



Looking upstream at the Hugh L. Keenleyside dam and its navigational lock on the left.

Columbia River Operations Summary

Spring 2020

This publication provides an overview of BC Hydro's operations on the Columbia River. At 2,000 kilometres long, the Columbia River is the fourth largest river in North America. The headwaters of the Columbia River are in Canal Flats, British Columbia (B.C.). The river then flows northwest through the Rocky Mountain trench before heading south through B.C. and Washington, emptying into the Pacific Ocean at Astoria, Oregon. Other major tributaries of the Columbia River in Canada include the Kootenay and Pend D'Oreille rivers.

Only 15% of the Columbia River basin lies in Canada. The Canadian portion of the basin is mountainous and receives a lot of snow producing, on average, 30 to 35% of the runoff for Canada and the United States (U.S.) combined. The river's large annual discharge and relatively steep gradient gives it tremendous potential to generate electricity. The hydroelectric dams on the Columbia's main stem and many more on its tributaries produce more hydroelectric power than on any other North American river.

BC Hydro's facilities in the Columbia basin include 11 hydroelectric dams, two water storage dams, and a system of reservoirs. Four of the larger reservoirs within Canada are operated according to the Columbia River Treaty and other agreements signed between Canada and the U.S.



BC Hydro's operating agreements

COLUMBIA RIVER TREATY

The Columbia River Treaty between Canada and the U.S. was ratified in 1964. The Treaty resulted in the construction of three dams in B.C. (the Duncan, Hugh L. Keenleyside and Mica dams) for flood control and to increase hydroelectric generating potential in both countries. The Treaty also provided for the construction of Libby Dam in the U.S. and the resulting Kootenai Reservoir, which crosses the Canada–U.S. border.

Water stored and then released by the Canadian reservoirs provides the U.S. with the potential to generate additional electricity, as well as to increase flood protection. Under the terms of the Treaty, Canada receives a one-half share of the extra power generation potential in the U.S. This is called the Canadian Entitlement to Downstream Benefits and is owned by the Province of British Columbia. The Canadian Entitlement varies from year to year, but is currently about 3,990 gigawatt hours (GWh) per year of energy and 1,141 megawatts (MW) of capacity for the period between August 1, 2019 and July 31, 2020.

Since September 16, 2014 both Canada and the U.S. have had the option to terminate the Treaty, provided that either country provides 10 years' notice of its intent to terminate. After extensive consultation with basin residents, the Province decided in March 2014 to continue with the Columbia River Treaty and seek improvements within the existing Treaty framework. More information on the Treaty and its review process can be found at: engage.gov.bc.ca/columbiarivertreaty.

Other agreements

The Treaty Entities, BC Hydro, Bonneville Power Administration (BPA), and the U.S. Army Corps of Engineers, periodically negotiate and sign supplemental operating agreements when there is mutual benefit to modify the water releases specified by the Columbia River Treaty. In September 2013, the Treaty Entities signed a short-term agreement to address some of Canada's concerns about the timing of water releases from the Libby Dam, known as the VarQ operating regime. This agreement was extended to be in effect until August 2021 and is supplemental to the Libby Coordination Agreement that was signed in 2000. Under the new agreement, the U.S. has committed to continued coordination with Canada to consider alternative reservoir operations to reduce flood risk in both countries, similar to the extensive collaboration that occurred during the 2012, 2017, and 2018 high water events. In addition, BC Hydro is compensated for energy losses at its Kootenay Canal operations that result from the

timing of water releases from the Libby Dam. The Entities have also agreed to continue working together to reach a long-term agreement.

In late 2019, the joint Canada–United States Treaty Operating Committee responsible for the implementation of the Flood Control Operating Plan signed the 2020 Non-Power Uses Agreement. This annual operating agreement modifies Arrow Lakes Reservoir releases between January and July 2020 to protect Canadian whitefish and trout in exchange for flow benefits for endangered U.S. salmon.

NON-TREATY STORAGE AGREEMENT (NTSA)

The Kinbasket Reservoir, created by Mica Dam, is licensed by the Province for more water storage than is required to meet the terms of the Columbia River Treaty. This additional storage is called Non-Treaty Storage and the water can only be released across the Canada–U.S. border under agreement between BC Hydro and its U.S. partners. The current Non-Treaty Storage Agreement (NTSA) was signed by BC Hydro and BPA in 2012 and remains in effect until 2024.

The new NTSA gives BC Hydro more control over reservoir levels, provides more energy benefits to B.C. and gives BC Hydro more operating flexibility to balance competing non-power interests on the Columbia system. These interests include recreational activities, wildlife habitat, and fisheries. Since the agreement was signed, BC Hydro and BPA have made good use of NTSA flexibility to reduce the impacts of high and low water levels downstream of Arrow Lakes Reservoir and to improve power and non-power benefits for both countries.



Raindrops on snowberry plant near Revelstoke.

BC Hydro's Columbia operations

Much of the region's summer and winter generating potential depends on precipitation and snowpack levels. The runoff for the entire Columbia basin (Canada and U.S. combined) between April and September 2020 is currently forecast to be 95% of normal. This is very similar to last year where the actual runoff at The Dalles was 94% of normal.

The Canadian portion of the Columbia basin is generally wetter than the U.S. portion and the runoff is 101% of normal. By comparison in 2019, the actual runoff was 87% of normal. Many types of future variables affect the ability to predict with certainty a long-term forecast including: weather, runoff volumes and patterns, system electricity demands, and Treaty discharge requirements.



Snow covered mountain ash berries near Arrow Lakes Reservoir.



High flows into our reservoirs expected this spring.



Test spill release down Mica dam spillway in July 2012.

Our facility operations during high runoff conditions

During periods of high runoff, the inflow to a reservoir typically exceeds the amount of water discharged from the power plant through electricity generation, resulting in reservoir refill. If inflows remain high as the reservoir level approaches full pool BC Hydro may implement the following typical flood operations:

Spill release

- To increase the reservoir discharge beyond the power plant capacity, BC Hydro can undertake a controlled release of water from the reservoir (spill). During this operation additional water is released through the dam spillway and other outlet works to maintain the reservoir level at or below its normal full pool level.

Store more water

- With prior permission from the provincial Comptroller of Water Rights, BC Hydro can store a pre-determined amount of additional water in the reservoir. Should the additional storage be used, the reservoir level will rise above the normal full pool level, typically by one to two feet. BC Hydro's facilities are designed to safely store this additional water.

KINBASKET RESERVOIR

Kinbasket Reservoir regulates discharges for both the Mica and Revelstoke Generating Stations, as well as for generating stations further downstream.

Kinbasket Reservoir did not fully refill to its normal full pool level in 2019 due to below average snowpack and runoff conditions. It reached a peak water level of 752.2 metres (2,454.4 feet) on September 27, 2019. This level was 6.27 metres (20.6 feet) below normal full pool. The fall and winter of 2019/20 started relatively dry but quickly turned wetter in December and January and this contributed to significant snow accumulation in the basin. Electricity demand was relatively light in the winter but a late season arctic outbreak in March and prolonged cooler and drier conditions in April increased electricity demand and generation from Mica Generating Station. As a result, the minimum level for Kinbasket Reservoir this year is forecast to be 717.50 metres (2,354 feet) in April 2020, about 8.5 metres below average. By comparison, last year's minimum level was 714.8 metres (2,345.2 feet) on April 14, 2019.

Snowpack for the Kinbasket basin is currently well above 2019 levels and inflows for February to September 2020 are currently forecast to be 109% of average. Given the lower than average water level this spring, the reservoir is expected to refill to within 3 metres (10 feet) of its full pool level this year. Depending on the rate of snowmelt and rainfall during freshet, we may store additional water in Kinbasket Reservoir and raise the water level up to 0.3 metres (1 foot) above its normal full pool level.



Aerial view of Mica Dam.

Under the *Water Sustainability Act* and the *Utilities Commission Act*, the Comptroller of Water Rights is responsible for the regulation of BC Hydro's water licenses. The licensed operating range for Kinbasket Reservoir is between 706.96 metres (2,319.42 feet) and 754.4 metres (2,475 feet).

Kinbasket Reservoir can be operated at up to two feet above its normal maximum water level, if approved by the Comptroller of Water Rights. Kinbasket Reservoir provides 7 million acre feet (MAF) of Treaty Storage and 5 MAF of Non-Treaty Storage, for a total storage of 12 MAF.



REVELSTOKE RESERVOIR

Revelstoke Reservoir was created by the Revelstoke Dam. Revelstoke Reservoir levels may fluctuate in response to weather patterns, inflow levels and generation requirements. During the spring freshet and winter peak electricity load periods, it is common to have daily fluctuations of the reservoir within 1.5 metres (5 feet) of full pool.

The reservoir may be periodically lowered below its normal minimum level of 571.5 metres (1,875 feet) to meet increasing system needs for short-term generating capacity or may fill to near full pool during periods of high reservoir inflows.

The licensed operating range for Revelstoke Reservoir is between 554.7 metres (1,820 feet) and 573 metres (1,880 feet). At most times, the reservoir is maintained at or above 571.5 metres (1,875 feet).



Arrow lily pads.

ARROW LAKES RESERVOIR

Arrow Lakes Reservoir was created by the Hugh L. Keenleyside Dam. Arrow discharges are regulated under the Columbia River Treaty and its supplemental operating agreements. Last year dry conditions were prevalent across the entire Columbia basin and the observed February to September 2019 inflows into Arrow reservoir was only 83% of normal.

Arrow Lakes Reservoir reached a peak level of 438.9 metres (1,440 feet), 1.2 metres (4 feet) below normal full pool on June 21, 2019. The reservoir drafted in the summer to meet the provisional draft provisions of the Columbia River Treaty. Under dry conditions, the coordinated system operates in proportional draft in the summer and fall resulting in more water releases from Arrow Lakes Reservoir. Conversely, under wet conditions, less water releases are required.

As inflows improved in the winter, the system came off proportional draft and Arrow Lakes Reservoir followed a typical draft across the winter to reach a minimum level of 428.2 metres (1,404.8 feet) on March 3, 2020. This is 1.07 metres (3.5 feet) lower than last year's minimum level of 429.25 metres (1,408.3 feet) reached on February 2, 2019.

The snowpack in the Arrow Lakes Reservoir basin is currently well above 2019 levels. The inflows into Arrow Lakes Reservoir for the period from February to September 2020 are forecast to be 105% of average. Based on this forecast, the reservoir is expected to refill to 439.5 metres (1,442 feet), 0.6 metres (2 feet) from normal full pool by the end of June 2020.

The normal licensed operating range for Arrow Lakes Reservoir is between 419.9 metres (1,377.9 feet) and 440.1 metres (1,444 feet). The reservoir can be operated up to two feet above its normal maximum level (to 440.7 metres or 1,446 feet), if approved by the Comptroller of Water Rights. Arrow Lakes Reservoir provides 7.1 MAF of Treaty Storage.



Arrow Lakes Reservoir flats south of Revelstoke.

DUNCAN RESERVOIR

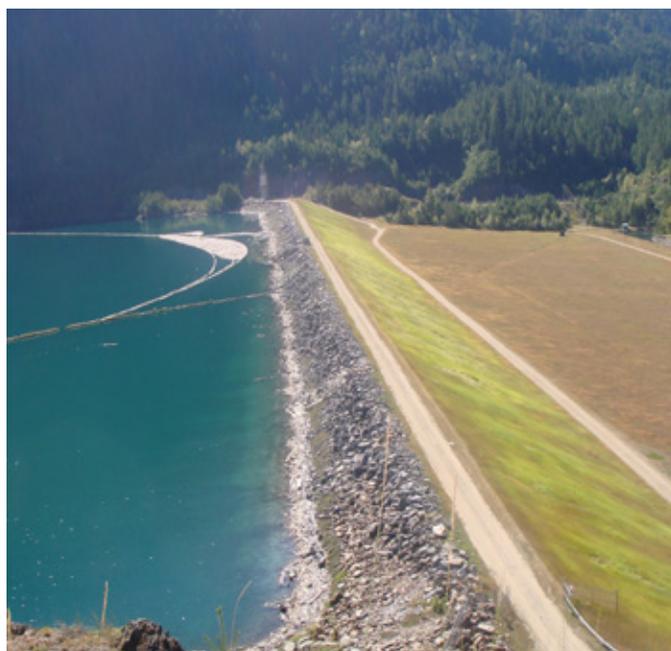
Duncan Dam's operations help meet Treaty flood control requirements, minimize flood risk on Kootenay Lake and provide minimum fish flows year round, as required by the Duncan Dam Water Use Plan.

In 2019, the Duncan Reservoir refilled very close to its normal full pool level, reaching a maximum level of 576.5 metres (1,891.2 feet) on August 2, 2019. This water level was 0.24 metres (0.8 feet) below full pool. The reservoir then drafted to about 575.46 metres (1,888 feet) on August 31, 2019 and stayed at this level until Labour Day.

From September to late December 2019, Duncan Reservoir was operated to provide the flows necessary for kokanee and whitefish spawning downstream of the dam. Discharges were later increased to help lower the reservoir for Treaty flood control requirements during the winter.

To manage flood risk downstream of the Duncan Dam at Meadow Creek and on Kootenay Lake, Duncan Reservoir is normally drafted to its licenced minimum level of 546.9 metres (1,794.2 feet) each year by April or before the start of the freshet. In response to a delayed freshet this year, BC Hydro asked for approval to reduce minimum flows downstream of the dam to conserve water until the start of freshet.

Snowpack in the Kootenay region is also well above average. The inflows into Duncan Reservoir for the period from February to September 2020 are forecast to be 106% of average. Based on the current inflow forecast, Duncan Reservoir is expected to refill close to full pool by August 2020.



The crest of Duncan Dam near Meadow Creek.

The normal operating range for Duncan Reservoir is between 546.9 metres (1,794.2 feet) and 576.7 metres (1,892 feet). The reservoir can be operated up to 1.2 feet above its normal maximum level of 577 metres (1,893.2 feet), if approved by the Comptroller of Water Rights. Duncan Reservoir provides 1.4 MAF of Treaty Storage.



Duncan Reservoir.

COLUMBIA RIVER FLOWS

Columbia River flows downstream of the Kootenay River confluence at Castlegar are the result of flow regulation at Hugh L. Keenleyside and other dams on the mainstem Columbia, as well as dams on the Kootenay River system. Actual discharges depend on many factors including upstream runoff, storage operations, and Treaty discharge requirements.

In 2019, there were no flood concerns on the Columbia River downstream of Hugh L. Keenleyside Dam. Columbia River flows are measured at the Birchbank flow measuring station downstream of the Kootenay River confluence between Castlegar and Trail. River flows peaked at about 2,694 cubic metres per second (m³/s) or 95,000 cubic feet per second (cfs) on July 28, 2019. This flow was well below the peak regulated flow experienced in 2012 of 6,090 m³/s (215,000 cfs), and the peak pre-dam flow of 10,590 m³/s (374,000 cfs) in 1961.

The 2020 inflows into the reservoirs and peak Columbia River flows at Birchbank are forecast to be higher than 2019 although actual flows will depend on the timing and volume of runoff. BC Hydro's water licence has no minimum discharge requirements for the Columbia River downstream of Hugh L. Keenleyside Dam, but under the Treaty there is an obligation to reduce to a minimum weekly average flow of 5,000 cfs under certain water conditions.

KOOCANUSA RESERVOIR

The Kooconusa Reservoir on the Kootenay River is controlled by Libby Dam in Libby, Montana and is operated by the U.S. Army Corps of Engineers. The reservoir backs into Canada and provides approximately 5 MAF of storage.

Kooconusa Reservoir reached a maximum level of 744.7 metres (2,443.24 feet), which is 4.8 metres (15.8 feet) below its full pool of 749.5 metres (2,459 feet), on October 25, 2019. Kooconusa Reservoir continues to be operated under VarQ procedures for U.S. fisheries' interests and flood control.

The latest Libby Operating Plan provides for release of:

- flows as needed during March and April to not exceed month-end Flood Risk Management targets;
- at least the minimum flows in May and June necessary to meet the flow rates and sturgeon volume objectives in the U.S. Fish & Wildlife Service Biological Opinion (BiOp) for sturgeon spawning and recruitment;
- minimum bull trout flows as outlined in the BiOp; and
- augmented downstream flows for salmon after the sturgeon flow operation is completed.

Kooconusa Reservoir is typically drafted during the winter for Treaty flood risk management. The reservoir is forecast to reach a minimum level of 732.7 metres (2,404 feet) in March 2020, similar to last year's minimum level of 733.26 metres (2,405.7 feet) on March 24, 2019. The 2020 forecast minimum level for Kooconusa Reservoir is about 10.67 metres (35 feet) higher than average.

The inflows into Kooconusa Reservoir from April to August 2020 are currently forecast to be 107% of average, compared to only 74% of average in 2019. The provision of sturgeon flows will be required this spring and will depend on the May inflow forecast.

Information regarding the operation of Libby Dam and Kooconusa Reservoir water levels is available from the U.S. Army Corps of Engineers at nws.usace.army.mil or by calling 406 293 3421.

The normal operating range for Kooconusa Reservoir is between 697.1 metres (2,287 feet) and 749.5 metres (2,459 feet). During periods of high downstream flood risk, the Treaty Entities may coordinate additional storage in Kooconusa Reservoir.



Libby Dam crest.

KOOTENAY LAKE

For information regarding Kootenay Lake, please contact FortisBC.

Website: fortisBC.com

Phone: 1 866 436 7847

Want to stay informed of BC Hydro operations?

REGIONAL OPERATIONS UPDATE MEETINGS

Every year we host meetings and open houses throughout the Columbia and Kootenay regions to:

- Listen to and learn from local residents, stakeholders, First Nations and community representatives who have an interest in the operation of the Columbia River Treaty facilities and BC Hydro facilities in the East Kootenay and Thompson/Okanagan/Columbia regions.
- Provide information on the operations of Columbia River Treaty facilities in Canada and other facilities that are operated in a coordinated manner on the Columbia system.
- Provide an update on BC Hydro activities.

This year, we will be hosting our annual Operations Update meetings in May and June by conference call due to the COVID-19 situation. To register for these calls, please contact Dayle Hopp at dayle.hopp@bchydro.com.

East Kootenay Operations Update Meeting

Wednesday, May 13 at 12:00 pm MDT

Columbia/Kootenay Operations Update Meeting

Tuesday, June 16 at 6:00 pm PDT

Duncan Operations Update Meeting

Tuesday, June 23 at 6:00 pm PDT



Operations Update open house at Seniors' Hall in Nakusp.

RESERVOIR WATER LEVEL AND RIVER FLOW INFORMATION

Water levels for our reservoirs can be found on our website that provides near real-time data: bchydro.com/energy-in-bc/operations/transmissionreservoir-data/previous-reservoir-elevations.html.

BC Hydro's toll-free reservoir information line:
1 877 924 2444

BC Hydro's toll-free reservoir information line provides up to date reservoir water level and river flow information. The recording is updated every Monday, Wednesday and Friday and provides:

- Current water levels: Arrow Lakes Reservoir, Duncan Dam Reservoir, Kinbasket Reservoir, Koochanusa Reservoir, Kootenay Lake, Revelstoke Reservoir, Sugar Lake Reservoir and Whatshan Lake Reservoir.
- Current river flows: Columbia River at Birchbank, Duncan River at the Lardeau Confluence, Shuswap River and the flow downstream from Wilsey Dam at Shuswap Falls.

Questions? Please contact:

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