ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

Washington, D.C. **Ottawa, Ontario**

30 September 2008

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

25 February 2009

The Honorable Hillary Clinton
Secretary of State
Washington, D.C.

The Honourable Lisa Raitt
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Clinton and Minister Raitt:

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-fourth Annual Report of the Permanent Engineering Board, dated 30 September 2008. The report documents the results achieved under the Treaty for the period from 1 October 2007 to 30 September 2008.

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

Respectfully submitted:

For the United States

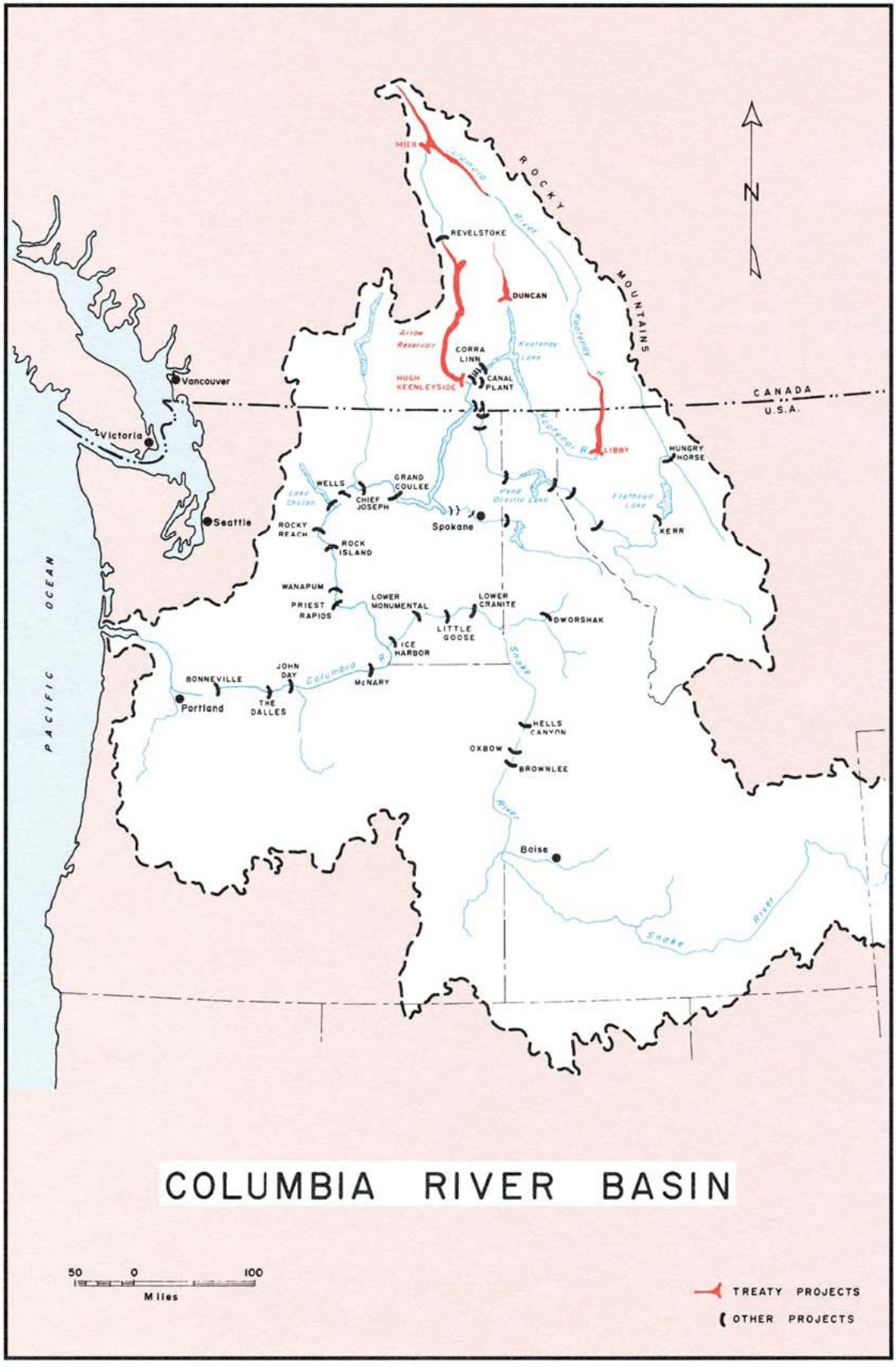
Steven Stockton, Chair

Ed Sienkiewicz

For Canada

Tom Wallace, Chair

Tim Newton



COLUMBIA RIVER BASIN

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PERMANENT ENGINEERING BOARD

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EXECUTIVE SUMMARY

The forty-fourth 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 2007 to 30 September 2008.

During the reporting period, the Canadian Treaty projects – Mica, Duncan, and Arrow – were operated according to the 2007–2008 and 2008–2009 Detailed Operating Plans, the 2003 Flood Control Operating Plan (FCOP), and several supplemental operating agreements. Treaty storage in the United States at the Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 Libby Coordination Agreement (LCA), U.S. requirements for power, and the guidelines set forth in the 2000 BiOp by the USFWS, the 2004 BiOp by the NMFS, and strict application of the eight-step VarQ operating procedures. As reported in this document, the objectives of the Treaty have been met for the reporting period.

The Canadian entitlement to the downstream power benefits for the reporting period was determined, according to the procedures set out in the Treaty and Protocol, to be 482.8 average megawatts (aMW) of energy and 1,241 megawatts (MW) of capacity from 1 August 2007 to 31 July 2008, and 464.9 aMW of energy and 1,245 MW of capacity from 1 August 2008 to 30 September 2008. The Canadian Entitlement obligation was determined by the 2007-2008 and 2008-2009 Assured Operating Plan and Determination of Downstream Power Benefits.

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. One curtailment of Canadian Entitlement occurred in May 2008 due to transmission constraints, totalling 6 MWh, which were delivered to Canada within seven (7) days of the constraint.

Canadian Treaty storage began the operating year on 1 August 2007 at 99.6 percent full, and ended the year on 31 July 2008 at 91.8 percent full. Seasonal flow volume above The Dalles was 92.5 percent of average for January through July 2008. The operating year 2007-2008 was characterized by near average precipitation in most parts of the Columbia River Basin.

There are issues associated with the ongoing implementation and litigation of the 2000 and 2004 BiOps issued by the National Oceanic and Atmospheric Administration (NOAA) Fisheries and USFWS to the U.S. Army Corps of Engineers, Bonneville Power Administration, and the Bureau of Reclamation (Action Agencies) for the operation of U.S. projects. In June 2008, USACE issued a Record of Decision for Libby Dam Flood Control and Fish Operations and incorporated VarQ Flood Control Procedures into the Libby Dam Water Control Manual. USACE will continue to coordinate with Canada on the operation of Libby Dam pursuant to the provisions of the Columbia River Treaty.

The Entities continued to operate the hydrometeorological network as required by the Treaty. The Columbia River Treaty Hydrometeorological Committee continued work to maintain and improve data availability and to improve inflow estimates to the Kootenay Lake.

The Entities continued work on Phase I technical studies as part of the Columbia River Treaty 2014/2024 Review. These studies are intended to provide baseline information about post-2024 operating conditions, both with and without the Treaty, and from the point of view of power and flood control values only. They are not intended to establish future operating strategies or policies or alternatives to the Treaty. The studies are a joint effort between the Canada and US Entities and are intended as a first step in a broader review of the Treaty, the characteristics of which will be determined by the governments of the two countries in the coming months.

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Photographs supplied by the British Columbia Hydro and Power Authority and the U.S. Army Corps of Engineers

LIST OF HYDROGRAPHS

APPENDICES

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
FCRPS ……Federal Columbia River Power System
ft ……Feet
hm^3 ……Cubic hectometres
IJC ……International Joint Commission
kaf ……Thousand acre-feet
kcfs ……Thousand cubic feet per second
km ……Kilometres
km^3 ……Cubic kilometres
kV ……Kilovolts
LCA ……Libby Coordination Agreement
m ……Meters
m^3/s ……Cubic meters per second
Maf ……Million acre-feet
mi ……Miles
MW ……Megawatts
MWh ……Megawatt hour
NMFS ……National Marine Fisheries Service
NOAA ……National Oceanic and Atmospheric Administration
NTSA ……Non-Treaty Storage Agreement
PEBCOM ……Permanent Engineering Board Engineering Committee
PSANI ……Puget Sound Area / Northern Intertie
TSR ……Treaty Storage Regulation
USACE ……U.S. Army Corps of Engineers
USFWS ……U.S. Fish and Wildlife Service
VarQ ……Variable discharge flood control

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 from 1 October 2007 through 30 September 2008, 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 totalling 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. All sales under the Sales Agreement have now expired.

Termination Provisions

Article XIX describes the period of the Treaty and provisions for its termination. While the Treaty has no official termination date, Canada or the United States may issue notice to terminate most of the provisions of the Treaty 60 years from its date of ratification (that is, on September 16, 2024), provided they have given at least ten years' written notice. Certain provisions of Treaty change automatically in 2024, while others continue for the useful life of the Treaty facilities.

The Entities are currently engaged in technical studies aimed at establishing baseline conditions for power and flood control operations post-2024 with and without the Treaty. These studies, together with other work and public consultation, will help inform decision makers on matters affecting the future of the Treaty.

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 locks and earthfill dam.
The new 185-MW power plant is on the north abutment (right-hand side).

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 OF THE BOARD

Meetings

The Board held its 75th meeting on 20 March 2008 in Portland, OR. In conjunction with this meeting, the Board also held its 56th joint meeting with the Entities.

The following topics were discussed at the meeting: the 2007 DOP and supplemental operating agreements; continued improvements to the delivery of the Canadian entitlement and the status of the PSANI action plan; implications of strict variable discharge flood control (VarQ) implementation at Libby; results of the 2012–2013 Assured Operating Plan and Determination of Downstream Power Benefits (AOP/DDPB) and development of future plans; prospects for a non-treaty storage agreement; update on Hydromet Committee activities; status of 2004 FCRPS BiOp remand; implementation of a Treaty website; status of 2014/2024 planning initiatives; Canadian Water Use Plans and the Canadian Columbia River Forum.

Reports Received

- Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 15 December 2007 through 31 July 2008, signed 12 December 2007

  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 2008 for the purpose of protecting eggs deposited on the streambed by Mountain Whitefish during December 2007 through January 2008; (5) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam during the period of December 2007 through early May 2008. This agreement supplements the 2007–2008 Detailed Operating Plan (DOP).

- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2012-2013, dated January 2008

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2012 through 31 July 2013.

- Columbia River Treaty Entity Agreement on the Assured Operating Plan and Determination of Downstream Power Benefits for the 2012-2013 Operating Year, signed 18 February 2008.

  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 2012 through 31 July 2013.

- Detailed Operating Plan for Columbia River Storage for 1 August 2008 through 31 July 2009, dated June 2008

  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 2008 through 31 July 2009.

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2008 through 31 July 2009, signed 19 June 2008

  This document is the agreement between the Entities to implement the DOP for Columbia River storage during the period 1 August 2008 through 31 July 2009.

- Columbia River Treaty Entity Agreement on the Preparation of Joint Studies related to the 2014/Post-2024 Columbia River Treaty Review, signed 21 July 2008.

  This agreement is for the purpose of establishing rules and guidelines for conducting the necessary joint studies related to the 2014/2024 Columbia River Treaty Review.

- Columbia River Treaty Operating Committee Agreement on Provisional Storage for the Period 22 September 2007 through 5 April 2008, signed 28 September 2007.

  This agreement is for the purpose of obtaining additional mutual benefits, both power and non-power, by shaping the discharge from the Arrow reservoir.

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 October 2007 through 30 September 2008, dated 18 December 2008.

  This report summarizes the operation of Treaty projects and other activities of the Entities for the period 1 October 2007 through 30 September 2008.

Report to the Governments

The forty-third Annual Report of the Board, dated 30 September 2007, was submitted to the governments of Canada and the United States.

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, 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. A fifth generating unit at Revelstoke is currently being installed, and additional generating units at Revelstoke and Mica dams in Canada are being considered for the near 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 39.6 m high (130 ft) and extends 792.5 m (2600 ft) across the Duncan River valley, 9.7 km (6 mi) north of Kootenay Lake. The reservoir behind the dam extends for as much as 43.5 km (27 mi) and provides 1.73 km^3 (1.4 Maf) of usable storage, which is all committed under the Treaty. No power facilities are included in this project.

The project is shown on page 13, 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, up to 233 km (145 mi) long when full, 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, completed in 2002 and owned by Arrow Lakes Power Corporation, is located on the north abutment (left bank). A 1493 m (4900 ft) intake approach channel runs along the north end of the concrete dam and diverts the water 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 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 on 31 March 2003. The dam is located on the Columbia River 137 km (85 mi) north of Revelstoke, British Columbia. The earthfill dam rises more than 244 m (800 ft) above its foundation and extends 793 m (2600 ft) across the Columbia River valley. It is one of the tallest dams in North America. It creates a reservoir, the Kinbasket Lake, that is up to 217 km (135 mi) long with a storage capacity of 24.7 km^3 (20 Maf). The project is operated within 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 six generating units. Four generators have been installed with a total capacity of 1805 MW.

The project is shown on page 19, 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 up to 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. 9 Maf), of which 6.1 km^3 (5.0 Maf) is 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 600 MW. Recent U.S. legislation (*Public Law 104-303*, 12 Oct. 1996) authorizes the U.S. Army Corps of Engineers (USACE) 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.

The CRTHMC continued to work with agencies to maintain data acquisition stations in 2008. The USACE, BPA, and BC Hydro partnered to install two new water temperature sensors in the Kootenay River to aid in water temperature modeling of the Koocanusa Reservoir. The BPA worked with the Natural Resources Conservation Service to review proposed closure of nine snow stations in Washington and Oregon. In Canada, the contracts for two non-Treaty climate stations in British Columbia (at Grand Forks and Wasa) were discontinued.

The Committee did not make any changes to the water supply forecast procedures in 2008. However, a change in inflow estimate to the Kootenay Lake was made to properly account for the travel time of Libby Dam releases.

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 (AOP) 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. The calculation of downstream power benefits accrued to each country under the Treaty is also prepared five years in advance based on the Treaty operation criteria in the AOP. At the beginning of each operating year, a detailed operating plan (DOP), which includes the three Treaty projects in Canada, is prepared in consideration of projected resources and demands 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. The operating plan for the Libby project in the United States has been prepared separately since 2000 and has not been included in the DOP thereafter. Details on Libby operations are discussed further below.

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 2007 through 31 July 2008*, dated July 2007, and the *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2008 through 31 July 2009*, dated June 2008, as well as in accordance with additional agreements between the Entities signed during the year. These documents were based on the operating criteria and hydro-regulation studies contained in the corresponding AOPs, together with any changes agreed to by the Entities.

The Libby operating criteria and expected operation of the Libby project are no longer included in the annual DOP beginning 2000-2001. Information on Libby operations is provided separately in the Libby Operating Plan prepared by the U.S. Entity. Operations at Libby take non-power considerations into account as required in the BiOps of the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic & Atmospheric Administration (NOAA) Fisheries Service. Compared to operations prior to 2000–2001, the BiOps requires increase in the release rate from Libby Dam in spring and summer flows and decrease in the fall and winter flow release rate. In addition, in January 2003, USACE adopted VarQ in determining 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, and is used only when dry-to-moderate hydrologic runoff conditions are forecasted. In June 2008, USACE issued a Record of Decision for Libby Dam Flood Control and Fish Operations and incorporated VarQ Flood Control Procedures into the Libby Dam Water Control Manual. USACE will continue to coordinate with Canada on the operation of Libby Dam pursuant to the provisions of the Columbia River Treaty.

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 outstanding issues of disagreement. The LCA could be terminated by either Entity 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 seven 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 circumstances so require 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

During the reporting period, the Canadian Entitlement was delivered as scheduled 99.99 percent of the time. A 6 MWh curtailment occurred on May 5, 2008 for one hour, and delivered three days later. The previous curtailment was April 20, 2005.

Proposed transmission and generation projects in the northwest, such as the Sea Breeze Power Corporation line from B.C to Washington State, the Montana-Alberta Tie Limited line, and the Cherry Point gas-fired cogeneration plant, did not receive all necessary regulatory approvals during the reporting period. However, some projects were close to receiving final approval in late 2008.

Work continues throughout North America on the implementation of the North American Electric Reliability Corporation's mandatory standards, which became enforceable in 2007 in the U.S. and some Canadian jurisdictions. Reliability oversight in British Columbia and Alberta is coordinated with the North American Electric Reliability Council and the Western Electricity Coordinating Council.

In the United States, legislation was proposed to amend the Federal Power Act to give the Federal Energy Regulatory Commission the authority to address known cybersecurity threats to the reliability of the bulk power system, and to provide emergency authority to address future cybersecurity threats to the reliability of the bulk power system.

These developments are not expected to have a negative impact on implementation of the Treaty. The Board will continue to keep governments informed of developments that could impact Treaty implementation.

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 (NTSA) 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). As of September 2008, the BC Hydro NTSA account was 88 percent full and the BPA NTSA account was 73 percent full. 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 USFWS 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 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 operating year from August to July of the following year. Although the Permanent Engineering Board reporting period is 1 October 2007 to 30 September 2008, Treaty operations thereunder are based on the Treaty operating year of 1 August 2007 to 31 July 2008. Additional information for 1 August 2008 to 30 September 2008 is based on the Treaty operating year 1 August 2008 to 31 July 2009.

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 USFWS, the 2004 BiOp by the NMFS, and strict application of the eight-step VarQ operating procedures.

- *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, stream flows 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 2007–2008*, dated January 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 2007 through 31 July 2008.

- *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 2008–2009*, dated January 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 2008 through 31 July 2009.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2007 through 31 July 2008*, dated July 2007

  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 2007 through 31 July 2008.

- *Columbia River Treaty Operating Committee Agreement on Provisional Storage for the Period 22 September 2007 through 5 April 2008*, signed 28 September 2007.

  This agreement is for the purpose of obtaining additional mutual benefits, both for power and non-power, by shaping the discharge from the Arrow reservoir.

- *Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 15 December 2007 through 31 July 2008*, signed 12 December 2007

  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 2008 for the purpose of protecting eggs deposited on the streambed by Mountain Whitefish during December 2007 through January 2008; (5) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam from December 2006 through early May 2008. This agreement supplements the 2007–2008 DOP.

- *Columbia River Treaty Operating Committee Agreement on Changes to Attachment B to 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 29 March 1999*, signed 19 December 2007

  This Agreement amends the scheduling guidelines for delivery of the Canadian Entitlement contained in Attachment B in the Aspects of Delivery Agreement.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2008 through 31 July 2009*, dated June 2008

  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 2008 through 31 July 2009.

- *Columbia River Treaty Operating Committee Agreement on Provisional Storage for the Period 1 September 2008 through 3 April 2009*, signed 9 September 2008.

  As above, this agreement is for the purposes of obtaining additional mutual benefits by shaping the discharge from the Arrow reservoir.

System Storage

The 2007–2008 operating year began on 1 August 2007 with the Canadian Treaty storage at 19.1 km^3 (15.4 Maf) or 99.6 percent full. This starting condition for storage was below DOP levels by only 101 hm^3 or 82 kaf, as determined in the Treaty Storage Regulation (TSR) study – primarily due to inadvertent draft. During August and September 2007, Canadian storage was operated to forecasted TSR levels, except for a small provisional draft and return authorized by the LCA. In accordance with a fall Supplemental Operating Agreement (SOA), Canadian storage filled in October 2007, ending the month 1,190 hm^3 (965 kaf) above TSR levels. In November and December, Canadian storage was operated in accordance with the SOA with releases in both months. The Canadian Entity exercised the option to provisionally draft Arrow the second time 274 hm^3 (222 kaf) in December, although some inadvertent draft also occurred in December 2007, with Canadian storage ending the month 661 hm^3 (536 kaf) above the TSR. The December 11th TSR was revised to include updated hydro independent generation and all calculations from December forward were updated. In accordance with a second Supplemental Operating Agreement, Canadian storage filled to about 1,760 hm^3 (1,427 kaf) above the TSR in January 2008, with all of the fall storage released by February. Canadian storage remained above the TSR through May, and returned to near TSR levels in July. Canadian storage ended the operating year on 31 July 2008, at 17.6 km^3 (14.2 Maf) or 91.8 percent full.

The 1 January 2008 water supply forecast for the Columbia River above The Dalles for January through July was 125.8 km^3 (102.0 Maf), or 95.1 percent of the 1971–2000 average. The water supply forecast rose slightly to 96 percent of average in the February and March forecasts, then dropped to 91.5 percent of average in June.

The operating year 2007-2008 was characterized by near average precipitation in most parts of the Columbia River Basin. Precipitation totals for the period 1 October 2007 through 30 September 2008 were 97 percent of normal in the Columbia River Basin above Grand Coulee Dam, 92 percent of normal in the Snake River Basin above Ice Harbor Dam, and 95 percent of normal in the Columbia River Basin above The Dalles. The January through July 2008 runoff volume at The Dalles was 122 km^3 (99.2 Maf) or 92 percent of the 1971-2000 average. The peak-unregulated discharge for the Columbia River at The Dalles was 19,576 m^3/s (691.3 kcfs) on 3 June 2008. A regulated peak flow of 11,451 m^3/s (404.4 kcfs) occurred on 5 June 2008 as measured at the same location.

Operations of the three Canadian reservoirs — Mica, Arrow, and Duncan — and the Libby Reservoir in the United States, are illustrated on pages 26 to 29 for the 13-month period from 31 August 2007 to 30 September 2008. 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

The Mica (Kinbasket) reservoir reached a maximum elevation of 754.3 m (2,474.8 ft) on 10 August 2007, 0.06 m (0.2 ft) below full pool. The reservoir was drawn down during the fall and winter to meet power demands and to prepare for the expected high runoff, reaching a minimum level of about 718.1 m (2,356.1 ft) on 5 May 2008, later than normal due to the delayed freshet. This level was 6.2 m (20.3 ft) lower than the 2007 minimum level of 724.3 m (2,376.4 ft). Reservoir releases were then reduced in mid May through early July in response to lower power demands and system constraints. This condition combined with high freshet inflows caused the reservoir to refill quite significantly across the same period. The reservoir continued to fill through early September to reach a maximum elevation of 750.4 m (2,462 ft), 4.0 m (13 ft) from full.

Arrow Reservoir

The Arrow reservoir reached a maximum elevation of 438.6 m (1,439 ft) on 7 July 2007, 1.5 m (5 ft) below full pool. As inflows continued to recede throughout the fall and winter period and outflows increased to meet Treaty requirements, the reservoir drafted steadily reaching a minimum level of 430.8 m (1,413.3 ft) on 12 May 2008, much later than normal due to the delayed freshet. Influenced by relatively good runoff conditions combined with Non-Treaty Storage Agreement (NTSA) and Treaty Flex operations, the reservoir refilled to its Treaty flood control level (maximum possible level) in May and June. The reservoir continued to refill across early July to reach a maximum elevation of 440.0 m (1,443.5 ft) on 5 July 2008, 0.15 m (0.5 ft) from full pool.

Duncan Reservoir

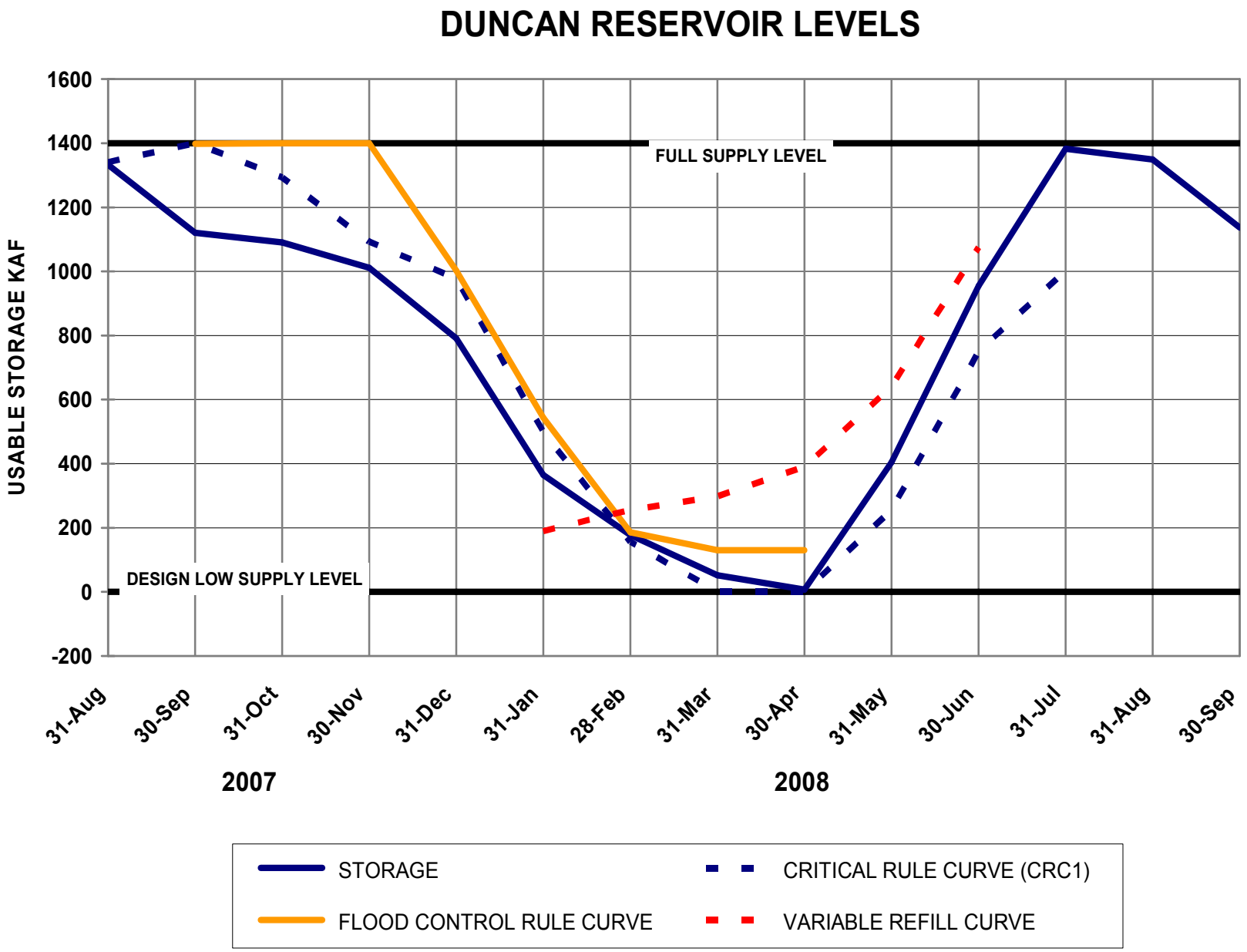
Duncan reservoir refilled to 576.7 m (1,892.06 ft), slightly above full pool on 21 July 2007. From September 2007 through April 2008, Duncan discharge was used to supplement inflow into Kootenay Lake and to provide spawning and incubation flows for fish. B.C. Hydro sought and received variance for February flood control to 552.5 m (1,812.5 ft). This was reached on 28 February 2008, and 551.0 m (1,807.7 ft) was reached on 12 March 2008. The reservoir drafted to empty at elevation 546.87 m (1,794.2 ft) on 28 April 2008. Reservoir discharge was reduced to a minimum of 3 m^3/s (0.1 kcfs) on 18 May 2008 to initiate reservoir refill. The reservoir refilled to a maximum elevation of 576.53 m (1,891.5 ft), 0.15 m (0.5 ft) below full pool on 11 August 2008. A second similar peak level was reached on 21 August 2008 due to a significant precipitation event in the area.

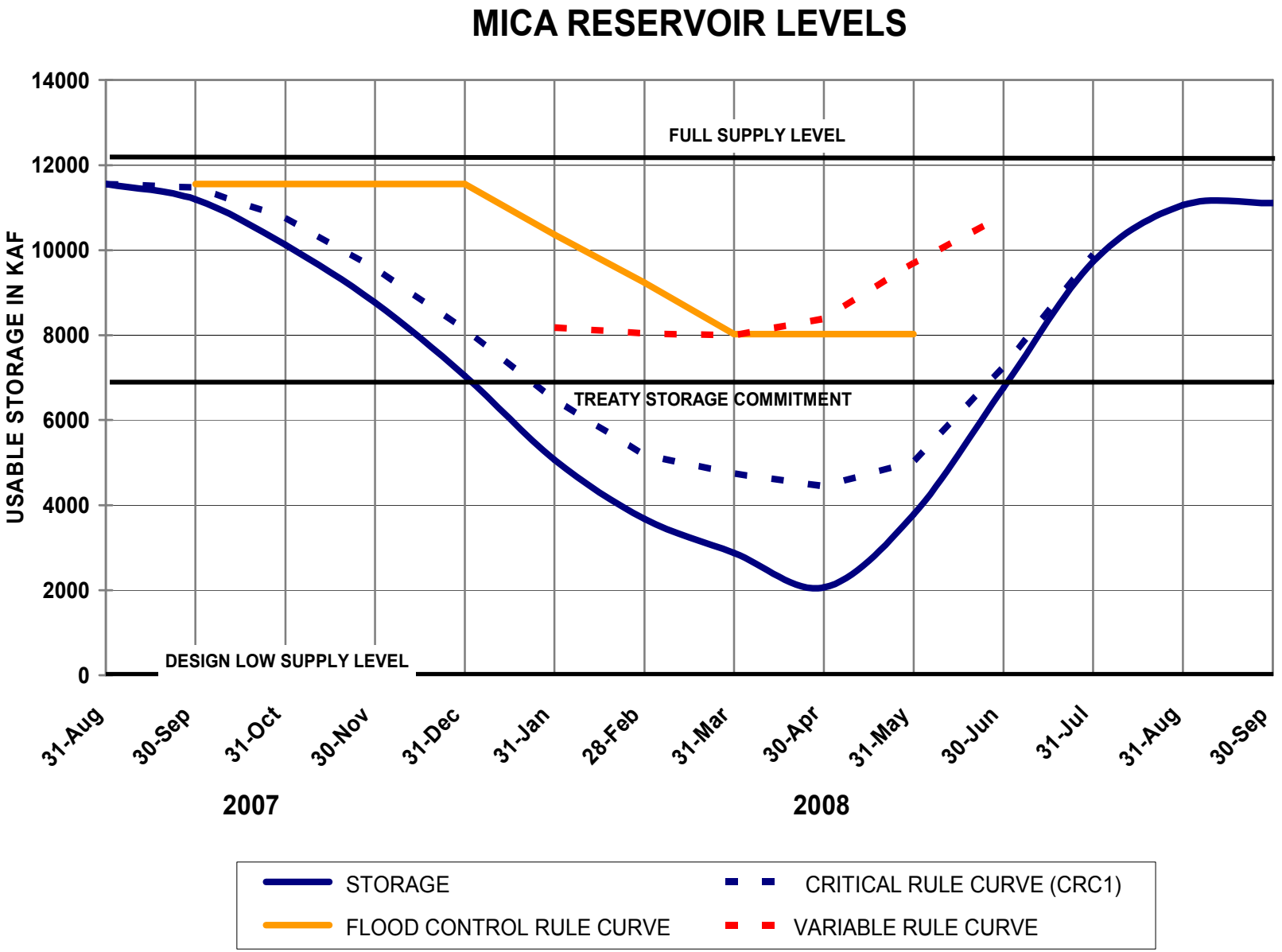
Libby Reservoir

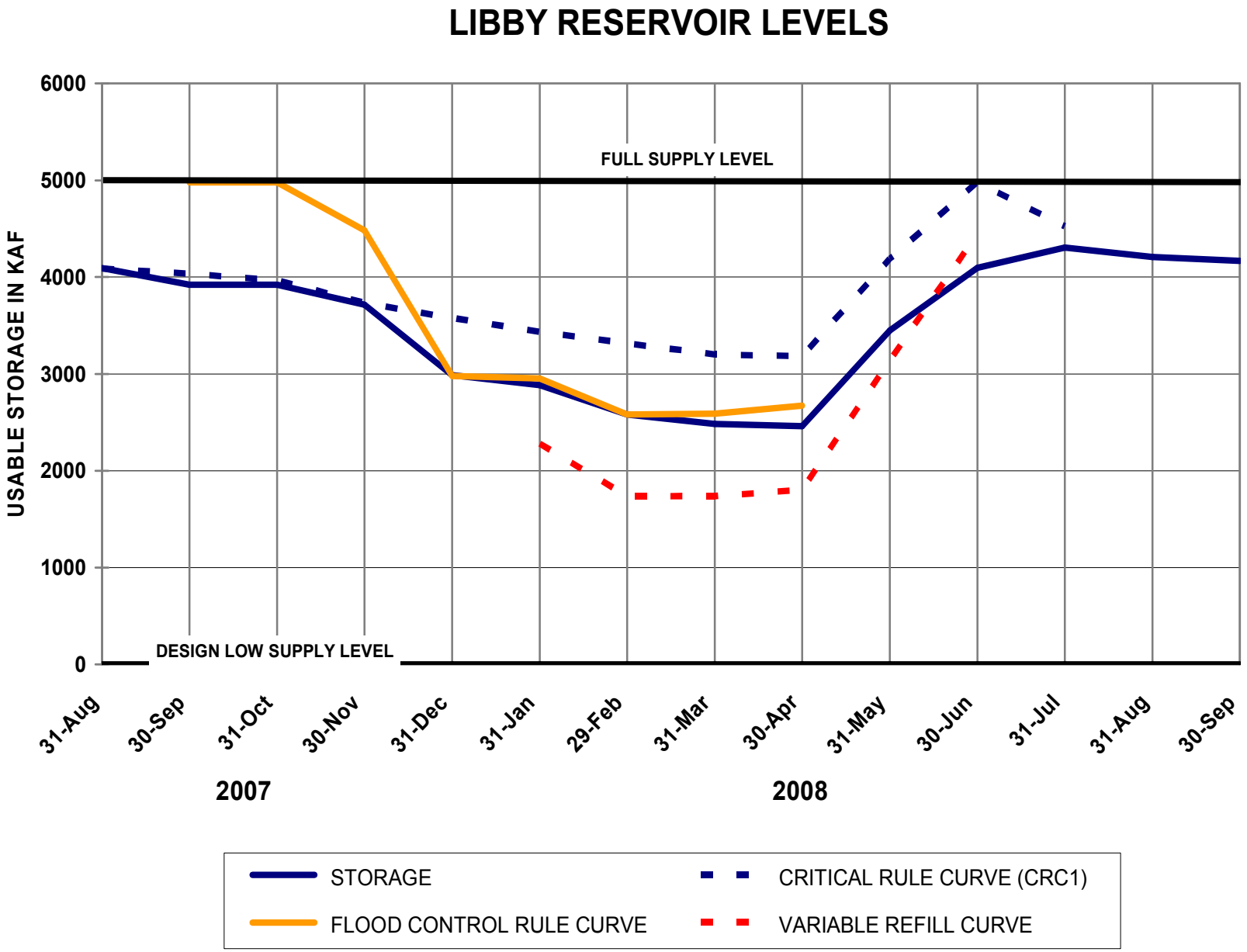
The Libby (Kookanusa) Reservoir began July 2007 at elevation 746.7 m (2,449.7 ft), 2.9 m (9.4 ft) from full and drafted through the fall and winter period. By 31 December, the reservoir was at elevation 734.87 m (2,411.0 ft) and operated during the winter to the VarQ storage reservation diagram. The reservoir drafted to its lowest elevation of 730.03m (2395.1 ft) on 13 April. During the refill period, Libby Dam operated in strict accordance to the VarQ operating procedures and provided 1.28 km^3 (1.04 Maf) of storage for sturgeon releases. The reservoir filled to its maximum elevation of 745.21 m (2444.9 ft) on 18 July 2008, 4.30 m (14.1 ft) from full pool. The project reached elevation 744.23 m (2441.7 ft) on 31 August, which stored 143.37 hm^3 (58.6 ksfd) due to the Libby Canadian storage agreement.

Flood Control Operations

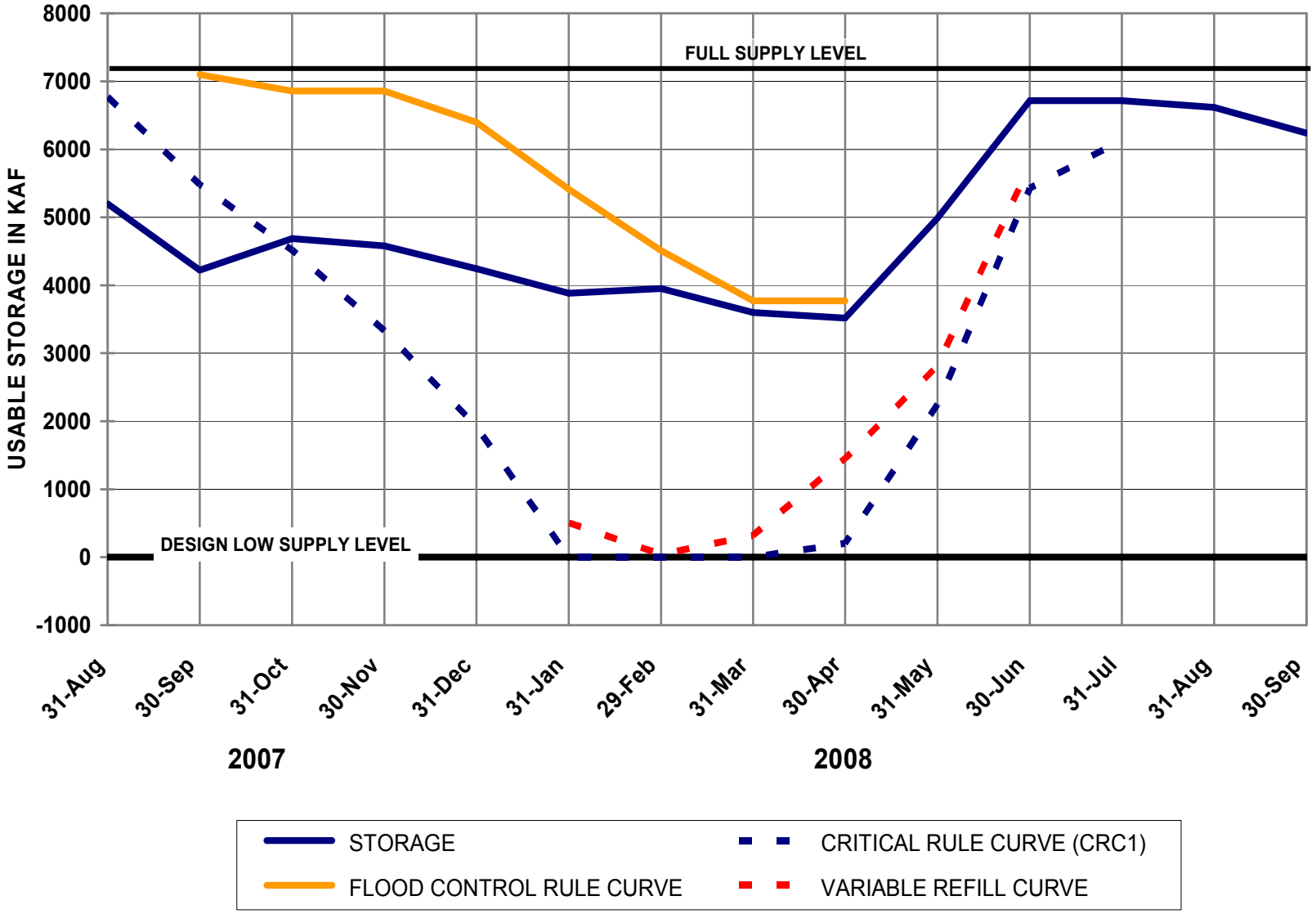
Columbia River Basin projects were operated according to the May 2003 Flood Control Operating Plans. The 2008 water supply forecasts averaged slightly below normal across the Columbia River Basin, including the upper Columbia Basin, while the Snake River Basin was slightly above normal. The Columbia River reservoir system, including the Columbia River Treaty projects, was required to draft for flood control in preparation for the spring freshet. The regulated peak flow at The Dalles, Oregon, was 11 451 m^3/s (404.4 kcfs) on 5 June 2008, and the unregulated flow was estimated at 19,576 m^3/s (691.3 kcfs) on 3 June 2008. The peak stage observed at Vancouver, Washington, was 4.51 m (14.8 ft.) on 22 May 2008, and the estimated unregulated stage was 7.28 m (23.9 ft.) on 4 June 2008.

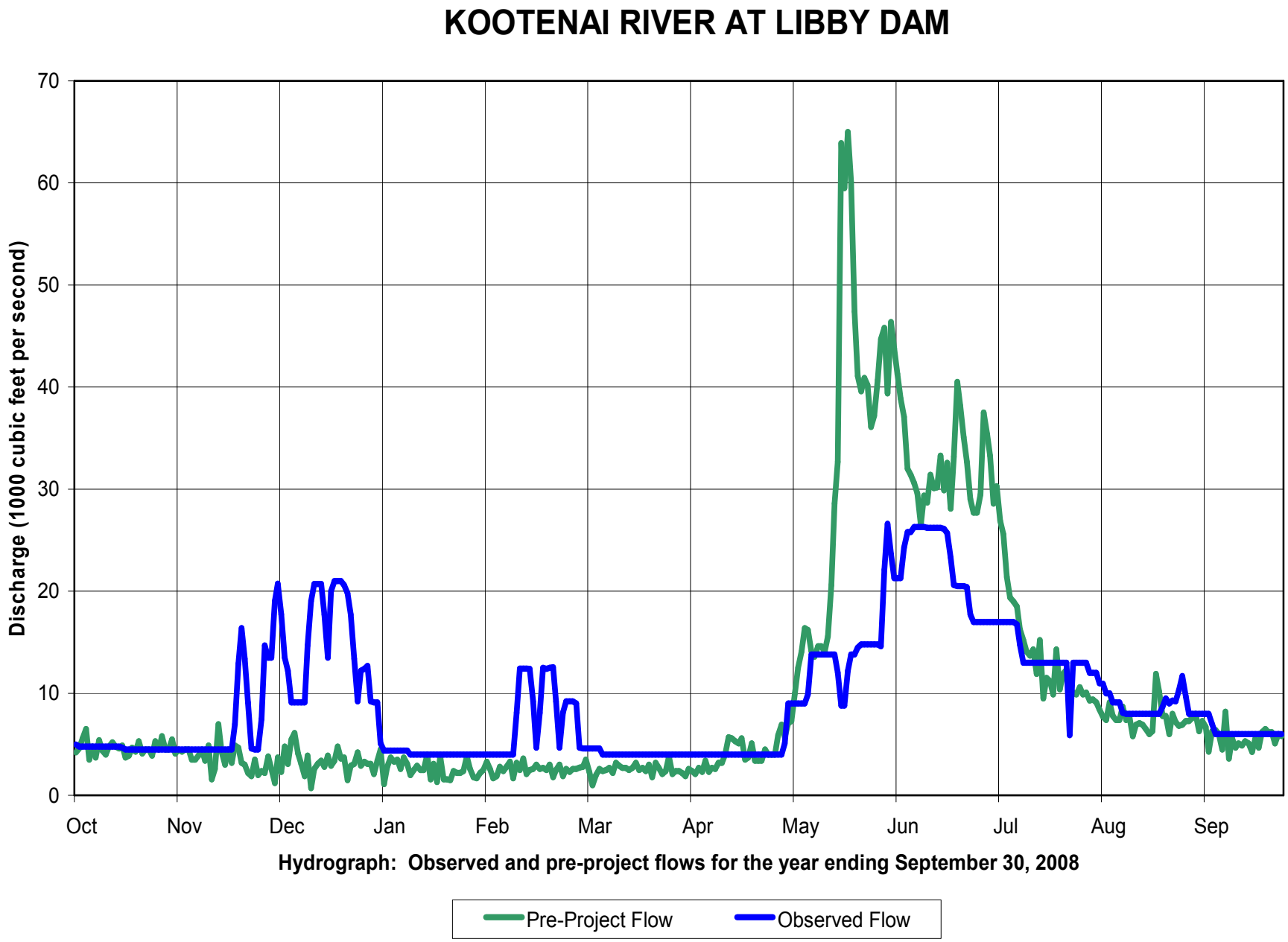

DUNCAN RESERVOIR LEVELS
USABLE STORAGE KAF
1600
1400
1200
1000
800
600
400
200
0
-200
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2007
2008
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE


MICA RESERVOIR LEVELS
USABLE STORAGE IN KAF
14000
12000
10000
8000
6000
4000
2000
0
FULL SUPPLY LEVEL
TREATY STORAGE COMMITMENT
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2007
2008
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE RULE CURVE

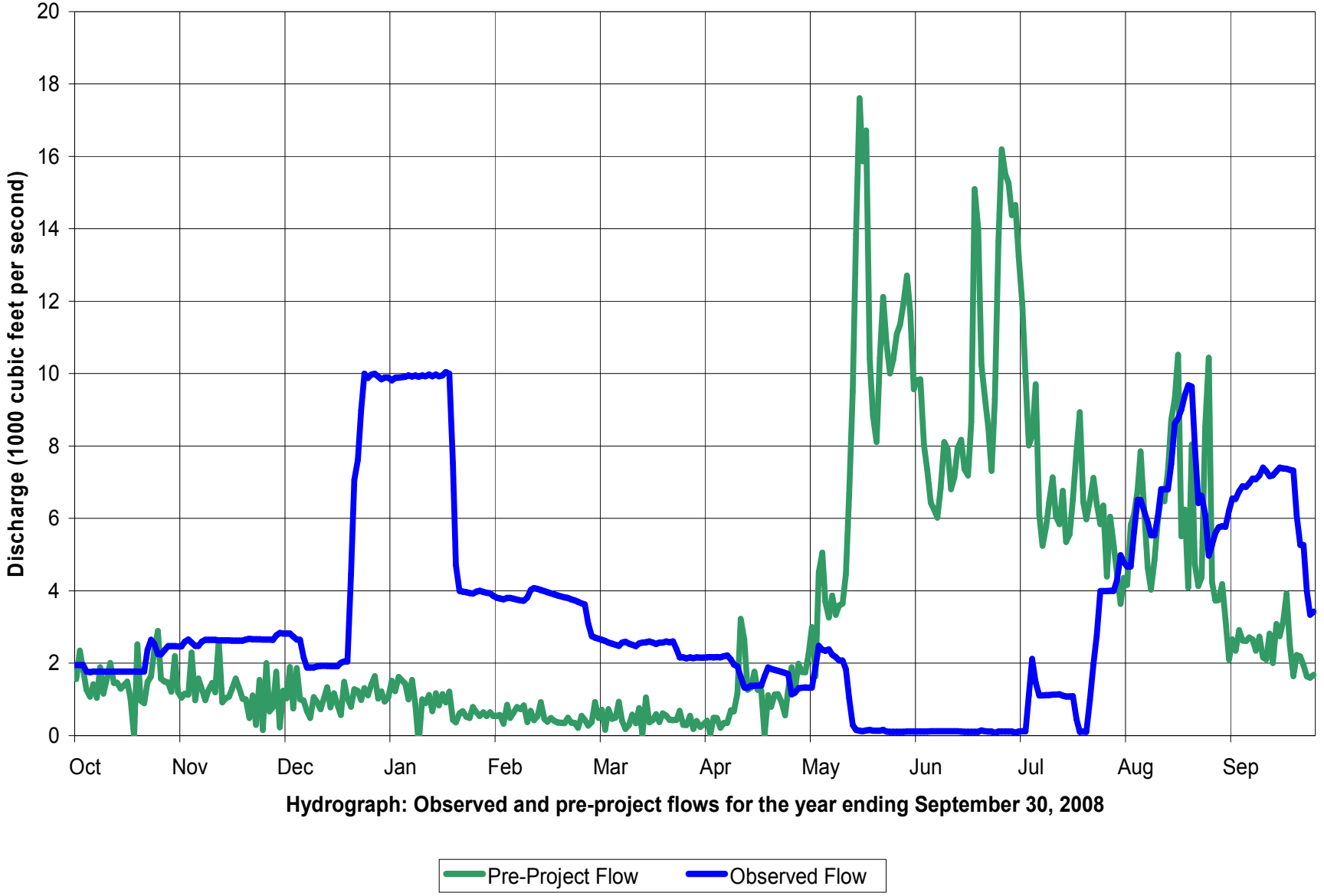

LIBBY RESERVOIR LEVELS
USABLE STORAGE IN KAF
6000
5000
4000
3000
2000
1000
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
29-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2007
2008
STORAGE
FLOOD CONTROL RULE CURVE
CRITICAL RULE CURVE (CRC1)
VARIABLE REFILL CURVE

ARROW RESERVOIR LEVELS

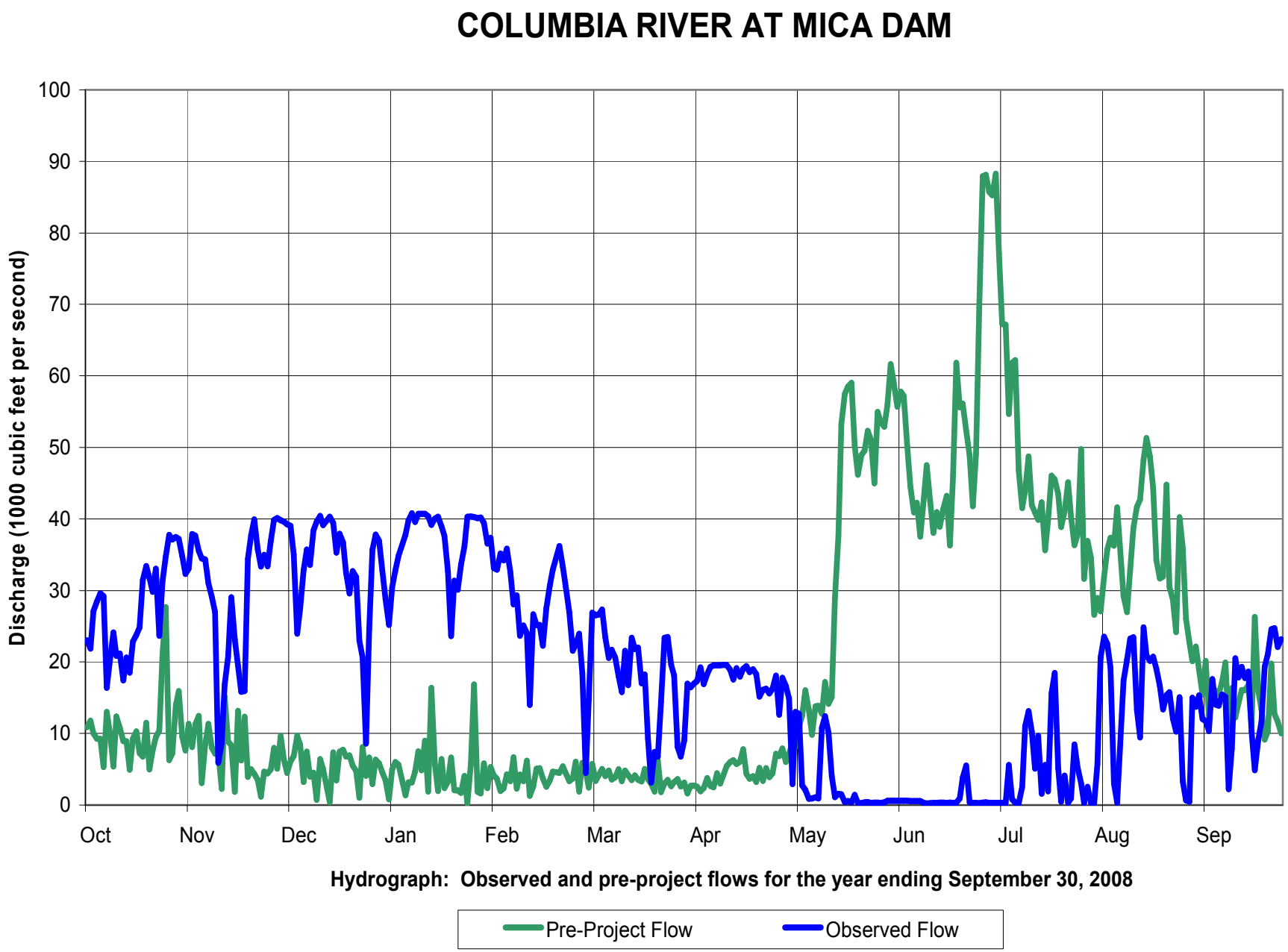



KOOTENAI RIVER AT LIBBY DAM
Discharge (1000 cubic feet per second)
70
60
50
40
30
20
10
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Hydrograph: Observed and pre-project flows for the year ending September 30, 2008
Pre-Project Flow
Observed Flow

DUNCAN RIVER AT DUNCAN DAM

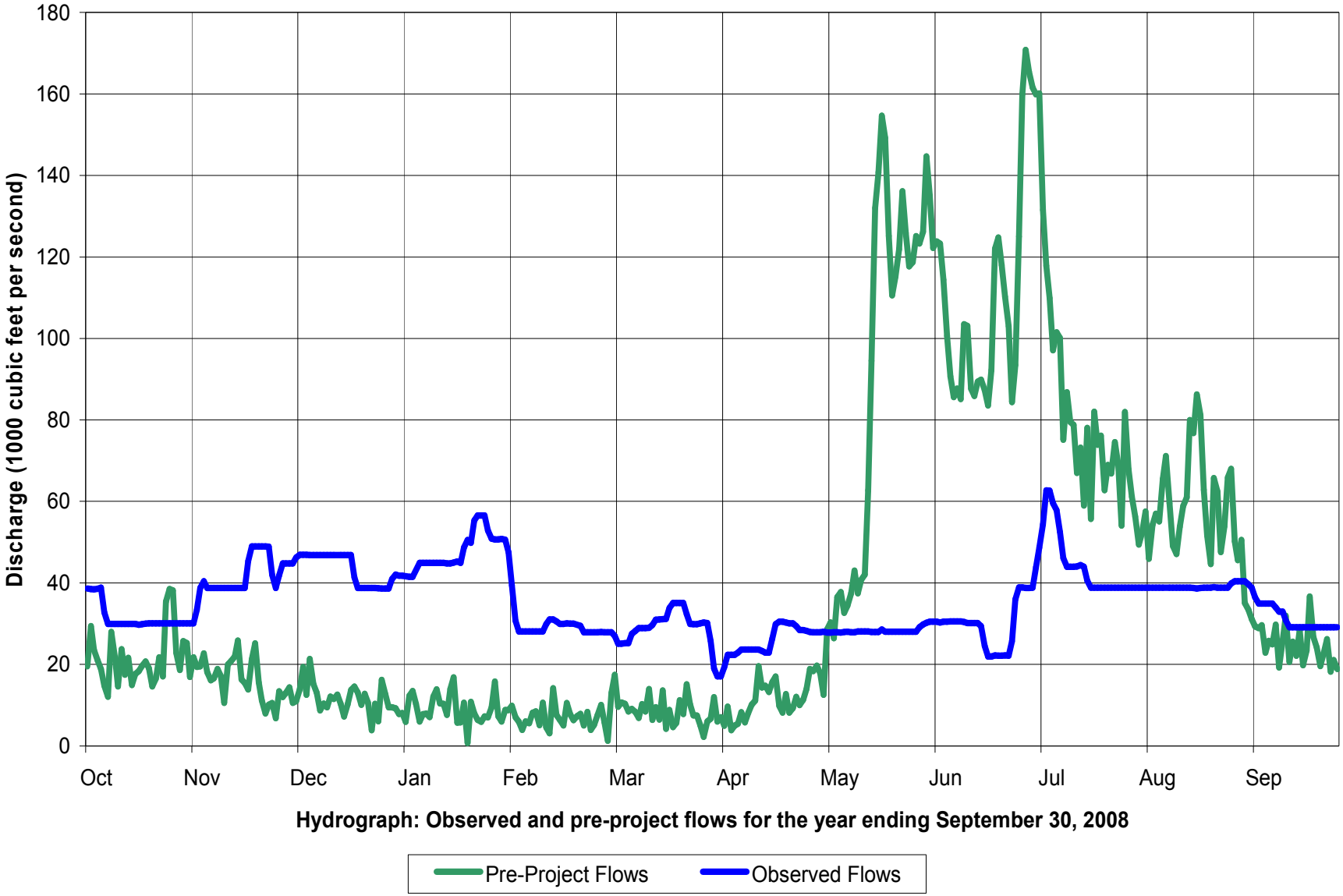


Hydrograph: Observed and pre-project flows for the year ending September 30, 2008

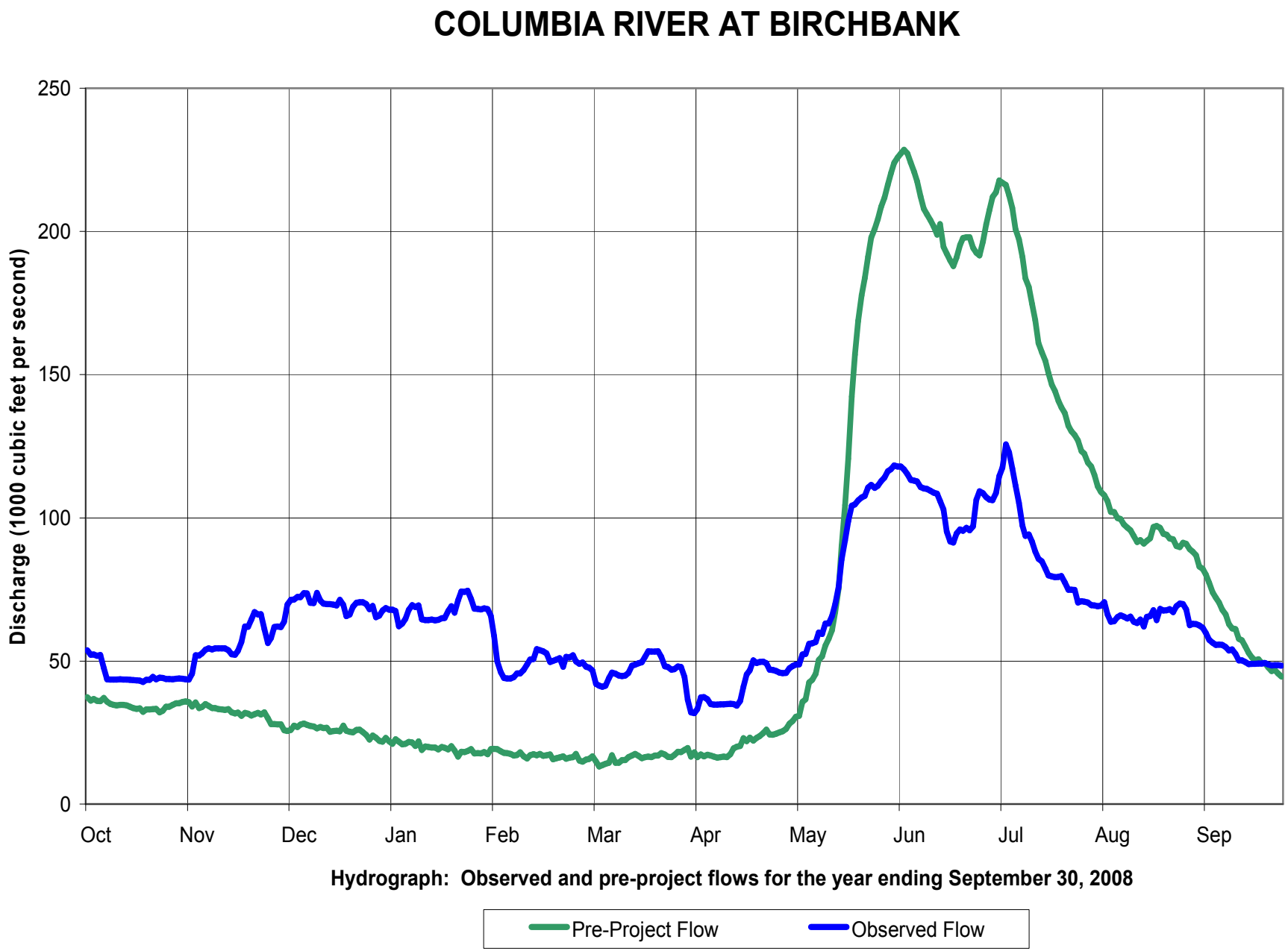


Hydrograph: Observed and pre-project flows for the year ending September 30, 2008

COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM



Hydrograph: Observed and pre-project flows for the year ending September 30, 2008



Hydrograph: Observed and pre-project flows for the year ending September 30, 2008

TREATY BENEFITS

Flood Control Benefits

Flood control operations under the 2003 Flood Control Operating Plan were not a major concern in 2007-08 operations as Columbia River water supplies were below average. The peak regulated flow and river stages are shown in the tables following.

Columbia River Steam flow at The Dalles, Oregon

Date	Peak Regulated Flow m^3/s (cfs)	Date	Peak Unregulated Flow m^3/s (cfs)
5 June 2008	11,451 (404,400)	3 June 2008	19,576 (691,300)

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)
22 May 2008	4.51 (14.8)	4 June 2008	7.28 (23.9)

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about 0.9 m (3 ft). Kootenay Lake releases were adjusted from January through mid-June per IJC criteria to maintain the lake below IJC levels. The lake reached a record low level on 8 April 2008 as a result of delayed spring runoff. 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 m (9.9 ft). The effect of storage in the Duncan, Arrow, Mica, and Libby reservoirs on flows at the sites, and on flows of the Columbia River at Birchbank, is illustrated by the hydrographs on pages 30 to 34. 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

From 1 August 2007 through 31 July 2008, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 482.8 megawatts of average energy at rates up to 1,241 megawatts. From 1 August 2008 to 30 September 2008, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 464.9 megawatts of average energy at rates up to 1,245 megawatts. During the 2007-08 Operating Year there was a one-hour curtailment of 6 MWh of Canadian Entitlement deliveries on 5 May 2008 which was rescheduled within 7 days of the curtailment.

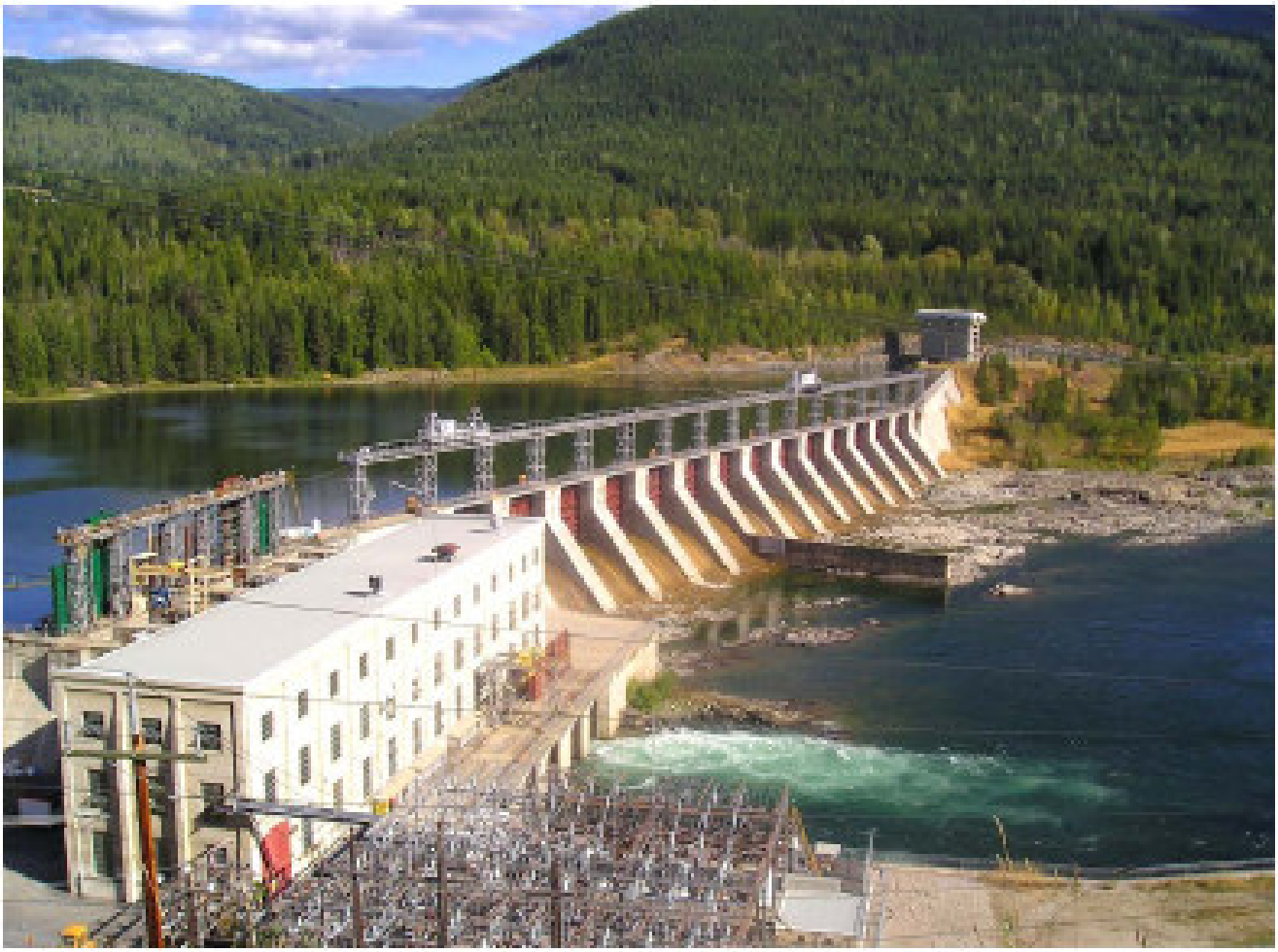
The Agreement between the Entities, signed on 20 November 1996, sets out the details of delivery points and reliability of delivery for the downstream power benefits returnable to Canada beginning 1 April 1998 and completed on 1 April 2003. No entitlement power was disposed directly in the U.S. during the Operating Year as allowed under specific provisions of the 29 March 1999 Agreement on "Disposals of the Canadian Entitlement within the U.S. for 4/1/98 through 9/15/2024."

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 fish needs in both countries. These arrangements are implemented under the Detailed Operating Plan and other agreements to provide mutual benefits.

Columbia River, British Columbia

Revelstoke Dam, Columbia River, B.C.



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. 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 USFWS, the 2004 BiOp by the NMFS, and strict application of the eight-step VarQ operating procedures.

2. The Canadian entitlement to the downstream power benefits for the reporting period was determined, according to the procedures set out in the Treaty and Protocol, to be 482.8 average megawatts (aMW) of energy and 1,241 megawatts (MW) of capacity from 1 August 2007 to 31 July 2008, and 464.9 aMW of energy and 1,245 MW of capacity from 1 August 2008 to 30 September 2008. One curtailment of Canadian Entitlement occurred in May 2008 due to transmission constraints, totaling 6 MWh, which were delivered to Canada within seven (7) days of the constraint.

3. Canadian Treaty storage began the operating year on 1 August 2007 at 99.6 percent full, and ended the year on 31 July 2008 at 91.8 percent full. Seasonal flow volume above The Dalles was 92.5 percent of average for January through July 2008. The 1 January 2008 water supply forecast for the Columbia River above The Dalles for January through July was 95.1 percent of the 1971–2000 average. The water supply forecast rose slightly to 96 percent of average in the February and March forecasts, then dropped to 91.5 percent of average in June. The actual January through July runoff volume at The Dalles was 99.2 km^3 (122.4 Maf) or 92.5 percent of the 1971–2000 average.

4. There are issues associated with the ongoing implementation and litigation of the 2000 and 2004 BiOps issued by the National Oceanic and Atmospheric Administration (NOAA) Fisheries and USFWS to the U.S. Army Corps of Engineers, Bonneville Power Administration, and the Bureau of Reclamation (Action Agencies) for the operation of U.S. projects. In June 2008, USACE issued a Record of Decision for Libby Dam Flood Control and Fish Operations and incorporated VarQ Flood Control Procedures into the Libby Dam Water Control Manual. USACE will continue to coordinate with Canada on the operation of Libby Dam pursuant to the provisions of the Columbia River Treaty.

5. The Entities continued to operate the hydrometeorological network as required by the Treaty. The Columbia River Treaty Hydrometeorological Committee continued work to maintain and improve data availability and to improve inflow estimates to the Kootenay Lake.

6. The Entities continued work on technical studies as part of Phase I of the Columbia River Treaty 2014/2024 Review. These studies, together with other work and public consultation, will help inform decision makers on matters affecting the future of the Treaty.

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

APPENDIX A

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

United States

Members

Mr. Steven Stockton, P.E., Chair
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Civil Works
U.S. Army Corps of Engineers
Washington, DC

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Consultant
Newberg, Oregon

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Institute for Water Resources
U.S. Army Corps of Engineers
Alexandria, Virginia

Mr. George Bell
Consultant
Lake Oswego, Oregon

Secretaries

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Principal Hydrologic & Hydraulic Engineer
Engineering & Construction CoP
Directorate of Civil Works
U.S. Army Corps of Engineers
Washington, DC

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Director General
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

Mr. Tim Newton, P.Eng.
Consultant
Vancouver, British Columbia

Mr. James Mattison, P.Eng.
Assistant Deputy Minister
Water Stewardship Division
B.C. Ministry of Environment
Victoria, British Columbia

Mr. Ivan Harvie, P.Eng.
Consultant
Calgary, Alberta

Mr. Darcy Blais
Economist
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

RECORD OF MEMBERSHIP

United States

Members

Mr. Wendell Johnson* 1964–1970
Mr. Morgan Dubrow 1964–1970
Mr. John Neuberger 1970–1973
Mr. Joseph Caldwell* 1971–1973
Mr. Homer Willis* 1973–1979
Mr. King Mallory 1973–1975
Mr. Raymond Peck, Jr. 1976–1977
Mr. Emerson Harper 1978–1988
Mr. Lloyd Duscha* 1979–1990
Mr. Ronald Wilkerson 1988–2005
Mr. Herbert Kennon* 1990–1994
Mr. John Elmore* 1994–1996
Mr. Steven Stockton* 1996–
Mr. Ed Sienkiewicz 2005–

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Mr. Alex Shwaiko 1974–1987
Mr. Herbert Kennon 1987–1990
Mr. Thomas Weaver 1979–1997
Mr. John Elmore 1990–1994
Mr. Paul Barber 1994–1995
Mr. Daniel Burns 1995–1997
Mr. George Bell 1997–
Mr. Earl Eiker 2000–2004
Mr. Robert Pietrowsky 2004–

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Mr. Verle Farrow 1969–1972
Mr. Walter Duncan 1972–1978
Mr. Shapur Zanganeh 1978–1995
Mr. Richard DiBuono 1995–2000
Mr. Robert Bank 2000–2004
Mr. Jerry Webb 2004–

*Chair

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Mr. Valter Raudsepp 1973–1974
Mr. Ben Marr 1974–1987
Mr. Tom Johnson 1987–1988
Mr. Douglas Horswill 1989–1991
Mr. John Allan 1991–1999
Mr. David Oulton* 1991–1996
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Mr. Charles Kang 1999–2001
Mr. Jack Ebbels 2001–2003
Mr. Tim Newton 2003–
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Mr. Mac Clark 1964–1992
Mr. Jim Rothwell 1964–1965
Mr. Hugh Hunt 1966–1988
Dr. Donald Kasianchuk 1988–1996
Mr. Vic Niemela 1992–1994
Mr. David Burpee 1994–2007
Mr. Jack Farrell 1996–1997
Mr. Prad Kharé 1997–1999
Mr. James Mattison 1999–
Mr. Ivan Harvie 2007–

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Mr. Mac Clark 1964–1992
Mr. David Burpee 1992–2003
Ms. Eve Jasmin 2003–2007
Mr. Darcy Blais 2007–

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
ENGINEERING COMMITTEE

CURRENT MEMBERSHIP

United States

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Principal Hydrologic & Hydraulic Engineer
Engineering & Construction CoP
Directorate of Civil Works
U.S. Army Corps of Engineers
Washington, DC

Mr. Kamau Sadiki
Manager
National Hydropower Program Business Line
Operations Community of Practice
U.S. Army Corps of Engineers
Washington, DC

Mr. Michael Cowan, P.E.
Technical Services Manager
Corporate Services Office
Western Area Power Administration
Lakewood, Colorado

Mr. James Fodrea, P.E.
Consultant
Cascade, Idaho

Canada

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Senior Advisor
Electricity Policy Branch
B.C. Ministry of Energy, Mines and
Petroleum Resources
Victoria, British Columbia

Mr. Darcy Blais
Economist
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

Dr. G. Bala Balachandran, P.Eng.
Acting Head, Licensing
Water Stewardship Division
B.C. Ministry of Environment
Victoria, British Columbia

Mr. Ivan Harvie, P.Eng.
Consultant
Calgary, Alberta

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
ENGINEERING COMMITTEE

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Mr. Gary Fuqua 1990-1996
Mr. Earl Eiker 1990-2000
Mr. Steve Wright 1990-1996
Mr. Larry Eilts 1991-1995
Mr. Richard Mittelstadt 1991-1996
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Mr. Larry Adamache 1996-2001
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Ms. Donna Clarke 2001-2003
Mr. Ivan Harvie 2002-
Ms. Eve Jasmin 2003-2007
Mr. Darcy Blais 2007-

*Chair

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

COLUMBIA RIVER TREATY ENTITIES

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Portland, Oregon

BG William E. Rapp, Member
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U.S. Army Engineer Division
Northwestern
Portland, Oregon

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Vice President
Generation Supply
Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. G. Witt Anderson, USACE Coordinator
Director
Programs Directorate
U.S. Army Engineer Division
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Public Utility Specialist
Regional Coordination
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Department of Energy
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President and CEO
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Vancouver, British Columbia

Mr. Christopher K. O'Riley, Deputy Chair
Executive Vice President
Engineering, Aboriginal Relations and Generation
British Columbia Hydro and Power Authority
Vancouver, British Columbia

Ms. Renata Kurschner, Coordinator
Director
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Douglas A. Robinson, Secretary
Specialist Engineer
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

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Bonneville Power Administration
Department of Energy
Portland, Oregon

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Treaty Team Coordinator
Regional Coordination
Bonneville Power Administration
Department of Energy
Portland, Oregon

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Chief
Columbia Basin Water Management Division
U.S. Army Engineer Division
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U.S. Army Engineer Division
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British Columbia Hydro and Power Authority
Burnaby, British Columbia

Ms. Gillian Kong, Member
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Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

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Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

COLUMBIA RIVER TREATY ENTITIES
HYDROMETEOROLOGICAL COMMITTEE

CURRENT MEMBERSHIP

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Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. Peter F. Brooks, Co-chair
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Hydrologic Engineering Branch
U.S. Army Engineer Division
Northwestern
Portland, Oregon

Canada

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Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Douglas Smith, Member
Manager
Hydrology and Technical Services
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, 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 2008

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	7.0	5.7	21.3	10.2	5.8	10.3	6.0	12.3	37.8	24.4	15.0	10.7
2	6.4	5.5	22.7	6.6	5.6	6.9	6.0	11.6	46.5	24.8	14.7	9.5
3	6.8	5.7	19.9	6.2	5.6	6.6	6.0	13.2	48.0	24.6	14.0	9.5
4	6.6	5.6	18.1	6.2	5.6	6.6	6.0	17.0	41.8	23.6	13.9	9.5
5	6.6	5.7	18.4	6.1	5.6	6.5	6.0	19.8	38.2	23.7	13.7	9.5
6	6.3	5.6	15.9	6.3	5.4	6.4	6.0	23.1	37.1	23.1	13.0	9.5
7	6.3	5.6	14.6	6.3	5.4	6.5	6.0	26.3	36.2	22.3	12.5	9.5
8	6.2	5.6	14.0	6.2	5.6	6.3	6.0	28.4	38.5	22.1	11.7	9.0
9	6.3	5.6	13.0	6.3	5.6	5.9	6.2	28.3	39.2	22.0	11.1	8.0
10	6.2	5.7	13.2	6.1	5.6	5.9	6.2	27.4	39.4	21.8	10.6	7.4
11	6.3	5.7	18.9	5.9	5.8	5.9	6.3	29.0	39.1	21.1	10.7	7.1
12	6.4	5.4	22.8	5.8	10.1	6.1	6.4	30.3	39.4	20.8	10.5	7.0
13	6.4	5.9	24.3	5.7	13.7	6.3	6.5	30.3	39.2	18.7	9.6	7.2
14	6.2	5.8	24.0	5.6	14.3	6.2	8.2	30.1	39.5	17.0	9.5	7.1
15	6.2	5.8	23.8	5.8	14.3	6.3	10.7	31.3	39.7	17.4	9.4	7.0
16	6.0	5.9	20.8	5.7	14.2	6.4	10.9	35.9	39.3	17.0	9.3	7.0
17	5.6	7.5	17.8	5.6	10.6	6.4	10.0	43.9	39.1	16.7	9.3	7.0
18	5.6	8.1	23.1	5.6	6.9	6.4	10.0	52.5	39.4	16.2	9.4	7.0
19	5.7	11.0	24.1	5.7	10.5	6.3	9.8	57.3	38.1	16.0	9.4	7.0
20	6.0	16.0	24.3	5.7	13.6	6.2	9.6	55.8	37.4	16.0	9.4	7.0
21	5.9	18.6	24.5	5.4	14.2	6.2	9.2	56.1	35.8	15.5	9.6	7.2
22	5.7	16.0	23.8	5.4	14.3	6.2	8.8	51.2	34.2	15.5	9.6	7.2
23	5.8	11.8	23.8	5.4	14.1	6.2	8.9	44.7	33.1	15.4	9.6	7.2
24	5.8	7.5	20.6	5.4	10.1	6.2	8.4	40.7	31.3	15.5	9.6	7.1
25	6.2	7.4	16.3	5.4	6.7	6.2	8.4	39.6	30.2	15.6	10.6	7.1
26	6.0	7.3	12.9	5.4	10.1	6.1	8.4	39.3	29.5	15.4	10.6	7.1
27	5.9	10.6	15.3	5.6	10.9	6.0	8.4	38.1	28.9	14.1	10.6	7.1
28	5.8	17.5	15.4	5.8	10.9	6.0	8.6	36.4	25.8	9.9	10.6	7.1
29	5.8	16.2	15.3	5.8	11.2	6.1	10.3	36.2	25.2	14.6	11.0	7.1
30	5.7	16.4	12.3	5.6	--	6.0	12.3	36.8	25.1	15.0	12.6	7.1
31	5.7	--	11.7	5.6	--	6.0	--	38.1	--	15.1	12.5	--
Mean	**6.1**	**8.8**	**18.9**	**5.9**	**9.4**	**6.4**	**8.0**	**34.2**	**36.4**	**18.4**	**11.1**	**7.8**

COLUMBIA RIVER AT BIRCHBANK, BRITISH COLUMBIA

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2008

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	53.8	43.5	69.7	67.9	65.8	48.0	36.5	45.8	116.2	107.2	70.4	62.5
2	52.1	45.6	71.3	67.9	58.8	47.7	32.1	47.5	117.0	106.3	69.5	62.9
3	52.2	52.0	71.4	67.5	49.9	46.7	31.8	48.2	118.2	106.2	69.5	62.8
4	51.8	51.9	72.4	62.1	46.1	42.1	33.2	48.8	117.8	108.7	69.1	62.4
5	52.0	52.7	72.3	63.1	44.0	41.3	37.3	48.8	117.9	114.5	69.4	61.6
6	47.6	53.9	73.7	64.8	43.8	41.0	37.4	52.3	116.9	117.6	70.5	59.7
7	43.6	54.4	73.6	67.8	43.9	41.4	36.6	52.5	115.2	125.7	66.3	57.4
8	43.5	54.0	70.3	69.5	44.4	44.1	34.9	56.0	113.3	122.9	63.8	56.4
9	43.5	54.4	70.2	68.8	45.6	45.9	34.7	56.2	113.0	117.2	64.0	55.7
10	43.5	54.4	73.7	69.4	45.7	45.6	34.8	56.7	112.7	111.3	65.3	55.7
11	43.5	54.4	71.1	64.6	46.8	45.0	34.8	59.9	110.8	105.2	65.9	55.6
12	43.5	54.4	70.0	64.3	48.8	44.8	34.8	59.4	110.3	97.3	65.5	54.9
13	43.5	53.7	69.9	64.3	50.5	44.9	34.9	63.0	110.1	93.7	64.9	53.6
14	43.4	52.4	69.9	64.5	50.7	45.9	35.1	63.2	109.4	94.2	65.5	54.1
15	43.3	52.2	69.7	64.2	54.2	48.3	34.9	65.7	108.8	91.7	63.8	52.5
16	43.2	53.6	69.5	64.4	53.7	48.7	34.4	69.9	108.4	88.1	63.2	50.3
17	43.1	56.6	71.3	64.9	53.4	49.2	36.1	76.0	105.9	85.7	64.5	50.3
18	42.7	62.0	69.6	65.0	52.7	49.5	41.0	85.4	102.9	84.8	62.0	49.7
19	43.4	62.0	65.7	67.4	49.6	51.4	45.3	92.1	95.2	82.2	65.4	48.9
20	43.4	64.5	66.3	69.1	50.1	53.4	46.7	98.8	91.8	80.0	65.7	49.0
21	44.5	67.1	69.0	66.9	50.5	53.3	50.2	104.2	91.4	79.5	67.7	49.0
22	43.6	66.3	70.4	71.1	50.9	53.3	49.3	104.7	94.6	79.2	64.3	49.1
23	44.2	66.4	70.5	74.2	48.0	53.4	49.7	106.1	95.9	79.4	68.2	49.1
24	44.1	61.2	70.5	74.1	51.4	51.5	49.8	107.1	95.4	79.6	67.6	49.3
25	43.7	56.2	69.9	74.6	51.3	48.2	49.2	107.7	96.5	77.5	67.7	48.8
26	43.6	58.1	68.1	71.6	52.0	47.9	47.0	110.6	95.6	74.9	68.1	48.5
27	43.6	61.9	69.3	68.3	49.9	47.0	46.8	111.5	97.0	74.9	67.1	48.6
28	43.8	62.0	65.3	68.2	49.0	47.2	46.5	110.5	106.3	74.9	69.1	48.5
29	43.8	61.9	65.8	68.0	49.4	48.1	45.9	111.2	109.2	70.4	70.1	48.4
30	43.7	63.8	67.6	68.3	--	48.0	45.8	112.8	108.6	70.9	69.8	48.5
31	43.6	--	68.5	68.1	--	44.5	--	114.1	--	70.7	68.0	--
Mean	**45.1**	**56.9**	**69.9**	**67.6**	**50.0**	**47.3**	**40.2**	**78.9**	**106.7**	**92.7**	**66.8**	**53.5**

APPENDIX D

PROJECT INFORMATION

Power and Storage Projects

Northern Columbia Basin	Plate No. 1

Project Data

Duncan Project	Table No. 1
Arrow Project	Table No. 2
Mica Project	Table No. 3
Libby Project	Table No. 4

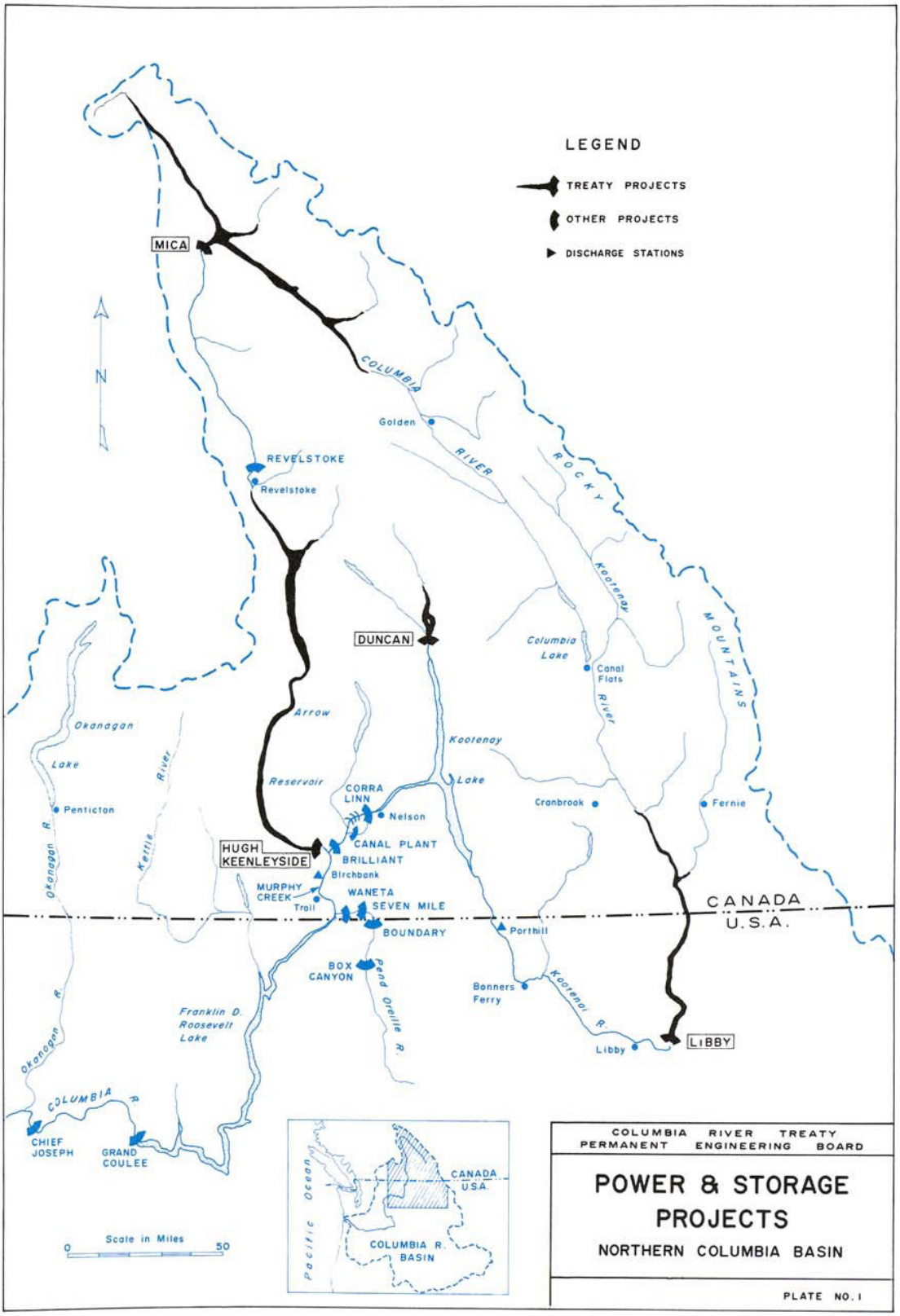
LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
COLUMBIA
Golden
RIVER
ROCKY
MOUNTAINS
REVELSTOKE
Revelstoke
Kootenay
DUNCAN
Columbia Lake
Canal Flats
River
Arrow
Okanagan
Lake
Kootenay
Reservoir
Lake
CORRA LINN
Nelson
Penticton
Okanagan R.
Kettle River
HUGH KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
MURPHY CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
CANADA
U.S.A.
Cranbrook
Fernie
Porthill
BOX CANYON
Pend Oreille R.
Bonners Ferry
Kootenai R.
Franklin D. Roosevelt Lake
Okanogan R.
Libby
LIBBY
COLUMBIA R.
CHIEF JOSEPH
GRAND COULEE
Scale in Miles
0
50
Pacific Ocean
CANADA
USA
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
Currently installed:	
4 units at 451 MW	1805 MW
Power commercially available	1976
Head at full pool	183 m (600 ft.)
Maximum turbine discharge of 4 units at full pool	1080 m^3/sec (38.14 kcfs)
Currently planned:	
2 units at 500 MW	1000 MW

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
Currently installed:	
5 units at 120 MW	600 MW
Power commercially available	1975
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)