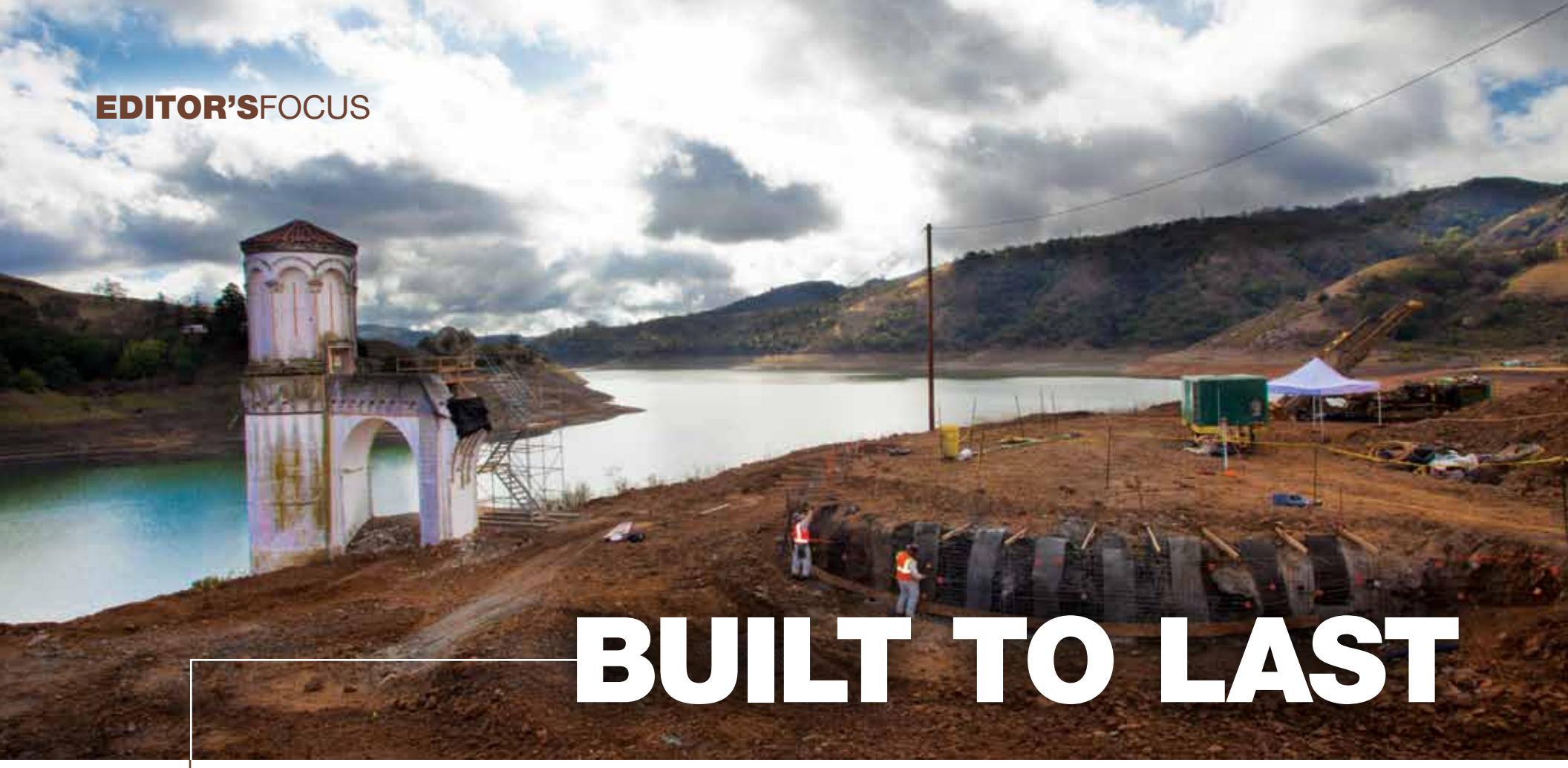


BUILT TO LAST

San Francisco water-ready for the big quake

By Harlan Kelly

World-class cities all boast something special and unique. Paris has the Eiffel Tower, Rome the Coliseum, and New York the Statue of Liberty. San Francisco is known for its iconic trolley cars—and earthquakes. It is not just the equally iconic singer Carole King who feels the earth move under her feet. Stoic San Franciscans are used to it, too.

Cataclysmic events remain unpredictable. With the devastation of the city's historic earthquake of 1906 and the more recent experience of the freeway-flattening Loma Prieta earthquake of 1989, Bay Area inhabitants know they live in a "when"—not an "if"—environment when it comes to natural disasters.

The 2.5 million residential, commercial and industrial customers of the Hetch Hetchy Regional Water System share some relief knowing that the San Francisco Public Utilities Commission (SFPUC) is nearing completion of a massive and masterful effort to prevent a major water supply disruption when an earthquake occurs. The SFPUC's $4.6-billion Water System Improvement Program (WSIP) consists of more than 80 projects to repair, retrofit and rebuild the system's aging infrastructure and facilities, and ensure that customers continue to receive high-quality drinking water in the future.

The crux of the challenge: pipelines and tunnels from Hetch Hetchy Reservoir—the city's water source, located 167 miles to the east—cross no less than three major earthquake faults with the potential to sever this liquid lifeline, causing an interruption in water service that could last for days or even weeks. On top of this, the Northern California region suffers from frequent droughts and recently pulled out of one with above-average snowfall in the Sierras in 2010. Naturally, dry years will return.

SFPUC declared that the aggressive effort undertaken by its managers, consultants and contractors has accomplished an "amazing" transformation of water reliability, saying that early this century, the agency marshaled both brains and brawn in a race against the tectonic clock, working with dogged determination and impressive success on more than 80 improvement projects ranging from local pump stations and pipelines to tunneling under San Francisco Bay.

While they are proud of that effort, even more noteworthy is that when completed in 2016, the WSIP will safeguard the health and safety of the community even in the most severe circumstances.

Contractor completes staging and begins work on grading the site for the construction of the new dam.

A Panoply of Projects

WSIP projects vary in size and complexity, covering all aspects of the water system—from dams, reservoirs, pipelines and tunnels to water treatment facilities, pump stations and water storage tanks. The WSIP is one of the largest water infrastructure programs in the nation, and it is the largest infrastructure program ever undertaken by the city of San Francisco, at an estimated cost of $4.6 billion. Notable facts about WSIP include:

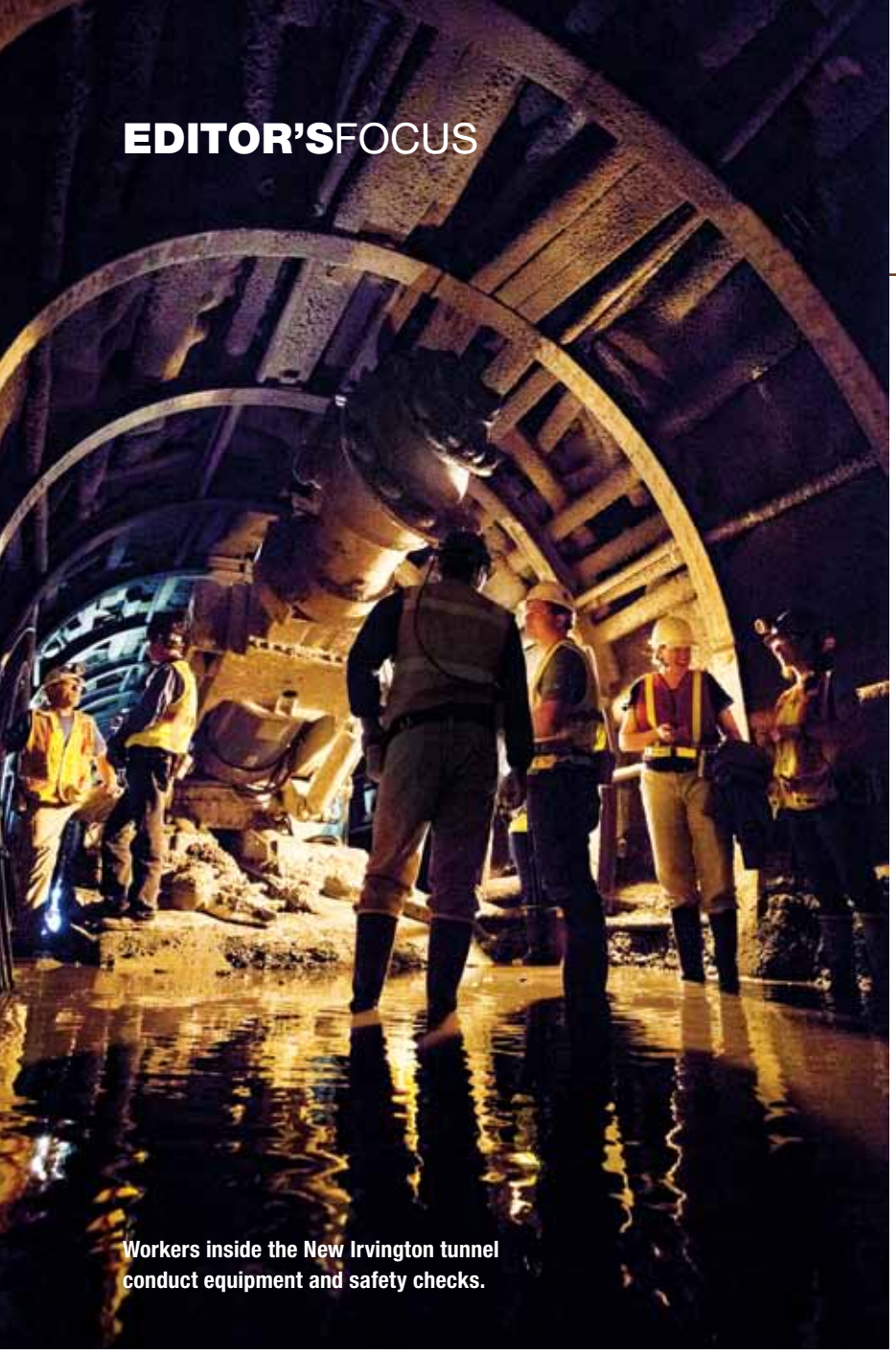
- Through the end of December 2011, 53 projects with a total value of $654 million are in closeout or have been completed.
- Twenty-one more projects are in construction with a total value exceeding $2.5 billion. The remaining seven projects are in pre-construction.
- The program completion date remains July 2016, when the Calaveras Dam Replacement Project—WSIP's largest—is forecasted to reach completion. Planning activities are nearing completion at 99%, whereas environmental, design and construction efforts are 88%, 94% and 40% complete, respectively.

Infrastructure development and improvement has provided jobs at a time when they are needed most. Through 2011, approximately 2.7 million craft hours were logged on WSIP projects, which represent wages exceeding $100 million on the projects covered by a well-negotiated project labor agreement.

Dam Revival

One of the most challenging and critical projects for the WSIP has been rebuilding the Calaveras Dam, located in southern Alameda County. It was conceived with great fanfare almost 87 years ago as the largest earth dam in the world—it held 31 billion gal of water in storage. But in 2001, the state decreed the dam no longer seismically stable. Since then, the water storage level has been reduced to 40% of its original capacity.

The need to rebuild this critical resource rendered it WSIP's largest project. When completed, the new Calaveras Dam—unfortunately located less than two football fields from the Calaveras fault—will withstand a 7.2-magnitude earthquake, according to SFPUC.



Workers inside the New Irvington tunnel conduct equipment and safety checks.

"Currently, our supply system is storage poor," said Betsy Lauppe Rhodes, Sunol regional communications manager for SFPUC. "This project means a significant improvement in our local water storage as well as emergency preparedness. We now rely on water that comes a very long distance from the Sierra Nevada Mountains to get to our customers' taps. We keep our fingers crossed that we'll finish before the next large quake. So far we've been lucky."

The new dam will be 220 ft high, 80 ft wide on top and 1,210 ft long. The dam will be 1,180 ft wide at the base and will be composed of 3.5 million cu yd of earth and rock fill, just a stone's throw downstream of the original structure.

Going Deep

Another hallmark of the WSIP seismic improvement strategy lies in several new tunnels that replace or provide redundancy to the pipelines that could fail during a catastrophic event. One example of this progress is the recently completed work on the New Crystal Springs Bypass Tunnel project.

In this instance, concrete cylinder pipes 96 in. in diameter move Hetch Hetchy water north of the peninsula and into to the city and county of San Francisco. But this conveyance lies only about 5 meters below the surface, and passes a slope that caused two failures in the mid-1990s. The high risk of earthquake damage made new construction strategies in this area imperative.

The WSIP plan called for the replacement of the 1,280-meter water pipeline of welded steel pipe protected by a tunnel installed deep into bedrock. Beginning in 2009, the New Crystal Springs Bypass Tunnel team set off to meet this challenge.

The tunnel boring machine (TBM) was designed to work within the sometimes unpredictable ground conditions of the San Francisco area, which include sandstone among other materials. In addition, the TBM featured 23 disc cutters 17 in. in diameter, capable of cutting through the relatively hard sandstone.

After traveling approximately 18 meters per day, the TBM arrived at the north shaft ahead of schedule in March 2010. Once the tunneling was complete in early May, construction began on the installation of a 2.4-meter-diameter welded steel pipe.

The WSIP features three tunnels: the New Irvington Tunnel in the Sunol region and the first-ever tunnel underneath the Bay. All of these projects have undergone a rigorous planning and environmental review process years in the making. It had been a long time since SFPUC plunged into WSIP work, particularly when it came to the tunnel work. It secured the services of some of the top tunneling consultants and used unconventional means and methods.

This strategy infuses the entire WSIP and is sure to pay decades of dividends to San Francisco residents as the program winds down over the next four years. But SFPUC's work is not done yet. Next up: a massive initiative to upgrade the city's sewer system that includes tunnels, treatment plants and other projects.

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