



PSI Water Technologies
A UGSI SOLUTIONS COMPANY

Distribution Network Water Quality Management

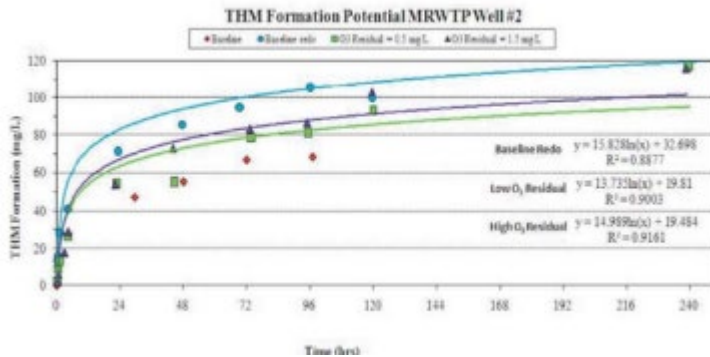
“Smart Tanks”



Utilities have no “free lunch” as the choice of secondary disinfectant will determine the problems they will contend with:

Free Chlorine

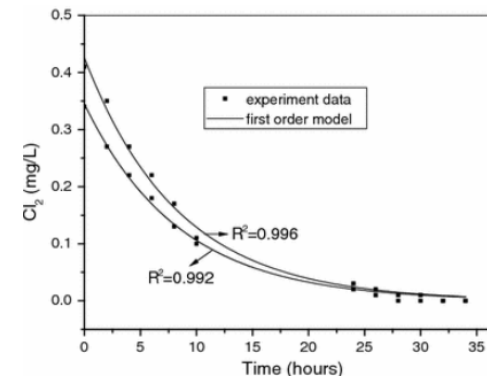
- Boosting to offset **degradation**
- DBP **formation** (THM and HAA5 issues)



DBP Formation Curve

Chloramines

- Chloramine **degradation** (ammonia formation)
- Nitrification (nitrite and nitrate MCLs)



Chloramine Degradation Curve



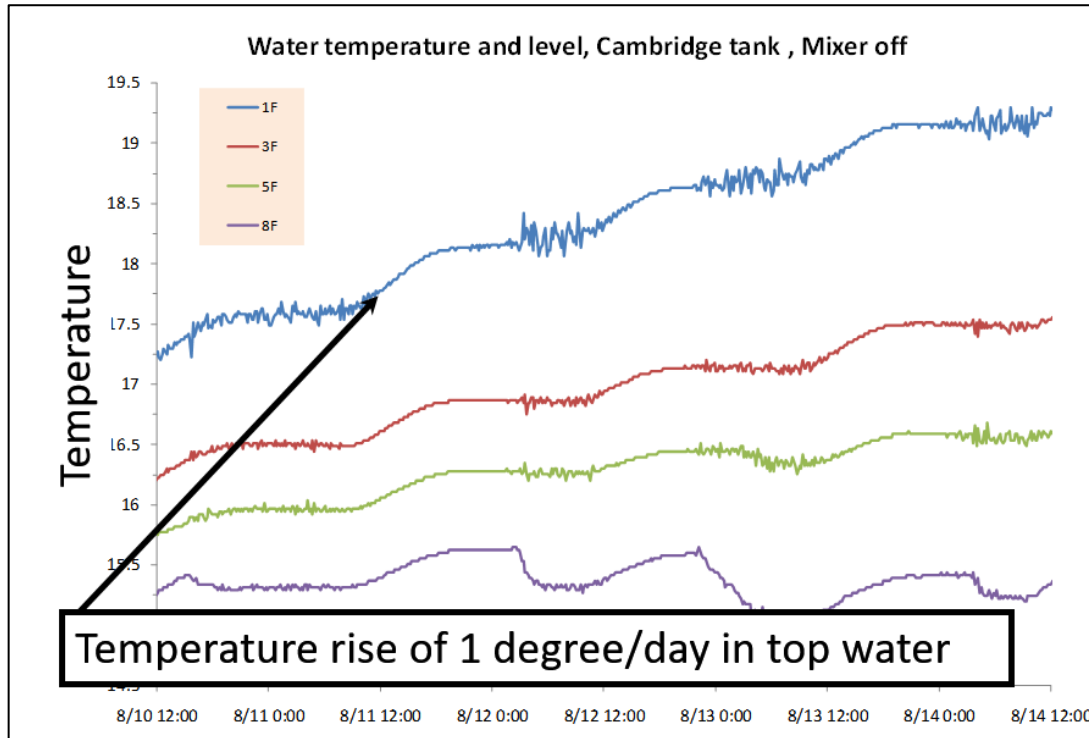
Water storage tanks often suffer from a lack of maintenance which exacerbates a loss of water quality



- Biofilm formation is indicative of a lack of disinfectant residual and can result in furthering coating failure as well as a source of AOB/NOB
- Compromised venting is common
- Sediment can increase disinfectant load and harbor colonies
- Infrequent maintenance reduces tank life

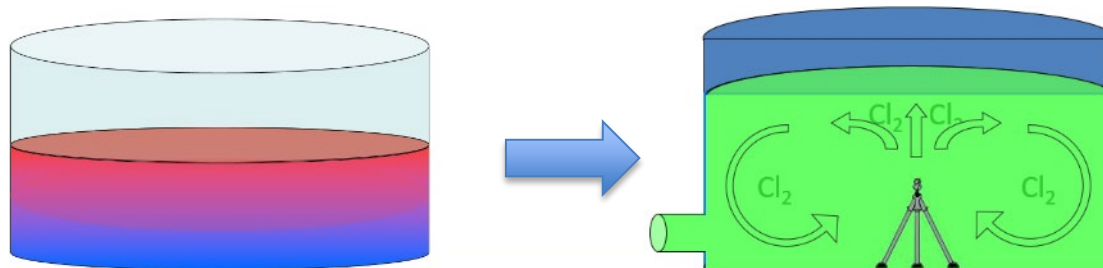


Un-mixed tanks suffer from temperature and chemical stratification which creates a cascade of issues

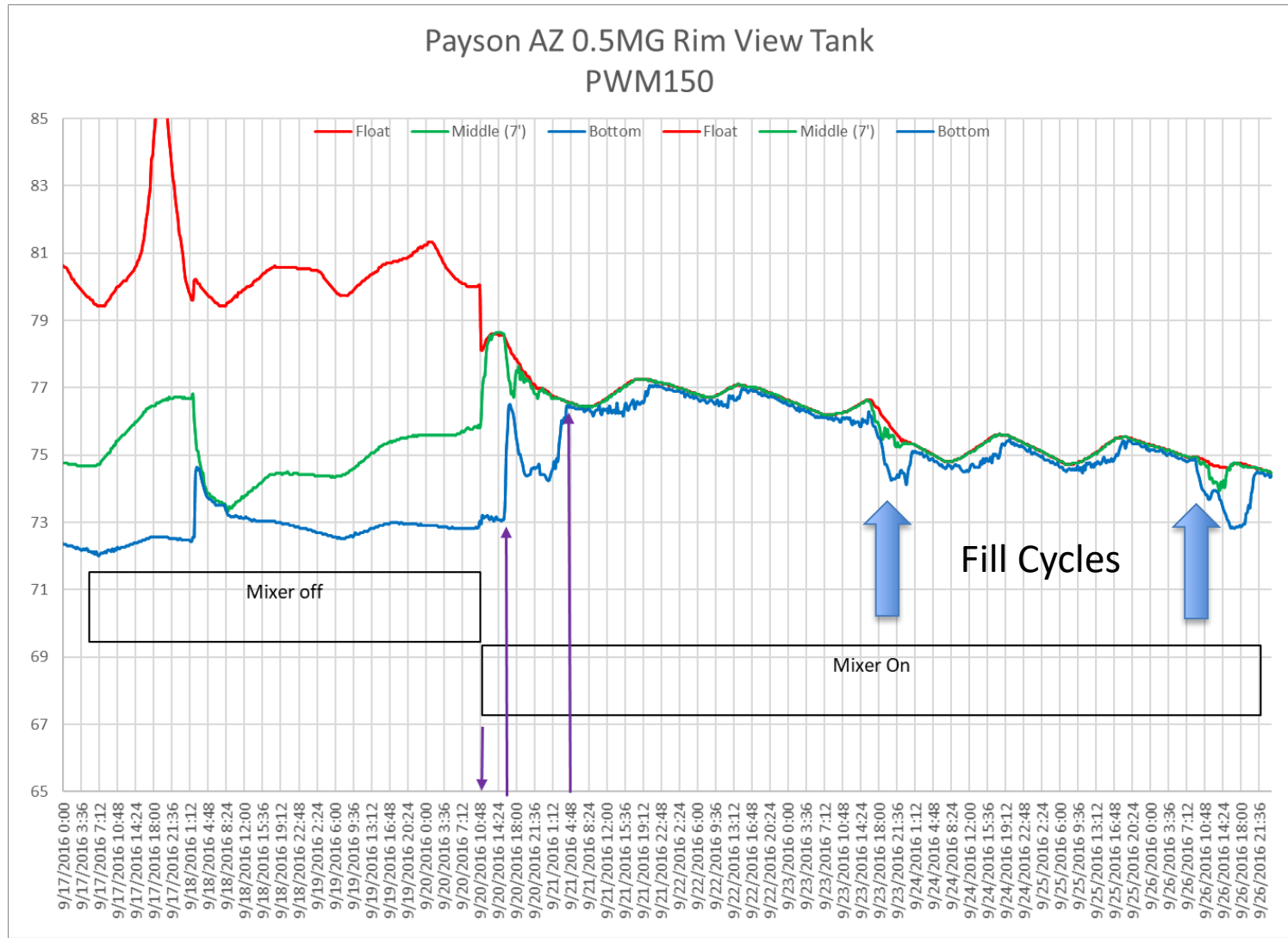


Effective tank mixing:

- Better distribution of disinfectant throughout the tank that can reduce biofilm risk and ensure consistent effluent residual
- Lower overall water temperature that is favorable for residual longevity
- Decreased sediment accumulation in tank
- Prevention of destructive ice formation



Properly sized active tank mixing eliminates tank stratification



Effective mixing can come in a variety of configurations (form factor and horsepower) depending upon process objective and site constraints



Tank Shark® Eductor Mixer



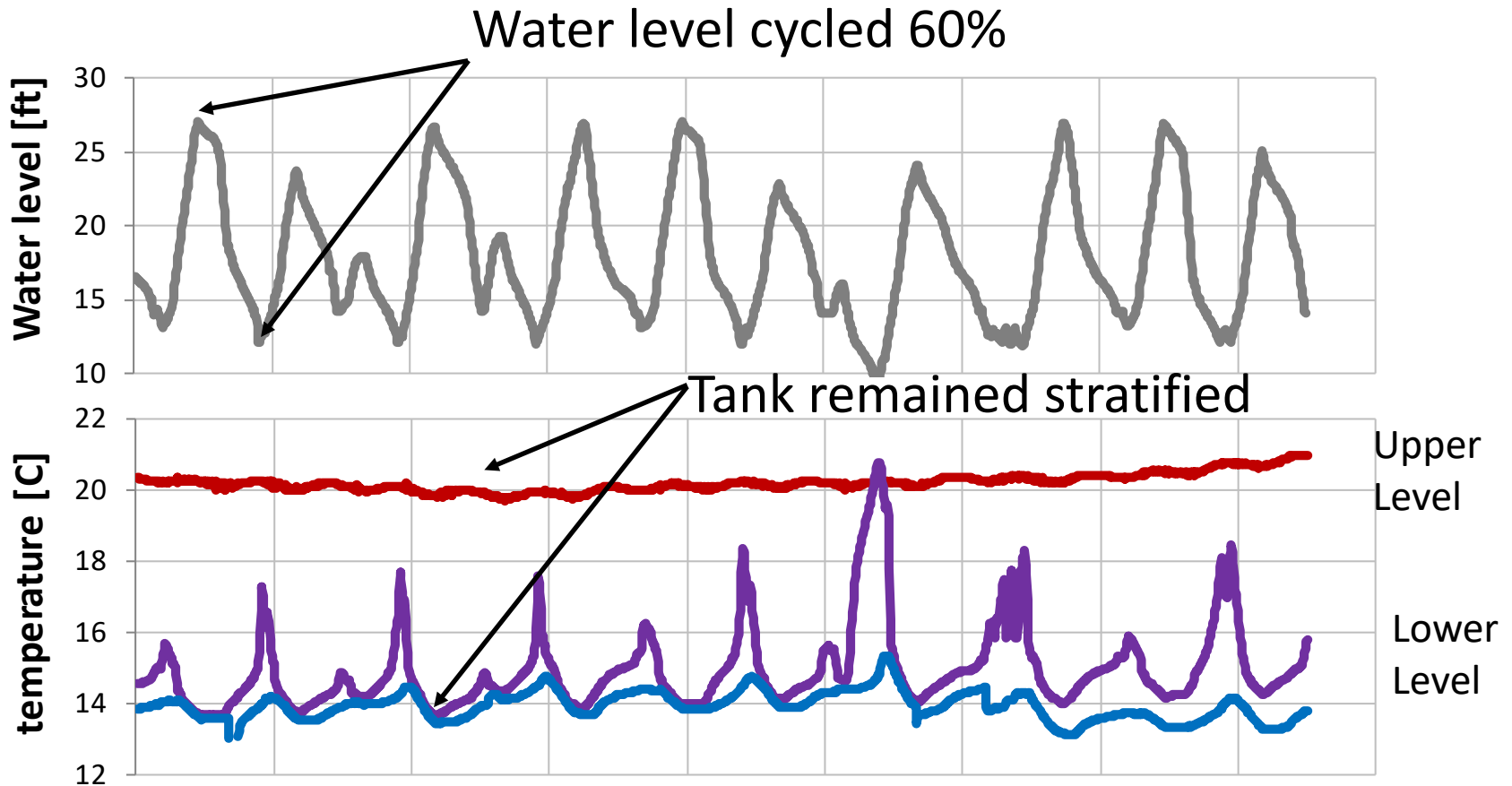
PAX Jet Mixer



PAX Impeller Mixer



Deep cycling is not a mixing solution – intermittent and ineffective



Mixer choice depends on process objective with consideration of available power, turnover, geometry, climate and dosing needs

For Example:

Turnover/Cycling

- Mixer must achieve mixed tank within cycle-time of tank (mixing has to be faster than rate water enters and leaves the tank)

Process Objective

- De-stratification, ice-prevention, chemical dosing, THM aeration all require different mixer capacity and power



THM Reduction: Starts with *Strong* Mixing

“Smart Tanks”



There are four general strategies to deal with THMs: change disinfectant (to chloramines), reduce NOM (naturally occurring organic material), reduce water age, or remove THMs after they form

PAX TRS™ removes THMs by tank aeration after they form

TIME



**Free Chlorine
(Cl)**

+



**Natural Organic
Matter
(NOM)**

=



**Disinfection
Byproducts
(DBP)**



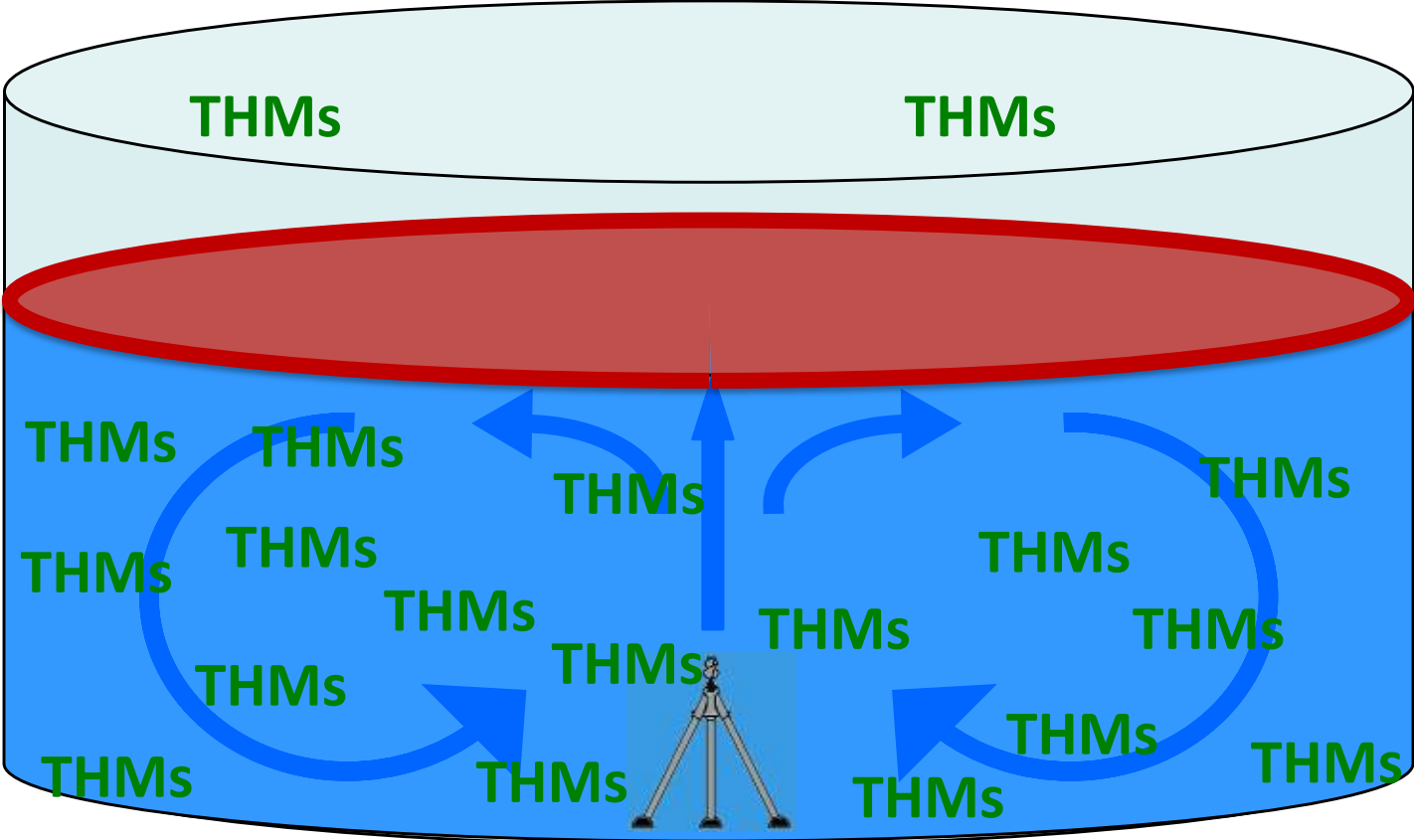
THMs are volatile ... just like CO₂

- THMs would rather be in gas phase than liquid phase
- The **driving force** for mass transfer from liquid phase to gas phase is based on a difference in concentration between THMs in the water and THMs in the air
- THMs can build up in the headspace of a tank if its not actively ventilated, stopping THM volatilization (Henry's Law)
- Optimizing a tank to volatilize THMs can be simple or complex, depending on the tank conditions, the amount of treatment needed and energy constraints/cost

“Headspace”



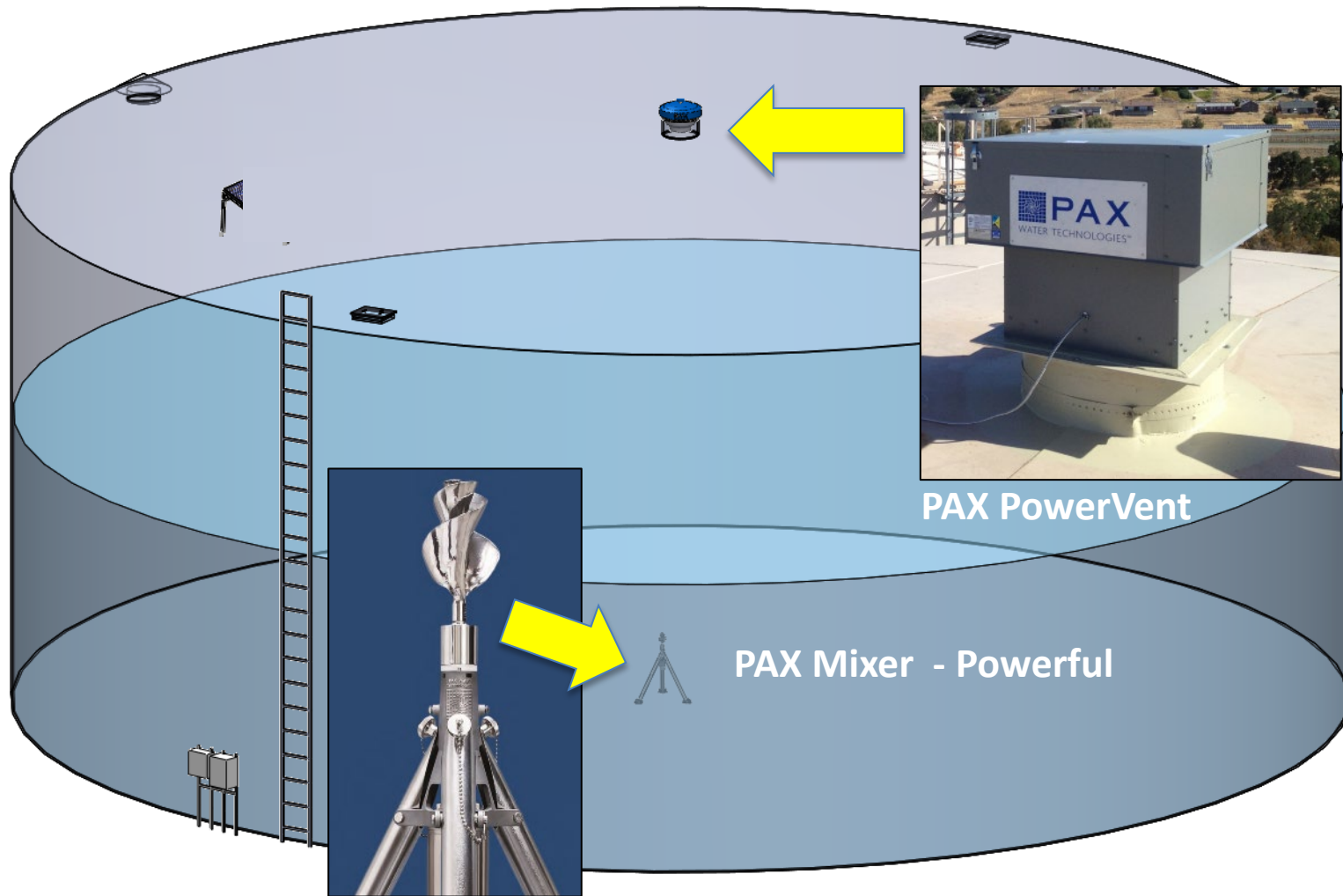
Henry's Law limits passive THM removal, but active mixing allows THM's to bridge the diffusional barrier



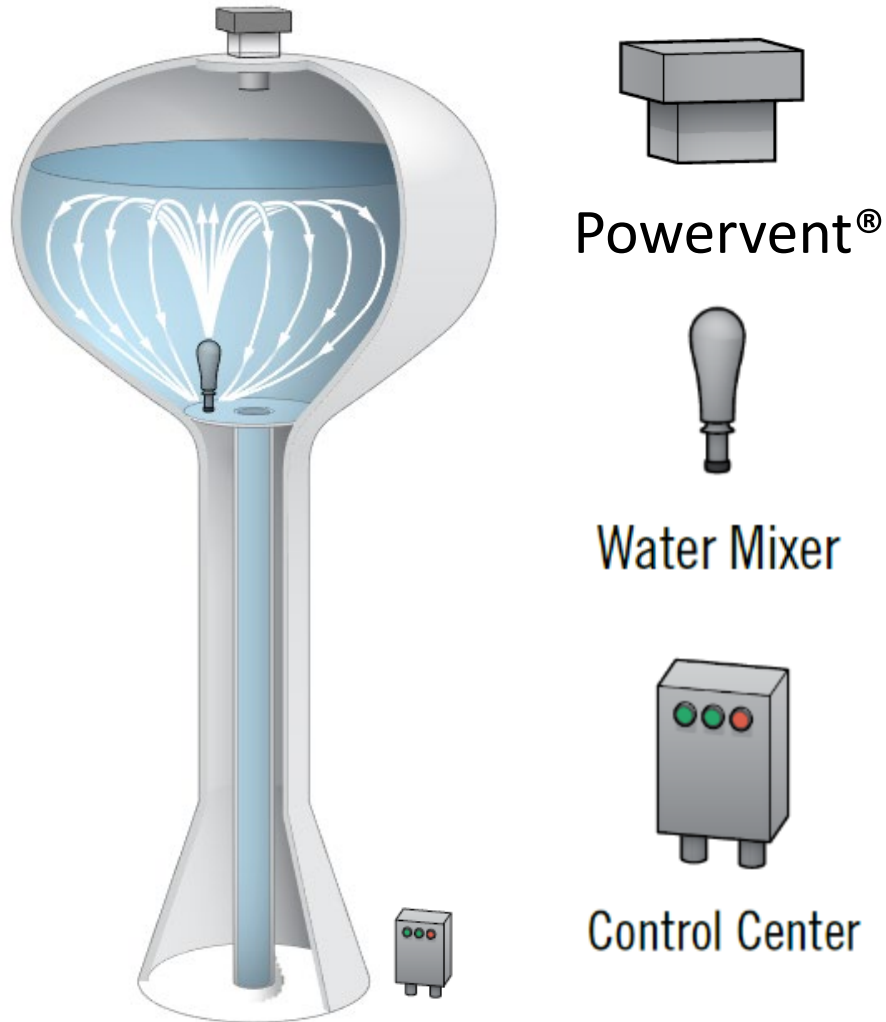
But you need **STRONG** mixing



Adding active ventilation breaks Henry's Law equilibrium in tank head-space



Mixer + Powervent[®]: ideal for tanks with high residence time

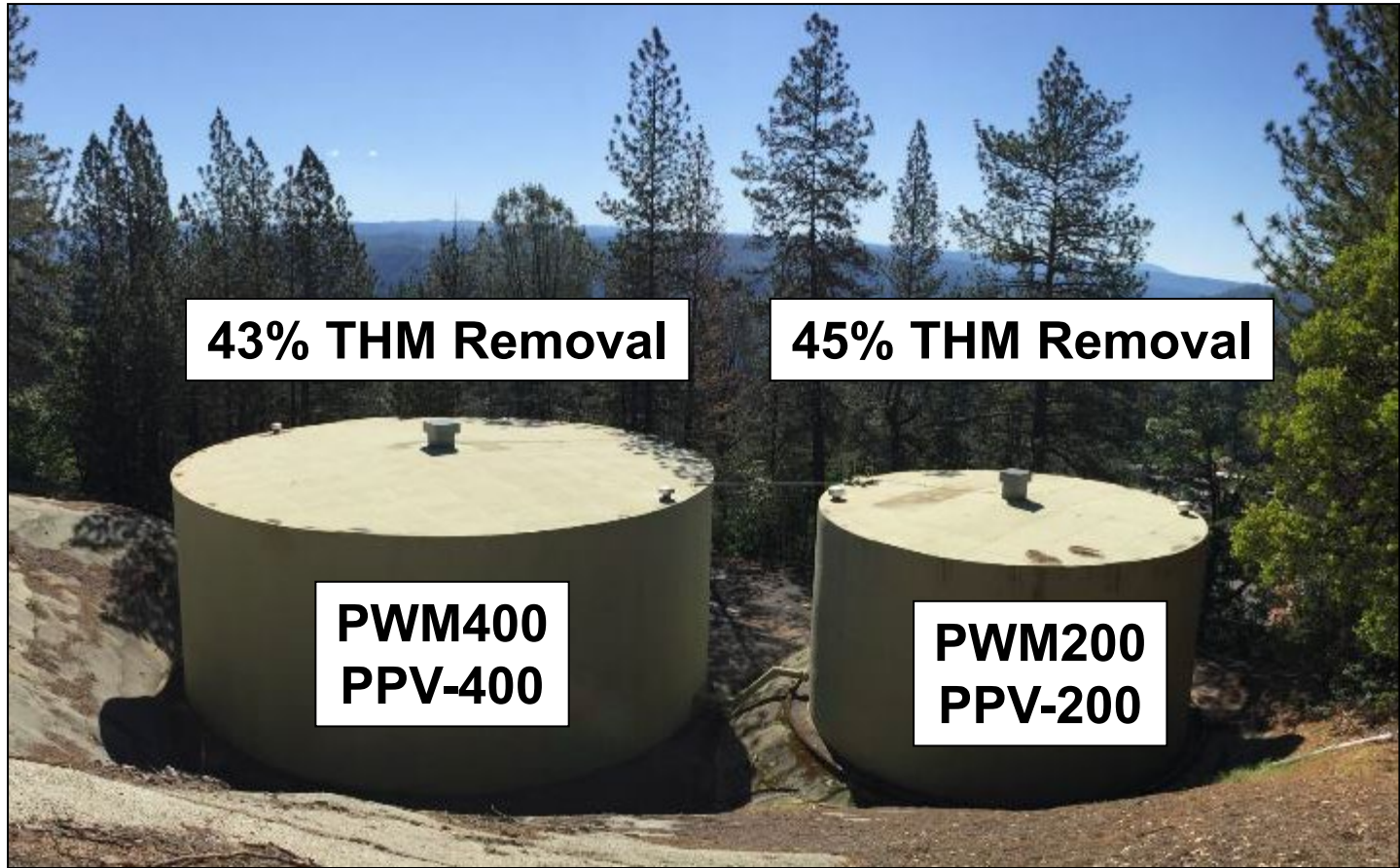


- Mixer + Powervent[®] relies on the PAX mixer to continually introduce water with high THM concentration to the air-water interface at the water surface. The longer the water is in the tank, the more opportunity for mass transfer. Removal rates over 50% are possible if tank detention time is high enough.
- Ideal economic stepping stone to additional removal levels with more aeration

Patented (www.PSIpatents.com)



Colfax: 0.3 MG, 1.0 MG clearwells (4 day detention)



Patented (www.PSIpatents.com)



Colfax: 0.6 MG Ball Park Tank (10 day detention) end of the line



Patented (www.PSIpatents.com)



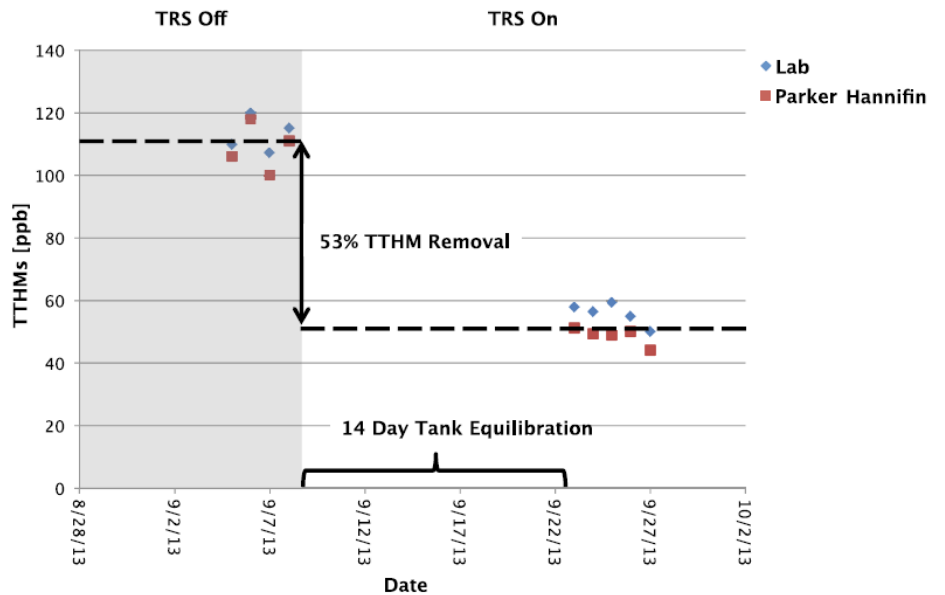
Performance Guarantees:

% removal achieved by on/off validation

A. Tank Parameters: The design of the PAX TRS and the Performance Guarantee are based on the following information relating to the nature and operation of the Tank, which the Customer certifies as accurate (the "Tank Parameters"). Accuracy of the Tank Parameters is a precondition to the Performance Guarantee. The Customer is responsible to maintain and supply complete and accurate records sufficient to demonstrate that the Tank is operated and maintained within the Tank Parameters throughout the period prior to and during the Performance Test (as defined below).

Tank Name	XXXX
Tank Type	XXXX
Tank Volume [gal]	XXXX
Tank Diameter [ft]	XXXX
Tank Height (TH) [ft]	XXXX
Overflow Elevation [ft]	XXXX
Power Available (volts/phase/amps)	XXXX
Maximum Turnover [gpd]	XXXX
High Water Level (HWL) [ft]	XXXX
Low Water Level (LWL) [ft]	XXXX
Minimum Water Temp. [°F]	XXXX
Tank Headspace [ft] (the distance between the tank ceiling and the HWL)	XXXX

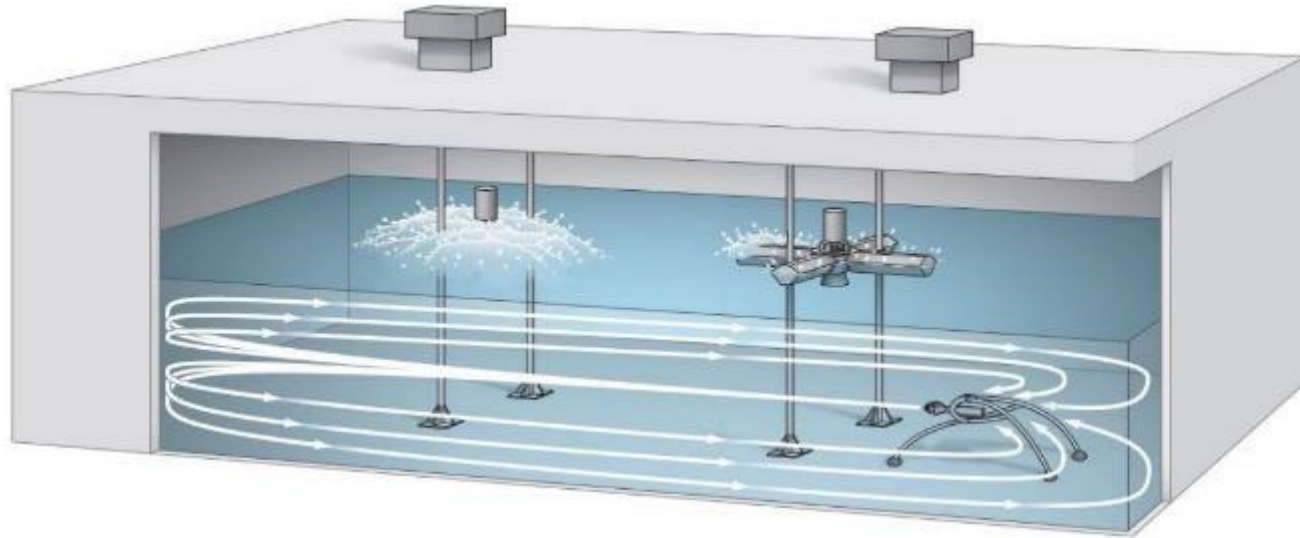
$$\text{Average percent removal} = 1 - \frac{\text{Average THM level with PAX TRS on}}{\text{Average THM level with PAX TRS off}}$$



A. If the average percent removal calculated as set forth in Part II is equal to or greater than the Removal Rate, the PAX TRS will have successfully passed the Performance Test, PAX will be deemed to have fully satisfied its obligations under the Performance Guarantee, and the PAX TRS will be accepted by the Customer with no further action required.

E. If the PAX TRS fails the third Performance Test, then, as the sole remedy for breach of the Performance Guarantee, either (i) PAX will remove the PAX TRS and refund all or any portion of the purchase price theretofore paid to PAX for the PAX TRS, or (ii) if the Customer would prefer to retain the PAX TRS despite such failure, PAX and the Customer will mutually agree on an appropriate price reduction based on the extent to which the average percent removal calculated as set forth in Part II fell short of the Removal Rate. If the parties are unable to agree to the amount of such reduction within 30 days after the failure of the third Performance Test, PAX will remove the PAX TRS and refund the purchase price as provided in clause (i).

Surface aeration is a good method to treat THMs in tanks, but proper equipment selection is key



- Surface Aeration is energy efficient
- Adding surface aerators to a tank is relatively easy as capacity demands change
- Maintaining surface aerators are easier than older style spray aeration systems
 - Some systems may have nozzles that can clog
 - New surface aerators require no maintenance
 - Run-to-fail
- The cost of energy usually outweighs the capital cost of the equipment over time – some designs allow aerators to be automatically turned on/off as THM levels vary



Installations are straightforward and do not require extensive tank modifications



San Jose, CA: 12 MG More Avenue Reservoir

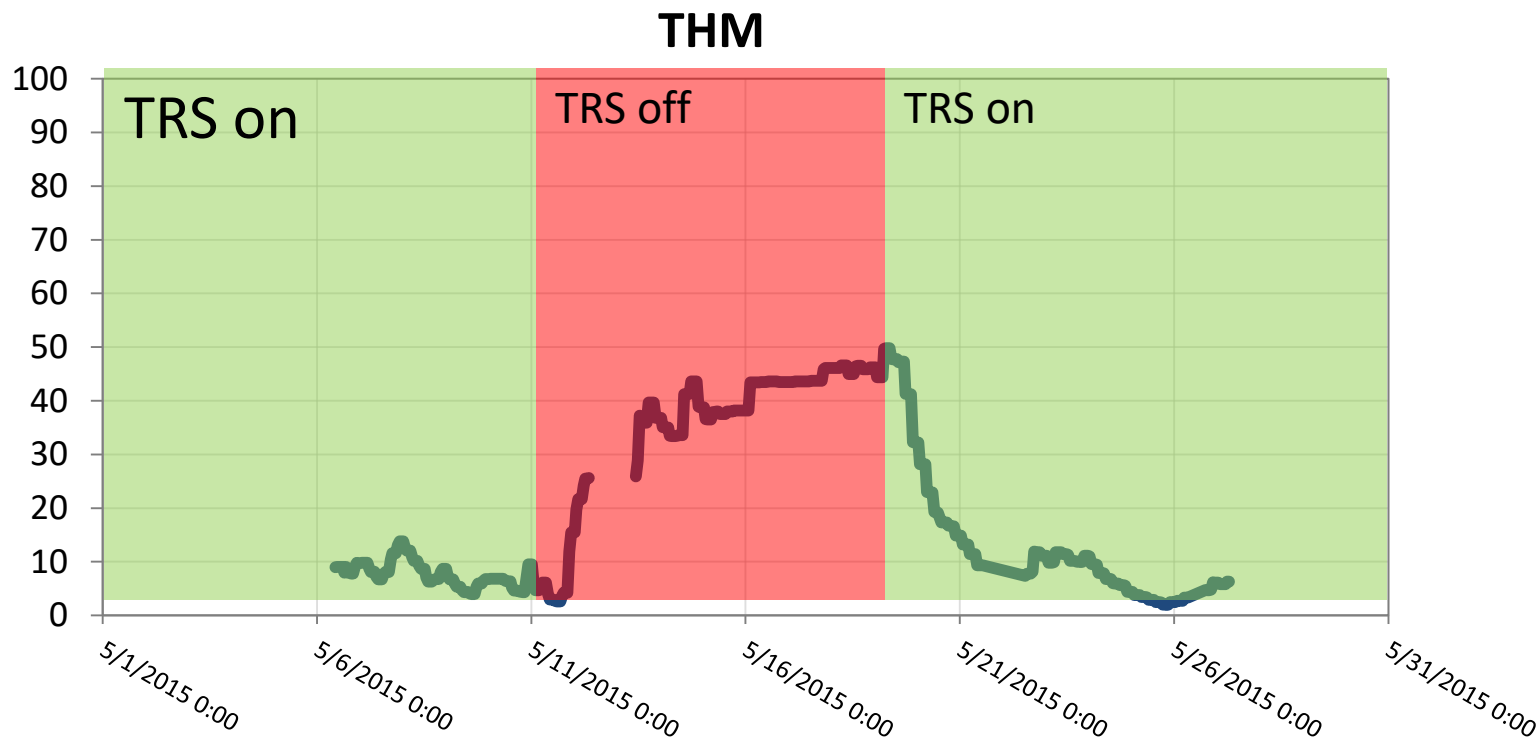
Case Study

- SJWC (investor owned utility) purchased water from Santa Clara Valley (wholesaler)
- Rising organics and bromide due to drought conditions

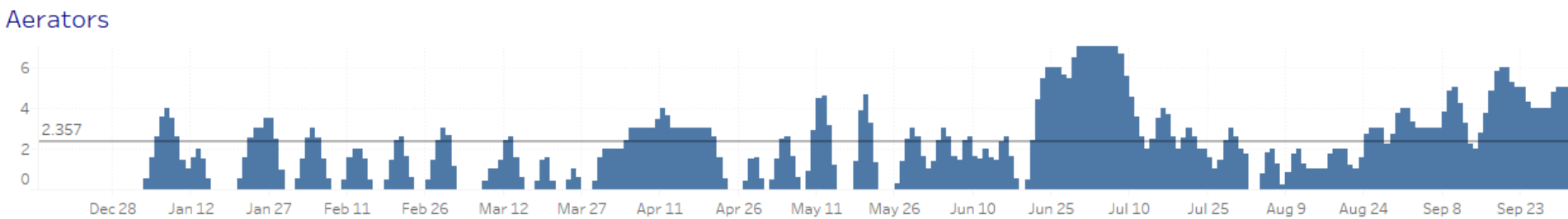
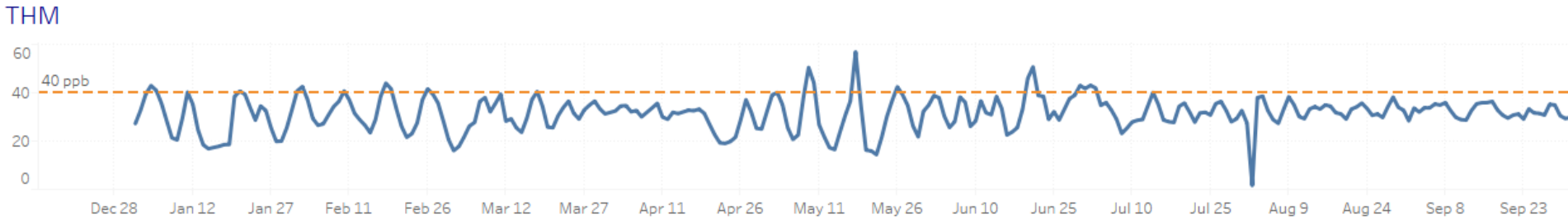




THM removal is influenced by tank turnover; the PAX TRS™ at More Avenue was delivering high rate of removal during periods of low demand (on/off validation)



PAX TRS™ active feedback control using THM sensors yield ~50% operating cost savings



Integration of on-line THM analyzers provide an opportunity to save on energy

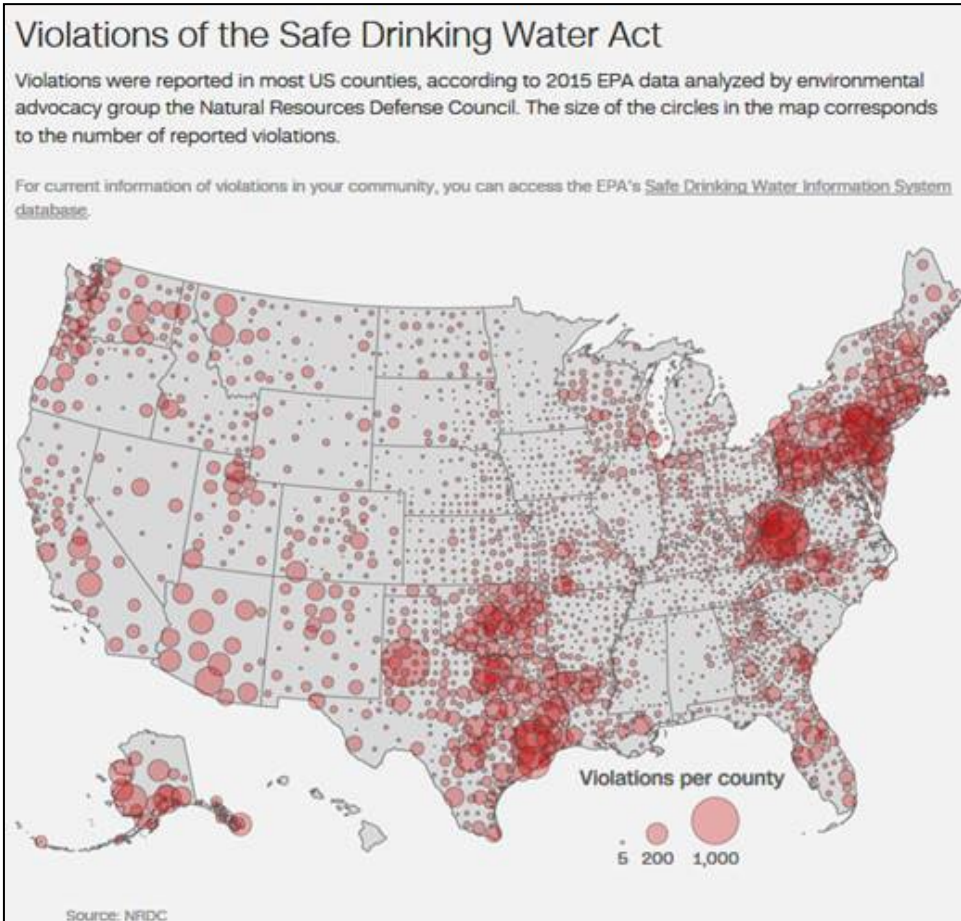


Disinfectant Residual Control: Starts with *Strong* Mixing

“Smart Tanks”



Increased focus on reducing violations in distribution networks is here...

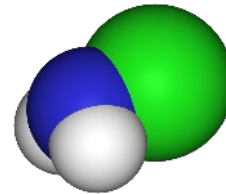
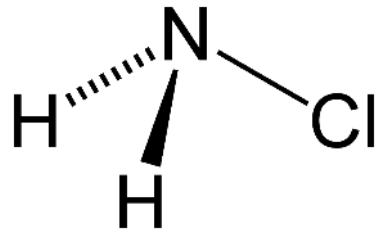
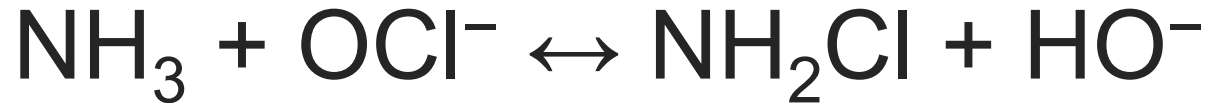


“Beginning April 29, 2019, a community water system using a chemical disinfectant or that delivers water that has been treated with a chemical disinfectant shall maintain a minimum residual disinfectant concentration throughout the distribution system sufficient to assure compliance with the microbiological MCLs and the treatment technique requirements specified in § 109.202. The minimum residual disinfectant concentration is **0.2 mg/L**”

- TX and LA have **0.5mg/l** mandatory residuals
- CO has implemented **0.2mg/l** in 2019



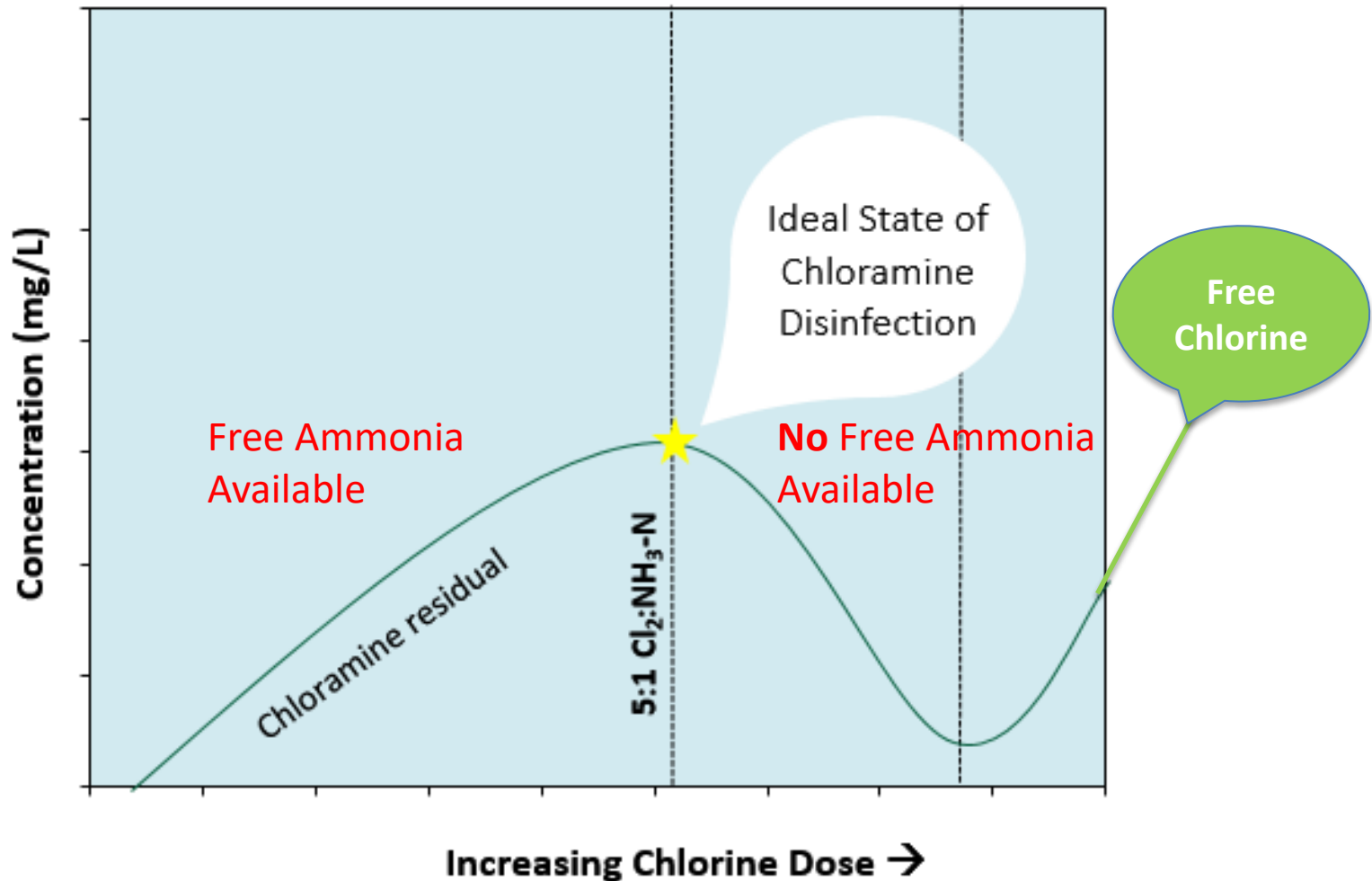
Chloramines, used in about a third of municipal water systems, provide longer protection in distribution systems and are less prone to encourage DBP formation



Monochloramine is formed by the reaction of chlorine and ammonia with a chlorine atom substituting for one of the three ammonia hydrogen atoms



Chloramine Breakpoint Curve: Know where you are on the curve

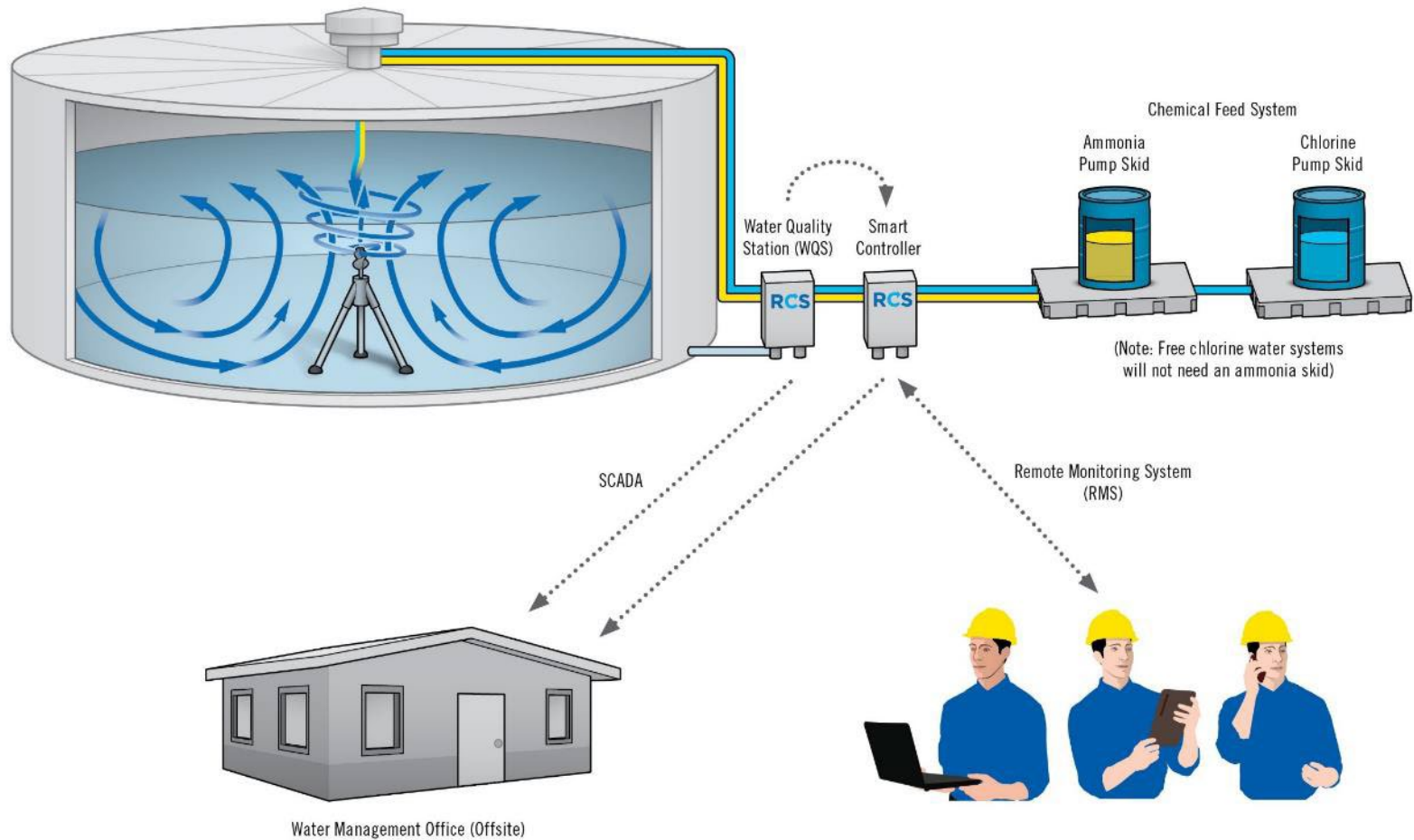


Four criteria must be met for proper chloramine control in reservoirs:

1. Proper mixing to ensure a homogenous water body that will not stratify
2. Accurate dosing of ammonia and chlorine to ensure proper ratio given the position on the breakpoint curve
3. High energy mixing that ensures instantaneous reaction of introduced chemicals
4. Real-time monitoring and control logic to maintain or achieve equilibrium by responding to dynamic reservoir conditions



A “Smart Tank” with residual control automatically adjusts disinfectant residual to a pre-determined set-point and maintains that set-point with beneficial water quality impact to the zones it serves

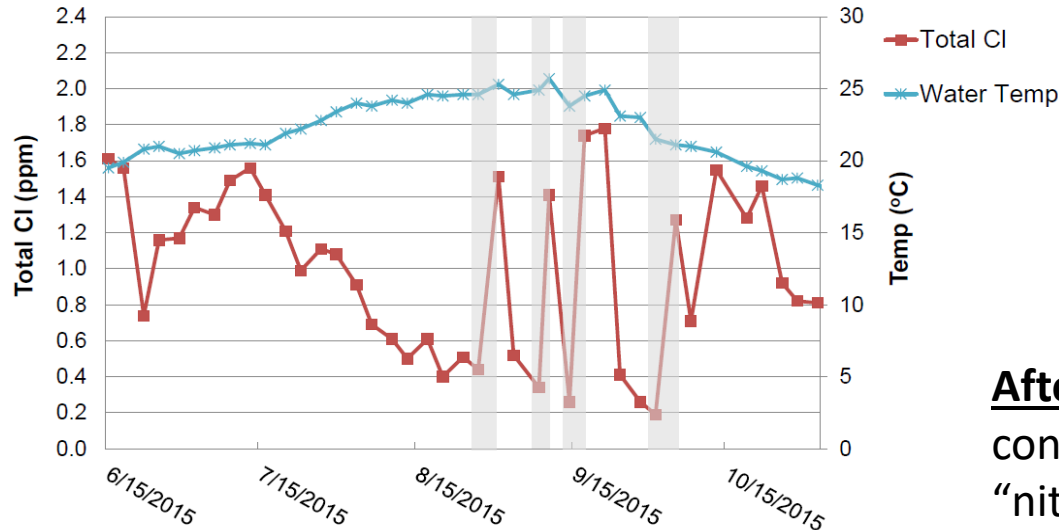


Effective disinfectant residual control completely eliminates the threat of nitrification

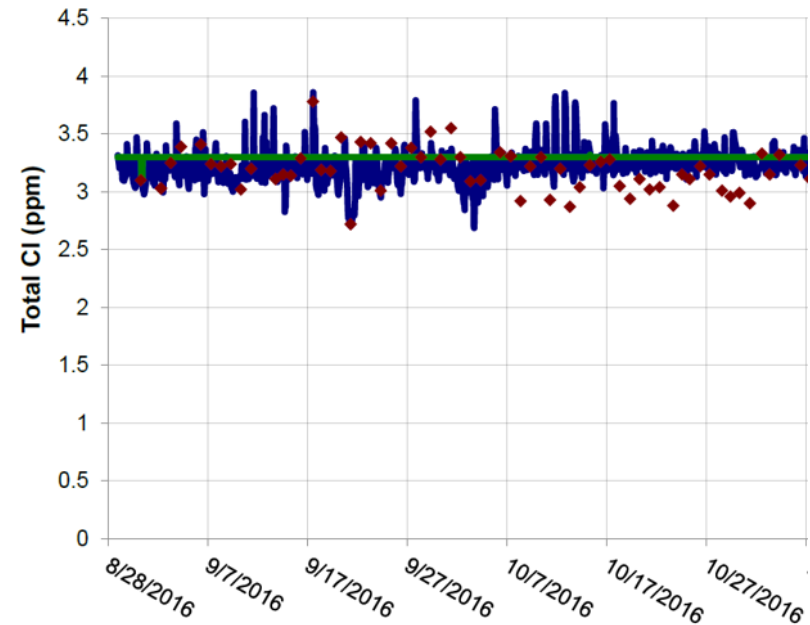
Before: August-October (4) tank nitrification events as water temperature remained high



Total Chlorine Before RCS Trial



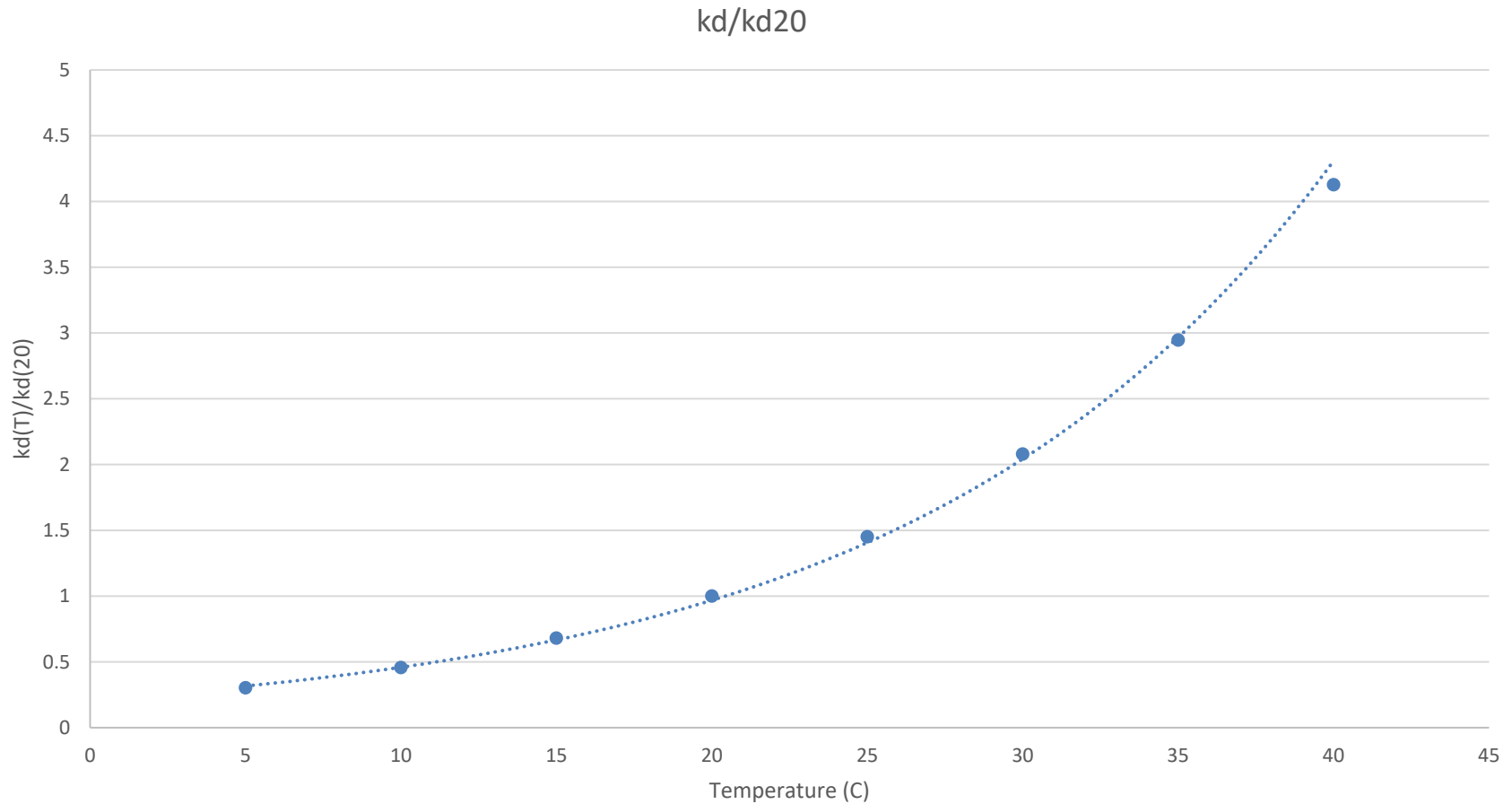
Total Chlorine During RCS Trial



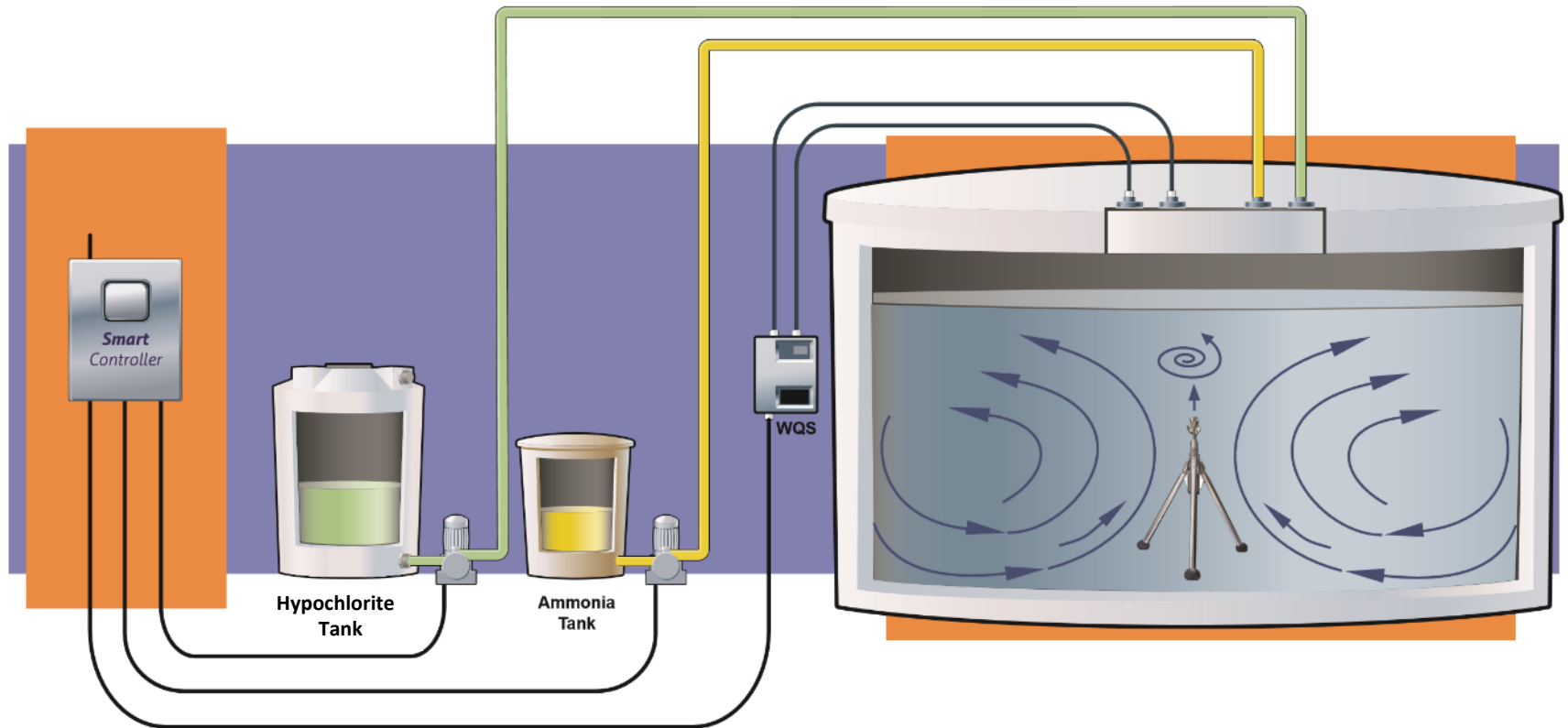
After: August-October next year with residual control – steady 3.3ppm residual through “nitrification season”



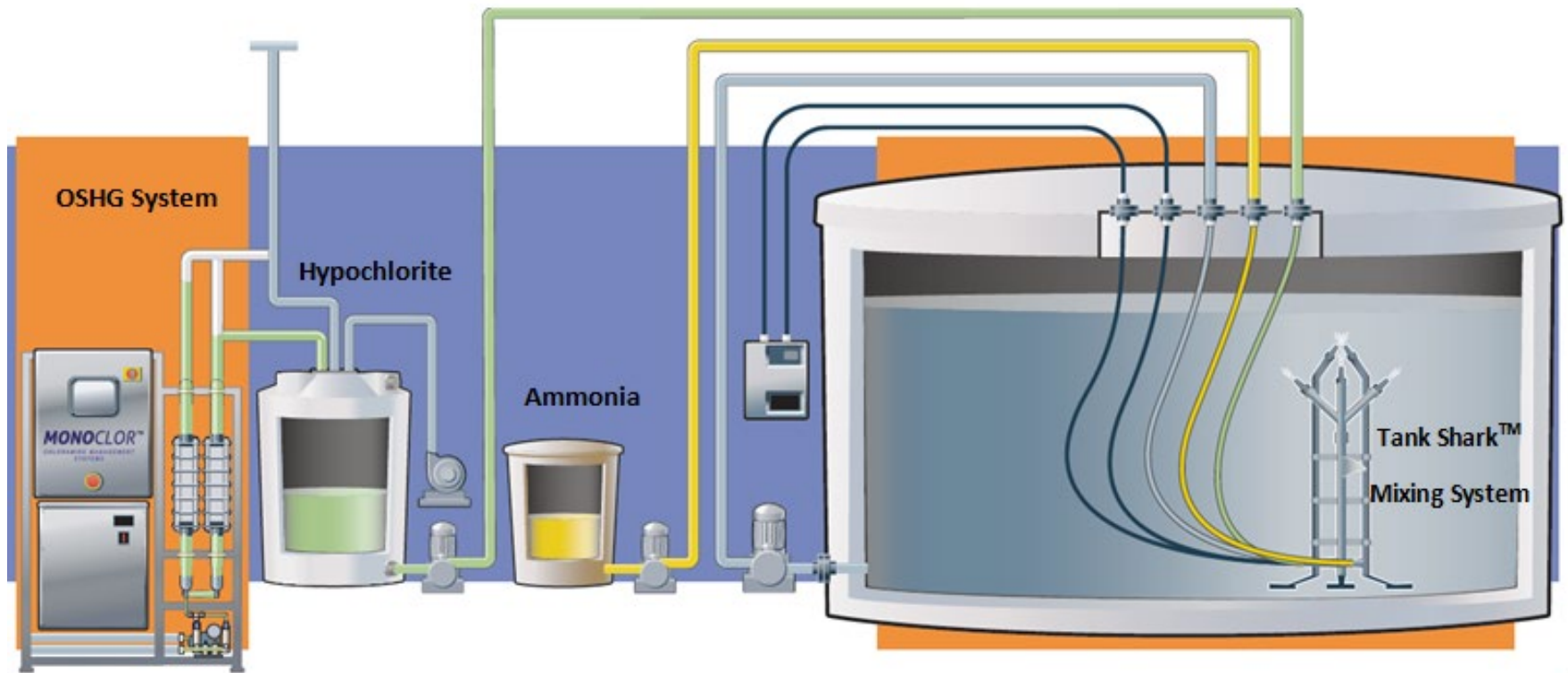
Chloramine decay rate triples from 50°F to 77°F - seasonal issues



Chloramine residual control systems can take on a number of different configurations depending on tank particulars and client preferences



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“Smart Tanks” efficiently dose chlorine and/or ammonia accurately and when needed to ensure a reservoir can maintain a disinfectant residual set-point

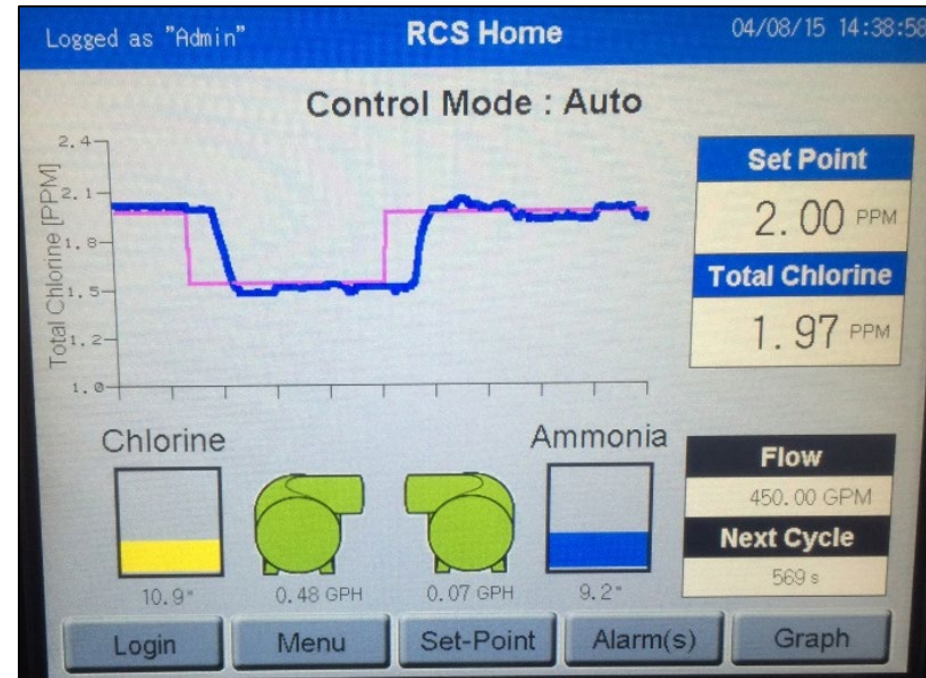
PAX Smart Controller



PAX Chemical Feed Skids



Chloramine Residual Management



San Jose, CA – Monoclor® RCS trailer at San Jose Water Company: 1 MG reservoir

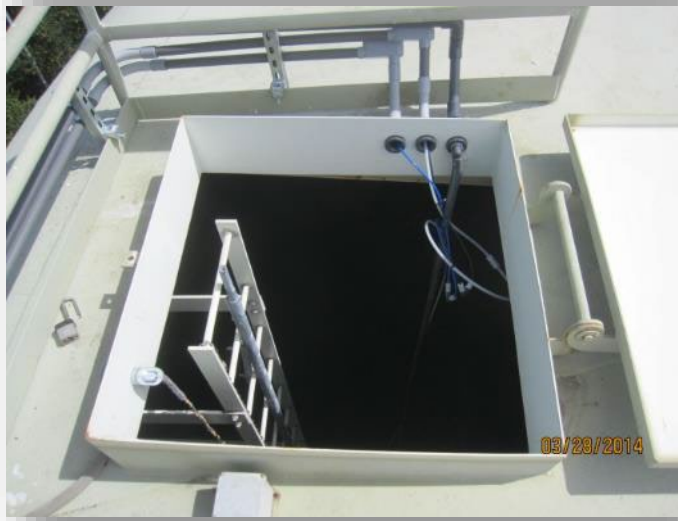
Case Study #1



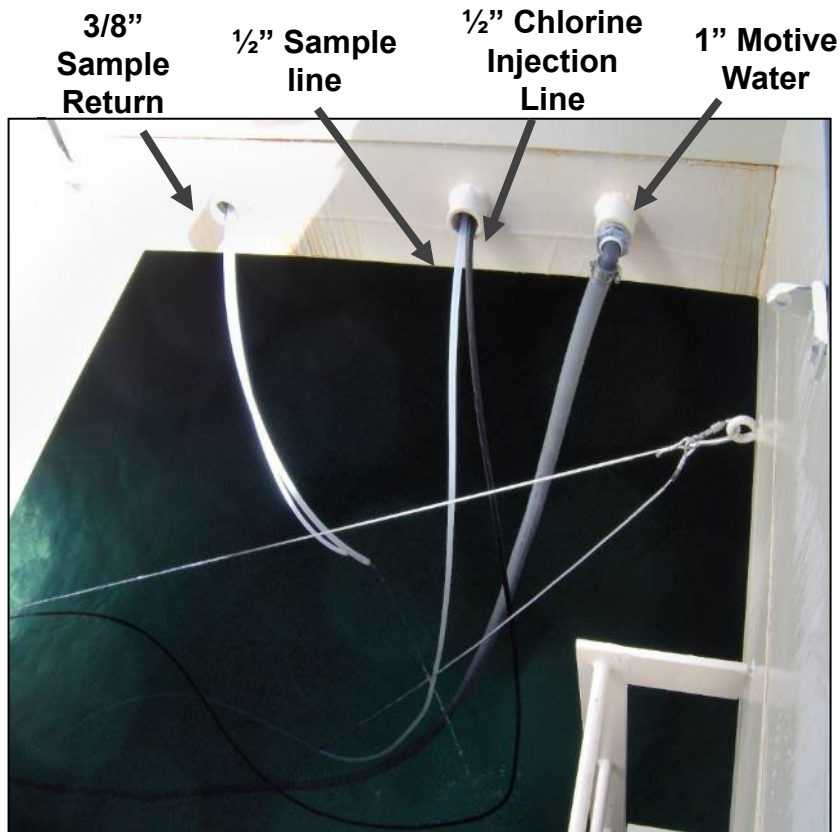
Tank Size: 1 MG
Turnover: 4 days
Problem: Chronically low residual (<0.2 mg/l)
Solution: Monoclor® RCS System



Site conditions in San Jose: Tank Shark® mixing and injection hardware



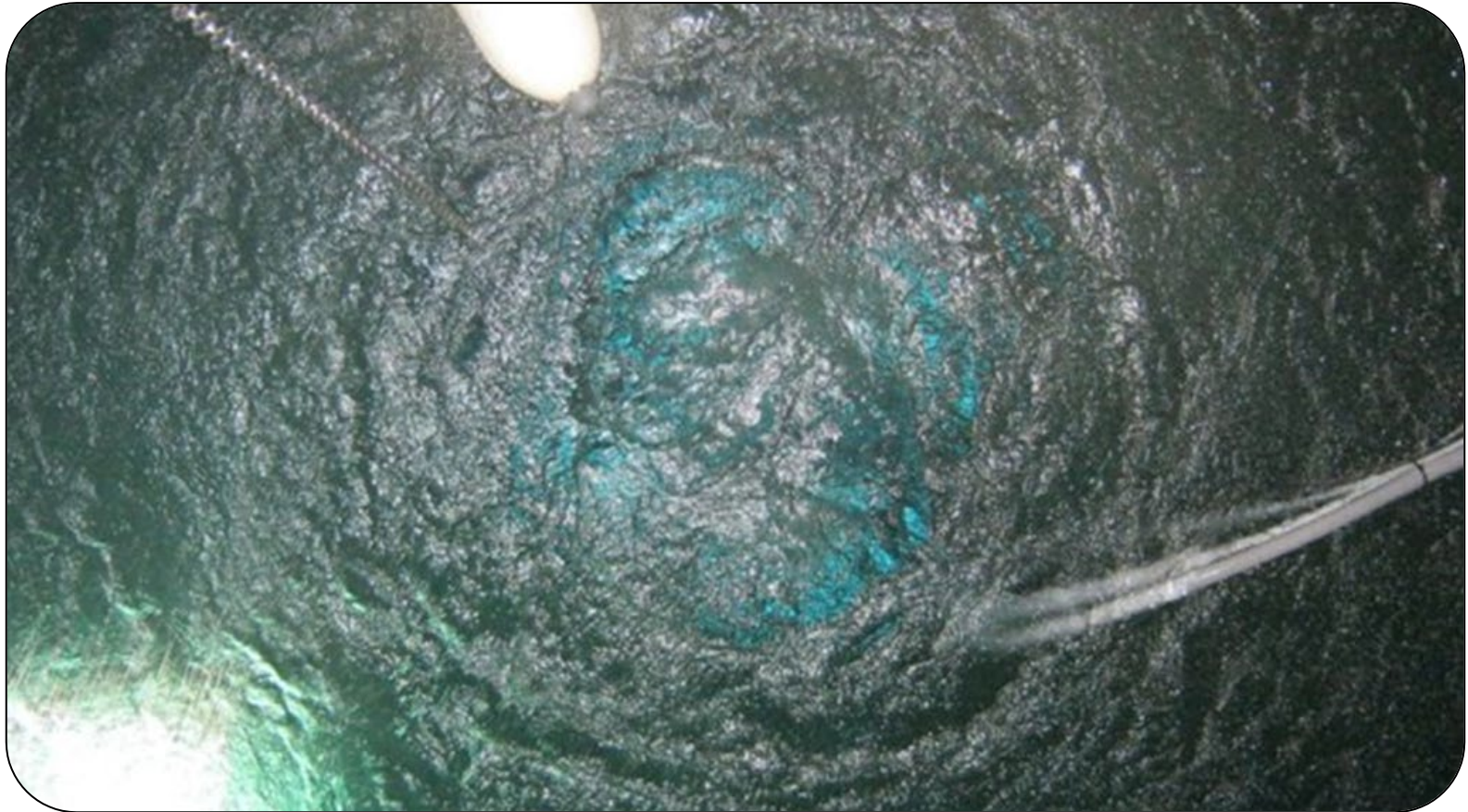
Tank Shark[®] mixer and injection device was installed while the tank was in service



TANK & HATCH PENETRATIONS



Moving water on the tank surface indicates active and energetic mixing

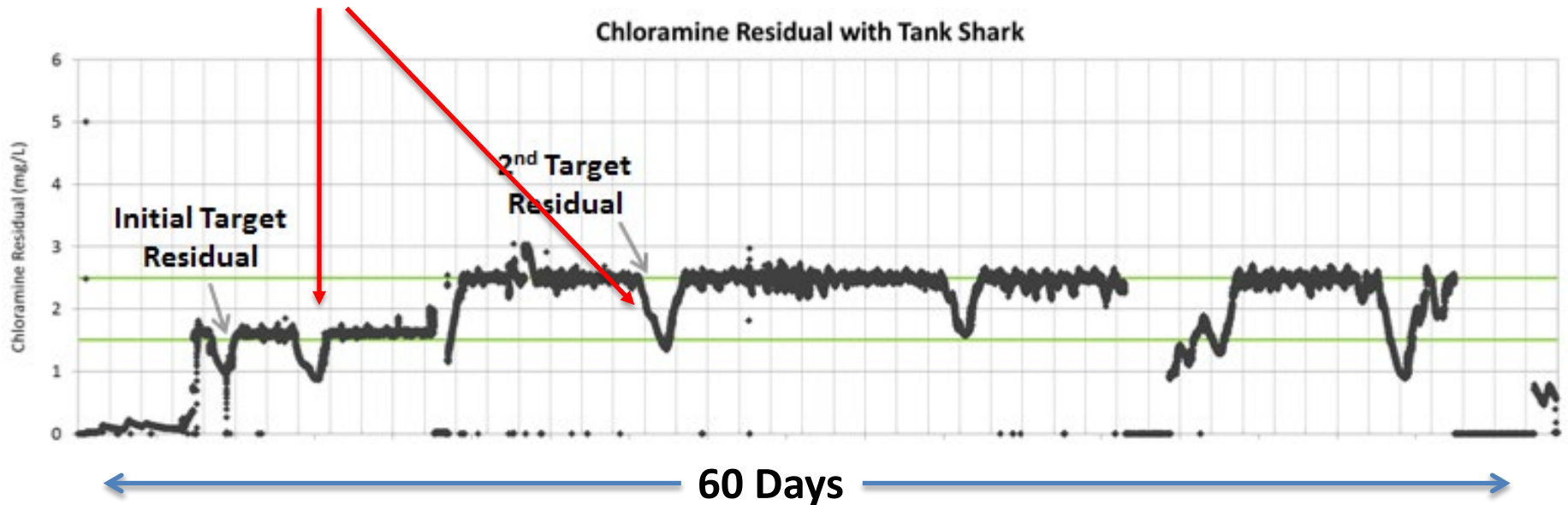


San Jose Tank Surface 2014



Residual Chloramine Management System Results

Introduction of “challenge water” volumes

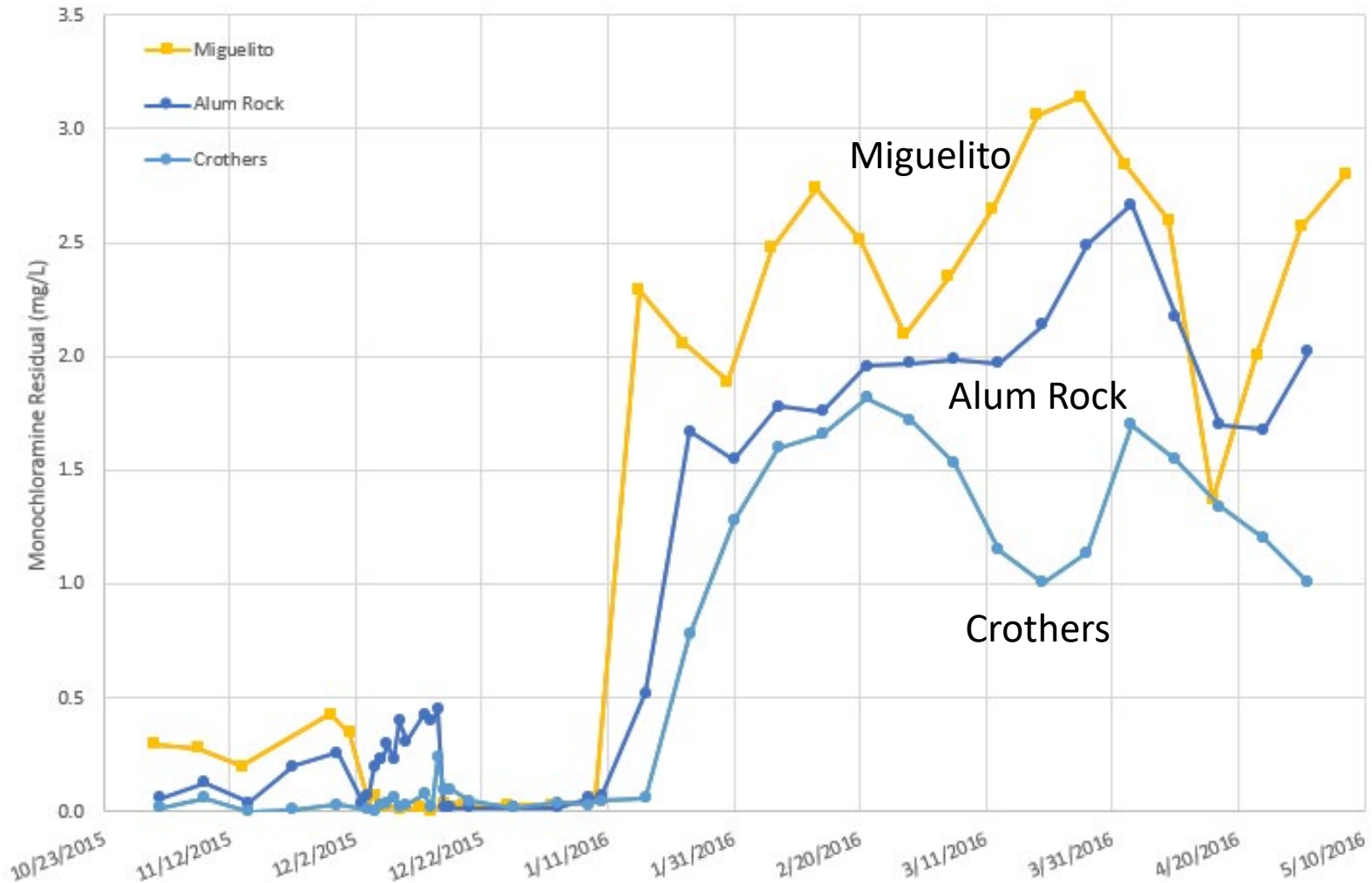


Imported water introduced in high quantities throughout the trial caused momentary and intermittent concentration changes followed by quick recovery

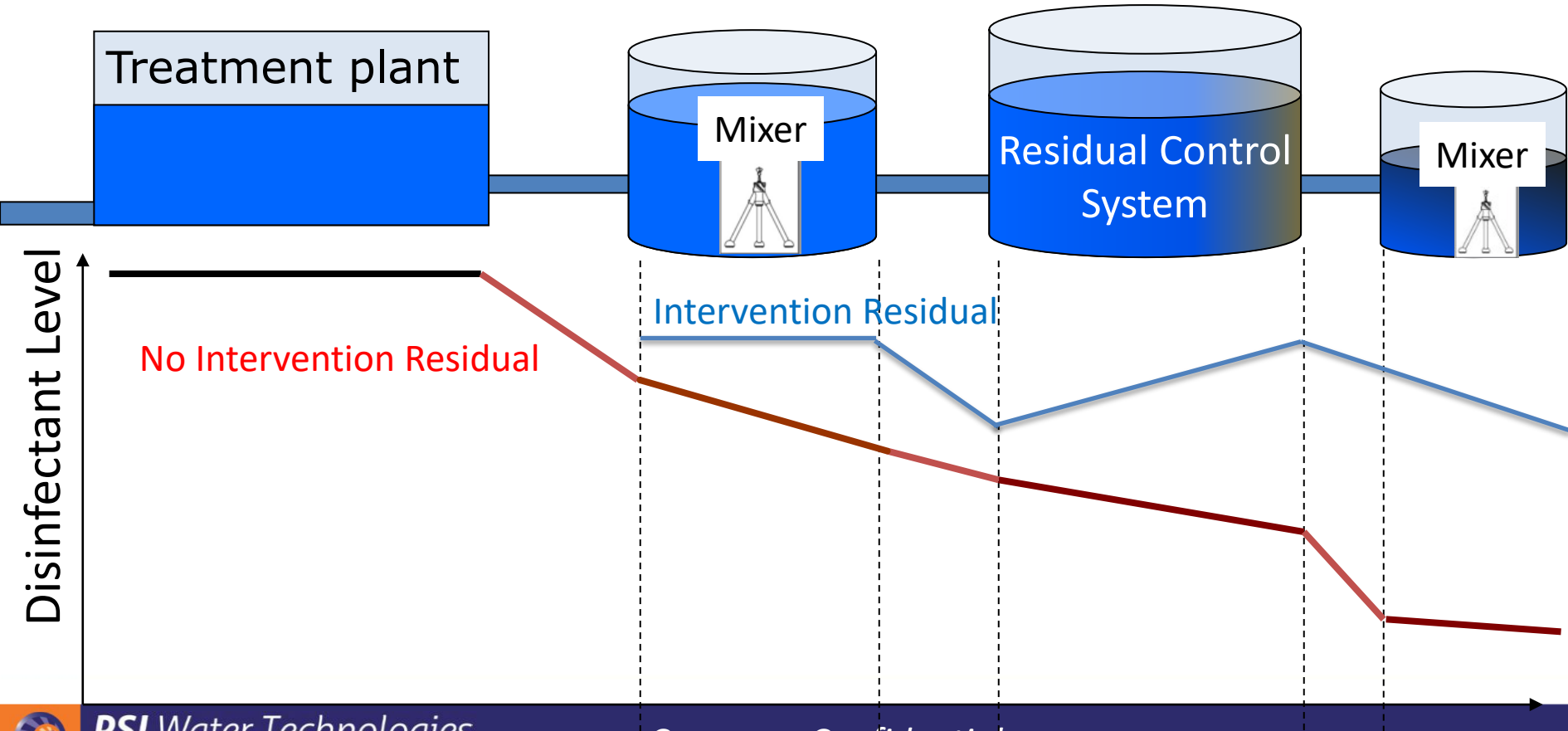


Installing a Boosting System in Miguelito Reservoirs Results in Achieving Target Residual Levels in Downstream Alum Rock and Crothers Tanks

SJWC Monochloramine Residuals after Monoclor at Miguelito



Ultimately, optimal disinfectant residual control involves a number of mitigation steps throughout a distribution network – analysis, mixing and controlled boosting





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“Smart Tanks”

***Many Case Studies and Additional Material
Available at: www.4psi.net***

