St. Francis Dam and the End of Mulholland’s Reign

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THANKS TO THE 1974 FICTIONALIZED MOVIE Chinatown, many people know the infamous story of the Los Angeles Aqueduct, built to capture runoff from the Sierra Nevada in the Owens Valley for delivery to Los Angeles. Construction of the aqueduct, started in 1908, compared in complexity to the building of the Panama Canal. It required 3,900 workers at its peak and involved the digging of 164 tunnels. At the time it was the longest aqueduct in the world, and perhaps more remarkably was completed on time and under budget. In addition, the 233-mile aqueduct, which was inaugurated in November 1913, gave William Mulholland, the project’s self-taught engineer, a reputation as an engineering rock star.

Beyond drawing water from the Owens Valley, Mulholland believed Los Angeles should plan to store water for use in the event of a drought or damage to the aqueduct. It was during the process of building the aqueduct that Mulholland first considered sections of San Francisquito Canyon, 40 miles northwest of Los Angeles, as a potential dam site. The canyon topography seemed well suited, though Mulholland had documented an unstable set of rock features at the eastern side of the canyon in a 1911 report to the Board of Public Works.

In 1924 construction began on the St. Francis Dam in San Francisquito Canyon. Completed in 1926, the St. Francis Dam was a curved concrete gravity dam—a type of dam that relies on its weight and internal strength for stability. It was designed to be a large regulating and storage reservoir for the gravity-fed Los Angeles Aqueduct. But this was not what happened.

Instead, the dam became a symbol of engineering hubris and failure. The 1928 collapse of the structure resulted in the deaths of well over 400 people and an estimated $7 billion in property damage. Many consider the St. Francis Dam collapse to be the worst American civil engineering disaster of the 20th century.

Bringing Water to the Thirsty Land

Before the construction of the aqueduct, Mulholland had already gained acclaim as the first American civil engineer to use hydraulic sluicing in dam building, a feat accomplished while constructing the Silver Lake Reservoir in 1906. Then in 1913 he was brought on to serve as a consultant for construction of the Calaveras Reservoir, part of the water system associated with the City of San Francisco.

That October, with construction of the dam
underway, San Francisco’s city engineer, Michael O’Shaughnessy (himself famous for the construction of Hetch Hetchy Dam), criticized Mulholland in private correspondence, writing that Mulholland and the chief engineer were "so intensely conceited that they imagine all they might do should be immune from criticism."

Concerned about the construction, O’Shaughnessy described sloppiness and recklessness at the Calaveras dam site. "Another feature which made objectionable impressions" on him was "the flippant manner in which the young college boys in charge of the work and Mulholland, with his swollen ideas of accomplishment, have undertaken this very serious engineering project."

Still, Mulholland continued to acquire accolades, receiving an honorary doctorate degree from the University of California, Berkeley, in 1914. The inscription on the diploma read "Percussit saxa et duxit flumina ad terram sitientum" (He broke the rocks and brought the river to the thirsty land).

On March 24, 1918, the Calaveras Dam suffered a partial collapse of the upstream slope. Fortunately, because the water in the reservoir was only 55 feet deep, no water was released. Mulholland’s contributions also escaped serious scrutiny.

**The St. Francis Dam Rises**

Los Angeles continued to grow rapidly. In the first half of the 1920s, multiple smaller reservoirs were built, and modifications were made to increase the height of one dam by seven feet, but still more storage was needed.

Originally, a new large reservoir was planned for Big Tujunga Canyon. Mulholland nixed that location after determining that the costs of acquiring ranches and other private land would be too high. He then returned to his idea of using San Francisquito Canyon, where federally owned and private property could be purchased for far less.

Although Mulholland had overseen the completion of numerous embankment dams, his experience in concrete dam design was limited to participation in the design of just one. That dam, a curved concrete gravity dam, was constructed between 1923 and 1925. And while there were some differences in the sites, Mulholland proposed a nearly identical dam for the canyon terrain across which St. Francis would be built.

After construction of the St. Francis Dam began, its height was raised by 10 feet on two separate occasions to meet expected future demands as Los Angeles continued to grow. Although these modifications increased the dam’s height by 20 feet, builders made no changes to its base width, though they did add a 588-foot-long wing dike along the top of the ridge adjacent to the western abutment to contain the enlarged reservoir. Mulholland’s team recognized that the changes had not been fully evaluated. They decided, however, that taking additional time to analyze the situation, acquire additional materials, and make adjustments to the construction would be too costly.

In 1926 operators begin to fill the reservoir with water and continued to do so steadily and uneventfully through 1927. Some leakage and cracks were noted but not considered significant. In April 1927 the reservoir level was brought to within 10 feet of the spillway, and during most of May the water level was within 3 feet of overflowing. No one detected large changes. Mulholland considered the amount of seepage insignificant for a dam the size of the St. Francis, pronouncing, "Of all the dams I have built and of all the dams I have ever seen, it was the driest dam of its size I ever saw."

Meanwhile, during the decade and half of Los Angeles Aqueduct operations, tensions in the Owens Valley, the source of its water, grew. The city’s operations had completely drained Owens Lake, creating massive disruptions to the livelihoods of the valley’s residents. Local citizens had taken to dynamiting the aqueduct and engaging in other acts of sabotage, disrupting the Los Angeles water supply. At least one written threat was directed at the St. Francis Dam itself, and Mulholland ordered a drawdown of the water levels as a precaution. Still, during these periods of disruption, Mulholland’s reservoirs saved the city from water shortages.
It was nineteen hundred twenty-eight when the engineer Mulholland
Said the St. Francis Dam was good to go
With a whole year’s worth of water for a thirsty growing Southland
And no danger to the people down below.

But a little short of midnight came a thunder like a cannon.
With a lot of sleeping people in the way
50 million tons of water came down Francisquito canyon
And a night-shift operator started calling folks to say:

Can you hear me in Castaic? This is Lucy on the line.
Wake your family, get them up to higher ground, there’s not much time.
You’d better run out of that canyon, leave all your things behind.
Now I’ve got some other calls to make, said Lucy on the line.

Now Lucy was a Hello Girl in the town of Santa Paula.
You’d hear her voice each time you used the phone
And sometimes she worked the evening shift alone.
Then one night in 1928 came word from up the valley
The dam had failed and death was on the way,
And though Lucy was no expert, she knew water runs downhill,
So she sat down at her switchboard, calling people up to say:

Can you hear me up in Saugus? This is Lucy on the line.
You know a lot of little towns are in the way, one is mine.
We’ve got a monster in our valley and we’re running out of time.
Go get the children out of bed, said Lucy on the line.

Then Piru gone right off the grid, the flood was coming closer
With a hundred feet of water, earth, and stone.
When the sheriff ordered Lucy out she simply told him, No sir,
And went back to saving people on the phone.

When the flood came down to Fillmore town, a lot of homes went under.
She knew which town would be the next to fall.
Then through an open window Lucy heard a growing thunder,
But she held the line to place just one more call.

Can you hear me, Santa Paula? This is Lucy on the line.
Wake your neighbors, wake your children . . .
And the families who, thanks to Lucy, made it out in time
Helped to spread the word and thanked the Lord for Lucy on the line.

The flood ran down along the banks of the Santa Clara River
Leaving fifty miles of death from dam to sea.
With near five hundred people lost, and some were never found,
Mulholland said, “Just put the blame on me.”

The song “Lucy on the Line” is a faithful recounting of the events beginning two and a half minutes before midnight on March 12, 1928. The St. Francis Dam was built to store water from the Owens Valley that was then transported to Los Angeles County via the California Aqueduct. Within days of being filled, the dam catastrophically failed. The collapse sent 12.4 billion gallons of water raging down San Francisquito Canyon into the Santa Clara River valley while people were sleeping in the small towns along the banks of the river.

"Lucy" is a composite character representing the Hello Girls (telephone switchboard operators) of Santa Paula. The operators worked at their switchboards through the night to reach as many people as possible up and down the river and get them out of harm’s way, though they knew they too were in the path of the oncoming flood. When the flood reached Santa Paula, it rose within a few feet of the switchboard office but left the Hello Girls unharmed. They continued making calls to warn the towns downstream even as chunks of concrete the size of houses rolled by.

There were other heroes that night, including law enforcement officers from various agencies who rushed into the path of the flood to get people out; some of them lost their lives. There is a bronze statue in the center of Santa Paula commemorating the extraordinary courage of those officers. The Hello Girls each received a $25 bonus, including overtime, from a grateful public.

Tim Griffin (Tim@GriffinEd.org) is an award-winning professional composer and performer. He loves writing and sharing music with kids and seeing them get excited about STEM and the other subjects covered in his songs. After working with his music, children have actually been found to perform better on standards-based assessments of their knowledge and vocabulary. Tim has performed to great hilarity and edification for the American Association for the Advancement of Science, at dozens of science fiction and folk conventions, and in hundreds of places of learning. The song “Lucy on the Line” won the 2019 Pegasus Award for Best Song. To listen to the song on YouTube, go to https://www.youtube.com/watch?v=ziOZ9xUOZdg.
By the end of 1927, the situation in the Owens Valley had eased. The reservoir continued to rise steadily until early February 1928. As the water level was brought to within one foot of the spillway, several new cracks appeared in the wing dike. A leak beginning at the base of the wing dike was discharging about 0.60 cubic feet per second. Mulholland judged it to be another contraction or temperature crack and left it open to drain, but by early March the leak had approximately doubled. Mulholland ordered an eight-inch concrete drainpipe to be installed to prevent more erosion. The sight of water flowing down the side of the structure caused alarm among the canyon residents.

"The Only Ones I Envy ... Are the Ones Who Are Dead"

On the morning of March 12, the dam superintendent alerted Mulholland to another new leak in the west abutment, where other leaks had previously appeared. The muddy runoff could mean the water was eroding the foundation of the dam.

Mulholland, accompanied by other key staff, spent two hours inspecting the dam. They had concerns about the leak's location and the inconsistent volume of the discharge, but Mulholland believed it was nothing out of the ordinary for a large dam. While some corrective measures were needed, they could be done at some time in the future.

He was wrong.

Twelve hours later, the dam collapsed. A blast of water, mud, and concrete made it all the way to the sea. Bodies were found washed ashore as far south as San Diego. There were no surviving eyewitnesses to the collapse, but investigative records found that at least five people passed the dam less than an hour before without noticing anything unusual.

Recovery crews worked for days to dig out bodies and clear the mud from the flood's path. While a final count may never be known, the official death toll, based on several sets of records, is estimated to be at least 431, of which at least 108 were minors.

Seconds after the collapse began, the dam was mostly gone. Much of the structure washed downstream as water surged down San Francisquito Canyon. The largest chunk of concrete, estimated at 10,000 tons, landed about three-quarters of a mile below the dam site.

Mulholland took full responsibility for the disaster and is said to have spent the rest of his life in relative seclusion, devastated by the tragedy. During the Los Angeles coroner's inquest, he said, "The only ones I envy about this whole thing are the ones who are dead." He later added, "Whether it is good or bad, don't blame anyone else, you just fasten it on me. If there was an error in human judgment, I was the human, I won't try to fasten it on anyone else."

It was later found that no geologist would have supported the building of the St. Francis dam without foundation treatment. Some rock formations at the site are known to absorb water and swell. The site also included sections of ancient landslides. Though the site overlaid the inactive San Francisquito fault line, it was not seismic activity that created the collapse. Instead the fault line served as a water pathway that led to the internal erosion of the structure. Investigators believed that there were no geologists on the project team and no outside party was consulted to review the safety of the location.

The lessons of the St. Francis Dam would alter the eventual design of Hoover Dam and led to reinforcement of and changes to the earlier concrete dam the city had constructed. It also prompted a series of new dam safety laws. A case study of this and other dam failures is to this day maintained by the Association of State Dam Safety Officials as a cautionary tale to all dam builders and inspectors.

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