COLUMBIA RIVER TREATY HYDROMETEOROLOGICAL COMMITTEE

2013 ANNUAL REPORT

Keystone Creek Snow Pillow, BC

Stephanie Smith	BC Hydro, Canada, Canadian Chair
Adam Gobena	BC Hydro, Canada, Member
Peter Brooks	U.S. Army Corps of Engineers, U.S., U.S. Co-Chair
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DECEMBER 2013

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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 2013 water year (October 1, 2012 – September 30, 2013). The Annual Report focuses on:

- action taken on proposed changes to the hydrometeorological monitoring network
- updates to CRT communications and data storage systems
- updates to data exchange requirements
- updates to forecasting procedures
- review of the 2013 CRT water supply forecasts
- other activities of the Committee

The CRTHC began issuing regular Annual Reports in 2001. General background information on CRTHC activities contained in the 2001 and 2002 annual reports is now presented in a separate supplemental document. The supplement 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 forecast requirements

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See 2013 Supplemental Report for a list of acronyms used in this report

2013 Annual Summary

The Columbia River Treaty Hydrometeorological Committee (CRTHC) was established in September 1968 by the Entities and is responsible for planning and monitoring the operation of hydrometeorological data collection network in accord with the Treaty and otherwise assisting the Entities as needed. The Committee consists of four members as follows:

UNITED STATES SECTION	CANADIAN SECTION
Peter Brooks, USACE Co-Chair	Stephanie Smith, B.C. Hydro, Chair
Ann McManamon, BPA Co-Chair	Adam Gobena, B.C. Hydro, Member

The CRTHC met twice in the 2013 water year:
Meeting 71: April 14, 2013 at BC Hydro
Meeting 72: September 18, 2013 at BPA

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

The 2012 CRTHC Annual Report was completed in January 2013, in advance of the annual Permanent Engineering Board Meeting.

Stations

The CRTHC process for reviewing proposed changes to the operation of stations within the hydrometeorological network is described in Appendix C of the 2013 Supplemental Report. The process is intended to ensure that changes made to the network do not negatively affect the monitoring, planning, and operations of Treaty facilities. In 2013, the current hydrometeorological station network was adequate for operating the Treaty. There is a deficit of snow monitoring stations in the Canadian portion of the basin which is actively being address with the planned installation of 4 snow monitoring stations. This activity is described later in this section.

In 2013, the Natural Resource Conservation Service (NRCS) reported that they would need to discontinue 39 snow courses in Montana and to curtail early season measurements at several others due to budget cuts. We reviewed the list of closed stations and determined that none of those stations were used to operate Treaty projects. However, three stations (Spotted Bear, Trinkus Lake and Upper Holland) used in the seasonal water supply forecast for Hungry Horse were part of the stations which were not measured during January and February. NRCS did provide estimates of those stations once they realized that the stations were important for water supply forecasting. Hungry Horse Reservoir, although not a Treaty project, is an important part of the Columbia River system and is therefore considered a supplementary station.

The BC government closed the Upper Kimberly snow course (2C11). After a review by the CRTHC it was determined that it is not used for Treaty monitoring or forecasting. Two snow pillows (Morrissey Ridge and East Creek) were damaged during the snow season and estimates of the snow water equivalent were provided by BC Hydro staff for first of the month measurements when needed.

In an effort to bolster our high elevation snow pack monitoring capabilities, Keystone Creek snow pillow was installed this past August. Keystone Creek is in the Revelstoke drainage and is at elevation 1890 meters. The site reports hourly snow water

equivalent, precipitation and temperature to provide additional hydrometeorological information in the northern portion of the Columbia basin. Three additional snow monitoring sites are scheduled to be installed during the summer of 2014. The additional sites are:

Name	Elevation (metres)
Near Sunbeam Lake or Bush River, BC	2010, 1920
Near Mt. Templeman, BC	1860
Near Kirbyville Lake or Downie Slide, BC	1750, 1630

These locations were chosen to be near long-term snow course monthly monitoring sites to be able to relate their real-time information to the historic record of the long term sites, so as to provide important snowpack information into the summer months after the last manual monthly snow survey is completed in May or June. This will inform streamflow forecasting in the basin during the snow melt period. It will take a minimum of 10 years of data collection before these stations will be directly useful in seasonal water supply forecasting procedures.

Computer Systems and Data Acquisition and Exchange

Each of the agencies has been updating several of their internal water data management systems to make the systems more resilient and to address the need for continuity of operations in a disaster. As such, this past year we experienced several challenges with data sharing between the agencies. To their credit, each of the agencies redoubled their efforts to make sure that critical data was made available in a timely fashion. The Corps in particular stepped in and set up a conference call held bi-monthly to address these issues with all the interested parties. This conference call includes a number of individuals and agencies which are not part of the Treaty, but who

have active roles in using and disseminating hydrometeorological data in the Pacific Northwest.

Forecasting

Dworshak Water Supply Forecast:

The committee reviewed and recommended for approval an updated version of the Dworshak water supply forecast. Walla Walla District was interested in developing a technique which better represented current conditions within the basin through better distribution of snow water equivalent information.

NWS ESP Water Supply Forecasts:

2013 was the second year that the new seasonal volume forecast procedure, Ensemble Streamflow Prediction, (ESP) was used by the Northwest River Forecast Center (NWRFC). During this water supply season, the CRTHC had recommended the use of the water supply forecasts which included 5 days of quantitative precipitation forecast (qpf) and which was available on the fifth working day of the month. The committee continues to believe that there is greater variability between subsequent forecasts which incorporated the 10-day short term forecast and found that this increased variability is less desirable for use in managing the large scale multi-purpose projects which make up the Columbia system. There was also a general sense that the meteorological science is still not adequate to have a reliable forecast out 10 days into the future, whereas, 5-day forecasts have been shown to be useful. Based on the experience this past year, the CRTHC continues its recommendation for the CRTOC of ESP forecast issue dates that will be the official ones for use in the Treaty Flood Control Operating Plan, the Actual Energy Regulation (AER) and the Treaty Storage Regulation (TSR). The dates will reflect the fifth working day of the month. At the October 2013 CRTOC meeting, these recommended forecast dates were adopted for the upcoming year. The dates are:

8 January 2014,

7 February 2014,

7 March 2014,

8 April 2014*,

7 May2014,

6 June, 2014,

8 July 2014.

* This date is actually the 6th working day in the month of April. The 5th working day falls on a Monday and there is the potential that the forecast available on that date may have been generated from the previous Friday which would not have allowed adequate time for incorporation of snow data or for any potential storms which might have occurred over that weekend. Considering the importance of the April Final forecast, this extra time for forecast generation is considered warranted.

October Precipitation Adjustment:

The October 2012 precipitation in the Canadian portion of the basin varied from 110% of normal at Park Mountain to 273% of normal at Cranbrook. The regional average of the 20 stations which are used in the water supply forecasts for Canadian Treaty project was 175% of normal. Use of these values directly in the water supply forecasts for the Treaty projects, caused forecasts to be artificially high. October precipitation is a predictor of subsequent February-September volume runoff for most forecast dates, as it is a representation of the antecedent soil moisture at the time of the ground freezing in the fall. The question then became how to adjust the anomalously high values to something that would still preserve the effect of high antecedent soil moisture at a level that is more reasonable in the context of all the other inputs to the forecasting procedure.

BC Hydro proposed a change that produced early season forecasts that were regionally consistent. Arrow, Whatshan, Sugar, Kootenay, Slocan, and Salmo had substantially higher unadjusted forecasts than Mica, Revelstoke, and Duncan. Forecasts for the latter suggested that the February-to-September inflows are around 110% of normal. Rather than arbitrarily adjusting October precipitation for individual projects, BCHydro tried to apply a consistent adjustment to all projects. They tested the effect of lowering

October precipitation to 0.5 and 1.0 standard deviations above normal on February to September inflow forecasts, and ultimately recommended the former as it provided water supply forecasts which were regionally consistent. The CRTHC therefore agreed that October precipitation predictors for Arrow, Whatshan, Sugar, Kootenay, Slocan, Salmo and Libby be set to 0.5 standard deviations above normal. The standard errors of the forecasts are not affected by the adjustments of October precipitation predictors.

May Runoff Adjustment for AER/TSR:

POP has set out an agreed upon process for coordinating flows that go into the AER/TSR. During the water supply season, flows are coordinated for the current month and the following month based on each parties internal forecasting process, and then the official January-July volume for each project is distributed for the remaining months to July based on the current modified flow distribution factors (in 2013 we were using the 71-year set). If any of the Treaty partners want to deviate from this process, the CRTHC may sanction this deviation after discussion.

This past May the region experienced significantly above average snowmelt and rainfall runoff occurring in the basin which caused May and early June flows to be much higher than in the AER/TSR coordination in the first half of the month. The above average flows in the first half of May left a very small remaining amount of the May final volume forecasts at many of the projects causing the July flows to be either an unrealistically small percent of the normal July flows, or even negative. After looking at these preliminary results, we decided to have the CRTHC discuss alternatives for flow coordination.

During a phone call on May 22nd, the CRTHC agreed that for the second AER/TSR of the month of May, that the parties would coordinate all three months (May, June and July) using internal forecasting processes and would not restrict those flows to match the May final volume forecasts.

Forecast Verification

The water supply forecasts and information on the hydrometeorology for the year are presented in the 2013 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 the forecasts and focuses on the results of the verification of the Treaty project forecasts and any lessons learned.

Canadian Projects

The Arrow local drainage is defined as the sum of the Arrow, Revelstoke, and Whatshan basins, while the Arrow total drainage is defined as the sum of the Arrow, Revelstoke, Whatshan, and Mica basins. Arrow local and total forecasts are aggregates of sub-basin forecasts.

Columbia River Treaty forecasts for Mica, Revelstoke, Arrow local and Duncan are based solely on statistical forecast model (i.e., principal component regression). For early-season (December) forecasts, total Feb-Jul forecast volumes are disaggregated into monthly volumes using the monthly runoff distribution from the 71-year mean. For consecutive forecast dates, total Feb-Jul volumes, or the residual thereof, are calculated by aggregating BC Hydro's monthly forecast volumes and disaggregated using the monthly runoff distribution from the 71-year mean. January forecasts are naïve (climatology, 71-year mean) forecasts. August forecasts are the difference between Apr-Aug forecasts and the Apr-Jul volume of the disaggregated Feb-Jul forecasts.

2013 Highlights

- ENSO was not a significant factor in 2013 as equatorial Pacific conditions were neutral. The water year started with an anomalously wet second part of October, followed by near normal precipitation in November and December. The latter two months experienced warmer than normal weather regionally, resulting in slightly

below normal snow accumulation by the end of December. Both January and February were drier than normal at regional scale although some locations such as Mica Dam and Mt. Fidelity (Revelstoke) experienced above normal precipitation in February. The rest of the snow accumulation season was wetter than normal and mountain snowpack was slightly above normal by the end of the accumulation season.

- The February-through-July observed inflow volumes to Canadian Columbia region projects varied from near to above average. Mica was 105% of the 71-year mean; Arrow total was 106% and Duncan was 110%.

- The evolution of the water supply predictions reflected the month to month variation in the hydroclimate of the region and the manual adjustments made to the October precipitation, where applicable. To gauge the impact of the manual intervention in retrospect, the Arrow local forecast for December was reduced from near 120% to 110%, the latter being closer to the final outcome than the unadjusted forecast. The corrections were maintained throughout the forecast season.

- December forecasts were slightly above average owing to wetter than normal antecedent conditions, but the WSF dropped in each of the subsequent three months (January, February, March) as winter precipitation and snowpack generally trended downward due drier than normal weather across the region. It is worth noting that the importance of fall precipitation to the WSF becomes secondary to that of snowpack information (or its proxies) as the season progresses.

- With a progressive increase in snow accumulation through the rest of the season, WSFs gradually recovered and ultimately ended up closer to the final observed outcome. Overall, although the nominal forecasts underestimated observed flows particularly between February and May, the ±1 standard error prediction bounds enclosed the observed flows on most forecast dates and the ±2 standard error

prediction bounds enclosed the observed flows on all forecast dates. The forecast evolution was similar for the Apr-Aug forecast target.

Libby

The 2013 water year was classified as an ENSO neutral year. The precipitation through the fall and early winter (October – December) was above average at about 125% of average but then dropped off significantly in January and February with 50% of average snowpack. The snow accumulation was average through February, and March. April ended up being the biggest snow-building month of the winter and early spring with precipitation for the month above 200% of average at some gages; and the snowpack increased to 125% of average. Though, between the 1-March and 1-April there was actually a drop in the forecasts as the influence of the QBO between March and April also decreased even though the snowpack and precipitation had substantial gains during the issuing of the forecasts. The spring saw average temperatures in April and a warm-up in May with the freshet beginning in the first part of May. The month of June was fairly normal until a massive wrap around storm off the Gulf Coast caused a 3-day storm that added 4 to 6 inches of rain to the basin. This storm in late June was estimated to add 1 MAF to the total Apr-Aug inflow volume. The observed April-August seasonal average snowpack was 121% of average. As seen in the table below, Libby Dam was slightly under-forecasted for the seasonal volume forecasts issued from December through June (a positive value for number of standard errors indicates an under-forecast). The under-forecasting was due mainly to the heavy precipitation which fell between June 18th and 20th.

Month of Forecast	First-of-Month Apr-Aug Volume Forecast (KAF)*	Model Standard Error (KAF)	Number of Standard Errors Different Than Observed	End-of-Month Flood Risk Management Target (FT)
Dec	6238	947	1.0	2411
Jan	6898	841	0.3	2395
Feb	6384	564	1.4	2404

Mar	6315	527	1.6	2406
Apr	6189	532	1.8	2412
May	6535	487	1.3	
June	6464	418	1.6	

**Note that the Observed April-August Libby inflow volume was 7150 KAF*

Schedule 1 CRTHC Action Items

Meeting Source	Description	Notes/Updates	Assigned To
OUTSTANDING ACTION ITEMS			
60.4.c	Disaster Recovery plans - Stephanie to determine what, if anything, BC Hydro will do about data recovery in the event of a major system interruption	BCH working on in 2011. BCH has established a remote/backup site in Calgary BCH working on business continuity planning and establishing timelines for recovery	Stephanie Smith
69.3.f	Document decision process for approving changes to water supply forecast inputs through CRTHC reps in CRTHC Supplemental Report. Alternates: Corps: Ron Malmgren; BPA: Steve Hughes. BCH: Adam Gobena. Review each Fall.	Add section to SUPP to document. Draft wording by summer mtg 2013, in place by next WSF season	Ann
69.5.c.	Present updates to Mica turbine curves to CRTOC	Present at CRTOC meeting	Stephanie Smith
70.4.d	Find individually archive CRTHC documents and upload to SharePoint site		all
71.2.f	Status of Fernie BC precipitation gage	Peter to query how Seattle District obtains the data. Stephanie to contact Environment Canada and see if station can be automated	Peter/Stephanie
72.2.e	Develop list of specific contacts to send letters to in US for Hydromet data needs	Peter working on USGS and Corps contacts, Ann working on NRCS and NWS contacts	Peter/Ann

Table 1 Outstanding Action Items 2013

Meeting Source	Description	Notes/Updates	Assigned To	Due Date	Completed
COMPLETED ACTION ITEMS					
69.5.d	Updates to Stations database: 1. Add columns for Start and End dates – Adam 2. Post Stations database spreadsheet to Sharepoint - Adam 3. Add LIB, DWO, HGH station lists - Peter	Items 1 and 2 done. New technician working for Peter to start soon. Peter's part moved to new item 70.2.c. April 2013: Adam to restructure original template to remove repeated stations and then pass on to Peter to add US stations	Adam / Peter	Summer 2013	Done
70.3.d	Prepare recommendation to CRTOC for use of ESP		Ann	Oct-2013	Done
71.2.c	Note MT snow course site closures in annual report		Ann	Fall 2013	Done
71.3.b	POP appendix 7 tables need updating	Need to use operating year, not water year for computation of mean and median statistics. Adjust August and September values	Ann	Oct-13	Done
71.3.c	POP Appendix 8 Table 1 needs updating to 80-year record	Update T-statistic computations	Adam	May-13	Done
72.3.e	Update BCHydro WSF equations to reflect change to 80-year record		Adam	Fall 2013	Done

Table 2 Completed Action Items 2013