CASE STUDY

SAN BRUNO

Automated Residual Boosting System Improves Chloramine Levels, Eliminates Nitrification in 400,000-gal Tank

OVERVIEW

Like many municipalities in urban and suburban areas, San Bruno's source water comes both from its own groundwater supply and through a purchase agreement with a major water utility – in this case, San Francisco Public Utilities Commission (SFPUC). And, like many municipalities in California, SFPUC, along with San Bruno, switched from free chlorine to chloramines in 2003 largely to reduce disinfection by-products.

At first, the conversion to chloramines didn't present a major challenge for San Bruno, other than having to fluctuate tank water levels to maintain proper chlorine residual. However, in 2010, San Bruno and the other 26 agencies receiving SFPUC water started experiencing issues with nitrification. San Bruno first detected low chlorine residual and high free ammonia with elevated nitrite levels in two of their remote tanks. Distribution operators at San Bruno worked quickly to isolate the affected pressure zones and water tanks, flushing and draining these parts of the system in an attempt to restore acceptable water quality.

"September and October were especially bad," explained Water System and Conservation Manager Mark Reinhardt. "That's our Indian summer – the hottest time of year in the Bay Area. At one point, we were detecting chlorine residuals as low as 0.5 ppm, far below our action level of 1.4 ppm. The storage tanks were drained in the excess of 60,000 gallons every two weeks and we'd have to send out a crew of 4-5 to flush water in this entire pressure zone – it was a big maintenance burden."

Seeking a way to reduce the cost and manpower associated with nitrification, San Bruno's utility managers researched technologies to lower the risk of nitrification in their water storage tanks. San Bruno managers implemented PAX Water Mixers in all their water storage tanks in 2012. This helped maintain residual in tanks, but operators knew that mixing alone would not solve all the nitrification problems the utility was facing.

Figure 1. The 400,000-gallon Sweeney Ridge tank is the high point of the San Bruno Water system. While the tank enjoys some of the best views in the San Francisco Bay Area, the elevation, extreme weather and isolation by a 1-mile pipeline makes water quality maintenance a challenge.

"Part of the problem was that we were receiving water of variable quality," said Mark Reinhardt. "Our goal is to maintain 2.6 ppm chlorine residual in our tanks, and we were occasionally receiving purchase water below 1.9 ppm." The utility needed a combination of active mixing and automated disinfectant boosting. So when engineers at PAX Water Technologies were seeking trial sites to demonstrate the effectiveness of their newly developed Residual Control System (RCS), San Bruno was first in line.

RCS combines the powerful PAX Water Mixer with a set of water quality sensors, a pair of chemical feed systems for adding chlorine and/or ammonia and a closed-loop control system to automatically and continuously monitor and adjust chloramine disinfectant levels in a distribution system storage tank. "The RCS acts like a thermostat on a building – setting and maintaining a constant level of residual disinfectant with the tank in continuous operation," explains Dr. Robin Giguere, who leads the PAX Water R&D team.

The 400,000-gallon Sweeney Ridge tank was selected as the site for the RCS trial (Figure 1). This tank is isolated by 1- mile of 14-inch pipeline and often experienced high water age, thermal stratification and elevated free ammonia levels which left it prone to nitrification. Dumping water from the tank was particularly problematic since Sweeny Ridge is located in a protected environmental area in Golden Gate National Recreation Area. While mixing solved the thermal stratification problem, RCS was needed to correct the ammonia-to-chlorine ratio. Operators from San Bruno and engineers from PAX Water installed the system in the summer of 2013.

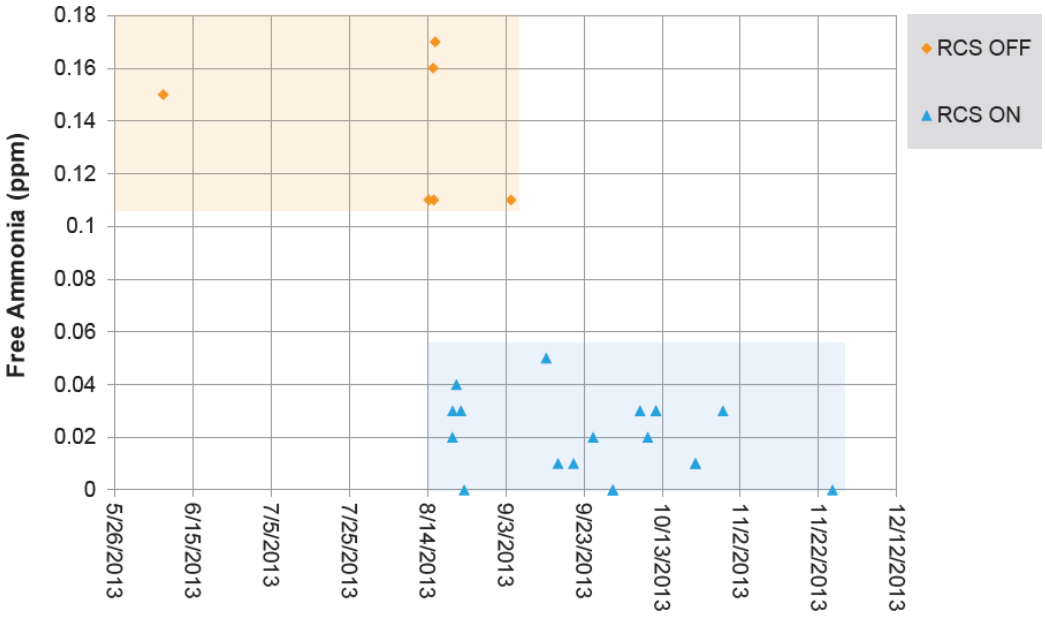

Figure 2. Free ammonia data taken with the RCS OFF (in orange) and ON (in blue). The average free ammonia level when the RCS was OFF was 0.14 ppm whereas when the RCS was in operation, free ammonia levels averaged less than 0.02 ppm.

"The site is wonderful in some ways," explained Giguere, "with chlorine sensors already installed on-site and a sweeping panoramic view of the San Francisco Bay and Pacific Ocean. Unfortunately, the weather conditions can go from beautiful and sunny to 50 mph winds, fog and large temperature drops in a matter of minutes. So it ended up being an extreme test for the environmental performance of our system."

Installation of RCS was completed in late May 2013 and testing began in June. In the first phase of tests, the goal was to use the RCS to continuously monitor the water chemistry in the tank, detect levels of free ammonia, and add just enough chlorine to fully combine with the ammonia to produce monochloramine. Rather than try to control a specific chloramine residual set-point (which would require the simultaneous addition of chlorine and ammonia) the RCS simply added enough chlorine to eliminate the free ammonia present in the water and then stop.

Figure 2 shows the free ammonia level for periods of time with the RCS OFF versus the RCS ON. The average free ammonia level when the RCS was OFF was 0.14 ppm whereas when the RCS was in operation, free ammonia levels averaged less than 0.02 ppm (the detection limit for the method used). Lab samples confirmed that the RCS maintained ideal monochloramine chemistry during this phase of the trial. The results proved to San Bruno operators that the RCS could eliminate their excess ammonia problem reliably while maintaining consistent monochloramine chemistry. "Right away, we saw chlorine residual levels improve in our Sweeney Ridge tank and our nitrification problem went away," said Reinhardt.

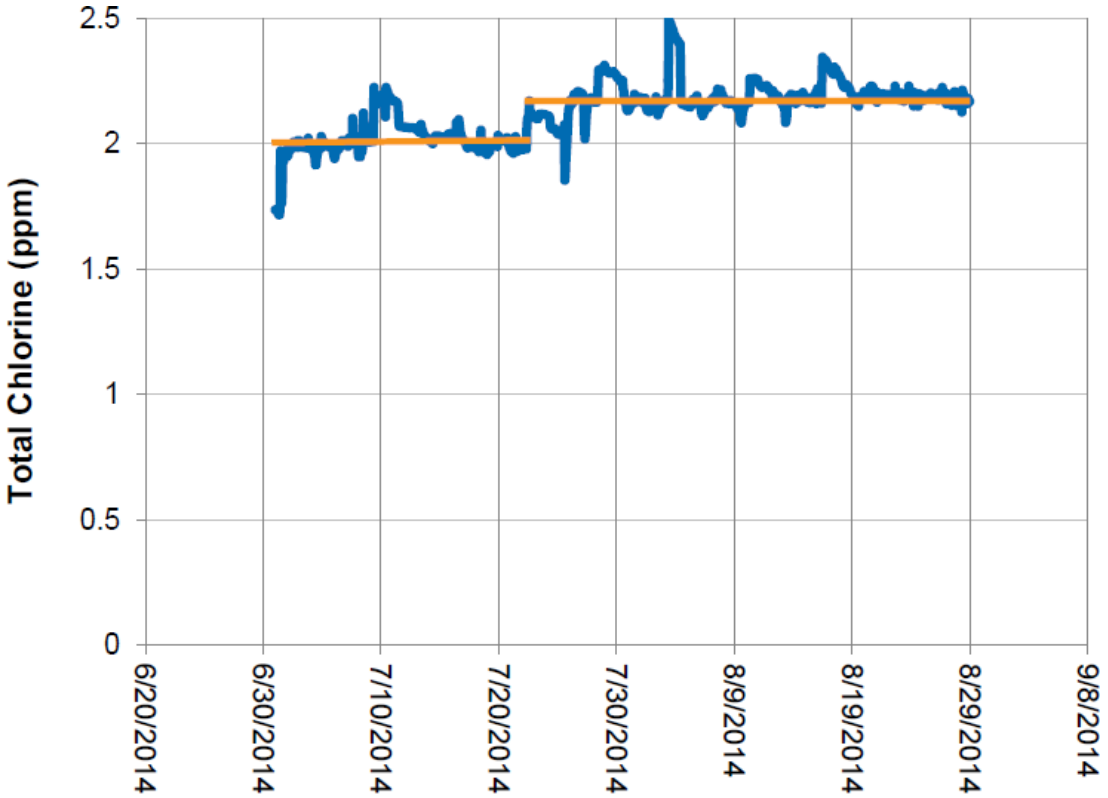

Figure 3. Phase 2 of the RCS trial demonstrated the direct and continuous control of total Cl levels in the Sweeney Ridge tank. Operators established a set point of 2.0 ppm on July 1, then raised the set point to 2.2 ppm on July 21.

After a year of site and environmental tests, San Bruno and PAX Water moved to Phase 2 of the trial: direct monochloramine set-point control. For this second phase of the trial, an ammonia chemical feed skid was installed and integrated with the RCS system. Prior to turning on the system, total chlorine levels in the tank averaged around 1.5 ppm. Operators chose an initial set point of 2.0 ppm total Cl and turned on the RCS. Within the first 24 hours, the RCS added chlorine and ammonia and continuously monitored water chemistry until the 2.0 ppm set point was reached (Figure 3). For the following three weeks, the RCS held the 2.0 pm set point as the tank was filled and drained. In late July, operators bumped the set point up to 2.2 ppm and the RCS quickly established this new level and held it through the summer.

Alongside RCS, PAX Water activated the remote monitoring system (RMS). This system takes the water quality data and operational parameters from the RCS controller and transmits it wirelessly to PAX Water and San Bruno operators. This allows operators (and PAX Water) not only to monitor the performance of the various RCS subsystems (such as to schedule refills of disinfectant chemicals), but also to provide them with continuous, real-time monitoring of the water quality inside the Sweeney Ridge tank.

Following completion of Phase 2 of the trial, San Bruno moved forward with the permanent installation of RCS at Sweeney Ridge and implementation of RCS at two additional tanks in their system: the reconstruction of their 2MGD Glenview tank and tank No. 4. "With the combination of active mixing in all our tanks and RCS, we're one of the only municipalities in the area to keep our tanks ¾ full and maintain good residual levels," said Reinhardt. "With the addition of another two RCS systems, I expect to keep my tanks completely full, with steady residual, no nitrification and year-round fire protection."

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- Mark Reinhardt, Water System and Conservation Manager, City of San Bruno

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