

ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

Washington, D.C.

Ottawa, Ontario

30 September 2019

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COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD
C A N A D A • U N I T E D S T A T E S

CANADIAN SECTION
M. PRESUTTI, Chair
Renata Kurschner, Member Nominee

UNITED STATES SECTION
E. Sienkiewicz, Member

5 February 2020

The Honorable Michael Pompeo
Secretary of State
Washington, D.C.

The Honourable Seamus O'Regan
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Pompeo and Minister O'Regan:

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 fifty-fifth Annual Report of the Permanent Engineering Board, dated 30 September 2019. The report documents the results achieved under the Treaty for the period from 1 October 2018 to 30 September 2019.

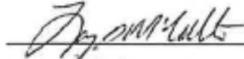
The Board wishes to draw your attention to Annex B of the Treaty, which describes the procedures by which the Treaty Entities are to determine downstream power benefits on the basis of an assured plan of operation (AOP), to be agreed between the Entities six years in advance of the operating year. At time of writing, the Entities have yet to develop the AOP for the 2025-26 operating year (AOP25).

The Entities are prioritizing work associated with the ongoing negotiations between Canada and the United States to modernize the Treaty, with the expectation that AOP25 will be informed by the outcome of those negotiations.

Respectfully submitted:

For the United States

For Canada



Larry McCallister, Alternate Chair



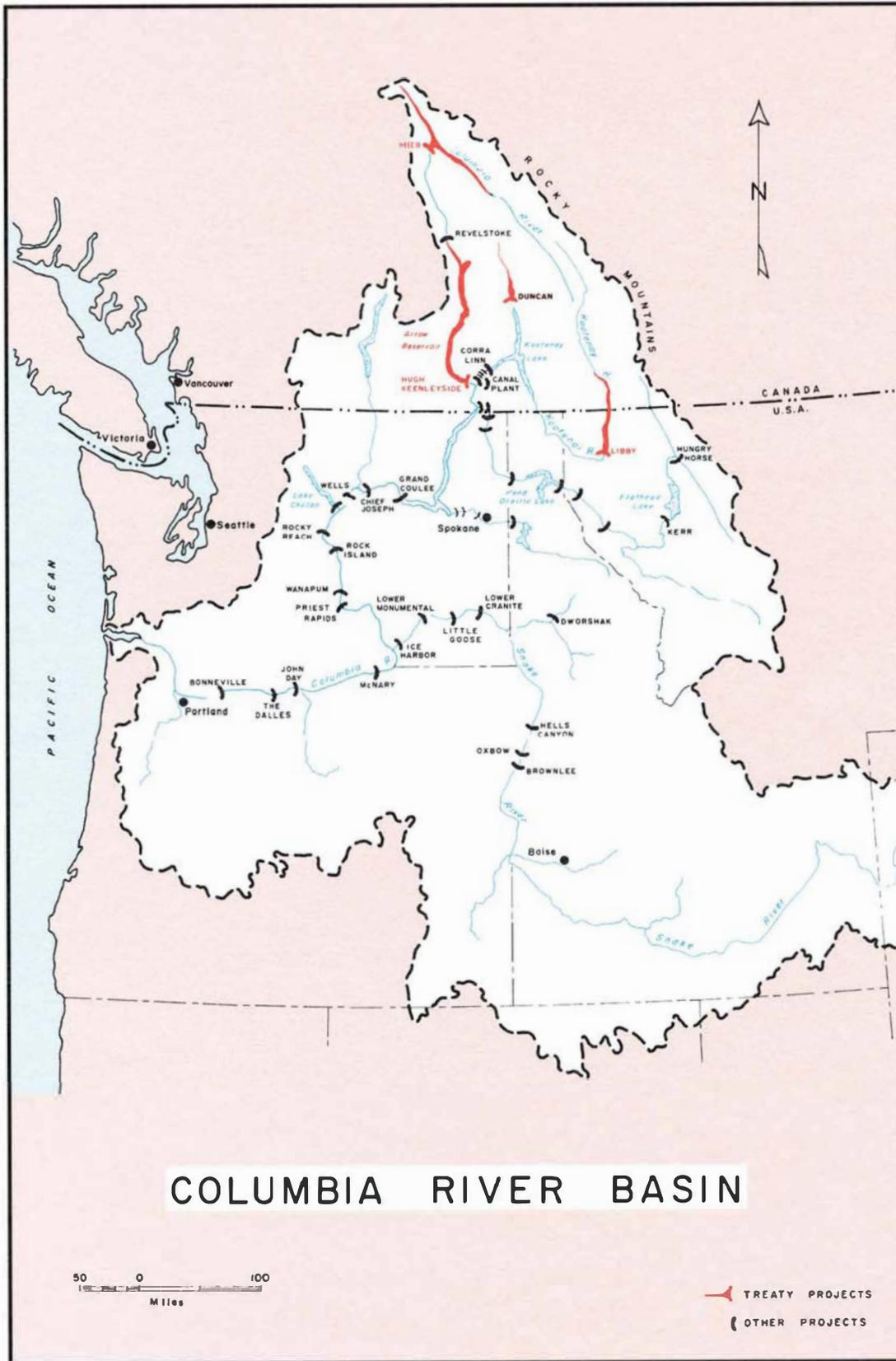
Les McLaren, Alternate Chair



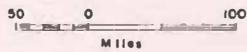
Ed Sienkiewicz, Member



Renata Kurschner, Member Nominee



COLUMBIA RIVER BASIN



- TREATY PROJECTS
- OTHER PROJECTS

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PERMANENT ENGINEERING BOARD

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EXECUTIVE SUMMARY

The fifty-fifth 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 2018 to 30 September 2019.

During the reporting period, the Canadian Treaty projects – Mica, Duncan, and Arrow – were operated according to the 2018-2019 and 2019-2020 Detailed Operating Plans, the 2003 Flood Control Operating Plan, and several supplemental operating agreements. The Libby project was operated consistently with the Libby Coordination Agreement and Short-term Entity Agreement on Coordination of Libby Project Operations, the Libby Operating Plan, United States (U.S.) requirements for power, and U.S. Fish and Wildlife Service's 2006 Biological Opinion (BiOp), as clarified, and U.S. Department of National Oceanic and Atmospheric Administration Fisheries' 2010 and 2014 Supplemental BiOp for operation and maintenance of the Federal Columbia River Power System.

Canadian Treaty storage began the Operating Year on 1 August 2018 at 95 percent full, and ended the year on 31 July 2019 at 85 percent full. The actual January through July runoff for the Columbia River above The Dalles was 111.3 cubic kilometres (km³) [90.2 million acre-feet (Maf)], or 89 percent of the 1981-2010 average. The actual April through August runoff for the Columbia River above The Dalles was 99.9 km³ [81.0 Maf], or 93 percent of the 1981-2010 average.

In early April of 2019, an atmospheric river impacted the Snake River drainage of the Columbia Basin generating significant precipitation and melting much of the low-lying snowpack in the basin, resulting in a significant change to the residual water supply forecast from the official April water supply forecasts. The Canadian portion of the basin did not experience a similar increase from the official April Treaty forecast.

The Canadian Entitlement to the downstream power benefits (CE) for the reporting period was determined according to the procedures set out in the Treaty and Protocol. From 1 August 2018 through 31 July 2019, the U.S. Entity delivery of the CE, before deducting transmission losses, was 472.5 average megawatts (aMW) of energy at rates up to 1,284 megawatts (MW) of capacity. From 1 August 2019 to 30 September 2019, the U.S. Entity delivery of the CE, before deducting transmission losses, was 454.3 aMW of energy at rates up to 1,141.5 MW of capacity. The CE obligation was determined by the 2018-2019 and 2019-2020 Assured Operating Plans and Determination of Downstream Power Benefits. There were no curtailments of the CE delivery during the reporting period.

CRT Hydrometeorological Committee (CRTHC) continues to work toward better data exchange processes. Recently, this has resulted in improvements to official notifications of data reporting changes, and the creation of Entity-specific point-of-contact directories for critical data exchange and validation issues.

The CRTHC routinely reviews the basin gauging network for adequacy. The Akamina Pass snow pillow site in Alberta, badly damaged by a forest fire in 2018, was re-established, though the site remains highly modified by fire damage. Several stations in Canada were decommissioned due to poor gauging, dangerous sampling conditions and damage caused by forest fire, while several other stations were added. At this time, the CRTHC believes that the station network is adequate for Treaty purposes.

The Entities continue to work toward a long-term solution to address Canadian concerns with variable discharge flood control (VarQ) at the Libby Dam. In the meantime, the Entities have extended the Short-term Entity Agreement on Coordination of Libby Project Operations (STLA) until 31 August 2020. The Agreement provides Canada the option to provisionally store up to 50 thousand cubic feet per day (ksfd) and draft up to 550 ksf.

Throughout the year, composite Canadian Treaty storage operations targeted the Treaty Storage Regulation (TSR) study levels, including any operations implemented under mutually agreed upon supplemental operating agreements, namely STLA and the Columbia River Treaty Operating Committee Agreement on Operation of Canadian Storage for Nonpower Uses (NPU). As in past years, the CRTOC negotiated an NPU in order to manage Keenleyside outflows to improve conditions for fish in both countries.

Negotiations on the modernization of the Columbia River Treaty began in May 2018 and were ongoing throughout the reporting period. Round eight of the negotiations was held in Cranbrook, BC. Negotiations focused on issues related to ecosystem operations, flood risk management and hydropower.

The PEB is satisfied that the Treaty objectives have been achieved during this reporting period.

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

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ABBREVIATIONS AND ACRONYMS

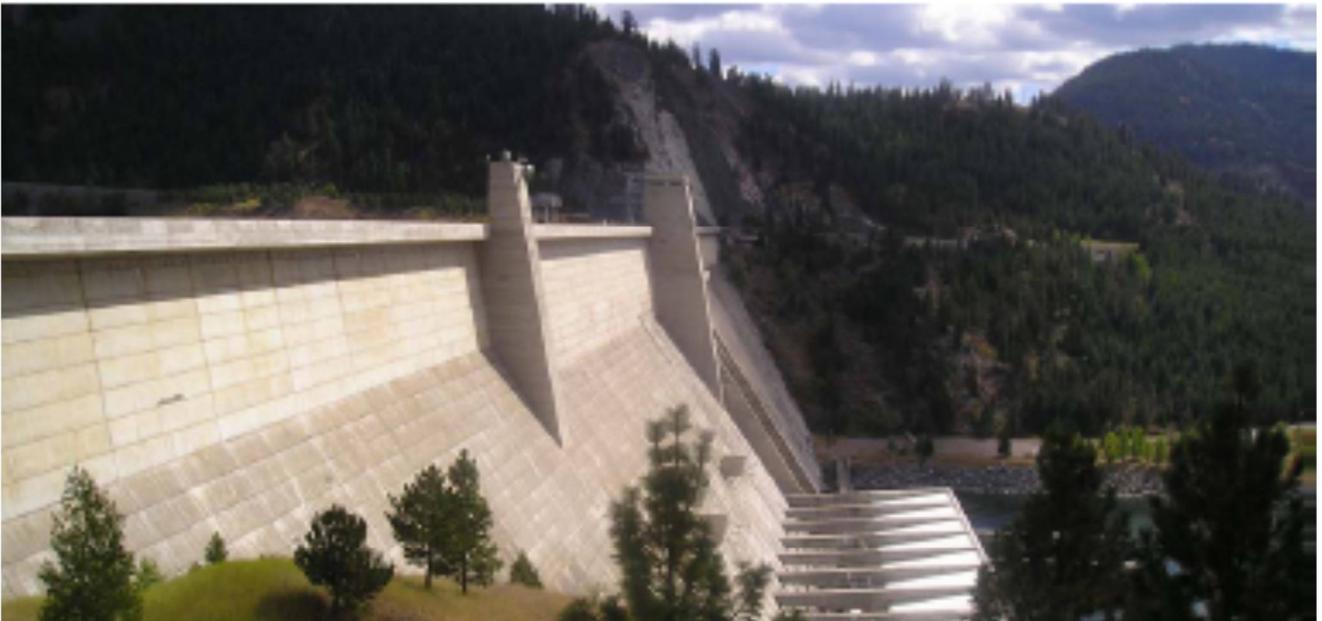
aMW	Average Megawatts
AOP	Assured Operating Plan (from 1 August to 31 July)
BC Hydro	.....	British Columbia Hydro and Power Authority
BiOp	.....	Biological Opinion
BPA	.....	Bonneville Power Administration
CEPA	.....	Canadian Entitlement Purchase Agreement
CRT or Treaty	.....	Columbia River Treaty
CRTHMC	.....	Columbia River Treaty Hydrometeorological Committee
CRTOC	.....	Columbia River Treaty Operating Committee
cfs	.....	Cubic feet per second
DDPB	.....	Determination of Downstream Power Benefits
DOP	.....	Detailed Operating Plan (from 1 August to 31 July)
ESA	.....	Endangered Species Act
ESP	.....	Ensemble Streamflow Prediction
FCOP	.....	Flood Control Operating Plan
FCRPS	.....	Federal Columbia River Power System
ft	.....	Feet
FRM	.....	Flood Risk Management
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
MW	.....	Megawatts
MWh	.....	Megawatt hour
NMFS	.....	National Marine Fisheries Service
NOAA	.....	U.S. National Oceanic and Atmospheric Administration
NPU	.....	Non-Power Uses Agreement
NTSA	.....	Non-Treaty Storage Agreement
PEB or Board	.....	Permanent Engineering Board
PEBCOM	.....	Permanent Engineering Board Engineering Committee
PNCA	.....	Pacific Northwest Coordination Agreement
POP	.....	Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans
PSANI	.....	Puget Sound Area / Northern Intertie
STLA	.....	Short Term Libby Agreement
TSR	.....	Treaty Storage Regulation
USACE	.....	US Army Corps of Engineers
USFWS	.....	US 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 2018 through 30 September 2019, outlines the essential features of the Treaty and Treaty projects, and the responsibilities of the Board and the Entities. It summarizes the Treaty storage operations, flow discharges at the border, and the resulting power and flood control benefits achieved by each country during the reporting period.

The report refers to items currently under review by the Entities, provides a summary of Board activities during the reporting period 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 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

The essential undertakings of the Treaty are as follows:

- (a) Canada will provide 19.1 km³ (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 during the sixty years following ratification.
- (e) The United States has the option of constructing a dam on the Kootenai River near Libby, Montana. The Libby Reservoir would extend some 67.6 km (42 miles) into Canada, and Canada would make the necessary Canadian land available for flooding.

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

(g) Differences arising under the Treaty that cannot be resolved by the two countries may be referred by either country to the International Joint Commission or to arbitration by an appropriate tribunal as specified by the Treaty.

(h) The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964. The Protocol of January 1964 amplified and clarified certain terms of the Columbia River Treaty. The Attachment Relating to Terms of Sale signed on the same date established agreement that, under certain terms, Canada would sell in the United States its entitlement to downstream power benefits for a 30-year period. The Exchange of Notes and Attachment Relating to Terms of Sale of January 1964 and the CEPA of 13 August 1964 (the Sales Agreement) provided that the Treaty storage would be operative for power purposes on the following dates: Duncan storage on 1 April 1968; Arrow storage on 1 April 1969; and Mica storage on 1 April 1973. All sales under the Sales Agreement have now expired.

Termination Provisions

Article XIX describes the period of the Treaty and provisions for its termination at any time after the Treaty has been in force for sixty years. 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 with at least ten years' written notice. Certain provisions of the Treaty terminate automatically in 2024, while other continue for the useful life of the Treaty facilities.

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. The duties and responsibilities of the Board are also stipulated in the Treaty and related documents.

Establishment of the Board

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

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

Duties and Responsibilities

The general duties and responsibilities of the Board to the governments, as set forth in Article XV(2) of the Treaty and related documents, include:

- (a) assembling records of the flows of the Columbia River and the Kootenay River at the Canada–United States of America boundary;
- (b) reporting to Canada and the United States of America whenever there is substantial deviation from the hydroelectric and flood control operating plans and, if appropriate, including in the report recommendations for remedial action and compensatory adjustments;
- (c) assisting in reconciling differences concerning technical or operational matters that may arise between the Entities;
- (d) making periodic inspections and requiring reports as necessary from the Entities, with a view to ensuring that the objectives of the Treaty are being met;
- (e) making reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty and making special reports concerning any matter that it considers should be brought to their attention;

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

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



Hugh Keenleyside Dam (Arrow Lakes Reservoir) – Columbia River, British Columbia
Concrete spillway and discharge works with navigation locks and earthfill dam.
The 185-MW power plant, completed in 2002, 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.

As part of the March 31, 1999 Exchange of Notes between the Government of Canada and the Government of the United States Permitting the Disposal of the Canadian Entitlement within the United States, pursuant to Article XIV(1) of the Treaty, Canada designed the Province of British Columbia as the Canadian Entity for the purposes of Article XIV(2)(i).

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 86th meeting on 5– 6 February 2019 in Vancouver, British Columbia, Canada. In conjunction with this meeting, the Board also held its 67th joint meeting with the Entities.

The Entities and the PEB met to discuss the current status of the CRT Review, the preparation and implementation of operating plans, the Libby Variable Flow (VarQ), Canadian Entitlement Delivery, FRM issues and other topics requested by the PEB. The STLA was extended for another year allowing additional time to complete and review studies.

Reports and Agreements Received

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

- Extension of the Columbia River Treaty Short-term Entity Agreement on Coordination of Libby Project Operations, signed February 2019.

This document is Amendment 4 to original agreement and provides for mutually agreeable storage and release of water and specified the associated financial payments through 31 August 2020.

- Columbia River Treaty Agreement on the Detailed Operating Plan (DOP) for Canadian Storage, signed July 2019.

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 2019 through 31 July 2020

- Columbia River Treaty Operating Committee Agreement on Operation of Canadian Storage for Nonpower Uses for 01 December 2018 through 31 July 2019.

This is a supplemental agreement to the DOP that provides mutual benefits in the form of storage and release of water for nonpower uses, such as whitefish and rainbow trout spawning in Canada and salmon migration in the US.

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 August 2018 through 30 September 2019.

This report summarizes the operation of Treaty projects and other activities of the Entities for the period of 1 August 2018 through 30 September 2019.

Report to the Governments

In accordance with Article XV, paragraph 2(e) of the Treaty, the fifty-fourth Annual Report of the Board, dated 30 September 2018, 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, and annual preparation of operating plans for power and calculation of downstream power benefits. The three Treaty storage projects in British Columbia (Duncan, Arrow, and Mica) and the Libby storage project in the United States have been operated accordingly to produce flood control and power benefits in both Canada and the United States. The locations of the Treaty projects are shown in Plate No.1 in Appendix D.

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 four turbines at Mica Dam by 1977 and two additional turbines in 2014 and 2015, completion of the Revelstoke dam including four turbines in 1984 (and a fifth turbine installed in 2010), and installation of two turbines adjacent to the Keenleyside Dam in Arrow Lakes in 2002, have resulted in approximately 5400 MW of generation capacity in British Columbia that might not have been installed without the Treaty. An additional generation unit at Revelstoke is also being planned.

The Treaty provides Canada with an option to divert the Kootenay River at Canal Flats into the headwater of the Columbia River starting 1984. BC Hydro undertook engineering feasibility and environmental studies, but no further work has been done in recent years.

Further to the expiration of the Sales Agreements 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.

Treaty Projects

Duncan Project

Duncan Dam, the smallest Treaty project, was scheduled to begin operation by 1 April 1968. It was the first of the Treaty projects to be completed and became fully operational on 31 July 1967, in advance of the Treaty requirement. The Sales Agreement for Duncan expired 31 March 1998.

The earthfill dam is situated 9.7 km (6 mi) north of Kootenay Lake and rises 39.6 m (130 ft) above its foundation. The reservoir behind the dam extends for as much as 43.5 km (27 mi) and provides 1.73 km³ (1.40 Maf) of usable storage, which is all committed under the Treaty. No power generation facilities have been installed.

The project is shown on page 12, and project data are provided in Appendix D, Table 1 on page 50.

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 the starting date of 1 April 1969 for the 30-year Sales Agreement.

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 extends 233 km (145 mi) upstream when full, including both the Upper and Lower Arrow lakes, and provides 8.8 km³ (7.1 Maf) of Treaty storage.

A 185-MW power plant located on the north abutment (left bank) of the Arrow Project was completed in 2002. It is licensed to Arrow Lakes Power Corporation which is owned by Columbia Basin Trust and Columbia Power Corporation, both Crown Corporations in British Columbia. A 1493 m (4900 ft) intake approach channel runs along the north end of the concrete dam and diverts the water of the Arrow Lakes 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 230 kV transmission line to the Selkirk substation integrate into BC Hydro's existing power grid. The power production at this generating facility is incidental to releases for Treaty purposes. This power plant reduces spill at Keenleyside Dam and provides environmental benefits by reducing the total gas pressure in the releases, which could be harmful to fish.

The project is shown on page 7, and project data are provided in Appendix D, Table 2 on page 51.

Mica Project

Mica Dam, the largest of the Treaty projects, was scheduled under the 30-year Sales Agreement to begin operation on 1 April 1973. The project was declared operational and commenced to store water on 29 March 1973. The dam is located on the Columbia River 137 km (85 mi) north of the town of Revelstoke in 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 km³ (20 Maf). The project is operated within 14.8 km³ (12 Maf) of live storage, of which 8.6 km³ (7 Maf) is committed under the Treaty.

The generating station has six Francis turbines; four 435 MW units, and two 520 MW units. The second 520 MW unit was commissioned in early 2016. The total capacity, with 6 units, is 2780 MW.

The project is shown on page 20, and project data are provided in Appendix D, Table 3 on page 52.

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 km³ (5.9 Maf), of which 6.1 km³ (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 US legislation (Public Law 104-303, 12 Oct. 1996) authorizes the US 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 on page 53.

Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 68 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 to establish and operate, in consultation with the Permanent Engineering Board, a hydrometeorological system to obtain data for the planning of flood control and power operations. This system includes snow courses, meteorological stations, and reservoir level and streamflow gauges. The Columbia River Treaty Hydrometeorological Committee (CRTHC) was established in September 1968 by the Entities and is responsible for coordinating hydrometeorological data collection, data exchange and water supply forecasting for the CRT projects in accordance with the Treaty and otherwise assisting the Entities, as needed.

The 2018 CRTHC Annual Report was completed in December 2018 and distributed prior to the end of the year. The 2019 Annual Report of CRTHMC was completed in early-December 2019.

The CRTHC updated Appendix 8 of the Principles and Procedures document to specify that early-season volume forecasts will not be used in developing monthly flows for the Actual Energy Regulation (AER)/Treaty Storage Regulation (TSR) but will be used for all other treaty calculations that require seasonal volumes. There was also a change adopted on the use of alternate methods for the forecast of monthly streamflows late in the season when the use of distribution factors for shape is no longer applicable.

In early April of 2019, an atmospheric river impacted the Snake River drainage of the Columbia Basin generating significant precipitation and melting much of the low lying snowpack in the basin, resulting in a significant change to the residual water supply forecast from the official April water supply forecasts. The Canadian portion of the basin did not experience a similar increase from the official April Treaty forecast. This dramatic increase in seasonal water supply volume caused some issues in the streamflow coordination of some of the projects for the second TSR in April. The CRTHC proposed that projects impacted by the storm would use the 15 April forecast generated by the Northwest River Forecast Center (NWRFC) which reflected the additional volume from the atmospheric river event. The Canadian projects and Libby (which were not impacted by the storm) would continue to use their official April forecasts. The same approach was taken during May, with the mid-month water supply forecast being used for all but the Treaty projects which remained largely unaffected by these late season storms.

In order to make water supply and flood risk management information available to the region and for use in Treaty coordination as early as possible in each month, the CRTHC recommended and CRTOC approved using the 10-day ESP forecast prepared on the third working day of each month.

The CRTHC routinely reviews the basin gauging network for adequacy. At this time, the CRTHC believes that the station network is adequate for Treaty purposes.

The Akamina Pass snow pillow site in Alberta which is used in the Libby water supply equation was damaged by a forest fire in 2018. The USACE proposed a procedure to estimate those data which was reviewed by the CRTHC for use during the 2019 forecasting season and will continue to use in 2020. That station has since been re-established, but the site is highly modified by the fire.

Several stations in Canada were decommissioned due to poor gauging, dangerous sampling conditions and damage caused by a forest fire; several other stations were added. One Treaty station was impacted: the Fauquier climate station was discontinued as the observer was no longer able to continue. A new automated climate station was installed by BC Hydro at the nearby Fauquier Water Treatment Plant in the fall of 2018, and will be used as a direct replacement of the old Fauquier site.

The committee continues to work toward better data exchange processes. Recently, this has resulted in improvements to official notifications of data reporting changes, and the creation of Entity-specific point-of-contact directories for critical data exchange and validation issues.

Operating Plans and Determination 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 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 determination 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) for the three Treaty projects in Canada is prepared. This plan accounts for projected resources and demands to determine operations that are more advantageous to both countries than those in accordance with the AOP. To supplement the DOP, the Entities may enter into agreements throughout the year regarding the operation 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, operation of Treaty storage in Canada was regulated under the rule curves set out in the Entities' Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2018 through 31 July 2019 dated June 2018, and the Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2019 through 31 July 2020, dated July 2019, as well as in accordance with the Columbia River Treaty Short-Term Entity Agreement on Coordination of Libby Project Operations (STLA) signed in September 2013 and extended in February 2019 to 31 August, 2020, and CRTOC Agreement on Operation of Canadian Storage for Nonpower Uses for 29 December 2018 through 31 July 2019, signed on 13 December 2018. These documents were based on the operating criteria and studies contained in the corresponding AOPs.

The Libby operating criteria and expected operation of the Libby project are no longer included in the annual DOP beginning in the 2000-2001 operating year. Information on Libby operations is provided separately in the Libby Operating Plan prepared by the U.S. Entity. Operation at Libby takes 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 higher releases from Libby Dam in the spring and summer and lower releases in the fall and winter. In January 2003, USACE adopted, on an interim basis, a new approach to determine operations at Libby. This approach, referred to as VarQ, applies only when dry-to-moderate hydrologic runoff conditions are forecasted. It uses (encroaches) flood control storage space to store water to increase flows for fisheries during the spring period. In June 2008, USACE issued a Record of Decision for Libby Dam Flood Control and Fish Operations and incorporated the VarQ Flood Control Procedures into the Libby Dam Water Control Manual. Canada believes that these operations result in loss of power generation and increased flood risk in Canada. USACE will continue to coordinate with Canada on the operation of Libby Dam pursuant to provisions in the Columbia River Treaty.

The Libby Coordination Agreement (LCA), signed on 16 February 2000, addressed some of the Treaty issues associated with salmon and white sturgeon fisheries operations of the Libby Project. It 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 since signing. The Entities continue to pursue full long-term resolution of the VarQ operational impacts on power and flood control. In the meantime, the Entities have entered into STLA, which includes and furthers the flexibility that is existing under the LCA.

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 appropriate Treaty interpretations, 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.

In addition to the delivery agreement referenced 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.

Delivery of Canadian Entitlement

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.

During the course of the 2018-2019 Operating Year, there were no Canadian Entitlement delivery curtailment events. The Board will continue to keep the governments informed of transmission developments that may 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

The Long Term Non-Treaty Storage Agreement (NTSA), executed in April 2012, was used by BPA and B.C. Hydro for power purposes through Operating Year 2018-2019. In accordance with the Entity agreement that approved the 2012 NTSA contract between BPA and B.C. Hydro, the CRTOC monitored the storage and release operations under the Agreement throughout the Operating Year to ensure they did not adversely impact the operation of CRT storage required by the DOPs. For the reporting period, NTSA water was released and stored by both parties into their respective accounts. On 01 March 2019, there was an agreement to open the Recallable accounts for additional draft flexibility. The drafted volume was returned in September 2019, fulfilling the parties' refill obligation under this 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 the Kinbasket Reservoir – 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 2018 to 30 September 2019, Treaty operations are based on the Treaty Operating Year of 1 August 2018 to 31 July 2019. Additional information for 1 August 2019 to 30 September 2019 is based on the Treaty Operating Year 1 August 2019 to 31 July 2020.

For the 1 August 2018 through 30 September 2019 reporting period, the Canadian Storage were operated according to the 2018-2019 and the 2019-2020 Detailed Operating Plans (DOPs), the 2003 Columbia River Treaty Flood Control Operating Plan (FCOP), and supplemental operating agreements as described below. The Libby project was operated consistently with the Libby Coordination Agreement (LCA), including the Libby Operating Plan (LOP), United States (U.S.) requirements for power, and U.S. Fish and Wildlife Service's 2006 Biological Opinion (BiOp), as clarified, and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service's (NOAA Fisheries') 2010 and 2014 Supplemental BiOp for operation and maintenance of the Federal Columbia River Power System (FCRPS).

Treaty storage in Canada was operated by the Canadian Entity in accordance with the documents listed below. The Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 LCA, including January 2010, October 2010 and July 2016 updates to the Libby Operating Plan (LOP), U.S. requirements for power, guidelines set forth in the U.S. Fish and Wildlife Service (USFWS) 2006 Biological Opinion, and the U.S. National Marine Fisheries Service (NMFS) Biological Opinions and Action Agency Plans, as approved by Court order, 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 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 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.

- *Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2018-2019*, dated November 2011

This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2018 through 31 July 2019.

- *Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2018–2019*, dated April 2013

This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2018 through 31 July 2019.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2018 through 31 July 2019*, dated June 2018

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 2018 through 31 July 2019.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2019 through 31 July 2020*, dated 08 July 2019

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 2019 through 31 July 2020.

- *Extension of the Columbia River Treaty Short-Term Libby Agreement on Coordination of Project Operations (STLA)*, signed 6 February 2019

This document addresses, until 31 August 2020, issues raised by the Canadian entity regarding VarQ operations at Libby. The STLA provides the Canadian Entity additional flexibility to draft and store at Arrow reservoir.

The CRTOC completed the following supplemental operating agreement during the reporting period:

- *Columbia River Treaty Operating Committee Agreement on Operation of Canadian Storage for Nonpower Uses for 29 December 2018 through 31 July 2019*, signed 13 December 2018.

This agreement is similar to previous agreements implemented to utilize Treaty storage for nonpower uses. These uses include providing flows for Canadian whitefish and trout spawning for the January through June period and enhancing the capability in the U.S. of providing spring and summer flow augmentation for salmon and steelhead. In addition to the agreement listed above, the Bonneville Power Administration and/or USACE and B.C Hydro developed an agreement that allowed storage, and subsequent release, of Non-Treaty Storage Agreement (NTSA) water during the period 1 August 2018 through 31 July 2019, providing mutual power and nonpower benefits during the period.

System Storage

The 2018-19 Operating Year began on 1 August 2018 with the Canadian Treaty Storage at 18.3 km³ (14.8 Maf), or 95 percent full. Canadian Storage drafted to a minimum of 3.9 km³ (3.2 Maf), or 20 percent full on 29 March 2019, and refilled to 16.3 km³ (13.2 Maf), or 85 percent full, on 31 July 2019. Canadian Storage operated in proportional draft mode during August 2018 through December 2018 and again during July 2019 through the end of this reporting period to meet Treaty firm loads. Throughout the Operating Year, the composite Canadian Storage targeted the Treaty Storage Regulation (TSR) study composite storage, plus any operations implemented under mutually-agreed-upon Supplemental Operating Agreements, including the Short Term Libby Agreement (STLA), and the Nonpower Uses Agreement (NPU). Exceptions occurred in all periods due to inadvertent draft or storage, which occurs routinely due to updated inflow forecasts or differences between forecast and actual inflows, as well as after-the-fact changes in proportional draft points.

As in past years, the CRTOC negotiated an NPU agreement to manage Keenleyside outflows and to improve conditions for fish in both countries. Under provisions of that agreement, the U.S. Entity stored 1.2 km³ (504 thousand second-foot-days (ksfd), 1 Maf) of flow augmentation water by 01 February 2019 to be released to support flow objectives in the U.S. for salmon Operation under the agreement also helped to manage flows downstream of Keenleyside for Canadian whitefish during the January through June period. Operation under the agreement helped to manage flows downstream of Keenleyside for Canadian whitefish during the January through June period. All of the water stored for Flow Augmentation under the NPU was released, for Columbia River salmon migration, from late June through late July 2019.

The actual January through July runoff for the Columbia River above The Dalles was 111.3 km³ (90.2 Maf), or 89 percent of the 1981-2010 average. The actual April through August 2019 runoff for the Columbia River above The Dalles was 99.9 km³ (81.0 Maf), or 93 percent of the 1981-2010 average. Below is the water supply forecast evolution for January - July at The Dalles.

January – July Water Supply Forecast for the Columbia River above The Dalles

As Projected in	Volume		Percent of 1981 – 2010 Average
	km ³	Maf	
January	102.7	83.3	95
February	92.9	75.3	86
March	94.5	76.6	88
April	93.3	75.6	86
May	101.6	82.4	94
June	101.9	82.6	94
Jan – Jul Actual	111.3	90.2	89
Apr – Aug Actual	99.9	81.0	93

Operations of the three Canadian projects (Mica, Keenleyside, and Duncan) and Libby in the United States for the 14-month period from 01 August 2018 to 30 September 2019 are illustrated in Section VIII as Charts 5 through 8. The hydrographs show actual reservoir levels, discharges, inflows, and the Flood Risk Management (FRM) Rule Curve. The FRM Rule Curve specifies maximum month-end reservoir levels which permit timely evacuation of the reservoir to mitigate potentially high inflows from precipitation and snowmelt events.

Mica (Kinbasket Reservoir)

Kinbasket reached a maximum elevation in 2018 of 747.25 m (2,451.6 ft), 7.13 m (23.4 ft) below normal full pool, on 17 August 2018. Low refill levels in 2018 were due to a compressed freshet leading to very dry summer conditions. Kinbasket reservoir was drafted as typically observed across the fall and winter. Winter of 2018-19 started relatively mild but quickly became unprecedentedly cold and dry; these conditions lasted through February and early March. Significantly more draft occurred as a result in February 2019 to meet high winter electricity demand. In 2019, the minimum level reached was 714.82 m (2,345.2 ft) on 14 April 2019, about 4.42 m (14.5 ft) lower than the 2018 minimum level.

From February to August 2019, reservoir inflows were about 93% of average. Low inflows combined with deep draft in the spring caused the reservoir to refill to below average levels: maximum was 748.10 m (2,454.4 ft) on 27 September 2019, 6.28 m (20.6 ft) below normal full pool.

Hugh Keenleyside (Arrow Lakes Reservoir)

In Operating Year 2017-18 Arrow reached a maximum level of 439.73 m (1,442.7 ft), or 0.40 m (1.3 ft) below full pool, on 13 July 2018. Arrow releases are regulated under the Treaty and its supplemental operating agreements. Under dry conditions, storage must be drafted as far as necessary to meet Treaty firm loads consistent with the principles of proportional draft under the CRT. When conditions become wetter, Treaty storage comes out of proportional draft. As the draft began from a near-full storage, Arrow Lakes Reservoir summer levels were within recreation range through 04 September 2018 (Labour Day). Arrow followed a typical draft across the winter to reach a minimum level of 429.25 m (1,408.3 ft) on 02 February 2019. By comparison, in 2018, Arrow Lakes Reservoir reached a minimum level of 429.16 m (1,408.0 ft) on 28 March 2018.

Arrow Lakes Reservoir refilled in April/May/June to a maximum level of 438.91 m (1,440.0 ft) on 21 June 2019. This is about 1.22 m (4.0 ft) below full pool and 0.82 m (2.7 ft) below the 2018 maximum level. As in past years, Arrow Lakes Reservoir drafted during the summer months, with levels reaching 434.46 m (1,425.4 feet) on Labour Day.

Duncan Dam (Duncan Reservoir)

Duncan began the operating year near-full pool, at 576.59 m (1,891.7 ft), 0.09 m (0.3 ft) below full pool on 01 August 2018. By comparison in the previous year, the reservoir reached a similar maximum level of 576.50 m (1,891.4 ft), 0.18 m (0.6 ft) below full pool on 13 August 2017. From September 2018 through April 2019, Duncan was operated to supplement flows into Kootenay Lake, to provide spawning and incubation flows for fish downstream in the Duncan River and to meet Treaty FRM requirements. As in most years, the reservoir was drafted to near empty in late April. Duncan reached its minimum level, 547.42 m (1,796.0 ft) on 18 April 2019. By comparison, the reservoir reached a similar minimum level of 547.09 m (1,794.9 ft) on 19 April 2018.

The reservoir discharge was reduced to its minimum of 3 m³/s (0.1 kcfs) in May to initiate reservoir refill and reduce flood risk downstream at Meadow Creek and around Kootenay Lake. Releases from Duncan were held at minimum until the end of July, when discharges were gradually increased to manage the rate of reservoir refill. In 2019, Duncan refilled to a maximum of 576.47 m (1,891.3 ft), 0.21 m (0.7 ft) below full pool on 02 August 2019. Duncan discharges were increased during August 2019 to facilitate drafting the reservoir to reach the summer recreation target of 575.46 m (1,888.0 ft) between 10 August 2019 and Labour Day 2019 as per the Duncan Water Use Plan Order.

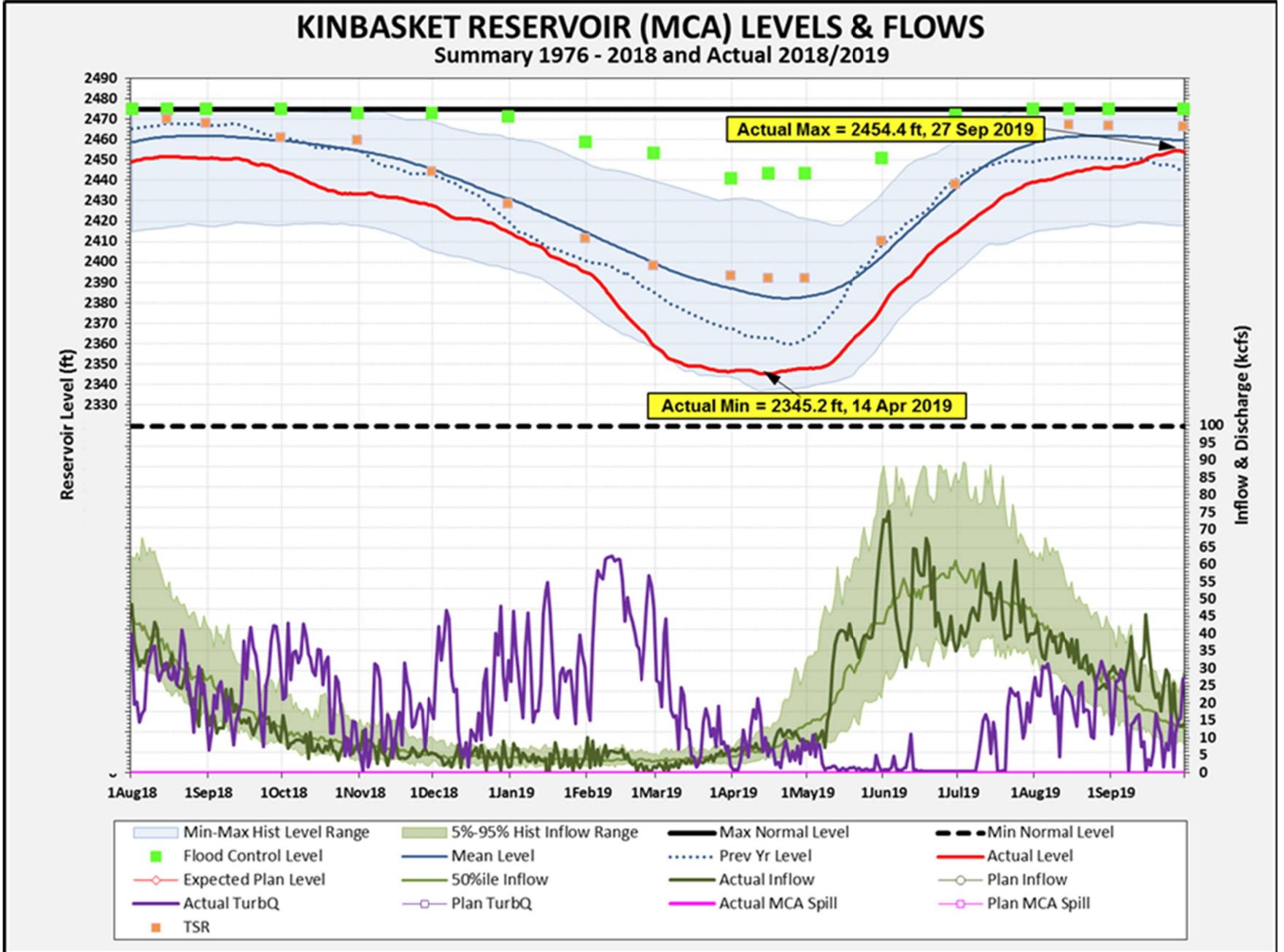
Libby (Lake Koocanusa)

Lake Koocanusa ended July 2018 at elevation 746.12 m (2,447.9 ft). The project was drafted to elevation 744.87 m (2,443.8 ft) at the end of August 2018. From September 2018 through April 2019, the project was operated to meet minimum bull trout flows, FRM requirements, and emergency hatchery operations. For ten days in early March, releases from Libby were increased to clear ice from the water intake for the Burbot and Kootenai Sturgeon fish hatchery. On 26 March 2019, Libby Dam reached its minimum elevation for the year of 733.26 m (2405.7 ft) then operated to its minimum flow until the onset of refill 22 April 2019, when operations went to the Variable Flow (VarQ) FRM rules until the start of the sturgeon pulse. On 29 May 2019, Libby began to release the sturgeon volume of 1.0 km³ (0.8 Maf) set by the May water supply forecast of 6.1 km³ (5.0 Maf), which is 85 percent of average. The 2019 sturgeon volume was released in a single pulse operation with the goal of matching timing with high elevation runoff. The pulse began on 29 May 2019 with project outflows ramping up to 566 m³/s (20.0 kcfs) for 20 days. The outflows were then stepped down to the minimum bull trout flow of 198 m³/s (7.0 kcfs) over six days using ramping rates. The sturgeon volume was expended on 26 June 2019. Lake Koocanusa ended the month of June at elevation 740.48 m (2,429.4 ft).

The operation for the rest of the summer, July through August 2019, was to try to refill Libby as much possible and meet the 746.46 m (2,449.0 ft) target by the end of September 2019, as required in the 2019 BiOp and coordinated through the Technical Management Team (TMT). Libby reached its peak elevation for the summer on 22 August 2019, at 744.47 m (2,442.5 ft) 22 August 2019, at 744.47 m (2,442.5 ft), which was 5.03 m (16.5 ft) below full pool. Due to low inflows and pool, Libby releases were kept at the minimum bull trout flow of 198 m³/s (7.0 kcfs) from July through August 2019 then ramped down to 170 m³/s (6.0 kcfs), the minimum bull trout flow for September 2019. Libby elevation was 744.35 m (2,442.1 ft) at the end of August 2019 and this elevation was maintained through the end of September 2019. The Kootenai Tribe of Idaho had requested low flows for in-stream habitat work in previous summers, but this request was not made in 2019. Libby held 170 m³/s (6.0 kcfs) through the end of September 2019.

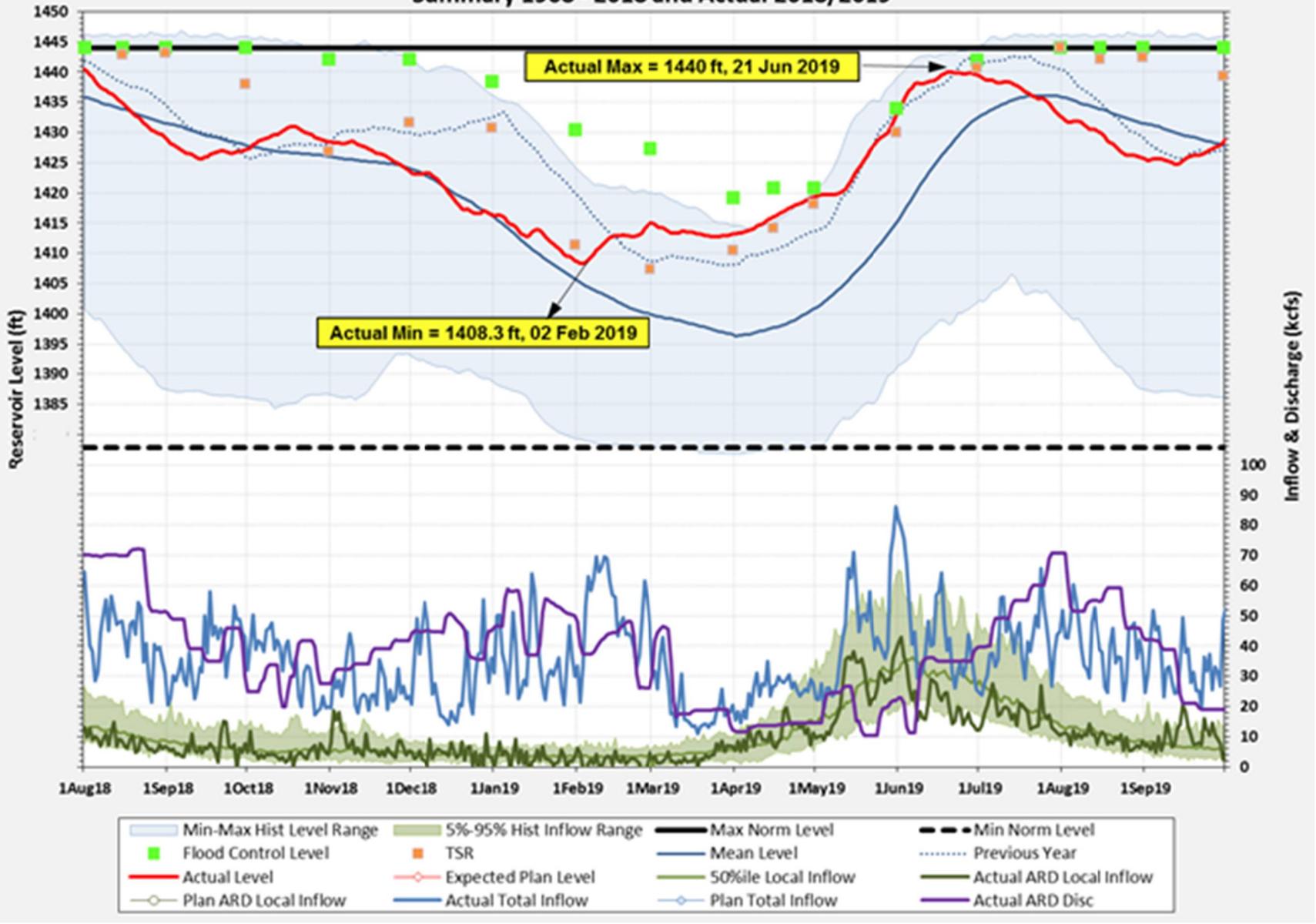
Flood Risk Management Operations

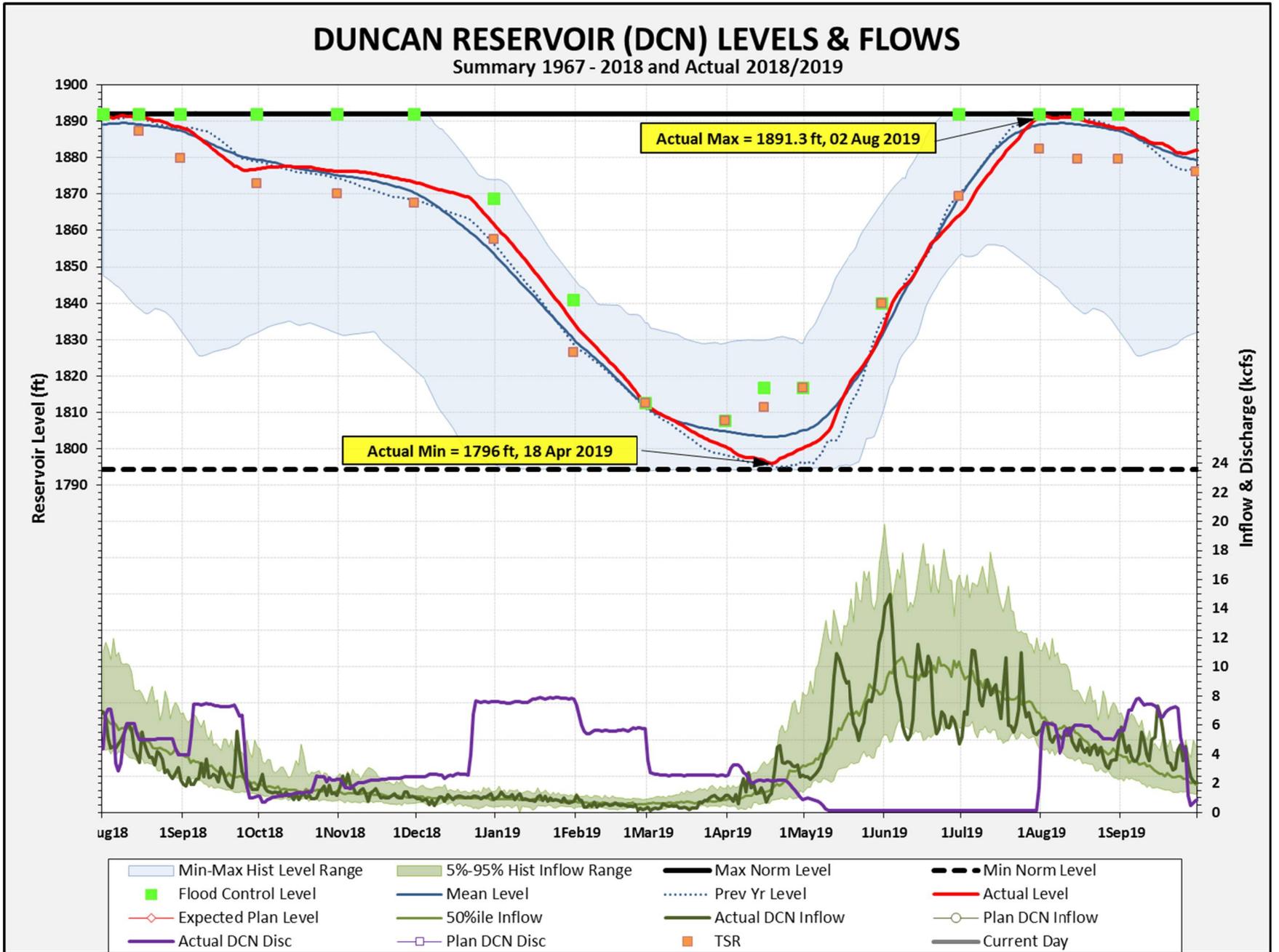
Columbia River Basin projects were operated for FRM objectives according to the May 2003 FCOP. Overall, the 2019 runoff volumes were below normal across the Columbia River Basin. The regulated peak outflow during the freshet from The Dalles Dam was 9,447 m³/s (333.6 kcfs) on 19 May 2019, and the unregulated peak flow was at 13,133 m³/s (463.8 kcfs) on 04 June 2019. The peak stage observed during the freshet at Vancouver, Washington, was 3.23 m (10.6 ft) on 19 May 2019, and the estimated peak unregulated stage was 4.94 m (16.2 ft) on 20 May 2019, while the flood stage is 4.88 m (16.0 ft). For the spring season, observed regulated peak stage at Vancouver, Washington, was 4.75 m (15.6 ft) with an unregulated peak of 5.58 m (18.3 ft), which occurred on 12 April 2019 and was due, in part, to high discharges from the Willamette River.



ARROW LAKES RESERVOIR (ARD) LEVELS & FLOWS

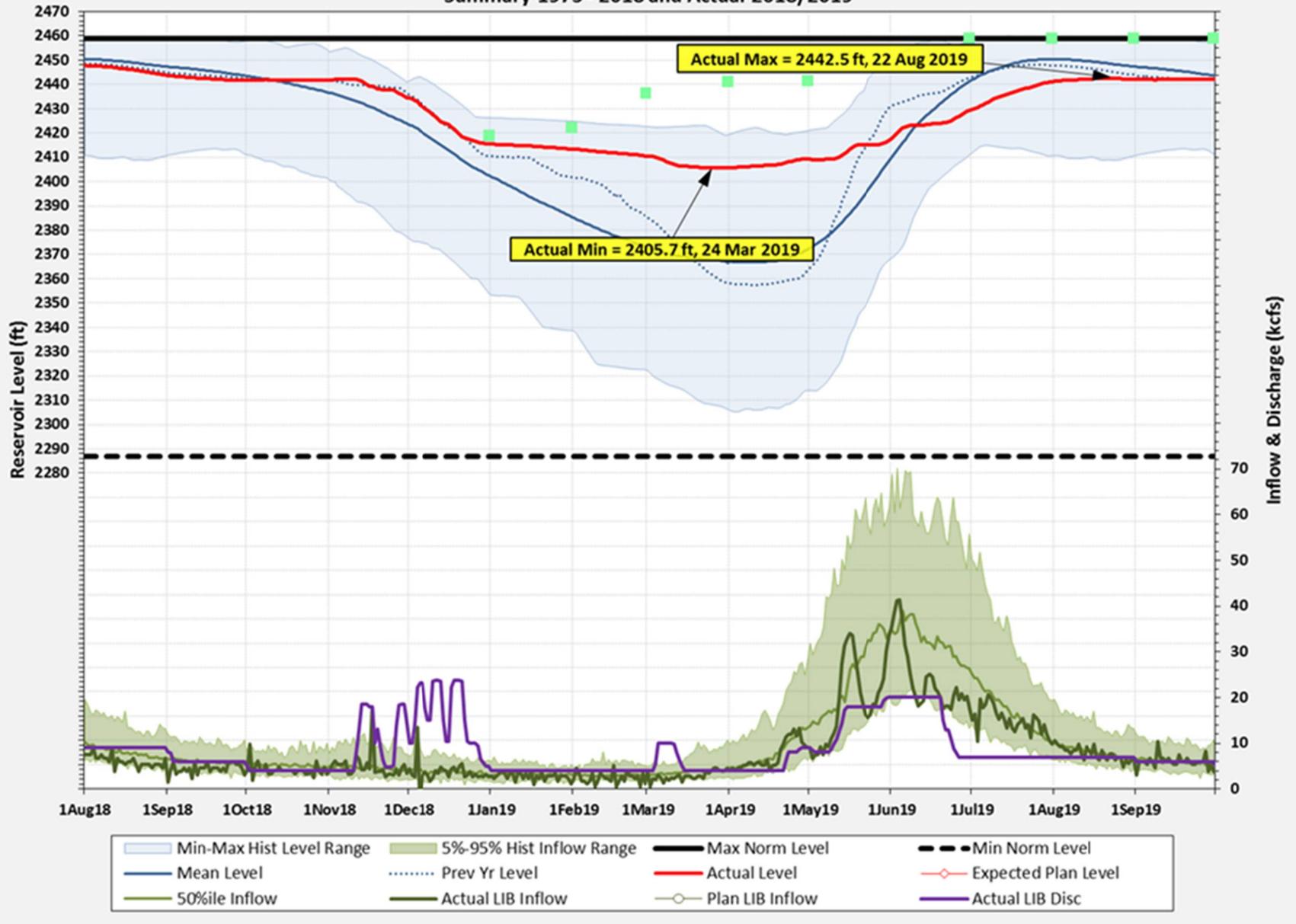
Summary 1968 - 2018 and Actual 2018/2019



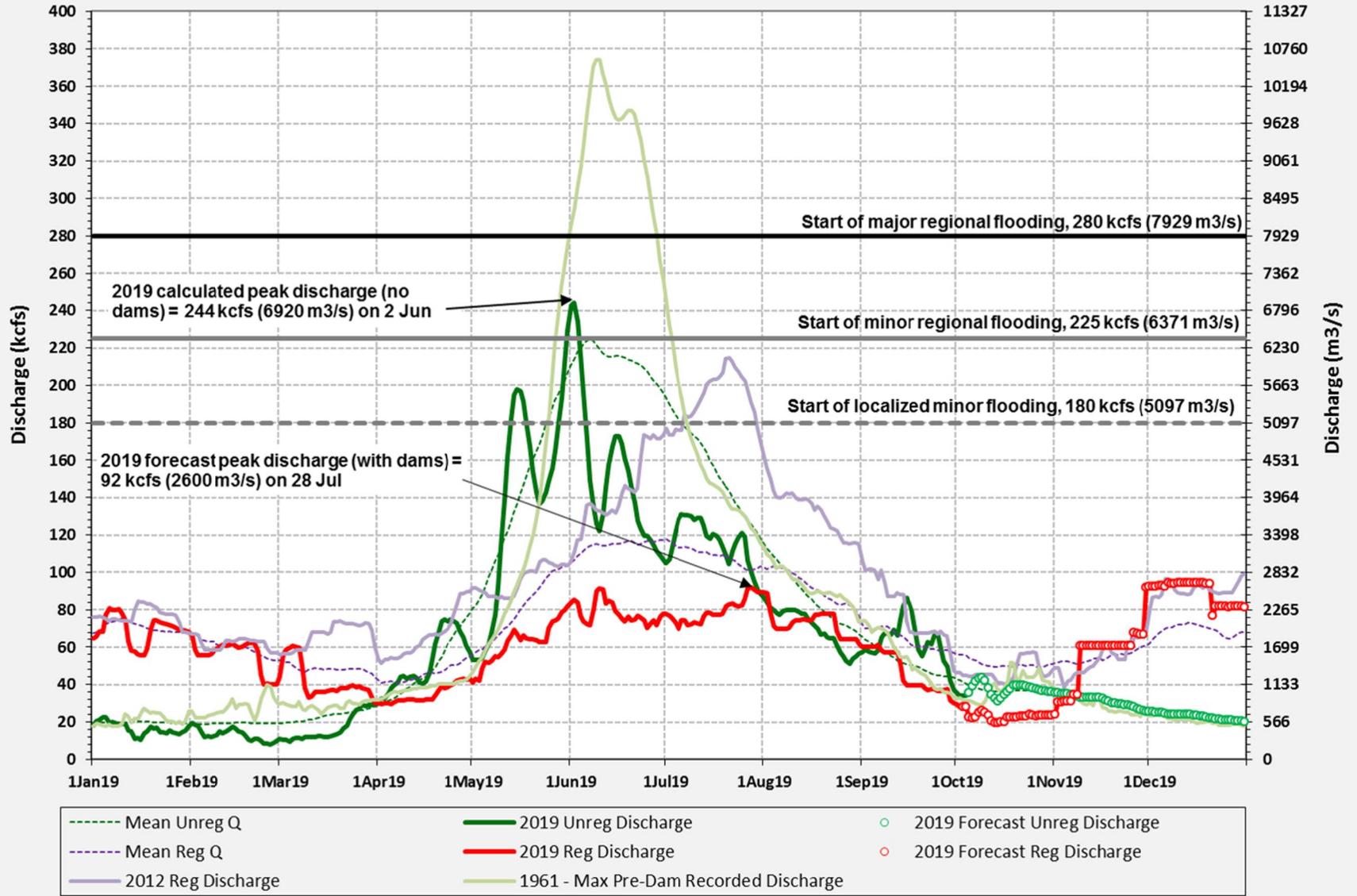


LIBBY RESERVOIR (LIB) LEVELS & FLOWS

Summary 1975 - 2018 and Actual 2018/2019



COLUMBIA RIVER AT BIRCHBANK AVERAGE DAILY DISCHARGE (Brilliant Project + Brilliant Expansion + Brilliant Spill + Arrow Lakes Hydro + Hugh Keenleyside)



TREATY BENEFITS

Flood Risk Management Benefits

Water Year 2019 resulted in a relatively quiet FRM season due to below average seasonal volumes. Below normal 01 April 2019 snow pack, early runoff, and below average late season precipitation across the basin resulted in no significant local flood risk issues. Reservoirs throughout the Columbia River basin, including the Treaty projects, were carefully managed to meet system needs and to achieve local FRM objectives as detailed below. The actual unregulated runoff volume for the overall Columbia River Basin (U.S. and Canada combined) measured at The Dalles for January through July 2019 was 111.3 km³ (90.2 Maf), 89 percent of the 1981-2010 average. The peak regulated (and estimated unregulated) flows and river stages are shown in the following tables:

Columbia River Streamflow at The Dalles Dam, Oregon

Date	Peak Unregulated Flow	Date	Peak Regulated Flow
04 June 2019	13,133 m ³ /s (463.8 kcfs)	19 May 2019	9,447 m ³ /s (333.6 kcfs)

Columbia River Stage at Vancouver, Washington

Flood Stage is 4.88 m (16.0 ft)

Date	Peak Unregulated Stage	Date	Peak Regulated Stage
20 May 2019	4.94 m (16.2 ft)	19 May 2019	3.23 m (10.6 ft)

Hydro-regulation by the Duncan and Libby projects limited the peak level of Kootenay Lake at Queen's Bay to 532.27 m (1,746.3 ft) on 05 June 2019. Without regulation from those Treaty dams, the peak level would have been approximately 533.52 m (1,750.4 ft). As documented in the 2003 FCOP, flood damages commence at Nelson when the Kootenay Lake elevation reaches 534.9 m (1,755.0 ft). Duncan, Keenleyside, Mica and Libby projects limited the peak flow of the Columbia River at Trail, just upstream of Birchbank, British Columbia, to 2,662 m³/s (94.0 kcfs) on 11 June 2019. Absent the dams, but with natural lake effects at Kootenay Lake, the flow would have been approximately 5,182 m³/s (183.0 kcfs). For reference as per the DOP16, the bankfull flow at Birchbank is estimated to be 5,097.0 m³/s (180.0 kcfs).

Power Benefits

A Determination of Downstream Power Benefits (DDPB) is computed in conjunction with the Assured Operating Plan (AOP). This computation represents the optimized generation from downstream U.S. projects that could have been produced by an optimized Canadian/U.S. system. The DDPB is prepared in accordance with the Treaty and Protocol, and other Entity Agreements. The Canadian Entitlement (CE) represents one-half of the DDPB. For the period 01 August 2018 through 31 July 2019, the CE amount, before deducting transmission losses, was 472.5 average Megawatts (aMW) of energy, scheduled at rates up to 1,284 Megawatts (MW). From 01 August 2019 through 30 September 2019, the amount, before deducting transmission losses, was 454.3 aMW of energy, scheduled at rates up to 1,141.5 MW. During the 2018-19 Operating Year, there were no CE delivery curtailment events.

Actual U.S. power benefits from the operation of Canadian Storage can only be roughly estimated. Canadian Storage has such a large impact on the operation of the U.S. system that its absence would significantly affect operating procedures, nonpower requirements, loads and resources, and market conditions, thus making any benefit analysis highly speculative. A rough estimate of the impact on U.S. hydroelectric power generation during the 2018-19 Operating Year, with and without the regulation of Canadian Storage, based on the Pacific Northwest Coordination Agreement (PNCA) Actual Energy Regulation (AER), that includes minimum flow and spill requirements for U.S. fishery objectives, is 343 aMW. The increase in hydroelectric power generation occurred primarily in the fall and winter months, October through March. No quantification of the financial benefit is provided in this report.

Other Benefits

During 2018-19, the CRTOC completed a supplemental operating agreement, the 2019 Non-power Uses Agreement (NPU), for the mutual benefit of both countries, signed 13 December 2018. This agreement provided for storing 1 Maf of flow augmentation water between 29 December 2018 and 1 February 2019 then releasing later in the year for downstream salmon migration. Provisions under the NPU shaped/smoothed flows over February and March, downstream of Keenleyside Dam, resulting in February flows to be higher and March flows to be lower than the TSR. There were no trout spawning operations in 2019. Water that was stored during the winter under the NPU is intended to enhance conditions for the downstream migration of salmon in the Columbia River from May – July. During 2019, the flow augmentation volume was released evenly from 22 June to 26 July.



Revelstoke Dam, Columbia River, BC



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

APPENDIX A

**COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD**

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

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Principal Hydrologic & Hydraulic Engineer
Engineering & Construction
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Natural Resources Canada
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Assistant Deputy Minister
Electricity and Alternative Energy Branch
BC Ministry of Energy and Mines
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Consultant
Delta, British Columbia

Mr. Darcy Blais
Associate Director
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
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Ms. Renata Kurschner 2017–

Mr. Mac Clark 1964–1992
Mr. David Burpee 1992–2003
Ms. Eve Jasmin 2003–2007
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PERMANENT ENGINEERING BOARD
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Senior Technical Advisor
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

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PERMANENT ENGINEERING BOARD
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APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

COLUMBIA RIVER TREATY ENTITIES

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US Army Engineer Division
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Mr. Kieron Connolly, BPA Coordinator
Vice President
Generation and Asset Management
Bonneville Power Administration
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Jason Ward, Secretary
Regional Coordination
Power Operations and Planning
Bonneville Power Administration
Portland, OR

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President and Chief Operating Officer
British Columbia Hydro and Power Authority
Vancouver, British Columbia

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Director
Generation Systems Operations
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Chris Revell, Secretary
Planning and Licensing Generation
Management System Operation
British Columbia Hydro and Power Authority
Burnaby, British Columbia

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Power and Operations Planning
Bonneville Power Administration
Department of Energy
Portland, Oregon

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Generation Resource Management
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Burnaby, British Columbia

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

Mr. Herbert Louie, Member
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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US Army Engineer Division
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Burnaby, British Columbia

Mr. Georg Jost, Member
Senior Engineer
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 2019**

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	6.45	5.06	14.80	5.74	5.03	5.02	7.23	16.50	29.10	9.52	7.86	7.38
2	5.22	5.20	11.00	5.03	5.04	5.09	7.33	15.90	29.00	9.46	7.67	6.60
3	5.31	5.89	10.70	5.15	5.50	4.83	7.39	15.00	28.70	9.63	7.48	6.57
4	4.92	5.74	15.90	5.18	5.04	4.67	7.53	14.30	27.90	9.46	7.25	6.46
5	4.89	5.69	22.50	5.13	5.13	6.45	7.99	14.70	26.80	8.91	7.24	6.57
6	4.84	5.45	23.50	5.12	5.21	10.40	8.49	15.50	26.20	8.08	7.39	6.54
7	4.94	5.12	22.50	5.28	5.16	10.80	8.92	16.30	26.00	7.56	7.45	6.68
8	4.98	5.13	18.50	5.13	5.28	11.00	9.36	17.50	25.50	7.58	7.35	6.58
9	4.80	4.92	16.10	5.15	5.35	11.00	9.53	18.10	24.90	7.92	7.52	6.49
10	4.77	5.09	17.10	4.99	5.06	11.00	11.00	19.40	24.20	7.95	7.37	6.69
11	4.61	5.00	23.60	5.11	4.66	11.00	11.90	21.20	24.10	7.59	7.74	6.68
12	4.56	5.91	24.40	5.08	4.73	10.70	11.60	24.40	24.10	8.17	7.77	6.70
13	4.71	11.70	24.50	5.03	4.43	8.90	11.10	28.60	23.90	8.03	7.55	6.52
14	4.58	18.40	23.20	5.07	4.69	7.36	10.50	31.20	23.80	7.90	7.54	6.55
15	4.58	19.30	16.10	4.95	4.74	5.96	10.30	33.20	23.50	7.54	7.53	6.37
16	4.44	19.20	11.50	4.84	4.43	5.31	9.91	33.70	23.30	8.06	7.44	6.59
17	4.45	18.70	12.40	4.92	4.70	5.29	9.37	34.20	23.20	8.26	7.64	6.47
18	4.48	11.70	22.90	4.93	4.74	5.35	9.34	33.80	23.10	7.92	7.69	6.43
19	4.48	10.70	24.80	4.94	4.77	5.38	9.55	31.50	22.50	8.09	7.46	6.50
20	4.38	13.40	24.90	4.95	4.80	5.51	11.80	29.60	22.60	7.63	7.40	6.52
21	4.40	9.84	24.80	5.11	4.84	5.65	14.40	28.00	21.50	7.59	7.32	6.61
22	4.46	7.10	23.20	4.98	5.01	5.74	14.40	27.10	17.70	7.73	7.50	6.56
23	4.51	5.74	16.10	5.05	5.01	5.98	15.80	26.50	15.60	7.56	7.44	6.50
24	4.65	5.84	11.30	5.11	5.05	6.37	19.20	26.80	14.00	8.05	7.34	6.44
25	4.56	5.58	10.60	4.96	4.94	6.43	20.70	26.60	11.80	8.05	7.14	6.69
26	4.50	6.55	10.40	5.01	4.95	6.87	20.10	27.40	10.60	7.38	7.34	6.50
27	4.93	14.40	10.40	5.01	4.90	7.25	19.20	28.30	10.20	6.59	7.42	6.71
28	5.02	19.00	9.37	5.02	5.03	7.18	19.10	28.00	9.82	6.91	7.28	6.77
29	5.14	19.50	7.27	5.00	0.00	7.18	17.90	27.90	9.78	7.15	7.52	6.61
30	5.17	19.10	6.47	4.79		7.10	17.20	29.20	9.60	8.10	7.35	6.55
31	5.06		6.09	4.86		7.09		29.30		7.88	7.44	
Mean	4.80	10.00	16.67	5.05	4.77	7.22	12.27	24.83	21.10	8.01	7.47	6.59

COLUMBIA RIVER AT BIRCHBANK, BC

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2019

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	53.33	47.68	50.86	52.63	50.86	42.03	36.73	56.87	134.92	144.81	111.61	71.35
2	52.98	47.68	52.27	52.98	51.21	42.03	36.03	58.28	136.69	143.75	110.20	69.23
3	52.63	47.68	53.33	53.33	50.51	41.68	36.38	59.69	138.81	142.34	109.49	68.87
4	52.27	47.68	54.39	54.39	49.45	42.03	36.38	61.10	140.57	140.57	108.79	68.17
5	50.86	47.68	55.10	55.45	49.09	40.97	36.73	62.87	142.69	138.81	107.73	67.46
6	50.15	46.98	56.16	55.81	49.09	39.56	36.73	64.28	144.46	138.10	106.67	68.17
7	49.45	46.62	56.16	56.16	48.74	39.21	36.38	66.05	146.22	137.75	105.61	68.52
8	48.74	46.27	55.81	56.16	48.74	38.85	36.73	68.17	146.93	137.04	104.19	68.17
9	48.04	45.92	56.51	56.87	48.04	38.50	37.44	70.64	147.64	135.98	102.43	67.81
10	47.68	46.27	56.87	57.57	47.33	39.21	37.79	72.76	147.64	134.57	100.66	66.75
11	47.33	46.27	56.51	57.22	47.68	39.91	38.50	75.23	147.28	133.16	99.25	65.34
12	46.98	46.62	56.51	56.87	48.39	39.56	38.85	77.70	147.64	132.45	97.13	64.64
13	46.98	46.98	57.22	56.16	48.39	39.21	39.21	80.53	147.99	131.74	95.72	63.93
14	46.98	46.98	57.22	55.81	48.04	39.21	40.26	83.36	148.70	131.39	94.30	62.87
15	46.98	46.98	56.87	55.45	47.68	39.21	41.32	86.53	149.05	130.33	92.54	61.81
16	46.98	45.92	56.51	55.10	47.68	39.21	42.38	89.71	149.76	129.62	91.13	60.40
17	46.62	46.27	56.16	54.75	47.33	39.56	43.09	92.89	150.46	129.27	90.42	59.69
18	46.62	46.98	55.81	54.04	47.33	39.56	43.44	95.72	150.82	128.92	89.71	59.34
19	46.98	46.98	55.45	53.33	46.62	39.21	43.80	98.54	150.82	128.21	88.65	58.98
20	46.98	47.33	55.10	52.98	45.92	39.21	44.50	101.72	150.46	127.51	86.89	58.98
21	47.33	47.33	54.39	52.98	44.86	39.56	45.21	104.55	149.40	126.09	85.47	57.92
22	47.33	47.33	54.04	52.98	44.50	39.56	46.62	108.08	148.34	124.33	84.77	57.22
23	46.98	46.98	53.69	52.63	43.80	39.91	48.04	111.26	148.34	122.56	83.71	56.51
24	47.33	47.33	51.92	52.63	43.44	39.91	49.45	114.79	148.34	120.79	82.30	56.16
25	47.33	47.68	51.21	52.63	43.09	39.91	49.80	118.32	148.34	118.68	81.59	55.45
26	46.98	48.39	50.86	52.27	42.74	40.26	50.51	121.85	147.99	116.91	81.59	55.10
27	46.98	48.74	51.21	52.27	42.38	40.26	51.57	124.33	146.93	115.50	81.94	55.10
28	46.98	49.80	51.92	52.27	42.03	40.26	52.98	126.80	146.58	114.79	80.88	55.10
29	47.33	49.80	52.63	51.92	0.00	39.56	54.39	129.27	146.22	113.73	79.47	54.75
30	47.33	49.80	52.98	51.92		38.85	55.45	131.04	145.52	113.38	78.06	54.04
31	47.68		52.98	51.92		37.79		133.16		113.02	75.58	
Mean	48.23	47.36	54.47	54.18	45.34	39.80	42.89	91.81	146.52	128.91	93.18	61.93

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

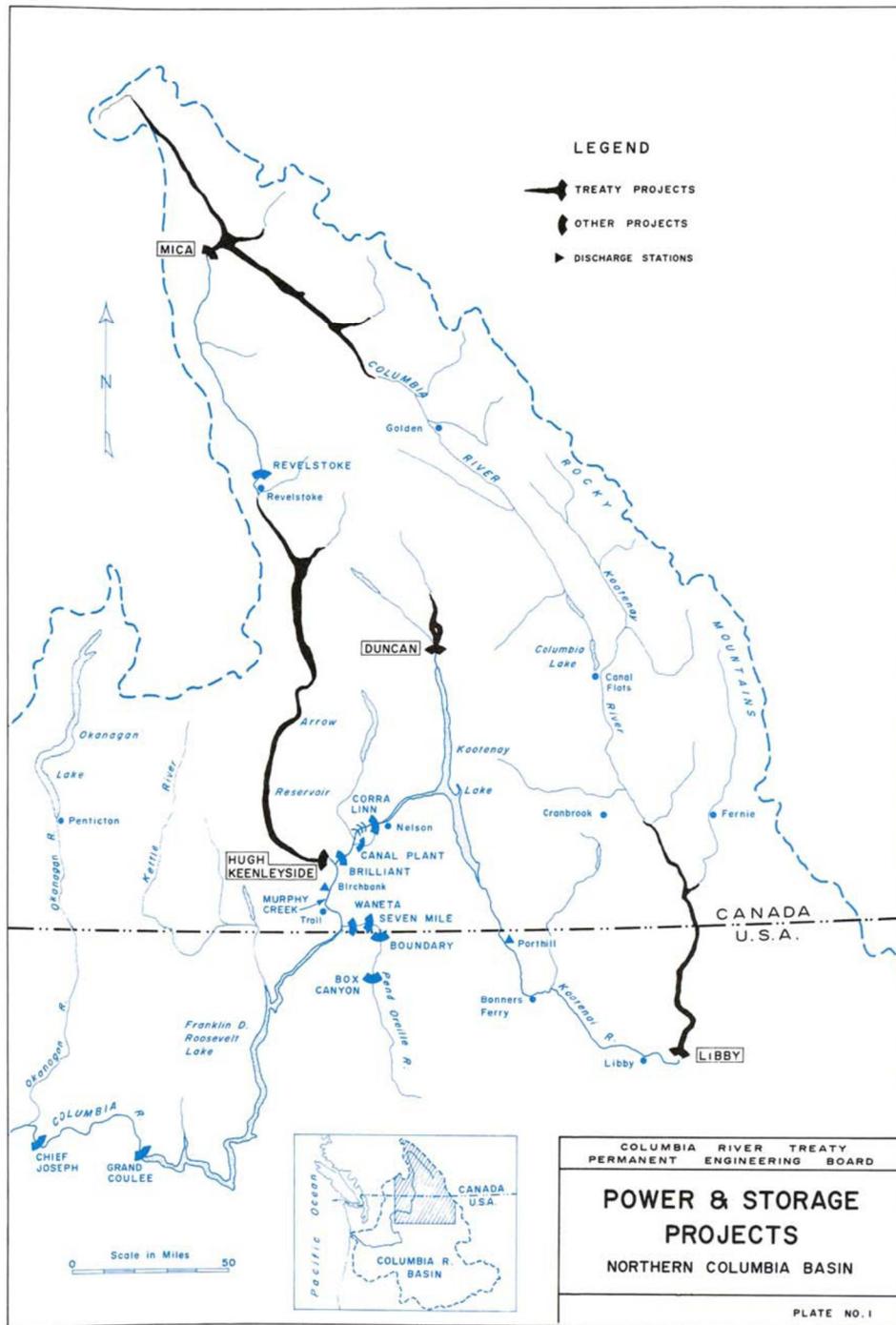


TABLE 1

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 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 m (2600 ft)
Approximate height above riverbed	39.6 m (130 ft)
Spillway – Maximum capacity	1350 m ³ /sec (47.7 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 (1378 ft)
Surface area at full pool	52,610 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	6800 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)	23.5 m (77 ft)
Maximum turbine discharge	1200 m ³ /sec (42.4 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	42,900 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	4250 m ³ /sec (150 kcfs)
Outlet works – Maximum capacity	1060 m ³ /sec (37.4 kcfs)

Power Facilities

Currently installed:

Authorized diversion in the project's water licence limits generation to 2750 MW.

Head at full pool 183 m (600 ft)

4 units at 451 MW	1805 MW
Power commercially available	1976
Maximum turbine discharge of 4 units at full pool	1080 m ³ /sec (38.2 kcfs)

2 units at 520 MW	1040 MW
Power commercially available	2014-15
Maximum turbine discharge of 2 units at full pool	330 m ³ /sec (37.4 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	697.1 m (2287 ft)
Surface area at full pool	18,820 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	931.2 m (3055 ft)
Approximate height above riverbed	112.8 m (370 ft.)
Spillway – Maximum capacity	4110 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
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Currently installed:

5 units at 120 MW	600 MW
Power commercially available	1975
Head at full pool	107 m (352 ft)
Maximum turbine discharge of 5 units at full pool	750 m ³ /sec (26.5 kcfs)