the reservoir level increased by 15 feet during November. The reservoir was maintained between elevations 1395 and 1400 feet until late March when it was lowered to elevation 1394 feet. During February and March British Columbia Hydro and Power Authority supplied thermal energy in lieu of water releases from Treaty storage. In this way extra storage was retained in Arrow reservoir for subsequent release in order that an equivalent amount of storage could be retained in McNaughton Lake as dead storage. Filling the reservoir to an elevation two feet above normal full pool level was necessary to accommodate this extra storage. Reservoir storing commenced early in May and by 19 July the reservoir reached elevation 1446 feet, the agreed full pool elevation for 1974. At the end of the report year the Arrow reservoir was at elevation 1430 feet.

At the beginning of the report year McNaughton Lake, the reservoir created by the Mica dam, was at elevation 2242.2 feet, well below operating rule curve requirements. The reservoir discharged at a maximum rate until 30 November 1973 when it reached its minimum elevation of 2157.4 feet. Discharges were then reduced to a minimum and the reservoir stored continuously until the end of July. At this time discharges were increased to the maximum practical rate for the remainder of the year. The reservoir reached its highest elevation of 2409.1 feet on 25 August 1974 and contained 6,200,000 acre-feet of dead storage and over 7,000,000 acre-feet of live storage thereby meeting Treaty requirements. At the end of the report year the reservoir was at elevation 2402.4 feet.



LAKE KOOCANUSA BRIDGE in Montana and Forest Development Road on west bank.

Lake Koocanusa, the reservoir created by the Libby project, did not fill during the 1973 freshet and was at elevation 2382.0 feet at the beginning of this report year, well below its operating rule curve. The reservoir was operated to meet firm load requirements until precipitation increased in November and some water was stored. However, the January forecast for a heavy runoff in 1974 made it necessary to evacuate the reservoir to provide flood control space and drafting proceeded in a manner consistent with the 1938 International Joint Commission Order for operation of Kootenay Lake in Canada and with construction needs at Grand Coulee. The minimum elevation of 2305.3 feet was reached on 26 March. Storing began on 5 May and on 25 July 1974 Lake Koocanusa reached the normal full pool elevation of 2459 feet for the first time. This level was maintained until late in September when drafting for power purposes began.



LOOKOUT POINT overlooking Libby Dam.

Flood Control Operation

Operation for flood control during the 1974 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 in accordance with that plan. The final 300,000 acre-feet at Libby could not be evacuated because winter inflows were relatively high in the Kootenay River basin. Storing for flood control commenced early in May and continued until after the peak of the freshet was reached late in June. This extremely large freshet was controlled to relatively low peak discharges with benefits as described in the following section.

BENEFITS

Flood Control Provided

Without regulation by upstream reservoirs the 1974 freshet would have produced the largest April through August runoff volume and the second highest peak discharge of this century at The Dalles, Oregon. In Canada, without the four storage projects constructed as a result of the Treaty, the peak discharge of the Columbia River at Trail would have exceeded all previous records for this century.

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by more than nine feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by about 21 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 44 by hydrographs which show actual discharges and 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.

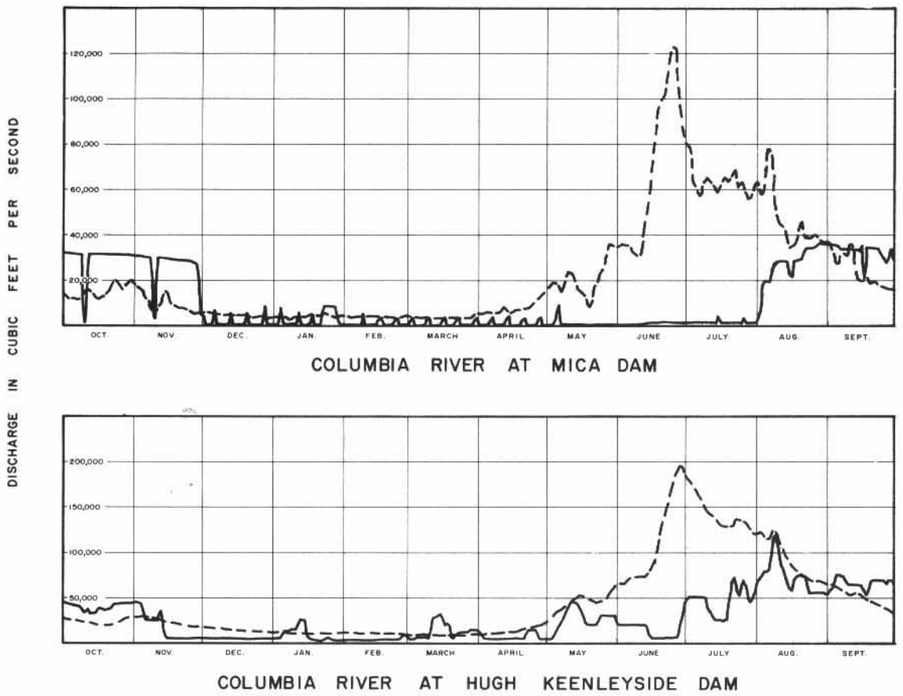
The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon by approximately 420,000 cfs to a flow of 590,000 cfs, about the size of an average

freshet without regulation. The corresponding reduction in peak stage at Vancouver, Washington amounted to almost ten feet. 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 1974. The regulation by the Treaty storage projects during the 1974 freshet period prevented substantial flooding in both 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.

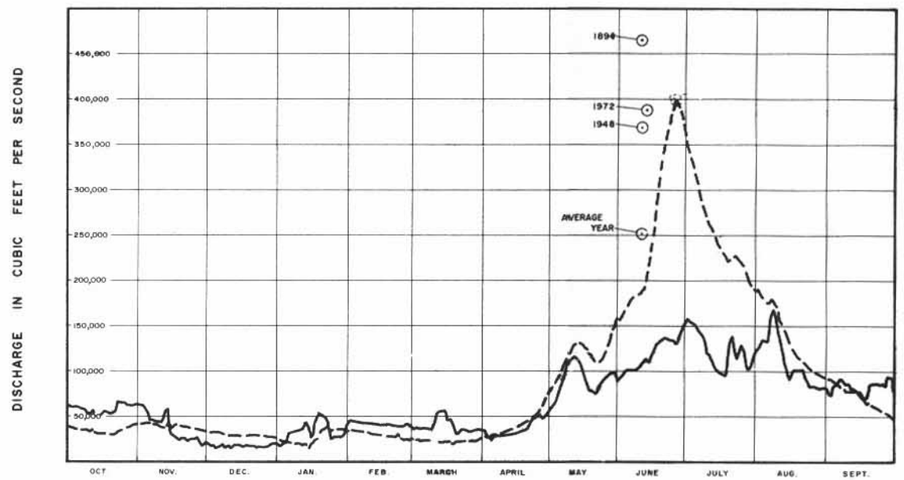
Power Benefits

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. The Kootenay River benefits in Canada, under Article XII of the Treaty, are retained wholly within Canada.

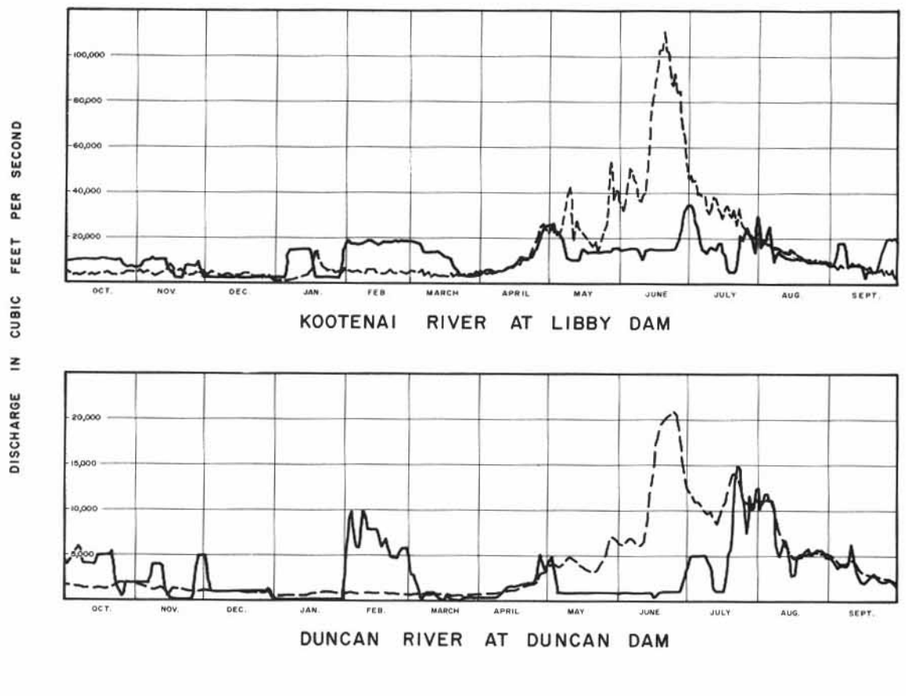


COLUMBIA RIVER AT MICA DAM

COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM



COLUMBIA RIVER AT BIRCHBANK



KOOTENAI RIVER AT LIBBY DAM

DUNCAN RIVER AT DUNCAN DAM

LEGEND

Observed Flows

Pre-Project Flows

⊙ Peak Discharges - Other Years

HYDROGRAPHS - Observed and pre-project flows for year ending 30 September 1974.

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.

2. Entity studies 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 1974 freshet period prevented substantial flooding in both Canada and the United States.

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

APPENDIX A

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 Senior Assistant 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 [1] Associate Deputy Minister of Water Resources, Department of Lands, Forests and Water Resources, Victoria, B.C.
Alternates	
Mr. Fred L. Thrall Consultant for Office, Chief of Engineers, U.S. Army, Washington, D.C.	Mr. E.M. Clark Regional Director, Pacific 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 Major Licences 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 Region, Inland Waters Directorate, Department of the Environment, Vancouver, B.C.

1) Vice Mr. V. Raudsepp as of 15 March 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 Richard E. McConnell
Division Engineer, North
Pacific Division,
Corps of Engineers,
U.S. Army,
Portland, Oregon

Canada

Mr. W.D. Kennedy, Chairman
B.C. Hydro and Power
Authority,
Vancouver, B.C.

APPENDIX C

RECORD OF FLOWS

AT THE

INTERNATIONAL BOUNDARY

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	61,800	63,500	19,500	17,600	45,300	36,600	34,900	59,600	91,700	157,000	126,000	75,700
2	61,200	63,200	18,100	18,900	44,300	37,600	28,600	61,900	93,600	155,000	128,000	73,900
3	60,700	60,200	18,900	20,900	44,400	37,000	27,700	66,000	96,900	153,000	134,000	81,700
4	60,300	55,300	16,600	20,900	44,500	37,100	23,000	72,200	101,000	152,000	133,000	84,100
5	59,400	45,300	17,100	31,200	44,000	37,800	28,500	79,600	101,000	150,000	133,000	85,600
6	59,100	45,100	17,700	32,300	43,500	37,200	27,900	86,700	102,000	147,000	144,000	90,200
7	57,700	44,600	19,500	32,600	43,000	36,900	28,000	94,400	101,000	143,000	162,000	92,000
8	56,700	44,700	16,500	33,400	42,800	36,200	28,500	104,000	102,000	140,000	167,000	87,600
9	52,500	44,800	17,100	33,900	42,500	35,000	28,500	111,000	102,000	131,000	160,000	86,200
10	53,900	44,400	17,100	33,900	42,500	41,200	28,600	115,000	103,000	121,000	141,000	87,100
11	56,800	47,700	15,900	36,000	42,400	53,500	29,400	116,000	105,000	119,000	130,000	81,900
12	50,800	55,500	17,800	43,600	42,200	55,500	29,800	114,000	109,000	113,000	119,000	81,800
13	50,800	57,500	17,900	43,900	41,400	56,000	30,000	112,000	113,000	106,000	109,000	79,100
14	50,800	33,000	18,000	39,200	41,500	57,100	30,300	108,000	110,000	102,000	97,800	76,500
15	54,400	29,900	17,400	27,500	41,600	54,300	31,100	101,000	111,000	101,000	90,500	77,600
16	56,600	27,600	16,300	29,600	41,300	45,900	31,800	94,200	118,000	98,000	95,400	71,600
17	55,700	25,900	17,600	45,100	40,300	46,600	32,700	86,200	126,000	96,600	101,000	70,700
18	54,500	23,900	17,600	54,300	40,700	42,600	33,700	80,400	130,000	95,000	101,000	74,600
19	54,400	25,300	17,800	52,500	40,400	32,500	34,700	78,800	133,000	107,000	101,000	84,400
20	54,800	25,300	17,600	51,400	39,900	31,100	35,700	77,100	136,000	131,000	102,000	86,300
21	56,200	24,600	17,200	49,600	40,000	31,600	39,900	75,900	137,000	138,000	102,000	86,600
22	67,300	23,700	15,300	44,900	38,300	36,000	46,400	75,700	136,000	122,000	95,100	86,900
23	65,900	25,300	15,900	33,900	38,900	35,100	47,900	81,700	135,000	114,000	84,700	87,200
24	65,400	25,200	16,500	25,400	38,800	34,600	48,900	88,100	134,000	122,000	83,900	85,700
25	65,700	25,200	15,800	27,100	41,100	33,800	51,400	89,800	133,000	129,000	84,700	86,700
26	62,500	25,300	16,100	27,100	41,900	33,400	52,100	93,600	131,000	124,000	83,800	84,900
27	62,400	22,100	17,800	27,200	39,800	34,400	47,500	95,600	131,000	110,000	81,600	94,300
28	62,400	17,800	20,000	27,100	40,600	36,200	50,300	97,300	141,000	102,000	80,100	94,600
29	62,700	19,600	21,000	27,100		36,400	53,400	98,300	146,000	103,000	81,100	93,700
30	62,900	20,700	20,600	31,600		36,200	56,500	98,800	153,000	111,000	81,900	78,200
31	63,000		20,700	41,900		36,000		95,900		120,000	81,300	
Mean	58,700	36,400	17,700	34,200	41,700	39,700	36,600	90,600	119,000	123,000	110,000	83,600

COLUMBIA RIVER AT BIRCHBANK, B.C. - Daily discharges for the year ending 30 September 1974 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	10,500	9,040	6,550	4,870	23,800	21,700	15,300	50,700	39,400	49,600	31,000	9,780
2	10,600	8,780	6,230	4,820	23,700	21,700	14,800	50,600	40,400	48,600	20,400	9,230
3	10,800	10,500	5,700	4,760	23,200	21,500	15,900	48,300	44,200	42,000	20,600	9,190
4	10,900	11,700	5,780	4,960	22,900	21,400	15,500	45,000	49,000	37,100	19,300	17,100
5	10,900	11,500	5,290	15,100	22,700	21,300	15,100	44,600	48,000	35,300	26,100	19,000
6	11,900	11,500	5,230	20,700	22,500	19,700	14,900	47,100	45,300	26,200	26,300	19,500
7	11,100	12,200	5,430	19,900	22,400	18,000	14,800	50,600	42,800	24,100	17,500	19,400
8	11,200	11,500	5,910	19,100	22,500	17,700	14,600	48,100	41,100	23,200	12,600	13,900
9	11,100	11,800	5,270	18,900	22,900	17,800	14,700	46,200	40,600	25,200	15,700	8,150
10	11,800	13,200	5,060	18,900	22,800	18,100	15,100	41,900	38,100	25,500	16,300	7,240
11	11,300	17,300	5,460	19,600	22,600	17,900	17,300	36,800	41,300	24,800	15,700	7,140
12	11,000	22,600	5,320	20,000	22,400	17,800	19,100	32,800	47,600	24,200	15,700	7,060
13	11,100	20,800	5,400	19,400	21,700	18,100	19,400	30,000	50,700	22,600	14,200	6,800
14	11,300	13,900	5,380	19,900	21,400	18,100	18,900	27,600	52,000	25,900	13,400	6,700
15	11,300	10,900	5,350	28,300	21,800	18,300	19,000	29,000	53,100	21,700	13,700	6,710
16	11,000	11,300	6,940	53,700	21,900	17,400	20,500	29,100	54,400	20,600	13,700	5,820
17	11,100	8,890	9,960	55,000	22,000	18,600	23,300	28,200	54,700	16,100	13,500	4,740
18	11,000	6,880	9,800	41,000	21,800	20,200	25,800	27,600	52,700	10,800	13,200	6,540
19	11,000	5,910	8,580	28,200	21,700	19,400	27,000	27,100	49,900	10,500	13,000	6,620
20	11,100	5,440	7,900	22,700	21,600	15,100	27,400	26,700	47,100	10,100	12,800	6,580
21	11,300	11,000	7,620	18,500	21,900	13,200	27,500	26,700	44,300	9,510	12,600	6,600
22	11,700	12,000	7,440	15,700	21,900	11,600	26,600	27,900	41,900	13,200	11,700	6,560
23	11,500	11,400	7,100	14,400	21,700	9,530	26,600	30,600	40,900	21,500	11,400	10,300
24	12,900	11,400	6,860	13,400	21,700	9,060	29,700	33,000	39,300	27,200	11,300	15,500
25	10,700	11,600	6,920	12,800	21,700	8,910	36,400	34,900	37,500	22,000	11,300	20,100
26	9,020	11,300	6,580	12,200	21,500	8,820	42,500	39,500	38,400	26,800	11,300	21,100
27	9,010	12,900	6,620	11,900	21,400	9,290	45,900	44,600	40,700	32,000	11,200	22,100
28	8,850	10,800	6,130	11,300	21,500	11,100	48,700	45,400	43,600	24,700	11,100	21,400
29	9,390	7,200	5,990	12,800		14,400	47,400	44,300	49,200	25,200	11,100	22,600
30	9,130	6,590	5,620	20,500		15,900	47,800	42,800	49,800	17,300	10,700	22,500
31	9,150		5,300	23,400		16,100		41,200		23,700	10,400	
Mean	10,800	11,400	6,410	19,600	22,200	16,400	24,900	38,000	45,300	24,800	15,100	12,200

KOOTENAI RIVER AT PORTHILL, IDAHO - Daily discharges for the year ending 30 September 1974 in cubic feet per second.

APPENDIX D

PROJECT INFORMATION

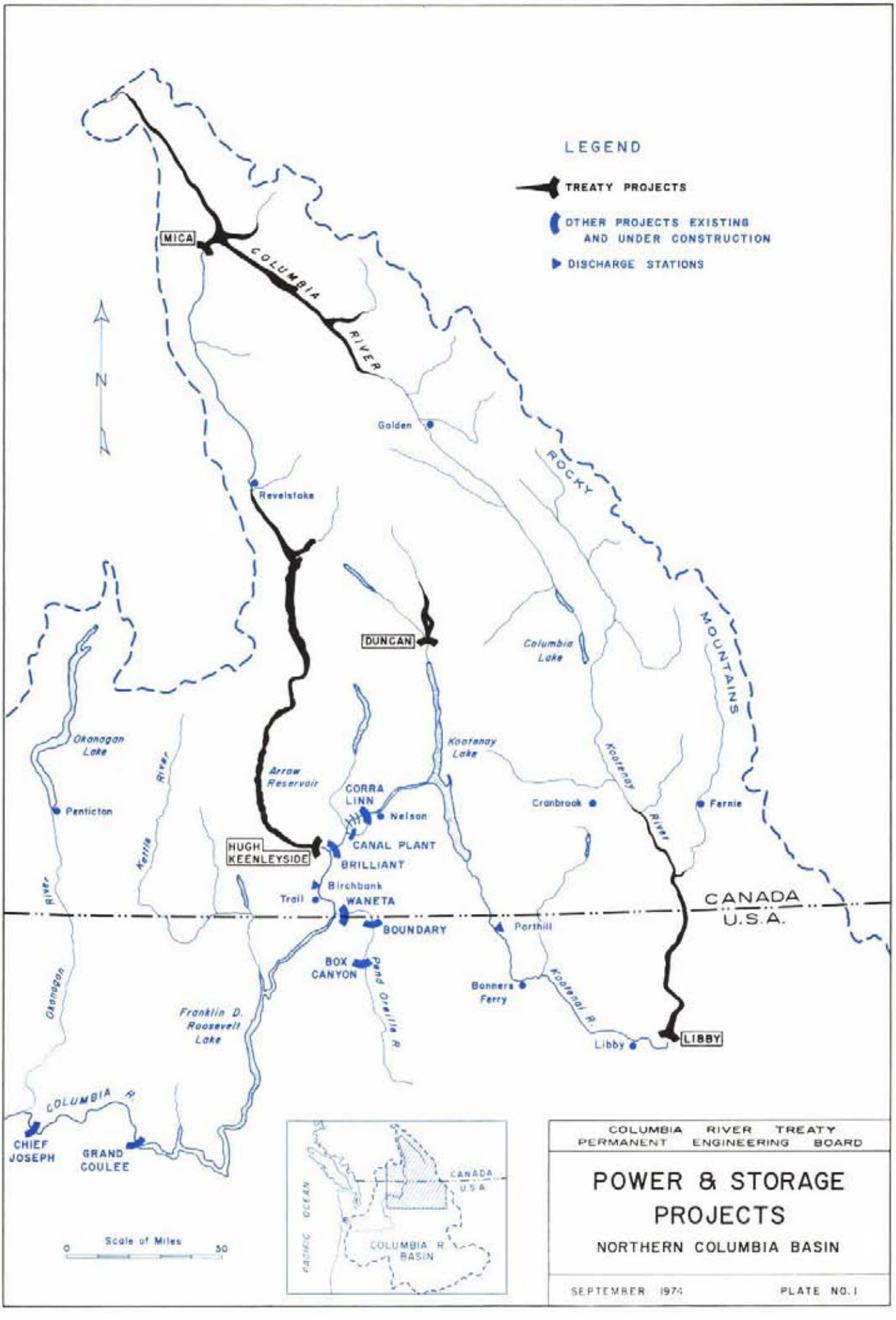

LEGEND
TREATY PROJECTS
OTHER PROJECTS EXISTING AND UNDER CONSTRUCTION
DISCHARGE STATIONS
MICA
COLUMBIA RIVER
N
Golden
ROCKY MOUNTAINS
Revelstoke
DUNCAN
Columbia Lake
Okanagan Lake
Arrow Reservoir
Kootenay Lake
Kootenay River
Penticton
Kettle River
CORRA LINN
Nelson
Cranbrook
Fernie
HUGH KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
Trail
WANETA
CANADA
U.S.A.
BOUNDARY
Porthill
BOX CANYON
Pend Oreille R.
Okanogan River
Franklin D. Roosevelt Lake
Bonners Ferry
Kootenai R.
Libby
LIBBY
COLUMBIA R.
CHIEF JOSEPH
GRAND COULEE
Scale of Miles
0
50
PACIFIC OCEAN
CANADA
U.S.A.
COLUMBIA R. BASIN
COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
POWER & STORAGE PROJECTS
NORTHERN COLUMBIA BASIN
SEPTEMBER 1974
PLATE NO. 1

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 Project	
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
First power planned for	July 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