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September 28, 2017

Scott Boettcher
Chehalis River Basin Flood Authority
2025 NE Kresky Avenue
Chehalis, WA 98532

Re: Annual Flood Warning System Update

Dear Scott,

The following paragraphs summarize our work maintaining and supporting operations of the Chehalis River Basin Flood Authority Flood Warning System in 2016-17.

WEST maintains the following gages: Haywire Ridge, Beeville, WF Satsop River at Cougar Smith Rd, Brooklyn, Cedar Creek, Chehalis below Thrash Creek, Newaukum-Weyerhaeuser, Riverside, Rock-Weyerhaeuser, and Skookumchuck. In addition to these gages, WEST upgraded and, on behalf of the flood authority, will assume maintenance of new equipment at Chehalis River at Centralia and Skookumchuck River at Centralia stream gages.

WEST also monitors reservoir elevations on Skookumchuck Reservoir utilizing sensors operated by TransAlta. If automated data reporting from TransAlta is interrupted, WEST coordinates with TransAlta to restore data communications.

The Chehalis River Basin Flood Warning System website is also managed by WEST Consultants.

Field Maintenance Site Access Permits

In 2017, site access permits to Weyerhaeuser lands to perform maintenance work on the Flood Warning System rainfall and stream gages located in the Chehalis River Basin expired.

- Weyerhaeuser Company – Authorized a 1-year extension to the original agreement which shall expire on August 7, 2018. (Signed by Washington Dept. of Ecology, Office of Chehalis Basin and Weyerhaeuser Company)

2016-2017 Chehalis River Basin Flooding Warning System Field Work

All gages are checked at the beginning of each week using the Contrail/OneRain website. Periodic communications with OneRain take place via phone or email to make sure alarms and notifications are working correctly and to correct any other communications issues. Gage sensor data is viewed graphically to check for problems.

October 12th – 25th 2016:

- All sites visited.
- Tip test on rain gages to USGS standards performed, funneling buckets removed and cleaned to manufacturer standards, and general inspection of equipment at all sites. End of orifice line checked at stage sites by visual inspection with purge.
- Haywire stopped transmitting. Failsafe reset.
- Reset rain gage counters for 2017 WY.
- All raw data downloaded from sites and backed up in WEST time series software.

December 14th, 2016:

- Haywire Rain gage stopped transmitting. Installed spare V2 logger/radio.

January 25th – 26th 2017:

- All sites visited except Haywire.
- Tip test on rain gages to USGS standards performed, funneling buckets removed and cleaned to manufacturer standards, and general inspection of equipment at all sites. End of orifice line checked at stage sites by physical inspection.
- All raw data downloaded from sites and backed up in WEST time series software.

April 11th – 12th 2017:

- All sites visited.
- Tip test on rain gages to USGS standards performed, funneling buckets removed and cleaned to manufacturer standards, and general inspection of equipment at all sites. End of orifice line checked at stage sites by physical inspection.
- All raw data downloaded from sites and backed up in WEST time series software.

August 17th – 4th 2017:

- Visited Beeville, WF Satsop and Riverside gages
- Installed V2 radios at Beeville and WF Satsop.
- Installed spare V1 radio (WEST owned) at Riverside
- Tip test on rain gages to USGS standards performed, funneling buckets removed and cleaned to manufacturer standards, and general inspection of equipment at all sites. End of orifice lines checked at stage sites by physical inspection.
- All raw data downloaded from sites and backed up in WEST time series software.



Figure 1: Haywire gage troubleshooting in December, 2016

October 2017 (tentatively scheduled for mid-October):

- All sites will be visited and inspected. A tip test to USGS standards will be performed, funneling buckets will be removed and cleaned to manufacturer standards and end of orifice lines physical inspected, if low water.
- Calibration test will be performed at all rain gages.
- All raw data will be downloaded from sites and backed up in WEST time series software.
- Rain gage counters will be reset for 2017 WY.
- V2 radio upgrades will be performed at three gages.

NWS Gage Upgrades

WEST upgraded equipment at Chehalis River at Centralia (12025500) and Skookumchuck River at Centralia (12026600) gages previously installed and operated by the National Weather Service. The equipment upgrades were performed in August and September of 2017 and included new data loggers, GOES telemetry, solar panels, new equipment enclosures, bubbler and radar water level sensors, and GPS and GOES antennas. WEST will make routine visits to the gaging stations to ensure equipment is measuring and transmitting accurate data, and to troubleshoot any problems that may arise.

Chehalis River Authority Flood Warning Website: Contrail

- The website was continuously monitored throughout the year.
- Periodic website software upgrades were monitored and verified.
- Alarms were managed and responded to as needed.
- Information sheets for outreach activities were updated.

Several highwater events occurred during the 2016-17 wet season largely due to the extraordinary number of atmospheric river events that made landfall along the west coast of the US during the season as shown in Figure 2. Figure 3 shows the graph of river stages on the Chehalis River near Grand Mound. The many river rises and falls during the winter were in response to the large number of atmospheric river events. Flood stage was exceeded in late November 2016 and moderate flood stages were reached in early February 2017. Fortunately, most of the atmospheric river events moved through fairly quickly and the region avoided a major flood event.

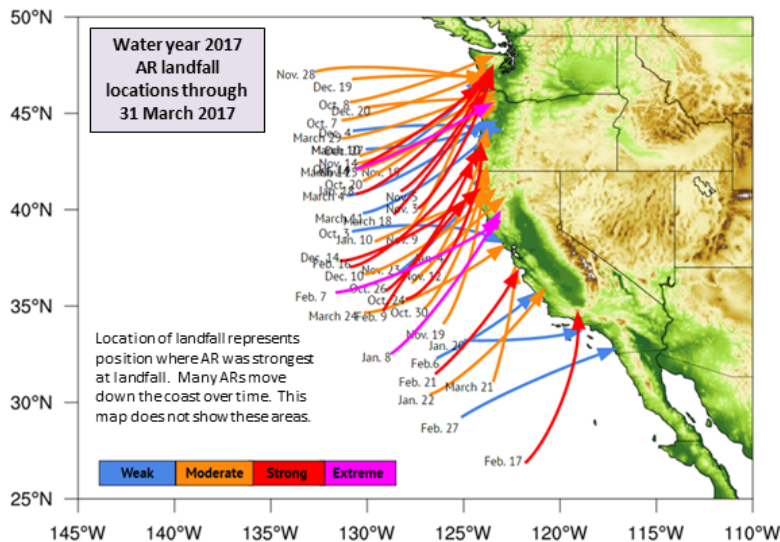
Distribution of Landfalling Atmospheric Rivers on the U.S. West Coast (From 1 Oct 2016 to 31 March 2017)

AR Strength	AR Count*
Weak	11
Moderate	20
Strong	12
Extreme	3

Ralph/CW3E AR Strength Scale	
■ Weak	IVT=250–500 kg m ⁻¹ s ⁻¹
■ Moderate	IVT=500–750 kg m ⁻¹ s ⁻¹
■ Strong	IVT=750–1000 kg m ⁻¹ s ⁻¹
■ Extreme	IVT>1000 kg m ⁻¹ s ⁻¹

*Radiosondes at Bodega Bay, CA indicated the 10–11 Jan AR was strong (noted as moderate based on GFS analysis data) and 7–8 Feb AR was extreme (noted as strong)

- 45 Atmospheric Rivers have made landfall on the West Coast thus far during the 2017 water year (1 Oct. – 31 March 2017)
- This is much greater than normal
- 1/3 of the landfalling ARs have been “strong” or “extreme”



Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY
AT UC SAN DIEGO

By F.M. Ralph, B. Kawzenuk, C. Hecht, J. Kalansky

Experimental

Figure 2: Landfalling Atmospheric River Events

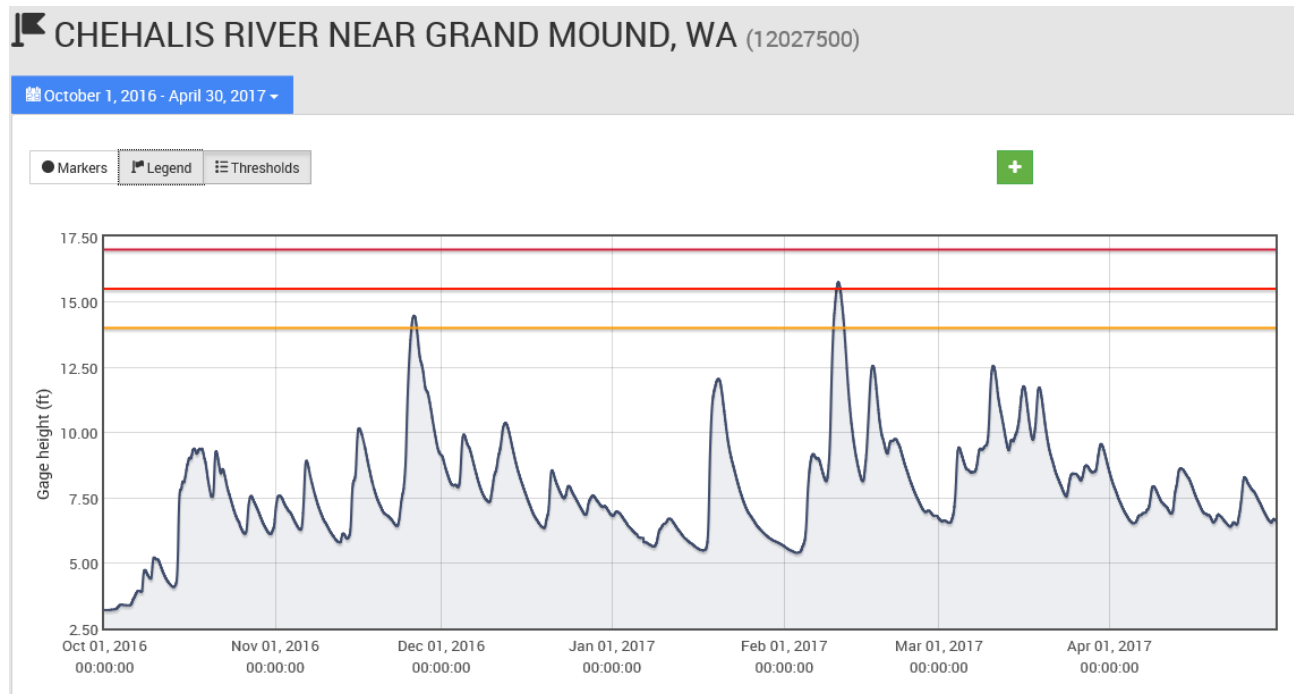


Figure 3: River Stages at the Chehalis River Near Grand Mound, WA

The Flood Authority’s Conrail website has the ability to automatically send alarms and alerts via text or email triggered by observed data. Since the website’s inception, high water alerts have been available as a test to approximately 40 individuals closely associated with the Authority. At the beginning of the 2015-16 wet season, the opportunity to receive high water alerts for selected river elevations was opened to the general public. The program has been very well received. Figure 4 shows the distribution of the current 951 highwater alert requests from 167 different individuals. (Some individuals requested alerts to home and work email addresses and many individuals requested alerts from multiple sites.)

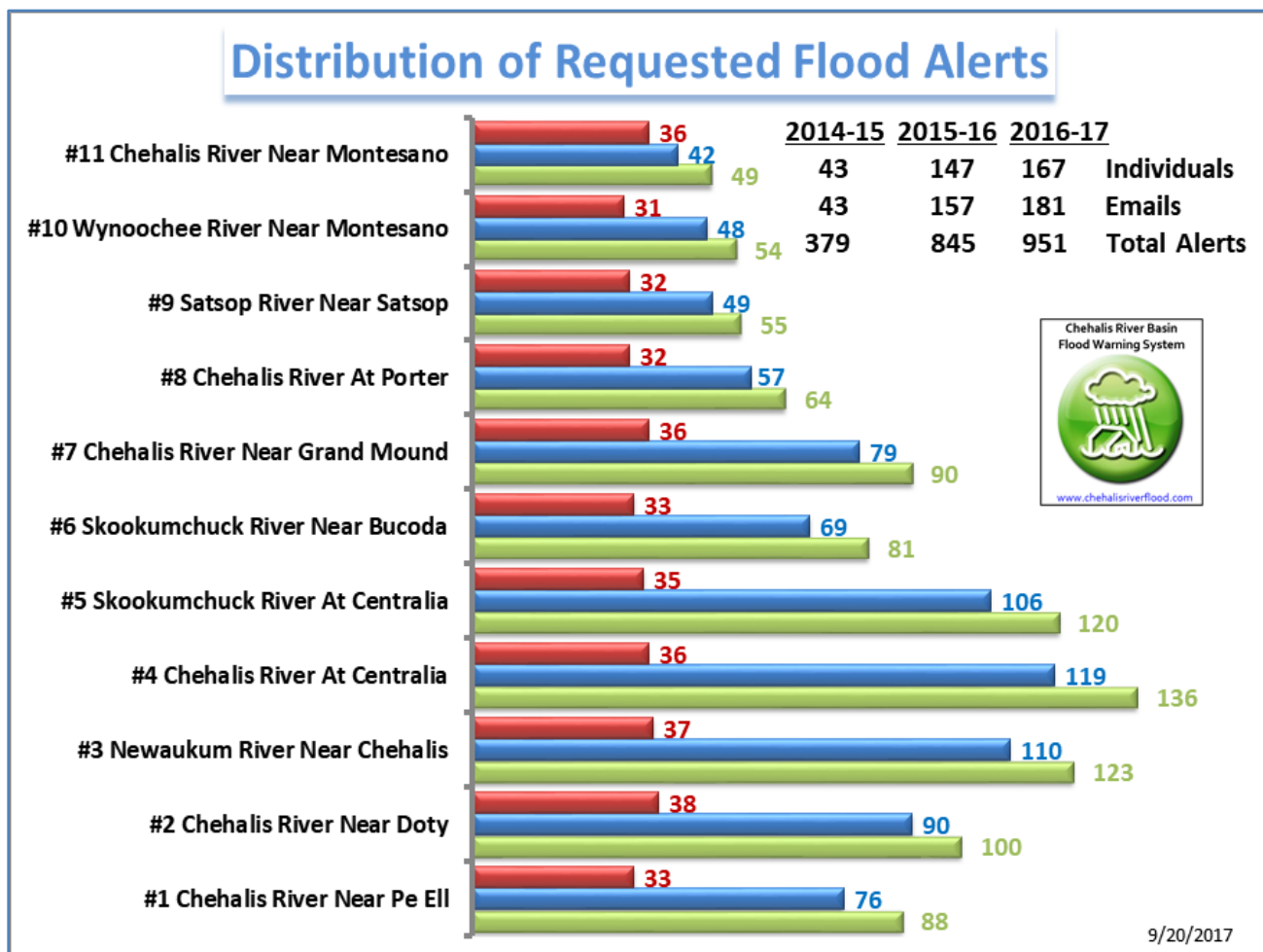


Figure 4: Chehalis River Flood Warning System High Water Alerts

In 2017, the Flood Authority commissioned a study to take inventory of all hydrometeorological sensors available in and near the Chehalis River Basin. In total the study discovered more than 4800 sensors in the region with more than 600 sensors available to supplement the approximately 160 sensors in the current Conrail database.

The study also reviewed current stream gage elevation datums and made recommendations to upgrade existing datums to the more accurate NAV88 datum standard. The conversion is intended to reduce confusion between datums used for maps created by various agencies and used by emergency responders and the public.

Stage rating curves relating stream flow to river water surface elevations were evaluated at two National Weather Service forecast points: the Chehalis River and Centralia and the Skookumchuck

River near Centralia. The results were forwarded to the National Weather Service River Forecast Center in Portland for further evaluation and potential incorporation into their river forecast procedures. If included, the new rating curves are expected to improve the accuracy of the forecasted river stages at these two locations.

2017-2018 Outlook

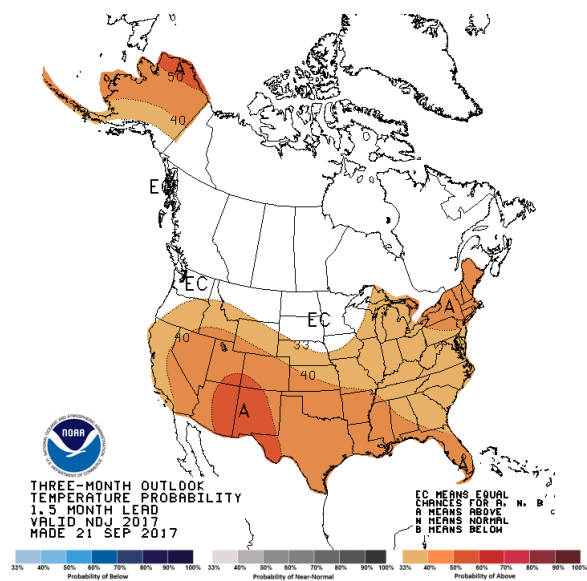


Figure 5: November, December, January Temperature Outlook

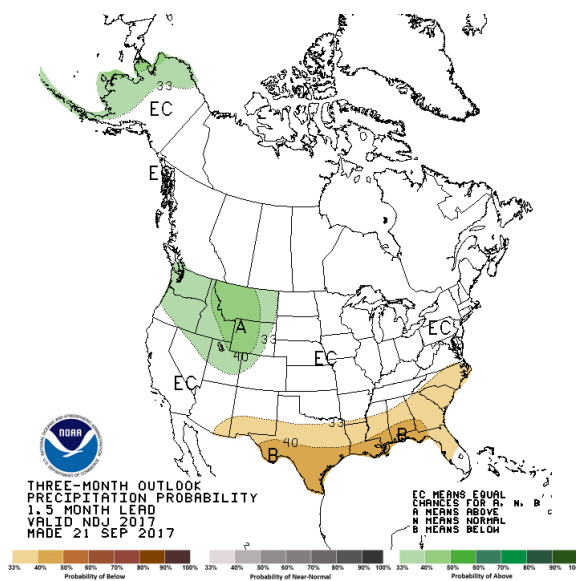


Figure 6: November, December, January Precipitation Outlook

Figure 5 and Figure 6 show the latest November-January temperature and precipitation outlooks from the NWS Climate Prediction Center. Current projections suggest a strong chance of above normal precipitation and with about normal temperature through the period.

With support from Scott Boettcher, we anticipate further community outreach to expand the high water alert program, and new additions to the website to increase flood threat awareness and utilization of the Chehalis River Authority Flood Warning System Website. If you have any questions, feel free to contact me directly.

Sincerely,

David C. Curtis, Ph.D.
Sr. Vice President

dcurtis@westconsultants.com