# COLUMBIA RIVER TREATY
# HYDROMETEOROLOGICAL COMMITTEE

## 2020 ANNUAL REPORT
## 1 OCTOBER 2019 – 30 SEPTEMBER 2020

**Condemned precipitation gauge at Queen's Bay, Kootenay Lake, BC**


| | |
|---|---|
| **Stephanie Smith** | B.C. Hydro, Canadian Chair |
| **Georg Jost** | B.C. Hydro, Canadian Member |
| **William Proctor** | U.S. Army Corps of Engineers, U.S. Co-Chair |
| **Ann McManamon*** | Bonneville Power Administration, U.S. Co-Chair |


## 2020 ANNUAL REPORT
## DECEMBER 2020

# COLUMBIA RIVER TREATY HYDROMETEOROLOGICAL COMMITTEE

## Introduction

The Columbia River Treaty Hydrometeorological Committee (CRTHC) was established in September 1968 by the Entities. The CRTHC is responsible for planning and monitoring the operation of the hydrometeorological data collection network in accord with the Columbia River Treaty (CRT). It also assists the Entities in matters related to hydrometeorological and water supply forecasting. This report summarizes CRTHC activities during the 2020 water year (1 October 2019 – 30 September 2020). The Annual Report focuses on:

- Station Adequacy
- Computer Systems and Data Acquisition and Exchange
- Forecasting Procedures
- Review of the 2020 CRT water supply forecasts
- Other activities of the Committee

In addition to this Annual report, the CRTHC publishes a Supplemental report, which contains general information that does not typically change from year to year. Appendices in the supplemental document include:

Appendix A – Introduction to the CRTHC terms of reference
Appendix B – Terms of reference for the CRTHC
Appendix C – Process for reviewing hydrometeorological data networks
Appendix D – List of contributors of hydrometeorological data
Appendix E – Data communication and storage systems
Appendix F – Data exchange reports
Appendix G – Treaty studies, models, and volume and streamflow forecast requirements
Appendix H - Adjusting Inputs to Approved Forecast Procedures

# 2020 ANNUAL REPORT

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See 2020 Supplemental Report for a list of acronyms used in this report

COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

2020 ANNUAL REPORT

## 2020 Annual Summary

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 Committee consists of the following four members:

| **UNITED STATES SECTION** | **CANADIAN SECTION** |
|---|---|
| Ann McManamon, BPA Co-Chair | Stephanie Smith, B.C. Hydro, Chair |
| William Proctor, USACE Co-Chair | Georg Jost, B.C. Hydro, Member |

The CRTHC conducted bi-monthly conference calls. Due to Covid-19 pandemic concerns this year the committee did not meet in person, but instead conducted one virtual meeting during the 01 October 2019 – 30 September 2020 period:

Meeting 84: 23 September 2020, BPA (Organizer)

In addition, the CRTHC members conducted several phone conference calls to discuss impending water supply forecast decisions or provide guidance for ongoing projects. The CRTHC maintains a list of all action items arising from these meetings in Schedule 1, attached to the end of the main body of the Annual Report, which details the outstanding action items and the list of actions completed this year. The 2019 CRTHC Annual Report was completed in December 2019 and distributed prior to the end of the year.

## Stations

The CRTHC routinely reviews the basin gauging network for adequacy and at this time believes that the station network is adequate for Treaty purposes. The CRTHC process for reviewing proposed changes to the operation of stations within the hydrometeorological network is described in Appendix C of the Supplemental Report. The process is intended to ensure that changes made to the network do not adversely affect the monitoring, planning, and operations of Treaty facilities.

### *Corra Linn climate*

B.C. Hydro decommissioned the precipitation station at Queens Bay due to safety concerns in maintaining the gauge. This parameter is not listed as a treaty or support station, but the pool elevation is used for operations and so the treaty station list has been updated to register the pool elevation as a support station parameter.

### *Akamina Pass snow pillow*

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 CRTHC approved a procedure to estimate those data during the 2020 forecasting season. The station has since been re-established as Akamina 2, but the location is severely altered by the fire. The USACE will continue to use the estimation procedure for Akamina in the Libby forecast in 2021, and will revisit updating the water supply forecast procedures to eliminate use of the Akamina snow station.

The CRTHC continues to add to and re-shape its station database for monitoring station adequacy, tracking station changes, and visualization of basin coverage. This database can now be used to generate maps of the Treaty station network like the example in Figure 1, and easily track changes to the network over time.

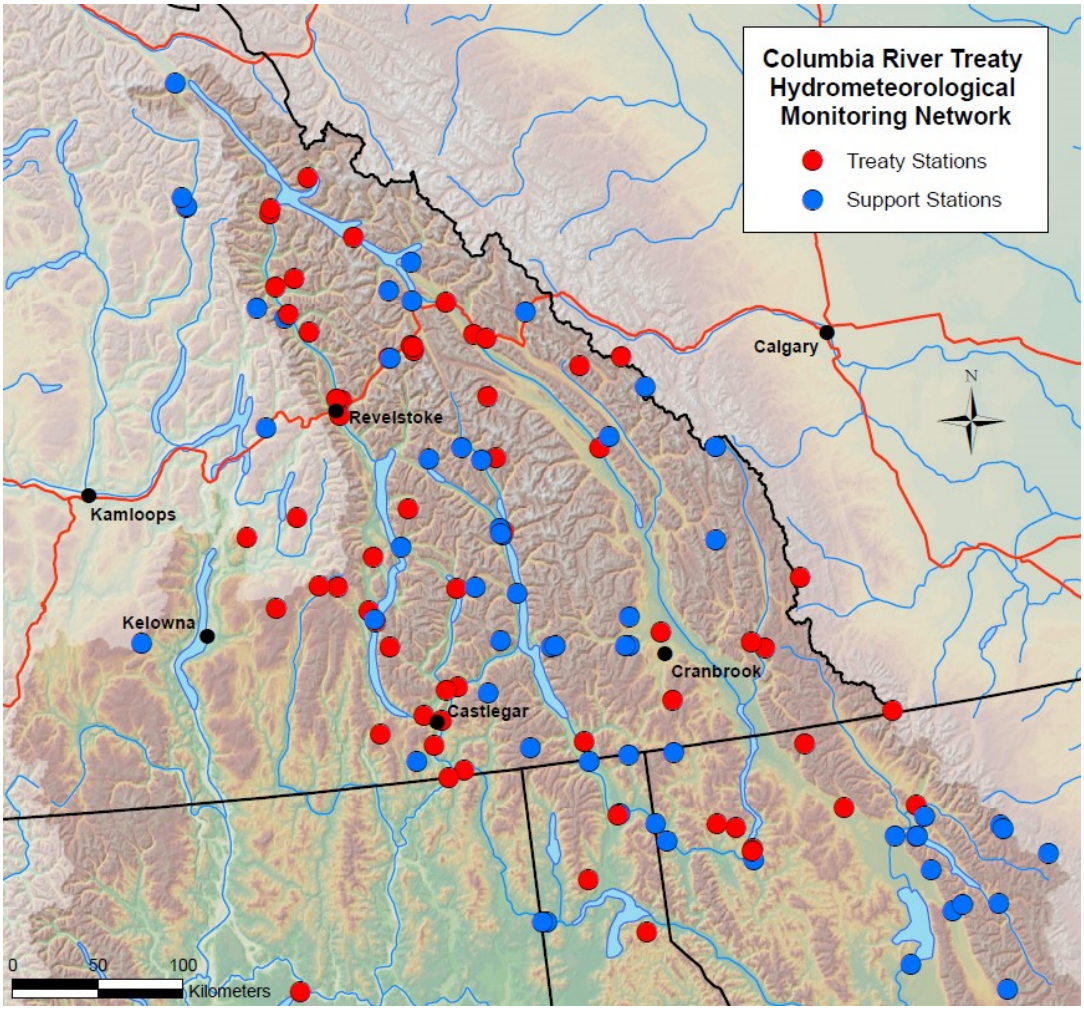


**Figure 1: Map of Treaty and Support station locations for the Upper Columbia Basin**

## Computer Systems and Data Acquisition and Exchange

BC Hydro updated their secure FTP site used for sharing hydrometeorological data and coordinated that effort with the US entity. This effort was well advertised and coordinated and provided significant testing lead time.

The committee continues to work toward better ways of documenting data exchange, changes to data networks, and staff contact information. The committee is continually improving protocols for official notification for changes to data reporting and creating a directory of contacts and staff at each entity for critical data exchange and validation issues.

# Forecasting

## *Adjustments to Treaty Storage Regulation*

On June 3, 2020, the CRTHC agreed to use seasonal volumes generated using Ensemble Streamflow Prediction (ESP) for the Canadian Treaty projects rather than the official statistical Treaty forecast residual based on a concern that the official 01 June statistical forecast was underestimating the remaining snow in the Upper Columbia. At the same time, the committee recommended using coordinated monthly streamflows developed using each agency's internal forecasting procedure for Libby rather than a monthly distribution of the residual water supply forecast.

Winter and spring of water year 2020 saw above average snow accumulation in the Canadian portion of the Columbia River Basin and a delayed onset of snowmelt particularly in the Upper Columbia (Mica Basin). Snow accumulation continued well into May at high elevations. Regional precipitation in May was observed as up to 130% of average for the Upper Columbia Region and 114% of average for the Kootenay Region.

The snow water equivalent (SWE) data used in the statistical forecast equations for Canadian projects for June's official forecast are from April 1 and May 1 snow surveys. There is no predictor based on early June data that could account for the continued snow accumulation in any of the statistical forecasts. There is also no predictor to directly account for the above average May precipitation in the forecast equations for Mica. The only predictor in the Mica statistical forecast that considers precipitation in May is the "spring to date precipitation" at Blue River (YCP). But with 73% of normal precipitation in May precipitation measured at Blue River (YCP) was an outlier in the region (all other stations in the area besides Mica Dam Climate were above normal in May). All the above issues result in a June residual statistical forecast for Mica that was ~ 7% lower than the equivalent Canadian ESP forecast. The official Northwest River Forecast Center (NWRFC) June forecast for Mica was effectively identical to the BC Hydro ESP forecast. BPA's internal ESP forecast also aligned with the higher Canadian and the NWRFC forecasts. NWRFC forecasts for other Canadian Treaty projects are also closer to the higher Canadian ESP forecasts than they were to the lower statistically-based forecasts.

## *POP Appendix 8 Updates*

There was a single update to POP Appendix 8 in 2020. To make referencing sections of the Appendix easier, the Hydrometeorological committee added a numbering scheme to the formatting of the Appendix. In addition, in the first section of the report on early season water supply forecasts, the committee also added the clarification that the early season forecasts were not to be used in adjusting the *streamflows* (emphasis added) for Actual Energy Regulation / Treaty Storage Regulation (AER/TSR) coordination.

## *2021 NWRFC ESP Water Supply Forecasts*

For 2020, the NWRFC had dropped the ESP forecasts with a 5-day deterministic short-term forecast that the CRT relied on. For 2021, the NWRFC offers ensemble forecasts which include a 10-day short-term forecast and ensembles that are forced with only historical weather sequences (climatology or 0 day). The NWRFC is also providing an experimental set of ensembles that transition from a short-term weather ensembles forecast into the historical weather sequences. The CRTHC recommends waiting for this experimental ESP forecast to be verified before considering it as a candidate for water supply forecasts. That limits the possible choices to either a forecast with no short range weather component or a forecast with a 10-day short range forecast. After analysing both options, the CRTHC continues to recommend to use the ESP forecast with a 10-day short-term forecast for Treaty purposes and for operational decisions on the Columbia River system for WY 2021.

In order to make other water supply based guidance available as early in the month as possible, we also continue to recommend using the NWRFC generated forecasts that are available at the close of business on the 3rd working day of the month. In recent years, the Bureau of Reclamation forecast for Hungry Horse and the US Army Corps forecasts for Dworshak and Libby have also been available by the 3rd working day. Canadian forecast procedures include manually collected data which is not fully available until the 3rd working day of the month. BC Hydro has committed to having a draft forecast available by noon on the 4th working day. This shift in schedule was able

to make the flood risk management guidance available one day earlier this past year. We continue to recommend this same approach for this coming year. The CRTOC approved the following dates for the upcoming year (WY21) for the ESP- based water supply forecasts generated by the NWRFC. Those dates are:

December 3rd
January 6th
February 3rd
March 3rd
April 5th
May 5th
June 3rd

# Water Supply Forecast Verification

The water supply forecasts and information on the hydrometeorology for the year are presented in the 2020 Annual Report of the Columbia River Treaty by the Entities (Section IV), and will not be repeated here. This section gives a brief overview of any lessons learned.

## *Canadian Projects*

### Precipitation, temperature, and snow

The following tables and figures summarize the observed conditions for the Canadian Columbia and Kootenay regions computed as an average of the stations reported in the monthly Canadian Water Supply Forecast update.

Table 1: WY 2020 observed average monthly hydrometeorological conditions for British Columbia portion of Columbia River Basin Source BC Hydro

| Month | Precipitation (% of normal) | Mean temperature deviation from normal | Snow water equivalent (% of normal) | Inflow (% of normal) |
|---|---|---|---|---|
| October | 76 | -2.5 | | 109 |
| November | 72 | -0.2 | 111 | 94 |
| December | 151 | 1.7 | 94 | 131 |
| January | 143 | -0.2 | 115 | 124 |
| February | 114 | -0.5 | 126 | 131 |

| Month | Precipitation (% of normal) | Mean temperature deviation from normal | Snow water equivalent (% of normal) | Inflow (% of normal) |
|---|---|---|---|---|
| March | 82 | -2.0 | 121 | 75 |
| April | 63 | -1.6 | 120 | 78 |
| May | 119 | -0.6 | 119 | 122 |
| June | 132 | -0.9 | 119 | 129 |
| July | 119 | -0.8 | | 122 |
| August | 69 | 0.1 | | 98 |
| September | 79 | 2.0 | | 85 |

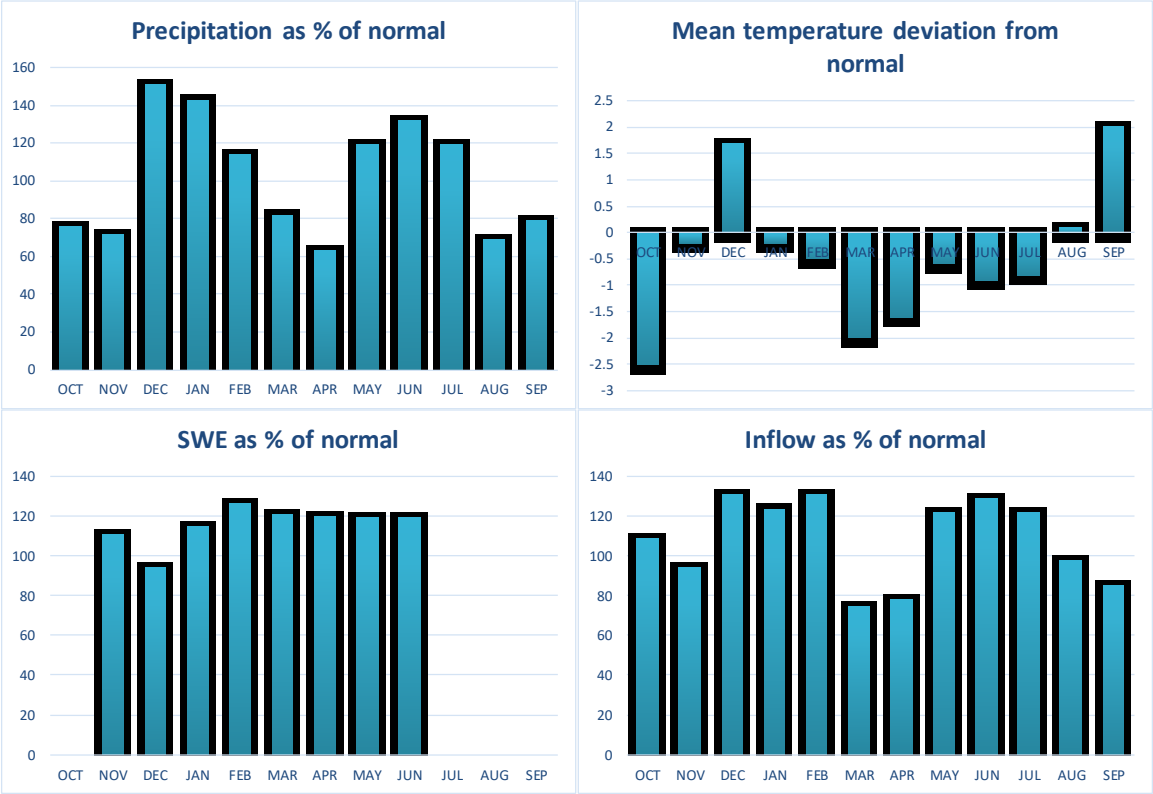


**Figure 2: WY 2020 observed average monthly hydrometeorological conditions for British Columbia portion of Columbia Basin Source: BC Hydro**

**Table 2: WY 2020 observed average monthly hydrometeorological conditions for Kootenay Basin in British Columbia Source: BC Hydro**

| Month | Precipitation (% of normal) | Mean temperature deviation from normal | Snow water equivalent (% of normal) | Inflow (% of normal) |
|---|---|---|---|---|
| October | 61 | -2.6 | | 109 |
| November | 52 | -0.2 | 107 | 68 |
| December | 148 | 2.8 | 82 | 97 |
| January | 163 | 1.4 | 85 | 106 |
| February | 119 | 0.4 | 120 | 122 |
| March | 82 | -1.1 | 118 | 67 |
| April | 51 | -1.2 | 114 | 71 |
| May | 114 | -0.2 | 144 | 118 |
| June | 79 | -0.4 | 60 | 120 |
| July | 70 | -0.4 | | 106 |
| August | 44 | 1.3 | | 90 |
| September | 71 | 2.0 | | 78 |

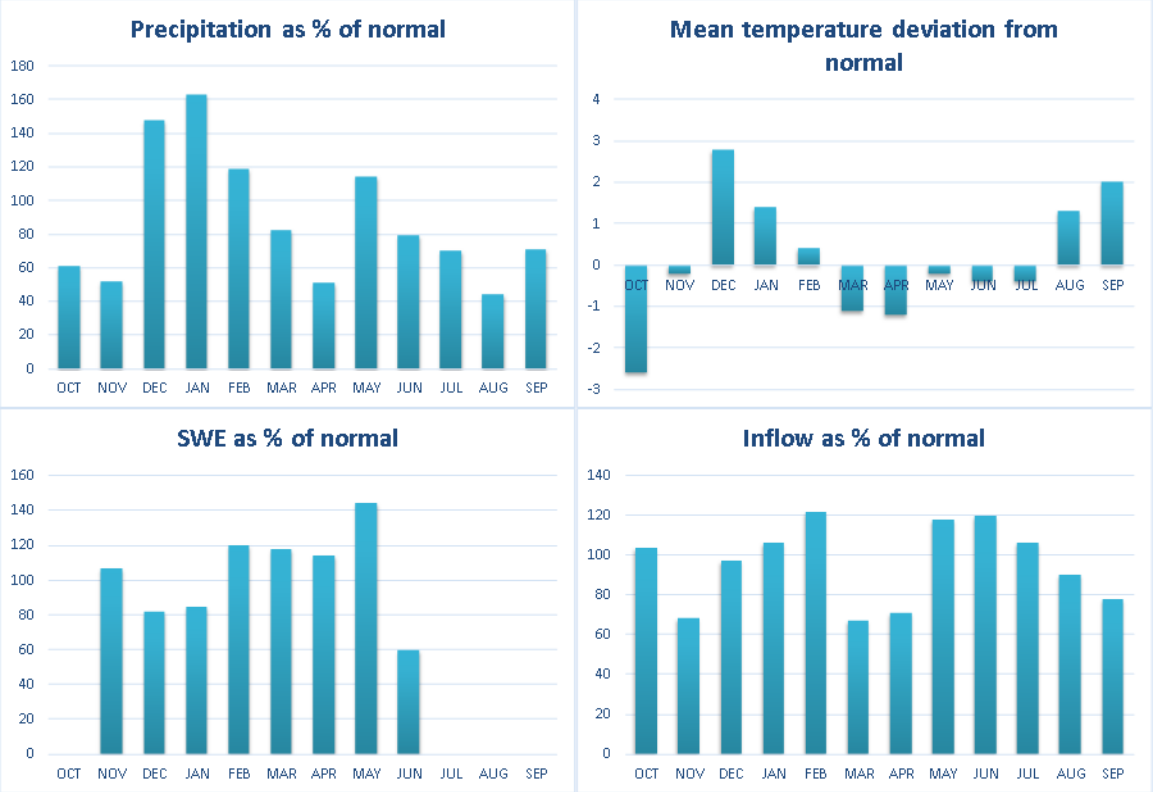


**Figure 3: WY 2020 observed average monthly hydrometeorological conditions for Kootenay Basin in British Columbia  Source: BC Hydro**

## Forecasts

The WY 2020 forecasts and observed volumes for Canadian Treaty projects are shown in the figures and tables below.

- Observed inflows for Mica, Arrow and Duncan were mostly within the ±1SE or ±2SE prediction bounds for both the Jan-Jul and Apr-Aug targets.
- Early season forecasts were below normal due to drier than normal fall weather.
- Above normal precipitation in December and January caused increases in forecasted volumes for both January and February.
- Forecasts remained more or less unchanged after February except for a small drop in the May forecast and subsequent recovery in the June and July forecasts. The drop in May was driven by well below normal precipitation in April, whereas the subsequent recovery over the next two months was a result of

wetter than normal conditions in the period leading to each forecast date (May and June).

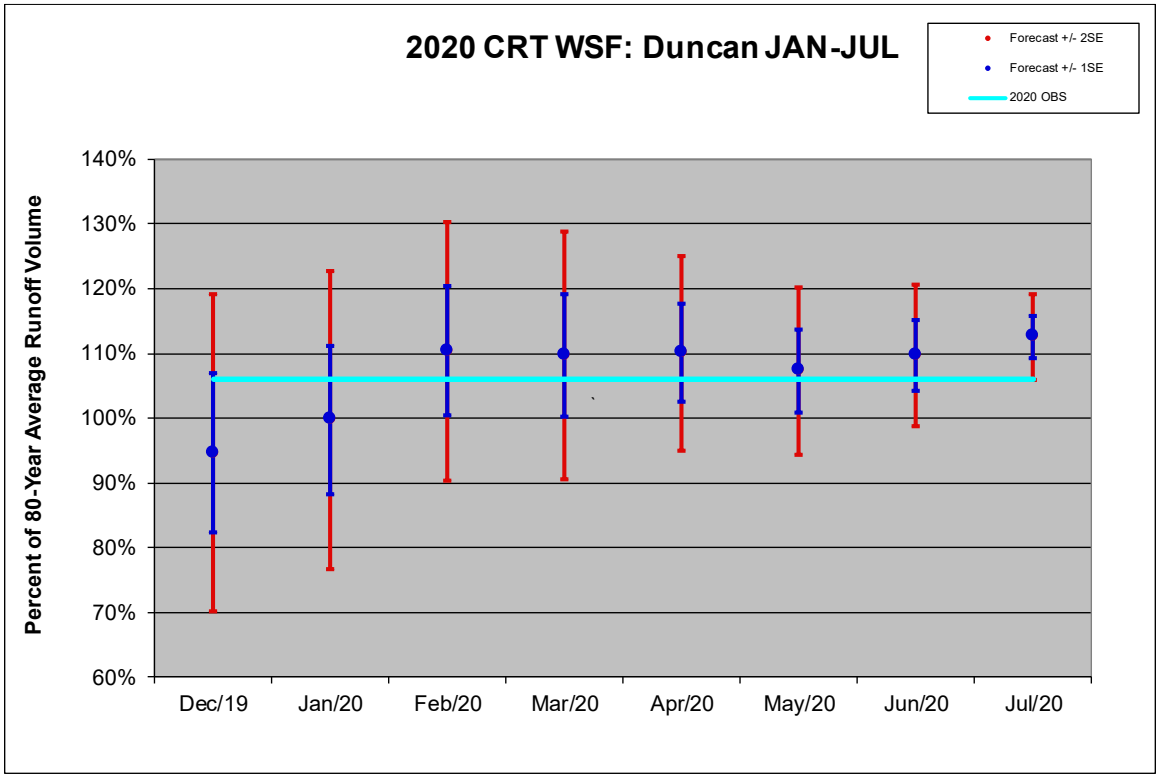


**Figure 4: Duncan Jan-Jul volume forecast verification Source: BC Hydro**

**Table 3: Duncan Jan-Jul volume forecast verification Source: BC Hydro**

| Duncan<br><br>Month | January-July Volume Forecast (kaf) | January-July Volume Forecast (% average) | Model Standard Error (%) |
|---|---|---|---|
| December | 1714 | 95 | 12 |
| January | 1807 | 100 | 11 |
| February | 2021 | 110 | 10 |
| March | 1987 | 110 | 10 |
| April | 1993 | 110 | 8 |
| May | 1944 | 107 | 6 |
| June | 1960 | 110 | 5 |
| July | 2038 | 113 | 3 |
| Observed | 1920 | 106 | |

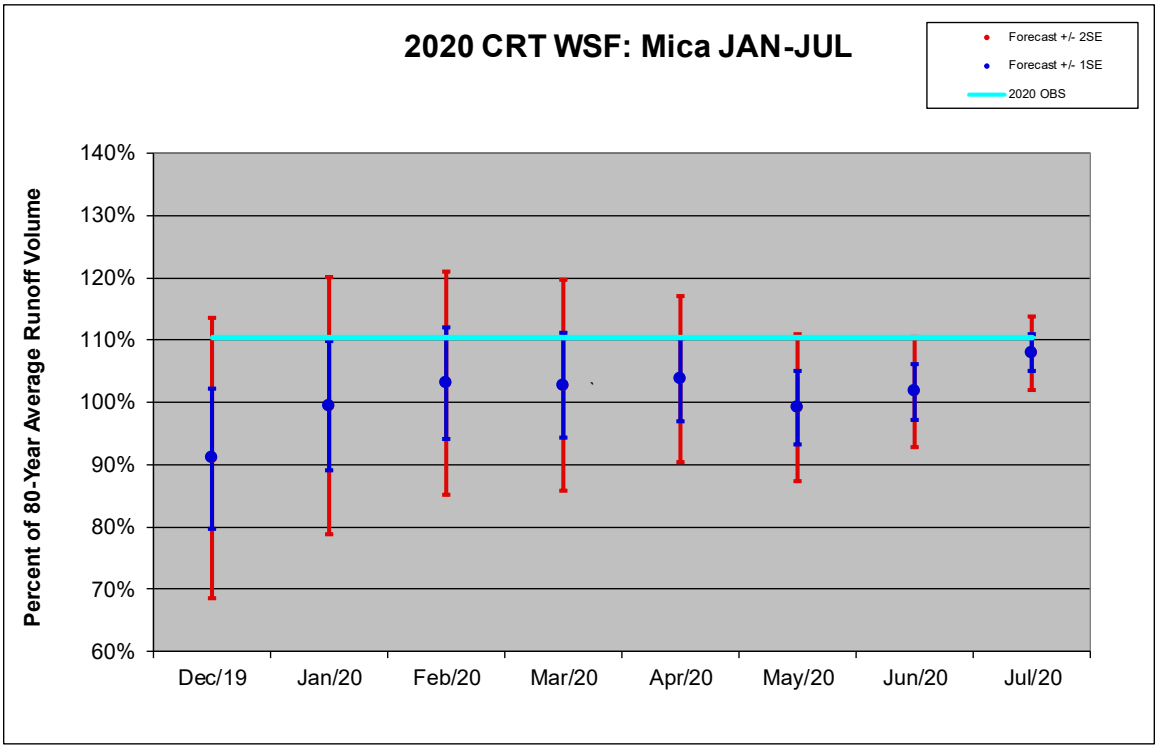


**Figure 5: Mica Jan-July Volume Forecast Verification Source: BC Hydro**

**Table 4: Mica Jan-July Volume Forecast Verification Source: BC Hydro**

| Mica<br><br>Month | January-July Volume Forecast (kaf) | January-July Volume Forecast (% average) | Model Standard Error (%) |
|---|---|---|---|
| December | 8923 | 91 | 11 |
| January | 9749 | 99 | 10 |
| February | 10104 | 103 | 9 |
| March | 10068 | 103 | 8 |
| April | 10165 | 104 | 7 |
| May | 9720 | 99 | 6 |
| June | 10671 | 102 | 4 |
| July | 10576 | 108 | 3 |
| Observed | 10830 | 112 | |

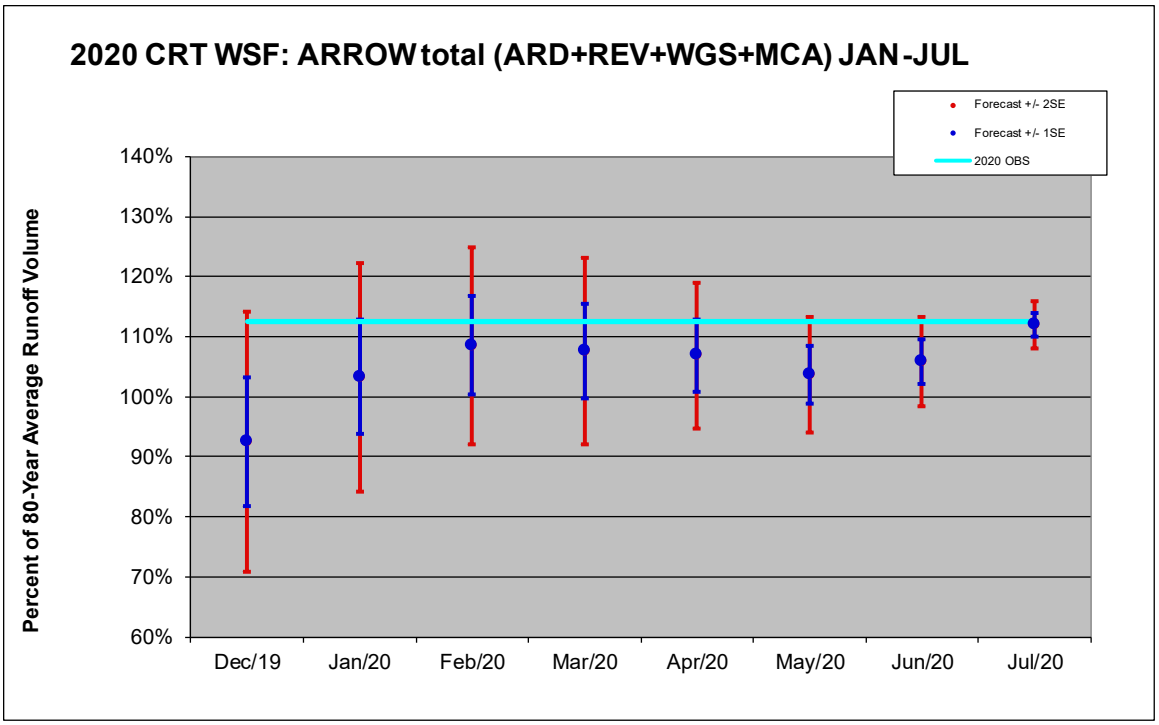


**Figure 6: Arrow Total Jan-Jul Volume Forecast verification Source: BC Hydro**

**Table 5: Arrow Total Jan-Jul Volume Forecast Verification Source: BC Hydro**

| Arrow Total<br><br>Month | January-July Volume Forecast (kaf) | January-July Volume Forecast (percent average) | Model Standard Error (%) |
|---|---|---|---|
| December | 18820 | 92 | 11 |
| January | 21016 | 103 | 10 |
| February | 22078 | 108 | 8 |
| March | 21900 | 108 | 8 |
| April | 21748 | 107 | 6 |
| May | 21101 | 104 | 5 |
| June | 22274 | 106 | 4 |
| July | 22803 | 112 | 2 |
| Observed | 22880 | 112 | |

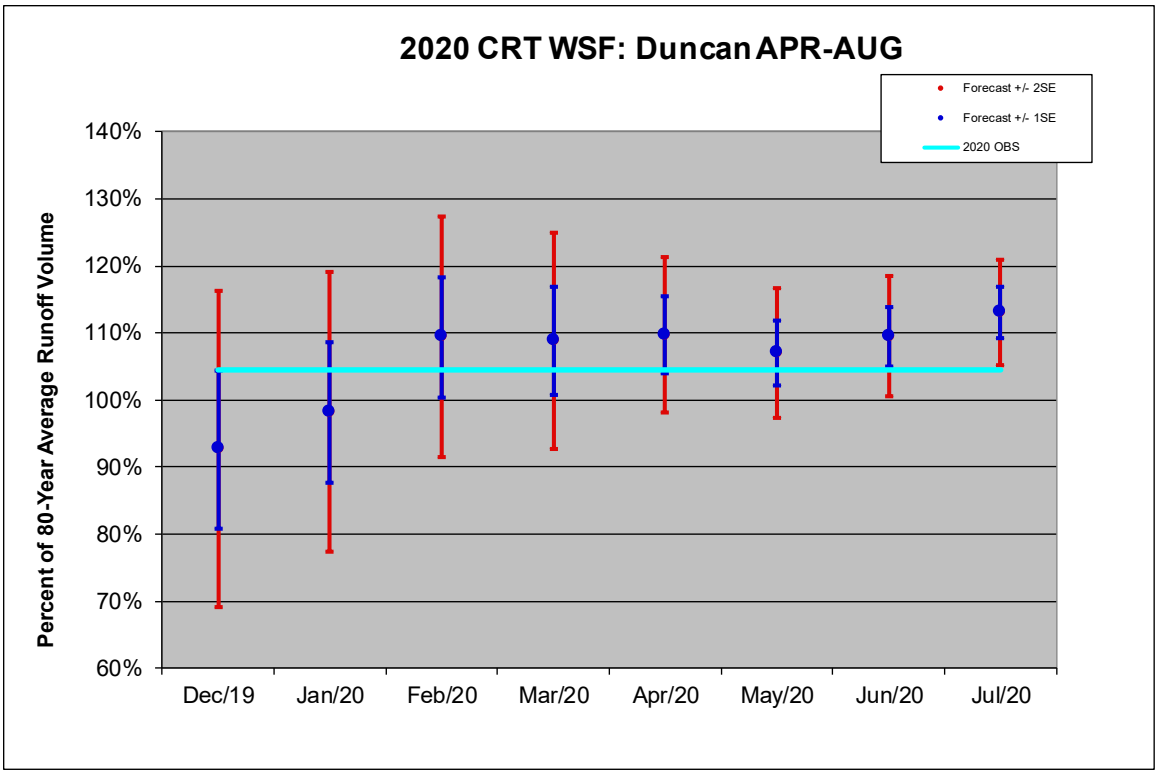


**Figure 7: Duncan Apr-Aug Volume Forecast Verification Source: BC Hydro**

**Table 6: Duncan Apr-Aug Volume Forecast Verification Source: BC Hydro**

| Duncan<br><br>Month | April-August Volume Forecast (kaf) | January-July Volume Forecast (percent average) | Model Standard Error (%) |
|---|---|---|---|
| December | 1885 | 93 | 12 |
| January | 1998 | 98 | 10 |
| February | 2227 | 109 | 9 |
| March | 2214 | 109 | 8 |
| April | 2233 | 110 | 6 |
| May | 2178 | 107 | 5 |
| June | 2132 | 109 | 4 |
| July | 2300 | 113 | 4 |
| Observed | 2127 | 105 | |

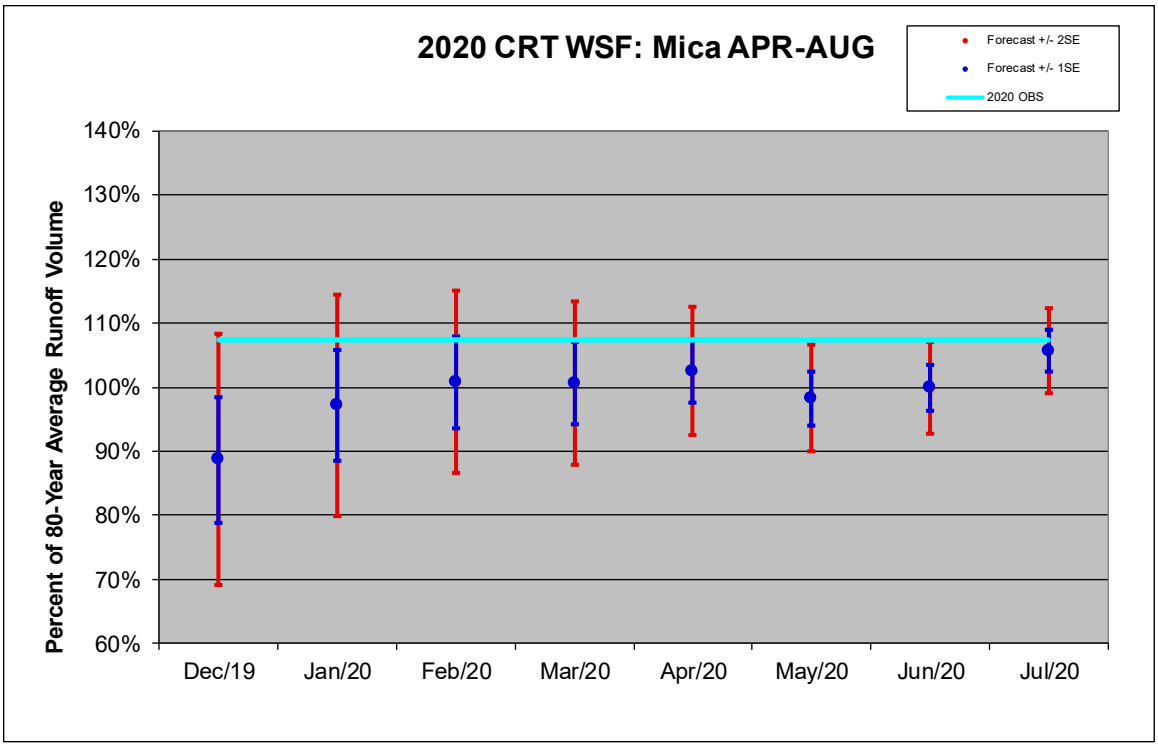


**Figure 8: Mica Apr-Aug Volume Forecast Verification Source: BC Hydro**

**Table 7: Mica Apr-Aug Volume Forecast Verification Source: BC Hydro**

| Mica<br><br>Month | April-August Volume Forecast (kaf) | January-July Volume Forecast (percent average) | Model Standard Error (%) |
|---|---|---|---|
| December | 10205 | 89 | 10 |
| January | 11179 | 97 | 9 |
| February | 11598 | 101 | 7 |
| March | 11579 | 101 | 6 |
| April | 11793 | 102 | 5 |
| May | 11308 | 98 | 4 |
| June | 12173 | 100 | 4 |
| July | 12161 | 106 | 3 |
| Observed | 12345 | 107 | |

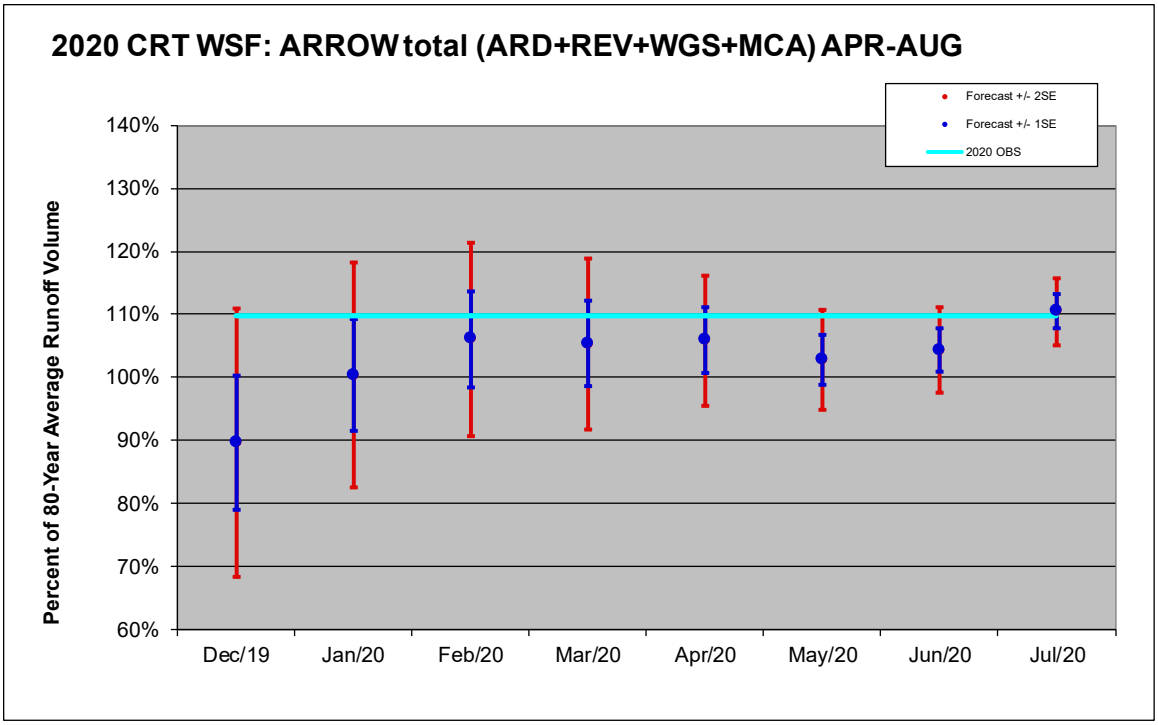


**Figure 9: Arrow Total Apr-Aug Volume Forecast Verification Source: BC Hydro**

**Table 8: Arrow Total Apr-Aug Volume Forecast Verification Source: BC Hydro**

| Arrow Total<br><br>Month | April-August Volume Forecast (kaf) | January-July Volume Forecast (percent average) | Model Standard Error (%) |
|---|---|---|---|
| December | 20208 | 90 | 11 |
| January | 22621 | 100 | 9 |
| February | 23898 | 106 | 8 |
| March | 23744 | 105 | 7 |
| April | 23858 | 106 | 5 |
| May | 23162 | 103 | 4 |
| June | 24192 | 104 | 3 |
| July | 24898 | 110 | 3 |
| Observed | 24705 | 110 | |

## *Libby*

### Precipitation, temperature, and snow

Precipitation varied throughout the season. Observed precipitation was generally below average in the Kootenai Basin in October, November, and December 2019, with the exception of the Fernie station in December with more than double the average precipitation. January featured generally above-average precipitation, followed by a trend toward drier conditions across February, March, and April. May was a much wetter month, with substantially above average precipitation. June precipitation was near-average, and then July and August were drier than average. Overall, Kootenai Basin precipitation was below average from the start of the water year through the end of May (Figure 10).

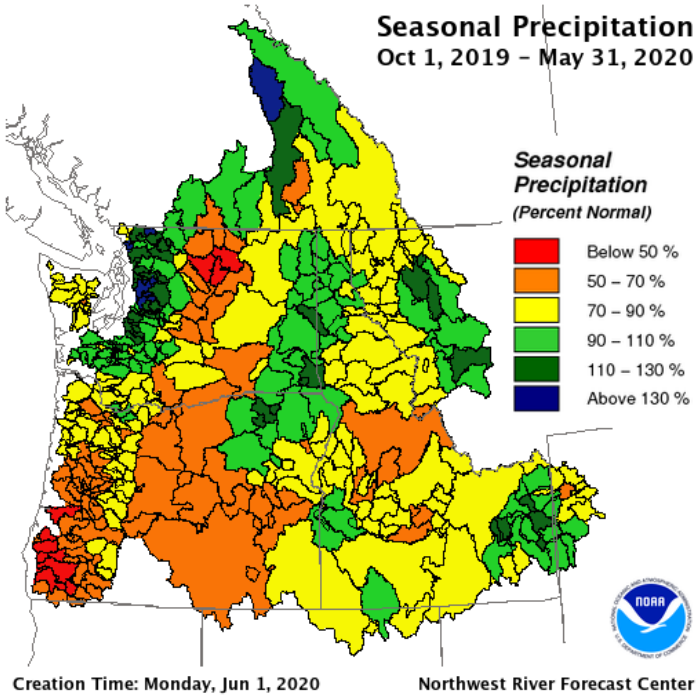


**Figure 10: Columbia Basin Regional Precipitation October through May 2020**

Despite generally below average precipitation recorded in the basin, mountain snowpack accumulated to above average levels. Snowpack was below average at the

start of the winter season in early January, but the greater precipitation of January increased snowpack to above-average levels; 115% for the Kootenai Basin as a whole by the end of January. Snowpack then remained above average up until the start of melt season, with all stations used for the Libby WSF reporting above-average snowpack on April 1st for the April forecast. Station behavior diverged during the melt season, with some stations depleted or nearly depleted by June 1st, and others retaining above average snowpack.

**Forecast**

The Libby April-August 2020 water supply forecast called for below-average inflows in the December and January forecasts, above average in the February, March, and April forecasts, and then slightly below average in the May and June forecasts. Observed Libby April-August 2020 inflow was 6320 kaf, or 107 percent of the 30-year normal (1981-2010). The February, March, and April forecasts were within 100 kaf of the observed inflow, but the May and June forecasts were approximately 500 kaf below the observed value.

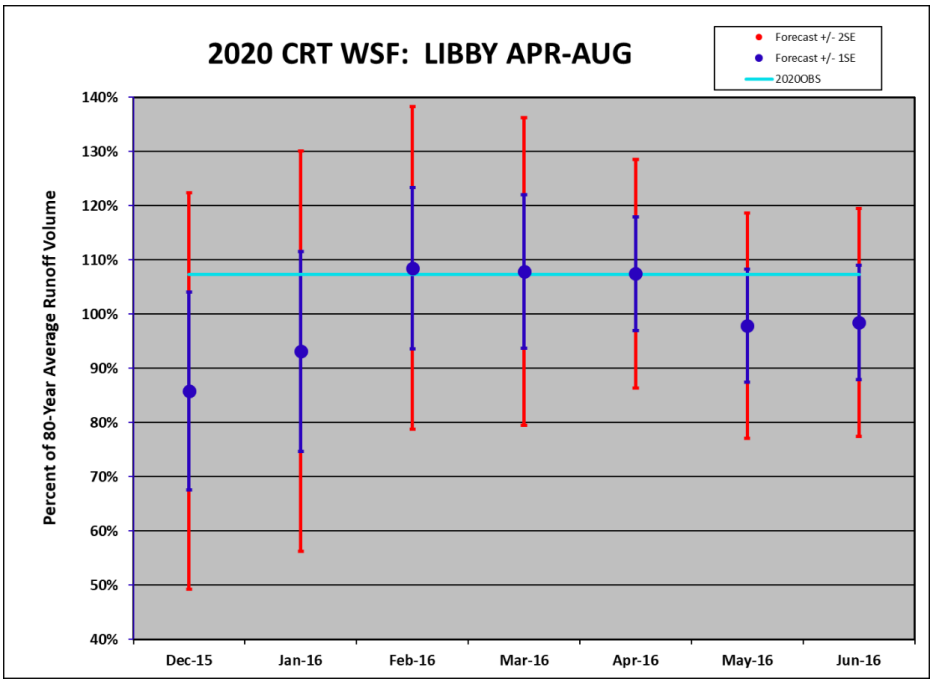


**Figure 11: Libby Apr-Aug Volume Forecast Verification Source: USACE Seattle District**

**Table 9: Libby Apr-Aug Volume Forecast Verification Source: USACE Seattle District**

| Libby<br><br>Month | April-August Volume Forecast (kaf) | January-July Volume Forecast (percent average) | Model Standard Error (%) |
|---|---|---|---|
| December | 5050 | 86 | 18 |
| January | 5481 | 93 | 18 |
| February | 6386 | 109 | 15 |
| March | 6349 | 108 | 14 |
| April | 6324 | 107 | 11 |
| May | 5759 | 98 | 10 |
| June | 5795 | 98 | 11 |
| Observed | 6320 | | |

This contrast between below-average precipitation and above-average snow accumulation in WY2020 may account for some of the error in the final May and June forecasts. The low precipitation values contributed to a lower forecast inflow volume, while the above-average snowpack present at the start of the melt season was able to drive above-average runoff.

# Schedule 1 CRTHC Action Items

## Table 10: Active Action Items

| Meeting Source | Description | Notes/Updates |
|---|---|---|
| 79.4.d.iii | Complete collaborators letters for station in Canada | |
| 79.5.b.ii | Data connection and transfer issues between BPA and Corps | There have been major issues with respect to data retrival. Ann and Bill to set up meeting to discuss |
| 80.5.3 | Protocol for managing updates to Canadian CROHMS stations and testing change to the files. Add a description of steps for requesting new CROHMS IDs from the Corps | |
| 81.4.d.i | SharePoint site – add contact information | Add recent organization charts and contact information for staff level contact and who should be contacted for which tasks |
| 82.3.d | send out CRT contact list for hydromet related stuff | |
| 83.2.e | BCH to confirm if error with GENIE sending last hour of Arrow reservoir data incorrectly has been corrected | Confirm with BPA/ Maler about whether this is now working. |
| 84.2.a | Several climatology stations have been reported with safety concerns | Stephanie has developed a list of sites that need to be reviewed and determined whether they should be replaced, upgraded or removed |
| 84.2.b | Update station spreadsheet | Need to add updated WSF stations from update to Canadian forecasting procedures last year |
| 84.4.b | Duncan spillway curves | Will the update of Duncan spillway curves impact the outflow and inflow historical data and require a recalibration of the Duncan water supply forecast procedure |
| 84.4.e | Update POP Appendix 8 | Over the last several years we have needed to approve deviations to the second AER flow coordination as the current May forecasts are not always reflective of the historical record. Update POP so that internal forecasts are used for that period rather than prescribed procedure. |
| 84.4.f | Notify Water supply forecasting agencies of need to get approval of changes from Hydromet committee | Draft email with expectations of coordination |
| 84.5 | Modified flow usage in POP | Begin to analyze updated Modified Flows record and formulate recommendation on how they might be used for Treaty purposes |

## Table 11: Completed Action Items

| Meeting Source | Description | Notes/Updates |
|---|---|---|
| 81.2.b.ii | Information on new stations | Stephanie to provide station meta data fro new pool elevation sites on Kootenay Lake and Revelstoke Reservoir |
| 82.5 | BPA to send BCH 2010 Modified flow for FEWS input | |
| 82.5 | BCH will send data available in June for 2020 Modified Flows | |
| 83.2.a.ii | Seattle District to review Libby WSF to choose an equation that does not include Akamina | Unable to find original files so are unable to use a different procedure, instead developed an estimator procedure for Akamina Pass |
| 83.2.c.i | Some challenges with accessing the data for an entire month for Fernie gage. This site goes into the Libby WSF. | Logan to send link they use to access Fernie to Stephanie and Georg. BC to look for QC data for the station. Should be retrieving from CBT - but currently from a web site |
| 83.2.d.i | BCH to send info on new Fauquier at Water Treatment Plan station replacing Fauquier observe station | |
| 83.3.b | "Snow density correction BCH is planning to implement:<br>ACTION: 83.3.b Seattle will email BC Hydro with stations they are using before updating equations and send data just to check.<br>ACTION: 83.3.b.ii BC will check with Frank to see if it is BC wide.<br>ACTION: 83.3.b.iii Contact the NRCS and NWRFC and inquire if they are using a correction for the density difference between glycol and water. " | Density correction/ data sent is consistent between current observations and historical record, so no need for massive update. Just recognize that the 'observed' value need to be corrected to reflect density difference between glycol and water for use outside of comparison with historical record |
| 83.4.a | Get write-ups from the NWRFC on the change in the deterministic period of the 10 day forecast | |
| 83.4.d | Mid November 2019 phone call to check in on how current WSF is evolving and remind forecasters about need to request changes to CRTHC. | |
| 83.5.a | BPA to send Modified flows data format template to BCH | |