The NHWC Transmission

November 2016

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Improving Flood Warning Lead Time Using Hydrologic Modeling

Don Colton, DataWise Environmental Monitoring
Fred Chapman, City of Petaluma, California

The City of Petaluma, California maintains a telemetered network of 19 rain gages and 19 stream gages as well as one weather station. Currently, the telemetry method uses the Legacy ALERT protocol, however a migration to ALERT2 is scheduled to begin in the spring of 2017. The system is primarily used for flood warnings for the City but historical data archiving is maintained and the data are available for download for the period of record for each gage via an externally accessible API.

Rain gage locations are shown in Figure 1 and water level stations in Figure 2. Historically, a considerable amount of flooding has occurred in northern Petaluma due to the Petaluma River overflowing its banks. As with most flood warning systems, alarms can be set on rainfall rates, water levels and water level rates of change.

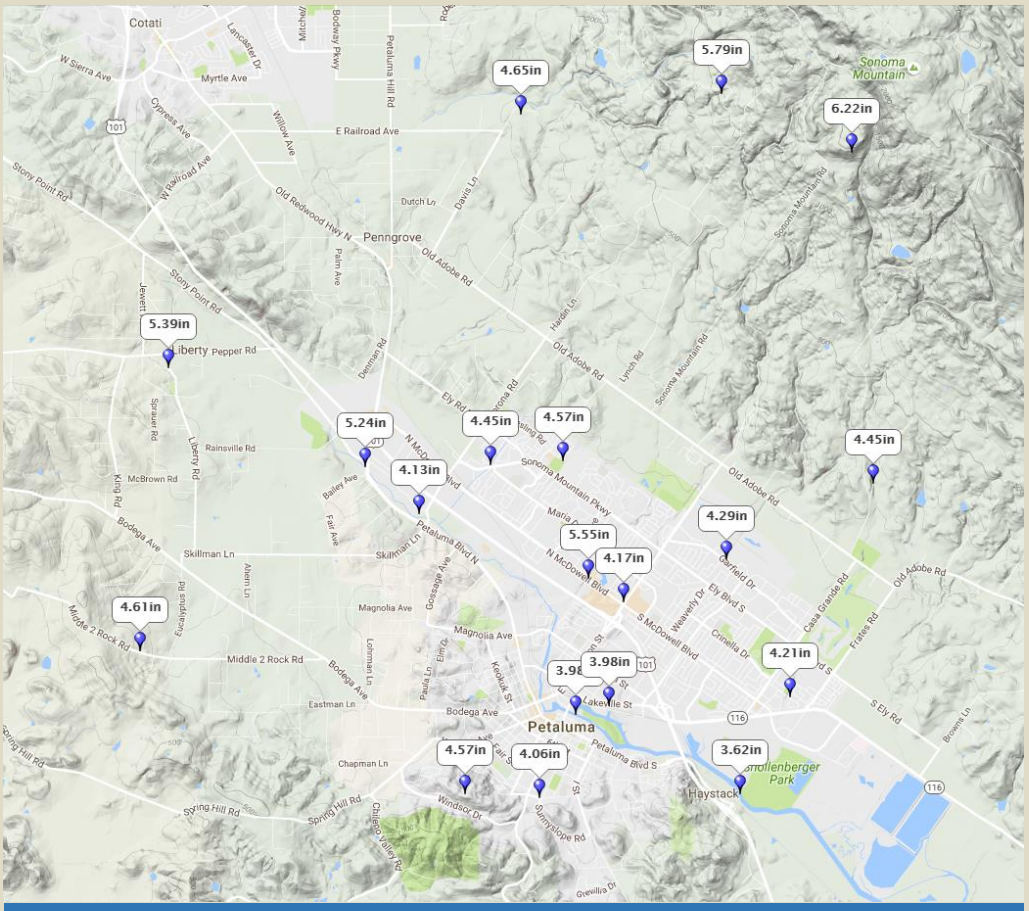


Figure 1. City of Petaluma telemetered rain gage locations. Rainfall amounts are for a recent 31 day period.

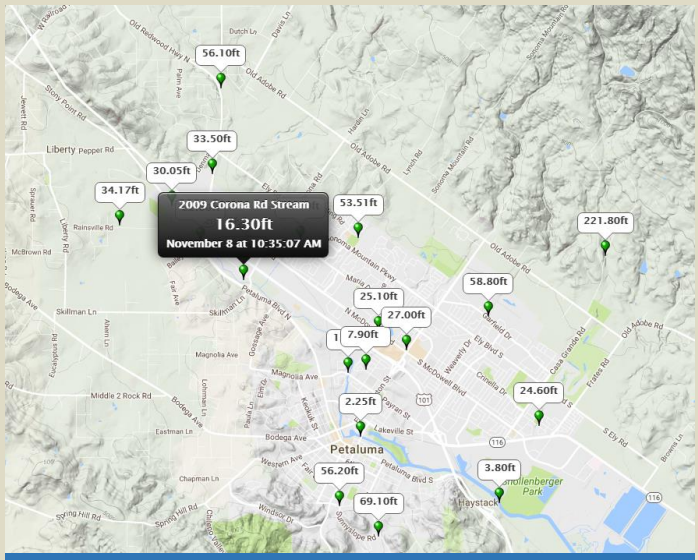


Figure 2. City of Petaluma water level stations, with the **hydrologic model forecast point** at Corona Road highlighted.

Water level alarm thresholds for the Petaluma River at Corona Road gage are shown in Table 1. Alarms are delivered via e-mail, MMS, and/or SMS messages to various recipients depending upon the alarm level.

While this has proven to be very helpful, to provide more lead time for high water event notification, the Sacramento Soil Moisture Accounting model (SSMA) has been implemented. Briefly, the SSMA computes the runoff from a watershed from observed (and "forecasted") rainfall. Implementing the SSMA required the "calibration" of the SSMA parameters from available historical data set. The initial calibration of the SSMA was performed by personnel in the California-Nevada River Forecast Center in the 1980's. Some adjustments to the model parameters have been made since then.

The Petaluma River watershed above Corona Road is close to ideal for modeling with the SSMA. It is relatively small (30.9 square miles), uncontrolled, and has a well-maintained network of rain gages. Since data are received in real-time, the SSMA model is executed frequently (every 10 minutes) with an internal time step of 10 minutes. As implemented here, the model is executed twice, once assuming no additional rainfall will occur and once using forecasted rainfall amounts. In this implementation, the forecasted rainfall amounts are produced by the NWS, automatically retrieved, and applied temporally. The output of the SSMA is a time-series (into the near future) of flow values. A ➡

Table 1. Petaluma River at Corona Road actions based upon stage

Stage (ft)	Action to Perform
22.7	Begin monitoring the situation closely.
24.9	Water crossing new path to rain gage and in parking lot behind commercial buildings.
25.2	Notify Fire Chief, Watch Commander, and Public Works & Utility Director. Evaluate need to activate the city's E.O.C.
26.7	Notify the City Manager.
27.0	At this level a flash flood warning is automatically announced by the National Oceanic and Atmospheric Administration (NOAA). This "flash flood" warning is broadcast over radio and television based on the height of water and is activated by NOAA in Monterey, California. Citizens may call in response to this broadcast. They should be advised that the water is high in the Petaluma River Basin and the areas specifically mentioned by name.
27.7	Water starts backing out of storm drain into Industrial Avenue near Corona Road.
28.2	Industrial Road flooded and should be closed.
28.6	Petaluma Boulevard north bound curb lanes flooded. Close Petaluma Boulevard at Corona Road.
31.7	Water at bridge deck height.
32.2	Water at 1986 flood level.

time-series of stage values is computed from the flow values using a rating table. Both time-series are then stored in the same database as observed data, which allows alarms to be set on the model output allowing key City employees to be notified of forecasted high water levels along with observed levels.

Additionally, the display shown in Figure 3 allows a quick view of observed and forecasted conditions. The display automatically updates when observed or forecasted conditions change.

On the display are 3 time-series plots, one for observed stage, one for the model forecasted stage with no additional rainfall, and one for the model forecasted stage using forecasted rainfall. Note that all displays are browser-based and viewable from any modern browser, including mobile devices.

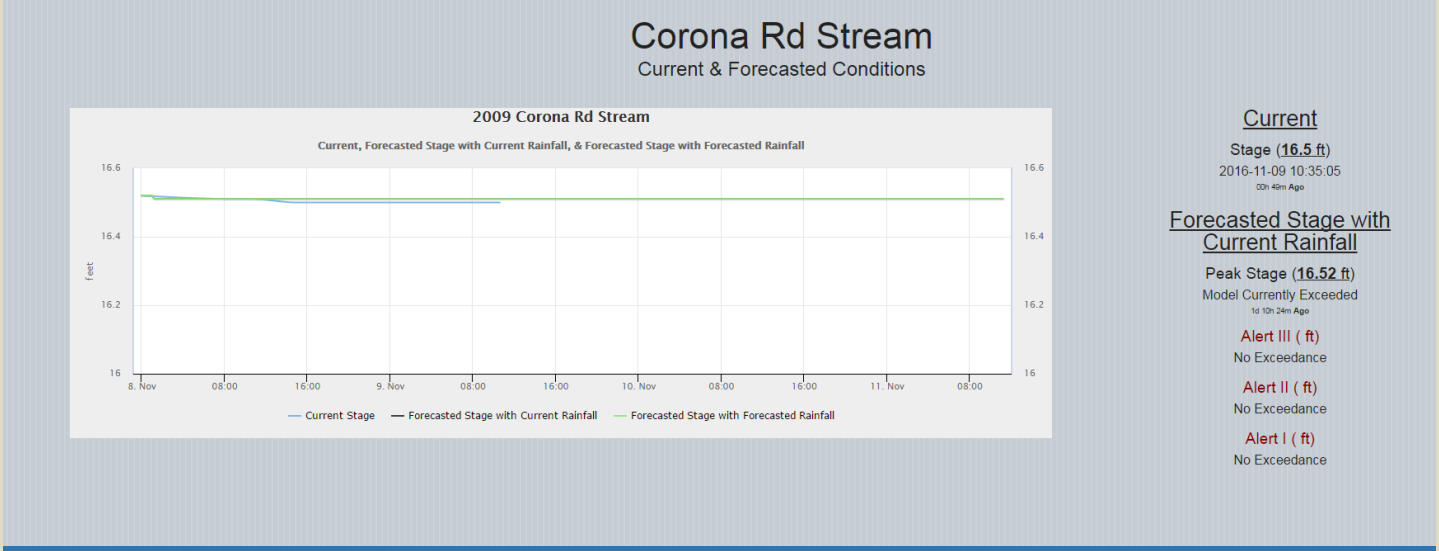


Figure 3. **Self-updating display** available to the public of forecasted water levels at Corona Road

State of ALERT2

David Haynes, Distinctive AFWS Designs, Inc.
NHWC ALERT2 TWG Chair

It has been a long time since the concept of a new and improved ALERT protocol was introduced at the San Diego NHWC Conference in 1999. After many, many hours of hard work designing, testing, and implementing, it can now be said that ALERT2 has arrived and is here to stay; providing enormous improvements in channel throughput and data quality over the forty (40) year-old ALERT protocol.

Various studies have shown that, in the ALERT world, when the number of data packets approached 2000 reports per hour a significant number of the reports were not properly received by the base station, thereby having a considerable negative impact on the overall quality of data received. With ALERT2, it is possible to have 7,200 data packet reports per hour without a single lost packet. Furthermore, the amount of information (and the resolution of the data) carried in those data packets has greatly increased. Previously a single rain gauge tip report typically consumed about 200 milliseconds (ms) of air time. In ALERT2, ten tipping bucket tips (there can be more) can be combined into a single rain report that consumes less than 300 ms rather than the two whole seconds with ALERT.

Unlike ALERT where data packet collisions (thus, data corruption) were possible and usually more frequent than most realized, the utilization of Time-Division-Multiple-Access (TDMA) in ALERT2 prevents this problem when a system is properly configured and

Old (~1988) ALERT standpipe on right, with its replacement ALERT2 installation (2016) on the left. Elkridge, MD

operating. Yes, data transmissions in ALERT2 can be interfered with but through the use of algorithms for error detection, most of the errors experienced can be autocorrected. These features alone are huge contributors to the overwhelming data quality improvements that ALERT2 users are experiencing.

Several agencies and most vendors of ALERT2 hardware and software have supplied information for this article. Its sole purpose is to show how far and wide ALERT2 is being deployed and used. Information was also gleaned from the ALERT2 Source Address Management System (SAMS) database.

Every agency is encouraged to use SAMS to register their ALERT2 addresses to prevent overlapping/conflicting address deployment. It can be found at www.alert2.org. Currently in that database, there are forty-seven registered agencies. Those agencies have registered one thousand nine hundred sixty-seven (1,967) ALERT2 source addresses. Some of those registrations are for future planned ALERT2 installations or upgrades. It is also known that there are some installed and operational ALERT2 gauging stations that have yet to be registered.

The map shows where ALERT2 base station demodulators, repeaters, and gauging stations have been registered in the SAMS database. Organizations with planned or deployed ALERT2 telemetry devices that have not been registered are encouraged to setup an account on SAMS and provide their ALERT2 station metadata.

Map 1 - ALERT2 Stations Registered in SAMS

The table below presents a summary of ALERT2 deployments in the United States. It contains an aggregate of numbers provided by individual vendors for the various items listed. Since these numbers were obtained, certainly additional units have been sold and/or deployed. Compared to the number of "registered" ALERT2 stations, users across the country are planning on buying a lot more ALERT2 units.

ALERT2 Deployments in the US to Date	
Descriptions	**Totals**
Deployed ALERT2 gauging stations	1232
Deployed ALERT2 Repeaters	77
Deployed Base Station Demodulators	41
Software Base Stations Receiving ALERT2	51
Systems in US using ALERT2	43
Systems in US that are 100% ALERT2 (no ALERT stations)	11

Because ALERT2 allows more efficient use of radio telemetry network band width than its predecessor, it is expected that this technology will be adopted for other data collection purposes that have not been envisioned to date. As its use increases and comes into contact with secure networks, the next improvement to the ALERT2 protocol and standard envisioned by the National Hydrologic Warning Council's ALERT2 Technical Working Group (the body which oversees development and management of the ALERT2 protocol) is the addition of a security layer.

Adding the security layer, something not present in the legacy ALERT protocol, will help to ensure that IT administrators will allow ALERT2 demodulators to be fully integrated into their secure network environments without compromising established security standards.

NHWC 2017 Conference

December 12th is the Deadline for Submittal of Presentation Abstracts

The National Hydrologic Warning Council (NHWC) biennial conference is being held in Olympic Valley, California from June 6 to 8, 2017. It is the largest conference of its kind in the United States, devoted specifically to real-time hydrologic warning systems and how these systems and associated technologies assist local officials with hydrologic hazard preparedness, emergency response, recovery, and mitigation.

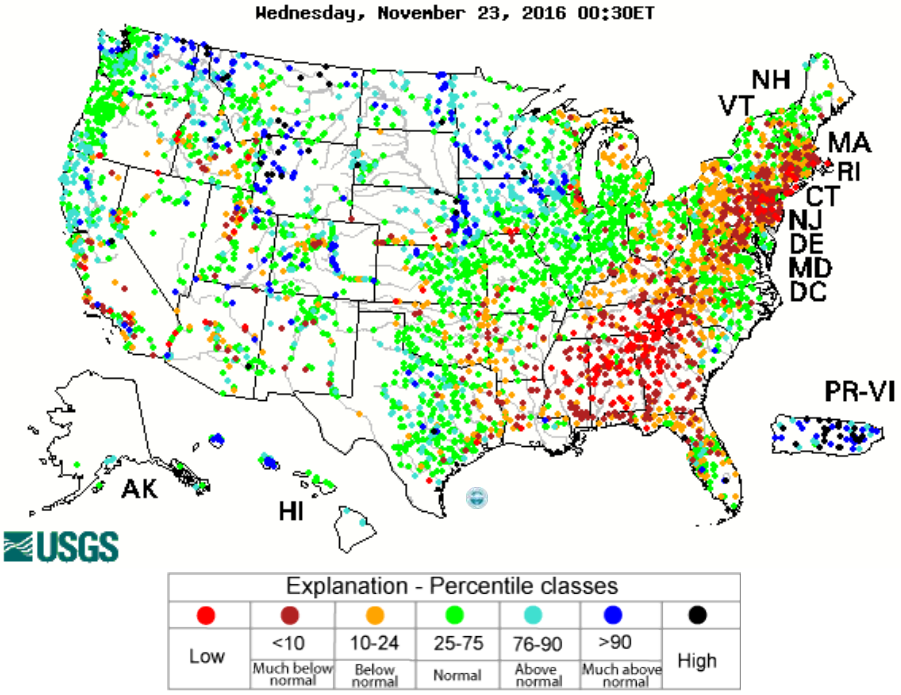
Reflecting the mountain location close to Lake Tahoe that was the site of the 1960 Winter Olympics, the theme of the 2017 conference is Taking Hydrologic Warning to Olympic Heights. The theme highlights the efforts of the hydrologic warning community in pushing boundaries to protect lives, as well as property and the environment, with advances in hydrologic warning systems. The conference provides a multi-disciplinary hydrologic warning training experience for field personnel, engineers, hydrologists, forecasters, water resource managers, emergency management officials, and others.

Become part of the conference by sharing your experiences and the advances you have been working on. Click **here** to see the full Call for Presentation Abstracts or go to

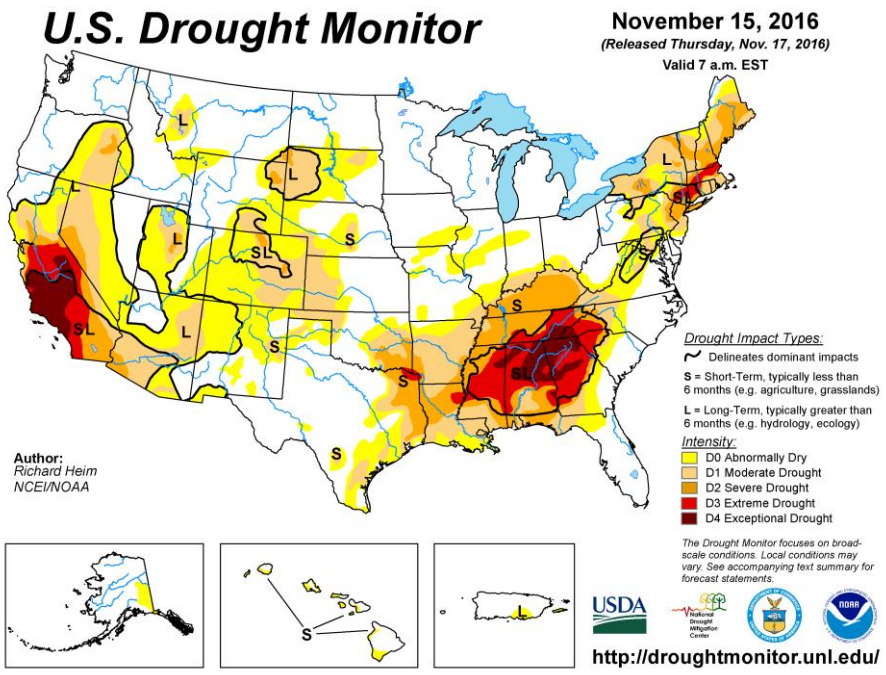
www.hydrologicwarning.org

Just a short abstract submittal is needed. Don't miss the upcoming December 12 deadline, speakers at the conference are eligible for the lowest registration fees.

Hydrologic Conditions in the United States
Through November 15, 2016



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



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

December 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

December 7th is the deadline for inclusion in the December issue.

Future Newsletter Articles Focus

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

Dec - Hazard Communication & Public Awareness
Jan - Modeling/Analysis
Feb - Data Collection
Mar - Hydrology

NHWC Calendar

June 5-8, 2017 - NHWC 2017 Training Conference & Exposition, Squaw Valley, California [Abstracts Due December 12th]

General Interest Calendar

April 30 – May 5, 2017 - ASFPM 41st Annual National Conference, Kansas City, Missouri

May 21-25, 2017 - American Society of Civil Engineers, EWRI World Environmental & Water Resource Congress 2017, Sacramento, California

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

Parting Shot

November 3, 2016

Eng. Esteban Velez of the National Institute of Water (INA-CIRSA) was awarded the Dr. Robert Cunningham Technology Leader Award by the Foundation for the Interaction of Systems Productive Educational Scientific Technology (FUNPRECIT) in recognition of his high merits in the field of their profession. Esteban regularly participates in NHWC conferences and lives in Villa Carlos Paz, Argentina.

Sue Swenor, High Sierra Electronics, Inc.