

When water is scarce, professional engineers put their technical expertise to use.

BY DANIELLE BOYKIN

DEALING WITH DROUGHT



“WHEN THE WELL IS DRY, WE KNOW THE WORTH OF WATER”

Benjamin Franklin

For a growing number of Americans, Franklin’s quote is becoming a stark reality as California, Texas, and other states contend with historic drought conditions that are forcing conservation efforts. Professional engineers and water resources engineering experts are playing a critical role in developing and implementing the solutions needed to overcome challenges of dealing with severe drought.

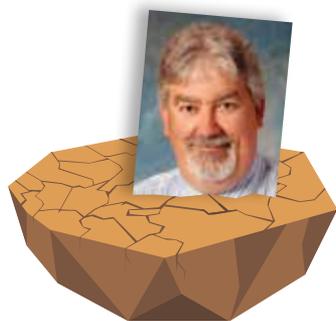
When it became apparent last year that California was going to experience its third consecutive year of drought, Governor Jerry Brown established a task force with the Department of Water Resources, the Department of Food and Agriculture, the State Water Resources Control Board, and the Office of Emergency Services. The task force was charged with providing water shortage information; assessing the regions affected by dry conditions and the socio and economic impacts; and taking actions to provide water delivery and reduce negative impacts of water shortages.

The state is experiencing some of the driest conditions in nearly 120 years, particularly in areas of Northern and Central California, says William Croyle, P.E., the

drought manager for the Department of Water Resources. "Over 90% of the state is dealing with extreme drought conditions and they continue to get worse, at about a 1% to 2% change every month as we get through this summer period and into the fall," says Croyle, who has more than 30 years of water operations experience.

Groundwater is essential to the state during dry periods and provides nearly 60% of the water supply, according to a DWR report. Groundwater levels have been on the decline since 2008 particularly in the northern section of the San Francisco Bay Hydrologic Region, the southern San Joaquin Valley, and the South Lahontan and South Coast hydrologic regions.

In January, Governor Brown issued an emergency drought proclamation requiring that the DWR issue a report on basins with potential water shortages and gaps in groundwater monitoring. California residents were asked to reduce water consumption by 20% and local water suppliers to implement water shortage contingency plans. An executive order issued in April charged the agency with providing outreach and technical assistance to local agencies in addition to increased groundwater monitoring and collection of data. The California legislature also approved a \$687 million drought relief package.



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The California agriculture industry has worked over many years to be efficient and effective at water use, says Croyle, but this most recent drought is taking its toll. The industry is not just important to the state's economy, but also has a national and global reach. "We have seen significant cropping patterns over the last 10 to 15 years to deal with food needs in the world," he says. "For example, growers of almonds have entered into long-term contracts with China and they rely on surface water delivery to keep those trees alive. Enough water is not available this year."

Drought also increases the wild fire threat. Croyle says the state has faced a 150% increase in fires this year, and the warning came fierce and early. "We had fires in January and February when we never previously had fires, especially on the North Coast. That raised an awareness that the fields are so dry that it's not going to take much for a major disaster," he says.

California's drought issues may be grabbing the most national news headlines, but Texas is no stranger to drought and the challenge of providing water to a growing population. In order to better deal with periodic drought conditions, the Texas Commission on Environmental Quality created the Office of Water in 2009 to bring together its divisions of water quality, water quality planning, and water supply, led by Deputy Director L'Oreal Stepney, P.E. Governor Rick Perry recently reissued a proclamation to take the necessary actions to address the threat of disasters due to extreme drought conditions. "We have a wide range of technical expertise that we can bring to bear when we have drought," says Stepney. "It's really important for us to be on the ground to effectively provide the technical, financial, and managerial assistance and put systems in place to provide safe drinking water."

Consistent public outreach and communication campaigns is critical, says Stepney. "We think it's key that we communicate with our water rights holders, our public drinking systems, or anyone struggling with a drought," she says. "If we see that an area is experiencing low stream flows or lake conditions, we send out an alert that they need to start implementing their drought contingency plans and ensuring that they have alternative water supplies."

The TCEQ also maintains a communications campaign to educate local agencies, businesses, and the public on conserving

water and protecting the environment. The agency also hosts workshops that highlights alternative water sources and new technologies for small communities. "We have experienced professionals that complete technical reviews of innovative technology applications, such as direct potable water reuse, and having these talented engineers on board has really helped with our technical services and review processes," says Stepney.

Feast or Famine

Why is California in particular experiencing drought conditions? One reason is that the state's weather is highly variable says John Moynier, vice president of Dewberry's Water Resource Consulting practice located in the firm's Sacramento office. The state's water supply is primarily dependent on winter precipitation, much of which falls as snow in the state's mountainous regions. As the snow melts, the runoff eventually finds its way into the state's rivers, streams, and reservoirs, where it can be used during the dry summer months. "California deals with a feast-or-famine scenario," says Moynier, whose 30-year career has involved dozens of water resources projects. "We typically intersperse very intense wet years with multiple years of drier conditions."

The last big wet year was 2011, says Moynier. The state is drawing on water that was stored in reservoirs or underground aquifers during that last wet period, and both of these supplies are at risk of being seriously depleted. "Many areas are currently scraping by through implementation of aggressive conservation measures, but if we have another dry winter, we will be in a serious water shortage with no readily available alternatives," he says.

Water resources engineers, adds Moynier, are critical to providing remedies and determining how to deliver water in times of drought and mitigate the impacts of drought. "The primary engineering challenge in California is moving water from where it is plentiful, mostly in the rural north and eastern portion of the state, to where it's needed in the heavily populated areas along the central coast and throughout southern California," he says. "A complex network of pipes, canals, reservoirs, pumps and other conveyance facilities is relied on to distribute the water throughout the state. This system is one of the engineering marvels of the world, and the state is poised to consider expansion of

the system yet again to try to remedy some of the impacts of extended drought periods such as we're currently experiencing."

People very seldom wonder where their water comes from, or what it takes to deliver the water to their tap. Water supply projects, and especially upkeep of water infrastructure maintenance projects, are not a very sexy news topic, says Moynier, and often not a high priority until disaster strikes, like the recent pipeline failure near the campus of UCLA. "It's very difficult to get people interested in making significant changes until you have a drought or a pipeline fails or you can't drink the water because it's not healthy," he says. "Most of us just turn on the tap and don't think twice about where our water comes from or how much energy and technical engineering goes into getting that water to our doorstep."

While some areas of the country are focused on drought management, other areas are primarily focused on stormwater and flood management. However, with changing and extreme weather patterns, more jurisdictions are facing the need to manage water in a more integrated manner, says Moynier. Professional engineers are at the forefront of ensuring system reliability and resiliency in the face of all of these issues. "More than ever, water resource planners and engineers are working closely with land use planners, floodplain managers, and other utilities maximize opportunities to capture and store water, whether it's in reservoirs or underground in aquifers during wet seasons, so it is available for use during our extended dry periods," he says. "There continues to be a big push toward integrated water resource management, and this will require engineers to provide solutions to optimize surface water and groundwater storage, storm water, and recycled wastewater reuse opportunities and other technologies, including ocean and brackish water desalination."

Challenges and Solutions

Three big challenges face California's agencies tasked with providing technical and water resources management solutions to deal with this drought, says Jeanine Jones, P.E., DWR's deputy drought manager and interstate resources manager. One challenge is better managing the state's ground water resources. She believes that legislation passed by the California legislature in August, establishing a groundwater management strategy, would ultimately help

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The second issue, says Jones, is improving water supply planning for small water systems. "We know that during a drought that small water systems, particularly those on fractured rock ground water and vulnerable areas, have problems [with] running out of water," says Jones, who has 30 years of experience with the agency and has led its statewide planning program and climate change adaptation programs. "They are also not very well accommodated within the institutional framework that we now have for helping local water agencies improve their reliability."

A third challenge is the ability of the agency to improve on its seasonal weather and climate forecasting. The agency, she says, has used emergency drought funding for three university research contracts directed at aspects of improving the ability to improve climate forecasting. "For example, we are trying to better understand the conditions that favor big atmospheric river storms, which is the West Coast equivalent of hurricanes," she says. "In partnership with [the National Oceanic and Atmospheric Administration], we built a \$25 million observing system, and we are finding out that these storms are so important from a water supply standpoint. If you are predicting their absence, you are in essence predicting dry conditions."

Developing and implementing solutions to dealing with long-term drought conditions is more of a societal challenge, not an engineering challenge, says Moynier. "As

a society, we will need to consider the best use of our limited resources and consider the real costs of providing these solutions, which may require very difficult technical and political decisions," he says.

Public officials and agency administrators will also have to educate the public on solutions, such as desalination and wastewater recycling, which are not inexpensive. Moynier cited the Orange County Water District's Groundwater Replenishment System as an example of a successful water reuse and purification project. "Water utilities like OCWD now are able to take highly treated wastewater and then put it to direct or indirect reuse, whether it's blending it in a surface water reservoir or putting it in the ground to be able to pump out as a ground water supply," he says.

Another challenge is the negative public perception. Society will have to get over the "yuck factor" that comes from the idea of toilet-to-tap water says Moynier. "We have the technology to treat this valuable resource to pure water standards, but you have to get over the public resistance," he says. "We can no longer flush the toilet and hope it goes into the ocean, while at the same time saying, 'I wish I had more water.'"

Communities throughout the state will have to rely on a more diverse water portfolio to build a reliable water supply, says Croyle, which includes surface water and ground water supplies, wastewater reclamation, stormwater management, and desalination.

There will also be more focus on integrated regional water management projects focusing on drought mitigation. This is requiring all stakeholders to have a "we are all in this together" mindset, says Croyle. "This drought is being managed with a unified coordination group with multiple state agencies assisting multiple local agencies and nongovernmental organizations and down to the public group, and it has been unprecedented," he says. "We are seeing more and more of this across the nation when you have these types of disasters."

Croyle adds: "From an engineering standpoint, it's really about thinking outside of the box and realizing that you need all of your skills and talent to come together to address these issues. You have to think about new technology and new relationships. You've got to dive in and you've got to move fast."