Annual Report to the Governments of the United States and Canada

Columbia River Treaty Permanent Engineering Board

Washington, D.C. | Ottawa, Ontario

30 September 2003

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

CANADA • UNITED STATES

CANADIAN SECTION
D. BURPEE, A/Chair
T. Newton, Member

UNITED STATES SECTION
S.L. STOCKTON, Chair
R.H. Wilkerson, Member

27 February 2004

The Honorable Colin Powell
Secretary of State
Washington, D.C.

The Honourable R. John Efford
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Powell and Minister Efford:

We refer you to the Treaty between the United States of America and Canada relating to cooperative 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), we are submitting the thirty-ninth *Annual Report of the Permanent Engineering Board*, dated 30 September 2003. The report documents the results achieved under the Treaty for the period from 1 October 2002 to 30 September 2003.

The requirements of the Treaty have generally been met. However, the Board notes that the assured operating plans (AOPs) and determinations of downstream power benefits (DDPBs) for operating years 2006–2007, 2007–2008, and 2008–2009 have not been prepared within the timeframes established in paragraph 9 of Annex A of the Treaty. This paragraph requires the Entities to prepare an AOP and the associated DDPB for the sixth succeeding year of operation. The Board recognizes that this delay is due to the continuing efforts of the Entities to refine and validate an updated study process. Since the Entities expect to complete these documents in the next reporting year, this delay will not have any impact on Treaty operations.

Respectfully submitted:

For the United States

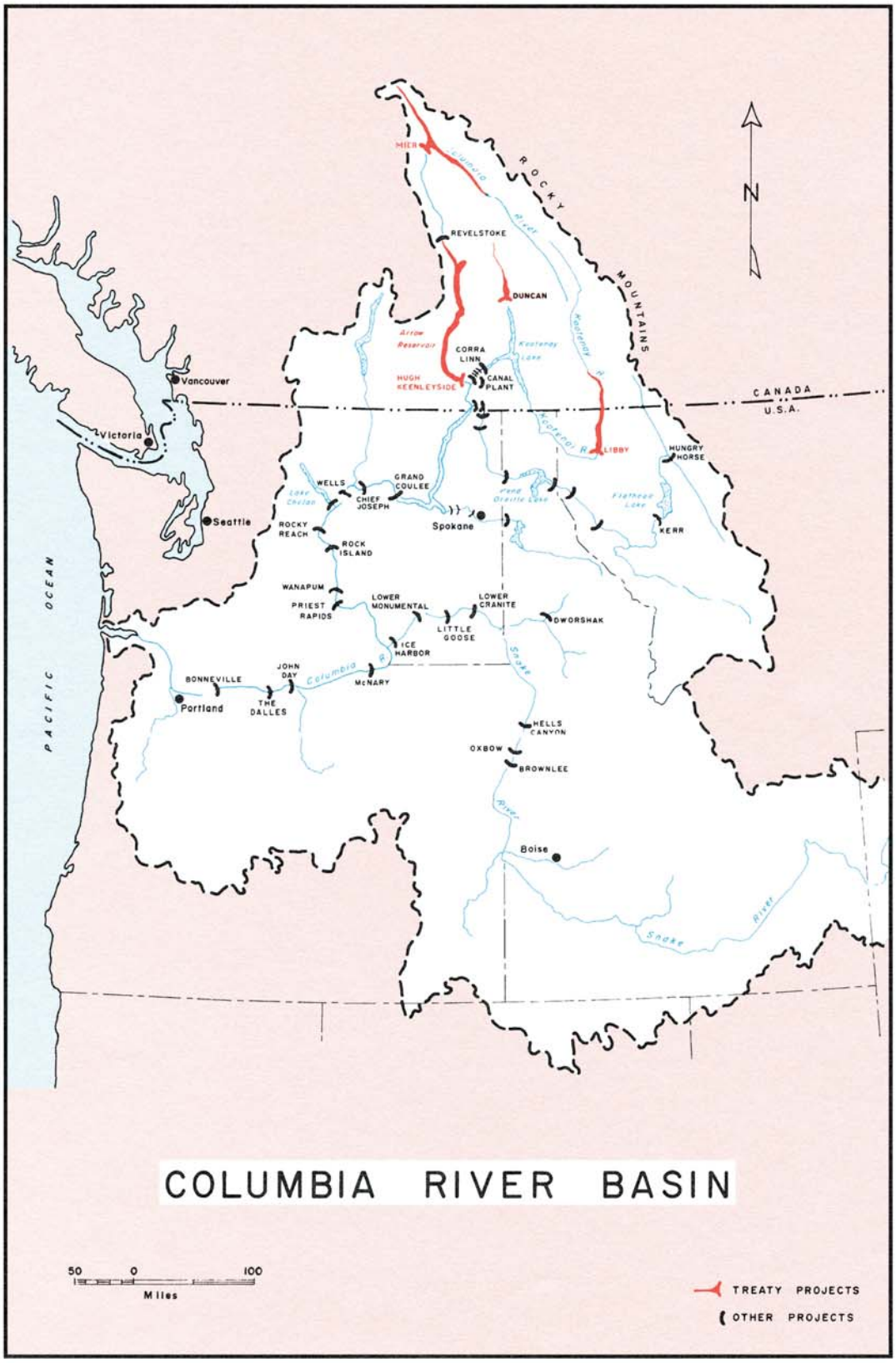
Steven Stockton, Chair

Ronald Wilkerson

For Canada

David Burpee, A/Chair

Tim Newton



COLUMBIA RIVER BASIN

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ABBREVIATIONS AND ACRONYMS

aMW	Average Megawatts
AOP	Assured Operating Plan (from 1 August to 31 July)
BC Hydro	British Columbia Hydro and Power Authority
BiOp	Biological Opinion
BPA	Bonneville Power Administration
CEPA	Canadian Entitlement Purchase Agreement
CRTOC	Columbia River Treaty Operating Committee
CTS	Canadian Treaty storage
cfs	Cubic feet per second
DDPB	Determination of Downstream Power Benefits
DOP	Detailed Operating Plan (from 1 August to 31 July)
FERC	Federal Energy Regulatory Commission
FCOP	Flood Control Operating Plan
FWS	U.S. Fish and Wildlife Service
hm^3	Cubic hectometers
kaf	Thousand acre-feet
km^3	Cubic kilometers
kcfs	Thousand cubic feet per second
ksfd	Thousand second-foot-days (=kcfs x days)
kV	Kilovolts
LCA	Libby Coordination Agreement
m	Meters
m^3/s	Cubic meters per second
Maf	Million acre-feet
MW	Megawatts
NMFS	National Marine Fisheries Service
RTO	Regional Transmission Organization
SMD	Standard Market Design
USACoE	U.S. Army Corps of Engineers
VarQ	Variable discharge flood control

SUMMARY

The thirty-ninth Annual Report of the Permanent Engineering Board *is submitted to the governments of Canada and the United States in compliance with Article XV of the* Columbia River Treaty *of 17 January 1961. This report describes Treaty projects, storage operations, and the resulting benefits achieved by each country for the period from 1 October 2002 to 30 September 2003.*

As reported in this document, the requirements of the Treaty have generally been met. However, the assured operating plans and determinations of downstream power benefits for operating years 2006–2007, 2007–2008 and 2008–2009 have not been received. Since the Entities plan to complete these reports in the next reporting year, this will not impact on Treaty operations.

The entitlement to the downstream power benefits accruing to each country from Treaty storage for the reporting period was determined, according to the procedures set out in the Treaty and Protocol, to be 534.5 average megawatts (aMW) of energy and 1170.7 megawatts (MW) of capacity from 1 October 2002 to 31 July 2003, and 537.3 aMW of energy and 1176.4 MW of capacity from 1 August 2003 to 30 September 2003.

The U.S. Entity's delivery of the Canadian entitlement to downstream power benefits attributed to the Duncan and Arrow projects was 293.1 aMW at rates of up to 642 MW from 1 October 2002 to 31 March 2003. Following the expiration of the sale related to Mica storage on 31 March 2003, delivery was 534.5 aMW at rates of up to 1170.7 MW from 1 April 2003 to 31 July 2003, and 537.3 aMW at rates of up to 1176.4 MW from 1 August 2003 to 30 September 2003. No entitlement power was disposed of in the U.S. during that period.

The Duncan, Arrow, and Mica projects were operated in compliance with the Treaty during the period covered by this report. The operation reflects the detailed operating plans developed by the Entities, the flood control operating plan for Treaty reservoirs, and other agreements between the Entities.

The reporting year was characterized by below-normal flow conditions in the Columbia River Basin. There was no significant flooding within the Basin.

The Entities continued to operate the hydrometeorological network as required by the Treaty. The Columbia River Treaty Hydrometeorological Committee prepared an annual report documenting the system according to the updated process adopted last year.

INTRODUCTION

The Columbia River Treaty *provides for the cooperative development of the water resources of the Columbia River Basin. Article XV of the Treaty established a Permanent Engineering Board and specified that one of its duties is 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 2002 through 30 September 2003, describes the activities of the Board, Treaty projects, storage operations, and the resulting benefits achieved by each country. It also presents summaries of the essential features of the Treaty and of the responsibilities of the Board and the Entities.

The report refers to items currently under review by the Entities; provides details on calculating flood control and power benefits, and on operation of Treaty reservoirs and flow discharges at the border; and presents the conclusions of the Board.

Libby Dam and Lake Koocanusa – Kootenai River, Montana
The dam and reservoir, Lake Koocanusa. The powerhouse is to the left of the spillway.

THE COLUMBIA RIVER TREATY

General

The Columbia River Treaty *was signed at 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, on 22 January 1964, in a formal agreement by an exchange of notes 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 (CEPA) was signed on 13 August 1964. Under the terms of this agreement, Canada's share of downstream power benefits resulting from the first 30 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 countries. The sum of US$253.9 million 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 of the United States, Prime Minister Pearson of Canada, and Premier Bennett of British Columbia.

Features of the Treaty and Related Documents

The essential undertakings of the Treaty are as follows:

(a) Canada will provide 19.1 km^3 (15.5 Maf) 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 the hydroelectric power facilities included in the base system and any new main-stem projects to make the most effective use of improved streamflow resulting from operation of the Canadian storage. Canada will operate the storage in

accordance with the procedures and operating plans specified in the Treaty.

(c) The United States and Canada will share equally the additional power benefit available 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 totaling US$64.4 million 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 67.6 km (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 use and, in addition, after September 1984, Canada has the option of making specific diversions of the Kootenay River into the headwaters of the Columbia River for power purposes.

(g) Differences arising under the Treaty that cannot be resolved by the two countries may be referred by either country 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 Exchange of Notes and Attachment Relating to Terms of Sale of January 1964 and the CEPA of 13 August 1964 (the Sales Agreement) provided that the Treaty storage would be operative for power purposes on the following dates: Duncan storage on 1 April 1968; Arrow storage on 1 April 1969; and Mica storage on 1 April 1973. As of the date of this report, all sales under the Sales Agreement have expired.

PERMANENT ENGINEERING BOARD

General

Article XV of the Columbia River Treaty *establishes a Permanent Engineering Board consisting of two members to be appointed by Canada and two members to be appointed 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 are also stipulated in the Treaty and related documents.*

Establishment of the Board

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

The names of Board members, alternate members and secretaries are shown in Appendix A, as are the names of the current members of the Board's Engineering Committee.

Duties and Responsibilities

The general duties and responsibilities of the Board to the governments, as set forth in Article XV(2) of 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 that 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; and

(g) consulting with the Entities on the establishment and operation of a hydrometeorological system as required by Annex A of the Treaty.

Hugh Keenleyside Dam (Arrow Lakes) – Columbia River, British Columbia
Concrete spillway and discharge works with navigation lock and earthfill dam.
The new 185-MW power plant is on the north abutment (left bank).

ENTITIES

General

Article XIV(1) of the Columbia River Treaty *provides that Canada and the United States of America shall each designate one or more Entities to formulate and execute the operating arrangements necessary to implement the Treaty. The powers and duties of the Entities are specified in the Treaty and its related documents.*

Establishment of the Entities

Executive Order No. 11177, previously referred to, designated the Administrator of the Bonneville Power Administration (BPA), the 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 Chair. Pursuant to the *Department of Energy Organization Act* of 4 August 1977, the BPA was transferred to the Department of Energy. Order in Council P.C. 1964-1407, dated 4 September 1964, designated the British Columbia Hydro and Power Authority (BC Hydro) as the Canadian Entity.

The names of the members of the Entities are shown in Appendix B.

Powers and Duties of the Entities

In addition to the powers and duties specified elsewhere in the Treaty and related documents, Article XIV(2) of the Treaty requires that the Entities be responsible for the following:

(a) coordination 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) establishment and operation of a hydrometeorological system as required by Annex A;

(f) assisting and cooperating with the Permanent Engineering Board in the discharge of its functions;

(g) periodic calculation of accounts;

(h) preparation of the hydroelectric operating plans and 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 of 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; and

(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.

ACTIVITIES OF THE BOARD

Meetings

The Board held its 70th meeting on 5 February 2003 in Vancouver, B.C. In conjunction with this meeting, the Board also held its 51st joint meeting with the Entities.

The following topics were discussed at the meeting: the status of assured operating plans/determinations of downstream power benefits (AOPs/DDPBs); transmission issues and return of the Canadian entitlement; impacts of U.S. resource agencies' Biological Opinions (BiOps) on Treaty operations; long-term implications of power deregulation in the U.S.; and a proposal to streamline Entity study processes.

Reports Received

Throughout the reporting year, the Entities maintained contact with the Board and the Board's Engineering Committee. Information pertinent to the operation of Treaty storage projects was made available to the Board.

Since the last Annual Report, the Entities have sent the Board the following documents involving the operation of Columbia River Treaty storage:

- U.S. Entity Approval Relating to Amendatory Agreement No. 1 to the 1997 Pacific Northwest Coordination Agreement, signed 13 June 2003

  This agreement amends the 1997 Pacific Northwest Coordination Agreement to include definitions; adds text related to previously received interchange energy; and replaces text related to interchange pricing, accounting, and review of charges.

- Detailed Operating Plan for Columbia River Storage for 1 August 2003 through 31 July 2004, dated July 2003

  This document provides the general guidelines, operating criteria, and reservoir rule curves for the operation of the three Treaty reservoirs (Mica, Arrow, and Duncan) in Canada for the operating year from 1 August 2003 through 31 July 2004.

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2003 through 31 July 2004, signed 7 July 2003

This document is the agreement between the Entities to implement the detailed operating plan (DOP) for Columbia River storage during the period 1 August 2003 through 31 July 2004.

- Columbia River Treaty Operating Committee Agreement on Implementation Procedures for Flood Control Reallocation for the 2003–2004 Operating Year, signed 16 July 2003

  This agreement instructs the U.S. Army Corps of Engineers (USACoE) to calculate and distribute Flood Control Rule Curves for Mica, Arrow, and Grand Coulee using the 5.03/4.44 km³ (4.08/3.6 Maf) flood control allocation between Mica and Arrow. The effect of the allocation and power drafts at upstream projects will be included in the Grand Coulee Flood Control Rule Curves.

- Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the period 27 September 2003 through 30 April 2004, signed 3 October 2003

  This agreement supplements the 2003–2004 DOP. The purpose of this agreement is to provide the Canadian Entity with enhanced spawning protection for Mountain Whitefish below Keenleyside Dam and to provide the U.S. Entity with increased flexibility in the operation of Treaty storage. This is accomplished by a provisional draft from Keenleyside Reservoir from 4 September 2003 through 22 December 2003, or the beginning of whitefish spawning. Storage will occur from 1 January 2004 through 20 January 2004, unless otherwise agreed. All provisional drafts will be returned by 30 April 2004 but shall not detrimentally impact whitefish during the March 2004 incubation period.

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 October 2002 through 30 September 2003, dated October 2003

  This report summarizes the operation of Treaty projects and other activities of the Entities for the period 1 October 2002 through 30 September 2003.

The Board received no documents involving the operation of Columbia River non-Treaty storage during this reporting year.

Report to the Governments

The thirty-eighth Annual Report of the Board, dated 28 February 2003, was submitted to the governments of Canada and the United States of America.

Duncan Dam – Duncan River, British Columbia
The earthfill dam with discharge tunnels to the left and spillway to the right.

TREATY IMPLEMENTATION

General

Implementation of the Treaty resulted in the construction of the Treaty projects, development of the hydrometeorological network, annual preparation of power and flood control operating plans, and annual calculation of downstream power benefits. The three Treaty storage projects in British Columbia — the Duncan, Arrow, and Mica projects — produce flood control and power benefits in both Canada and the United States. The Libby storage project in the United States also provides flood control and power benefits in both countries. In the United States, increased flow regulation provided by Treaty projects facilitated the installation of additional generating capacity at existing plants on the Columbia River. In Canada, completion of the Canal Plant on the Kootenay River in 1976, installation of generators at Mica Dam in 1976–1977, and completion of the Revelstoke project in 1984, all owned by BC Hydro, have resulted in additional power benefits. These benefits amount to some 4000 MW of generation capacity in British Columbia that might not have been installed without the Treaty. In addition, the construction of a two-unit, 185-MW hydropower plant adjacent to the Hugh Keenleyside Dam was completed in 2002. Additional generating units at Revelstoke and Mica dams in Canada are being considered for the future.

The Treaty provides Canada with an option, which commenced in 1984, of diverting the Kootenay River at Canal Flats into the headwaters of the Columbia River. BC Hydro undertook certain engineering feasibility and environmental studies of the potential diversion. No further activities have occurred since that time.

Further to the expiration of the Sales Agreement in 1998, 1999, and 2003, the Board has monitored issues relating to the transmission and return of the Canadian entitlement, and the restructuring of electricity markets. It has also reviewed the impacts of U.S. resource agencies' biological opinions (BiOps) on Treaty operations.

The locations of the Treaty projects are shown in Appendix D, Plate No. 1.

Treaty Projects

Duncan Project

Duncan Dam, the smallest Treaty project, was scheduled in the 30-year 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 Sales Agreement for Duncan expired 31 March 1998.

The earthfill dam is about 39.6 m high (130 feet) and extends 792.5 m (2600 feet) across the Duncan River valley, approximately 9.7 km (6 miles) north of Kootenay Lake. The reservoir behind the dam extends for about 43.5 km (27 miles) and provides 1.73 km^3 (1.4 Maf) of usable storage, which is committed under the Treaty. No power facilities are included in this project.

The project is shown on page 12, and project data are provided in Appendix D, Table 1.

Arrow Project

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 1 April 1969, the date scheduled in the 30-year Sales Agreement. The Sales Agreement for Arrow expired 31 March 1999.

The dam consists of two main components: a concrete gravity structure that extends 366 m (1200 feet) from the north bank of the river and includes the spillway, low-level outlets, and navigation lock; and an earthfill section that rises 52 m (170 feet) above the riverbed and extends 503 m (1650 feet) from the navigation lock to the south bank of the river. The reservoir, about 233 km (145 miles) long, includes both the Upper and Lower Arrow lakes and provides 8.8 km^3 (7.1 Maf) of Treaty storage.

The new 185-MW power plant at the Arrow Project, owned by Arrow Lakes Power Corporation, is located on the north abutment (left bank). An intake approach channel of about 1493 m (4900 feet) runs along the north end of the concrete dam and diverts the waters of the Arrow Reservoir through a powerhouse located in a rock outcrop 396 m (1300 feet) downstream. The generating facility contains two 92.5-MW Kaplan turbines. The facility is connected by a new 230-kV transmission line to the Selkirk substation for integration into BC Hydro's existing power grid. The installation of the generating units was completed in the spring of 2002, and the power production at the new generating facility is incidental to releases for Treaty purposes. This new power plant will reduce spill at Keenleyside Dam and will provide environmental benefits by reducing entrained gases that are harmful to fish.

The project is shown on page 7, and project data are provided in Appendix D, Table 2.

Mica Project

Mica Dam, the largest of the Treaty projects, was scheduled under the 30-year Sales Agreement for initial operation on 1 April 1973. The project was declared operational and commenced storing on 29 March 1973. The Sales Agreement for Mica expired 31 March 2003.

The dam is located on the Columbia River about 137 km (85 miles) north of Revelstoke, British Columbia. The earthfill dam rises more than 244 m (800 feet) above its foundations and extends 793 m (2600 feet) across the Columbia River valley. It is the tallest dam in North America. It creates a reservoir 217 km (135 miles) long, called Kinbasket Lake, with a total storage capacity of 24.7 km^3 (20 Maf). The project utilizes 14.8 km^3 (12 Maf) of live storage, of which 8.6 km^3 (7 Maf) are committed under the Treaty.

Although not required by the Treaty, BC Hydro added a powerhouse to the project. The underground powerhouse has space for a total of six generating units. So far, four generators have been installed, with a maximum capacity of 1805 MW.

The project is shown on page 20, and project data are provided in Appendix D, Table 3.

Libby Project in the United States

Libby Dam is located on the Kootenai River, 27.4 km (17 miles) northeast of the town of Libby, Montana. Construction began in the spring of 1966, and storage has been fully operational since 17 April 1973. Commercial generation of power began on 24 August 1975, which coincided with the formal dedication of the project. The concrete gravity dam is 931 m (3055 feet) long, rises 113 m (370 feet) above the riverbed and creates Lake Koocanusa, which is 145 km (90 miles) long and extends 67.6 km (42 miles) into Canada. Lake Koocanusa has a gross storage of 7.2 km^3 (5 869 000 acre-feet), of which 6.1 km^3 (4 980 000 acre-feet) are usable for flood control and power purposes. When completed in 1976, the Libby powerhouse had four units with a total installed capacity of 420 MW.

Construction of four additional generating units was initiated during fiscal year 1978, but Congressional restrictions imposed in the 1982 *Appropriations Act* provided for completion of only one of these units. That unit became available for service late in 1987. The total installed capacity for the five units is 525 MW. Recent U.S. legislation (Public Law 104-303, 12 Oct. 1996) authorizes the USACoE to complete generating units 6 through 8. No action was taken in this regard during this reporting period.

The Libby project is shown on page 2, and project data are provided in Appendix D, Table 4.

Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 67.6-km (42-mile) portion of Lake Koocanusa in Canada. British Columbia is responsible for reservoir debris clean-up on the Canadian side of the border.

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 the detailed programming of flood control and power operation. This system includes snow courses, meteorological stations, and streamflow gauges. The Columbia River Treaty Hydrometeorological Committee, formed by the Entities in 1968, makes recommendations on further development of the Treaty Hydrometeorological System.

In 1976, the Entities, with the concurrence of the Board, adopted a document that defined the Columbia River Treaty Hydrometeorological System, and outlined a method of classifying facilities into those required as part of the Treaty system and those of value as supporting facilities. In 1977, the Entities, with the concurrence of the Board, adopted a plan for the exchange of operational hydrometeorological data.

As a result of the emergence and adoption of more sophisticated streamflow forecasting procedures, the number of stations used in the

Treaty studies increased from 866 in 1992 to about 1500 in 2000. Considerable effort was required to classify and prepare the documentation produced by network stations on a regular basis.

In consultation with the Board, effective 1 October 2001, the Entities adopted a revised method for classifying the stations used in the Treaty studies. The Entities eliminated the practice of categorizing each data station as either "Treaty" or "Support." Instead, a new classification, "Treaty/Support," was adopted for stations that are used directly or indirectly to monitor, plan and operate Treaty projects. The Entities communicate with data collection agencies regularly to remain informed of the status of the network, and take the necessary steps to ensure that the monitoring, planning and operation of Treaty facilities are not adversely affected by any changes to the hydrometeorological network. The format of future Hydrometeorological Committee documents was revised to include only changes to the network, as opposed to complete listings of all stations.

The first Annual Report of the Hydrometeorological Committee, since adoption of the changes mentioned above, was completed in 2003.

Power Operating Plans and Calculation of Downstream Power Benefits

The Treaty and related documents require the Entities to develop and agree on an assured operating plan for the sixth succeeding year of operation from the current year. This AOP, prepared five years in advance, represents the basic commitment of the Canadian Entity to operate the Treaty storage in Canada (Duncan, Arrow, and Mica) and provides the Entities with a basis for system planning. At the same time, Canada's commitment to operate under an AOP is tied directly to the benefits produced by that plan. The calculation of downstream power benefits, which defines the power benefits accruing to each country under the Treaty, is also prepared five years in advance based on the Treaty operation criteria contained in the AOP. At the beginning of each operating year, a detailed operating plan, or DOP, which includes the three Treaty storage projects in Canada, is prepared on the basis of current resources and loads to obtain results that may be more advantageous to both countries than those obtained by operating in accordance with the AOP. To supplement the DOP, the Entities may enter into agreements throughout the year regarding the operations of Treaty storage that provide mutual benefits to both Entities. Since 2000, the operating plan for the Libby project in the United States has been presented separately and has not been included in the DOP. Further details on Libby operations are presented on the next page.

During this reporting period, the actual operations of the Treaty storage in Canada were regulated under the rule curves set out in the Entities' reports entitled *Detailed Operating Plan for Columbia River Treaty Storage*, *1 August 2002 through 31 July 2003*, dated July 2002, and *Detailed Operating Plan for Columbia River Treaty Storage*, *1 August 2003 through 31 July 2004*, dated July 2003, and in accordance with additional agreements between the Entities signed during the year. Essentially, the 2002–2003 and 2003–2004 DOPs for Canadian storage are based on the operating criteria and hydroregulation studies contained in the 2002–2003 and 2003–2004 AOPs, together with any changes agreed thereto by the Entities.

Beginning with the 2000–2001 DOP, the operating criteria and expected operations of the Libby project are no longer included in the annual DOP. Information on Libby operations is presented separately in the Libby Operating Plan prepared by the U.S. Entity. Operations at Libby are based on coordinated operations of the U.S. hydro system which take into account the BiOps and associated non-power requirements of the U.S. Fish and Wildlife Service (FWS) and of the National Marine Fisheries Service (NMFS), now the National Oceanic & Atmospheric Administration Fisheries Service. One of the main measures defined in the BiOps concerns changing the customary seasonal release rates from Libby Dam so that spring and summer outflows would be higher, and fall and winter outflows lower, than in the past. In addition, in January 2003, the USACoE adopted the variable discharge flood control (VarQ) for operations at Libby on an interim basis. VarQ is the conditional use of reserved flood control storage to provide augmentation flows for fisheries during the spring period. VarQ is used only when dry-to-moderate hydrologic runoff conditions are forecasted.

The Libby Coordination Agreement (LCA), signed on 16 February 2000, addressed some of the issues concerning fisheries operations at the Libby Project, and allowed the Entities to coordinate reservoir releases and agree to AOPs and DDPBs without having to alter their respective positions on the validity of the operations under the Treaty. The Canadian Entity believes that these fisheries operations are not consistent with the Treaty. The LCA essentially freezes the dispute, potentially until 2024, unless either Entity chooses to terminate early, on 30 days' notice. Details of the LCA are presented later in this report under "Operations Under the Treaty." The Entities have successfully implemented the LCA for the past three years.

A lengthy dispute between the Entities during the early 1990s regarding the calculation of downstream power benefits was resolved by signing the *Entity Agreement on Resolving the Dispute on Critical Period Determination, the Capacity Entitlement for the 1998–1999, 1999–2000, and 2000–2001 AOP/DDPBs, and Operating Procedures for the 2001–2002 and Future AOPs.* If this issue is raised in the future, the Board will re-examine the matter by using its earlier recommendations as guidelines for the appropriate Treaty interpretation, and for the application of the critical streamflow period definition and the established operating procedures. A more detailed discussion of this issue is contained in the 1996 and 1997 annual reports of the Board.

The arrangements for returning the Canadian entitlement to British Columbia across existing transmission lines are based on the *Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for April 1, 1998 through September 15, 2024*, signed 29 March 1999. This agreement provides arrangements for the delivery of the Canadian entitlement, including the point of delivery, method of accounting for transmission losses, and guidelines for scheduling.

In addition to the delivery agreement referred to above, the terms and conditions for the disposal of portions of the Canadian entitlement within the United States are based on the *Agreement on Disposals of the Canadian Entitlement Within the United States for April 1, 1998 through September 15, 2024 Between Bonneville Power*

Administration, Acting on Behalf of the U.S. Entity, and the Province of British Columbia, signed 29 March 1999.

Both the delivery agreement and the disposal agreement became effective on 31 March 1999 through an exchange of diplomatic notes between Canada and the United States.

Transmission Developments

The BPA continues to work on potential new transmission construction, configurations and operational practices to secure entitlement returns to the Canada-U.S. border. During this reporting period, the BPA partially implemented curtailment procedures in order to place entitlement return deliveries on an equal footing with other firm Pacific Northwest customers during curtailment periods.

As part of the continuing effort to provide open access for wholesale power transactions in the U.S., the Federal Energy Regulatory Commission (FERC) issued Order 2000 calling for the creation of independent regional transmission organizations (RTOs). The FERC subsequently issued additional guidance for a "one-size-fits-all" standard market design (SMD) to further encourage the development of wholesale electricity markets.

In the Pacific Northwest, RTO-West is being developed to address the complexities of the Western system. Concerns have subsequently been expressed that the SMD concept may not be compatible with large hydropower systems like the ones in the Pacific Northwest. In response to concerns, the FERC established public working group meetings to address specific issues related to market design in the Western interconnection.

RTO-West development continues to be a work in progress, and the Entities will continue to monitor its potential impacts on the Treaty. The FERC's final SMD Rule was expected to be issued in 2003; however, it has been delayed possibly until 2006 or beyond owing to stakeholder concerns.

Flood Control Operating Plan

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* (FCOP), dated October 1972, was received from the Entities and reviewed by the Board in the 1973 reporting year, and was in effect until October 1999. The revised plan, dated October 1999 and updated in May 2003, defines the flood control operations of the Duncan, Arrow, Mica, and Libby reservoirs during the period covered in this report.

Flow Records

Article XV(2)(a) of the Treaty specifies that the Permanent Engineering Board shall assemble records of flows of the Columbia and Kootenai rivers at the Canada-U.S. boundary. Flows for this reporting year are tabulated in Appendix C for the Kootenai River at Porthill, Idaho, and for the Columbia River at Birchbank, British Columbia.

Non-Treaty Storage

Since 1984, agreements have also been reached between BC Hydro and the BPA concerning the use of non-Treaty storage. These agreements do

not interfere with operations under the Treaty. They do extend the concepts of the Treaty and benefit both BC Hydro and the BPA.

Fisheries Operations

Many U.S. reservoirs are presently operated in accordance with BiOps issued by the FWS and the NMFS under the Endangered Species Act. Treaty reservoirs in Canada are operated in accordance with the requirements of Fisheries and Oceans Canada. These efforts continue to evolve. In this regard, the Board notes that the AOP and DDPB are to be based on optimal operations for power and flood control in accordance with the requirements of the Treaty. The Board continues to maintain its long-standing position that the Entities may develop DOPs to address fisheries' needs, providing these actions do not conflict with Treaty objectives.

Mica Dam and Lake Kinbasket – Columbia River, British Columbia
The spillway is on the right of the earthfill dam, and the underground powerhouse on the left.

OPERATIONS UNDER THE TREATY

General

The Columbia River Treaty Operating Committee (CRTOC) was established by the Entities to develop operating plans for the Treaty storage, and to direct the operation of this storage in accordance with the terms of the Treaty and subsequent Entity agreements. These plans follow the water year from August to July of the following year. Although the Permanent Engineering Board reporting period is 1 October 2002 to 30 September 2003, Treaty operations thereunder are based on the Treaty operating year of 1 August 2002 to 31 July 2003. Additional information for 1 August 2003 to 30 September 2003 is based on the Treaty operating year 1 August 2003 to 31 July 2004.

Treaty storage in Canada was operated by the Canadian Entity in accordance with the documents listed below. Treaty storage in the United States at the Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 LCA, U.S. requirements for power, and the guidelines set forth in the FWS and the NMFS 2000 BiOps.

- Columbia River Treaty Entity Agreement on Principles for Preparation of the Assured Operating Plan and Determination of Downstream Power Benefits, dated July 1988

  This agreement states the principles for changes to the preparation of the AOP and DDPB. These changes involve revisions to the information to be used in studies, such as the definition of the power loads and generating resources in the Pacific Northwest area, streamflows to be used, estimates of irrigation withdrawals and return flows, and other related information.

- Columbia River Treaty Entity Agreement on Changes to Procedures for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefit Studies, dated August 1988

  This agreement states the specific procedures to be used in implementing the previous agreement on Principles for Preparation of the Assured Operating Plan and Determination of Downstream Power Benefits.

- Agreement executed by the United States of America Department of Energy acting by and through the Bonneville Power Administration, and the British Columbia Hydro and Power Authority

relating to: (a) Use of Columbia River Non-Treaty Storage, (b) Mica and Arrow Refill Enhancement, and (c) Initial Filling of non-Treaty Reservoirs, signed 9 July 1990

This agreement provides information relating to the initial filling of Revelstoke Reservoir, the coordinated use of some of the Columbia River non-Treaty storage, and actions taken to enhance the refill of the reservoirs impounded by the Mica and Arrow dams.

- Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans, dated December 1991

  This document serves as a guide for the preparation and use of hydroelectric operating plans, such as the AOP and DOP, for operation of the Columbia River Treaty storage.

- Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024, signed 29 March 1999

  This agreement provides arrangements for the delivery of the Canadian entitlement, including the point of delivery, method of accounting for transmission losses, and guidelines for scheduling. The Agreement became effective on 31 March 1999 through an exchange of diplomatic notes between the United States and Canada. Execution of this agreement supersedes and terminates the Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024 between the Canadian Entity and the United States Entity, dated 20 November 1996, and the Entity Agreement of the same name, dated 26 March 1998, which never reached its effective date.

- Agreement on Disposals of the Canadian Entitlement Within the United States for 1 April 1998 through 15 September 2024 Between the Bonneville Power Administration, Acting on Behalf of the U.S. Entity, and the Province of British Columbia, signed 29 March 1999

  This agreement describes the arrangements by which the Province of British Columbia may dispose of the Canadian entitlement in the United States.

- Assured Operating Plan for Columbia River Treaty Storage, 1 August 2002 through 31 July 2003, dated January 2000

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2002 through 31 July 2003.

- Columbia River Treaty Entity Agreement Coordinating the Operation of the Libby Project with the Operation of Hydroelectric Plans on the Kootenay River and Elsewhere in Canada, signed 16 February 2000

  The LCA addresses issues concerning the operation of the Libby project and allows the Entities to coordinate reservoir operations and agree to AOPs and DDPBs without having to alter their respective positions on the validity of the Libby fisheries operations under the Treaty.

- Columbia River Treaty Entity Agreement Relating to Extension of the Expiration Date of the Non-Treaty Storage Agreement, signed 28 June 2002

This agreement between the Entities extends the use of Columbia River non-Treaty storage, Mica and Arrow refill enhancements, and the initial filling of non-Treaty storage to 24:00 PST on 30 June 2004.

- Detailed Operating Plan for Columbia River Storage for 1 August 2002 through 31 July 2003, dated July 2002

  This document provides the general guidelines, operating criteria, and reservoir rule curves for the operation of the three Treaty reservoirs (Mica, Arrow, and Duncan) in Canada for the operating year from 1 August 2002 through 31 July 2003.

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2002 through 31 July 2003, signed 22 July 2002

  This agreement between the Entities implements the DOP for Columbia River storage during the period 1 August 2002 through 31 July 2003.

- Columbia River Treaty Operating Committee Agreement on the Operation of Duncan and Kootenay Lake Reservoirs for the period 18 November 2002 through 20 March 2003, signed 20 November 2002

- Columbia River Treaty Operating Committee Agreement on the Operation of Arrow and Grand Coulee Storage Reservoirs for the period 10 December 2002 through 19 January 2003, signed 23 December 2002

- Columbia River Treaty Operating Committee Agreement on the Operation of Canadian Treaty Storage for the period 1 January 2003 through 31 July 2003, signed 10 February 2003

- Columbia River Treaty Flood Control Operating Plan, updated May 2003

  This plan prescribes the criteria and procedures by which the Canadian Entity will operate the Mica, Duncan, and Arrow reservoirs to achieve desired flood control objectives in the United States and Canada. Criteria for the Libby Reservoir were included in the plan to meet the Treaty requirement to coordinate its operation for flood control protection in Canada. The plan was originally prepared in October 1972. The 1999 plan provides current information, incorporates new storage reservation diagrams, and clarifies procedures. The plan was updated in May 2003.

- U.S. Entity Approval Relating to Amendatory Agreement No. 1 to the 1997 Pacific Northwest Coordination Agreement, signed 13 June 2003

  This agreement amends the 1997 Pacific Northwest Coordination Agreement to include definitions; adds text related to previously received interchange energy; and replaces text related to interchange pricing, accounting, and review of charges.

- Detailed Operating Plan for Columbia River Storage for 1 August 2003 through 31 July 2004, dated July 2003

  This document provides the general guidelines, operating criteria, and reservoir rule curves for the operation of the three Treaty reservoirs (Mica, Arrow, and Duncan) in Canada for the operating year from 1 August 2003 through 31 July 2004.

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia

River Storage for 1 August 2003 through 31 July 2004, signed 7 July 2003

This agreement between the Entities implements the DOP for Columbia River storage during the period 1 August 2003 through 31 July 2004.

- Columbia River Treaty Operating Committee Agreement on Implementation Procedures for Flood Control Reallocation for the 2003–2004 Operating Year, signed 16 July 2003

  This agreement instructs the USACoE to calculate and distribute Flood Control Rule Curves for Mica, Arrow, and Grand Coulee using the 5.03/4.44 km³ (4.08/3.6 Maf) flood control allocation between Mica and Arrow. The effect of the allocation and power drafts at upstream projects will be included in the Grand Coulee Flood Control Rule Curves.

- Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the period 27 September 2003 through 30 April 2004, signed 3 October 2003

  This agreement supplements the 2003–2004 DOP. The purpose of this agreement is to provide the Canadian Entity with enhanced spawning protection for Mountain Whitefish below Keenleyside Dam and to provide the U.S. Entity with increased flexibility in the operation of Treaty storage. This is accomplished by a provisional draft from Keenleyside Reservoir from 4 September 2003 through 22 December 2003, or the beginning of whitefish spawning. Storage will occur from 1 January 2004 through 20 January 2004, unless otherwise agreed. All provisional drafts will be returned by 30 April 2004, but shall not detrimentally impact whitefish during the March 2004 incubation period.

System Storage

The 2002–2003 operating year began with the system storage at more than 90 percent full. Dry conditions during the fall season (through December) provided a below-average snowpack at the beginning of calendar year 2003. Based on these relatively dry conditions, the January 2003 water supply forecast for the Columbia River at The Dalles (January–July 2003) was only 99.3 km³ (80.5 Maf), or 76 percent of average. Precipitation during the winter period was not sufficient to bring the snowpack back up to a normal level. For most of January through July, precipitation totals were below average. The exceptions were March and April. March was the wettest month, with monthly precipitation at 200 percent of average above Grand Coulee, 134 percent of average above Ice Harbor on the Snake River, and 175 percent of average above The Dalles. The actual unregulated runoff at The Dalles for January through July 2003 was 108.2 km³ (87.7 Maf), or 82 percent of average. With this below-average runoff, the Canadian Treaty storage (CTS) drafted from 17.4 km³ (14.1 Maf), or 91.3 percent full, to 17.0 km³ (13.7 Maf), or 88.7 percent full, at the end of the operating year. The U.S. storage projects refilled by 30 June 2003. Projects were then drafted to the NMFS 2000 BiOp draft limits for 31 August, except for Dworshak Dam, which reached the draft limit in September.

Flows in the Basin were generally below average throughout the year. On 1 June 2003, the unregulated flow at The Dalles peaked at 16 772 m³/s (592.3 kcfs). The observed peak flow at The Dalles was 10 944 m³/s (386.5 kcfs) on 31 May 2003.

Operations of the three Canadian reservoirs — Mica, Arrow, and Duncan — and the Libby Reservoir in the United States, are illustrated on pages 28 to 31 for the 13-month period from 31 August 2002 to 30 September 2003.

The hydrographs show actual reservoir levels (Storage Curve) and key rule curves which govern the operations of the Treaty storage. The Flood Control Rule Curve specifies maximum month-end reservoir levels which will permit evacuation of the reservoir to control precipitation and snowmelt events. The Critical Rule Curve shows minimum month-end reservoir levels which should be maintained to enable the anticipated power demands to be met under the most adverse water supply conditions. The Variable Refill Curve shows the reservoir elevations necessary to ensure refilling of the reservoir by the end of July with a reasonable degree of confidence.

Mica Reservoir

During the previous reporting year, Mica Reservoir reached its maximum elevation of 751.37 m (2465.1 feet) on 3 September 2002. The reservoir drafted rapidly during October through December, reaching 733.23 m (2405.6 feet) by 31 December 2002. This figure was 2.62 m (8.6 feet) above the historical minimum elevation for that date. The reservoir continued to draft from January through March 2003, reaching a minimum elevation of 714.09 m (2342.8 feet) on 8 April 2003. The refill of Mica Reservoir during the operating year was reduced by a low initial level as well as below-normal season inflows. As a result, the refill level for the operating year was well below normal, reaching a maximum elevation of 7444.32 m (2442 feet) on 23 August 2003, 10.1 m (33.0 feet) below full pool.

Arrow Reservoir

During the previous reporting year, Arrow Reservoir reached its maximum elevation of 439.92 m (1443.3 feet), 0.21 m (0.7 feet) below full pool, on 17 July 2002. The coordinated hydro-system was on proportional draft from August 2002 through January 2003. This contributed to Arrow Reservoir being drafted to its minimum elevation much earlier than normal, reaching 424.68 m (1393.3 feet) by 3 February 2003. The reservoir refilled to a maximum elevation of 439.09 m (1440.6 feet) on 4 July 2003, 1.04 m (3.4 feet) below full pool. The operation of Arrow Reservoir was modified during the operating year under three Operating Committee agreements to enhance whitefish and rainbow trout spawning and the emergence downstream of the Arrow project in British Columbia, and to provide additional power and non-power benefits in the United States.

During the 2002–2003 operating year, the Revelstoke project was operated as a run-of-river plant with the reservoir level maintained generally within 0.91 m (3.0 feet) of its normal full pool elevation of 573.02 m (1880 feet). During the spring freshet, March through July, the reservoir operated as low as elevation 571.60 m (1875.3 feet), or 1.34 m (4.7 feet) below full pool, to provide additional operational space to control high local inflows. Changes in Revelstoke storage levels did not affect Treaty storage operations. The project is shown on page 39.

Duncan Reservoir

Duncan Reservoir reached a maximum elevation of 576.78 m (1892.3 feet) on 16 July 2003, 0.09 m (0.3 feet) above full pool. From September 2002 through December 2002, Duncan discharge was used to supplement inflow into Kootenay Lake. By mid-January 2003, the reservoir had drafted to minimum pool and was passing inflow. Reservoir discharge was reduced to the minimum of 3 m^3/s (100 cfs) on 11 May to initiate reservoir refill. The reservoir was at 576.38 m (1891.0 feet), or 0.31 m (1.0 feet) below full pool, on 1 August 2003.

Libby Reservoir

At Libby Dam, Lake Koocanusa began the operating year at elevation 748.3 m (2455.1 feet), which was

1.2 m (3.9 feet) from full. In August 2002, Lake Koocanusa began to draft toward elevation 743.4 m (2439 feet) to meet the draft limits outlined in the NMFS BiOp. In 2002, the U.S. and Canada reached an agreement for a Libby-Canadian Storage Exchange as outlined in Attachment D of the LCA. The Storage Exchange Agreement was for no more than 173 million hm^3 (70 ksfd or 140 kaf); therefore, Lake Koocanusa targeted an end-of-August elevation of 744.4 m (2442.3 feet), rather than the normal BiOp interim draft limit of elevation 743.4 m (2439 feet). The draft was accomplished by releasing relatively steady outflow between 481.4 m^3/s (17.0 kcfs) and 623.0 m^3/s (22.0 kcfs) for most of August. The outflow was reduced in the last few days of August to make a smooth transition into fall operations.

The operating strategy in December 2002 was to release outflow for optimal power generation and draft Lake Koocanusa to elevation 734.9 m (2411 feet) by the end of December. The power objectives were achieved by releasing as much as full powerhouse outflow through 21 December and shape flow through the week. On 22 December, the outflow was reduced using the slow ramp-down rates recommended in the FWS bull trout BiOp. By 25 December, Libby was releasing 206.7 m^3/s (7.3 kcfs) and it reached its objective of elevation 734.87 m (2411 feet) on 31 December 2002.

In January 2003, the USACoE adopted the VarQ for operations on an interim basis. VarQ is the conditional use of reserved flood control storage to provide augmentation flows for fisheries during the spring period. VarQ is used only when dry-to-moderate hydrologic runoff conditions are forecasted. Based on the January water supply forecast at Libby of 6.0 km^3 (4.86 Maf), or 78 percent of average, for the period April through August, the end-of-January VarQ target flood control elevation was 739.66 m (2426.7 feet), and the 15 March target flood control elevation was 744.05 m (2441.1 feet). January inflow to Libby was less than 113.3 m^3/s (4.0 kcfs), and the dam reduced outflow to its normal minimum outflow of 113.3 m^3/s (4.0 kcfs). The February and March water supply forecasts remained well below average, and the target flood control elevations remained well above the reservoir elevations that could physically be achieved. Libby Dam continued to release a minimum outflow of 113.3 m^3/s (4.0 kcfs) through March and into April, and was unable to refill to the flood control elevation. By March the water supply forecast had deteriorated to 5.16 km^3 (4.18 Maf), or 67 percent of average, and the end of April flood control target was as high as elevation 748.83 m (2456.8 feet), or only 0.67 m (2.2 feet) from full. However, low inflow since January kept the reservoir drafting, and the actual elevation of Libby Reservoir was as low as elevation 732.80 m (2404.2 feet) at the end of March, or 13.35 m (43.8 feet) below the VarQ flood control elevation. There was some increase of inflow to the reservoir in April, and although Libby continued to release 113.3 m^3/s (4.0 kcfs) in April, the reservoir refilled to only elevation 734.96 m (2411.3 feet).

During May 2003, the inflow to Libby increased somewhat, and the peak of the freshet was slightly greater than 1529 m^3/s (54.0 kcfs) on 30 May. The dam continued to release only 113.3 m^3/s (4.0 kcfs) in May and refilled to elevation 742.34 m (2435.5 feet) on 31 May, only 7.16 m (23.5 feet) from full. In June and July, the operating strategy shifted so that operations for listed sturgeon in the Kootenai River could meet the objectives of the FWS BiOp. To do so, the USACoE was to release 986.7 million hm^3 (800 kaf) from Libby in excess of a minimum flow of

113.3 m^3/s (4.0 kcfs) and try to refill the reservoir by 30 June and not spill. These objectives were achieved by increasing the outflow from Libby to nearly 708 m^3/s (25.0 kcfs) (maximum powerhouse outflow) by 7 June and maintaining that outflow for 12 days before reducing slightly to 538 m^3/s (19.0 kcfs). This operation was timed to enhance the release of larval sturgeon in the Kootenai River. At the end of June, inflow to the reservoir was at, or slightly less than, powerhouse outflow capacity, and Lake Koocanusa was at elevation 749.08 m (2457.6 feet), or 0.43 m (1.4 feet) from full. Lake Koocanusa filled to within a third of a meter (one foot) of full on 2 July and remained at that level through 15 July, when the reservoir began to draft to meet the 31 August draft limit for the BiOp of elevation 743.41 m (2439 feet). Outflow from Libby was held between 396.4 m^3/s (14.0 kcfs) and 509.7 m^3/sec (18.0 kcfs) for the remainder of July and August in order to draft to this elevation. No agreement was reached for a Libby-Arrow storage exchange in 2003 because of unfavorable hydrologic conditions in Canada.

In September 2003 the outflow was reduced to no lower than 169.9 m^3/s (6.0 kcfs) to maintain wetted habitat in the Kootenai River downstream of Libby, and the reservoir drafted to near elevation 741.88 m (2434 feet).

Federal Columbia River Power System

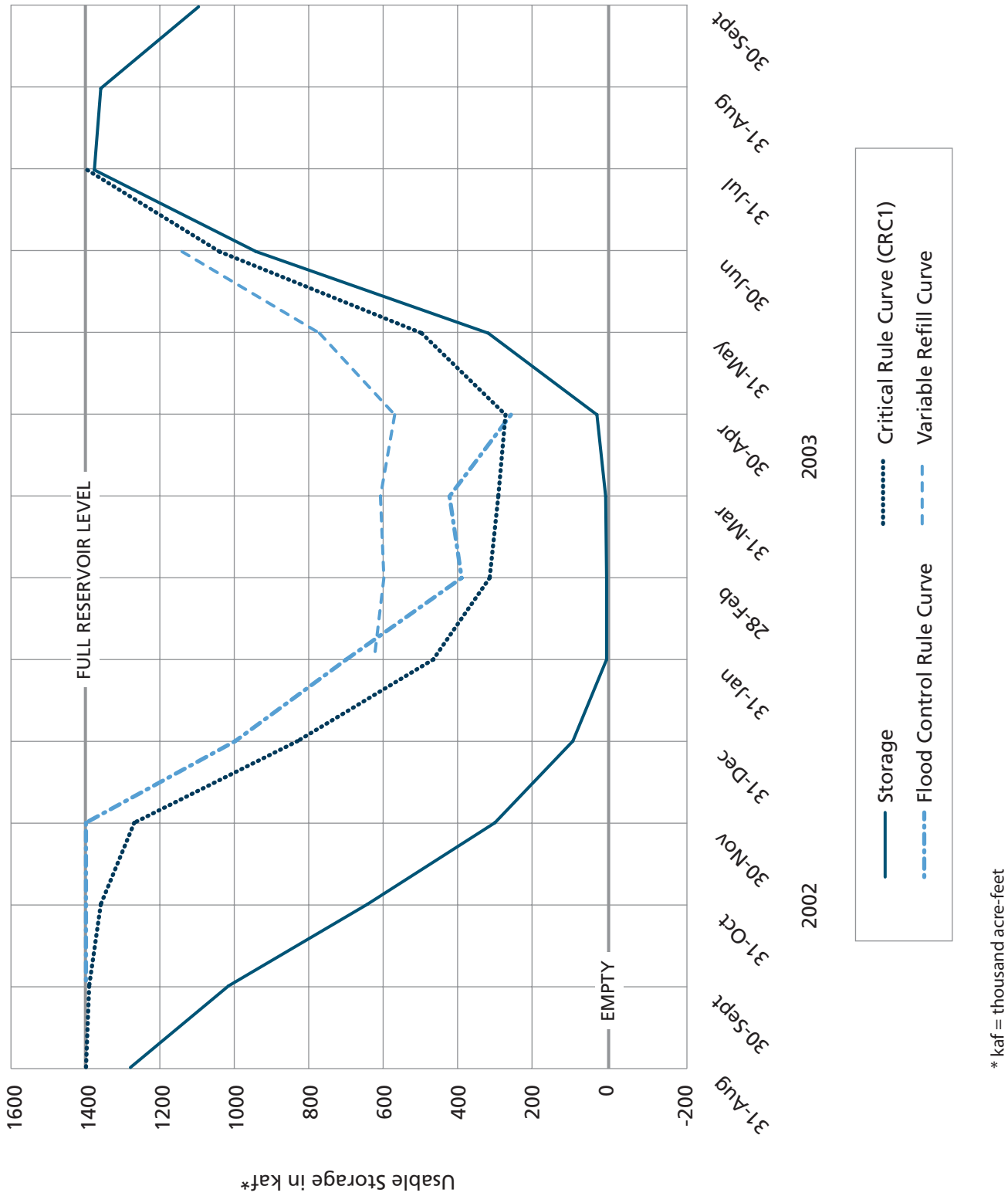
The U.S. Federal Columbia River Power System was operated to meet the needs of listed chum downstream of Bonneville Dam beginning 6 November 2002. The operation meant maintaining the tailwater elevation at Bonneville Dam at, or above, elevation 3.44 m (11.3 feet), so as to keep the areas downstream of Bonneville wetted while the chum moved into the area and spawned. This tailwater elevation was the minimum allowable for Bonneville until the emergence of the chum fish in May.

Operations for the NMFS BiOp and the FWS BiOp were completed in 2002–2003. The operations included refilling reservoirs to the 10 April flood control elevation if inflow was great enough, refilling on or about 30 June, and drafting reservoirs to summer draft limits. Because March and April were somewhat wet, the spring flow objectives at Priest Rapids, Lower Granite, and McNary were met. Spill was executed for spring and summer 2002 at all projects, and the Lower Snake River projects were operated at, or near, their minimum operating pools for the season.

Flood Control Operations

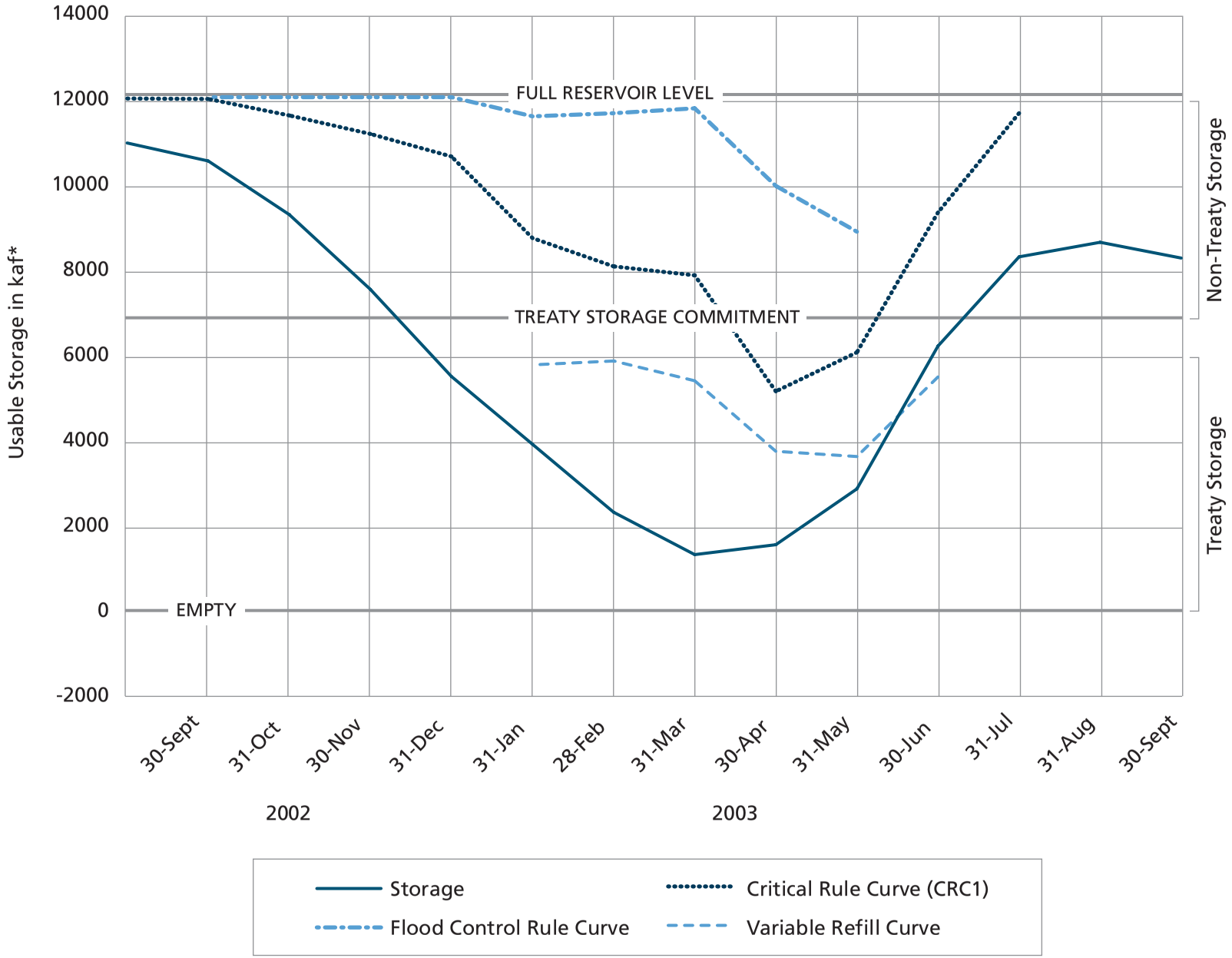
With the 2003 water supply forecasts well below average across the Columbia River Basin, the reservoir system, including the Columbia River Treaty projects, required minimal draft for flood control in preparation for the spring freshet. No major flooding occurred. The regulated peak flow at The Dalles, Oregon, was 10 024 m^3/s (354.2 kcfs) on 31 May 2003, and the unregulated flow was estimated at 16 772 m^3/s (592.33 kcfs) on 1 June 2003. The peak stage observed at Vancouver, Washington, was 4.25 m (14.0 ft) on 1 February 2003, and the estimated unregulated stage was 6.34 m (20.8 ft) on 2 June 2003.

Duncan Reservoir Levels



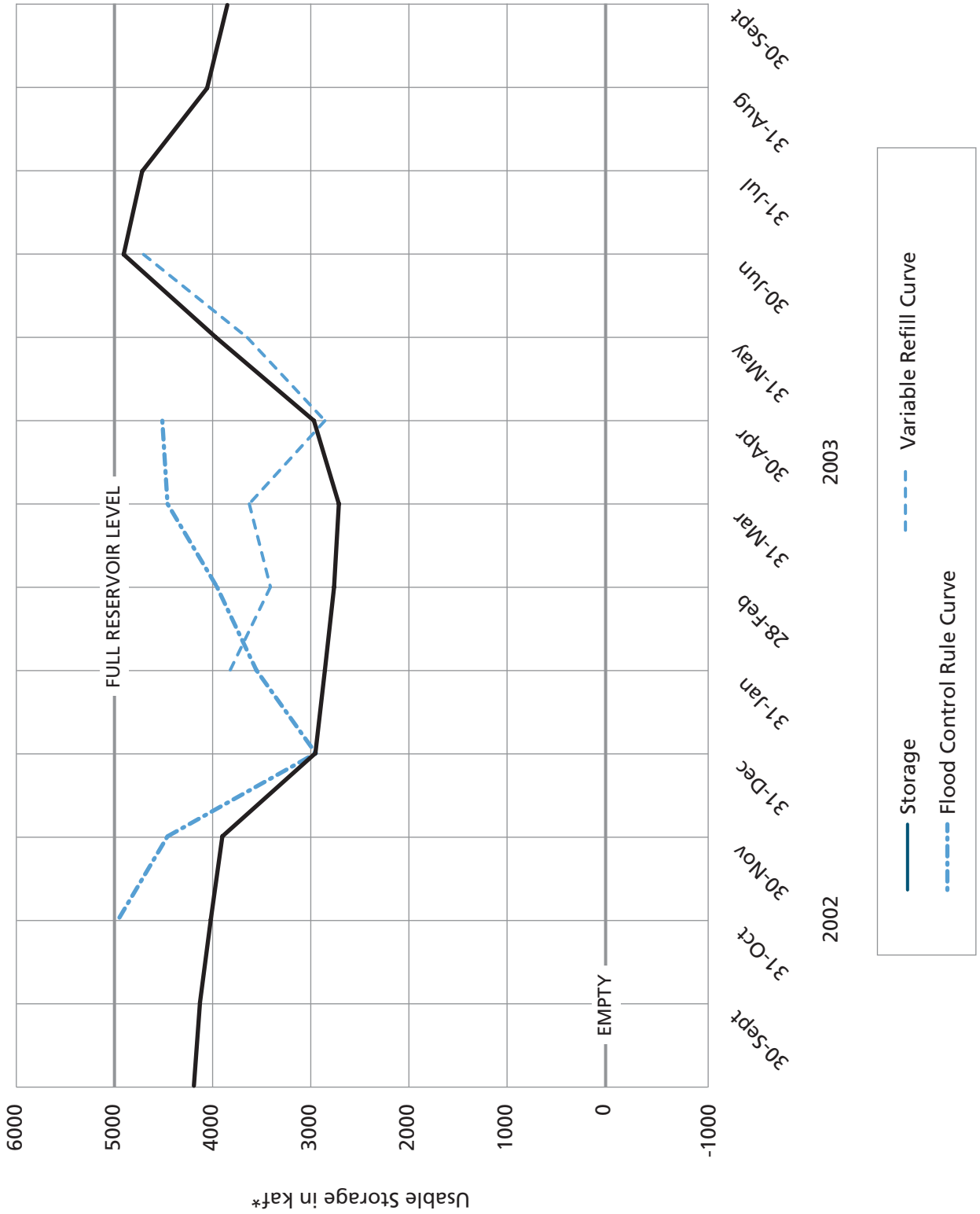
* kaf = thousand acre-feet

Mica Reservoir Levels



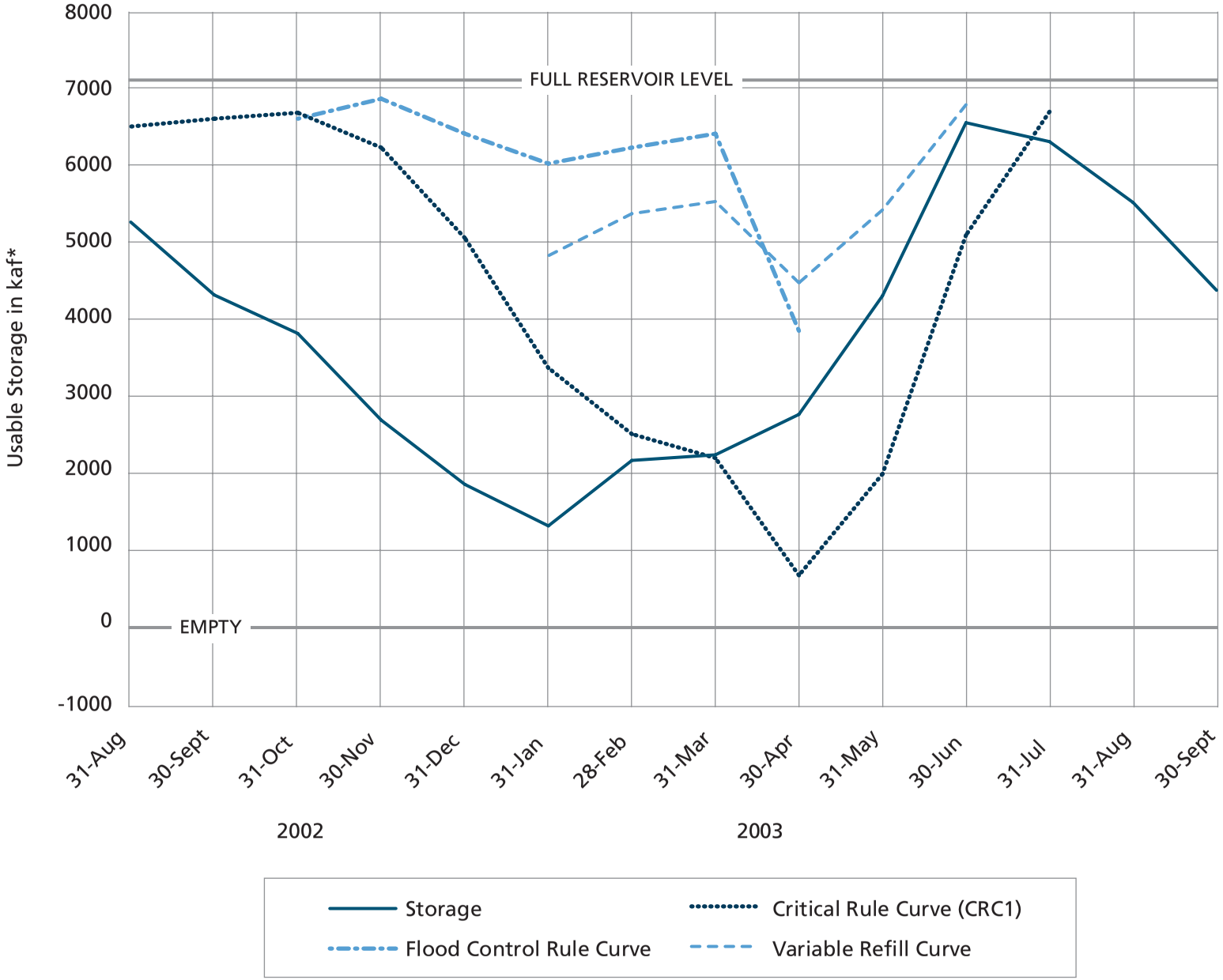
* kaf = thousand acre-feet

Libby Reservoir Levels

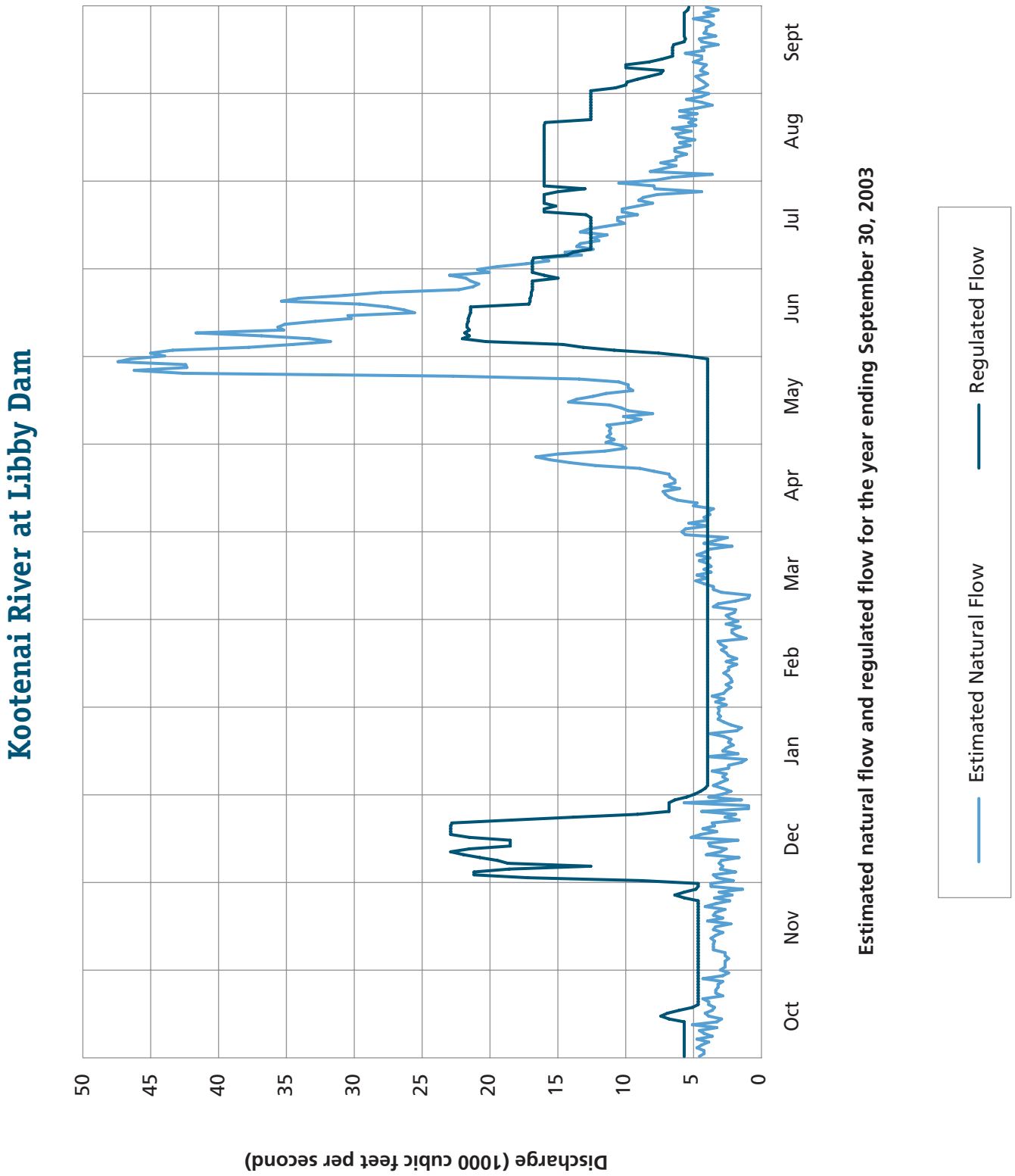


* kaf = thousand acre-feet

Arrow Reservoir Levels

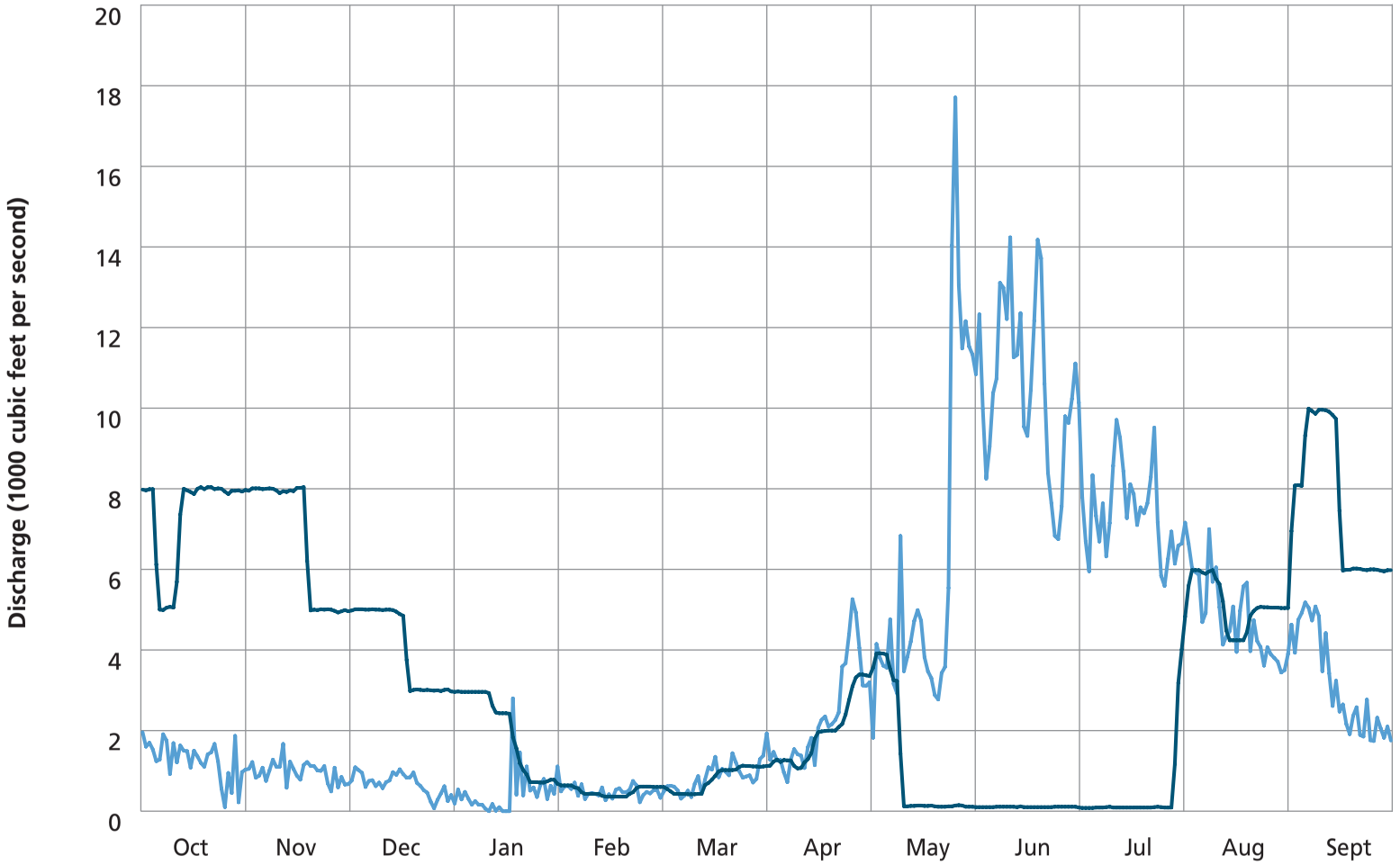


* kaf = thousand acre-feet



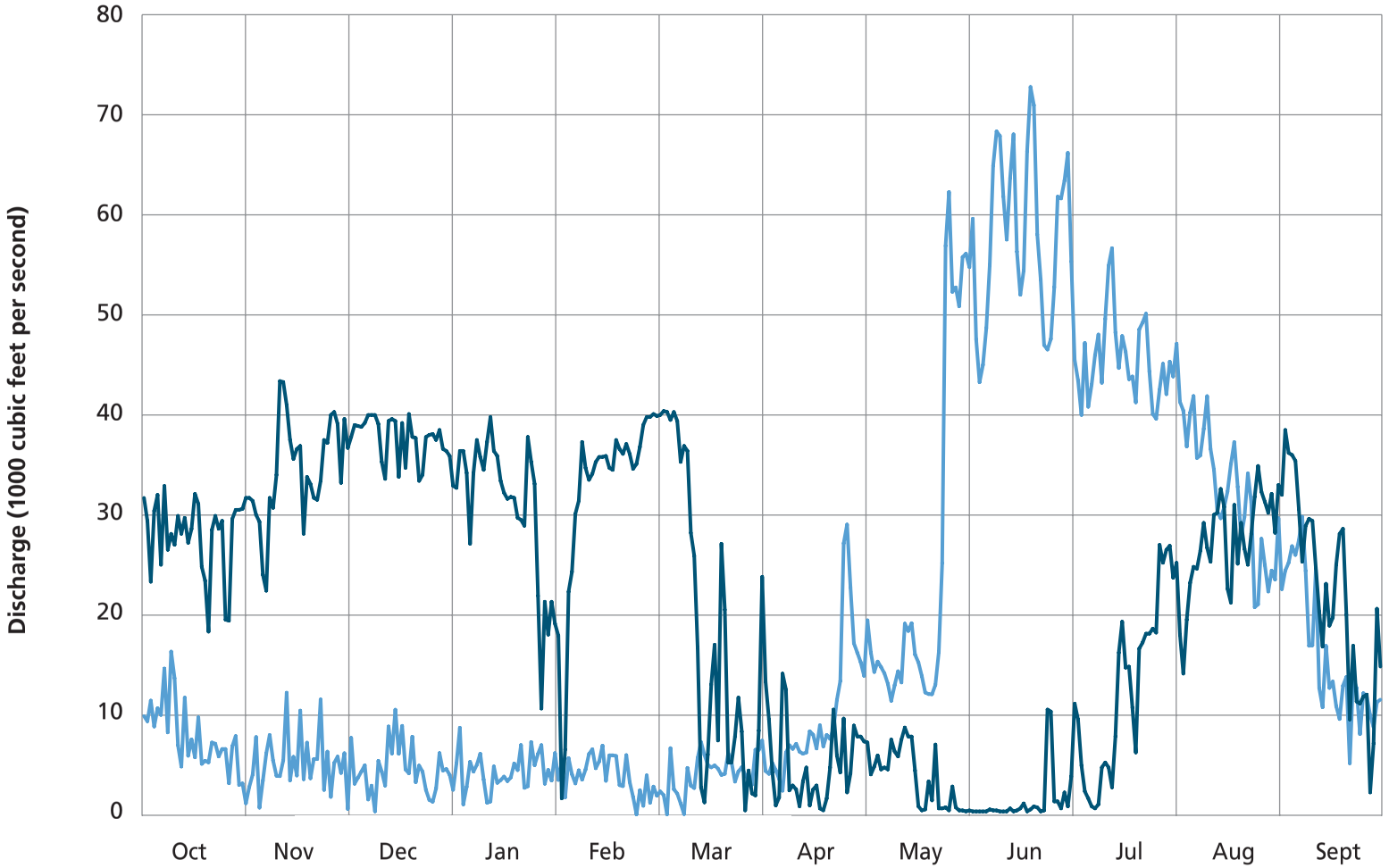
Estimated natural flow and regulated flow for the year ending September 30, 2003

Duncan River at Duncan Dam



Estimated natural flow and regulated flow for the year ending September 30, 2003

Columbia River at Mica Dam

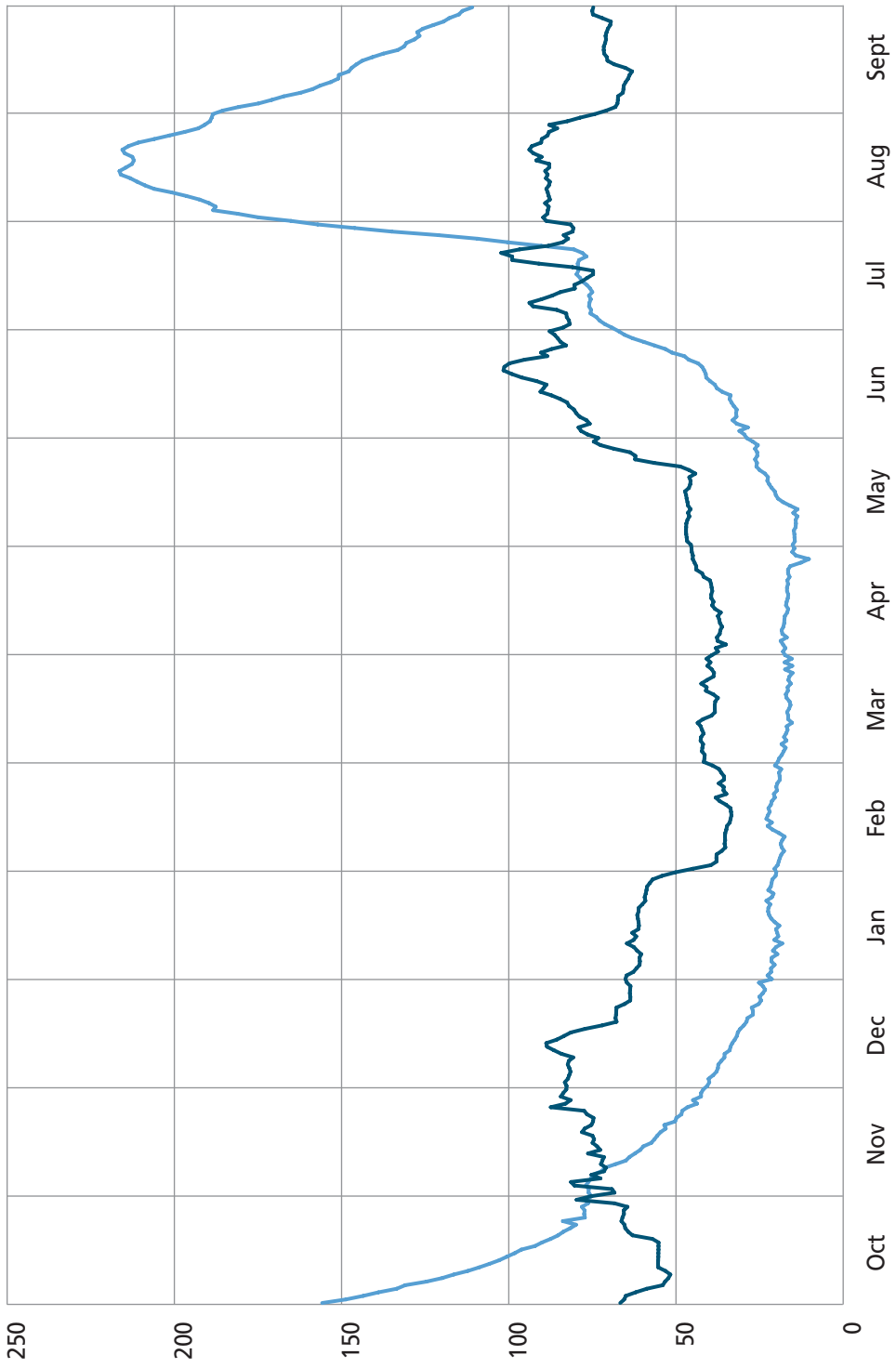


Estimated natural flow and regulated flow for the year ending September 30, 2003

Columbia River at Hugh Keenleyside Dam

Estimated natural flow and regulated flow for the year ending September 30, 2003

Columbia River at Birchbank



Estimated natural flow and regulated flow for the year ending September 30, 2003

TREATY BENEFITS

Flood Control Benefits

There was no Columbia River flooding during the 2002–2003 operating year. Operations for flood control were not a major factor because natural flows were well below average. However, storage operations did keep peak flows below flood control levels. The peak regulated flow and river stages are shown in the tables below.

Columbia River Stream Flow at The Dalles, Oregon

Date	Peak Regulated Flow m^3/s (cfs)	Date	Peak Unregulated Flow m^3/s (cfs)
31 May 2003	10 024 (354 200)	01 June 2003	16 760 (592 000)

Columbia River Stage at Vancouver, Washington (Flood Stage is 4.9 meters [16.0 feet])

Date	Peak Regulated Stage meters (feet)	Date	Peak Unregulated Stage meters (feet)
01 Feb 2003	4.3 (14.0)	02 June 2003	6.1 (20.0)

It is estimated that the Duncan and Libby projects reduced the peak stage of Kootenay Lake by about 0.61 m (2.0 feet). The Duncan, Arrow, Mica, and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia, by about 3.23 m (10.6 feet). It should be noted that both regulated and unregulated peak stages at Trail were below flood stages. The hydrographs on pages 28 to 36 illustrate the effect of storage in the Duncan, Arrow, Mica, and Libby reservoirs on flows at the project sites, and on flows of the Columbia River at Birchbank. These show the actual discharges

and the flows that would have occurred if the dams had not been built. The hydrograph showing pre-project conditions for Birchbank has been computed on the assumption that the effects of Duncan, Arrow, Mica, and Libby regulation, and of the regulation provided by the Corra Linn development on Kootenay Lake, have been removed.

Power Benefits

Downstream power benefits in the United States, which arise from operation of the CTS, were predetermined for the first 30 years of operation of each project, and the Canadian share was sold in the United States under the terms of the CEPA. The U.S. Entity delivered capacity and energy to Columbia Storage Power Exchange participants, the purchasers of the Canadian entitlement. Canada retains the benefits of additional generation made possible on the Kootenay River in Canada through the regulation provided by Libby, as well as generation at the Mica, Revelstoke and Arrow projects. The benefits of Libby regulation, which occur downstream in the United States, are not shared under the Treaty.

The CEPA expired in stages from 1998 to 2003. The portion of Canada's share of downstream power benefits attributable to each of the Treaty projects is the ratio of each project's storage to the whole of the CTS. The table below summarizes Canada's share of the downstream power benefits from each project:

Treaty Storage	Date Returned	Share of Canadian Entitlement (%)
Duncan	1 April 1998	9.0
Arrow	1 April 1999	45.8
Mica	1 April 2003	45.2

As of 1 April 2003, Canada's share of downstream benefits has been fully returnable.

The U.S. Entity's delivery of the Canadian entitlement to downstream power benefits, attributed to Duncan and Arrow projects, was 293.1 aMW at rates of up to 642 MW from 1 October 2002 to 31 March 2003. Following the expiration of the sale related to Mica storage on 31 March 2003, the delivery was 534.5 aMW at rates of up to 1170.7 MW from 1 April 2003 to 31 July 2003, and 537.3 aMW at rates of up to 1176.4 MW from 1 August 2003 to 30 September 2003.

An agreement between the Entities, signed on 20 November 1996, sets out the details of delivery points and the reliability of delivery for the downstream power benefits returnable to Canada beginning 1 April 1998 and completed on 1 April 2003. Further, on 31 March 1999, the agreement permitting disposal of the Canadian entitlement directly in the United States was adopted through an exchange of diplomatic notes. The Province of British Columbia was designated as the Canadian Entity for the purpose of the disposal. No returnable entitlement power was disposed of in the U.S. during the reporting period.

Other Benefits

By agreement between the Entities, streamflows are regulated for non-power purposes, such as accommodating construction in river channels and providing water to meet fisheries' needs in both countries. These arrangements are implemented under the DOP and other agreements to provide mutual benefits.

Revelstoke Dam – Columbia River, British Columbia
The earthfill dam is located on the west bank of the river, and the concrete gravity dam in Little Dalles Canyon.
The powerhouse is in the riverbed, immediately downstream of the concrete dam.

CONCLUSIONS

1. The Duncan, Arrow, and Mica projects were operated in compliance with the Treaty during the period covered by this report. Operations reflected DOPs developed by the Entities, the FCOP for Treaty reservoirs, and other agreements between the Entities.

2. Flow conditions in the Columbia Basin for the operating year 1 August 2002 to 31 July 2003 were below average. Seasonal flow volume at The Dalles was 82 percent of average for January through July 2003. CTS began the year at 91.3 percent full, and ended the year at 88.7 percent full.

3. The entitlement to the downstream power benefits accruing to each country from Treaty storage for the reporting period was determined, according to the procedures set out in the Treaty and Protocol, to be 534.5 aMW of energy and 1170.7 MW of capacity from 1 October 2002 to 31 July 2003, and 537.3 aMW of energy and 1176.4 MW of capacity from 1 August 2003 to 30 September 2003.

4. The U.S. Entity's delivery of the Canadian entitlement to downstream power benefits attributed to the Duncan and Arrow projects was 293.1 aMW at rates of up to 642 MW from 1 October 2002 to 31 March 2003. Following expiration of the sale related to Mica storage on 31 March 2003, the delivery was 534.5 aMW at rates of up to 1170.7 MW from 1 April 2003 to 31 July 2003, and 537.3 aMW at rates of up to 1176.4 MW from 1 August 2003 to 30 September 2003. No entitlement power was disposed of in the U.S. during that period.

5. With the 2003 water supply forecasts well below average across the Columbia River Basin, the reservoir system, including the Columbia River Treaty projects, required minimal draft for flood control in preparation for the spring freshet. No major flooding occurred. The regulated peak flow at The Dalles, Oregon, was 10 024 m^3/s (354.2 kcfs) on 31 May 2003, and the unregulated flow was estimated at 16 772 m^3/s (592.33 kcfs) on 1 June 2003. The peak stage observed at Vancouver, Washington, was 4.25 m (14.0 ft) on 1 February 2003, and the estimated unregulated stage was 6.34 m (20.8 ft) on 2 June 2003.

6. The Entities continued to operate the hydrometeorological network as required by the Treaty. The Columbia River Treaty Hydrometeorological Committee prepared an annual report in 2003.

7. The Board therefore concludes that the requirements of the Treaty have generally been met. However, the 2006–2007, 2007–2008, and 2008–2009 AOPs/DDPBs are currently behind the established schedule, which requires submission for the sixth consecutive year. The Entities plan to complete these reports in the upcoming year, and the delay is not expected to impact on Treaty operations.

APPENDIX A

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

United States	Canada
Members	
Mr. Steven Stockton, P.E., Chair Director of Programs Management South Pacific Division U.S. Army Corps of Engineers San Francisco, CA	Nominee pending, Chair
Mr. Ronald H. Wilkerson Consultant Missoula, Montana	Mr. Tim Newton, P.Eng. Consultant Vancouver, British Columbia
Alternates	
Mr. Earl Eiker, P.E. Consultant Ellicott City, Maryland	Mr. David Burpee Director, Renewable and Electrical Energy Division Electricity Resources Branch Natural Resources Canada Ottawa, Ontario
Mr. George Bell Consultant Lake Oswego, Oregon	Mr. James Mattison, P.Eng. Director, Water Management Branch Land and Water British Columbia Inc. Victoria, British Columbia
Secretaries	
Mr. Robert Bank, P.E. Engineering and Construction Division Headquarters, U.S. Army Corps of Engineers Washington, D.C.	Ms. Eve Jasmin Renewable and Electrical Energy Division Energy Resources Branch Natural Resources Canada Ottawa, Ontario

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

Record of Membership

United States		Canada	
Members			
Mr. Wendell Johnson[1]	1964–1970	Mr. Gordon McNabb[1]	1964–1991
Mr. Morgan Dubrow	1964–1970	Mr. Arthur Paget	1964–1973
Mr. John Neuberger	1970–1973	Mr. Valter Raudsepp	1973–1974
Mr. Joseph Caldwell[1]	1971–1973	Mr. Ben Marr	1974–1987
Mr. Homer Willis[1]	1973–1979	Mr. Tom Johnson	1987–1988
Mr. King Mallory	1973–1975	Mr. Douglas Horswill	1989–1991
Mr. Raymond Peck, Jr.	1976–1977	Mr. John Allan	1991–1999
Mr. Emerson Harper	1978–1988	Mr. David Oulton[1]	1991–1996
Mr. Lloyd Duscha[1]	1979–1990	Mr. Daniel Whelan[1]	1996–2002
Mr. Ronald Wilkerson	1988–	Mr. Charles Kang	1999–2001
Mr. Herbert Kennon[1]	1990–1994	Mr. Jack Ebbels	2001–2003
Mr. John Elmore[1]	1994–1996	Mr. Tim Newton	2003–
Mr. Steven Stockton[1]	1996–		
Alternates			
Mr. Fred Thrall	1964–1974	Mr. Mac Clark	1964–1992
Mr. Emerson Harper	1964–1978	Mr. Jim Rothwell	1964–1965
Mr. Alex Shwaiko	1974–1987	Mr. Hugh Hunt	1966–1988
Mr. Herbert Kennon	1987–1990	Dr. Donald Kasianchuk	1988–1996
Mr. Thomas Weaver	1979–1997	Mr. Vic Niemela	1992–1994
Mr. John Elmore	1990–1994	Mr. David Burpee	1994–
Mr. Paul Barber	1994–1995	Mr. Jack Farrell	1996–1997
Mr. Daniel Burns	1995–1997	Mr. Prad Kharé	1997–1999
Mr. George Bell	1997–	Mr. James Mattison	1999–
Mr. Earl Eiker	2000–		
Secretaries			
Mr. John Roche	1965–1969	Mr. Mac Clark	1964–1992
Mr. Verle Farrow	1969–1972	Mr. David Burpee	1992–2003
Mr. Walter Duncan	1972–1978	Ms. Eve Jasmin	2003–
Mr. Shapur Zanganeh	1978–1995		
Mr. Richard DiBuono	1995–2000		
Mr. Robert Bank	2000–		

[1] Chair

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD
ENGINEERING COMMITTEE

Current Membership

United States	**Canada**
Members	
Mr. Robert Bank, P.E., Chair Engineering and Construction Division Headquarters, U.S. Army Corps of Engineers Washington, D.C.	Mr. Roger McLaughlin, P.Eng., Chair Electricity Policy Branch Ministry of Energy and Mines Victoria, British Columbia
Mr. Kamau Sadiki Water Management Division U.S. Army Corps of Engineers Northwestern Division Portland, Oregon	Ms. Eve Jasmin Renewable and Electrical Energy Division Natural Resources Canada Ottawa, Ontario
Mr. Michael Cowan, P.E. Office of Technical Services Western Area Power Administration Lakewood, Colorado	Dr. Bala Balachandran, P.Eng. Water Management Branch Land and Water British Columbia Inc. Victoria, British Columbia
Mr. James Fodrea, P.E. U.S. Bureau of Reclamation Pacific Northwest Region Boise, Idaho	Mr. Ivan Harvie, P.Eng. Renewable and Electrical Energy Division Natural Resources Canada Calgary, Alberta
Mr. Jerry Webb, P.E. Principal Hydrologic & Hydraulic Engineer Hydrology, Hydraulics & Coastal Community of Practice Leader Headquarters, U.S. Army Corps of Engineers Washington, D.C.	

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

United States

Members

Mr. Steven Wright, Chair
Administrator and Chief Executive Officer
Bonneville Power Administration
Department of Energy
Portland, Oregon

BG William T. Grisoli
Division Engineer
Northwestern Division
U.S. Army Corps of Engineers
Portland, Oregon

Canada

Members

Mr. Larry Bell, Chair
British Columbia Hydro and Power Authority
Vancouver, British Columbia

APPENDIX C

RECORD OF FLOWS AT THE INTERNATIONAL BOUNDARY

Kootenai River at Porthill, Idaho

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2003

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1	6.79	5.54	6.22	6.01	7.45	5.77	13.50	12.70	21.30	21.40	19.00	15.10
2	6.76	5.43	11.00	5.50	8.39	5.65	14.30	13.00	21.70	21.20	18.90	14.60
3	6.74	5.67	19.20	5.24	7.57	5.63	13.20	13.80	22.50	21.10	18.90	13.00
4	6.71	5.74	23.30	5.35	7.16	5.61	12.00	13.90	24.90	21.00	18.80	12.20
5	6.74	5.64	24.00	5.36	6.68	5.50	11.30	13.60	26.00	20.80	18.80	11.90
6	6.72	5.62	20.30	5.30	6.40	5.47	10.70	13.20	28.40	20.30	19.00	10.80
7	6.74	5.60	16.20	5.34	6.22	5.65	10.20	12.60	33.60	18.30	19.00	9.91
8	6.75	5.61	21.50	5.18	6.10	5.58	9.75	12.10	34.90	17.10	19.00	8.98
9	6.72	5.65	22.50	5.27	6.07	5.87	9.69	11.80	34.80	16.00	19.00	9.57
10	6.49	5.65	23.80	4.96	5.98	5.54	10.50	11.40	34.70	16.00	18.90	11.90
11	6.71	5.58	25.30	4.80	5.84	5.50	11.20	11.40	34.20	15.80	18.90	11.40
12	6.70	5.63	26.10	4.88	5.75	6.07	12.30	11.70	33.80	15.80	19.00	10.00
13	6.63	5.76	24.10	5.19	5.70	7.60	13.10	12.10	33.10	15.40	18.90	9.11
14	6.60	5.72	22.10	5.24	5.61	10.20	13.50	13.10	32.70	15.50	18.90	8.34
15	7.87	5.74	23.00	5.16	5.64	10.90	13.70	14.00	31.80	15.50	18.90	8.41
16	8.38	5.68	23.50	5.06	5.56	10.90	13.40	14.20	31.20	15.50	18.90	8.20
17	7.78	5.52	26.70	5.13	5.68	10.90	12.80	13.40	30.80	15.20	18.90	8.20
18	6.91	5.57	27.30	5.09	5.76	10.40	12.50	12.50	30.50	15.30	19.00	8.07
19	6.03	5.69	27.10	5.05	5.73	9.79	12.10	12.10	29.40	15.30	18.90	7.30
20	5.66	5.81	27.00	4.98	5.65	9.48	11.70	11.70	26.40	15.20	18.80	7.37
21	5.63	5.81	26.70	4.99	5.72	9.23	11.80	11.40	25.50	16.20	18.90	7.28
22	5.68	5.82	25.80	4.97	5.80	9.96	12.40	11.40	24.20	18.80	18.10	7.27
23	5.54	5.97	20.50	4.82	5.74	13.70	13.70	12.30	23.90	19.00	15.00	7.30
24	5.53	5.85	15.20	4.94	5.49	13.70	15.10	14.30	23.40	18.20	14.70	7.33
25	5.51	5.85	10.50	5.05	5.47	12.20	16.30	19.90	23.00	18.90	14.80	7.23
26	5.53	6.95	8.18	5.29	5.61	11.20	16.70	24.10	22.70	19.00	14.80	7.21
27	5.52	7.48	8.29	7.37	5.78	10.60	15.90	23.00	22.50	19.00	14.60	7.25
28	5.61	6.78	8.01	7.46	5.70	9.94	14.80	21.80	22.30	19.00	14.70	7.16
29	5.72	6.00	8.20	6.79	--	9.48	13.80	22.20	19.00	17.20	14.70	7.28
30	5.57	5.82	7.36	6.41	--	9.24	13.20	22.70	20.90	16.50	14.70	6.91
31	5.68	--	6.63	6.34	--	9.67	--	21.60	--	18.80	14.70	--
Mean	**6.4**	**5.7**	**18.9**	**5.4**	**5.5**	**8.6**	**12.4**	**14.8**	**26.6**	**17.7**	**17.7**	**8.9**

Columbia River at Birchbank, British Columbia

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2003

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1	66.68	68.38	82.72	64.79	39.58	39.07	39.28	45.35	73.23	87.79	88.82	70.84
2	65.47	69.15	83.25	62.76	37.87	41.69	37.43	45.53	76.45	83.84	89.73	68.12
3	65.01	80.36	82.30	61.82	37.91	41.50	38.08	46.65	78.39	81.77	88.46	67.49
4	62.07	81.41	81.93	60.88	37.88	41.40	35.06	46.80	79.15	82.00	88.32	67.37
5	58.75	72.57	81.53	60.79	36.32	42.24	37.53	46.95	75.77	82.66	88.05	67.34
6	53.94	75.29	81.89	60.92	35.23	42.12	37.77	47.00	76.74	82.81	89.15	65.88
7	53.27	71.52	82.37	60.39	35.47	41.88	36.91	46.95	78.85	85.62	87.70	65.72
8	52.27	70.93	82.04	61.63	35.29	42.65	36.75	46.91	79.87	92.73	88.06	65.63
9	51.66	72.45	80.71	62.58	35.36	42.48	36.20	46.58	80.49	93.83	88.36	65.04
10	53.14	72.02	84.26	64.69	35.27	41.73	36.85	45.99	81.97	90.20	88.77	64.31
11	55.28	71.51	86.49	62.66	34.94	42.22	37.07	46.42	82.55	87.06	87.99	63.89
12	55.37	76.31	88.57	61.87	34.75	42.61	37.48	45.63	84.69	84.59	87.70	63.12
13	55.32	72.66	88.80	63.10	33.91	43.54	36.59	46.40	87.26	80.24	88.89	65.14
14	55.27	73.57	85.62	61.29	33.68	41.97	38.36	46.57	90.54	80.40	88.38	68.50
15	55.26	74.96	83.50	61.08	33.42	39.39	39.19	46.82	89.59	78.16	89.11	70.49
16	55.23	74.48	81.45	61.18	33.54	38.35	38.77	46.98	88.71	76.53	87.92	70.68
17	55.23	74.98	77.26	61.39	33.69	38.39	39.44	47.31	91.71	74.78	87.91	71.48
18	55.21	78.12	72.03	61.58	35.06	38.40	39.47	46.13	96.11	74.78	91.76	71.60
19	57.04	77.30	67.76	61.18	36.96	38.26	39.14	45.74	99.13	80.94	90.17	71.58
20	63.00	75.29	68.09	61.16	38.13	37.46	39.35	45.64	101.59	91.01	92.65	71.18
21	64.25	74.79	67.92	60.07	34.91	38.87	39.51	46.03	101.32	98.98	93.86	70.92
22	65.17	74.66	67.86	59.14	35.79	41.06	39.84	44.20	99.76	98.97	93.10	71.06
23	65.41	76.59	67.78	59.37	35.72	40.82	41.69	46.06	95.33	102.26	90.31	70.76
24	66.32	77.47	65.39	59.05	37.22	42.46	42.20	48.71	88.49	96.77	90.14	70.37
25	66.00	87.46	63.67	58.82	35.65	40.75	43.93	56.46	90.35	88.18	88.39	69.68
26	65.56	83.03	63.64	58.64	35.65	38.81	43.94	62.21	87.21	83.86	87.97	69.46
27	65.62	81.50	63.79	57.82	36.47	38.61	44.45	62.14	82.87	82.25	85.52	72.10
28	64.49	84.44	63.73	56.96	37.13	39.28	44.99	63.76	84.54	83.58	87.92	74.84
29	68.37	83.71	63.59	54.18	--	40.58	44.94	68.60	85.33	80.90	82.49	75.05
30	79.72	82.78	64.69	50.15	--	39.67	45.28	72.56	86.31	80.67	78.74	74.72
31	75.37	--	65.11	44.97	--	40.87	--	74.60	--	81.50	74.32	--
Mean	**61.0**	**76.3**	**75.5**	**59.9**	**35.8**	**40.6**	**39.6**	**50.8**	**86.5**	**85.5**	**88.1**	**69.1**

APPENDIX D

PROJECT INFORMATION

Power and Storage Projects

Project Data

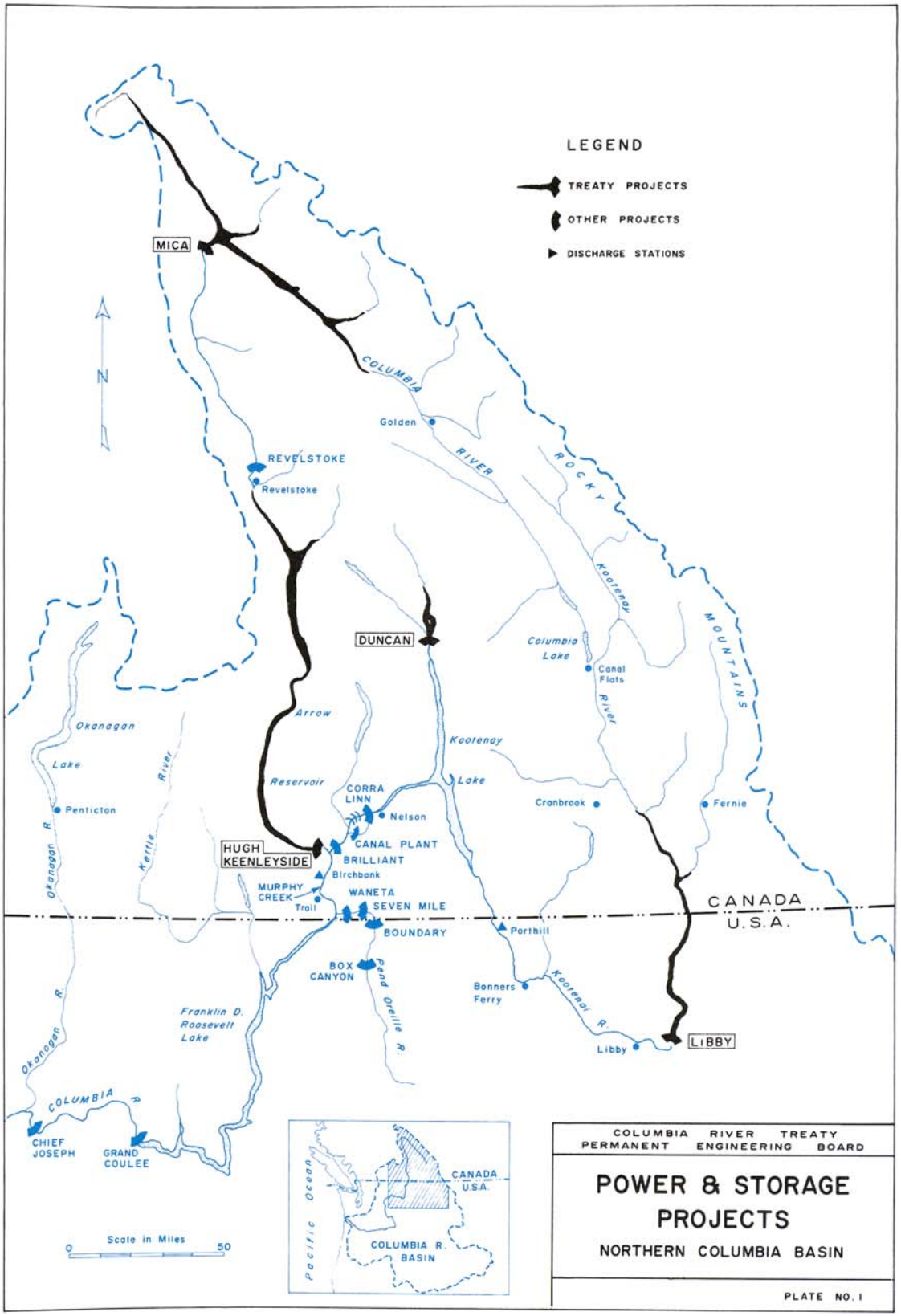

LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
N
COLUMBIA
Golden
RIVER
ROCKY
MOUNTAINS
REVELSTOKE
Revelstoke
DUNCAN
Columbia Lake
Canal Flats
Kootenay
River
Arrow
Reservoir
Okanagan
Lake
Penticton
Okanagan R.
Kettle River
Kootenay
Lake
Cranbrook
Fernie
CORRA LINN
Nelson
HUGH KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
MURPHY CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
CANADA
U.S.A.
Porthill
BOX CANYON
Pend Oreille R.
Bonners Ferry
Kootenai R.
Libby
LIBBY
Franklin D. Roosevelt Lake
Okanogan R.
COLUMBIA R.
CHIEF JOSEPH
GRAND COULEE
Scale in Miles
0
50
Pacific Ocean
CANADA
U.S.A.
COLUMBIA R. BASIN
COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
POWER & STORAGE PROJECTS
NORTHERN COLUMBIA BASIN
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	577 m (1892 feet)
Normal minimum pool elevation	547 m (1794.2 feet)
Surface area at full pool	7290 hectares (18 000 acres)
Total storage capacity	1.77 km^3 (1 432 400 acre-feet)
Usable storage capacity	1.73 km^3 (1 400 000 acre-feet)
Treaty storage commitment	1.73 km^3 (1 400 000 acre-feet)

Dam, Earthfill

Crest elevation	581 m (1907 feet)
Length	792.5 m (2600 feet)
Approximate height above riverbed	39.6 m (130 feet)
Spillway—Maximum capacity	1350 m^3/sec (47 700 cfs)
Discharge tunnels—Maximum capacity	570 m^3/sec (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	440 m (1444 feet)
Normal minimum pool elevation	420 m (1377.9 feet)
Surface area at full pool	52 650 hectares (130 000 acres)
Total storage capacity	10.3 km^3 (8 337 000 acre-feet)
Usable storage capacity	8.8 km^3 (7 100 000 acre-feet)
Treaty storage commitment	8.8 km^3 (7 100 000 acre-feet)

Dam, Concrete Gravity and Earthfill

Crest elevation	445 m (1459 feet)
Length	869 m (2850 feet)
Approximate height above riverbed	52 m (170 feet)
Spillway—Maximum capacity	6700 m^3/sec (240 000 cfs)
Low-level outlets—Maximum capacity	3740 m^3/sec (132 000 cfs)

Power Facilities

Currently installed	
2 units at 92.5 MW	185 MW
Power commercially available	2002
Head at full pool (Gross maximum head)	23.6 m (77 feet)
Maximum turbine discharge	1200 m^3/sec (42 400 cfs)

TABLE 3

MICA PROJECT
Mica Dam and Kinbasket Lake

Storage Project

Construction began	September 1965
Storage became fully operational	29 March 1973

Reservoir

Normal full pool elevation	754.4 m (2475 feet)
Normal minimum pool elevation	707.1 m (2320 feet)
Surface area at full pool	42 930 hectares (106 000 acres)
Total storage capacity	24.7 km^3 (20 000 000 acre-feet)
Usable storage capacity	14.8 km^3 (12 000 000 acre-feet)
Treaty storage commitment	8.6 km^3 (7 000 000 acre-feet)

Dam, Earthfill

Crest elevation	762.0 m (2500 feet)
Length	792.5 m (2600 feet)
Approximate height above foundation	244 m (800 feet)
Spillway—Maximum capacity	2250 m^3/sec (150 000 cfs)
Outlet works—Maximum capacity	1060 m^3/sec (37 400 cfs)

Power Facilities

Designed ultimate installation	
6 units at 450 MW	2700 MW
Power commercially available	1976
Currently installed	
4 units at 451 MW	1805 MW
Head at full pool	183 m (600 feet)
Maximum turbine discharge	
of 4 units at full pool	1080 m^3/sec (38 140 cfs)

TABLE 4

LIBBY PROJECT
Libby Dam and Lake Koocanusa

Storage Project

Construction began	June 1966
Storage became fully operational	17 April 1973

Reservoir

Normal full pool elevation	749.5 m (2459 feet)
Normal minimum pool elevation	697.0 m (2287 feet)
Surface area at full pool	18 830 hectares (46 500 acres)
Total storage capacity	7.2 km^3 (5 869 000 acre-feet)
Usable storage capacity	6.1 km^3 (4 980 000 acre-feet)

Dam, Concrete Gravity

Deck elevation	753.5 m (2472 feet)
Length	916.0 m (3055 feet)
Approximate height above riverbed	112.8 m (370 feet)
Spillway—Maximum capacity	4106 m^3/sec (145 000 cfs)
Low-level outlets—Maximum capacity	1730 m^3/sec (61 000 cfs)

Power Facilities

Designed ultimate installation	
8 units at 105 MW	840 MW
Power commercially available	1975
Currently installed	
5 units at 105 MW	525 MW
Head at full pool	107.0 m (352 feet)
Maximum turbine discharge	
of 5 units at full pool	745.6 m^3/sec (26 500 cfs)