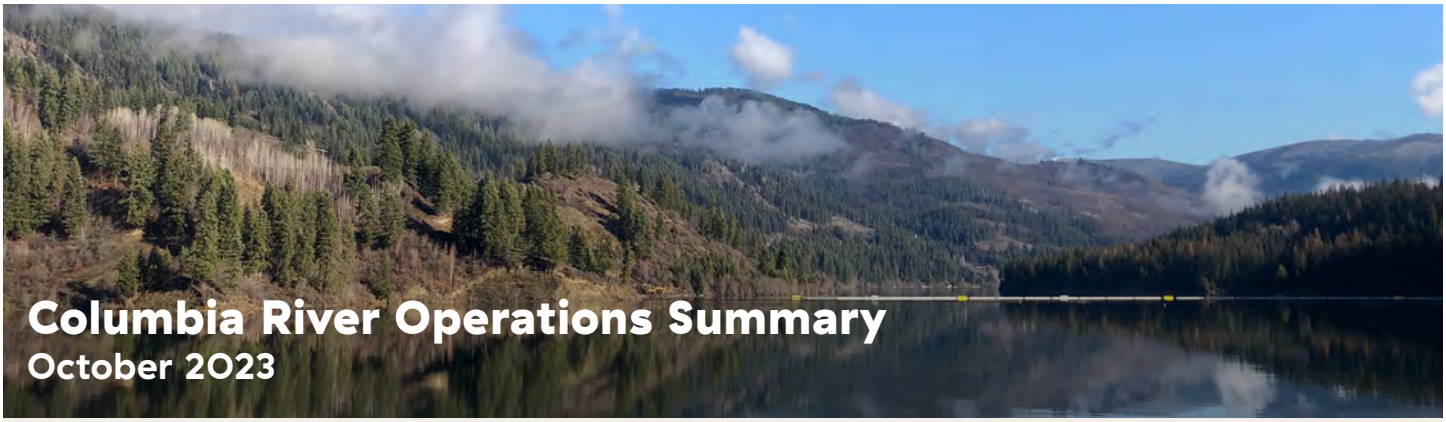

Columbia River Operations Summary
October 2023

Seven Mile forebay with the the Pend d'Oreille River in the background – Credit: Fabio Moscatelli

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, receives a lot of snow, and produces, 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 for generating electricity. The hydroelectric dams on the Columbia's mainstem and its many tributaries produce more hydroelectric power than on any other North American river.

BC Hydro's facilities in the Columbia basin include 13 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.

The Columbia River basin

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 British Columbia (Duncan, Hugh L. Keenleyside and Mica) for flood control and to increase hydroelectric generating potential in both countries. The Treaty also provided for the construction of the Libby Dam in the U.S. and the resulting Koocanusa Reservoir, which crosses the Canada–U.S. border.

The water that is stored and released by Canadian reservoirs provides the U.S. with the potential to generate additional electricity. Under the terms of the Treaty, Canada receives a one–half share of the U.S.'s extra power generation potential. 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 September 1, 2021 and July 31, 2022.

BC Hydro
Power smart

Since September 16, 2014 both Canada and the U.S have had the option to terminate the Treaty. In March 2014, after extensive consultation with basin residents, the Province of British Columbia decided to continue with the Columbia River Treaty and to seek improvements within the existing Treaty framework. More information on the Treaty and its review process can be found online 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 (USACE)—periodically negotiate and sign supplemental operating agreements when there is mutual benefit to modify the water releases specified by the Columbia River Treaty.

The confluence of the Columbia and Kootenay rivers in Castlegar – Credit: Matt Casselman

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 Libby Dam (known as the VarQ operating regime). This agreement is supplemental to the Libby Coordination Agreement (signed in 2000). Under this agreement, the U.S. committed to continued coordination with Canada to consider alternative reservoir operations that reduce flood risk in both countries (similar to the extensive collaboration that occurred during the 2012 high water event). In addition, BC Hydro was compensated for energy losses at its Kootenay Canal operations that resulted from the timing of water releases from Libby Dam. This agreement ended in August 2023.

In late 2022, the Columbia River Treaty Operating Committee signed the 2023 Non-Power Uses Agreement. This annual operating agreement allowed Arrow Lakes Reservoir releases to be reshaped between January and July 2023 to protect Canadian whitefish in exchange for flow benefits for endangered U.S. salmon.

Non-Treaty Storage Agreement (NTSA)

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

The NTSA provides BC Hydro with more control over reservoir levels, more energy benefits to B.C., and 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 high and low water impacts downstream of Arrow Lakes Reservoir and to improve power and non-power benefits for both countries.

In order to minimize impacts to Arrow Lakes Reservoir levels, BC Hydro utilized storage under NTSA in May during the peak of freshet to reduce Treaty releases from Arrow Lakes Reservoir in order to support higher Arrow levels. This operation resulted the reservoir being 2.4 metres (8 feet) higher from May through mid-August. The water was released by mid-August as per the agreement with the U.S. to meet U.S. fisheries objectives.

BC HYDRO'S COLUMBIA OPERATIONS

Snowpack and runoff

Snowpack in the Columbia basin during the 2022/23 winter was well below average, particularly in the Canadian portion of the basin, due to low precipitation in the fall and winter. Actual runoff between April and September 2023 was low, at 78% of normal for the Canadian portion of the basin, and 83% of normal for the entire Columbia basin. By comparison, the runoff in the Canadian basin in 2022 was 111% of normal and the overall runoff in the Columbia basin was 107% of normal.

Kinbasket Reservoir

Kinbasket Reservoir is created by Mica Dam. Kinbasket Reservoir regulates discharges for both Mica and Revelstoke dams as well as for power plants further downstream.

The normal licensed range for Kinbasket Reservoir is between 754.4 metres (2,475 feet) and 706.96 metres (2,319.42 feet) respectively. The reservoir can be operated up to two feet above its normal maximum level, if approved by the Comptroller of Water Rights. Kinbasket Reservoir provides seven–million–acre feet (MAF) of Treaty storage and five MAF of non–Treaty storage.

On September 18, 2022, Kinbasket Reservoir refilled to a maximum level of 752.89 metres (2,470.5 feet). This is about 1.3 metres (4.5 feet) below the normal maximum operating level of 754.38 metres (2,475 feet), equivalent to 98% of full storage.

Province–wide precipitation had been generally below average for much of the fall and winter of 2022/2023. Precipitation at Mica amounts to only 71% of normal since October 1, 2022. This represents the driest year on record. With low precipitation in the basin, snowpack in the Upper Columbia basin peaked at only 75% of normal this spring. Snowpack depleted rapidly in May following several heatwaves and persistent drought conditions. These conditions continued through the summer, leading to a provincial classification of drought level 4 in the Upper Columbia and drought level 5 in the Lower Columbia this summer. As of September 14, the Upper Columbia basin is in drought level 3, and the Lower Columbia basin remains in drought level 5.

The current year weather conditions culminated to low inflows at Mica — at 85% of normal for February to September 2023 — the fifth driest year on record. Low inflows combined with relatively cool spring loads in March and April resulted in increased draft of the reservoir during this period.

Kinbasket Reservoir reached a minimum level of 715.8 metres (2,348.5 feet) on April 22, 2023. The current forecast maximum is 746.76 metres (2,450 feet) in mid to late October, which is 2.4 feet (8 feet) below average.

Revelstoke Reservoir – Credit: Susan Edgell

Revelstoke Reservoir

Revelstoke Reservoir is created by Revelstoke Dam. Revelstoke Reservoir water levels may fluctuate in response to weather patterns, inflow levels, and electricity demand. It is common to have daily fluctuations of the reservoir within 1.5 metres (five feet) of full pool during the spring freshet and winter peak load periods. The reservoir is also periodically lowered below its normal minimum level of 571.5 metres (1,875 feet) to meet increasing system needs for short–term generating capacity. The reservoir may fill to near full pool during periods of high reservoir inflows.

Water is occasionally released over the Revelstoke Dam spillway during low demand and high inflow periods to maintain minimum flows, or to maintain the reservoir water level. This year, spills were minimal and limited to only three days.

The licensed range for Revelstoke Reservoir is between 573 metres (1,880 feet) and 554.7 metres (1,820 feet). Most of the time, Revelstoke Reservoir is maintained at or above 571.5 metres (1,875 feet).

Arrow Lakes Reservoir

Arrow Lakes Reservoir is created by the Hugh L. Keenleyside Dam. Water releases from Arrow Lakes Reservoir are regulated under the Columbia River Treaty and its supplemental operating agreements. For operations to be consistent with the principles of the Treaty, it is necessary to store excess water under wet conditions so that surplus energy is not generated by downstream U.S. Columbia River projects. Conversely, under dry conditions, storage must be drafted as far as necessary to meet Treaty firm loads consistent with the principles of proportional draft.

On July 8, 2022, Arrow reached a maximum level of 438.7 metres (1,439.3 feet) – about 1.4 metres (4.7 feet) below full pool or 92% of full storage. Arrow Lakes Reservoir drafted across the summer months, but water levels were within the recreational target ranges until September 5, 2022 (Labour Day).

Runoff conditions in the overall Columbia basin had become drier in the summer. Persistent dry conditions in the fall and winter of 2022/23 resulted in lower basin inflows and increased draft of Arrow Lakes Reservoir. Arrow reached a minimum level of 424.0 metres (1,391 feet) on January 9, 2023. By comparison, the minimum level reached in 2022 was 426.4 metres (1,399 feet) on March 12, 2022.

From February to September 2023, inflows into Arrow were only 83% of normal, with notably record low inflows in June through August following the early depletion of below normal snowpack in May. Despite low inflows, Arrow refilled relatively close to full this spring due to the ability to exercise Non-Treaty storage in the spring for releases in the summer under the Non-Treaty Storage Agreement with BPA. This agreement resulted in Arrow Lakes Reservoir reaching a maximum level of 439.06 metres (1,440.5 feet) on June 23, 2023, about 1.07 metres (3.5 feet) below full pool. By comparison in 2022, Arrow reached a maximum level of 438.7 metres (1,439.3 feet) on July 8, 2022. Without the agreement, Arrow Lakes reservoir would have been about 2.4 metres (8 feet) lower from May to mid-August.

As expected for this summer, the combination of low inflows and increased Treaty discharges under proportional draft operations resulted in a deeper draft of Arrow Lakes Reservoir across the summer months, reaching 426.7 metres (1,400 feet) on September 2, 2023 (Labour Day).

Duncan Dam high viewpoint – Credit: Jen Walker-Larsen

The normal licensed range for Arrow Lakes Reservoir is between 440.1 metres (1,444 feet) and 419.9 metres (1,377.9 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 million-acre feet (MAF) of Treaty storage.

Columbia River at Centennial Park in Revelstoke – Credit: Jen Walker-Larsen

Arrow is currently forecasted to continue to draft throughout the fall and will likely reach a minimum level of 422.15 metres (1,385 feet) by the end of November.

This year's low levels resulted in significant challenges and impacts across the reservoir. To minimize impacts to fish, crews were deployed to assess stranding sites and salvage fish where possible. 530 kilometres of shoreline were assessed to identify pools and focus ground surveys and salvage efforts, and 159 pools were sampled at 26 different sites. As of October 13, over 39,000 fish have been salvaged. The salvaged fish are mostly small and young, the vast majority being Northern Pikeminnow, Redside Shiner, Carp, Suckers, Dace, and Sculpins. We continue to have crews on the ground, and they are actively working to salvage fish where possible and reduce the number of mortalities.

The low levels also exposed archeological sites across the reservoir. Additional archeological assessments were completed in low elevation areas, and known exposed archeological sites were revisited. The preliminary results show several new sites were recorded, and several existing sites were expanded. We also mobilized the Guardian Watch Program to have a presence on the reservoir and spread information about the importance of archeological resources.

We have received a number of reports of structures and materials along the shoreline of the reservoir that were exposed during this year's low levels. Normally, when these structures and materials are exposed, they are covered by snow. Unfortunately, this year this was not the case, and

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

we have received a lot of reports of remaining structures and materials, which is hazardous to reservoir users and are a difficult reminder of what was lost when the reservoir was created. We have now compiled all of the reports we received from the public, as well as our own historical information, and we are now undertaking an inventory of the remaining structures and materials. Once this inventory is completed, we will assess each site based on environmental considerations, archeological and heritage values, accessibility, and public safety concerns. We will assess the structures and material to determine whether they can be removed or altered or should remain left untouched. This assessment will be based on environmental considerations, archeological and heritage values, accessibility, and public safety concerns. Once complete, we will develop an implementation plan to remove as much of the remaining material as possible.

Duncan Reservoir

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

Similar to the Columbia basin, the snowpack in the Kootenay basin and runoff forecast is expected to be below average. From February to September 2023, reservoir inflows are at 83% of average.

Duncan Reservoir is normally drafted each year to its licensed minimum level of 546.9 metres (1,794.2 feet) by April, or before the start of freshet for flood risk management. Duncan Reservoir reached a minimum level of 547.2 metres (1,795.3 feet) on April 20, 2023. By comparison, the minimum level reached in 2022 was 547 metres (1,794.7 feet) on May 3, 2022.

To begin reservoir refill, Duncan discharges were reduced to a minimum of three cubic metres per second (m^3/s) or 100 cubic feet per second (cfs) starting in June 2023. Releases from Duncan were held at minimum until July 6, 2023, when discharges were increased to manage the rate of reservoir refill.

In order to manage the integrated Columbia system under drought conditions and to support higher Arrow Lakes Reservoir levels in the summer, flow increases at Duncan were implemented to help offset Arrow Treaty releases in August. As a result, levels on Duncan Reservoir deviated from the Duncan Reservoir Water Use Plan recreation target elevation of 575.5 metres +/– 0.3 metres (1,888.1 feet +/– 1 foot) until Labour Day. In 2023, Duncan refilled to a maximum of 575.01 metres (1,886.5 feet), 1.68 metres (5.5 feet) below full pool on August 10, 2023, and reached an elevation of 1878.9 feet on September 2, 2023 (Labour Day).

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 and storage operations and Treaty discharge requirements.

In 2023, due to below normal runoff, there were no flood concerns on the Columbia River downstream of the 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.

Columbia River flows peaked on May 22, 2023 at about 3,494 m^3/s or 123,400 cfs. This flow is well below the peak regulated flow experienced in 2012 of 6,090 m^3/s (215,000 cfs), and the peak pre–dam flow of 10,590 m^3/s (374,000 cfs) in 1961.

BC Hydro's water licence has no minimum discharge requirements for the Columbia River downstream of the Hugh L. Keenleyside Dam. However, BC Hydro is obliged (per the Columbia River Treaty) to reduce flows to a minimum weekly average flow of 141.5 m3/s or 5,000 cfs under certain water conditions. Minimum Treaty discharges are probable under wet water conditions for the overall Columbia system. The last time we saw flows this low was in November 2016 due to wet fall conditions.

1 VarQ was developed to improve the multi–purpose operation of Libby and Hungry Horse while maintaining the current level of system flood control protection in the Columbia River. VarQ reduces the contribution of reservoir space at Libby and Hungry Horse for system flood control of spring runoff in the Columbia River in years with low to moderate potential for flooding. For more information, please visit: **nwd–wc.usace.army.mil/cafe/forecast/VARQ/varq.htm**.

Koocanusa Reservoir

Koocanusa Reservoir on the Kootenay River is controlled by Libby Dam in Libby, Montana, and is operated by the USACE. The reservoir backs into Canada and provides approximately five MAF of storage.

Koocaunusa Reservoir – Credit: Adil Zaheer

Koocanusa Reservoir is typically drafted during the winter for Treaty flood risk management. The observed runoff from USACE is only 71% of normal for April to August 2023. Due to well-below-average inflow forecast, lesser draft is required to manage flood risk this year. As such, the reservoir reached a minimum level of 732 metres (2,401.5 feet) on April 10, 2023, about nine meters (30 feet) above average for this date. By comparison in 2022, the reservoir reached a minimum of 720.4 metres (2,363.5 feet) on February 28, 2022, 3.6 metres (11.8 feet) below average for this date.

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

Libby Dam continues to be operated under VarQ[1] procedures for U.S. fisheries interests and flood control.

The latest Libby Operating Plan provides for:

- Flows as needed during March to April to meet the April 30 flood control target;
- 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; and
- Minimum bull trout flows as outlined in the BiOp; and augmented downstream flows for salmon after the sturgeon flow operation is completed.

Information regarding the operation of Libby Dam and Koocanusa Reservoir water levels is available from the USACE at **nws.usace.army.mil** or by calling **406 293 3421.**

Kootenay lake

For information regarding Kootenay Lake, please contact FortisBC at **fortisBC.com** or by phone: **1 866 436 7847.**

WANT TO STAY INFORMED ABOUT BC HYDRO OPERATIONS?

Regional operations update meetings

BC Hydro hosts annual operations update meetings. These take place each spring for Columbia basin communities. These meetings are held 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 Southern Interior;
- 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; and
- Provide an update on BC Hydro's activities.

If you would like to receive e-mail notifications about these meetings, please contact us at **southern-interior.info@bchydro.com**.

Operations update conference calls

BC Hydro periodically hosts conference calls to provide updates on our Columbia and Kootenay system operations. If you would like to receive e-mail notifications regarding these meetings and conference calls, please contact us at **southern-interior.info@bchydro.com**.

Bc Hydro's reservoir level updates

BC Hydro provides reservoir water level forecasts by e-mail each week. To receive these updates, please contact us at **southern-interior.info@bchydro.com**.

Near real-time water level information for various locations around our reservoirs is available online at: **bchydro.com/energy-in-bc/operations/transmission-reservoir-data/previous-reservoir-elevations/columbia.html**.

BC Hydro's toll-free reservoir information line (**1 877 924 2444**) provides up-to-date reservoir elevation and river flow information. The recording is updated every Monday, Wednesday and Friday and includes:

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

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