



## March 2018

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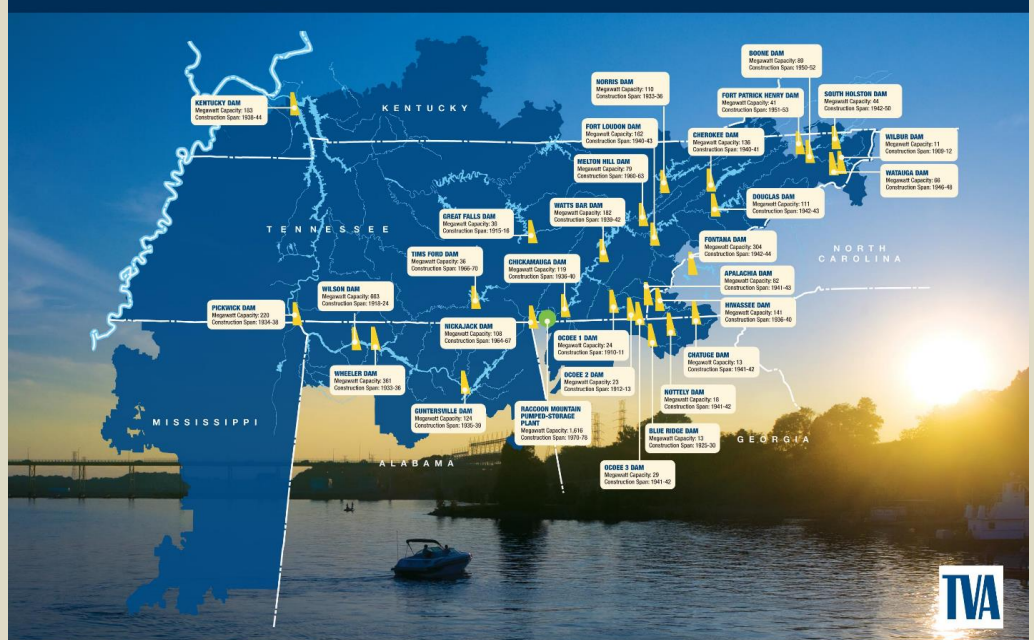


# Tennessee Valley Authority River Management

**Nathan Barber and Curtis Jawdy, Tennessee Valley Authority**

Beginning in 2013, Tennessee Valley Authority's River Management<sup>1</sup> began overhauling and modernizing its river operations and decision system. This included a new software framework, new hydrologic and hydraulic models, unification of several independent applications running in a variety of programming languages, as well as a new data reporting and dissemination system. In February of 2017, this system became operational, allowing for increased system flexibility, streamlined coordination with neighboring agencies, improved modelling, and an optimistic outlook for long-term maintenance and support.

## TVA MAJOR UNIT STATUS

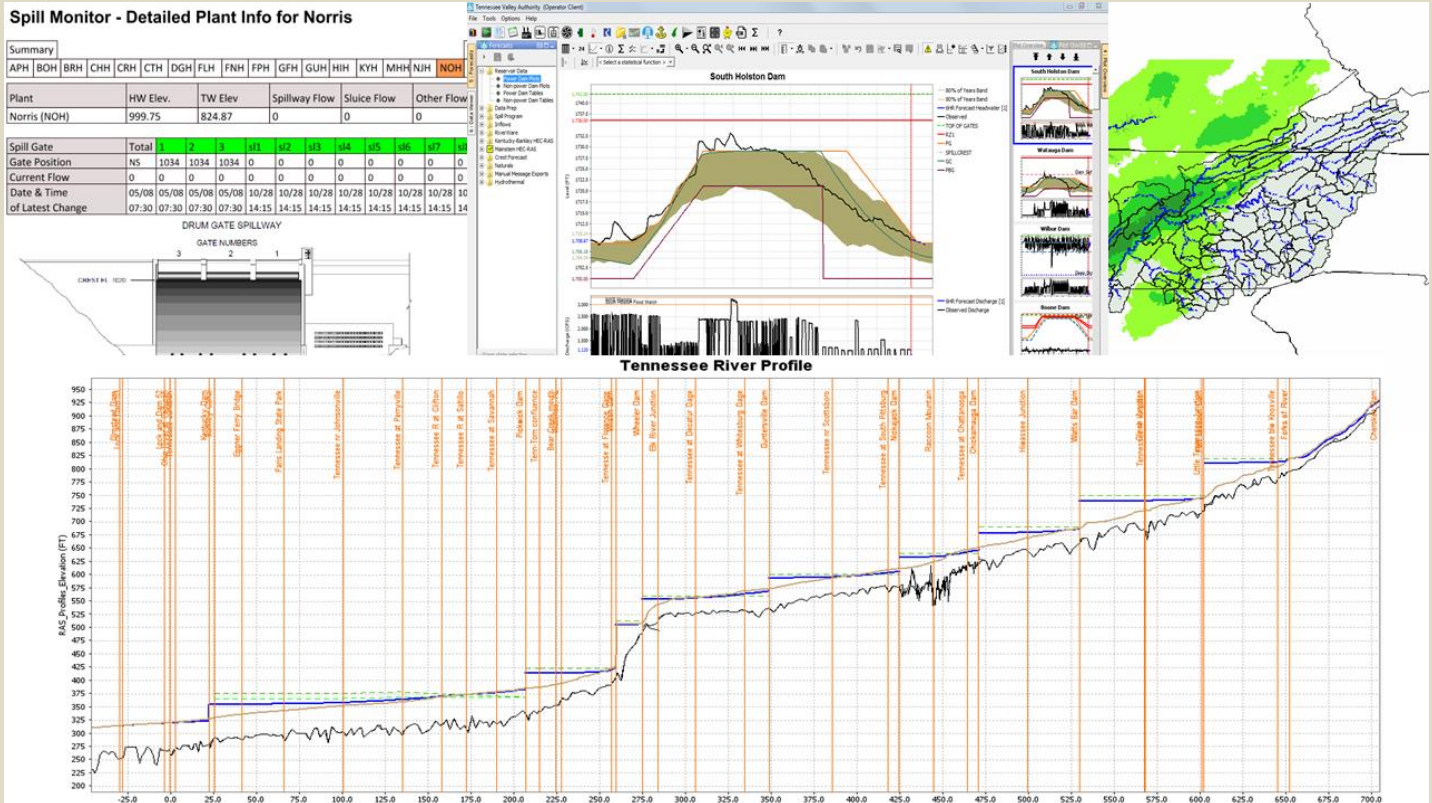


TVA owns and operates 49 dams - 29 are power-producing, 1 is a pumped-storage facility, and 5 are “non-power” but have controllable spill gates and valves. The other 14 dams provide flood control and recreational benefits. Spanning nearly 41,000 square miles and stretching from the western divide of the Appalachian Mountains to its drainage point into the Ohio river near Paducah, KY, the Tennessee River valley is a major resource and asset to the regional economy. These 30 power-producing hydroelectric facilities can provide as much as 18% of the maximum, possible power produced by all TVA generation facilities. They are one of TVA’s most important vehicles for meeting daily, power-demand peaks. While generating electricity is typically the primary factor which determines how a dam is operated, many are designated multi-use dams which serve to maintain a navigable pool for barge traffic, and provide enough flow for water use and recreation – all while meeting several environmental and nuclear requirements.

<sup>1</sup> More information about River Management can be found at:

<https://www.tva.com/Environment/Lake-Levels/How-TVA-Manages-Water-Levels>

The new framework, Delft-FEWS (Flood Early Warning System)<sup>2</sup>, is used by the National Weather Service's Office of Water Prediction (OWP), Department of Energy's Bonneville Power Administration (BPA), as well as other mission-related agencies in the United States and abroad. This active and focused community allows TVA the flexibility to continuously improve the system through shared interests. Generally, the Delft-FEWS framework allows TVA to focus on the mission-critical components such as improved modelling using a standard model adaptor. The flexibility of this "plug and play" structure alleviates the burden of changing out models in the future while simultaneously empowering TVA to stay up-to-date in the latest river modelling science.



Model and operational interfaces produced in Delft-FEWS

In conjunction with the updated framework, TVA replaced its Antecedent Precipitation Index (API) hydrologic model with the Sacramento Soil Moisture Accounting Model (SAC-SMA). This included a suite of secondary models and processes used at OWP's river forecast centers. This upgrade encourages mutual modelling improvements between the Lower Mississippi River Forecast Center (which officially forecasts for the Tennessee River Valley) as well as streamlined coordination. Operationally, it improves TVA's ability to manipulate the rainfall/runoff prior to passing this on to hydraulic and reservoir optimization models.

TVA now runs 10 HEC-RAS models including a joint USACE/TVA reservoir model most notably used to hit targets on the Ohio and Mississippi Rivers. The RAS models cover ~700 miles, from Cherokee Dam on the Holston River, to the Ohio River at Cairo, Illinois. These upgraded hydraulic models allow refined headwater forecasts at each dam, as well as improved intermediate points of interest between dams. Accompanying the operational models, TVA also invested in an improved "Naturals" RAS model which provides conditional forecasts for events without the current reservoir structures. These conditional forecasts are incorporated into a calculation which provides an estimate of flood damages averted during high flows.

Riverware<sup>3</sup>, TVA's decision model for scheduling hydropower, was also integrated into the Delft-FEWS framework as part of the project. Inflows from the OWP suite of models, as well as a plethora of

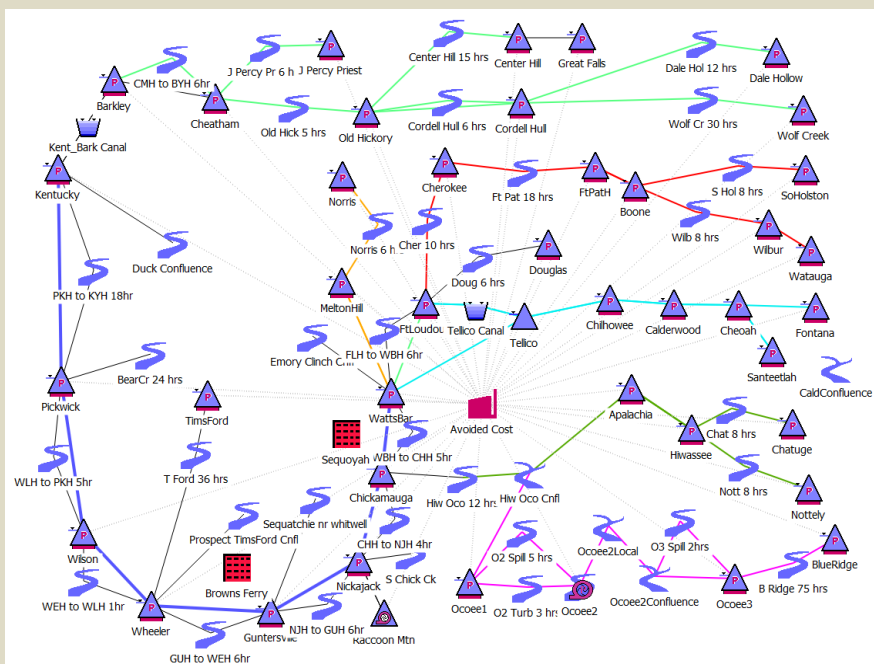
<sup>2</sup> <http://oss.deltares.nl/web/delft-fews/>

<sup>3</sup> Riverware is a river system modelling tool developed and maintained by the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) – More information can be found at <https://www.colorado.edu/cadswes/creative-works/riverware>

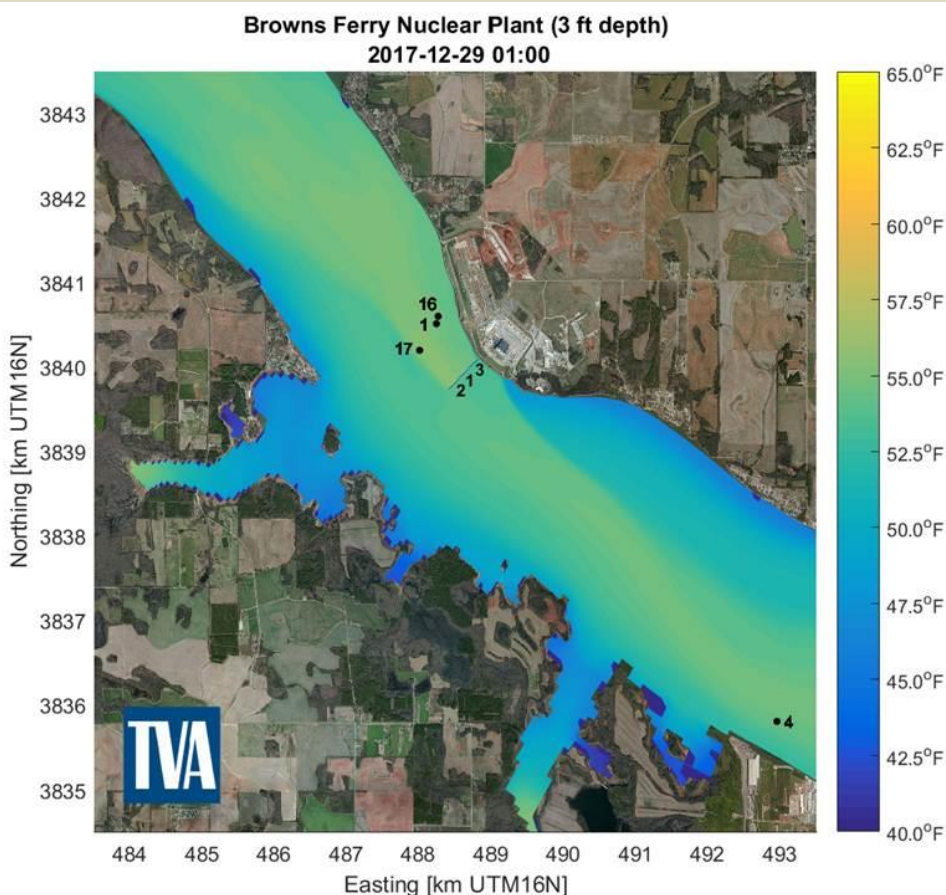


other data used in optimization, are passed into Riverware where hydropower decisions are generated. This integration increases the potential for contingency forecasts and ensemble inputs in future development.

Legacy hydrothermal models were integrated into the framework, which now bring two previously disjoint systems into alignment. This integration allows for shared datasets and inputs, a shared infrastructure, as well as the potential to further integrate hydrothermal modelling within river scheduling. While this project focused on system integration, another hydrothermal project is also near completion which focuses on improved model fidelity. Delft-3D is employed at several reaches within the bounds of nuclear plant withdrawals, where one-dimensional models are historically inadequate. These new models will piggyback off the integration with FEWS and further utilize the flexible and adaptable nature of the framework.



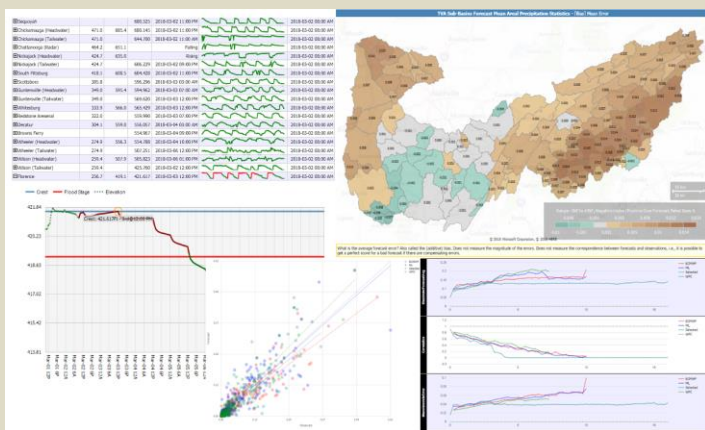
TVA's reservoir topology as modeled in Riverware



Browns Ferry Nuclear Plant water temperature modeled in Delft-3D

As an operational agency, TVA is required to continuously issue a variety of reports and messages to its constituents. TVA can send roughly 200 distinct report/message types and during high flows has sent as many as 11,000 individual updates in a single day (Many of these are scheduled updates to public media).<sup>4</sup> This project brought nearly every one of these distinct messages/ reports under the Microsoft Business Intelligence suite of tools utilizing a SQL server data warehouse, SQL Server Integration Services (SSIS), and SQL Server Report Services (SSRS). Reports are now generated, disseminated, logged, and archived under a single framework.

<sup>4</sup> 11,315 messages/reports were sent by TVA River Management's River Forecast Center on 02/27/2018



Planned verification system will include performance tracking, error assessment and intelligent forecast selection

With the river forecast system a year removed from “going live”, a variety of other projects are in the works and/or are near completion. A verification system will soon be in place, allowing for performance tracking, assessment of error, and (potentially) incorporating machine learning algorithms for forecast selection. A project to implement a more frequent, and iterative, approach to hydropower scheduling, with respect to TVA’s other power generation systems, will begin in FY2019. Flood inundation mapping within the Delft-FEWS framework is also slated to begin in FY2019. This project aims to produce real-time flood inundation maps through HEC-RAS, within Delft-FEWS, for the Mainstem Tennessee River. 🌊

## Mark Your Calendars for the 13th NHWC Conference June 17-20, 2019 in Louisville, Kentucky.



It seems like just yesterday that we were all up at High Camp, enjoying cocktails and hors d'oeuvres and overlooking the majesty of Squaw Valley. The 12th NHWC Conference in Olympic Valley, California was definitely one for the record books. Although the snow, the breathtaking views, the speaker presentations, and the networking opportunities may be fresh in our minds, planning has already begun for our 2019 Conference, which will be held June 17-20, 2019 at the Galt House in Louisville, Kentucky.

Situated along the Ohio River, Louisville is easily accessed by Interstates 64, 65, and 71, as well as by the Louisville International Airport. Known for bourbon, bats, bluegrass, and horse racing, Louisville and the surrounding area is home to numerous historic distilleries and thoroughbred farms. In Louisville you'll be able to explore the Louisville Slugger Museum & Factory, tour Churchill Downs – home of the Kentucky Derby – see the Falls of the Ohio, or take a cruise in a real old-fashioned riverboat. With its abundant restaurants, museums, and live music venues, a trip to Louisville will be fun for the whole family.

The Galt House, located at the north end of Louisville's 4th Street Entertainment District, is the only riverfront hotel in downtown Louisville. A four-star hotel, the Galt House boasts six restaurants and lounges, a salon and spa, and a rooftop fitness center to meet the needs of conference attendees and family. The center of conference activity will be the Archibald and Cochran Ballrooms, with space for up to 25 exhibitors, and six surrounding meeting rooms for breakout sessions. Also, whether you're taking a break in the exhibit hall or at the offsite social gathering, enjoying a cocktail in the hotel's conservatory lounge or the NHWC hospitality suite, or having dinner conversation at our awards dinner on the 25th floor of the Rivue Tower, the 2019 NHWC Conference will provide ample professional networking opportunities.

The theme of the 2019 Conference is “Observe, Disseminate, Respond: the Triple Crown”, integrating hydrologic warning themes with Louisville's horse racing heritage. Training and educational workshops and concurrent session tracks will be built around this central theme. The NHWC is now forming the Conference Planning Committee. Assistance will be needed to coordinate and execute all facets of the conference, including agenda design, attendee registration, social activities, and exhibitors. If you are interested in this highly rewarding experience, please contact Brad Heilwagen, 2019 NHWC Conference Chair at:

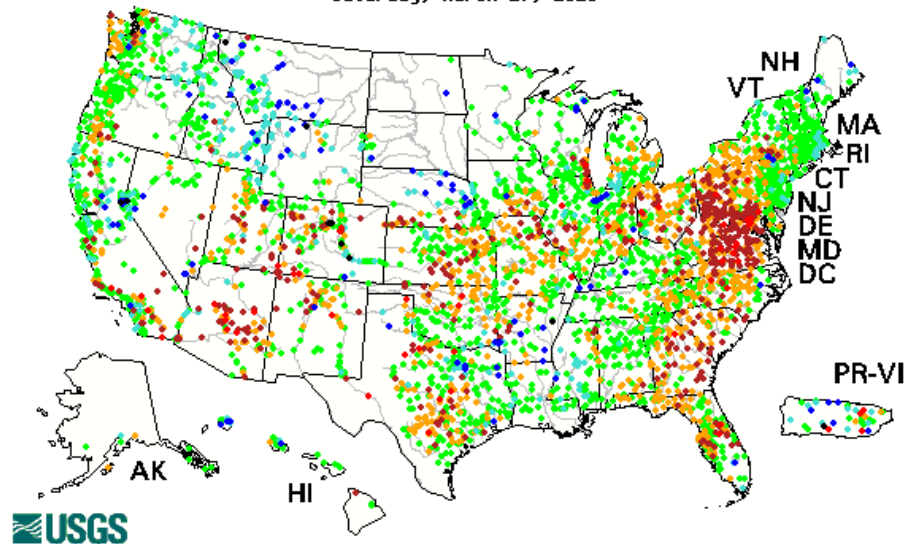
[nhwc2019conference@hydrologicwarning.org](mailto:nhwc2019conference@hydrologicwarning.org)





# Hydrologic Conditions in the United States Through March 13, 2018

Saturday, March 17, 2018

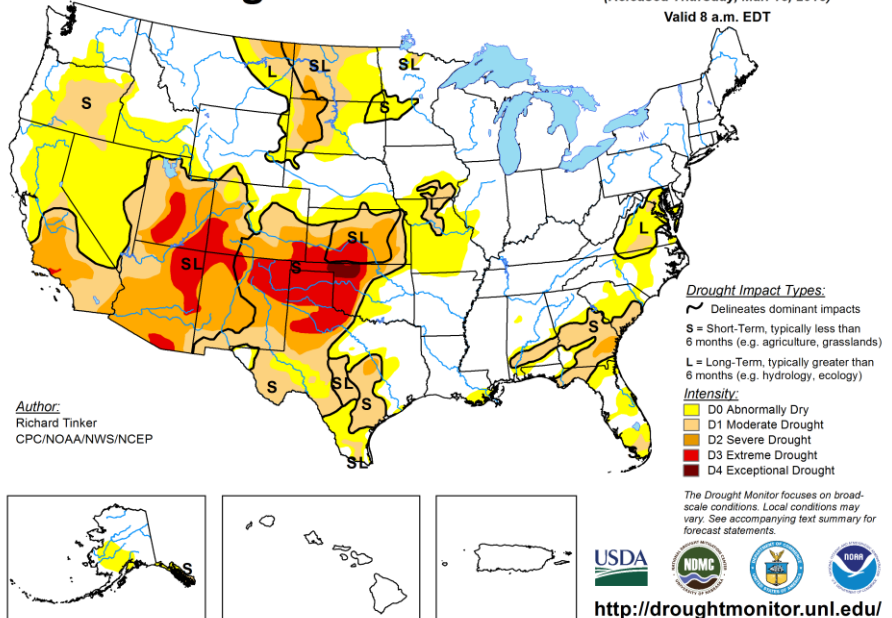


Explanation - Percentile classes						
<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="color: orange;">●</span>	<span style="color: green;">●</span>	<span style="color: cyan;">●</span>	<span style="color: blue;">●</span>	<span style="color: black;">●</span>
Low	<10	10-24	25-75	76-90	>90	High
	Much below normal	Below normal	Normal	Above normal	Much above normal	

Latest stream flow conditions in the United States. (courtesy USGS)

## U.S. Drought Monitor

March 13, 2018  
(Released Thursday, Mar. 15, 2018)  
Valid 8 a.m. EDT



Latest drought conditions in the United States.  
(courtesy National Drought Mitigation Center)

## April Newsletter Articles Focus: Hazard Communication & Public Awareness

NHWC is requesting articles that focus on getting the word out.

Please prepare an article that explains how your organization gets the right real-time data and information to the right people for the right response.

Submit your article to:

[editor@hydrologicwarning.org](mailto:editor@hydrologicwarning.org)

April 6<sup>th</sup> is the deadline for inclusion in the April issue.

## Future Newsletter Articles Focus

To give you more time to prepare articles, below is the article focus schedule for the next four months:

**Apr - Hazard  
Communication &  
Public Awareness**  
**May - Modeling/Analysis**  
**Jun - Data Collection**  
**Jul - Hydrology**

## NHWC Calendar

June 17-20, 2019 – The NHWC 13<sup>th</sup> Biennial Training Conference and Exposition, Louisville, Kentucky

## General Interest Calendar

March 29, 2018 – [Southwest Extreme Precipitation Symposium \(SWEPSYM\)](#), Scripps Seaside Forum, Scripps Institution of Oceanography, California

April 17-20, 2018 – [The ALERT User's Group Training Conference and Exposition](#), Ventura, California



June 4-7, 2018 – [2018 ASCE Environment and Water Resources Institute International Congress](#), Minneapolis, Minnesota

June 17-21, 2018 – [ASFPM 2018 Annual Conference](#), Phoenix, Arizona

(See the [event calendar](#) on the NHWC website for more information.)

## Parting Shot

USGS Stream Gage and NWS NWRFC Forecast Point  
Chehalis River at Porter, Washington, 12031000



46° 56' 22" N, 123° 18' 54" W

Photo by **David Curtis**, WEST Consultants, Inc.

## National Hydrologic Warning Council

*Providing Timely, Quality Hydrologic Information to Protect Lives,  
Property, and the Environment*

<http://www.hydrologicwarning.org>