Annual Report to the Governments of the United States and Canada

Columbia River Treaty Permanent Engineering Board

REPORT

Washington, D.C. | Ottawa, Ontario

30 September 2006

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

CANADA • UNITED STATES

CANADIAN SECTION
T. WALLACE, Chair
T. Newton, Member

UNITED STATES SECTION
S.L. STOCKTON, Chair
E. Sienkiewicz, Member

28 February 2007

The Honorable Condoleezza Rice
Secretary of State
Washington, D.C.

The Honourable Gary Lunn
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Rice and Minister Lunn:

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 forty-second *Annual Report of the Permanent Engineering Board*, dated 30 September 2006. The report documents the results achieved under the Treaty for the period from 1 October 2005 to 30 September 2006.

The Board is pleased to report that, for this reporting period, the objectives of the Treaty were met.

Respectfully submitted:

For the United States

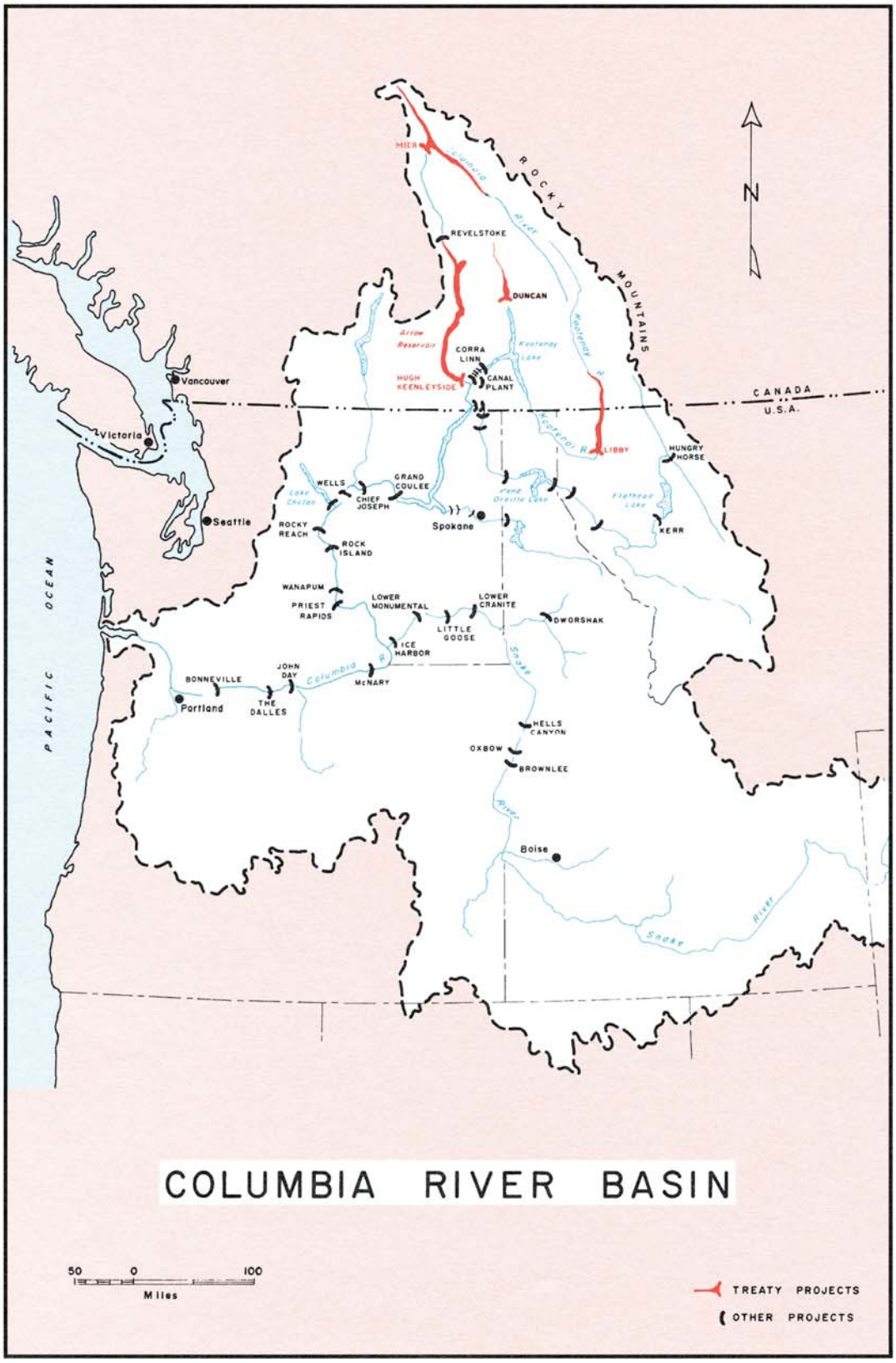
Steven Stockton, Chair

Ed Sienkiewicz

For Canada

Tom Wallace, Chair

Tim Newton



COLUMBIA RIVER BASIN

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IN MEMORIAM

Mr. Shapur Zanganeh, or "Shap" as his family and friends knew him, served as Secretary of the United States Section, Columbia River Treaty Permanent Engineering Board, from 1978 until 1995. His 17 years of dedicated and effective service to the Board make him the longest-serving U.S. Secretary in the Treaty's history. During most of that time period, Shap also served as Chairman of the United States section of the Board's Engineering Committee.

In 1995, Shap retired from his position as a civil engineer and hydropower expert with the U.S. Army Corps of Engineers at its headquarters in Washington, D.C. He died February 2, 2006, of Amyotrophic Lateral Sclerosis, Lou Gehrig's disease, at his home in Falls Church, Virginia, U.S.A.

SHAPUR A. ZANGANEH
1928–2006

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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
CRTHMC . . . . . Columbia River Treaty Hydrometeorological Committee
cfs . . . . . Cubic feet per second
DDPB . . . . . Determination of Downstream Power Benefits
DOP . . . . . Detailed Operating Plan (from 1 August to 31 July)
FCOP . . . . . Flood Control Operating Plan
ft. . . . . Feet
FWS . . . . . U.S. Fish and Wildlife Service
hm^3 . . . . . Cubic hectometers
kaf . . . . . Thousand acre-feet
kcfs . . . . . Thousand cubic feet per second
km . . . . . Kilometers
km^3 . . . . . Cubic kilometers
kV . . . . . Kilovolts
LCA . . . . . Libby Coordination Agreement
m . . . . . Meters
m^3/s . . . . . Cubic meters per second
Maf . . . . . Million acre-feet
mi. . . . . .Miles
MW . . . . . Megawatts
NMFS . . . . . National Marine Fisheries Service
PEBCOM . . . . . .Permanent Engineering Board Engineering Committee
TSR . . . . . Treaty Storage Regulation
USACoE . . . . . U.S. Army Corps of Engineers
VarQ . . . . . Variable discharge flood control

SUMMARY

The forty-second 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 2005 to 30 September 2006.*

During the reporting period, the Canadian Treaty projects — Mica, Duncan, and Arrow — were operated according to the 2005–2006 and 2006–2007 detailed operating plans, the 2003 flood control operating plan (FCOP), and several supplemental operating agreements. The Libby project was operated according to the 2003 FCOP, the 2000 Libby Coordination Agreement, U.S. requirements for power, and the guidelines set forth in the U.S. Fish and Wildlife Service's 2000 Biological Opinion, the National Marine Fisheries Service's 2004 Biological Opinion, and the 2006 interim variable discharge flood control (VarQ). As reported in this document, the objectives of the Treaty have been met for the reporting period.

As a result of the flooding incident downstream of Libby in June 2006, the U.S. Army Corps of Engineers conducted an After Action Review of Libby operations to identify lessons learned and potential changes to future operations. The report, prepared by the Corps' Northwestern Division in January 2007, concluded that the implementation of the VarQ operation in 2007 will be a strict application of the eight-step VarQ operating procedures in order to reduce the risk of future flood damages and increase the likelihood of achieving the intended benefits of VarQ.

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 535.1 average megawatts (aMW) of energy and 1218 megawatts (MW) of capacity from 1 October 2005 to 31 July 2006, and 488.5 aMW of energy and 1244 MW of capacity from 1 August 2006 to 30 September 2006.

The U.S. Entity delivered the Canadian entitlement to the Canadian Entity at existing points of interconnection on the Canada-U.S. border according to the Entity Agreement on Aspects of the Delivery

of the Canadian Entitlement for 1 April 1998 through 15 September 2024, dated 29 March 1999. No curtailment of the Canadian entitlement occurred due to transmission constraints, forced outages, or emergencies on either the U.S. or Canadian side of the border during the 2005–2006 operating year.

Canadian Treaty storage began the operating year on 1 August 2005 at 98.4 percent full, and ended the year on 31 July 2006 at 97.1 percent full. Seasonal flow volume above The Dalles was 107 percent of average for January through July 2006.

The Entities continued to operate the hydrometeorological network as required by the Treaty. At the Board's request, the Columbia River Treaty Hydrometeorological Committee submitted a report that identifies specific issues and makes recommendations regarding the ongoing loss of data acquisition stations in October 2005. The final report was presented to the Board at the February 2006 annual meeting.

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 2005 through 30 September 2006, 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 – Kootenai River, Montana

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 Canadian 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 mi.) 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 (PEBCOM).

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 (moved by a later Executive Order to the Department of Energy), and the Division Engineer, North Pacific (now Northwestern) 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

ACTIVITIES OF THE BOARD

Meetings

The Board held its 73rd meeting on 8 February 2006 in Portland, Oregon. In conjunction with this meeting, the Board also held its 54th joint meeting with the Entities.

The following topics were discussed at the meeting: continued improvements to the delivery of the Canadian entitlement; implications of variable discharge flood control (VarQ) implementation at Libby; production of the 2011–2012 assured operating plan/determination of downstream power benefits (AOP/DDPB); prospects for a non-treaty storage agreement; update on the Arrow Lakes Hydro Channel damage and repair; recommendations on the loss of data acquisition stations; implementation of a Treaty website; the Entities' views on Libby operations and their consistency with Treaty objectives; and the Columbia River Partnership as a successor to the Columbia River Initiative.

Reports Received

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

Since the last annual report, the Board has received the following documents involving the operation of Columbia River Treaty storage:

- Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 1 December 2005 through 31 July 2006, signed 16 December 2005

  This agreement is similar to previous agreements implemented to utilize Treaty storage for non-power uses. These uses include the following: (1) providing flows for Canadian trout spawning for the April through June period; (2) enhancing the capability in the U.S. of providing spring and summer flow augmentation for salmon and steelhead by storing 1 Maf of water in Arrow by late April; (3) enhancing Arrow Lakes levels by ensuring progressive refill; (4) providing a minimum discharge objective at Arrow during January through March 2006 for the purpose of protecting eggs deposited on the

streambed by Mountain Whitefish during December 2005 through January 2006; (5) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam during the period of December 2005 through early May 2006. This agreement supplements the 2005–2006 Detailed Operating Plan (DOP).

- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2010–2011, dated January 2006

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2010 through 31 July 2011.

- Columbia River Treaty Entity Agreement on the Assured Operating Plan and Determination of Downstream Power Benefits for the 2010–2011 Operating Year, signed 6 February 2006

  This document is the agreement to implement the AOP and DDPB that provide information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2010 through 31 July 2011.

- Detailed Operating Plan for Columbia River Storage for 1 August 2006 through 31 July 2007, dated May 2006

  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 2006 through 31 July 2007.

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2006 through 31 July 2007, signed 22 June 2006

  This document is the agreement between the Entities to implement the DOP for Columbia River storage during the period 1 August 2006 through 31 July 2007.

- Columbia River Treaty Entity Agreement determining no adverse Treaty impacts of BPA-BC Hydro storage in non-Treaty space for the period 25 May 2006 to 30 September 2006, dated June 2006

  This agreement between the Entities allows the short-term use of non-Treaty storage for mutual benefits.

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 October 2005 through 30 September 2006, dated October 2006

  This report summarizes the operation of Treaty projects and other activities of the Entities for the period 1 October 2005 through 30 September 2006.

Report to the Governments

The forty-first Annual Report of the Board, dated 28 February 2006, 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 plans and flood control operating plans (FCOPs), 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, the 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 ft.) and extends 792.5 m (2600 ft.) across the Duncan River valley, approximately 9.7 km (6 mi.) north of Kootenay Lake. The reservoir behind the dam extends for about 43.5 km (27 mi.) 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 ft.) 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 ft.) above the riverbed and extends 503 m (1650 ft.) from the navigation lock to the south bank of the river. The reservoir, about 233 km (145 mi.) 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 ft.) 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 ft.) 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.

In April 2004, the concrete lining at the base of the intake approach channel was damaged at one location. Permanent repairs were undertaken, the damaged lining was replaced, and the plant returned to full operation in early 2006.

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 mi.) north of Revelstoke, British Columbia. The earthfill dam rises more than 244 m (800 ft.) above its foundations and extends 793 m (2600 ft.) across the Columbia River valley. It is the tallest dam in North America. It creates a reservoir 217 km (135 mi.) 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 mi.) 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 ft.) long, rises 113 m (370 ft.) above the riverbed, and creates Lake Koocanusa, which is 145 km (90 mi.) long and extends 67.6 km (42 mi.) into Canada. Lake Koocanusa has a gross storage of 7.2 km^3 (5.869 Maf), of which 6.1 km^3 (4.980 Maf) 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 U.S. Army Corps of Engineers (USACoE) to complete generating units six through eight. 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-mi.) 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 (CRTHMC), formed by the Entities in 1968, makes recommendations on further development of the Treaty Hydrometeorological System.

In February 2005, the Board asked the CRTHMC to present a report identifying issues and making recommendations regarding the ongoing loss of data acquisition stations. The CRTHMC presented its final report to the Board at the February 2006 annual meeting. In its report, the CRTHMC emphasized the importance of ensuring good communications with the agencies concerned regarding Treaty data requirements, and proposed four recommendations to address Canadian station network issues:

1) The CRTHMC will continue to use its process to review hydrometeorological data networks.

2) The CRTHMC will continue to inform the agencies concerned — BC Hydro, British Columbia Ministry of the Environment, Environment Canada's Water Survey of Canada, and Environment Canada's Atmospheric Monitoring Division — of the importance of data collection to the Columbia River Treaty. The CRTHMC will work with agencies to clarify their roles in supporting the Columbia River Treaty.

3) The CRTHMC will discuss communications issues with Environment Canada's Atmospheric Monitoring Division to ensure all parties have the same understanding with respect to the importance of maintaining Treaty stations.

4) BC Hydro will implement closer monitoring of the availability of Treaty stations in real time to identify potential issues regarding missing data as they arise.

During the reporting period, the CRTHMC was also involved in the review of several sets of new water supply forecasting procedures for Dworshak, Mica, Arrow, and Duncan dams that were updated by the USACoE and BC Hydro.

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 annually for the sixth succeeding year 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 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 later.

During the reporting year, the actual operations of the Treaty storage in Canada were regulated under the rule curves set out in the Entities' *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2005 through 31 July 2006*, dated June 2005, and the *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2006 through 31 July 2007*, dated May 2006, as well as in accordance with additional agreements between the Entities signed during the year. These documents were based on the operating criteria and hydroregulation studies contained in the corresponding AOPs, together with any changes agreed to by the Entities.

Beginning with the 2000–2001 DOP, the Libby operating criteria and expected operation 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 flows would be higher, and fall and winter flows lower, than in the past. In addition, in January 2003, the USACoE adopted the VarQ for operations at Libby on an interim basis. The VarQ is the conditional use of reserved flood control storage to provide augmentation flows for fisheries during the spring period. The 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 salmon and white sturgeon fisheries operations at the Libby Project, and allowed the Entities to coordinate reservoir releases and agree to AOPs and DDPBs without having to fully resolve the matter in dispute at that time. The LCA essentially suspends the active issues of disagreement, 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 six 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. Over the past nine years, such efforts added to BPA's Congestion Management Plan for the Puget Sound Area Northern Intertie (PSANI) were approximately US$90 million. During the reporting period, the Canadian entitlement was delivered as scheduled 100 percent of the time.

Major proposed transmission and generation projects in the northwest include the following:

- In September 2006, the Canadian National Energy Board approved the Sea Breeze Power Corporation's application to construct a 550-MW international power line — via two HVDC submarine cables — between Vancouver Island, British Columbia, and Washington State. One cable will run between Port Angeles, Washington, and Vancouver Island, British Columbia, with a second to run between Fairmount, Washington, and Vancouver, British Columbia. The first cable could be in service by the winter of 2007, and the second in 2008.
- The Montana-Alberta Tie Limited 150-MW transmission line is currently before regulators for approval.
- The Northern Lights transmission line from northern Alberta to the U.S. is still under discussion, but no applications have been made to regulators for approval.
- The 720-MW Cherry Point gas-fired cogeneration plant is expected to go into service in 2008–2009. It will link into the BPA system at the south end of the Northern Intertie.

In April 2006, the BPA issued a white paper entitled, *Challenge for the Northwest: Protecting and Managing an Increasingly Congested Transmission System*. In addition, ColumbiaGrid, a non-profit membership Washington corporation, was formed in March 2006 to improve the operational efficiency, reliability, and planned expansion of the northwest transmission grid. RTO GridWest development continues to be a work in progress, and the Entities will continue to monitor its potential impacts on the Treaty.

In May 2006, the U.S. Federal Energy Regulatory Commission issued a Notice of Proposed Rulemaking proposing amendments to Order Nos. 888 and 889 to ensure transmission services are provided on a nondiscriminatory, just and reasonable basis. The Commission also issued a revised pro forma open access transmission tariff. The Final Rule could become effective in 2007.

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*, 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. As per contract terms, release rights under the Non-Treaty Storage Agreement terminated effective 30 June 2004. The extended provision of the agreement requires that active non-Treaty storage space in Mica be refilled within seven years (the deadline is 30 June 2011). The parties to the agreement have indicated their interest in negotiating a new Non-Treaty Storage Agreement.

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 Treaty permits the Entities to develop DOPs to address fisheries' needs, to the extent that 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

OPERATIONS UNDER THE TREATY

General

The Columbia River Treaty Operating Committee 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 2005 to 30 September 2006, Treaty operations thereunder are based on the Treaty operating year of 1 August 2005 to 31 July 2006. Additional information for 1 August 2006 to 30 September 2006 is based on the Treaty operating year 1 August 2006 to 31 July 2007.

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 2000 BiOp by the FWS, the 2004 BiOp by the NMFS, and the 2006 interim VarQ.

- 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 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.

- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2005–2006, dated August 2001

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2005 through 31 July 2006.

- 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 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.

- Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans for Operation of Canadian Treaty Storage, dated 16 December 2003

  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 Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2006–2007, dated February 2004

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2006 through 31 July 2007.

- Detailed Operating Plan for Columbia River Storage for 1 August 2005 through 31 July 2006, dated June 2005

  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 2005 through 31 July 2006.

- Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 1 December 2005 through 31 July 2006, signed 16 December 2005

  This agreement is similar to previous agreements implemented to utilize Treaty storage for non-power uses. These uses include: (1) providing flows for Canadian trout spawning for the April through June period; (2) enhancing the capability in the U.S. of providing spring and summer flow augmentation for salmon and steelhead by storing 1 Maf of water in Arrow by late April; (3) enhancing Arrow Lakes levels by ensuring progressive refill; (4) providing a minimum discharge objective at Arrow during January through March 2006 for the purpose of protecting eggs deposited on the streambed by Mountain Whitefish during December 2005 through January 2006; (5) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam from December 2005 through early May 2006. This agreement supplements the 2005–2006 DOP.

- Detailed Operating Plan for Columbia River Storage for 1 August 2006 through 31 July 2007, dated May 2006

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 2006 through 31 July 2007.

- Columbia River Treaty Operating Committee Agreement on Implementation Procedures for Flood Control Reallocation for the 2005–2006 Operating Year, signed 13 July 2005

  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 Entity Agreement determining no adverse Treaty impacts of BPA-BC Hydro storage in non-Treaty space for the period 25 May 2006 to 30 September 2006, dated June 2006

  This agreement between the Entities allows the short-term use of non-Treaty storage for mutual benefits.

System Storage

The 2005–2006 operating year began on 1 August 2005 with the Canadian Treaty storage at 18.8 km³ (15.2 Maf) or 98.4 percent full. This starting condition for storage was slightly below DOP levels by 121 hm³ or 98 kaf, as determined in the Treaty Storage Regulation (TSR) study. The Canadian storage was operated to forecasted TSR levels during August through December 2005, except for a small provisional draft authorized by the LCA. Substantial inadvertent draft occurred in December 2005, with Canadian storage ending the month 822.5 hm³ (665.7 kaf) below the TSR. This was caused by a large change in December composite Treaty storage content of about 863 hm³ (700 kaf) in the final TSR run in January. The January TSR incorporated large inflow changes that materialized after the last TSR was run in December. In accordance with a Supplemental Operating Agreement, Canadian storage filled to 1524 hm³ (1236 kaf) above the TSR by February 2006, remained above the TSR through June, and returned to the TSR in July. Canadian storage ended the operating year at 18.6 km³ (15.0 Maf) or 97.1 percent full, and 373 hm³ (302.5 kaf) below the TSR.

The 1 January 2006 water supply forecast for the Columbia River above The Dalles for January through July was 125.0 km³ (101.0 Maf), or 94.5 percent of the 1971–2000 average. The water supply forecast remained close to average through April, and then ended up at 103.6 percent of normal by the June forecast. The actual January through July runoff volume at The Dalles was 141.0 km³ (114.7 Maf) or 106.6 percent of the 1971–2000 average. Above The Dalles, the seasonal precipitation for the water year was 128 percent of average. The unregulated peak

flow at The Dalles, Oregon, was estimated at 20 564 m^3/s (724 kcfs) on 25 May 2006. A regulated peak flow of 11 357 m^3/s (401.5 kcfs) occurred on 29 May 2006.

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 2005 to 30 September 2006. The hydrographs show actual reservoir levels (Storage Curve) and key rule curves that 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

Mica (Kinbasket) Reservoir reached a maximum elevation of 750.56 m (2426.5 ft.) on 8 August 2005, 3.82 m (12.5 ft.) below full pool. After reaching its peak level, the reservoir continued to draft, and departed from normal levels beginning in late summer due to low basin inflow conditions in August and September. As inflows continued to recede throughout the fall and winter period, and outflows increased to meet winter load requirements, the reservoir drafted steadily, reaching 735.27 m (2412.3 ft.) on 31 December 2005. With reduced generation requirements in early 2006, the reservoir recovered to near normal levels by mid-February 2006. However, it continued to draft steadily during spring 2006 to reach a minimum elevation of 727.0 m (2384.2 ft.) on 7 April 2006, 19.9 m (65.2 ft.) above empty. The reservoir refilled during the summer months, ending August 2006 at 751.73 m (2466.3 ft.) or 2.03 m (6.6 ft.) above the mean elevation for this date.

Arrow Reservoir

Arrow Reservoir reached a maximum elevation of 434.63 m (1425.9 ft.) on 1 July 2005, 5.5 m (18.1 ft.) below full pool. Influenced by a low initial level, Arrow drafted to below-normal levels, reaching 427.83 m (1403.7 ft.) by 31 December 2005, and a minimum elevation of 425.88 m (1397.3 ft.) on 31 March 2006, 5.87 m (19.3 ft.) above empty. Arrow refilled to a maximum elevation of 439.82 m (1443.0 ft.) on 10 July 2006, 0.31 m (1.0 ft.) below full pool. The operation of Arrow Reservoir was modified during the operating year under the *Non-Power Uses Agreement* and the *2006 Summer Storage Agreement (Non-Treaty)*. The Non-Power Uses Agreement helped to enhance the success of whitefish and rainbow trout spawning and their emergence downstream of the Arrow project, and to provide additional non-power benefits in the U.S. The *2006 Summer Storage Agreement (Non-Treaty)* helped to reduce inflow into Grand Coulee during the freshet, provide summer flow support for U.S. fisheries, and enhance Arrow reservoir elevations for summer recreation. The agreement did not infringe on Treaty operations or storage operations under the *1990 Non-Treaty Storage Agreement*.

Duncan Reservoir

Duncan Reservoir reached a maximum elevation of 576.48 m, (1891.4 ft.) on 31 July 2005, 0.17 m (0.6 ft.) below full pool. From September 2005 through April 2006, Duncan discharge was used to

supplement inflow into Kootenay Lake and to provide spawning and incubation flows for fish. The reservoir drafted to a minimum elevation of 546.95 m (1794.5 ft.) on 17 April 2006, 0.08 m (0.3 ft.) above empty. Reservoir discharge was reduced to a minimum of 3 m^3/s (100 cfs) on 4 May 2006 to initiate reservoir refill. The reservoir refilled to full pool at about 576.7 m (1892 ft.) on 23 August 2006.

Libby Reservoir

Libby Reservoir was operated for power during October through December 2005, as developed in the TSR in accordance with the *Columbia River Treaty* and 2003 Columbia River Treaty FCOP. Libby operated to Principal Component Methodology water supply and flood control draft in December 2005. The December forecast was 106 percent of average, and the recommended draft for Libby Reservoir was 2.46 km^3 (2 Maf), to elevation 734.9 m (2411 ft.) on 31 December.

Libby operated to VarQ flood control in the January through spring period. The FWS finalized a BiOp on 18 February 2006 for white sturgeon in the Kootenai River downstream of Libby Dam. The Libby Operating Plan was updated on 21 April 2006, and the USACoE signed a Record of Consultation and Summary of Decision on the BiOp on 8 May 2006. Libby Reservoir operated to a stacked flow operation for sturgeon beginning 14 May 2006. This was followed by above-average precipitation in early and mid-June 2006, and spill from Libby Dam. During the time of peak inflows, the project outflow was 1472 m^3/s (52 kcfs). Outflow reached a maximum of 1557 m^3/s (55 kcfs), which included 877 m^3/s (31 kcfs) spill, on 17 June. The flow operation controlled Libby reservoir (Lake Koocanusa) to full pool elevation. By 19 June, calculated six-hour inflows had dropped to 1189 m^3/s (42 kcfs), and the project was holding 1557 m^3/s (55 kcfs) in order to provide some storage for any unexpected inflow rises. In combination with river rises below the project and required releases from Libby Dam, Bonners Ferry stage reached the flood level of 537.7 m (1764.0 ft.) late on 16 June, and appeared to have peaked late on 18 June, at 538.47 m (1766.63 ft.), with only minimal direct flood damages noted. This was the first time the flood stage was exceeded since the construction and operation of Libby Dam. Bonners Ferry stage went below the flood level the afternoon of 22 June. Beginning 20 June, spill was decreased 28.3 m^3/s (1 kcfs) every four hours and reached 170 m^3/s (6 kcfs) on 24 June (total outflow was 849 m^3/s or 30 kcfs). Spill was reduced to zero on 27 June. The project ended the month at elevation 748.8 m (2456.73 ft.), or 0.69 m (2.27 ft.) from full.

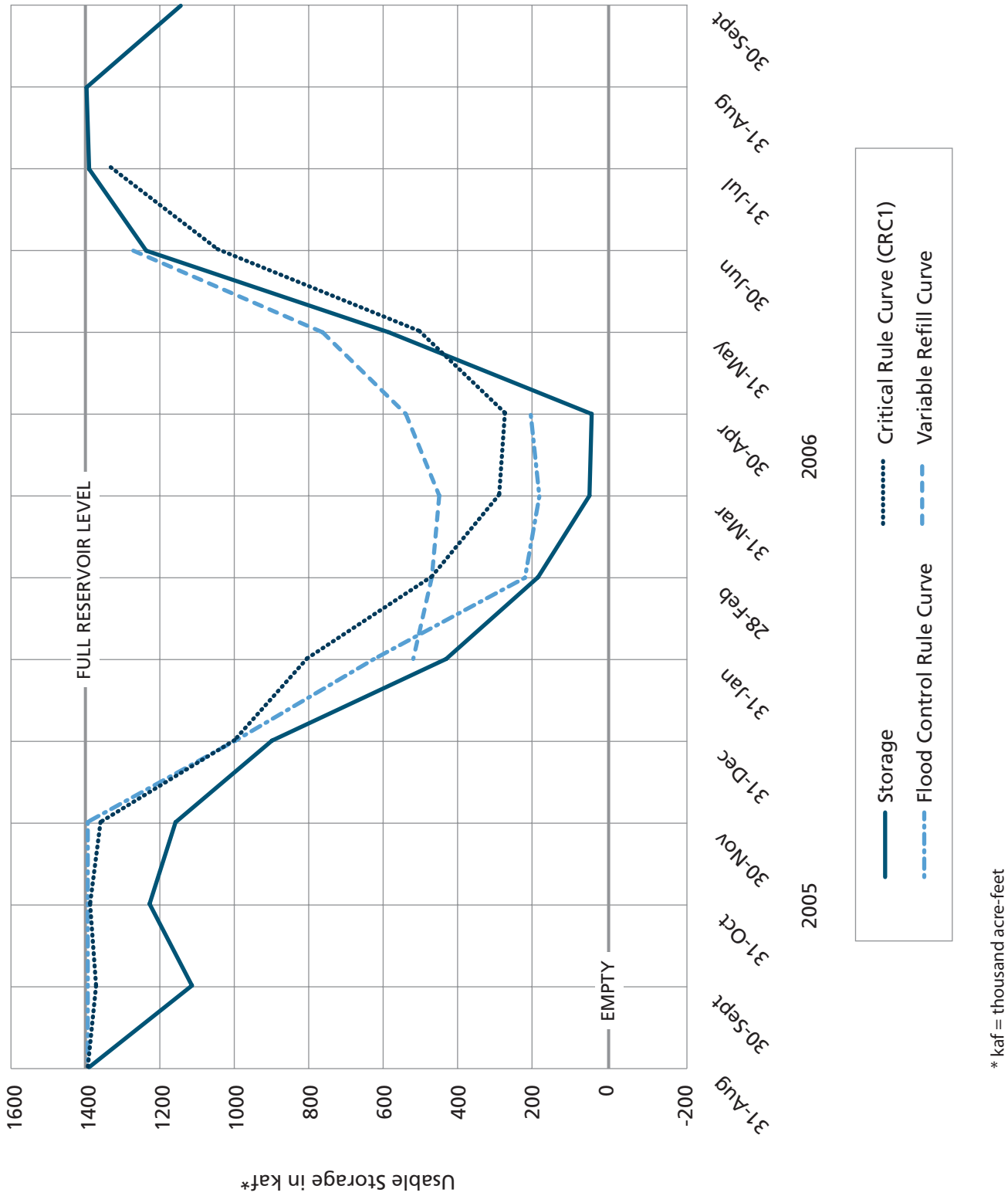
Federal Columbia River Power System

The U.S. Federal Columbia River Power System was operated to meet chum needs below Bonneville Dam from December 2005 into April 2006. U.S. reservoirs were also operated to achieve the 10 April 2006 flood control elevation as per the NMFS 2004 BiOp for juvenile fish needs. For 2006, Libby Dam released the volume of water requested by the FWS to meet downstream Kootenai River white sturgeon needs. The U.S. storage projects generally filled by 30 June 2006 as per the BiOps. Grand Coulee and Hungry Horse drafted to their end-of-August BiOp target elevations to improve fish migration flows. The fish flow draft at Libby was extended into late September 2006 at the request of fishery managers. Dworshak Dam drafted its target elevation for fish flows in mid-September 2006.

Flood Control Operations

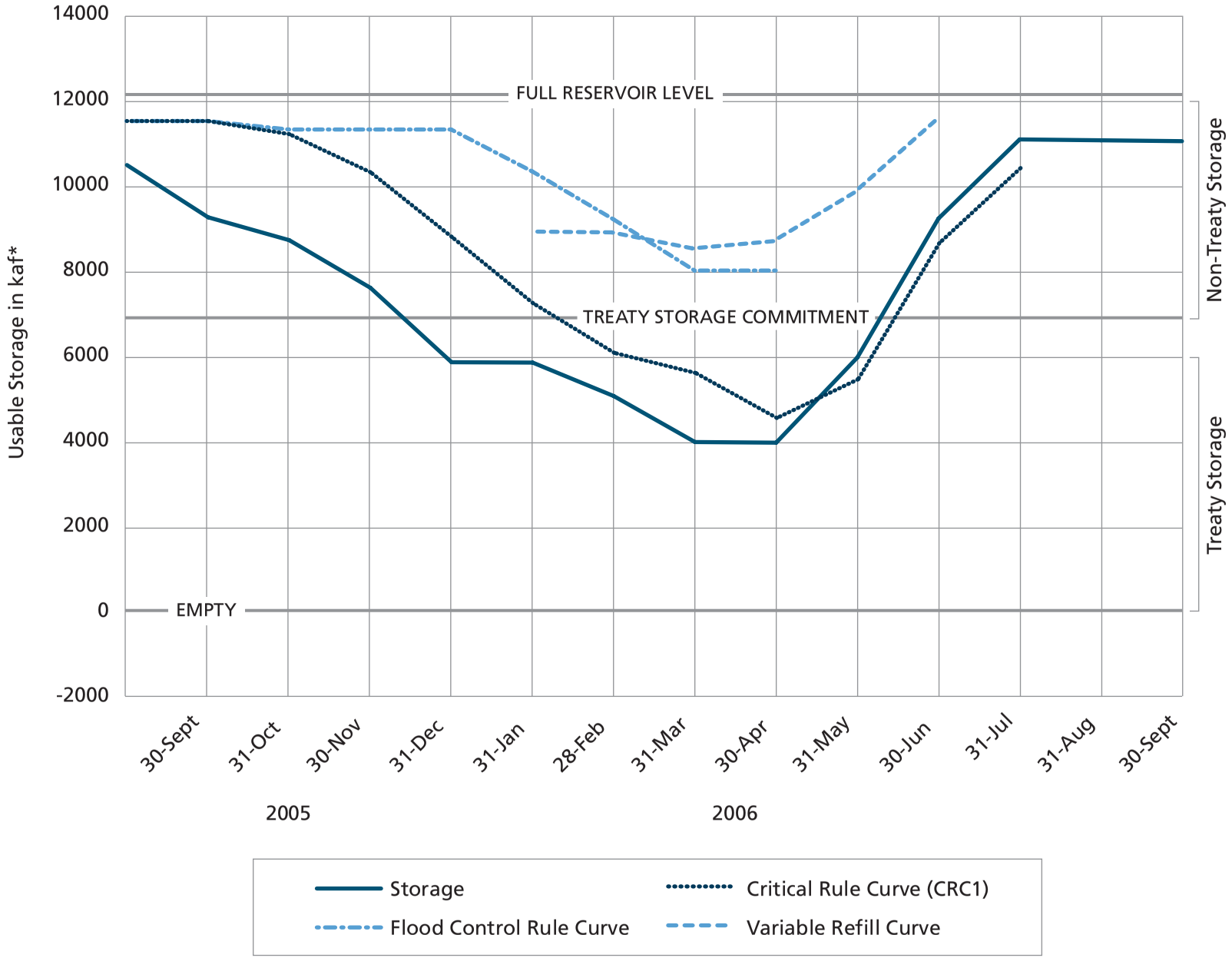
The 2003 FCOP played a prominent part in the 2005–2006 flood control operations of the Columbia River Basin as the Columbia River water supplies were slightly above average. The regulated peak flow at The Dalles, Oregon, was 11 357 m^3/s (401.5 kcfs) on 29 May 2006, and the unregulated flow was estimated at 20 564 m^3/s (724.0 kcfs) on 25 May 2006. The peak stage observed at Vancouver, Washington, was 3.97 m (13.0 ft.) on 30 May 2006, and the estimated unregulated stage was 7.95 m (26.1 ft.) on 26 May 2006.

Duncan Reservoir Levels



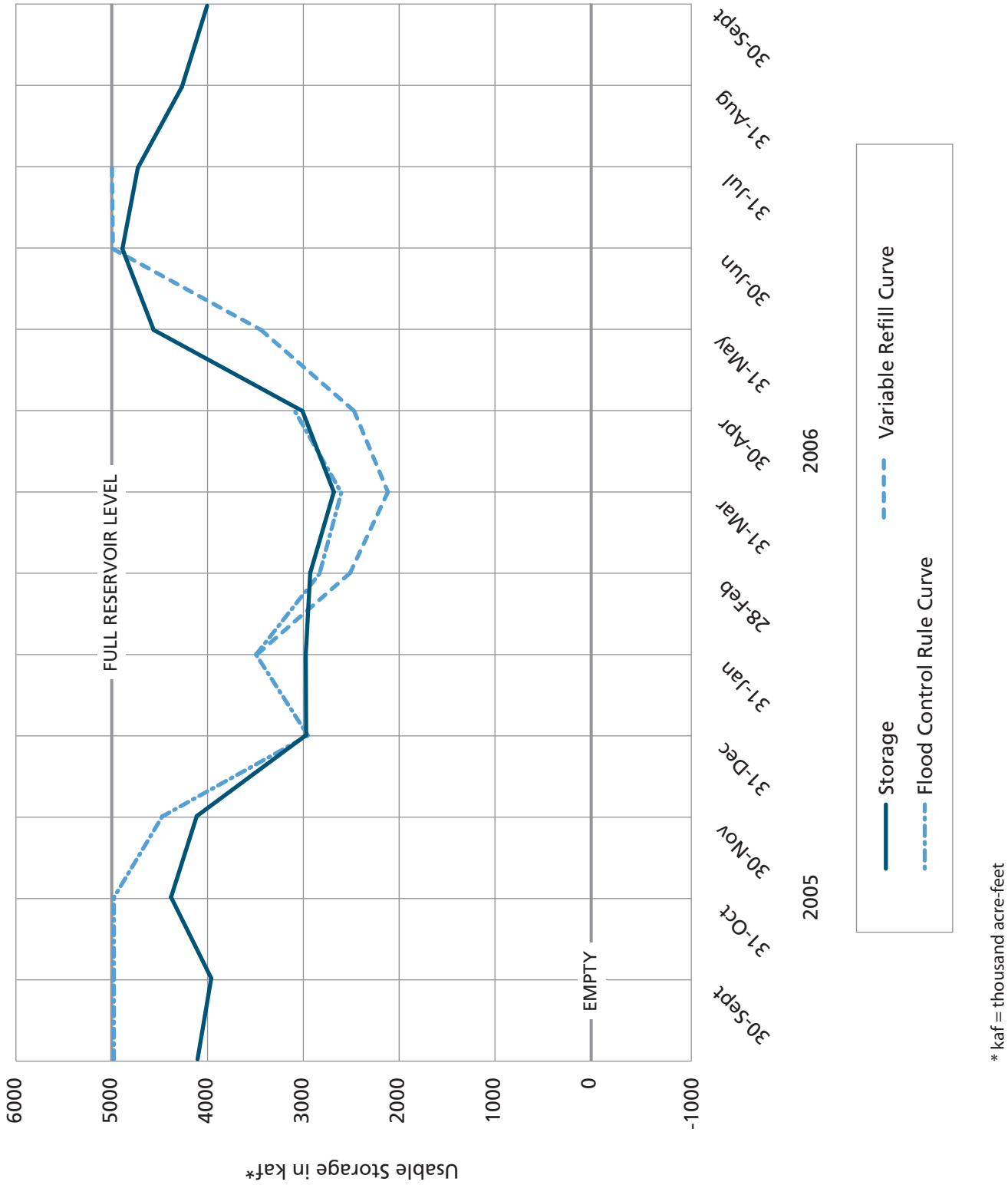
* kaf = thousand acre-feet

Mica Reservoir Levels



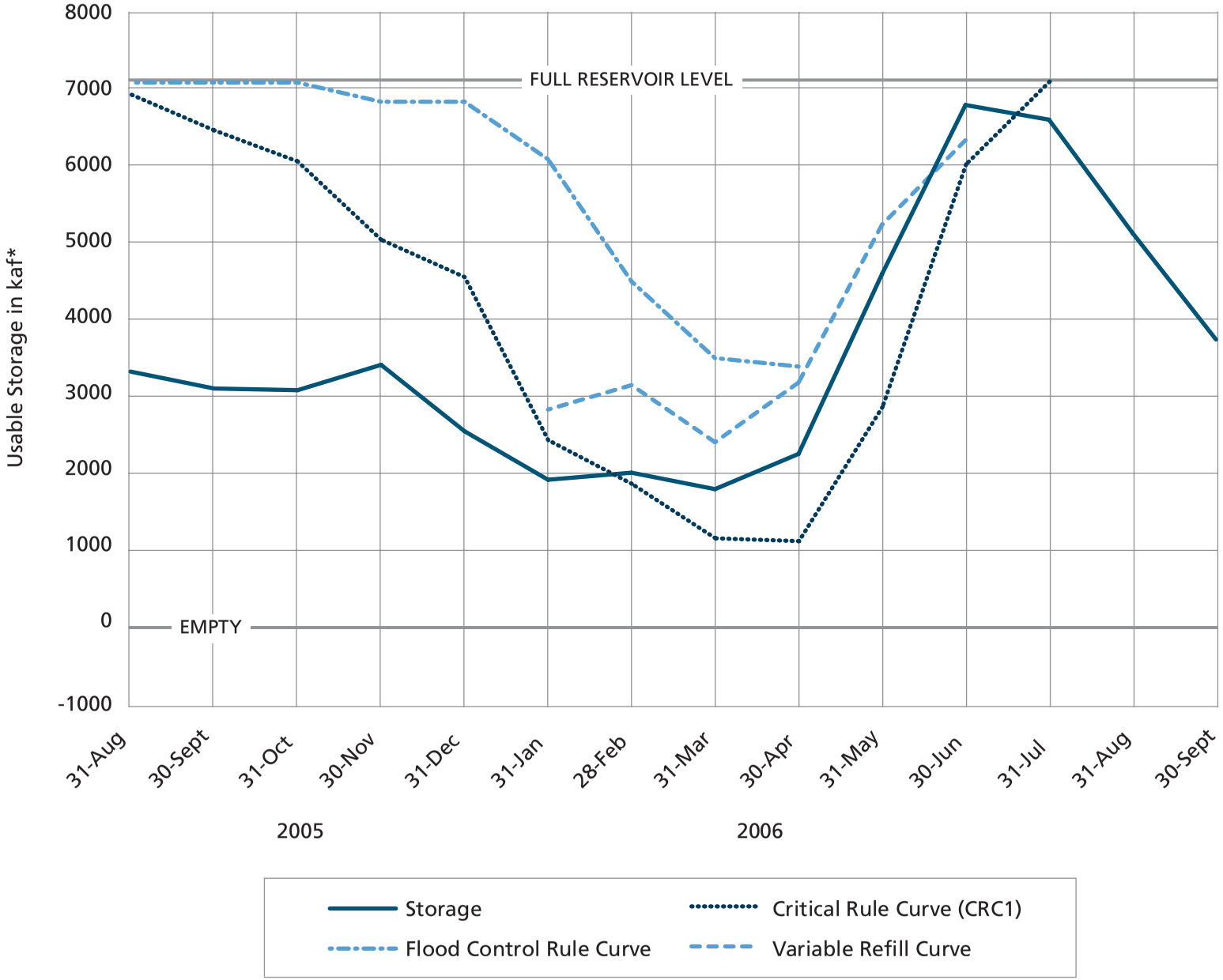
* kaf = thousand acre-feet

Libby Reservoir Levels

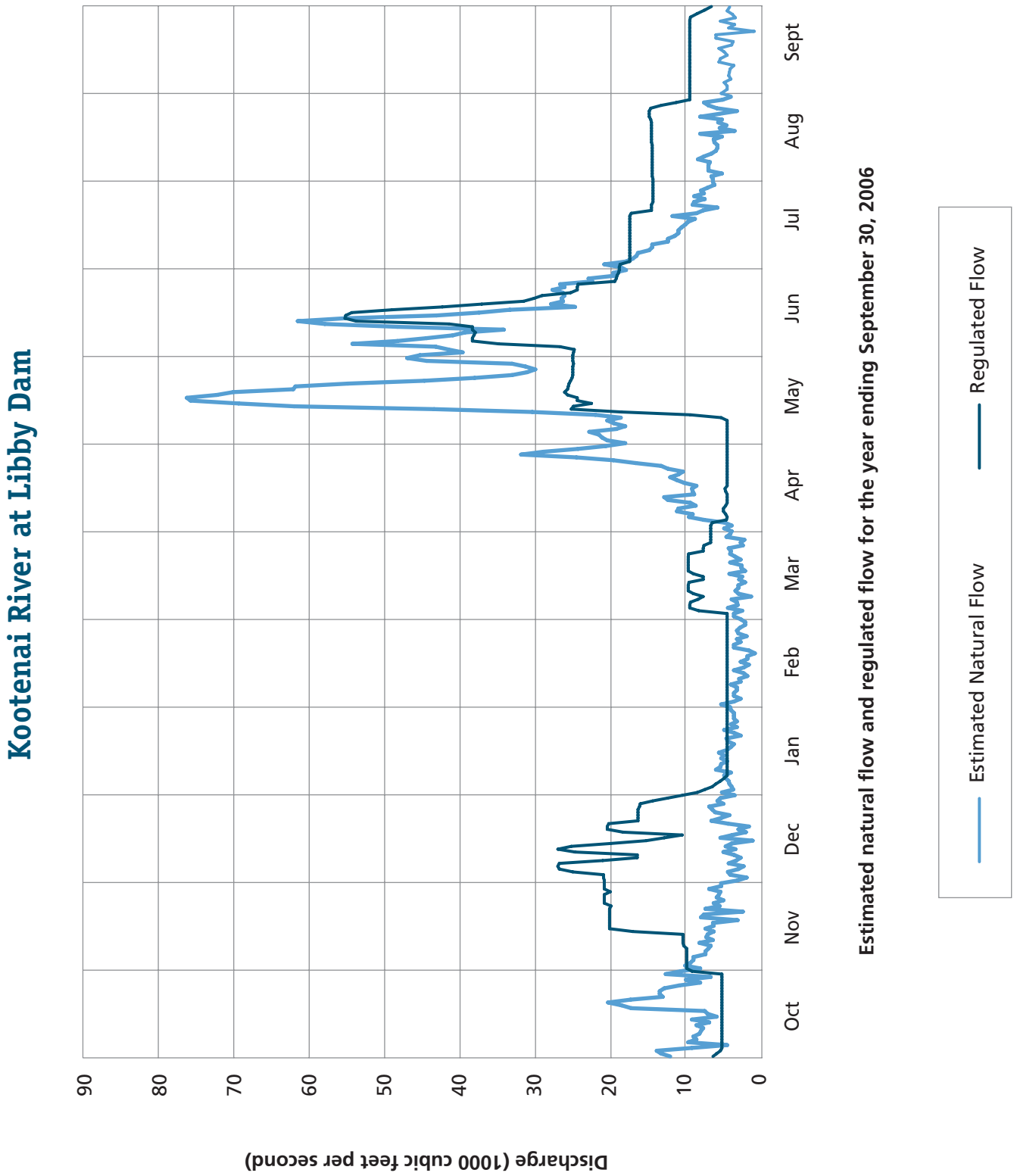


* kaf = thousand acre-feet

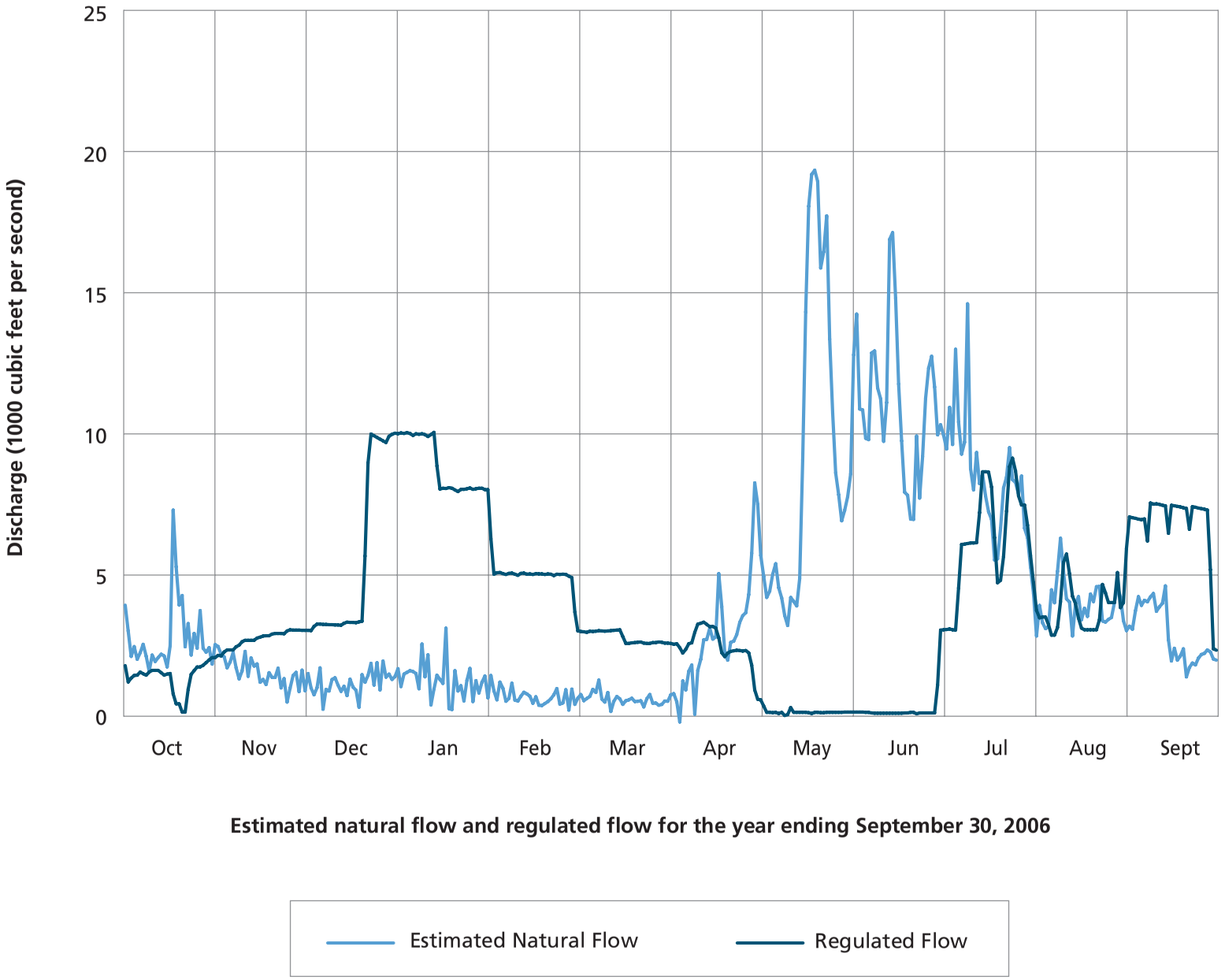
Arrow Reservoir Levels



* kaf = thousand acre-feet

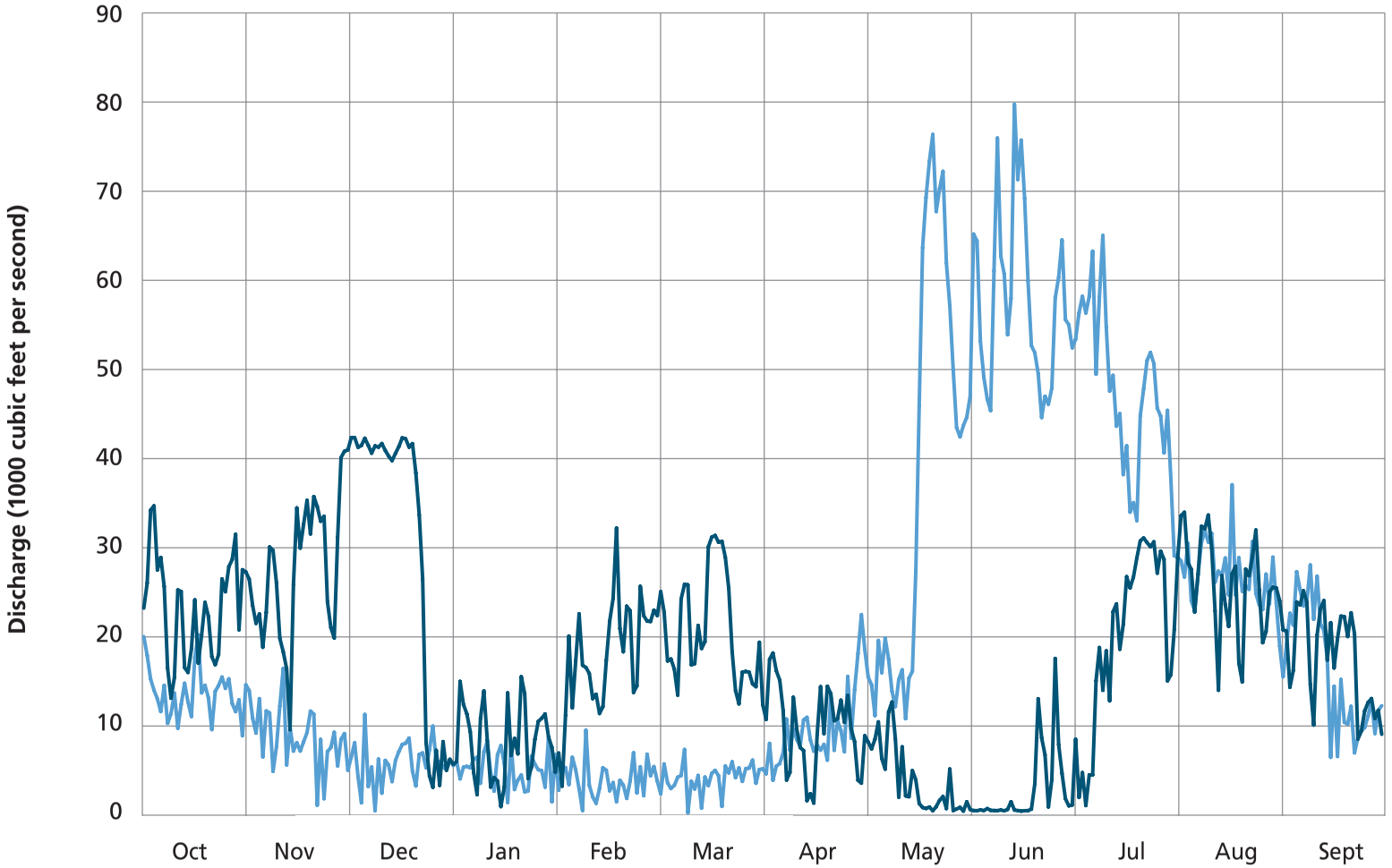

Kootenai River at Libby Dam
Discharge (1000 cubic feet per second)
0
10
20
30
40
50
60
70
80
90
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Estimated natural flow and regulated flow for the year ending September 30, 2006
Estimated Natural Flow
Regulated Flow

Duncan River at Duncan Dam



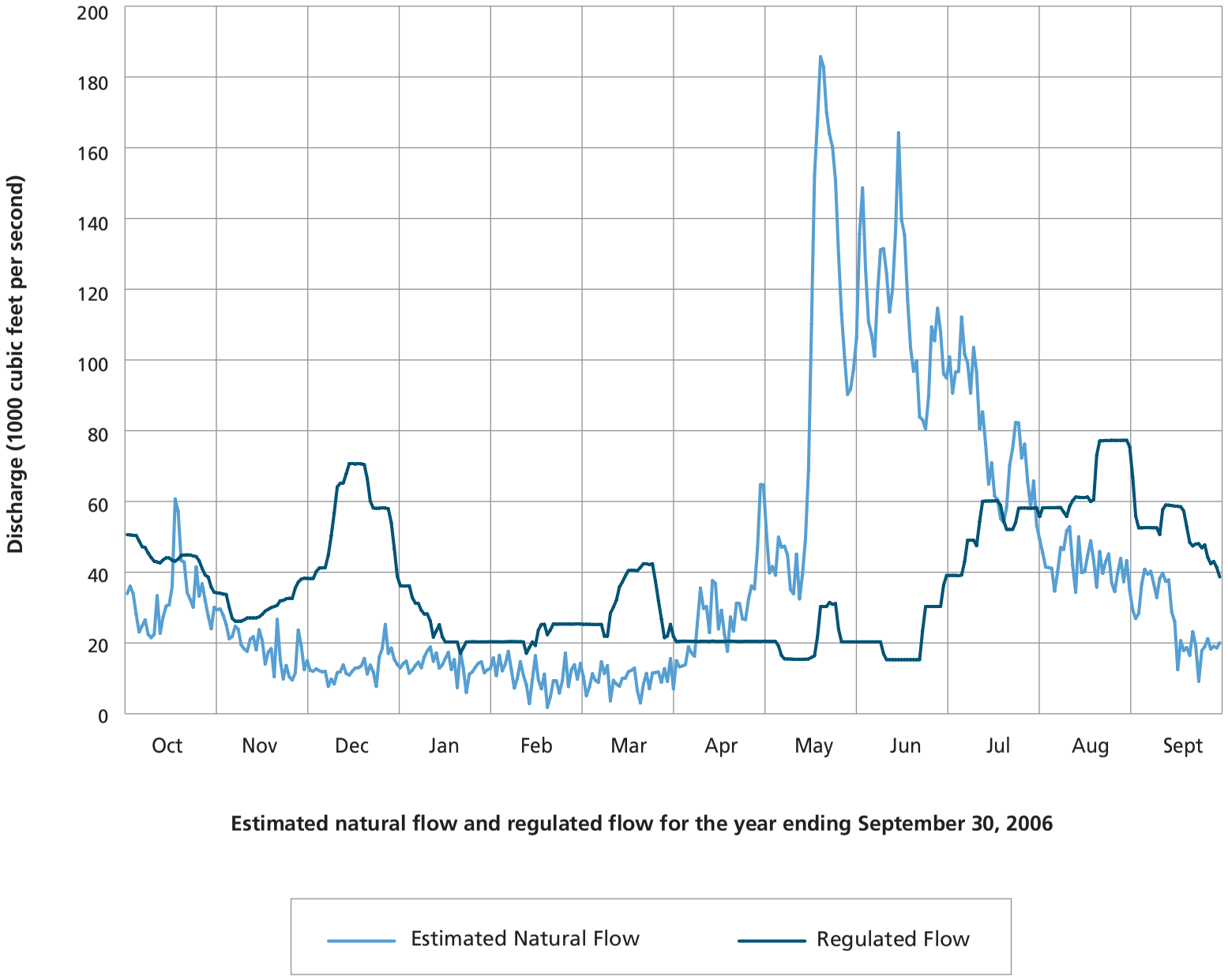
Estimated natural flow and regulated flow for the year ending September 30, 2006

Columbia River at Mica Dam



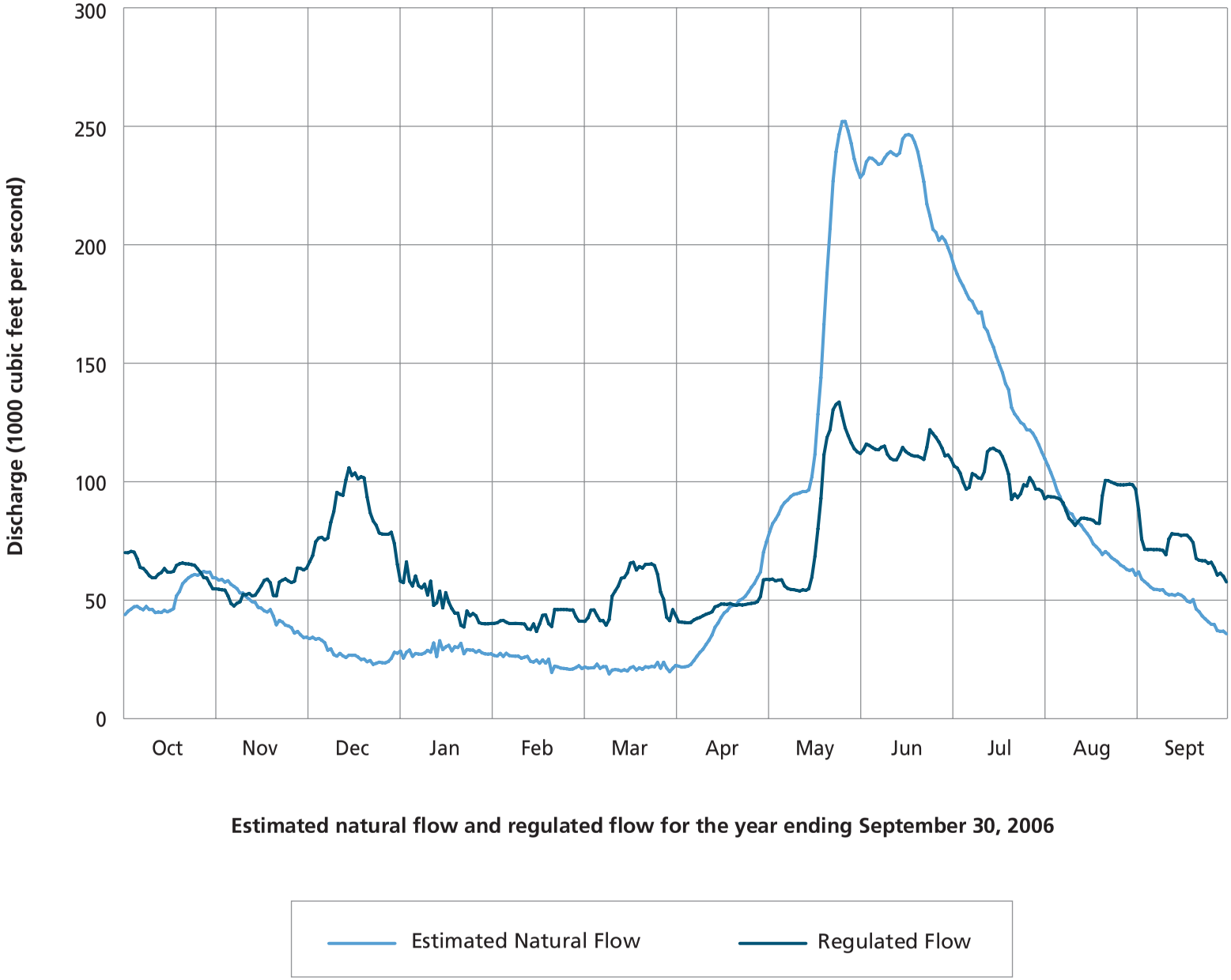
Estimated natural flow and regulated flow for the year ending September 30, 2006

Columbia River at Hugh Keenleyside Dam



Estimated natural flow and regulated flow for the year ending September 30, 2006

Columbia River at Birchbank



Estimated natural flow and regulated flow for the year ending September 30, 2006

benefits

TREATY BENEFITS

Flood Control Benefits

The 2003 FCOP played a prominent part in the 2005–2006 flood control operations of the Columbia River Basin, as the Columbia River water supplies were slightly above average. 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)
29 May 2006	11 357 (401 500)	25 May 2006	20 564 (724 000)

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)
30 May 2006	3.97 (13.0)	26 May 2006	7.95 (26.1)

It is estimated that the Duncan and Libby projects reduced the peak stage of Kootenay Lake by about 0.95 m (3.1 ft.). The Duncan, Arrow, Mica, and Libby projects reduced the peak stage of the Columbia River at Trail, just upstream of Birchbank, British Columbia, by about 3.4 m (11.2 ft.). 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 Cora Linn development on Kootenay Lake, have been removed.

Power Benefits

From 1 August 2005 to 31 July 2006, the U.S. Entity delivery of the Canadian entitlement to downstream power benefits was 535.1 aMW at rates of up to 1195 MW. From 1 August 2006 to 30 September 2006, the U.S. Entity delivery of the Canadian entitlement to downstream power benefits was 488.5 aMW at rates of up to 1244 MW. There were no curtailments of Canadian entitlement deliveries during the 2005–2006 operating year.

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, an 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 entitlement power was disposed directly in the U.S. during the 2005–2006 operating year as allowed by this agreement.

Other Benefits

By agreement between the Entities, reservoirs 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.

Columbia River, British Columbia

Revelstoke Dam - Columbia River, British Columbia

Cora Linn Dam (FortisBC) – at the outflow of Kootenay Lake, British Columbia

CONCLUSIONS

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

2. 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 535.1 aMW of energy and 1195 MW of capacity from 1 October 2005 to 31 July 2006, and 488.5 aMW of energy and 1244 MW of capacity from 1 August 2006 to 30 September 2006. There were no curtailments of Canadian entitlement deliveries or entitlement power disposed directly in the U.S. during the 2005–2006 operating year.

3. As a result of the flooding incident downstream of Libby in June 2006, the USACoE conducted an After Action Review of Libby operations to identify the lessons learned and potential changes to future operations. The report concluded that the VarQ operation to be implemented in 2007 will be a strict application of the eight-step VarQ operating procedures. The USACoE will not consider or implement any deviations from the VarQ operating procedures in 2007 that would cause the reservoir to be above the rule curve or reduce outflow below the prescribed VarQ outflow, except for short-term deviations when necessary to protect human life and safety, and to comply with the order of the International Joint Commission.

4. The 2003 FCOP played a prominent part in the 2005–2006 flood control operations as Columbia River water supplies were slightly above average. The observed January through July flow volume above The Dalles was 141 km^3 (114.7 Maf), 107 percent of the 1971–2000 average. The unregulated peak flow at The Dalles was estimated at 20 564 m^3/s (724.0 kcfs) on 25 May 2006, while a regulated peak flow of 11 357 m^3/s (401.5 kcfs) occurred on 29 May 2006. Canadian Treaty storage began the year at 98.4 percent full, and ended the year at 97.1 percent full.

5. The Entities continued to operate the hydrometeorological network as required by the Treaty. At the Board's request, the Columbia River Treaty Hydrometeorological Committee submitted a report that identifies specific issues and makes recommendations regarding the ongoing loss of data acquisition stations in October 2005. The final report was presented to the Board at its annual meeting in February 2006.

6. The Board concludes that the objectives of the Treaty have been met for the reporting period.

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	Mr. Tom Wallace, Chair Director General Electricity Resources Branch Natural Resources Canada Ottawa, Ontario
Mr. Ed Sienkiewicz Consultant Portland, Oregon	Mr. Tim Newton, P.Eng. Consultant Vancouver, British Columbia
Alternates	
Mr. Robert A. Pietrowsky Director, Institute of Water Resources Headquarters, U.S. Army Corps of Engineers Washington, D.C.	Mr. David Burpee Special Advisor to the Director General 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. Jerry W. Webb, P.E. Principal Hydrologic & Hydraulic Engineer Hydrology, Hydraulics & Coastal Community of Practice Leader Headquarters, U.S. Army Corps of Engineers Washington, D.C.	Ms. Eve Jasmin Senior Policy Advisor Renewable and Electrical Energy Division Electricity 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	1988–2005	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–	Mr. Tom Wallace[1]	2004–
Mr. Ed Sienkiewicz	2005–		
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	2000–2004		
Mr. Robert Pietrowsky	2004–		
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	2000–2004		
Mr. Jerry Webb	2004–		

[1] Chair

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD
ENGINEERING COMMITTEE

Current Membership

United States	**Canada**
Members	
Mr. Jerry W. Webb, P.E. Principal Hydrologic & Hydraulic Engineer Hydrology, Hydraulics & Coastal Community of Practice Leader 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 Operations Division Headquarters, U.S. Army Corps of Engineers Washington, D.C.	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. Consultant Pacific Northwest Region Boise, Idaho	Mr. Ivan Harvie, P.Eng. Renewable and Electrical Energy Division Natural Resources Canada Calgary, Alberta

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 Gregg F. Martin, Member
Division Engineer
Northwestern Division
U.S. Army Corps of Engineers
Portland, Oregon

Canada

Members

Mr. Robert Elton, 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 2006

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1	9.4	10.3	22.3	14.5	7.4	7.7	12.4	28.6	37.6	27.2	15.4	14.8
2	9.2	11.4	22.4	12.7	7.3	7.8	12.4	25.9	38.9	23.7	15.4	13.2
3	8.0	12.2	22.3	10.5	7.2	7.4	13.0	22.7	39.9	23.9	15.4	11.1
4	6.6	11.8	22.6	9.4	7.2	7.6	13.1	20.3	38.9	23.4	15.3	10.2
5	6.4	11.7	22.6	8.5	7.2	7.6	13.2	19.0	39.1	22.6	15.3	10.2
6	6.2	11.4	26.3	7.8	7.3	7.4	14.0	18.7	37.9	22.2	15.3	10.1
7	6.2	11.6	27.3	7.8	7.1	7.4	16.1	19.5	36.9	22.9	15.4	10.0
8	6.6	11.3	27.2	7.6	6.9	11.6	18.9	20.3	37.6	21.2	15.3	10.0
9	6.6	11.4	26.4	7.1	7.1	12.7	18.0	19.8	41.4	21.0	15.1	10.0
10	6.3	11.9	22.2	7.4	6.9	13.2	17.9	18.6	46.6	19.9	15.2	10.0
11	6.2	11.7	18.1	9.2	6.5	13.0	17.5	17.8	47.7	20.4	15.4	9.8
12	6.2	11.8	18.1	10.0	6.5	11.6	17.1	17.8	47.0	19.9	15.4	10.0
13	6.2	11.9	25.5	9.6	6.4	10.9	17.0	18.9	47.4	20.6	15.3	9.9
14	6.3	12.3	27.4	9.5	6.5	12.2	17.6	19.0	49.2	20.2	15.2	10.0
15	6.3	18.9	25.7	10.8	6.2	13.0	21.3	20.9	52.5	19.7	15.1	10.0
16	6.2	21.7	21.7	10.4	6.1	13.0	22.8	29.6	53.9	19.8	15.2	10.0
17	6.2	22.1	16.7	9.7	5.7	12.8	20.9	44.6	58.9	19.9	15.0	10.0
18	6.2	22.1	13.6	9.0	5.4	12.6	18.5	55.6	60.6	19.6	15.1	10.0
19	6.2	21.9	12.0	8.8	5.6	10.8	16.9	56.9	61.1	19.3	15.1	10.0
20	6.4	22.0	19.8	8.2	5.8	10.6	16.1	56.4	62.7	19.1	15.1	10.1
21	6.5	22.0	22.2	7.9	6.1	12.1	15.7	55.4	58.8	19.2	15.2	10.1
22	6.8	22.3	22.2	7.5	6.2	12.7	16.4	51.4	55.4	19.5	15.2	10.0
23	6.5	22.0	21.4	7.4	6.2	12.9	17.5	51.7	50.0	19.7	15.2	10.0
24	6.6	21.5	18.7	7.3	6.1	13.0	17.0	49.3	42.5	19.1	15.3	10.0
25	6.5	21.9	18.9	7.3	5.8	13.3	16.5	46.6	37.7	19.1	15.2	10.0
26	6.4	22.0	18.5	6.9	5.7	13.8	16.2	44.8	36.6	18.2	15.2	10.0
27	6.6	22.2	18.6	6.7	6.1	13.9	16.8	41.8	34.7	15.6	15.3	10.0
28	6.5	22.1	19.0	6.6	7.0	14.1	18.0	39.5	31.6	15.5	15.3	9.8
29	6.1	21.5	18.6	6.6	--	12.8	20.2	39.1	30.0	15.4	15.2	8.9
30	6.2	22.2	18.2	6.8	--	12.4	25.2	38.6	28.5	15.4	15.2	8.0
31	6.4	--	16.4	7.4	--	12.6	--	37.8	--	15.4	15.2	--
Mean	**6.6**	**17.0**	**21.1**	**8.6**	**6.5**	**11.4**	**17.1**	**33.8**	**44.7**	**20.0**	**15.2**	**10.2**

Columbia River at Birchbank, British Columbia

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2006

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1	70.5	54.9	66.5	57.7	40.7	41.4	43.8	59.1	112.4	110.0	93.2	88.5
2	70.4	54.7	69.2	66.6	41.6	41.3	41.1	59.0	114.0	107.1	94.3	76.2
3	71.0	54.6	75.0	58.4	41.8	42.8	41.0	59.3	116.5	106.4	94.1	71.8
4	70.7	52.2	76.7	56.3	41.0	46.2	40.9	58.5	115.8	104.2	94.0	71.7
5	68.0	48.9	77.0	60.6	40.4	46.2	40.7	58.8	115.0	100.2	93.6	71.8
6	64.1	47.8	75.8	56.4	40.4	43.8	40.9	58.9	114.2	97.3	93.1	71.7
7	63.8	49.0	76.6	55.5	40.5	41.6	41.9	56.3	114.0	98.1	91.6	71.8
8	62.4	49.6	83.3	57.1	40.4	41.6	42.6	55.3	115.1	103.9	88.2	71.7
9	60.7	52.7	87.8	52.5	40.3	39.7	43.0	54.9	115.6	103.3	84.9	71.4
10	59.8	52.6	96.0	58.4	40.2	42.1	43.7	54.8	112.0	102.1	83.7	69.6
11	59.8	53.2	95.2	48.1	38.2	52.1	44.3	54.5	110.3	101.8	82.0	76.3
12	61.3	52.1	94.7	49.2	37.9	54.2	44.8	54.2	109.7	104.8	83.6	78.5
13	62.0	52.4	101.3	54.2	40.3	56.3	45.3	54.7	109.8	113.2	85.0	78.3
14	63.7	54.3	106.4	47.0	37.0	59.6	47.5	54.5	112.1	114.4	85.1	78.2
15	62.2	56.3	103.1	53.5	40.2	59.9	47.9	55.1	115.0	114.6	84.8	77.7
16	62.1	58.6	104.2	49.4	43.9	61.8	48.7	60.1	113.3	113.8	84.5	77.9
17	62.5	59.2	101.7	46.7	44.1	66.0	48.6	68.9	112.4	113.3	84.1	77.8
18	65.0	57.7	102.6	44.8	40.3	66.3	48.5	80.5	111.6	111.1	82.9	76.5
19	65.7	52.3	102.1	44.8	39.1	63.0	48.9	93.4	111.3	107.7	82.8	74.7
20	66.1	52.1	94.0	39.7	46.4	64.6	48.4	111.9	111.3	103.6	94.6	68.0
21	65.7	58.0	87.4	38.9	46.3	63.9	48.1	119.2	110.7	92.9	101.1	67.2
22	65.7	58.8	83.9	45.7	46.3	65.5	48.4	122.4	109.9	95.3	100.9	67.0
23	65.4	59.4	82.0	43.6	46.3	65.5	48.2	131.0	115.0	93.7	100.3	67.0
24	65.1	58.4	78.8	44.7	46.3	65.7	48.5	133.2	122.5	95.4	99.8	65.9
25	63.5	57.8	78.3	43.7	46.2	65.0	48.7	134.2	120.8	99.2	99.2	66.4
26	62.0	58.3	78.2	40.8	46.2	61.2	48.9	128.6	119.2	98.6	99.2	64.1
27	59.9	63.9	78.2	40.4	43.3	53.7	49.1	123.3	117.3	102.2	99.2	60.9
28	59.7	63.8	79.1	40.3	41.4	50.7	49.7	120.0	114.8	100.4	99.2	61.7
29	57.3	63.1	74.3	40.3	--	43.0	51.8	116.9	111.4	97.3	99.5	60.4
30	55.1	63.9	65.4	40.4	--	41.6	58.9	114.5	111.9	97.3	99.2	58.0
31	55.1	--	58.3	40.5	--	46.3	--	113.2	--	96.4	97.3	--
Mean	**63.4**	**55.7**	**84.9**	**48.9**	**42.0**	**53.3**	**46.4**	**84.5**	**113.8**	**103.2**	**92.1**	**71.3**

APPENDIX D

PROJECT INFORMATION

Power and Storage Projects

Project Data

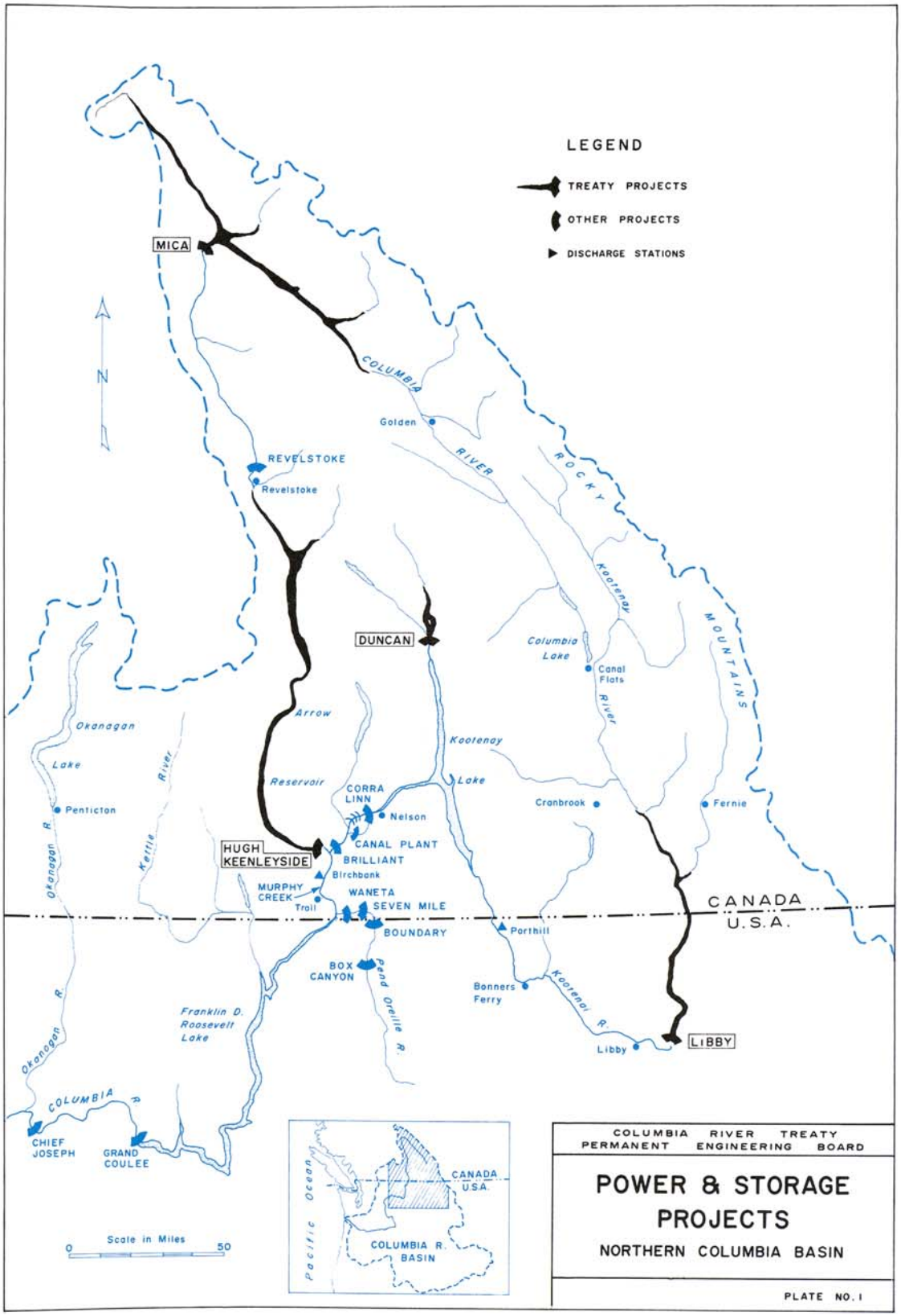

LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
N
COLUMBIA
Golden
RIVER
ROCKY
MOUNTAINS
REVELSTOKE
Revelstoke
DUNCAN
Columbia Lake
Canal Flats
Kootenay
River
Arrow
Reservoir
Okanagan
Lake
Penticton
Okanagan R.
Kettle River
Kootenay
Lake
Cranbrook
Fernie
CORRA LINN
Nelson
HUGH KEENLEYSIDE
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 ft.)
Normal minimum pool elevation	547 m (1794.2 ft.)
Surface area at full pool	7290 hectares (18 000 acres)
Total storage capacity	1.77 km^3 (1.43 Maf)
Usable storage capacity	1.73 km^3 (1.40 Maf)
Treaty storage commitment	1.73 km^3 (1.40 Maf)

Dam, Earthfill

Crest elevation	581 m (1907 ft.)
Length	792.5 m (2600 ft.)
Approximate height above riverbed	39.6 m (130 ft.)
Spillway—Maximum capacity	1350 m^3/sec (47.70 kcfs)
Discharge tunnels—Maximum capacity	570 m^3/sec (20.0 kcfs)

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 ft.)
Normal minimum pool elevation	420 m (1377.9 ft.)
Surface area at full pool	52 650 hectares (130 000 acres)
Total storage capacity	10.3 km^3 (8.34 Maf)
Usable storage capacity	8.8 km^3 (7.10 Maf)
Treaty storage commitment	8.8 km^3 (7.10 Maf)

Dam, Concrete Gravity and Earthfill

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

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 ft.)
Maximum turbine discharge	1200 m^3/sec (42.40 kcfs)

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

Dam, Earthfill

Crest elevation	762.0 m (2500 ft.)
Length	792.5 m (2600 ft.)
Approximate height above foundation	244 m (800 ft.)
Spillway—Maximum capacity	2250 m^3/sec (150 kcfs)
Outlet works—Maximum capacity	1060 m^3/sec (37.40 kcfs)

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 ft.)
Maximum turbine discharge	
of 4 units at full pool	1080 m^3/sec (38.14 kcfs)

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 ft.)
Normal minimum pool elevation	697.0 m (2287 ft.)
Surface area at full pool	18 830 hectares (46 500 acres)
Total storage capacity	7.2 km^3 (5.87 Maf)
Usable storage capacity	6.1 km^3 (4.98 Maf)

Dam, Concrete Gravity

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

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 ft.)
Maximum turbine discharge	
of 5 units at full pool	745.6 m^3/sec (26.50 kcfs)