

# TEMPE TOWN LAKE DAM – ANOTHER BURST BUBBLE

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## ABSTRACT

On the night of 20 July 2010, one of the rubber bladders that comprise Tempe Town Lake Dam failed, sending a wave of water, within the banks of the Salt River past Phoenix Sky Harbor International Airport and through the Phoenix Metropolitan area. There was no loss of life or serious flood inundation, as the water was contained safely within the banks of the otherwise dry Salt River. Fortunately the dam failed that night instead of either earlier that afternoon or the next day when construction and engineering personnel would have been working downstream of the dam. The construction personnel were to begin the replacement of those four, 16-foot diameter bladders that make up the nearly 1,000-foot long dam. Stantec Consulting Services Inc. provided the engineering, inspection, permitting, agency coordination, and construction management for the emergency repair of the dam. The construction contractor was PCL Construction Inc., and the bladders were manufactured by Bridgestone Industrial.

The team worked closely with the dam owner (City of Tempe), the Arizona Department of Water Resources, the US Army Corps of Engineers, the Flood Control District of Maricopa County, the Arizona Department of Environmental Quality, the Salt River Project, Phoenix Sky Harbor International Airport, and other agencies and stakeholders in meeting the dam safety, permit, environmental, and construction requirements. To make the effort more challenging, the city had committed to having the lake functional before winter to meet scheduled events and tourist attractions.

In addition to construction management, Stantec performed structural inspection of the dam superstructure as each bladder was removed, and coordinated the material testing of the failed bladder to ascertain the cause of failure. The dam was repaired and lake filling commence in October 2010, meeting the City's schedule.

The presentation covers the dam failure, its cause, inspection, bladder replacement, and construction challenges. The failure of Tempe Town Lake Dam illustrates the poor condition of our dams and infrastructure, and the possible dire consequences to our public welfare.

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## EXECUTIVE SUMMARY

Tempe town Lake provides a unique attraction and economic benefit to the City of Tempe and the Phoenix metropolitan area. The lake was created by placing two dams across the Salt River as it passes through Tempe. Due to the requirement that the dams not impede the passage of floods in the Salt River nor raise the regulatory 100-year flood water surface level, traditional dam and spillway configuration was not possible. Rather, the dams are essentially gates that can be fully opened to allow the passage of infrequent, but also potentially large flood discharges. To achieve that objective, Bridgestone industrial rubber bladders were used for both dams. The downstream dam consists of four bladders, each 16 feet in diameter and 200 feet long, see Figure 1. The four upstream bladders are 5 feet in diameter and 200 feet long. The "lake" formed in the Salt River channel between the two dams can be filled either by water supplied by the Salt River Project, or by retaining runoff at the recession of a flood. The operational goal is to deflate one or more upstream and downstream bladders during floods to pass flood discharges through the Salt River channel and reinflate the bladders after the flood recedes. The downstream bladders can be inflated or deflated in 45 minutes. The dams are operated for the City of Tempe by the Salt River Project.

The lake is about 2 miles long, 800 to 1,200 feet wide, 220 acres of surface area, 7 to 19 feet deep, and contains about 3,000 acre-feet of water. It is surrounded by recreational grounds and facilities, offices and residences, and tourist amenities.

The lake is the second largest attraction in Arizona, behind the Grand Canyon, with more than 2.7 million visitors each year. It is the host of events such as the Arizona Ironman Competition, and Super Bowl and college football Bowl Championship Series (BCS) parties. It has provided about \$415 million economic impact in its 10 years of existence.

Groundbreaking for the dams was 8 August 1997, and construction was completed in 2 years. The lake was filled by Salt River Project water in July 1999 and was open to the public in November 1999.

The dam is under the jurisdiction of the Arizona Department of Water Resources and is inspected annually. The 2007 inspection presented concerns about the integrity of the downstream dam rubber bladders. The City entered into discussion with Bridgestone regarding replacement of the bladders under warranty. In 2009, Bridgestone agreed to replace the bladders, at no cost to the City of Tempe, for 5 years. After 5 years, either the bladders would be replaced by Tempe or Bridgestone would receive compensation for their use from that time on.



**Figure 1.** Tempe Town Lake Dam with four (4), 16-foot high, 200-foot long rubber bladders forming a lake within the Salt River banks in Arizona prior to failure

In 2009, Tempe hired PCL to be the contractor for the replacement of the four, 16-foot diameter, downstream bladders. Stantec was selected by Tempe to provide construction administration services including the inspection of the superstructure of the dam during bladder replacement. Ultimately, Stantec performed other services including permitting for the emergency replacement of the bladders and investigations into the cause of the bladder failure in 2010. According to the 2009 bladder replacement plan, the four bladders would be replaced, one at a time, beginning in January 2010 and finished in January 2011. That process would require placing a steel coffer dam in the bay of one of the bladders while that bladder was replaced. This would allow the lake to remain functional during bladder replacement, although requiring a year to complete the replacement of all four bladders.

The winter of 2009-2010 produced above normal precipitation in the Salt River watershed above the dam. Rainfall and snowmelt runoff was released by the Salt River Project through the numerous water supply and flood control dams on the Salt and Verde Rivers. That runoff precluded the start of bladder replacement until the summer of 2010.

During the day of 20 July 2010, staff of PCL and Stantec were in the Salt River channel downstream of the dam preparing to begin bladder replacement on 21 July. That night at 9:44 pm, one of the four bladders burst, releasing 2,400 acre-feet of water into the Salt River below the dam, see Figure 2. The peak discharge was estimated at 40,000 cfs. Fortunately, there was no loss of life or property damage since the flood wave was contained within the banks of the Salt River. The failure received national news coverage including concern about sabotage or terrorist activity.

Replacement of the bladders commenced under heightened urgency to restore the lake prior to the fall/winter tourist season. However, Bridgestone could only provide three of the four bladders prior to the date when the lake needed to be filled. The bladder failure and lake draining allowed three of the four bladders to be replaced without the need to install a coffer dam in each bay prior to existing bladder removal. That facilitated bladder replacement significantly for the three bladders, as installation of the coffer dam for each bay requires about two weeks. By October 2010, three bladders were replaced and the steel coffer dam was temporarily placed in the fourth bay so that the lake could be filled, see Figure 3. The final bladder was replaced in November 2010 with the coffer dam in place and a full lake.



**Figure 2.** Rubber bladder failure at Tempe Town Lake Dam on 20 July 2010.



**Figure 3.** Installation of the fourth rubber bladder at Tempe Town Lake Dam with the steel coffer dam in place and the lake filled.

The replacement bladders will likely withstand the existing desert heat and sun damage conditions better than the original bladders because the new bladders will have the benefit of shade from a newly constructed pedestrian bridge and will be cooled from a new water sprayer system designed by Stantec. The new bladders will also have a lower operating pressure (which will reduce the continuous pneumatic pressure on the rubber) and will be smaller than the original bladders (15-foot diameter rather than 16-foot).

The Tempe Town Lake Dam Failure presentation will discuss the bladder failure and likely cause, inspection of the superstructure, and construction highlights of the replacement bladders.