The NHWC Transmission

May 2017

CONTENTS

Click on hyperlinks located throughout this newsletter for more information.

Flood Forecast Modeling & Timely Decision Making Processes For "Low Water" Reservoir Operations

Shawn Johnson, County of Santa Barbara Flood Control District

Flood forecast modeling takes on a heightened awareness within Santa Barbara County when its largest south-coast reservoir (Cachuma Lake ~200K ac-ft.) may be approaching full capacity. Subsequent down-river dam releases need to be balanced with additional inflow forecasts, at the same time managing the impact to down-river lands & habitats, all the while maintaining an objective of retaining full reservoir capacity.

However, managing and releasing too much water hasn't been the case in recent years with a record setting 5-year drought in California, as Cachuma reservoir has been at historic low levels, reaching its lowest level in November 2016 (~7% capacity). Winter-season concerns focused rather on accessing the limited existing water within the reservoir, as southern California was still experiencing drier than normal conditions - in contrast with a much wetter northern California.

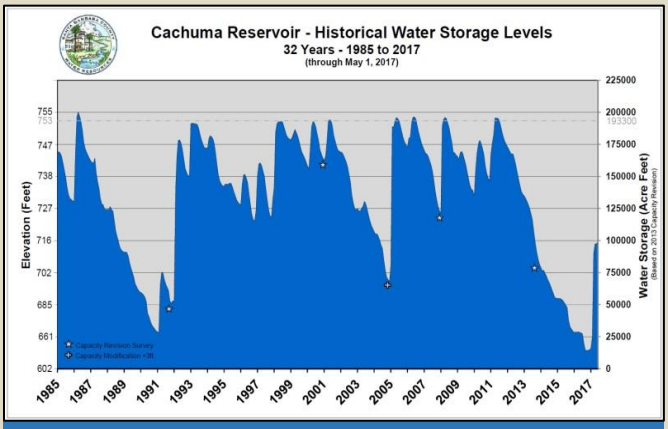


Figure 1 – Cachuma Reservoir Elevation & Storage (1985-2017)

Once the reservoir water level dropped below the critical ~675 foot elevation (~20% capacity), water within the reservoir could not be delivered through the normal gravity-fed tunnel for distribution to water providers on the south coast. The adopted solution included construction of a (temporary) complex and costly ($6M) multi-phase pump barge and (pile supported) pipeline system that extends up to ~2 miles into the pool area to access deeper locations of the shallow reservoir to feed the existing water delivery system.

Figure 2 – Pump Barge, Pipeline, & Intake Tower

But what if a storm were forecast with the potential for significant reservoir inflow?

- Would there be enough lead-time to remove the extensive pump-barge & pipeline/piling infrastructure?
- What if the forecast rainfall & subsequent modeled inflow did not materialize, and the pre-storm infrastructure removal became an unnecessary, costly, and counter-productive process?

In response to these concerns, it was critical to establish closely coordinated decision support protocols involving the organizations responsible for the decision-making aspects of the program – including the primary Dam Operator (The U.S. Bureau of Reclamation), Cachuma Reservoir Operations Board (COMB), Santa Barbara County Flood Control District (SBCFCD), and other regional and local water agencies.

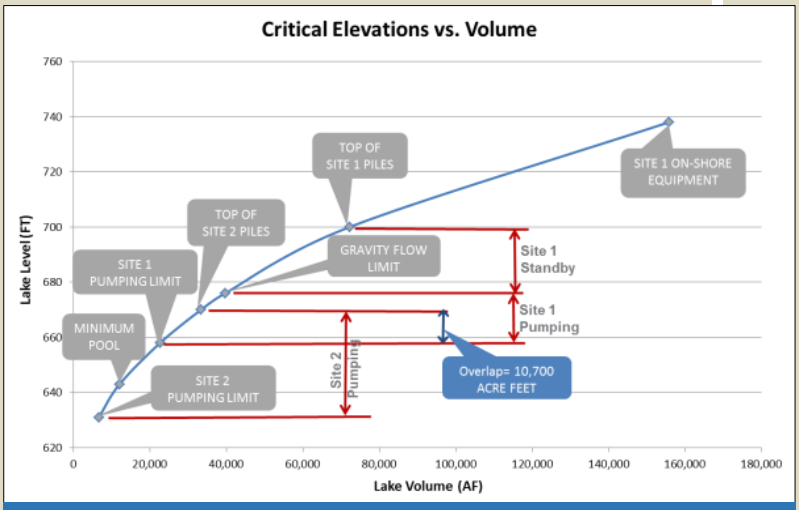


Figure 3 – Critical Project Reservoir Elevations

Hydrologic Forecast Modeling became a focal point of the decision support process, with the SBCFCD coordinating the dissemination of Flood Forecast estimates using an in-house developed "Santa Ynez River Flood Forecast" (SYRFF) Hydrologic Modeling program. The SYRFF Modeling Program has evolved over a ~30 year period with program improvements and multi-year post-storm model calibrations – all supporting a proven and long-established flood forecast model. The model encompasses the ~1200 sq-mi watershed extending from the east to west county limits, incorporating antecedent conditions, predicting reservoir inflows and, by extension, reservoir elevations and volumes. A graphical module presents modeling results for decision support.

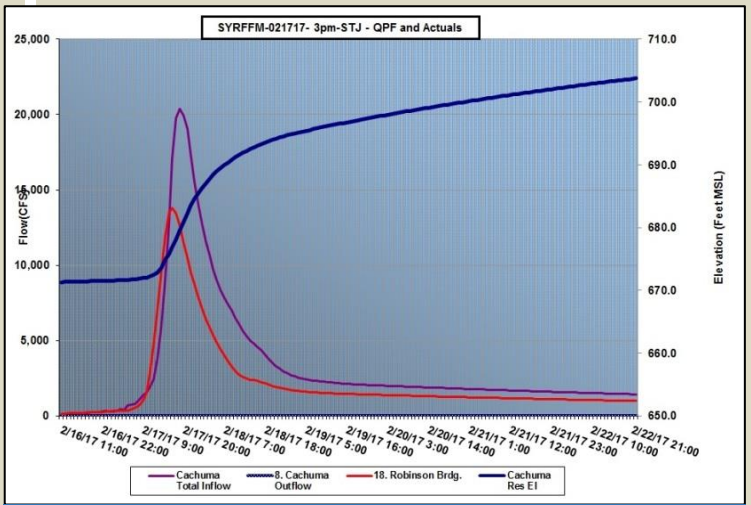


Figure 4 – Flood Forecast Model – Graphic Output Showing Reservoir Elevation and Inflow

Flood Forecast Modeling will always have its limitations, especially when forecast rainfall is a principal initial input parameter (until actual ALERT/"real-time" rainfall information is introduced into the Model).

The first test of the decision support system occurred when a mid-February 2017 storm was forecast by the National Weather Service (NWS) to deliver significant runoff & inflows to Cachuma Reservoir. Once the storm rainfall began, Flood Forecast Modeling became a 24 hour operation, with actual rainfall & reservoir data supplanting the forecast information, and updated with the most recent NWS QPF rainfall data.

As predicted, the storm produced about 9 inches of rainfall (occurring mostly within a 24-hour period), created peak river flows of up to ~20,000 cfs, and resulted in a ~40-foot rise in Cachuma reservoir elevation (+~50,000 ac-ft). The storm related inflows brought the reservoir up to ~50% capacity (See Figure 1)

As reservoir stages reached the previously-identified Critical Project Reservoir Elevations (See Figure 3) decisions driven by the SYRFF hydrologic model's predictions provided the necessary confidence and lead time for the "multi-stage" removal of the pump barge and pipeline system.

The desired project results were realized through a tightly coordinated effort of multiple agencies, the essential NWS QPF forecast data, the SBCFCD website based real-time ALERT monitoring system, and the Hydrologic modeling processes.

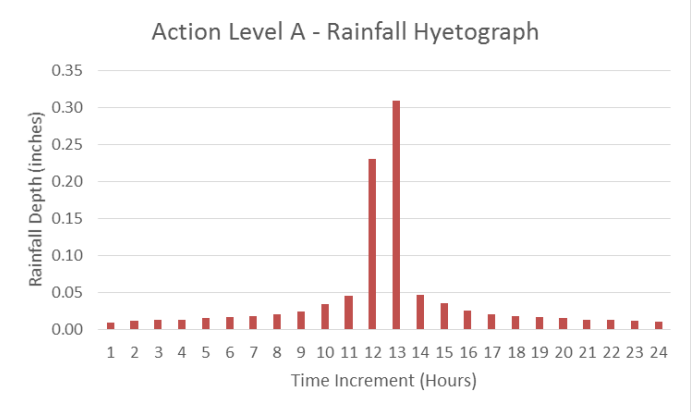
ALCAL – Nashville SAFE's Quick and Easy Flood Prediction Model

Bradley Heilwagen, Amec Foster Wheeler

Background

The Nashville SAFE (Situational Awareness for Flooding Events) Program is a partnership formed between federal and local agencies following the flooding that occurred in May 2010 in Nashville, Tennessee. From the beginning, the mission of Nashville SAFE was to better prepare the city for future floods by improving coordination between responding agencies, developing more and better data for analysis during a flood event, and training more personnel to make informed decisions during a flood event.

Early in the program, the U.S. Army Corps of Engineers (USACE) performed detailed hydrologic and hydraulic (H&H) modeling to ensure that as many streams as possible had flood modeling and mapping available. They modeled 11 precipitation scenarios, 24 hours in duration, with an SCS Type II distribution, as shown in the figure located at right, with total rainfall depths of one inch through 11 inches, in one-inch intervals. The resulting water surface elevations and mapping serve as the basis for an Action Level approach to flood prediction, with Action Levels lettered A through K, which represent the resulting 11 flood scenarios.



In addition, Metro Water Services created the role of Watershed Advisor within their ranks to support Emergency Management by providing scientifically-based impact assessments and decision recommendations to their Situation Management Team. During the first two years, it became clear that Watershed Advisors needed a way to quickly and easily determine an

anticipated Action Level(s), given current and predicted rainfall. A pilot project to develop HEC-RTS (a real-time H&H modeling system developed by USACE) modeling was initiated, and will eventually result in implementation across all watersheds in the Metro Nashville area over several years.

In the meantime, to help Watershed Advisors quickly determine a current and predicted Action Level in the watersheds of Metro Nashville, Amec Foster Wheeler (AmecFW) developed a rudimentary flood model that would eventually be called the Action Level Calculator (ALCAL).

ALCAL Calculation Process

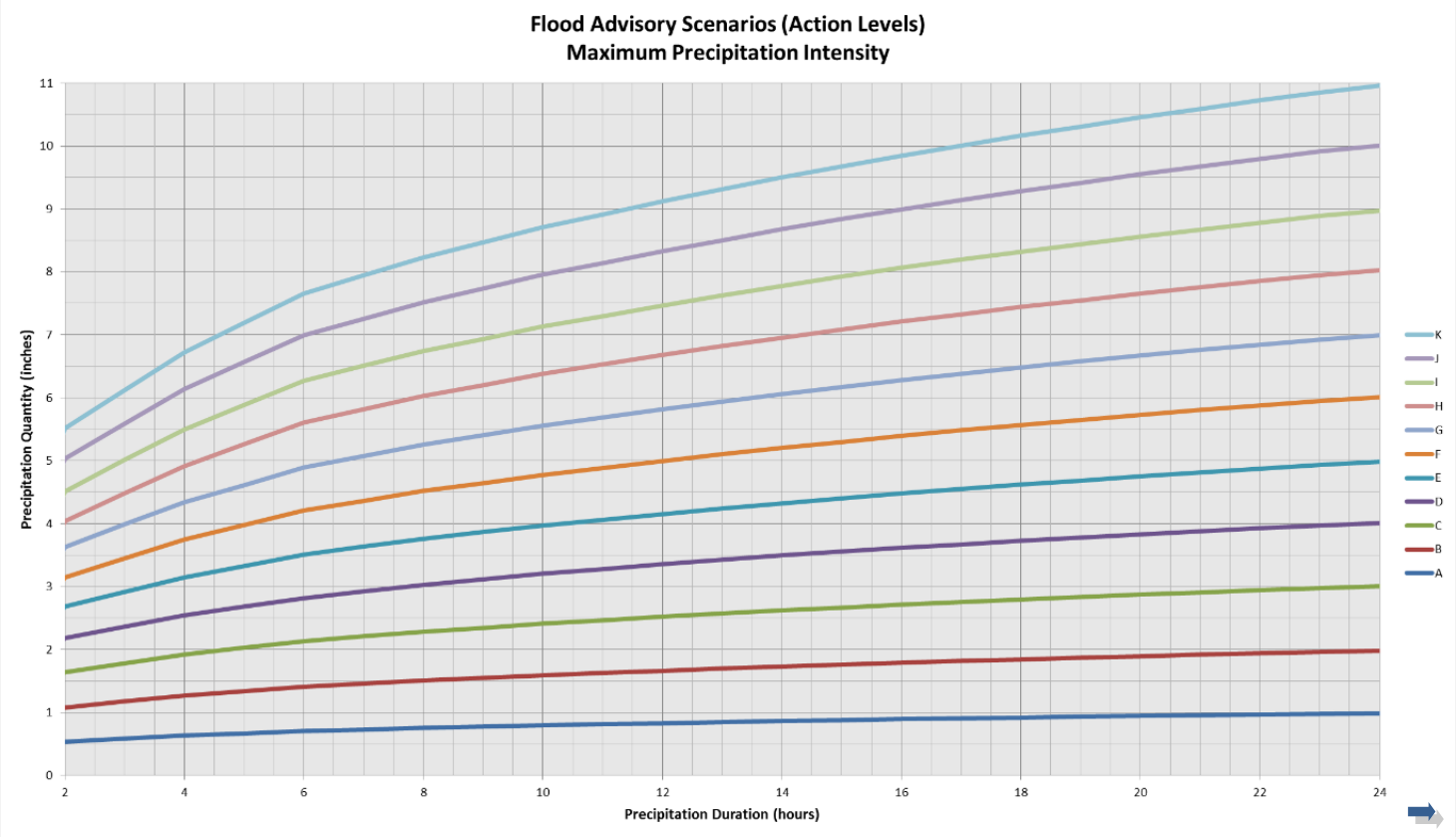
Maximum Precipitation Intensity (MPI) Curves, derived from the 11 precipitation scenarios modeled by USACE, serve as the technical basis for the calculations within ALCAL. They assume that a shorter duration event with a similar rainfall depth as the most intense two-hours of a longer duration event will have the same or similar net result. For example, an event having four inches of rain falling over a four-hour period will result in a similar Action Level to an event having six inches of rain falling over a 24-hour period.

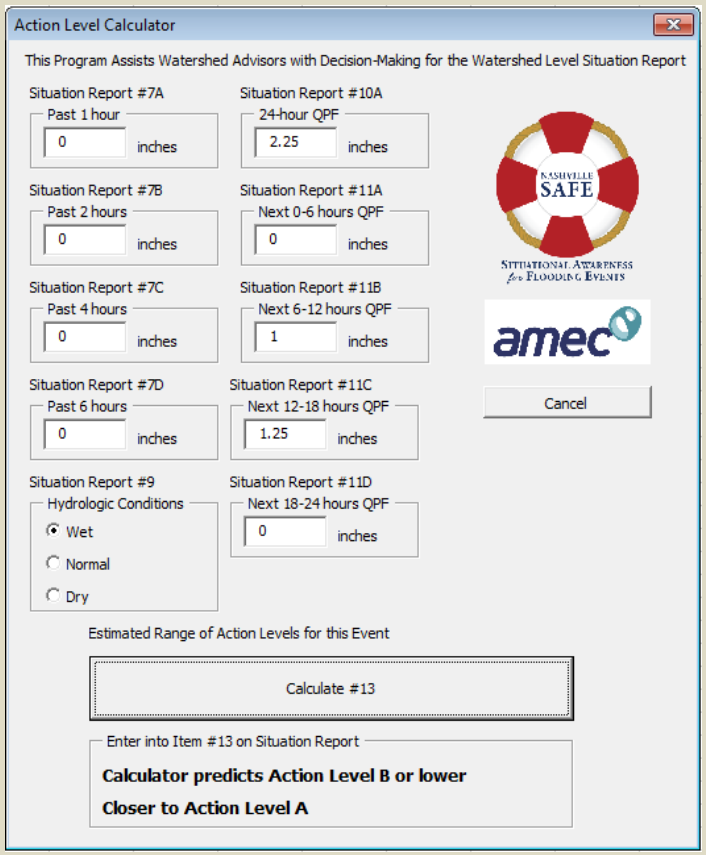
The input data for ALCAL had to be quickly and easily accessed by Watershed Advisors. Two websites were selected from which to pull data – one operated by the USGS and one operated by the NWS. The first provides estimated recent rainfall at several gages throughout Metro Nashville, accumulated over multiple time periods in a single table. The second provides precipitation forecasts in 6-hour increments for the next 24 hours.

Using the input data collected and the MPI Curves, the Watershed Advisor can calculate current and future Action Levels given the current and predicted meteorological conditions. The calculation involves assigning an Action Level to the quantity of rainfall observed in the last 2-, 4-, and 6-hours, the predicted rainfall over the next 24 hours, and variations of predicted incremental rainfall in 6-, 12-, and 18- hour increments. The result is a range and average of potential current and future Action Levels.

Automating the Calculation

Calculations were originally performed manually and recorded in a Situation Report. To speed up the process, a Microsoft Excel macro was developed to automate the calculation. The maximum precipitation intensity ordinates for each Action Level were placed into an array, one for each incremental rainfall duration (1-hour, 2-hour, etc.). The macro then uses Visual Basic commands to read the array and assign an Action





Level to each piece of input data. The form editor in Microsoft Excel was used to develop an easy-to-use interface for the macro (see figure at left).

Summary & Future Development

Using readily available data, the project team created a user-friendly automated decision support tool. With the concept proven, ALCAL is being rewritten into a web-based interface and expanded to accept automated inputs from USGS, NWS, Metro Nashville, and USACE data sources, including outputs from HEC-RTS modeling. In addition, a new GIS viewer is being developed to display data for the current and predicted Action Levels. Calculations will be automated and run on an hourly basis to keep a continuous eye on the potential for flooding in Metro Nashville.

Although ALCAL will never be as accurate as real-time H&H modeling systems such as HEC-RTS, it provides enough information for the emergency managers of Nashville to make rapid and informed decisions during, or in preparation of, a flood emergency.

Title Sponsors

ALERT USERS GROUP

FM Global

HydroLynx

OneRain The Rainfall Company AND HIGH SIERRA ELECTRONICS, INC environmental monitoring solutions Celebrating 25 Years 1992-2017

Partnering Sponsor

LYNKER TECHNOLOGIES

Water & Earth TECHNOLOGIES Water Resources and Environmental Consulting

WEST CONSULTANTS, INC.

Special Event Sponsors

CAMPBELL SCIENTIFIC WHEN MEASUREMENTS MATTER

KISTERS

vieux & ASSOCIATES

Exhibitors

American Signal Corporation
AMR Consults, LLC
Aquatic Informatics
Campbell Scientific
DataWise Environmental Monitoring, Inc.
Davis Instruments
FTS
Geonor, Inc.
Hydrolynx
KISTERS North America
Microcom design, Inc.
NOAA/National Weather Service
OneRain/High Sierra Electronics
Ott Hydromet/Sutron
Stevens Water Monitoring Systems, Inc.
U.S. Geological Survey
Vieux & Associates, Inc.
WEST Consultants
Xylem

12th National Hydrologic Warning Council Training Conference and Exposition

June 6-8, 2017
Olympic Valley, California

Just 2 Weeks To Go!

You can still attend the NHWC Conference in the Lake Tahoe area of California and experience:

- Keynote addresses by Dr. Tom Graziano, Director, Office of Water Prediction, National Weather Service, Dr. Don Cline, Associate Director for Water, US Geological Survey, and Robert Hartman, National Weather Service (retired)
- Luncheon speakers discussing social media during a disaster and the nearby Oroville Dam spillway failure
- Field tours of the Sierra Snow Lab and the Lake Tahoe Dam
- 12 extended workshops
- Over 60 concurrent technical presentations
- Panel sessions on climate change and ALERT2
- An ALERT2 Technical Workgroup meeting
- An exposition of the latest products and services
- Opportunities to network with attendees from across the U.S. and from other countries, including a unique social evening at High Camp, a gondola ride above Squaw Valley at 8,300 feet

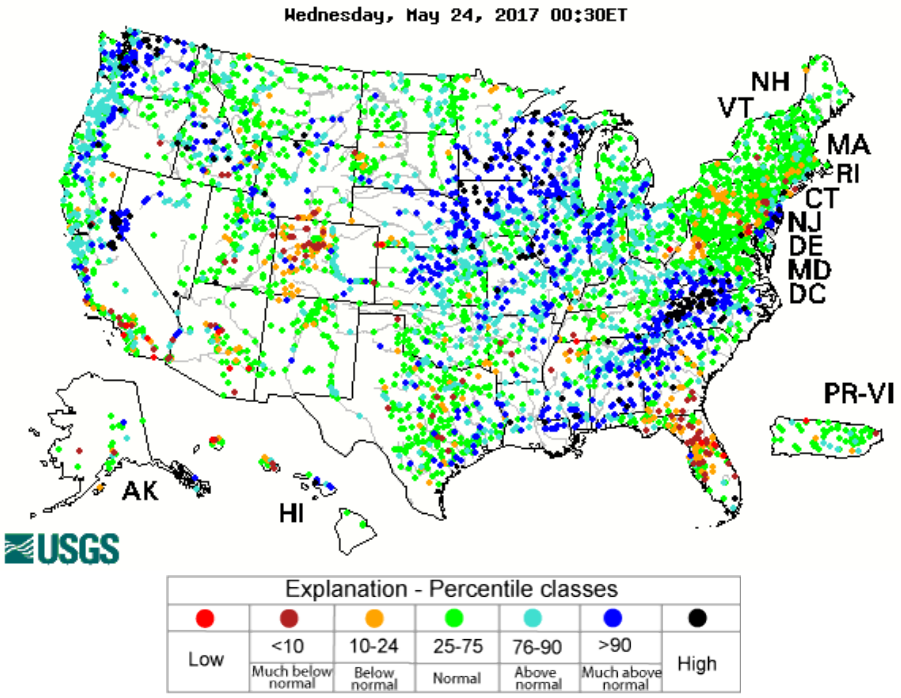
For additional conference information and registration visit

www.hydrologicwarning.org

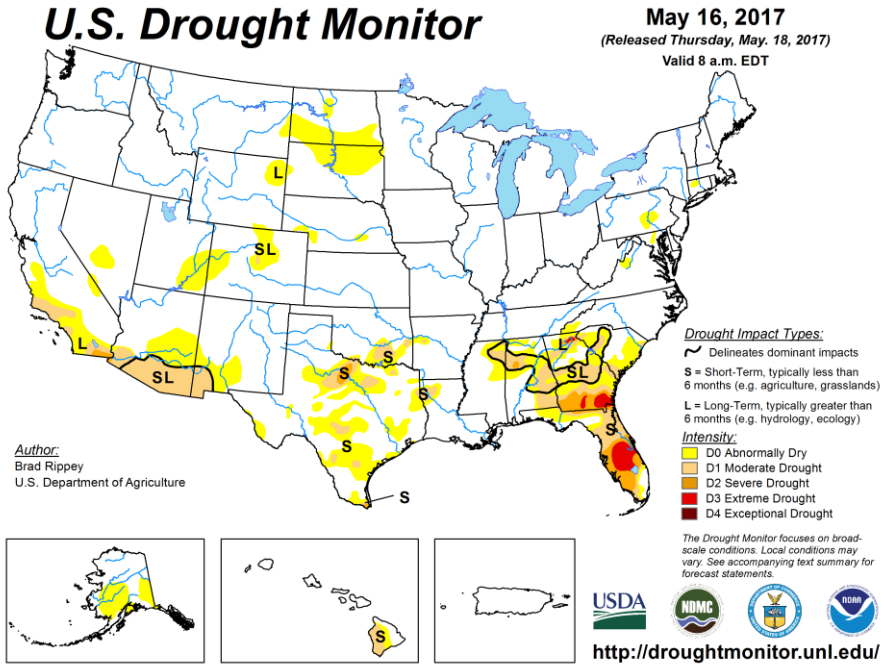
For assistance with late hotel reservations contact

april@aprilkrieg.com

Hydrologic Conditions in the United States
Through May 16, 2017



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



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

June Newsletter Articles Focus:

Data Collection

The NHWC is requesting articles that focus on practices, technologies and tools used to gather and disseminate real-time hydro-meteorological data.

Please consider writing an article that highlights how your organization collects and disseminates real-time data.

Submit your article to:

editor@hydrologicwarning.org

June 14th is the deadline for inclusion in the June issue.

Future Newsletter Articles Focus

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

Jun - Data Collection
Jul - Hydrology
Aug - Hazard Communication & Public Awareness
Sep - Modeling/Analysis

NHWC Calendar

June 5-8, 2017 - NHWC 2017 Training Conference & Exposition, Squaw Valley, California

General Interest Calendar

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

November 5-9, 2017 - AWRA Annual Conference, Portland Oregon

April 17-20, 2018 – The ALERT User's Group Training Conference and Exposition, Ventura, California

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

Parting Shot

April 19, 2017 – National Weather Service Stakeholder Engagement

The Flood Control District of Maricopa County, Arizona hosted a one-day forum presented by officials of the NWS to Inform local hydrologic warning stakeholders of proposed new National Weather Service water resource services and to get feedback from participants. The day included a panel discussion of local issues followed by presentation of three new proposed NWS Flash Flood Products/Services to breakout focus groups.

Photo by **Brian Iserman**, JE Fuller/Hydrology & Geomorphology, Inc.