Case Study
Active Mixing in 5 MG Concrete Tank
Pinellas, FL

The Problem

Pinellas County, Florida is typical of many major metropolitan water systems, with over 700,000 customers, 2,000 miles of piping and several large water storage facilities. Like many major metropolitan water systems, Pinellas County Department of Environment and Infrastructure (DEI) has seen a decline in water usage over the last decade, both due to active water conservation programs and downturns in the regional economy. This decrease in water usage has increased water age, and coupled with warm southern temperatures, has increased incidences of nitrification in parts of their chloraminated system.

In 2000, Pinellas County DEI embarked on a major upgrade in anticipation of their conversion to chloramines as a secondary disinfectant and installed passive mixing systems in each of their ground-level water storage tanks. Once the chloramine conversion was complete in 2002, DEI found that nitrification was still an issue in some of their storage tanks. To reduce nitrifying bacteria and biofilm growth, DEI performed a chlorine maintenance (or free chlorine burn) each spring in which the secondary disinfectant was switched from chloramines to free chlorine for several weeks. DEI also increased its flushing, averaging roughly 255 million gallons of water per year.

In 2009, Pinellas County DEI experienced its earliest recurrence of nitrification after chlorine maintenance in the beach community at the southern end of the County. Despite the presence of passive mixing systems in their tanks, operators at DEI were aware that mixing conditions were not optimal. One indication: as tanks were drained, operators saw a steady drop of chlorine levels, suggesting that the upper layers of water in the tanks were depleted of disinfectant residual.

“These storage tanks were designed to be full,” explained Royce Rarick, Senior Water Plant Operator at Pinellas County DEI. “We would watch the residual drop as the tank was pumped out.” Temperature measurements at various levels within the tank rarely showed the presence of thermal stratification, but the variations in chlorine levels (and the episodes of nitrification) strongly suggested that the existing mixing systems were unable to maintain homogeneous water chemistry.

The Solution

Anticipating further decreases in water demand (due to the loss of a secondary water customer), DEI asked Jones Edmunds & Associates, Inc. to study their distribution system and propose infrastructure and operational improvements to reduce the risk of nitrification and the need for large bulk water turnover by flushing. Jones Edmunds recommended the use of active mixers to improve mixing in the storage tanks and contacted Utility Service Group to set up a demonstration test using a PAX Water Mixer. Unlike passive mixing systems, which only introduce momentum into the tank during the fill cycle, PAX Water’s

The Solution

active mixing systems operate 24/7, creating a powerful flow pattern within the tank and ensuring uniform distribution of disinfectant residual.

In order to confirm that active mixing would be sufficient to overcome the chemical stratification inside the tanks, Pinellas County DEI conducted a performance trial in which temperature and residual would be monitored. Two 5 MG tanks at the North Booster Pump Station were selected. A PAX Water Mixer (PWM400) was installed in one tank and the other tank was left as a control (Figure 2). Both tanks were filled and drained only from their outlet sumps – simulating worst-case hydraulic conditions inside the tanks. Temperature probes were installed and grab samples were taken from the bottom, middle and top of each tank every day over a 1-week period.
Initially, when the PAX Water Mixer was installed, power was inadvertently set to only 50% of its total power rating.

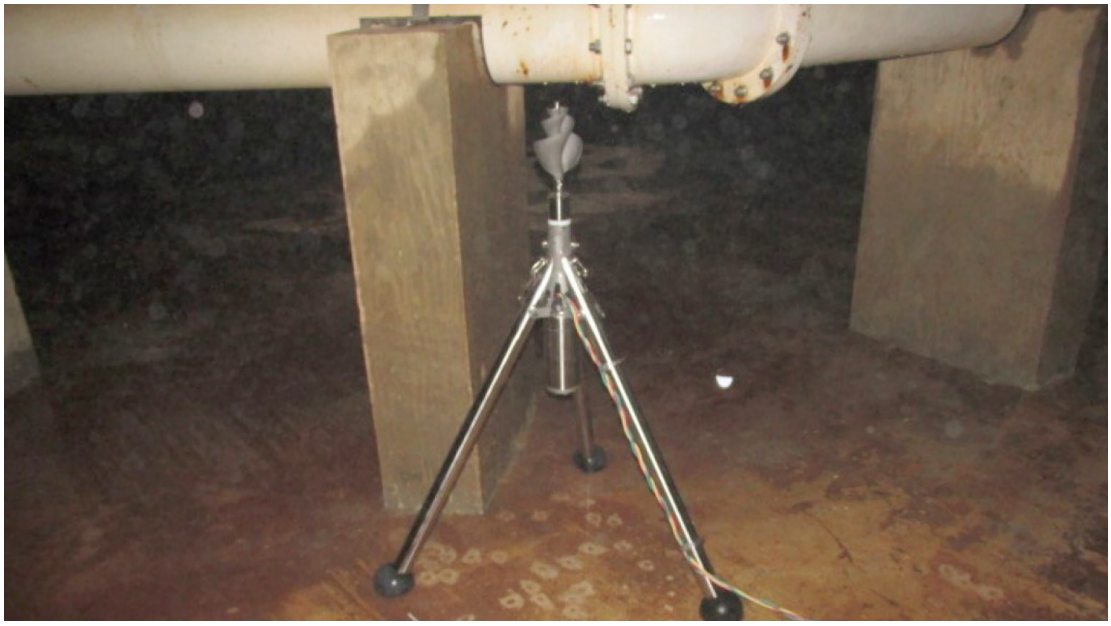

Figure 2. The PAX Water Mixer was installed in a 5MG tank with an existing passive mixer (shown behind PAX Water Mixer in above image).

The Conclusion

The temperature data showed only slight differences in thermal stratification between the control tank and the actively mixed tank. The control tank showed slightly more thermal stratification at the top of the tank, but the magnitude was small, averaging only 0.2 °C during the study (Figure 3). From the temperature data alone, both tanks would appear to be sufficiently mixed.

It was the chlorine residual data that told the real story. In the control tank, residual chlorine quickly became stratified, with levels 0.5 to 0.9 ppm lower at the top of the tank compared to the bottom. However, in the actively mixed tank, chlorine residual levels were within 0.1 ppm of each other (Figure 4). The data revealed that while thermal conditions remained relatively uniform, significant chemical stratification quickly developed. The active mixer was able to restore homogeneous chlorine distribution throughout the tank.

The Conclusion

In a 2013 Florida Water Resources Conference presentation[1], Jones Edmunds reported their findings: significant chemical stratification can exist inside water tanks that show little or no thermal stratification. The active mixing system installed in the 5 MG tank was able to eliminate the chemical stratification even with the worst-case inlet/outlet conditions. "The most impressive part is that even at 50% of the mixer's total power rating, it still provided great performance," Chris Baggett, Senior Engineer at Jones Edmunds.

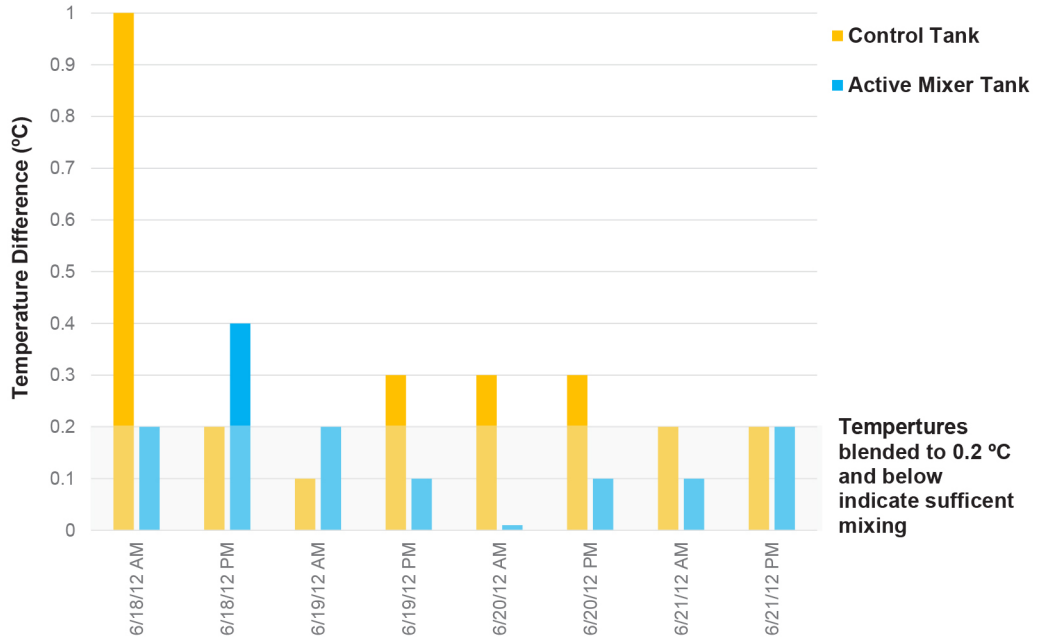

Figure 3. Temperature measurements from the bottom and top of both tanks showed mild thermal stratification. The tank with active mixing (blue bars) showed a slightly smaller amount of thermal stratification than the control tank (yellow bars).

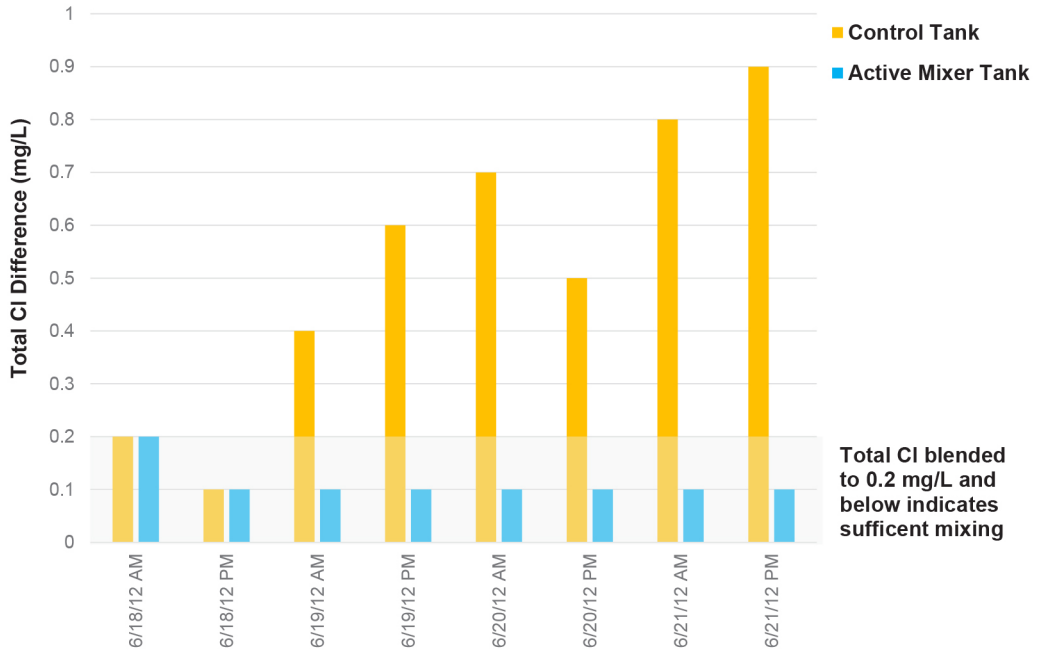

Figure 4. Chlorine measurements from the bottom and top of the tanks showed major differences. The control tank (yellow bars) showed substantial chemical stratification for much of the trial. However, the tank with the active mixing system (blue bars) showed uniform chemical conditions (within +/- 0.1 mg/L).

The Conclusion

By the end of 2013, Pinellas County DEI had installed PAX Water Mixers in eight of their tanks. Active mixing was not the only recommendation made by Jones Edmunds and adopted by Pinellas County DEI. Operational levels in some of the water storage tanks were lowered to reduce water age and pressures were adjusted in some parts of the distribution system to improve flows. Managers also added a second chlorine maintenance event at the end of the warm season and, in one area a water storage tank was taken offline. As a result, Pinellas County DEI saw a substantial reduction in their flushing (Figure 5). From 2011-2013, monthly flushing rates averaged 35 MG during the first half of the year, whereas in 2014, monthly flushing rates averaged just 17 MG for the same time period (just below Pinellas County's target of 20 MG/month).

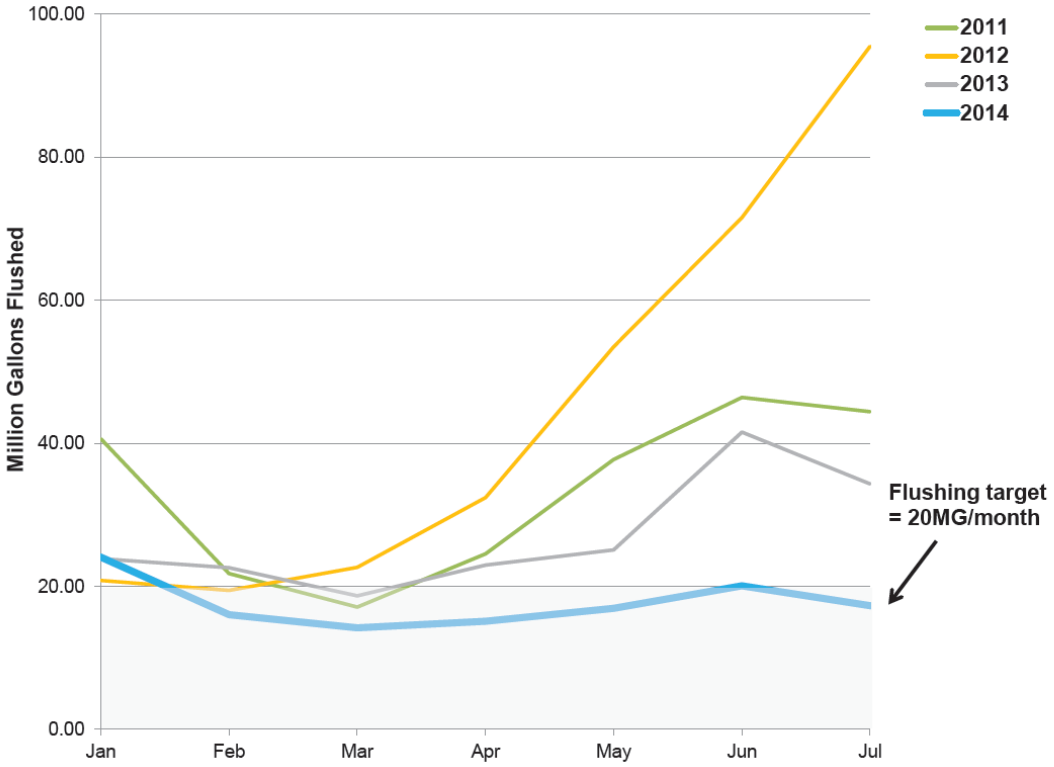

Figure 5. Pinellas County DEI has a flush target of 20MG/month. From 2011-2013, monthly flush rates averaged 35 MG during the first half of the year. After the majority of the PAX Water Mixers were installed by early 2014, flush rates averaged just 17 MG/month for the same time period.

"Between the combination of mixers going in and running the tanks lower, we are definitely maintaining better residuals than in the past, and we are flushing less than we had been."

— Royce Rarick, Senior Water Plant Operator, Pinellas County DEI

Key Takeaways

1. Thermal uniformity does not guarantee good mixing: major differences in disinfectant uniformity can exist inside a tank that is thermally uniform.

2. An active mixing system (even operating at 50% of its total power rating) provided sufficient mixing power to maintain fully-mixed conditions in a 5 MG storage tank, eliminating both thermal and chemical stratification.

References

[1] Baggett, C. C., Horvath, J. H., Rosario, R. A., Hall, J., and Powell, R., (2013) Controlling Nitrification within Pinellas County's Ground Storage Tanks. Florida Water Resources Journal v. 65, no. 12, p. 22-26.