Columbia River Treaty Socio-Economic Performance Measures: Columbia River System

Draft Measures for Public Input – January 2023

CONTENTS

INTRODUCTION AND OVERVIEW

The Columbia Basin is host to several dams and reservoirs, including four that were constructed as a result of the Columbia River Treaty (CRT)—a water management agreement between Canada and the United States that regulates Columbia River flows for flood control and power generation. These are:

1) On the mainstem of the Columbia River:
   a) Kinbasket Reservoir - created by Mica dam south of Valemount; and
   b) Arrow Lakes Reservoir - created by Hugh L. Keenleyside dam near Castlegar.
2) On the Kootenay River system:
   a) Duncan Reservoir – created by Duncan dam north of Kaslo; and
   b) Koocanusa Reservoir - created by Libby dam in Montana south of Cranbrook.

Canadian and US governments are currently in negotiations to modernize the treaty, which was ratified in 1964.

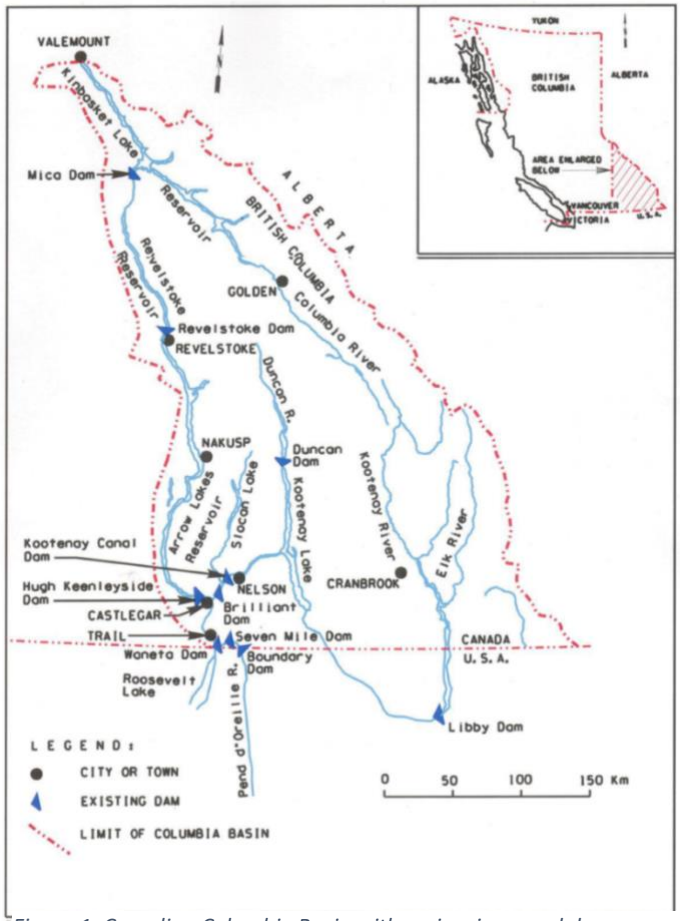


Figure 1: Canadian Columbia Basin with major rivers and dams

This CRT Socio-Economic Integration initiative—funded by the Province of BC and spearheaded by the Columbia River Treaty Local Governments Committee—supports inclusion of socio-economic interests in the ongoing CRT negotiations. Socio-economic interests that are affected by reservoir levels and river flows, such as flood risk management, navigation, recreation, tourism, health and others are very important to communities. Performance measures describing the required and preferred reservoir elevations and flow levels for these interests are being defined. These measures will be used to evaluate alternative hydro operations scenarios to inform the ongoing CRT negotiations and implementation of the modernized treaty. Other groups are working on performance measures for ecosystem function (learn more here), Indigenous cultural values and power generation.

For more detailed information on the Columbia River Treaty, see the Province of BC's website.

For more detailed information on the socio-economic performance measures initiative see the CRT Local Governments Committee's website.

SUMMARY PURPOSE AND OUTLINE

The purpose of this Summary and the related webinar is to provide the public with an overview of the performance measure research and development work, to share the draft performance measures, and to invite feedback. Summaries have been split into two sub-regions: the Columbia River System (including the Mica and Hugh Keenleyside dams, and their associated reservoirs and the Lower Columbia River) and the Kootenay River System (including Koocanusa Reservoir, Kootenay Lake, and Duncan dam/Reservoir).

This Summary is focused on performance measures for the Columbia River System.

You can access the Summary for the Kootenay River system here.

The following sections are included in this Summary:

- The Overview of the Columbia System section provides basic details about each major segment of the system.
- The Performance Measures section lists the currently recommended performance measures and links to documents that contain detailed information. It also includes an overview of how performance measures were developed.
- Appendix 1: Columbia System Operations includes additional details on each system segment and provides an overview of the major factors determining how each is operated.

OVERVIEW OF COLUMBIA SYSTEM

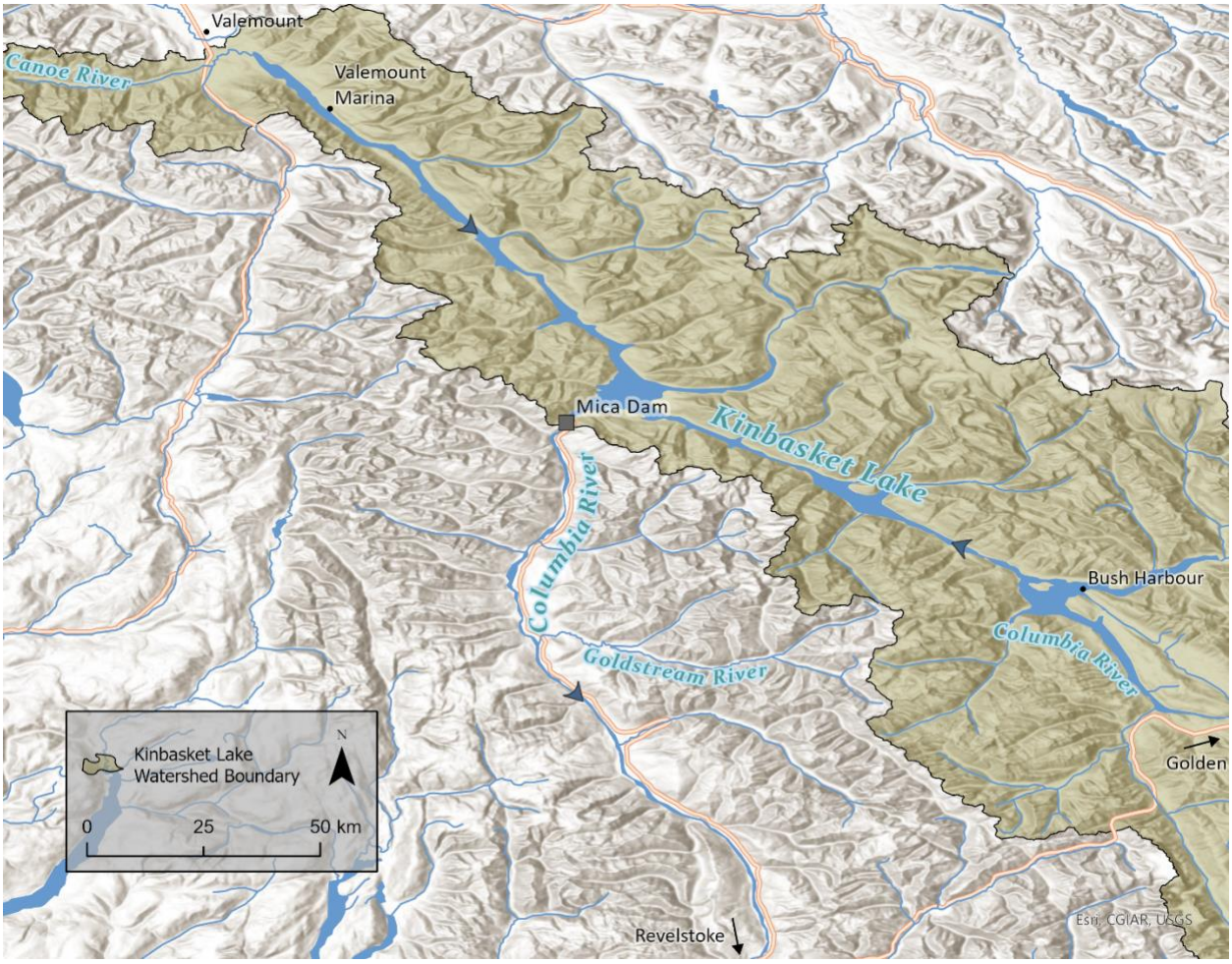
Below, major segments of the Columbia River system are described, including the location of each, description of inflows, storage capacity, and generating capacity of downstream dams. For a detailed description of Columbia System hydroelectric operations, see Appendix 1.

Lake Revelstoke/the Revelstoke Reservoir (the portion of the Columbia River between Mica and Revelstoke dams) is not included in this Summary because the research team's review of available information did not reveal any major socioeconomic concerns related to operation of this reservoir.

Kinbasket Reservoir

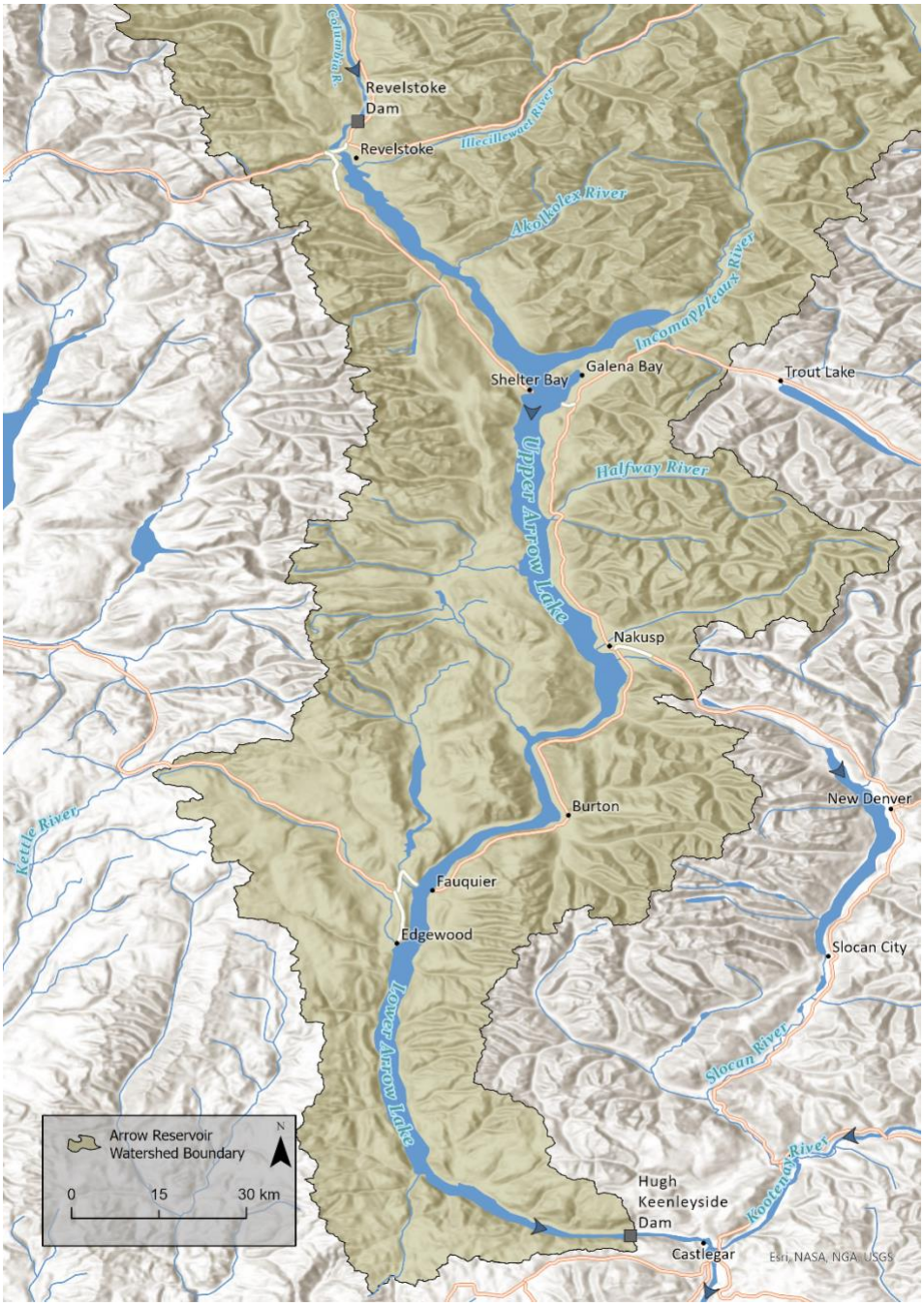
Kinbasket Reservoir was created by Mica dam (owned by BC Hydro) located 140 km north of Revelstoke. It is the largest storage reservoir in the Columbia system, stretching 216 km from north of Golden to south of Valemount and providing 12 million acre feet (MAF) of water storage. It has a drawdown range of approximately 150 ft (45.7 m). The map below shows the location of the reservoir with main tributaries and nearby communities.

All inflows into this reservoir are natural as there are no upstream dams. From Mica dam, the river flows south through Lake Revelstoke to the Revelstoke dam. Mica dam and Revelstoke dam are somewhat operated in tandem for hydro-power generation, together producing a large component of the hydroelectric power used in B.C. and providing essential capacity during periods of high demand. Mica has an installed capacity of approximately 2700 MW. With the addition of a fifth generating unit in 2011, Revelstoke's installed capacity is currently 2480 MW.



Arrow Lakes Reservoir

Arrow Lakes Reservoir is located on the Columbia River, downstream of the Revelstoke dam. The reservoir is created by the Hugh Keenleyside dam located 8 km upstream of Castlegar. The map below shows the Arrow Reservoir in more detail. It is 230 km long and has several communities, including Revelstoke, Nakusp, Burton, Fauquier and Edgewood, and settlement areas along its length. It includes two distinct sections—the "Revelstoke Reach", sometimes also called the Mid-Columbia River (i.e., the historically riverine portion of the reservoir between Revelstoke and Shelter Bay) and the main body of the reservoir that incorporates what was the Upper and Lower Arrow Lakes (i.e., between Shelter Bay and Hugh Keenleyside dam near Castlegar).

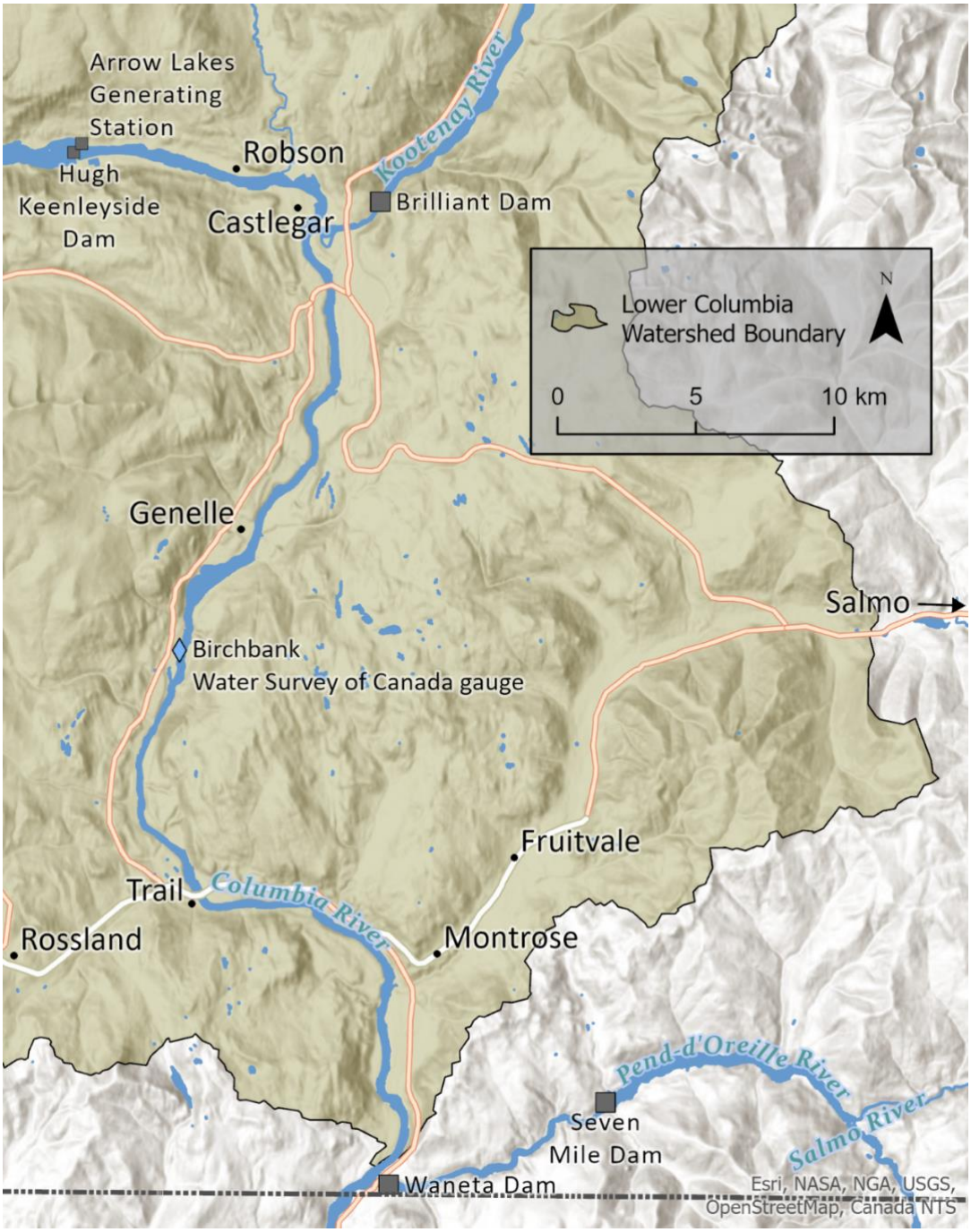


Hugh Keenleyside dam (owned by BC Hydro) is a Columbia River Treaty dam that provides significant storage primarily for downstream benefits in the US. BC benefits from the dam through additional flood protection to Castlegar/Trail, the Downstream Benefits revenue for US power generation, and the 185 MW of installed capacity at Arrow Lakes Generation Station. The Arrow Lakes Generating Station, completed in 2002, is owned by a joint venture between the Columbia Basin Trust and Columbia Power Corporation, both BC Crown corporations.

Arrow reservoir has a storage volume of approximately 7 million acre feet, and has a drawdown range of approximately 66 ft (20.1 m). BC Hydro typically operates Arrow in the top 40ft to 50ft (12.2m – 15.2m).

Lower Columbia River

The Lower Columbia is located downstream of the Hugh Keenleyside dam and the Arrow Lakes Generating Station on the Columbia River, flowing past Castlegar and Trail to the U.S. border. The map below shows this section of the Columbia River in more detail. It is about 60km long, with several communities along its banks, including Castlegar, Trail and Montrose as well as numerous settlement areas including Robson and Genelle.



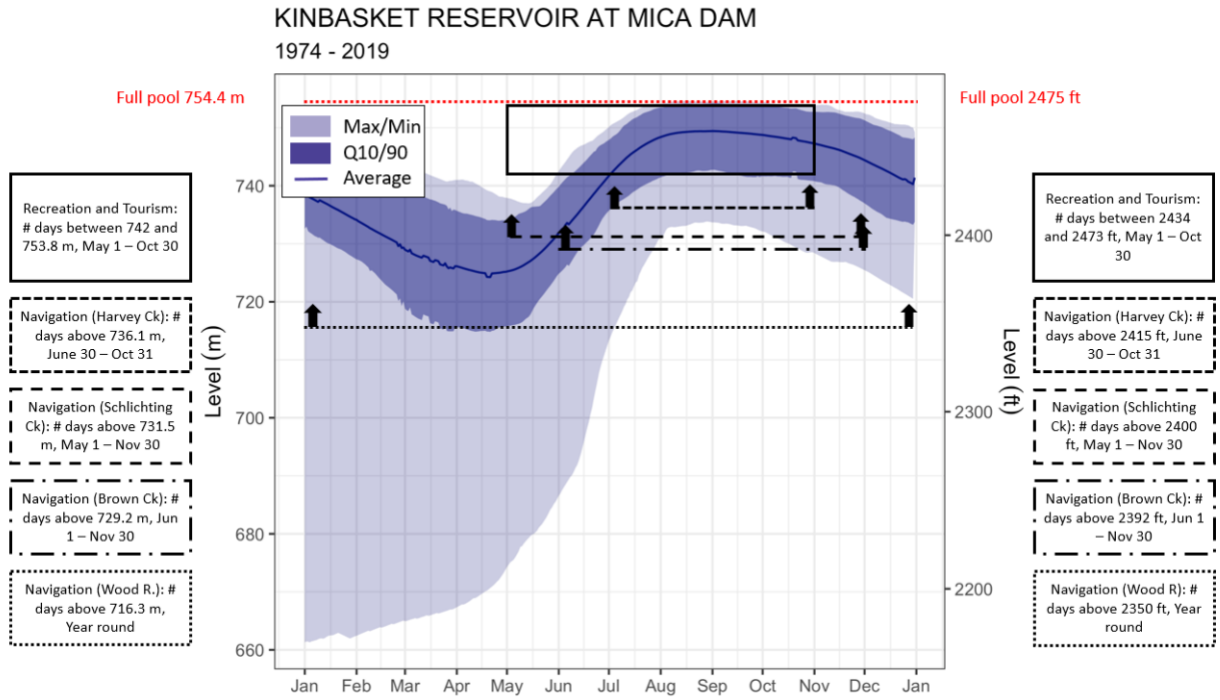
The flows in this segment of the Columbia River are regulated by the following hydro-electric facilities:

- Hugh L Keenleyside dam (see description above)
- Arrow Lakes Generating Station (see description above)
- Brilliant dam and Generating Station on the Kootenay River
  - The Kootenay River enters the Columbia River to the east of Castlegar, approximately 10 kilometres downstream from Hugh Keenleyside dam. The Brilliant dam and Expansion Project (owned by a joint venture between the Columbia Basin Trust and Columbia Power Corporation), located just upstream of the confluence and with 140 MW of installed generating capacity, regulates the Kootenay River flows into the Columbia.
- Waneta dam and Expansion Generating Station on the Pend d'Oreille River
  - The Waneta dam (owned by BC Hydro) and the Expansion Generating Station (owned by a joint venture between the Columbia Basin Trust and Columbia Power Corporation) regulates the flow of the Pend d'Oreille River into the Columbia River just upstream of the Canada – U.S. border.

PERFORMANCE MEASURES

Kinbasket Reservoir

The figure below illustrates the historical range and average levels of Kinbasket Reservoir from 1974, when the Mica dam began operations, to 2019, the latest date that these data are available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph – the 90th percentile is the highest 10% of reservoir levels and the 10th percentile is the lowest 10%.

Recreation and Tourism

Goal: Maximize the community benefits from quality and diversity of recreation and tourism.

Recommended Performance Measure:

Objective / Location	Performance Measure	Description
Recreation & Tourism/Kinbasket Reservoir	Recreation Access and Experience Days	Total number of days/year reservoir elevation is between 2434ft and 2473ft (742m and 753.8m), May 1 – Oct 30. More is better.

Sub-measures representing preferred elevation ranges for specific recreational activities or sites will inform detailed scenario evaluation.

Sub-Measure Objective	Season	Elevation Range
High water debris	May 1 – Oct 31	Above 2373ft/753.8m, in the years the elevation is above this level
General shoreline preference (Columbia Reach)	May 1 – Oct 31	2444ft-2473ft (744.9m-753.8m)
Motorized boating preference (Canoe Reach)	May 1 – Oct 31	2434ft-2470ft (742m-752.9m)
Motorized boating access (Canoe Reach)	May 1 – Oct 31	2390ft (728.5m) and above
Motorized boating access (Columbia Reach)	May 1 – Oct 31	2381ft (725.8m) and above
Motorized boating preference (Columbia Reach)	May 1 – Oct 31	2375ft – 2470ft (723.9m-752.9m)
Valemount hot springs access	Mar 1 – Apr 30	2358ft (719m) and below.

For more information about the Kinbasket Reservoir Recreation and Tourism performance measure, view the full info sheet here.

Navigation

Goal: Minimize disruptions to commercial navigation and transportation.

Recommended Performance Measure:

Area	Performance Measure	Description
Kinbasket Reservoir	Navigability days	Sum of number of days per year each of the following elevation thresholds are met or exceeded during the stated seasons (more is better): 2415ft (736.1m): Jun 30 – Oct 31 2400ft (731.5m): May 1 – Nov 30 2392ft (729.2m): June 1 – Nov 30 2350ft (716.3m): Year-round

For more information about the Kinbasket Reservoir Navigation performance measure, view the full info sheet here.

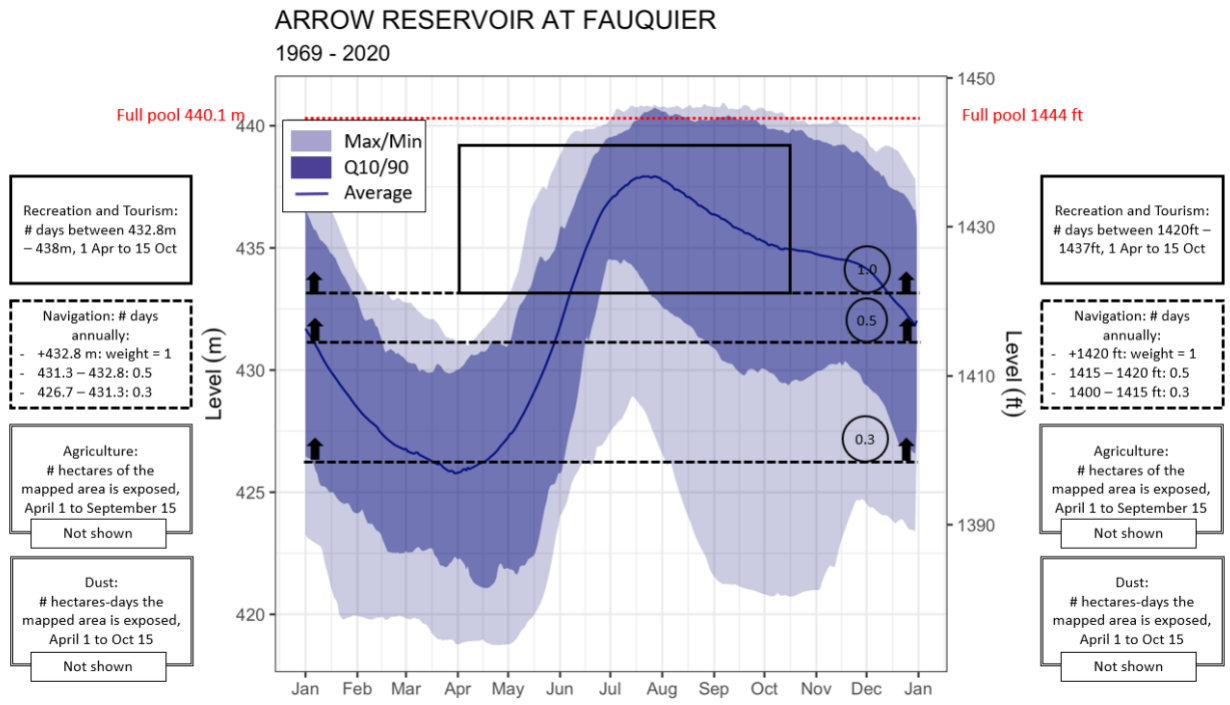
Erosion

The CRT Socio-Economic Integration Team has been informed of erosion concerns around Kinbasket Reservoir, especially related to very high water levels, at the Valemount Marina as well as private property and resource roads at the southern end of the reservoir. Erosion is a complex process that is influenced by water levels, soil types, terrain and other factors. It impacts ecosystem function and cultural interests in addition to socio-economic interests. The Columbia River Treaty Planning Model

Joint Steering Team, which directs this work, is convening a group, including erosion experts, to discuss how best to incorporate performance measures for erosion in the modelling.

Arrow Lakes Reservoir

The figure below illustrates the historical range and average levels of Arrow Reservoir from 1969, the year after Hugh Keenleyside dam became operational, to 2020, the latest date that these data are available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph.

Recreation and Tourism

Goal: Maximize community benefits from quality and diversity of recreation and tourism

Recommended Performance Measure:

Objective/ Location	Performance Measure	Description
Recreation/ Arrow Lakes Reservoir	Recreation Access and Experience Days	Total number of days/year that the reservoir water level is within the preferred range (1420ft – 1437ft / 432.8m – 438m) during the recreation season (1 Apr to 15 Oct). More is better.

Sub-measures representing preferred elevation ranges for specific recreational activities or sites will inform detailed scenario evaluation.

Sub-Measure Objective	Season	Elevation Range
Nakusp beach floating dock use preference	Jun 15 – Sep 15	1437ft (438m) and above
Motorized boating access (Revelstoke Centennial Ramp)	Apr 1 – Oct 15	1437ft (438m) and above
Private boat launch and dock use preference	Apr 1 – Oct 15	1430ft–1435ft (435.9m–437.4m)
Scotties Marina preference	Apr 1 – Oct 15	1428ft–1430ft (435.2m-435.9m)
General shoreline preference (Shelter Bay to Hugh Keenleyside dam)	Apr 1 – Oct 15	1425ft–1435ft (434.3m-437.4m)
Syringa beach preference	Jun 15 – Sep 15	1425 –1435 ft (434.3 - 437.4 m)
Motorized boating experience preference	Apr 1 – Oct 15	1424ft–1435ft (434m-437.4m)
Motorized/non-motorized access to the Revelstoke reach drawdown zone	Apr 1 – Oct 15	Below 1424ft (434m)
Nakusp Marina dock damage avoided	Apr 1 – Oct 15	Above 1420ft (432.8m)
Motorized boating access (Scotties Marina boat ramp)	Apr 1 – Oct 15	1408ft (429.2m) and above
Motorized boating access (BC Hydro Boat Ramps)	Apr 1 – Oct 15	Above 1401ft (427m)

For more information about the Arrow Lakes Reservoir Recreation and Tourism performance measure, view the full info sheet here.

Navigation

Goal: Minimize disruptions to commercial navigation and transportation.

Recommended Performance Measure:

<table>
<tr><th>Objective/ Location</th><th>Performance Measure</th><th>Description</th></tr>
<tr><td>Navigation/ Arrow Lakes Reservoir</td><td>Navigability</td><td>Number of weighted days annually that the reservoir water level allows for log transport through the Narrows, according to the following table. More is better.
<table>
<tr><td>Elevation Range</td><td>Weighting</td></tr>
<tr><td>Above 1420ft</td><td>1</td></tr>
<tr><td>1415– 1420ft</td><td>0.5</td></tr>
<tr><td>1400–1415ft</td><td>0.3</td></tr>
<tr><td>Below 1400ft</td><td>0</td></tr>
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For more information about the Arrow Lakes Reservoir Navigation performance measure, view the full info sheet here.

Agriculture

Goal: Maximize agriculture opportunities.

Recommended Performance Measure:

Objective / Location	Performance Measure	Description

Agriculture Potential/ Arrow Reservoir	Agriculture potential hectares	# hectares per year of the mapped area of previously cultivated lands that are exposed throughout the growing season (April 1 to September 15). More is better.

For more information about the Arrow Lakes Reservoir Agriculture performance measure, view the full info sheet here.

Dust Potential

Goal: Minimize dust generation.

Recommended Performance Measure:

Objective / Location	Performance Measure	Description
Dust Control/ Arrow Reservoir	Dust potential hectare-days	Sum of # of hectare-days per year that the mapped area around Burton is exposed between April 1 and Oct 15 (when dust generation potential is highest in the lower elevations). Less is better.

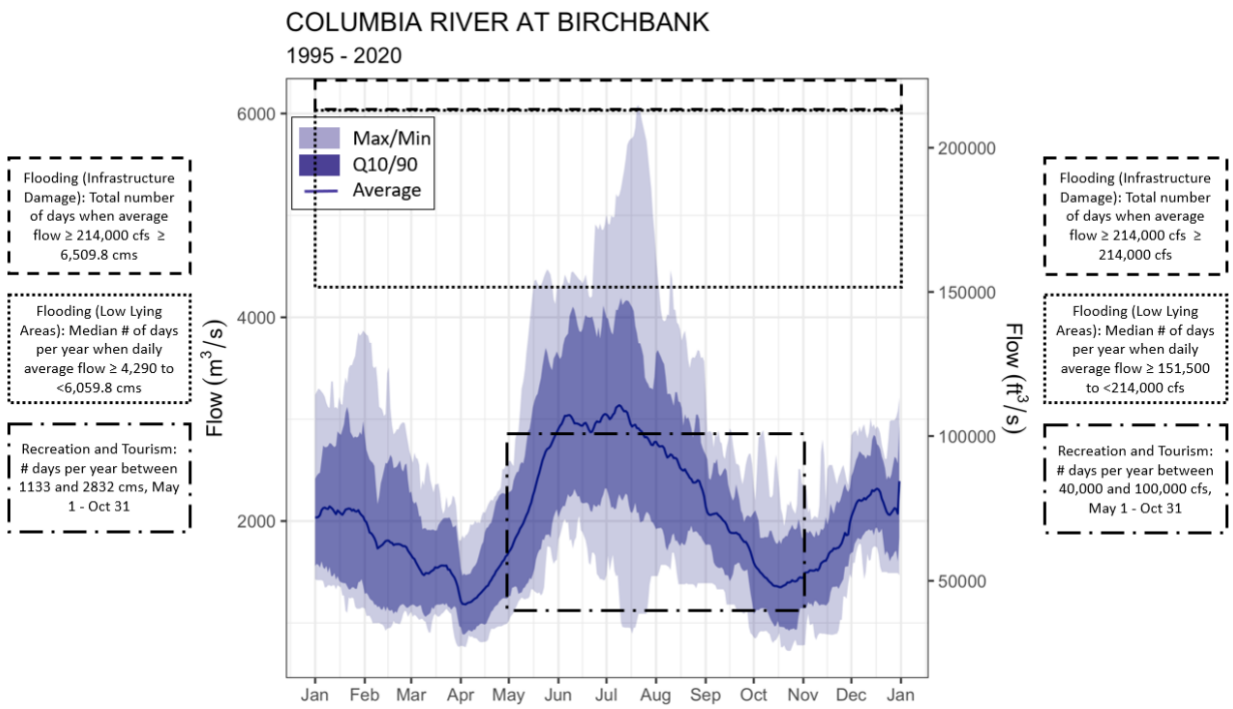
For more information about the Arrow Lakes Reservoir Dust performance measure, view the full info sheet here.

Erosion

The Socio-Economic Performance Measures research team has been informed of erosion impacts around Arrow Lakes reservoir, especially related to very high water levels on recreation assets, private property and highway 23S between Burton and Fauquier. Erosion is a complex process that is influenced by water levels, soil types, terrain and other factors. It impacts ecosystem function and cultural interests in addition to socio-economic interests. The Columbia River Treaty Planning Model Joint Steering Team, which directs this work, is convening a group, including erosion experts, to discuss how best to incorporate performance measures for erosion in the modelling.

Lower Columbia River

The figure below illustrates the historical range and average water flow levels for the Lower Columbia, measured at the Birchbank Water Survey of Canada gauge, from 1995, when the Libby dam flows were last refined, to 2020, the latest date that these data area available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph.

Flooding

Goal: Minimize damage to private property and community infrastructure, and injury to people.

Recommended Performance Measure:

Objective / Location	Performance Measure	Units	Description
Flooding/ Lower Columbia River	Low lying area flooding	Median number of days per year when daily average flow ≥ 151,500 to <214,000 cfs (4,290 to <6,059.8 cms). Less is better.	Frequency that recreation sites begin to be flooded
	Infrastructure damage	Total number of days when average flow ≥ 214,000 cfs. Less is better	Frequency that Castlegar sewer infrastructure, recreation infrastructure and Genelle access and septic systems are damaged

The following sub-measures will inform detailed scenario evaluation.

Flow (kcfs)	**Total no. of days flow is reached**	**No. of years when flow is reached**
300-350		
280-299		

250-279		
225-249		
214-224		

For more information about the Lower Columbia flooding performance measure, view the full info sheet here.

Recreation and Tourism

Goal: Maximize the community benefits from quality and diversity of recreation and tourism.

Recommended performance measure:

Objective/ Location	Performance Measure	Description
Recreation and tourism/Lower Columbia River	Access and Experience Days	Total number of days per year flow at Birchbank gauge is between 40,000 and 100,000 cfs (1133 and 2832 cms), May 1 - Oct 31. More is better.

Sub-measures representing preferred elevation ranges for specific recreational activities or sites will inform detailed scenario evaluation.

Sub-Measure Objective	Season	Flow Range
Whitewater kayaking access: Industrial Hole	May 1 – Oct 31	124,000 cfs / 3,500 cms and above
Whitewater kayaking access: One Shot Wave	May 1 – Oct 31	88,000-106,000 cfs / 2,500-3,000 cms
Swimming	June 15 – Sep 15	78,035 – 99,327 cfs / 2,209 – 2,813 cms
Motorized boating preference	May 1 – Sep 15	70,902 – 156,035 cfs / 2,008 – 4,418 cms[1]
Other non-motorized boating (excepting whitewater kayaking)	May 1 – Oct 31	70,902 - 102 823 cfs / 2,008 – 2,912 cms
General shore-based recreation	May 1 – Oct 31	60,309 - 99,327 cfs / 1,707 – 2,813 cms
Shore-based angling	May 1 – Oct 31	60,309 – 99,327 cfs / 1,707 – 2,813 cms
Whitewater kayaking access: Trail Wave/Hero Hole	May 1 – Oct 31	50,000 cfs / 1,416 cms and below
Boat-based angling preference	May 1 – Sep 15	40,000 – 60,000 cfs 1,133 – 1,699 cms[2]

For more information about the Lower Columbia recreation and tourism performance measure, view the full info sheet here.

Performance Measure Development Process

In order to identify community interests that are affected by reservoir operations, the research team first consulted overarching assessments of Columbia River Treaty community impacts (such as the Columbia River Treaty Summary of Canadian Dam and Reservoir Issues and CRT Community Meeting Summaries from 2018 and 2019), then reviewed the three past processes that developed performance measures for the Columbia River system to identify relevant performance measures for the community interests. These processes include:

- The Columbia River Water Use Plan Consultative Committee process (2004);
- The Non-Treaty Storage Agreement Options Review (2010); and
- The Columbia River Treaty Review Technical Studies (2013).

To ensure our performance measures reflected the latest available knowledge on priority interests, the research team reviewed relevant new studies that have been completed since 2013 as well as older studies when needed to verify information used in past processes. In some cases, we reached out to individuals or groups when it was not possible to find information in a formal report.

The draft performance measures presented in this document have undergone two rounds of review with members of the Columbia River Treaty Local Governments Committee and Columbia Basin Regional Advisory Committee. They have therefore been vetted by people or groups representing diverse interests for each reservoir. The research team recognizes, however, that, due to the complexity of socio-economic issues affected by hydro system operations, community members will have further input that is valuable to this process.

APPENDIX 1: COLUMBIA SYSTEM OPERATIONS

The actual physical operations of the Canadian dams on the Columbia River are a result of a combination, or layering, of different agreements that fall within the Columbia River Treaty framework, plus some limited unilateral flexibility that Canada has to meet system and non-power needs. The Columbia River Treaty itself is highly prescriptive to meet detailed requirements for flood control and power generation. Other agreements are used by the Canadian and US Entities responsible for operating the hydro facilities on the Columbia River to achieve a more advantageous operation and address other interests such as fisheries or recreation interests. These other agreements fall into two categories:

- Those that alter the operation of the 15.5 million acre feet (19.1 km^3) of Treaty Storage, and
- Those that change the operation of the additional storage built in Canada, referred to as Non-Treaty Storage.

When Mica dam was constructed, it was built with an additional 5 million acre-feet (6.2 km^3) of live storage capacity beyond that required under the terms of the Columbia River Treaty. It was economic to build this extra storage due to the increased power generation at Mica from the higher head and the improved ability to regulate reservoir discharges. This additional reservoir storage cannot be fully utilized without agreement from the US Entity as doing so could conflict with reservoir discharge requirements under the Columbia River Treaty. Similarly, an additional 0.25 MAF (0.31km^3) of storage was built into the Arrow Reservoir (El. 1444ft – 1446ft/440.1m – 440.7m); however, this storage is only available when required for flood control.

This additional storage is managed under the Non-Treaty Storage Agreement (NTSA). The combination of operations of the Treaty Storage and Non-Treaty Storage managed under the different agreements determines the total flow released from Canadian reservoirs. However, BC Hydro has flexibility to operate the individual dams for Canadian benefits provided 1) the flood control draft requirements at each reservoir are maintained, and, 2) the total discharge from Canadian reservoirs remains unchanged. This Canadian flexibility allows BC Hydro to 'move water' between Mica, Revelstoke, Arrow, and Duncan (within project operating constraints) in response to various power, social and environmental interests.

It was primarily through use of this Canadian flexibility and use of BC Hydro's portion of the Non-Treaty storage that beneficial changes to operations on the Columbia were investigated in the Columbia Water Use Plan (WUP). The Columbia WUP consultative planning process was conducted from 2000 to 2004 and resulted in a number of constraints (hard and soft) within which operations were generally acceptable to the consultative committee. The Water Use Plan and BC Hydro's water licences, which are consistent with the Columbia River Treaty requirements, provide the overall framework for system operations. Any operational changes considered by BC Hydro with respect to Non-Treaty storage utilization or agreements for mutual benefit on the use of Treaty storage must adhere to these overall operational conditions.