
COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

**2001
ANNUAL
REPORT**



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COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

2001 ANNUAL REPORT

Summary

The Columbia River Treaty Hydrometeorological Committee (CRTHMC) was established in September 1968 by the Entities. The Committee is responsible for planning and monitoring the operation of data facilities in accord with the Treaty. It also assists the Entities in matters related to hydrometeorological and water supply forecasting.

In October 2001, the Committee received approval from PEBCOM to adapt a new way of ensuring that the hydrometeorological network meets Treaty requirements. This report explains the shift in how the status of the hydrometeorological network is reported. Rather than providing a catalog of stations required for Treaty purposes, the Committee will report any changes in status of Treaty-designated stations.

This report also summarizes Committee activities during the 2001 Operating Year. The current system for data communications and data exchange is described in detail. Finally, the Committee's response and action to proposed changes to the network in 2001 are reported.

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Acronyms

AEC	-	Actual Energy Capability
AER	-	Actual Energy Regulation
AOP	-	Assured Operating Plan
BC Hydro	-	British Columbia Hydro and Power Authority
BPA	-	Bonneville Power Administration
CBT	-	Columbia Basin Telecommunications
CROHMS	-	Columbia River Operational Hydrometeorological Management System
CRT	-	Columbia River Treaty
CRTHMC	-	Columbia River Treaty Hydrometeorological Committee
CRTOC	-	Columbia River Treaty Operating Committee
DOP	-	Detailed Operating Plan
EC	-	Environment Canada
ESA	-	Endangered Species Act
ESP	-	Ensemble (or Extended) Streamflow Prediction
FCOP	-	Flood Control Operating Plan
FRO	-	Fall runoff, used in Libby water supply forecasting procedure
FTP	-	File Transfer Protocol
HYDSIM	-	Hydrologic Simulation model
MSC	-	Meteorological Service of Canada, Environment Canada

MSRM - BC Ministry of Sustainable Resource Management
 NRCS - Natural Resources Conservation Service
 NWPP - Northwest Power Pool
 NWRFC - Northwest River Forecast Center, US National Weather Service
 NWSRFS - National Weather Service River Forecast System
 Operating Year - October 1 to September 30 (CRTHMC)
 August 1 to July 31 (CRTOC)
 PEBCOM - Permanent Engineering Board Engineering Committee
 PNCA - Pacific Northwest Coordination Agreement
 QPF - Quantitative Precipitation Forecast
 RCS - Regional Climate Station
 RODS - BPA's Real-time Operations Dispatch and Scheduling
 SNOTEL - NRCS snow survey network
 SSARR - Synthetic Streamflow and Reservoir Regulation hydrologic model
 TSR - Treaty Storage Regulation study
 UBCWM - University of British Columbia Watershed Model
 USACE - US Army Corps of Engineers
 USBR - US Bureau of Reclamation
 WSC - Water Survey of Canada, Environment Canada
 WSF - Water Supply Forecast

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Role of the CRTHMC

The Canadian and United States Entities of the CRT established the CRTHMC in 1968. The mandate of the Committee is primarily to be responsible for ensuring that hydrometeorological data necessary for the planning and operation of Treaty project facilities are collected and communicated to the Entities.

The “Introduction to the Terms of Reference for the CRTHMC”, shown in appendix A, gives a brief history of the Committee.

Committee Terms of Reference are included in appendix B.

Committee Reports

The CRTHMC produced documents that provided catalog listings of Treaty, Support, and Supplemental stations. These stations are required to plan,

monitor, and operate Treaty projects¹. The CRTHMC submitted the first major compilation of network stations to the Entities in 1975, following the construction of Mica Dam. The report, entitled “Columbia River Treaty Hydrometeorological System”, was updated in 1980, 1983, 1987, 1989, 1990 and 1992.

The CRTHMC has not updated the document of station lists since 1992 for several reasons.

- Appreciable changes to the network had not occurred for several years following the issuance of the 1992 document.
- The Committee had not revised official statistical streamflow forecast procedures for several years. BC Hydro revised volume runoff forecast procedures for Canadian Treaty storage facilities in 1997. The Committee deliberated an update of the station list because data requirements changed from previous procedures^{2 3 4 5}.

Until the past few years, several United States agencies, including the USACE and the NWRFC, had not updated statistical water supply procedures for basins used to forecast volume runoff for the Columbia River at The Dalles.

¹ *The Committee's Terms of Reference, as shown in appendix B, define Treaty, Support, and Supplemental designations for CRT stations in the hydrometeorological “system”. The system, which refers to the network of hydrometeorological stations and not the hydroelectric system, is required to monitor, plan, and operate the Treaty projects.*

² *CRTHMC meeting minutes, 28 October 1997*

³ *CRTHMC meeting minutes, 18 November 1998*

⁴ *CRTHMC meeting minutes, 23 November 1999*

⁵ *CRTHMC meeting minutes, 09 November 2000*

- The Committee was uncertain as to how to designate stations used in new forecasting procedures being adopted by United States agencies. About the same time that the Committee began deliberating an update to the station list to account for revised Canadian inflow forecast procedures in 1997, the USACE and BPA were working with the NWRFC to develop new hydrological modeling procedures for the Columbia River above The Dalles. The agencies' strategy was to replace the SSARR hydrological model with a new model, NWSRFS, for both operational forecasting and support of water supply forecasting.

The agencies adopted several new philosophies in applying the NWSRFS. First, whereas SSARR bases areal extent of precipitation over a watershed on observed data at one to a few climate stations, the NWSRFS uses a larger number of stations. Each modeled basin typically uses from three to 10 pre-weighted stations to estimate mean areal precipitation. Those stations not used directly in the calculation are used to estimate missing data and to validate questionable data. Second, the NWSRFS requires more temperature sites than currently used by the SSARR model. Temperature data are used to determine whether precipitation falls in the form of snow or rain so that the accumulation of snow across the basin can be better modeled. Third, BPA is developing a regression-based system that allows modeled snow water equivalent values to be updated based on observed field measurements.

The increase in the number of stations required for forecasting purposes meant that the size of the network catalog would expand dramatically. Committee members felt that the effort required to maintain a current list of Treaty and Support stations was not effective in supporting the continuing operation of hydrometeorological stations for Treaty purposes.

Rather, the CTRHMC considered a new process for ensuring that the integrity of the hydrometeorological network is maintained. In February 2001, the

Committee forwarded its proposal to PEBCOM⁶. The essence of the proposal was to focus on station closures or changes to station operations to ensure that they do not negatively affect monitoring, planning studies, and project operations. Completion of station catalogs would no longer be required. Committee members felt that there was no need to revise its Terms of Reference because of the change in process.

The PEBCOM approved the revised process in October 2001⁷.

Process to Review Proposed Changes to the Hydrometeorological Network

The CRTHMC ensures that the integrity of hydrometeorological stations that are required to monitor, plan, and operate Treaty facilities is maintained by following a prescribed process. The process involves several steps, as described below.

STEP 1 COMMUNICATE WITH DATA COLLECTION AGENCIES

Each year, the Committee formally reminds each contributing data collection agency or utility to inform the Committee of any impending changes in its operation of hydrometeorologic stations near or within the Columbia River basin. A list of agencies and utilities to be contacted is included in Appendix C.

⁶ CRTHMC. 2001/02.

⁷ PEBCOM. 2001/10.

STEP 2 DESIGNATED TREATY STATUS OF STATIONS SUBJECT TO OPERATIONAL CHANGES

If informed of a proposed change to the operation of any hydrometeorological station, the Canadian and United States Sections of the Committee both determine if the change affects the ability to monitor, plan, or operate a Treaty facility. Specifically, the Committee will designate a station as Treaty or Support if data from it are required:

- as input to the AOP
- as input to the DOP
- as input to TSR studies
- as input to HYDSIM
- as input to the NWSRFS or UBCWM models for Columbia River sub-basins
- as input to seasonal water supply forecasting procedures required by the FCOP
- to monitor or operate Treaty facilities, including daily and additional seasonal forecasts for Treaty facilities

Brief descriptions of Treaty planning processes and models are included in Appendix D.

STEP 3 RESPOND TO DATA AGENCIES WHEN A CHANGE IN STATION OPERATION AFFECTS TREATY OPERATIONS

Where a change in the operation of a designated Treaty or Support station is proposed, the Canadian and United States Sections of the CTRHMC will explore several options:

- If the change in station operation compromises monitoring, planning for, or operating a Treaty facility, the appropriate Section of the Committee will urge data collection agencies on its respective side of the border to continue the current operation of the station.
- Where data collection agencies are unable to continue the current operation of a Treaty or Support station, the Committee will examine the impact that the proposed station change has on monitoring or operating a Treaty project. The Committee will also examine the practicality of modifying planning models to accept the proposed station change. The impact of the change in operation of the station should not, in the view of the Committee, deteriorate the accuracy of model results significantly. If the change does not significantly affect the ability to monitor, plan, or operate a Treaty facility, the Committee will not object to the proposed change.
- Where changes to a Treaty or Support station are detrimental to Treaty monitoring, planning, or operations, the CTRHMC will attempt to fund and arrange other resources required to continue the operation of the station. Alternatively, a suitable replacement station may be investigated.

STEP 4 DOCUMENT COMMITTEE WORK

The Committee will document the following:

- Committee activity during the operating year, which is defined as October 1 to September 30
- changes to the operation of Treaty or Support stations proposed within the Committee's operating year
- the Committee's response to the proposed changes
- resolution of proposed changes to the hydrometeorological network
- processes to communicate and exchange hydrometeorological data.

STEP 5 REGULARLY REVIEW HYDROMETEOROLOGICAL DATA REQUIREMENTS FOR TREATY MODELS

As required, the Committee will review existing and proposed models used for CRT planning studies and operations to assess hydrometeorological data requirements. The Committee will recommend preferred daily and seasonal forecasting models to be used in CRT operations to the CRTOC.

2001 Operating Year

The 2001 Committee consisted of four members:

<u>UNITED STATES SECTION</u>	<u>CANADIAN SECTION</u>
Nancy L. Stephan, BPA Co-chair	Eric Weiss, BC Hydro, Chair
Rudd A. Turner, USACE Co-chair	Wuben Luo, BC Hydro, Member

Mr. Luo was appointed to replace Mr. Don Druce on 1 October 2000; Mr. Turner was appointed to replace Mr. Peter Brooks on an interim basis on 17 July 2001.

The Committee met three times and engaged in several conference calls in order to accomplish its work in 2001. The first meeting was held on November 9, 2000. The meeting was a continuation of previous discussions concerning the definition of a Treaty station. Each Section brought a station listing with sites that were to be considered Treaty stations. The size and complexity of the station list created further discussion as to how, where, and by whom this listing was to be maintained.

The Committee met on January 17, 2001 to continue the discussion of Treaty stations and review a paper Eric Weiss had prepared for PEBCOM. The paper contained proposed changes and future updates of Committee documents,

covering issues ranging from Treaty stations definitions to data exchange and communication. After lengthy discussion, an overview of the results was presented at the CRTOC meeting the next day in order to receive comments and suggestions for proceeding with the paper.

At the joint PEB and Entities meeting on February 21, 2001, Nancy Stephan and Eric Weiss presented a final report entitled “Proposed Strategy for Future Updates of Committee Documents”. They described a new process for ensuring the continued operation of stations required to monitor, plan, and operate CRT facilities.

Following the meeting, the Treaty Coordinators wrote to the PEBCOM requesting approval of the CRTHMC’s proposed changes⁸. PEBCOM approved the process on October 9, 2001.

The Committee also provided the CRTOC with a review of the Libby forecast procedure for the 2000 water year. The CRTOC tasked the CRTHMC with looking into the large forecast errors that occurred that year. The main causes for the large forecast error with the Libby forecast procedure included:

- Record high November runoff due to a heavy, warm rain event that occurred late in the month. The November runoff is part of the FRO term in the equation. The FRO term has a relatively small regression coefficient that normally results in a small contribution to the overall forecast value. However, the magnitude of the fall runoff that occurred in 1999 was a major contributor to the overall error.
- Mild winter temperatures. The warm winter made it difficult to assess the distribution of snowpack in the Libby basin by looking at snow survey stations used in the procedure. Some snow course sites used in the Libby basin forecast procedure lie outside the basin. The representation as well as the uneven distribution

⁸ CRT Entities letter, June 20, 2001.

caused the procedure to have difficulty assessing the snow pack conditions.

- Below normal spring precipitation. The forecast procedure assumes normal subsequent precipitation. Spring precipitation in the Libby basin was below normal resulting in a slight decrease in overall runoff.

The Committee also noted that the July 1, 2000 forecast was based on the NWRFC's forecast procedures, since USACE forecast procedures only provide forecasts through June.

USACE is actively engaged in developing a more accurate and reliable set of regression equations for Libby. They expect to submit their analysis to the CRTOC for review during FY2003.

Summary of Changes to Station Networks

The Committee was notified of several potential changes to hydrometeorological station networks in Operating Year 2001. In Canada, nine stations were referred to the Committee:

- Arrow Creek snow course (report 2)
- Beaverfoot snow course (report 7)
- Field snow course (report 3)
- Gray Creek Lower snow course (report 5)
- Gray Creek Upper snow course (report 6)
- Kicking Horse snow course (report 4)
- Mt. Cook snow pillow (report 9)

- Redfish Creek near Kootenay River snow pillow (report 8)
- Sinclair Pass snow course (report 1)

No changes to stations located in the United States were referred to the Committee.

Appendix E reports on the status of the station changes. Specifically, the appendix provides the following details:

- Description of the station
- Measurement frequency
- Associated operating and funding agencies
- The station's use in planning studies
- Description of the proposed change in operation
- Correspondence log
- Action taken by the Entities
- Resolution

Communication Systems

In the 1980 Committee Document, the CARTHMC provided a plan for communicating the exchange of data. The communications system described how data from BC Hydro, USACE, BPA, NWRFC, NRCS, USBR and data from other automated and non-automated hydrometeorological networks were interfaced with CROHMS.

In the past 5 to 10 years, the nature of communications has changed significantly. The CBT system, operated by the USACE in Portland, is the primary communications system for the Columbia River Treaty

hydrometeorological network. The CBT system receives data directly from both USACE and USBR projects and consolidates data collected by other agencies into CROHMS.

CROHMS

CROHMS is the central system for the collection and redistribution of hydrometeorological data used in support of the operations of the Treaty projects. CROHMS computers and databases reside in Portland, Oregon, and are maintained and operated by the USACE. A number of agencies, including BC Hydro, BPA, the NWSRFC and the NRCS, exchange data with CROHMS.

CBT

The USACE also operates the CBT system. CBT is one of several major subsystems of CROHMS. The CBT system provides the primary communications system between the hydropower projects and the operating agencies. The CBT system directly receives data from both the USACE and the USBR projects and consolidates project data collected by other agencies. The following is a list of the current “members” of the CBT system:

- Avista Corporation, Spokane, WA
- BC Hydro, Vancouver, B.C.
- Bonneville Power Administration, Portland, OR and Vancouver, WA
- Controlled Area Scheduling Service, Spokane, WA
- Eugene Water and Electric Board, Eugene, OR
- PacifiCorp, Portland, OR
- Portland General Electric, Portland, OR
- PP&L Montana, Butte, MT
- Public Utility District No. 1 of Chelan County, WA

- Public Utility District No. 1 of Douglas County, WA
- Public Utility District No. 1 of Pend Oreille County, Newport, WA
- Public Utility District No. 2 of Grant County, WA
- Puget Sound Energy, Redmond, WA
- Seattle City Light, Seattle, WA
- Tacoma Power and Light, Tacoma, WA
- USACE, Portland, OR, Seattle & Walla Walla, WA
- USBR, Boise, ID

Typically, data collection agencies transmit hourly data from their respective systems to the CBT system in one of two ways. Data are transmitted either via the CBT web page (HTTP/HTTPS protocols) or direct file transfer (FTP protocol). Specifically;

- BPA, NWRFC, and USBR have direct private circuits to the USACE in Portland to transmit data for the Grand Coulee and Hungry Horse projects. They may use the Internet as an alternative circuit.
- BC Hydro uses the Internet as its primary telecommunications circuit. Data from Canadian locations are first retrieved through a DOMSAT satellite downlink and are then forwarded to CBT via the Internet.

Data collection agencies are also provided with dial-up accounts to the USACE. These accounts allow access the CBT system over standard public telephone circuits in the event that the private circuits and the Internet are unavailable. Information posted to the CBT web pages for retrieval by the CBT community is accessible only through secure, encrypted transmissions. Public access to the CBT system is not permitted.

The CBT system operates much like an Email server. Each arriving message is coded with a list of addressees targeted to receive the message. The content of

the message is a text field containing the data coded in “CBT Format”, a convention adapted and used by the operating agencies across the Pacific Northwest since 1957. The CBT computer in Portland re-posts each message to the appropriate CBT web page of each agency. It simultaneously forwards the data to CROHMS and to BPA’s RODS system.

OTHER COMMUNICATIONS SYSTEMS

Other communications systems and networks transmit data into CROHMS. The NRCS transmits data from SNOTEL stations to the NWRFC in Portland. The NWRFC then forwards these data to the USACE’s CROHMS system.

Streamflow data for sites in the United States are retrieved from the USACE’s DOMSAT satellite downlink and input directly to the CROHMS system.

Some data collection agency or other data sources have expanded their communications systems to include Web pages, anonymous FTP, and NOAA Port satellite downlinks to supplement communication through the traditional CBT and CROHMS systems.

Data Exchange

Data exchanged among operational projects and entity agencies may be categorized according to the type of data and the frequency of transmission. Types of data include project data, weather and streamflow data, forecasts, as well as reports and messages. The frequencies of transmission may be hourly, daily, or monthly. The following sections summarize data exchange categories.

HOURLY PROJECT DATA REPORTS

These reports include hourly project data for the following hydropower projects:

- Libby
- Albeni Falls
- Grand Coulee
- Hungry Horse
- Dworshak
- The Dalles

The CBT system is used to send the following data to CROHMS each hour.

- Inflow
- Outflow
- Spillway flow
- Reservoir and tailwater elevations
- Generation

DAILY PROJECT DATA REPORTS

Daily project data reports are sent to CROHMS just after midnight using the CBT system. The reports include project data for the following hydropower projects:

- Libby
- Albeni Falls
- Grand Coulee
- Hungry Horse
- Dworshak
- The Dalles

Reports include the following data:

- Instantaneous and daily average inflow
- Daily average outflow
- Daily average spillway flow
- Day-end reservoir and tailwater elevations
- Daily total generation data

METEOROLOGICAL DATA REPORTS

- Meteorological data reports, sent to CROHMS by mid-morning each day, typically include the following:
- Maximum daily temperature
- Minimum daily temperature
- Instantaneous temperature
- Incremental or accumulated precipitation

Weather data from hydropower projects and Canadian stations are sent to CBT. Alberta Environment sends precipitation data for one station directly to the USACE via Email. Weather data for other stations in the United States are collected by the NWRFC and transferred to the USACE using FTP over a dedicated circuit.

SNOW DATA REPORTS

Daily SNOTEL data and monthly snow course data for United States stations are collected by the NRCS and transmitted to the NWRFC.

The NWRFC pulls snow pillow data for Canadian sites from British Columbia's MSRM web site. The USACE accesses snow data directly through its circuit to the NWRFC.

RESERVOIR CONTROL CENTER MESSAGES

Operational messages and instructions for project operations are sent out to the projects from the USACE Reservoir Control Center throughout the day or night as needed. Daily flow forecasts submitted by the NWRFC are also included. These messages are distributed using the CBT system.

BPA MESSAGES

Dedicated circuits between USACE and BPA use FTP to send and receive BPA messages on the CBT. Messages include:

- Operational messages
- Generation schedules
- Grand Coulee forecasts
- PNCA Entitlements

WATER SUPPLY FORECASTS

Volume runoff forecasts are exchanged by email and posted to the web sites of the originating agencies for review and coordination with other Treaty participants.

Other Operational Issues

Environment Canada Climate Network: In the coming operating year, EC is proposing to reduce the size of its regional climate stations that it is committed to operate to a much smaller network of 50 Regional Climate Stations for Pacific Region. Based on current funding and staff level, EC will not actively decommission the non-RCS stations. However if funding problems or observer issues arise at non-RCS, the station will be discontinued.

If a non-RCS station is to be discontinued and it is on BC Hydro's required station list, EC will alert BC Hydro. The normal CARTHMC referral process will go into effect.

NWSRFS calibrations: The NWRFC continued its calibration of basins for the new NWSRFS hydrological model. NWRFC and BPA intend to replace natural flow portion of SSARR with the NWRFC. However, the transition to the NWSFRS for operational purposes for the Columbia River Basin is not expected to occur until the spring of 2002.

US statistical forecasting procedures: The NWRFC began efforts to develop new statistical water supply equations for the Columbia Basin based on principal component methodology. The NWRFC expects to be completed by 2003.

US communications: During 2001, the communication of Treat data shifted to an Internet-based method.

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Appendix A Introduction to the Committee Terms of Reference

The Columbia Treaty between Canada and the United States of America relating to cooperative development of water resources of the Columbia River Basin was jointly signed by the heads of the respective Governments on January 17, 1961. Final ratification of the Treaty occurred when Canada Ratified the Treaty on September 16, 1964.

Article XIV, Arrangements for Implementation contains:

2. In addition to the powers and duties dealt with specifically elsewhere in the Treaty, the powers and duties of the entities include:
 - e. The establishment and operation of a hydrometeorological system as required by Annex A,

Annex A, Principles of Operation states:

2. A hydrometeorological system, including snow courses, precipitation stations and streamflow gauges will be established and operated, as mutually agreed by the entities

and in consultation with the Permanent Engineering Board, for use in establishing data for detailed programming of flood control and power operations. Hydrometeorological information will be made available to the entities in both countries for immediate and continuing use in flood control and power operations.

In March of 1965, an International Task Force on Hydrometeorological Network, Columbia River Treaty was appointed to recommend establishment and operation of the Hydrometeorological Network and procedures for exchange of information between the two Entities. Each of the Entities was guided by the following instructions:

- A In collaboration with the respective Section of the task force, participate in the following activities:
 - 1 Recommend additions to the present hydrometeorological network to provide information essential to the operation of the Treaty storage to achieve the benefits contemplated by the Treaty which will:
 - a Provide current data on reservoir and streamflow conditions.
 - b. Provide sufficient information for forecasting streamflow on a long-range (seasonal), medium range (10 days to a month or two), and short-range (up to 10 days) basis to meet the operational criteria of each project.

- 2 Recommend establishment and operation of a communication system for timely reporting of all hydrometeorological factors to meet operational and forecasting requirements.

This system should utilize existing facilities where possible, and new facilities should be recommended where needed.

- 3 Review the network from time to time and recommend additions to or deletions from facilities to ensure peak network efficiency.
- 4 Prepare reports and recommendations to the entities from time to time as appropriate.

B. In addition, the Entities shall be responsible for the following:

- 1 Prepare such interim or supplemental reports as may be needed to adequately inform the Entities on significant developments, alternative considerations, and progress.
- 2 Coordinate activities as needed with the other task forces.
- 3 In developing the required network facilities, seek technical advice and obtain technical assistance, as necessary, from Canadian and other United States Agencies such as the Geological Survey, Soil Conservation Service, and the National Weather Service as well as within your own agencies, B.C. Hydro and Power Authority, the Bonneville Power Administration, and the Corps of Engineers.

- 4 Provide the Entities with copies of all correspondence, reports and drafts of reports, minutes of meetings, and distribution of all material.

The International Task Force was in operation from 1965 through September 19, 1968. During this period, recommendations were prepared and subsequently adopted by the Entities with the concurrence of the Permanent Engineering Board. These recommendations established the basic hydrometeorological network of stations required by the Entities under the Treaty to provide data necessary for the operation of the Treaty projects. These were termed “Treaty Facilities.”

The Entities agreed on October 23, 1967, to a definition for other hydrometeorological stations and communications not considered elements of the Treaty hydromet system but necessary for operational forecasting for the Columbia River. These were termed “Supporting Facilities.”

On September 19, 1968, the United States and Canadian Entities agreed to abolish the Task Force. The Hydrometeorological Committee was established at the same time. The terms of reference that follow outline the responsibilities given to the Committee at that time.

This document will be updated from time to time as changes occur in hydrometeorological requirements or facilities listings.

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Appendix B Terms of Reference for the CRTHMC

May 20, 1968

1 - GENERAL

The Columbia River Treaty Hydrometeorological Committee will be composed of representatives of each Entity. The Committee will recommend the establishment of the Columbia River Treaty Hydrometeorological System. This system (hereinafter called "Treaty Facilities") and the Supporting Facilities thereto are defined in an agreement between the Canadian and United States Entities dated October 23, 1967, as follows:

a Treaty Facilities

- 1 The Columbia River Treaty Hydrometeorological System shall consist of new and existing streamflow and reservoir gauges, snow courses, meteorological stations, and other related hydrometeorological data-collecting facilities a plan for methods and frequency of reporting, and a

communication system to provide information for the operation of Duncan, Arrow, Mica and Libby reservoirs. It shall include hydrometeorological stations which provide operational and forecasting data relevant to the flow of the Columbia River at Birchbank, British Columbia, or at an equivalent streamflow gauge, and in addition certain key streamflow and reservoir gauges on the Columbia River downstream from Birchbank and [certain key streamflow and reservoir gauges] on the Clark Fork - Pend Oreille tributary.

- 2 All stations included in the System will be as agreed from time to time by the Entities in consultation with the Permanent Engineering Board.
- 3 Additions to or deletions from the System will be subject to mutual agreement by the Entities with the objective of assuring continued operation of the system.

b Supporting Facilities

- 1 It is desirable to identify other hydrometeorological stations and communications, not considered as elements of the system, which provide information for operational forecasting for the Columbia River.
- 2 A list of the hydromet stations and communications referred to in (1) above will be maintained by the Entities and all elements included in the list will be identified as “supporting facilities.”

- 3 Each Entity will make reasonable effort to assure the continued operation of supporting facilities located in its own country.

c Supplemental Data

Available hydrometeorological data from any part of the Basin required by either Entity from time to time will be provided by the other Entity on request.

2 - COMPOSITION OF COMMITTEE

The Committee will be composed of a United States Section and a Canadian Section. The members of each Section will be designated by their respective Entity. One member of each Section will be formally designated as chairman of the Section.

3 - DUTIES OF THE COMMITTEE

The duties of the Committee will include the following, subject to modification and addition as may be deemed appropriate by the Entities from time to time.

i Governing Treaty Facilities:

- a Review existing hydrometeorological facilities and where necessary recommend additions and improvements in order to develop a hydrometeorological system which will:
 - 1 Provide current data on reservoir streamflow conditions.

- 2 Provide sufficient information for forecasting streamflow to determine operation of the Treaty projects.
- b Recommend establishment of communication for timely reporting of hydrometeorological information to meet operation and forecasting requirements. Existing communication facilities should be used where adequate and new facilities should be recommended where needed.
- c Recommend a plan for methods and frequency of reporting.
- d Review the system from time to time and recommend additions or deletions of Treaty Facilities and to insure peak network efficiency.

ii Governing Supporting Facilities:

Recommend other existing hydrometeorological stations and communications not considered as Treaty Facilities for inclusion by the Entities in a list of "Supporting Facilities."

- iii Prepare annual reports reviewing the Committee's activities for the preceding year and such other reports and recommendations to the entities from time to time as appropriate.
- iv In the event of any substantial disagreement between the United States Section, the Chairmen of the Canadian and United States Sections will immediately refer the matter to the respective Entities through the Manager, Canadian Entity

Services and the Staff Coordinators for instructions.

- v Consult, and coordinate its work, with the Columbia River Treaty Operating Committee.

In addition, each Section will be responsible to its respective Entity for the following:

- a Prepare such interim or supplemental reports as may be needed to keep the appropriate Entity informed on significant developments, alternative considerations, progress, and operation of the Treaty Facilities and Supporting Facilities.
- b Coordinate activities as needed with the appropriate Section of other Columbia River Treaty committees.
- c In determining and reviewing the required Treaty Facilities and Supporting Facilities, seek technical assistance as necessary from other agencies in the appropriate country.
- d Provide the appropriate Entity with copies of all correspondence, reports, and drafts or reports, minutes of meetings, and the distribution of all material.

COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

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Appendix C Hydrometeorological data networks

Most hydrometeorological data required for the operation of the Columbia River Treaty are collected by various federal, provincial, and state agencies. Data collection agencies include:

- Alberta Environment
- BC Ministry of Environment, Lands, and Parks
- Environment Canada
- US Army Corps of Engineers
- US Bureau of Reclamation
- US Geological Survey
- US National Weather Service River Forecast Center
- US Natural Resources Conservation Service
- Water Survey of Canada

Several electric utilities also collect and provide hydrometeorological information.

- Avista
- BC Hydro
- Bonneville Power Administration

- CASSO Corporation
- Chelan PUD
- Douglas PUD
- Grant PUD
- Idaho Power
- Montana Power
- PacifiCorp
- Pend Oreille PUD
- PP&L Montana
- Utilicorp Networks Canada

COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

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Appendix D Models and Planning Studies

Several forecasting and operational models require the input of hydrometeorological data. These models are used to forecast seasonal water supply or daily inflows, or to plan the operation of Treaty Facilities for power production or flood control. The following sections briefly describe these models.

ASSURED OPERATING PLAN

The Entities jointly prepare an Assured Operating Plan (AOP) each year for the sixth succeeding Operating Year. For purposes of the AOP, the Operating Year is defined as August 1 to July 31. The AOP optimizes the system generation potential, with and without Treaty storage considered. The AOP also provides the Entities with essential information for effective operational planning of their respective power systems that are dependent on or coordinated with the operation of Canadian storage.

Downstream Benefit computations are prepared in conjunction with the AOP. The computations define the downstream power benefits in the United States from Canadian storage five years in advance for each year in which the Treaty is in force.

DETAILED OPERATING PLAN

Each year, the US Entity, in consultation with the Canadian Entity, performs system regulation studies to develop a Detailed Operating Plan (DOP) for Canadian Treaty storage reservoirs, the whole of Canadian Treaty storage, and for Libby reservoir. The DOP is normally developed based on the respective AOP for that operating year. Planning for the DOP begins in the fall, with the final Canadian Entity data submittal made by 01 February, prior to the start of the next August-to-July Operating Year.

ACTUAL ENERGY REGULATION

The Pacific Northwest Coordination Agreement (PNCA) was created in 1964 to coordinate the utilities and agencies controlling generating facilities in the region for the purpose of optimizing power production while fulfilling project constraints and non-power uses of the system.

The PNCA requires each party to determine their Actual Energy Capability (AEC) given their short-term operations. The party's AEC determines each party's interchange, in-lieu, or provisional storage-draft rights or obligations.

Beginning in 1977, PNCA parties decided to have the Northwest Power Pool (NWPP) use a single hydro model to simulate the coordinated hydro system to determine each parties AEC and rights and obligations. This hydro model is called the Actual Energy Regulation (AER). The AER is run at least twice a month and may be run more often at the request of a PNCA party.

The AER uses the following input to determine the desired storage operation and to specify the hydroelectric component of each party's AEC:

- planned loads
- resources

- operating criteria, including Endangered Species Act (ESA) operations
- current unregulated streamflow forecasts
- flood control rule curves
- and operating rule curves

The draft rights and obligations of the Canadian projects at Mica, Arrow, and Duncan are determined through the Treaty Storage Regulation (TSR) process and then inserted into the AER studies. While the TSR is very similar to the AER, it does not incorporate ESA operations.

TREATY STORAGE REGULATION

The Columbia River Treaty was implemented in 1964 to coordinate the operation of Canadian Columbia basin reservoirs for optimum power and flood control benefits downstream in Canada and the United States. A Detailed Operating Plan (DOP) is prepared annually according to the Treaty for this purpose.

The DOP requires a TSR study as input to determine the monthly storage rights and obligations for the Canadian reservoirs Mica, Arrow, and Duncan. The TSR also provides mid-month storage rights and obligations for the months of April and August. The TSR is similar to the AER, except that ESA-related operating constraints are not considered and hydro system power loads are estimated slightly differently. The TSR uses the following input to determine basic operating requirements for Canadian Treaty reservoirs:

- DOP operating criteria for 76 coordinated system projects in the United States and Canada
- current unregulated stream flow forecasts
- flood control curves
- refill curves

The TSR is normally run twice per month to provide the operation of Canadian reservoirs for the AER. Either of the Canadian or United States Entities may request that the TSR be run more often.

Actual operation of the Canadian Treaty storage projects is established by weekly Entity agreements that are based on the TSR end-of-month storage results, combined with supplemental operating agreements or flood control requirements. TSR operating information for Libby is provided at the weekly meeting for coordination operations on the Kootenay, but is not used for Libby's actual operation.

HYDSIM

HYDSIM is a reservoir simulation model that was developed for planning the seasonal operation of the Northwest hydropower system. The Canadian and United States Entities use HYDSIM for developing the AOP, DOP, and TSR studies carried out throughout the year. HYDSIM regulations are divided into 14 intervals during the water year; twelve monthly periods, with both April and August divided into two. Input to the model includes plant characteristics, operational data, and rule curves that guide the operation.

FLOOD CONTROL OPERATING PLAN

The FCOP was developed under provisions of the Columbia River Treaty. It prescribes criteria and procedures by which the Canadian Entity will operate Mica, Duncan, and Arrow Reservoirs. Libby Reservoir is included in the FCOP to meet the Treaty requirement to coordinate its operation for flood control protection in Canada. The operation of Treaty storage reservoirs is intended to reduce stages at all potential flood damage areas in Canada and the United States to non-damaging levels where possible. During large flood events where

flood damage can not be avoided, the plan aims to control levels to minimize damage.

The FCOP addresses both local and system flood control requirements. Local flood control relates to areas immediately downstream of project reservoirs. System flood control relates to overall system storage operations that reduce flood potential in Portland, Oregon. Flows on the Columbia River at The Dalles are used to prescribe system flood control requirements. The operation of Canadian storage for system flood control requirements is integral and has been factored into the FCOP.

The plan develops operations for the evacuation and refill phases through the winter and spring. Operational requirements for system flood control are determined through the use of reservoir storage diagrams, current operations guidance, and flood stage levels at damage centers.

The FCOP was initially developed in 1965. Changes to the Libby evacuation flood control curve were made in 1989. The USACE, Northwestern Division, North Pacific Region recently published a revised plan in October 1999, entitled "Columbia River Treaty Flood Control Operating Plan". Revisions were made in response to changes in flood control criteria and development of new evaluation procedures.

WATER SUPPLY FORECASTING

Columbia River Treaty seasonal water supply forecasts are required for two reasons. First, they are required to plan the evacuation of storage space from Treaty reservoirs for flood control purposes prior to the onset of the spring freshet (USACE, 1999). Second, they are required to plan reservoir operations to ensure a reasonable likelihood of refill following the spring freshet.

Seasonal water supply forecasts are generally made over a period of time when snowmelt runoff predominates. Common forecast periods for Treaty projects are

from the forecast date to the end of July, or to the end of September. Forecasts are made on the first of each month, usually starting January 01⁹. The last seasonal inflow forecasts are made on August 01 of each year for Canadian projects and July 01 for US projects.

Seasonal water supply forecasts are based on either statistical procedures or conceptual hydrological model simulations.

STATISTICAL PROCEDURES

Statistical procedures are usually developed using linear multiple regression techniques. Forecast water supply to a reservoir over the coming spring and summer period is regressed against a variety of predictor variables. These variables typically include data from a number of hydrometeorologic stations. Data are used to compute such predictor variables as mountain snow water equivalent and accumulated valley-bottom precipitation. In addition, such antecedent conditions as fall precipitation or winter baseflow are commonly used as predictor variables.

The most recent statistical forecasts for Mica, Arrow, and Duncan Reservoirs were developed by BC Hydro in 1997 (Luo, 1997). The USACE recently revised statistical forecast procedures for Libby Reservoir (USACE, 1999). The NWRFC in Portland, Oregon prepares water supply forecasts for sub-basins throughout the Columbia River Basin during the winter and early spring in cooperation with the NRCS, USACE, and others. Agencies rely on hydrometeorological and snow survey station data throughout the United States and Canadian portions of the

⁹ The NWRFC prepares three forecasts each month between late December and June. These forecasts include early-bird, final, and mid-month forecasts. The early-bird and mid-month forecasts use preliminary data from a subset of stations as input. Final forecasts use observed data through the end of the previous month for all stations in the forecast procedure. The USACE uses final forecasts to develop flood control operations and modify reservoir elevation targets each month. Other groups use the water supply forecasts to plan power production and irrigation needs as well.

basin. Statistical procedures produce “official” forecasts used to determine storage space evacuation from Treaty reservoirs required for flood control and refill criteria.

ENSEMBLE STREAMFLOW PREDICTION

A conceptual hydrological model may be used to forecast water supply using a procedure known as Ensemble Streamflow Prediction, or ESP. Once initial watershed conditions, such as snowpack and groundwater storage, are determined on the forecast date, historical weather data are input to the conceptual model, one year at a time, beginning each time with the current initial basin-state conditions. A series of synthetic hydrographs, as shown in figure 1, is produced. By assuming that each hydrograph simulation has an equal likelihood of occurring in the coming season, the synthetic series generated is analyzed to produce a probabilistic forecast of seasonal water supply over the coming season.

BC Hydro uses the UBC Watershed Model (UBCWM) to simulate flows required for the ESP procedure, whereas BPA and NWRFC use the NWS River Forecast System (NWSRFS). Forecasts produced using ESP techniques are generally used by utilities as input to other models to determine probable outcomes of operations on hydro generation and fisheries operations. They also provide a valuable comparison to forecasts produced using statistical procedures.

Mica ESP Inflow Forecast August 1997

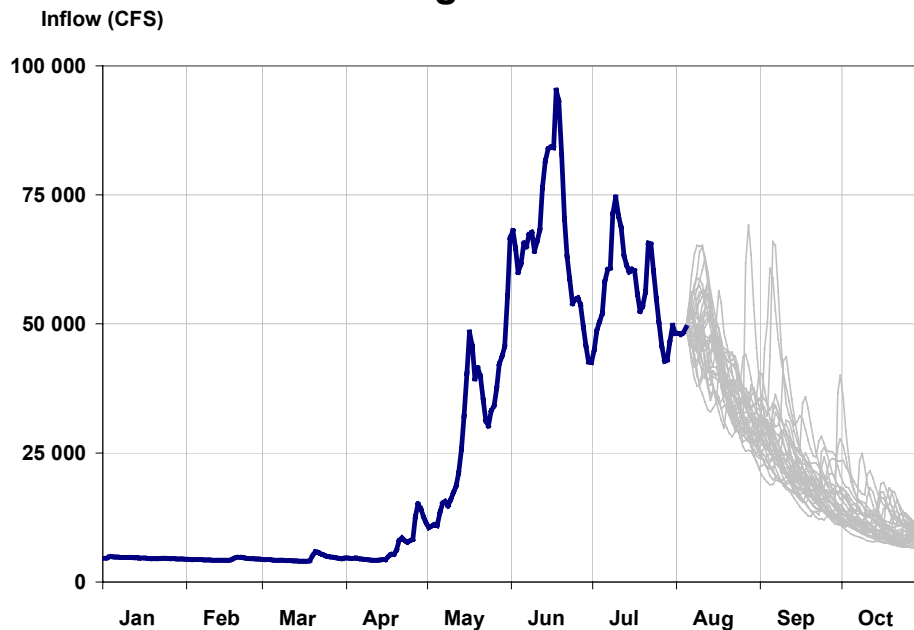


Figure 1 Series of synthetic hydrographs produced using the ESP forecasting procedure. Forecast date is 01 August in the example

The two forecasting methods have advantages and disadvantages over each other. One advantage of statistical procedures is that they are relatively easy to develop. They are also entirely objective; that is, forecasts are deterministic and consistent, regardless who prepares them. ESP forecasts produced by conceptual models may be subjective. For example, individual forecasters may adjust a model's basin state conditions differently in order to get the model to "track" observed flows to the forecast date. The subjective adjustments to basin state conditions can lead to different water supply forecasts. However, forecasts produced using conceptual models provide the best means available today for disaggregating seasonal runoff volumes into daily runoff distributions

over the forecast period. These distributions are invaluable input to operational models required for Treaty projects.

DAILY INFLOW FORECASTS

BC Hydro, BPA, and NWRFC independently produce daily inflow forecasts to assist in planning daily and weekly operations of Treaty facilities.

BC Hydro uses FLOCAST to produce daily reservoir inflow forecasts. FLOCAST was developed in-house in the mid-1970's based on algorithms of the Stanford watershed model. Such basin-state conditions as snow water equivalent and groundwater are simulated up to the day before the forecast date. Daily total precipitation, maximum temperature, and maximum freezing level are the model's forcing variables. Observed forcing variables over the past five days and quantitative precipitation, temperature, and freezing level forecasts (QPFs) over the coming five days are input to the model to forecast reservoir inflows over the combined ten-day period. At BC Hydro, hydrologists produce five-day inflow forecasts for Mica, Arrow, and Duncan Reservoirs by noon of each working day. BC Hydro plans to replace FLOCAST with the UBC Watershed Model in April 2002.

The US Entities produce independent daily forecasts for Canadian and US projects from Mica to Bonneville Dam and on the Willamette River. BPA and NWRFC recently converted from the SSARR watershed model to the NWSRFS model to produce daily reservoir inflow forecasts.

The NWSRFS is a lumped physically-based model that uses mathematical equations to represent physical processes of the hydrologic cycle. The system consists of components that model snowpack, soil moisture, time of concentration of flow, reservoir operations, and river routing. The NWRFS has been calibrated for 178 sub-basins in the Columbia River basin above The Dalles. During calibration, as many as 40 years of mean areal precipitation and temperature data were used to develop model parameters.

In operational use, observed and forecast weather data are input to the model. Precipitation and temperature data over the past 5 to 10 days are input. Hydrologists may make minor adjustments to model states and inputs to improve the simulated streamflow to better match observed flows. BPA meteorologists forecast future precipitation and temperature that hydrologists input to the model to generate streamflow forecasts. BPA produces daily forecasts in 6-hour time steps out 14 days into the future. The NWRFC varies its forecast period from 3 to 10 days, depending on the time of year and circumstances.

Hydrologists use model output as primary guidance when issuing an inflow forecast. However, forecasters often use other available information and data, as well as their own experience, to adjust model output before issuing a forecast. The USACE accepts streamflow forecasts from the NWRFC and regulates inflows to meet project objectives.

COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

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Appendix E Changes to the Hydrometeorological Network in 2001

The following pages document changes to the Columbia River Treaty Hydrometeorological Network in Operating Year 2001. Reports for Canadian stations include:

- Arrow Creek snow course (report 2)
- Beaverfoot snow course (report 7)
- Field snow course (report 3)
- Gray Creek Lower snow course (report 5)
- Gray Creek Upper snow course (report 6)
- Kicking Horse snow course (report 4)
- Mt. Cook snow pillow (report 9)
- Redfish Creek near Kootenay River snow pillow (report 8)
- Sinclair Pass snow course (report 1)

No changes were reported in 2001 for stations United States.

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 1

STATION INFORMATION			
New ☐		Existing ☒	
Station Name Sinclair Pass Snow Course			
Station ID			
DCP		SnowPillow	
AES		SnowCourse	2C01
WSC		Other (specify)	
Measurement frequency			
Mar 1, Apr 1, May1			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☒	DOP ☐
BCH	☐	☐	TSR ☐
WKP	☐	☐	FCOP ☐
AltaEnv	☐	☐	Operations ☒
Other (specify)	☐	☐	Other (specify) ☐
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV ▼		
Initiating Date	October 11, 2000		
Contact	Janis Wright		
		New addition ☐ Decommission ☒ Funding Cut ☐ Relocation ☐ Measurement Frequency ☐ Other (specify) ☐	
Summary			
MSRM/BC Gov would like to discontinue surveys at the snow course due to budget restrictions.			

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 1

CORRESPONDENCE LOG

Notify Entity

BPA ☒

USACE ☒

Date of Notification

Summary

An e-mail note was sent out by E. Weiss to N. Stephan of BPA and P. Brooks of USACE regarding the proposed changes. A reply indicated that the snow course is used in two NWS NWRFC forecast equations and it may also be required in the new NWSRFS streamflow model.

ACTIONS BY ENTITIES

No action required by entities ☐

Modify models ☐

Require other agencies to modify station ☐

Require other agencies to relocate station ☐

Pending ☐

Change measurement frequency to

Change operating agency to

Change funding agency to

Summary

An arrangement was made to have MSRM/BC Gov continue with managing the operations of the snow course and BCH cover the operational cost.

REVIEW AND APPROVAL

CRTHMC U.S. SECTION

NAME

SIGNATURE

DATE

Rudd Turner (USACE)

Nancy Stephan (BPA)

CRTHMC CANADIAN SECTION

Eric Weiss (BCH)

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 2

STATION INFORMATION			
New ☐		Existing ☒	
Station Name Arrow Creek Snow Course			
Station ID			
DCP		SnowPillow	
AES		SnowCourse	2D11
WSC		Other (specify)	
Measurement frequency 			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☒	DOP ☐
BCH	☐	☐	TSR ☐
WKP	☐	☐	FCOP ☐
AltaEnv	☐	☐	Operations ☐
Other (specify)	☐	☐	Other (specify) ☐
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV ▼		New addition ☐
Initiating Date	November 29, 2000		Decommission ☒
Contact	Dave Gooding		Funding Cut ☐
			Relocation ☐
			Measurement Frequency ☐
			Other (specify) ☐
Summary MSRM/BC Gov advised that the Arrow Creek snow course will be discontinued starting in the coming snow season.			

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 2

CORRESPONDENCE LOG		
Notify Entity BPA ☒ USACE ☒ Date of Notification January 17, 2001		
<u>Summary</u> Discontinuation of Arrow Creek snow course was discussed in CRTHMC meeting No. 47 on January 17, 2001.		
ACTIONS BY ENTITIES		
☒ No action required by entities ☐ Modify models ☐ Require other agencies to modify station ☐ Require other agencies to relocate station ☐ Pending Change measurement frequency Change operating agency to ▼ Change funding agency to ▼		
<u>Summary</u> The snow course is not used in any CRT volume forecast procedures. Both entities accepted the proposed changes.		
REVIEW AND APPROVAL		
CRTHMC U.S. SECTION		
NAME	SIGNATURE	DATE
Rudd Turner (USACE)		
Nancy Stephan (BPA)		
CRTHMC CANADIAN SECTION		
Eric Weiss (BCH)		

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 3

STATION INFORMATION			
New ☐ Existing ☒		Station Name Field Snow Course	
Station ID		SnowPillow	
DCP	AES	SnowCourse 2A03A	Other (specify)
Measurement frequency		Other (specify)	
Feb 1, Mar 1, Apr 1, May 1			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☒	DOP ☐
BCH	☐	☒	TSR ☐
WKP	☐	☐	FCOP ☐
AltaEnv	☐	☐	Operations ☐
Other (specify)	☐	☐	Other (specify)
		as a backup for data estimation	
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV ▼		New addition ☐
Initiating Date	Apr 24, 2001		Decommission ☐
Contact	Janis Wright		Funding Cut ☐
			Relocation ☐
			Measurement Frequency ☒
			Other (specify)
Summary			
BCH pays for Feb 1, Mar 1, and Apr 1 snow surveys, and MSRM/BC Gov pays for May 1. MSRM proposes to cancel May 1 snow survey due to a lesser snowpack and limited budget.			

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 3

CORRESPONDENCE LOG

Notify Entity

BPA ☒

USACE ☒

Date of Notification

Summary

E. Weiss sent an e-mail note to N. Stephan and J. Barton regarding the proposed changes.

ACTIONS BY ENTITIES

No action required by entities ☒

Modify models ☐

Require other agencies to modify station ☐

Require other agencies to relocate station ☐

Pending ☐

Change measurement frequency to

Change operating agency to

Change funding agency to

Summary

The snow course is not used in any CRT volume forecast procedures. Both entities accepted the proposed changes.

REVIEW AND APPROVAL

CRTHMC U.S. SECTION

NAME

SIGNATURE

DATE

CRTHMC CANADIAN SECTION

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 4

STATION INFORMATION			
New ☐		Existing ☒	
Station Name Kicking Horse Snow Course			
Station ID			
DCP		SnowPillow	
AES		SnowCourse	2A07
WSC		Other (specify)	
Measurement frequency			
Feb 1, Mar 1, Apr 1, May 1, May15			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☒	DOP ☐
BCH	☐	☒	TSR ☐
WKP	☐	☐	FCOP ☐
AltaEnv	☐	☐	Operations ☒
Other (specify)	☐	☐	Other (specify) ☐
		Jan 1 SWE also used for Libby forecast	
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV ▼		
Initiating Date	Apr 24, 2001		
Contact	Janis Wright		
	New addition ☐ Decommission ☐ Funding Cut ☐ Relocation ☐ Measurement Frequency ☒ Other (specify) ☐		
Summary			
BCH pays for Feb 1, Mar 1, and Apr 1 snow surveys, and MSRM/BC Gov pays for May 1&15. MSRM proposes to cancel the regular May 1&15 snow surveys due to typically lesser snowpack on the two dates and limited budget.			

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 4

CORRESPONDENCE LOG		
Notify Entity BPA ☒ USACE ☒ Date of Notification Apr 24, 2001 <u>Summary</u> E. Weiss sent an e-mail note to N. Stephan and J. Barton regarding the proposed changes. The USACE replied with no objections but would like to see Jan 1 included in the snow survey schedule as it is needed for Libby forecast.		
ACTIONS BY ENTITIES		
No action required by entities ☐ Modify models ☐ Require other agencies to modify station ☐ Require other agencies to relocate station ☐ Pending ☐ Change measurement frequency to Jan 1, Feb 1, Mar 1, Apr 1 Change operating agency to ▼ Change funding agency to ▼ <u>Summary</u> Both entities have no problems with the proposed changes to Kicking Horse snow course survey schedule by MSRM. As requested by USACE, Jan 1 will be included in the snow survey schedule starting in the 2001/02 snow season, the cost of which will be covered by BCH.		
REVIEW AND APPROVAL		
CRTHMC U.S. SECTION		
NAME	SIGNATURE	DATE
Rudd Turner (USACE)		
Nancy Stephan (BPA)		
CRTHMC CANADIAN SECTION		
Eric Weiss (BCH)		

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 5

STATION INFORMATION			
New ☐ Existing ☒			
Station Name Gray Creek Lower			
Station ID			
DCP		SnowPillow	
AES		SnowCourse	2D05
WSC		Other (specify)	
Measurement frequency			
Jan 1, Feb 1, Mar 1, Apr 1, May 1&15, Jun 1&15			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☐	DOP ☐
BCH	☐	☐	TSR ☐
WKP	☐	☒	FCOP ☐
AltaEnv	☐	☐	Operations ☒
Other (specify)	☐	☐	Other (specify) ☐
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV ▼		
Initiating Date	24 April 2001		
Contact	Janis Wright		
New addition ☐ Decommission ☐ Funding Cut ☒ Relocation ☐ Measurement Frequency ☐ Other (specify) ☐			
Summary			
West Kootenay Power (WKP) funds the snow surveys at both Gray Creek Upper (2D05) and Gray Creek Lower (2D10) considered discontinuing the funding at both sites as they don't see the direct value of the snow information from their perspective. Dan Egolf of WKP indicated snow survey information directly benefits BCH and therefore the cost should be borne by BCH.			

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 5

CORRESPONDENCE LOG

Notify Entity

BPA ☒

USACE ☒

Date of Notification

Summary

The US entity replied that the Feb 1 and Mar 1 measurements at 2D05 are crucial for their volume forecast to Kootenay Lake. BCH uses the Feb 1, Mar 1 and Apr 1 SWE at the two sites in its procedures. WKP utilizes the BCH's forecast in its routing models to provide projections of lake levels to its customers.

ACTIONS BY ENTITIES

No action required by entities ☐

Modify models ☐

Require other agencies to modify station ☐

Require other agencies to relocate station ☐

Pending ☐

Change measurement frequency to

Change operating agency to

Change funding agency to

Summary

Snow surveys at the two snow courses are reduced to 5 times per year to Jan 1, Feb 1, Mar 1, Apr 1, May 1. WKP agreed to continue covering the cost (Email note: Degolf to Eweiss, Dec 18, 2000).

REVIEW AND APPROVAL

CRTHMC U.S. SECTION

NAME

SIGNATURE

DATE

CRTHMC CANADIAN SECTION

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 6

STATION INFORMATION			
New ☐ Existing ☒			
Station Name Gray Creek Upper			
Station ID			
DCP		SnowPillow	
AES		SnowCourse	2D10
WSC		Other (specify)	
Measurement frequency			
Jan 1, Feb 1, Mar 1, Apr 1, May 1&15, Jun 1&15			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☐	DOP ☐
BCH	☐	☐	TSR ☐
WKP	☐	☒	FCOP ☐
AltaEnv	☐	☐	Operations ☒
Other (specify)	☐	☐	Other (specify) ☐
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV	New addition ☐	
Initiating Date	24 April 2001	Decommission ☐	
Contact	Janis Wright	Funding Cut ☒	
		Relocation ☐	
		Measurement Frequency ☐	
		Other (specify) ☐	
Summary			
West Kootenay Power (WKP) funds the snow surveys at both Gray Creek Upper (2D05) and Gray Creek Lower (2D10) considered discontinuing the funding at both sites as they don't see the direct value of the snow information from their perspective. Dan Egolf of WKP indicated snow survey information directly benefits BCH and therefore the cost should be borne by BCH.			

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 6

CORRESPONDENCE LOG

Notify Entity

BPA ☒

USACE ☒

Date of Notification

Summary

BCH uses the Feb 1, Mar 1 and Apr 1 SWE at both Gray Creek Upper and Gray Creek Lower snow courses in its procedures. WKP utilizes the BCH's forecast in its routing models to provide projections of lake levels to its customers.

ACTIONS BY ENTITIES

No action required by entities ☐

Modify models ☐

Require other agencies to modify station ☐

Require other agencies to relocate station ☐

Pending ☐

Change measurement frequency to

Change operating agency to

Change funding agency to

Summary

Snow surveys at the two snow courses are reduced to 5 times per year to Jan 1, Feb 1, Mar 1, Apr 1, May 1. WKP agreed to continue covering the cost (Email note: Degolf to Eweiss, Dec 18).

REVIEW AND APPROVAL

CRTHMC U.S. SECTION

NAME

SIGNATURE

DATE

CRTHMC CANADIAN SECTION

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 7

STATION INFORMATION																											
New ☐ Existing ☒		Station Name Beaverfoot Snow Course																									
Station ID DCP AES WSC		SnowPillow SnowCourse 2A11 Other (specify)																									
Measurement frequency Jan 1, Feb 1, Mar 1, Apr 1, May 1																											
AGENCY <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;"></th> <th style="width: 25%; text-align: center;">Operator</th> <th style="width: 25%; text-align: center;">Funder</th> </tr> </thead> <tbody> <tr> <td>Can Gov</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td>BC Gov</td> <td style="text-align: center;">☒</td> <td style="text-align: center;">☐</td> </tr> <tr> <td>BCH</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☒</td> </tr> <tr> <td>WKP</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td>AltaEnv</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td>Other (specify)</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td colspan="3" style="text-align: center;"> </td> </tr> </tbody> </table>			Operator	Funder	Can Gov	☐	☐	BC Gov	☒	☐	BCH	☐	☒	WKP	☐	☐	AltaEnv	☐	☐	Other (specify)	☐	☐				CRT USE AOP ☐ DOP ☐ TSR ☐ FCOP ☐ Operations ☐ Other (specify) ☒ as a backup for data estimation	
	Operator	Funder																									
Can Gov	☐	☐																									
BC Gov	☒	☐																									
BCH	☐	☒																									
WKP	☐	☐																									
AltaEnv	☐	☐																									
Other (specify)	☐	☐																									
SUGGESTED CHANGES																											
Initiating Agency MSRM/BC GOV		New addition ☐ Decommission ☐ Funding Cut ☐ Relocation ☒ Measurement Frequency ☐ Other (specify)																									
Initiating Date May 09, 2001																											
Contact Janis Wright																											
Summary The snow course has been severely encroached upon and damaged by road construction. According to Surveyors' Feb 1/01 field notes, a significant section of the snow course was taken out by the road construction. Four sites were totally destroyed and other site characteristics were altered with changes to topography and vegetation covers around the snow course. Based on a site visit this summer, MSRM recommends to reduce the snow course to 5 stations from the current 10 stations without significantly affecting the consistency of the data.																											

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 7

CORRESPONDENCE LOG		
Notify Entity BPA ☒ USACE ☒ Date of Notification May 11, 2001 <u>Summary</u> Notification was sent out by E. Weiss to N. Stephan and J. Barton. Reply from Kevin Berghoff of NWS NWRFC dated 22 May 2001 indicates that the station is used as a backup for estimation of missing data.		
ACTIONS BY ENTITIES		
No action required by entities ☒ Modify models ☐ Require other agencies to modify station ☐ Require other agencies to relocate station ☐ Pending ☐ Change measurement frequency to Change operating agency to ▼ Change funding agency to ▼ <u>Summary</u> The station is used by BCH and US NWS River Forecast Center as a backup for estimating missing data. Both Canadian and US entities can accept the proposed changes to the station. BCH will continue funding for this snow course.		
REVIEW AND APPROVAL		
CRTHMC U.S. SECTION		
NAME	SIGNATURE	DATE
Rudd Turner (USACE)		
Nancy Stephan (BPA)		
CRTHMC CANADIAN SECTION		
Eric Weiss (BCH)		

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 8

STATION INFORMATION																																									
New ☒ Existing ☐																																									
Station Name Redfish Creek near Kootenay River Snowpillow																																									
Station ID																																									
DCP	RFC	SnowPillow	490231BA																																						
AES		SnowCourse																																							
WSC		Other (specify)																																							
Measurement frequency Hourly data transmitted every 3 hours																																									
AGENCY <table style="width:100%; border: none;"> <tr> <td></td> <td align="center">Operator</td> <td align="center">Funder</td> </tr> <tr> <td>Can Gov</td> <td align="center">☐</td> <td align="center">☐</td> </tr> <tr> <td>BC Gov</td> <td align="center">☒</td> <td align="center">☒</td> </tr> <tr> <td>BCH</td> <td align="center">☐</td> <td align="center">☐</td> </tr> <tr> <td>WKP</td> <td align="center">☐</td> <td align="center">☐</td> </tr> <tr> <td>AltaEnv</td> <td align="center">☐</td> <td align="center">☐</td> </tr> <tr> <td>Other (specify)</td> <td align="center">☐</td> <td align="center">☐</td> </tr> <tr> <td colspan="3" style="border: 1px solid black; height: 20px; margin-top: 5px;"></td> </tr> </table>			Operator	Funder	Can Gov	☐	☐	BC Gov	☒	☒	BCH	☐	☐	WKP	☐	☐	AltaEnv	☐	☐	Other (specify)	☐	☐				CRT USE <table style="width:100%; border: none;"> <tr><td>AOP</td><td align="center">☒</td></tr> <tr><td>DOP</td><td align="center">☐</td></tr> <tr><td>TSR</td><td align="center">☐</td></tr> <tr><td>FCOP</td><td align="center">☐</td></tr> <tr><td>Operations</td><td align="center">☐</td></tr> <tr><td>Other (specify)</td><td align="center">☐</td></tr> <tr><td colspan="2" style="border: 1px solid black; height: 20px; margin-top: 5px;"></td></tr> </table>		AOP	☒	DOP	☐	TSR	☐	FCOP	☐	Operations	☐	Other (specify)	☐		
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SUGGESTED CHANGES																																									
Initiating Agency MSRM/BC GOV ▼		New addition ☒																																							
Initiating Date September 4, 2001		Decommission ☐																																							
Contact Jim Whyte		Funding Cut ☐																																							
		Relocation ☐																																							
		Measurement Frequency ☐																																							
		Other (specify) ☐																																							
<u>Summary</u> A Snowpillow was installed at the Redfish Creek climate station, 6 km North of Harrop Ferry, in the West Arm of Kootenay Lake, on Redfish Cr, for the coming 2001/02 snow season. The original climate station was established about 4 years ago for studies by BC Ministry of Forestry. The station is at elevation 2070 m.																																									

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 8

CORRESPONDENCE LOG

Notify Entity

BPA ☒

USACE ☒

Date of Notification

Summary

ACTIONS BY ENTITIES

No action required by entities ☒

Modify models ☐

Require other agencies to modify station ☐

Require other agencies to relocate station ☐

Pending ☐

Change measurement frequency to

Change operating agency to

Change funding agency to

Summary

REVIEW AND APPROVAL

CRTHMC U.S. SECTION

NAME

SIGNATURE

DATE

CRTHMC CANADIAN SECTION

Columbia River Treaty Hydrometeorological Committee Report on Hydrometeorologic Network Change

Report No. 9

STATION INFORMATION			
New ☒		Existing ☐	
Station Name Mt Cook Snowpillow at the Snow Course			
Station ID			
DCP	4901B0A0, MNC	SnowPillow	1E02P
AES		SnowCourse	1E02
WSC		Other (specify)	
Measurement frequency			
Hourly data transmitted every 3 hours			
AGENCY		CRT USE	
	Operator	Funder	
Can Gov	☐	☐	AOP ☐
BC Gov	☒	☒	DOP ☐
BCH	☐	☐	TSR ☐
WKP	☐	☐	FCOP ☐
AltaEnv	☐	☐	Operations ☐
Other (specify)	☐	☐	Other (specify)
SUGGESTED CHANGES			
Initiating Agency	MSRM/BC GOV		
Initiating Date	September 4, 2001		New addition ☒
Contact	Janis Wright		Decommission ☐
			Funding Cut ☐
			Relocation ☐
			Measurement Frequency ☐
			Other (specify)
Summary			
MSRM/BC Gov installed a snow pillow at the existing Mt Cook snow course site to start reporting in the coming snow season. They also pulled out the Gamma ray snow sensors that have been tested at this site in 99/00 and 00/01 snow seasons.			

**Columbia River Treaty Hydrometeorological Committee
Report on Hydrometeorologic Network Change**

Report No. 9

CORRESPONDENCE LOG

Notify Entity

BPA ☒

USACE ☒

Date of Notification

Summary

ACTIONS BY ENTITIES

No action required by entities ☒

Modify models ☐

Require other agencies to modify station ☐

Require other agencies to relocate station ☐

Pending ☐

Change measurement frequency to

Change operating agency to

Change funding agency to

Summary

REVIEW AND APPROVAL

CRTHMC U.S. SECTION

NAME

SIGNATURE

DATE

CRTHMC CANADIAN SECTION

COLUMBIA RIVER TREATY
HYDROMETEOROLOGICAL COMMITTEE

2001 ANNUAL REPORT

Appendix F Correspondence

Relevant correspondence in 2001 includes:

CRT Entities. 2001/06/20. Letter to PEBCOM in support of CRTHMC proposed strategy for future updates to Committee documents.

PEBCOM. 2001/10. Approval letter to CRT Entity Coordinators for CRTHMC's report entitled, 'Proposed Strategy for Future Updates of Committee Documents'

COLUMBIA RIVER TREATY ENTITIES
CANADA • UNITED STATES

Mr. Steven L. Stockton
Chairman, United States Section
Columbia River Treaty, Permanent Engineering Board
U.S. Army Corps of Engineers - CESPD
333 Market Street
San Francisco, CA 94105-2195

Mr. Daniel R. Whelan
Chairman, Canadian Section
Columbia River Treaty, Permanent Engineering Board
Natural Resources, Canada
580 Booth Street, 17th Floor
Ottawa, Ontario K1A 0E4

20 June, 2001

Gentlemen:

At the 21 February 2001 PEB/Entities meeting, chairs Nancy Stephan and Eric Weiss of the Columbia River Treaty Hydrometeorological (Hydromet) Committee presented a report entitled, "Proposed Strategy for Future Updates of Committee Documents". In summary, the Hydromet Committee proposed to:

- Consider a hydromet station as Treaty / Support if the station is used to monitor, plan, and operate Treaty projects.
- Communicate with data collection agencies each year to remind them of the Committee's desire to be informed about changes in network status associated with the Columbia River basin.
- Take steps to ensure that monitoring, planning, and operations of Treaty facilities would not be detrimentally affected by proposed changes to the hydromet network.
- Regularly review existing and proposed models used for Columbia River Treaty (CRT) planning studies and operations, to assess hydromet data requirements.
- Recommend to the Columbia River Treaty Operating Committee (CRTOC), preferred daily and seasonal forecasting models for CRT operations.
- Revise the format of future Hydromet Committee documents to:
 - Re-iterate the Committee's process for responding to proposed changes to the hydromet network.
 - Document any network changes proposed by data collection agencies and hydroelectric utilities that would potentially affect Treaty monitoring, planning, and operations.
 - Describe the committee response to any proposed changes to the network. The outcome or status of each proposed change would be documented, but **complete listings of Treaty and Support stations would no longer be provided.**
 - Describe current data communication systems.

U.S. Chairman:
Administrator and Chief Executive Officer
Bonneville Power Administration
Department of Energy
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U.S. Member:
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Canadian Chair:
Chairman of the Board
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333 Dunsmuir, Vancouver, B.C. V6C 2X8

COLUMBIA RIVER TREATY ENTITIES
CANADA • UNITED STATES

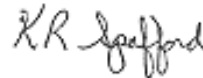
- Document data-exchange plans between the Entities, including the frequency of data measurement and communications.

The Hydromet Committee is now prepared to implement the documented proposal. If the PEB has comments, suggestions or objections to the proposal, please provide them as soon as practical. The Treaty Coordinators believe the Treaty hydromet requirements will be met by this proposal, and support its implementation for the 2001/02 hydrologic year which begins 1 October 2001.

Sincerely,



Michael B. White
Coordinator, USACE



Ken R. Spafford
Coordinator, BC Hydro



Gregory K. Delwiche
Coordinator, BPA

cc: Nancy Stephan, Chair, US Section Hydromet Committee
Eric Weiss, Chair, Canadian Section Hydromet Committee
Tony White, Secretary, US Entity
Doug Robinson, Secretary, Canadian Entity

U.S. Chairman:
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COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD
C A N A D A • U N I T E D S T A T E S

CANADIAN SECTION
D.R. WHELAN, Chairman
C. Kang, Member

UNITED STATES SECTION
S.L. STOCKTON, Chairman
R.H. Wilkerson, Member

October 9, 2001

Michael B. White
Coordinator, USACE
US Army Engineer Division,
Northwestern
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Gregory K. Delwiche
Coordinator, BPA
Bonneville Power
Administration - PG
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Portland, Oregon 97208

Gentlemen:

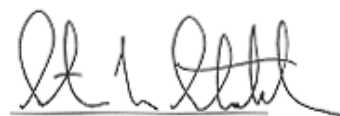
Thank you for your June 20, 2001 letter regarding the Columbia River Treaty Hydrometeorological (Hydromet) Committee's report entitled "Proposed Strategy for Future Updates of Committee Documents." This report was presented at the February 2001 PEB/Entity meeting. PEB subsequently asked the PEBCOM to review the contents of the proposal.

The Board has no objections to the implementation of this proposal as it appears the Entities will be able to ensure that they always have an appropriate mix of data, forecasting, and modeling methodologies to effectively implement the requirements of the Treaty.

As the modified procedures do represent a departure from past practice, the Board would appreciate receiving future updates (perhaps at future Board/Entities meetings and in Entities Annual Reports) on how well the new procedures are meeting expectations. As well, we look forward to receiving updated Hydromet Committee Terms of Reference in due course.

Sincerely,


Daniel R. Whelan
Chairman, Canadian Section


Steven L. Stockton
Chairman, United States Section

c.c. David Burpee, Secretary, Canadian Section PEB
Bob Bank, Secretary, United States Section PEB
Roger McLaughlin, Chairman, Canadian Section PEBCOM