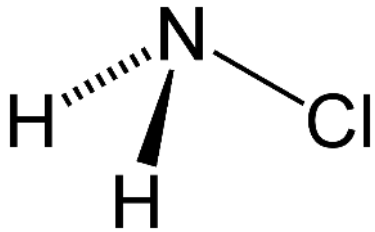
Chloramine Residual Optimization & Management:

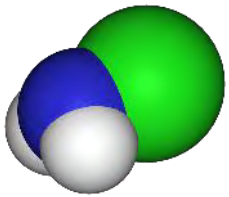
MONOCLOR™

CHLORAMINE MANAGEMENT SYSTEMS

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

$$NH_3 + OCl^- \leftrightarrow NH_2Cl + HO^-$$





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

There are three "chloramine" variants – only one of which is desirable in a water system

(1) $HOCl + NH_3 \leftrightarrow NH_2Cl + H_2O$
monochloramine

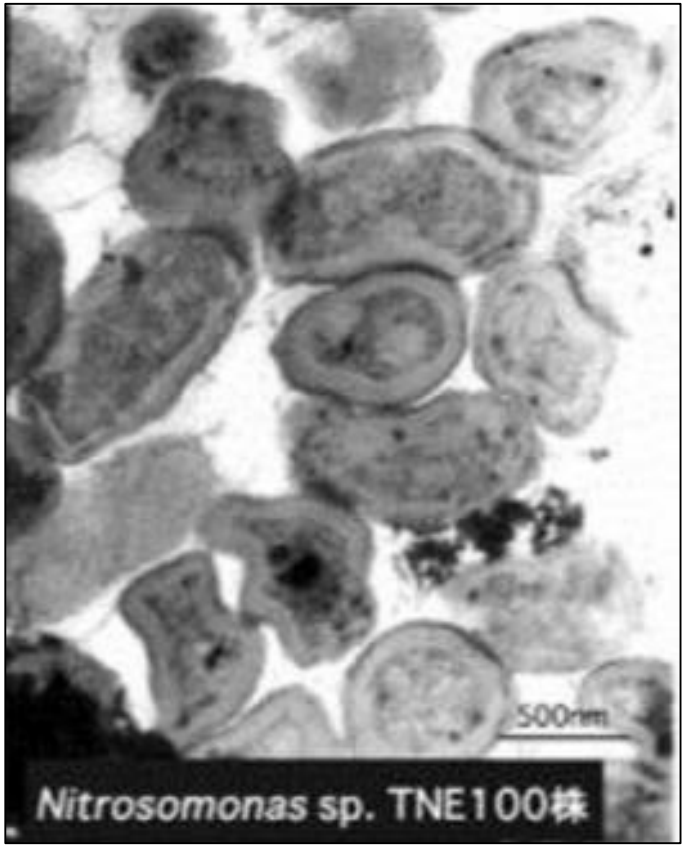
(2) $HOCl + NH_2Cl \leftrightarrow NHCl_2 + H_2O$
dichloramine

(3) $HOCl + NHCl_2 \leftrightarrow NCl_3 + H_2O$
trichloramine

Only monochloramine is considered a suitable disinfectant

Chloramine usage has been problematic due to difficulty in accurately controlling ammonia and chlorine dosage in a dynamic distribution system

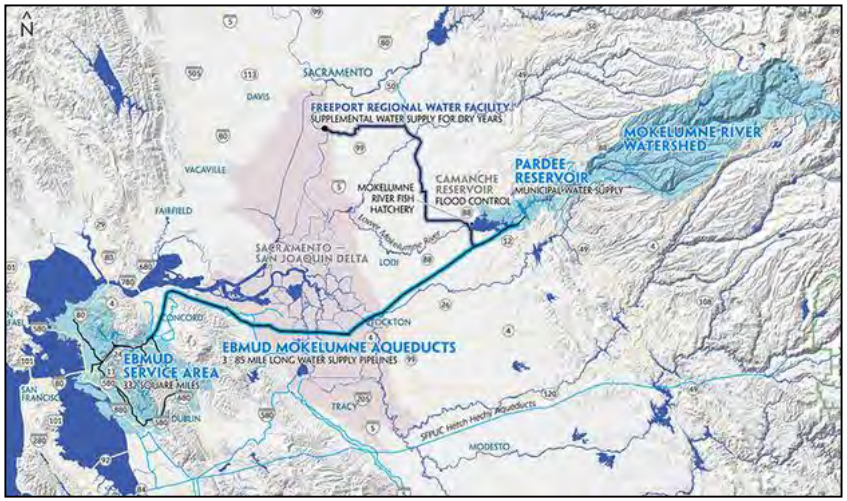
- Introduction of ammonia can lead to nitrification as it is a nutrient to AOB's
- Over-chlorination can create chloramine variants which lead to taste and odor problems in drinking water (dichloramine and trichloramine)
- Low residual levels can also lead to costly mitigation efforts such as:
  - Chlorine burns
  - Line flushing
  - Water wasting or tank dumping
  - Corrosion control measures



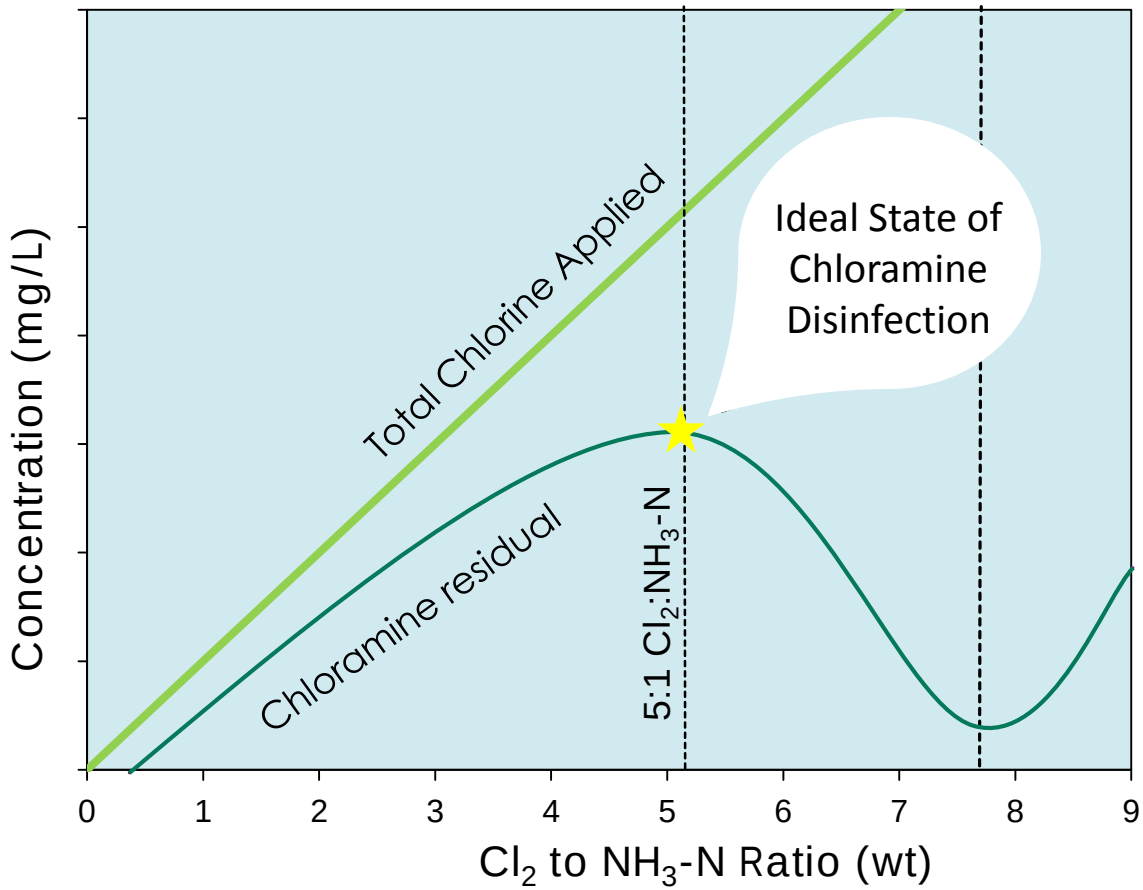
Ammonia Oxidizing Bacteria (AOB)

In a “real world” water system, chloramine levels are challenged by a number of factors:

- Temperature stratification in reservoirs and tanks
- Chemical stratification in reservoirs and tanks
- Imported or mixed water compatibility
- Water aging in pipelines and reservoirs
- Changes in constituent ratios over time and as pipeline conditions change over transmission distance



Chloramine Breakpoint Curve: Know where you are on the curve

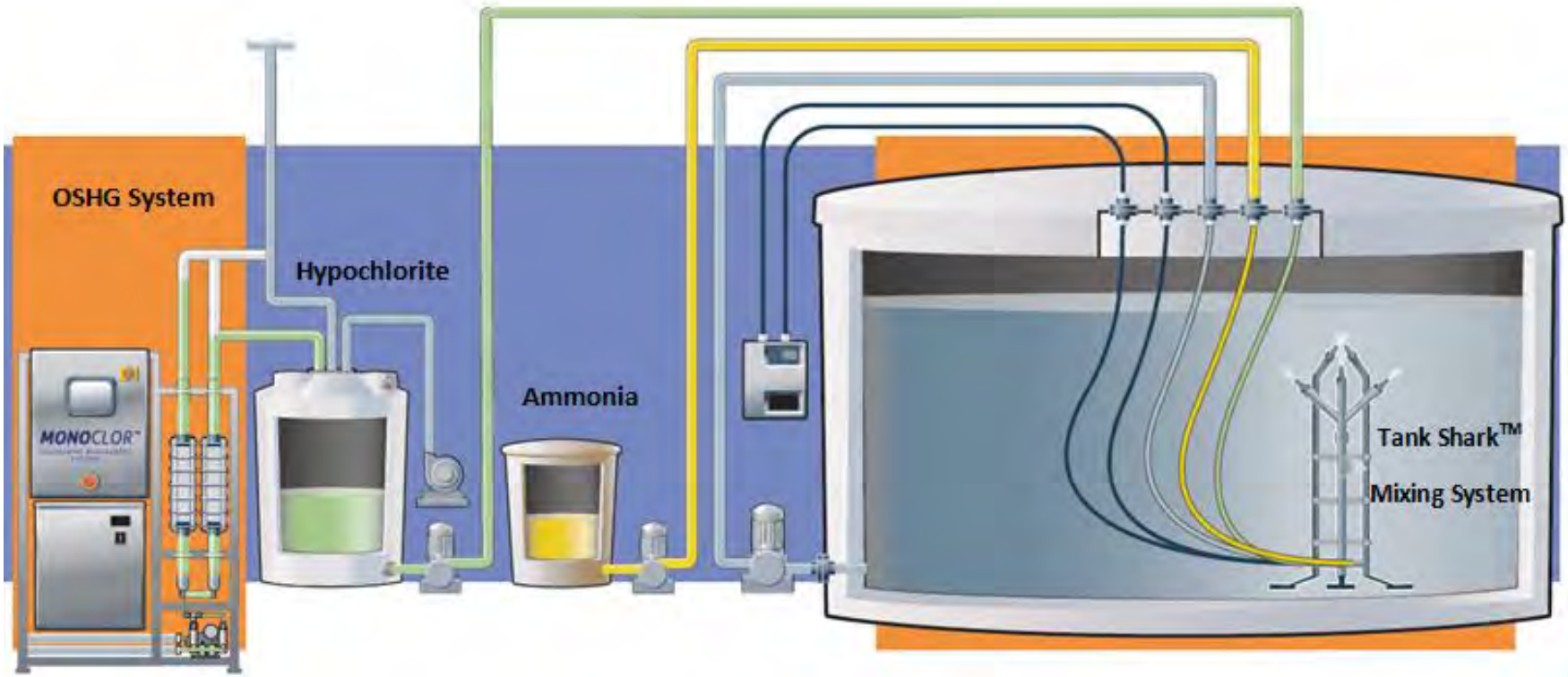


Four criteria must be met for proper chloramine control in reservoirs:

1. Accurate dosing of ammonia and chlorine to ensure proper ratio given the position on the breakpoint curve
2. Proper mixing to ensure a homogenous water body that will not stratify
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

MONOCLOR™

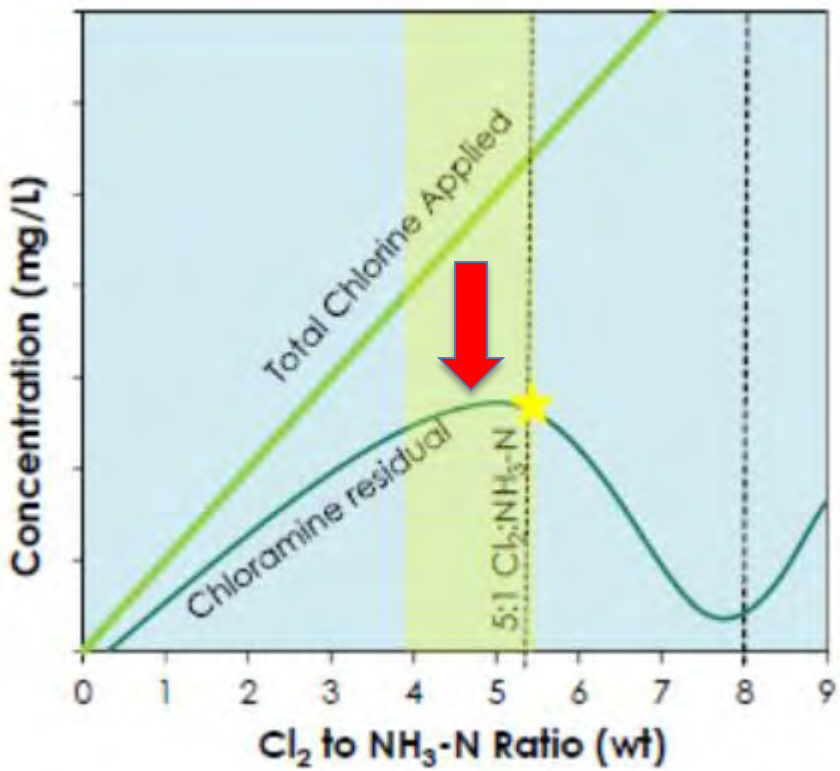
CHLORAMINE MANAGEMENT SYSTEMS



The Monoclor™ Chloramine Management System operates in two modes:

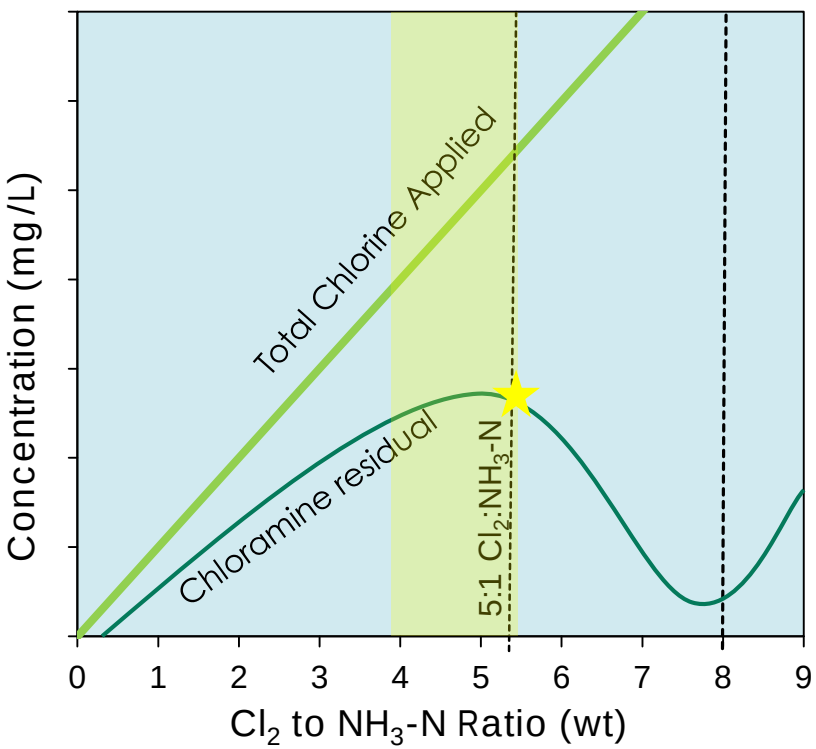
The Monoclor™: Mode 1 → Free Ammonia Present

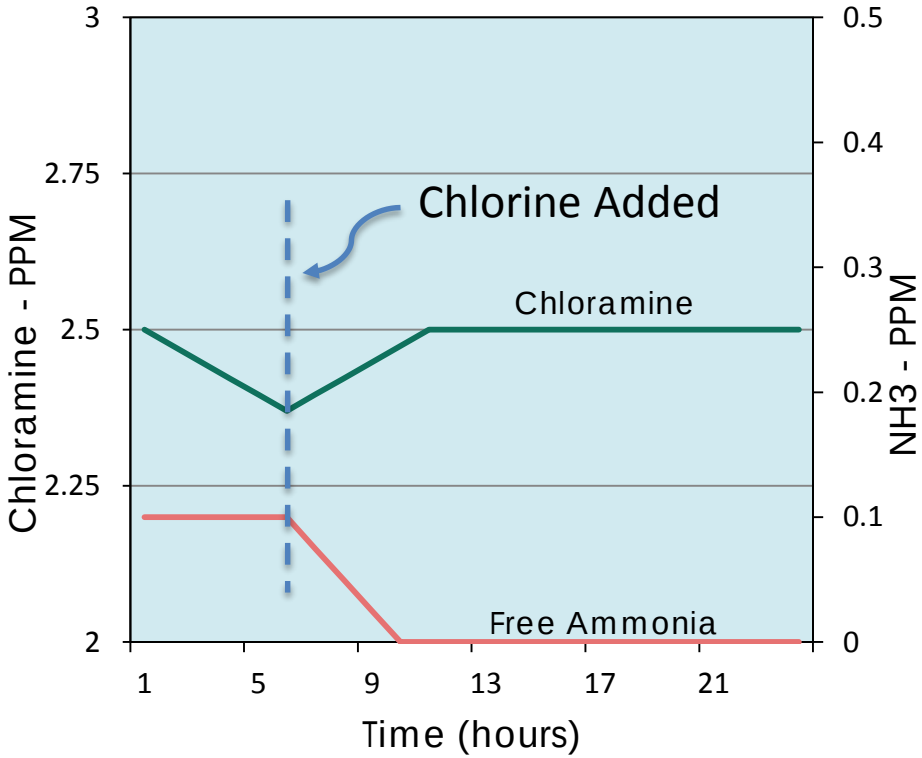
STAGE 1	Monoclor™ detects drop in chloramine residual.	✓
STAGE 2	Engage free chlorine feed.	✓
STAGE 3	Chloramine residual is reestablished.	✓



The Monoclor™ Chloramine Management System:

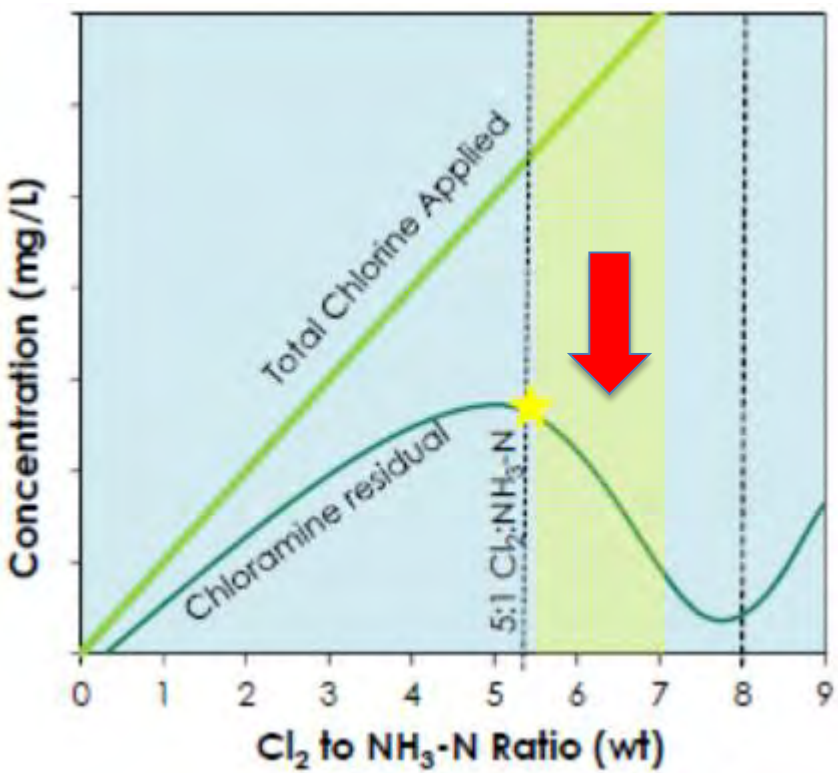
Reservoir Condition: Free Ammonia Present





In the Mode 2 -the Monoclor™ detects there is no free ammonia present:

		No Free Ammonia Present
STAGE 1	Monoclor™ detects drop in chloramine residual.	✓
STAGE 2	Engage free chlorine feed.	✓
STAGE 3	Monoclor™ detects further drop in chloramine residual.	✓
STAGE 4	Engage ammonia feed along with free chlorine feed.	✓
STAGE 5	Chloramine residual is reestablished.	✓



The Monoclor™ Chloramine Management System

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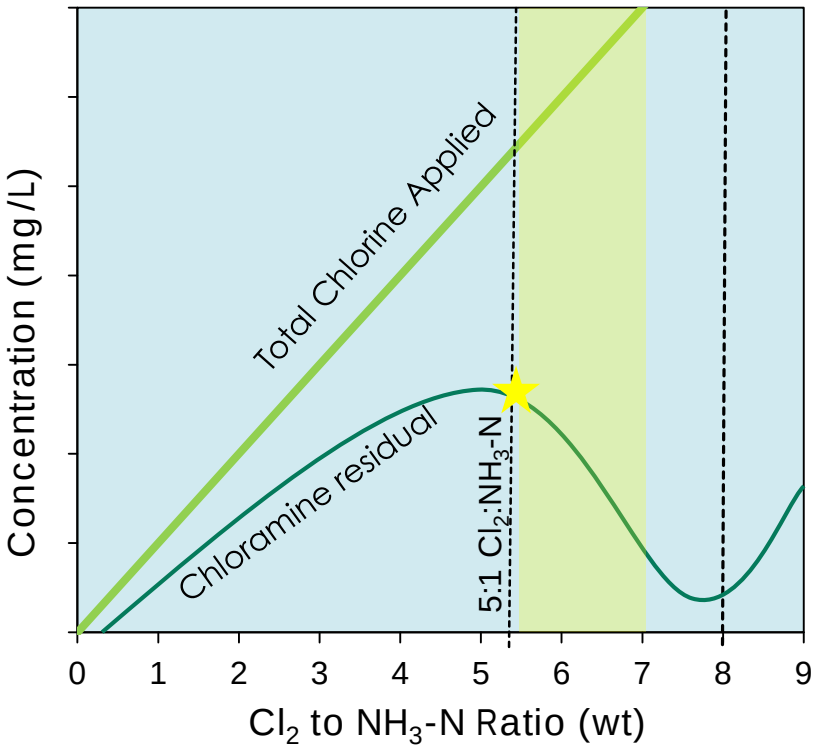
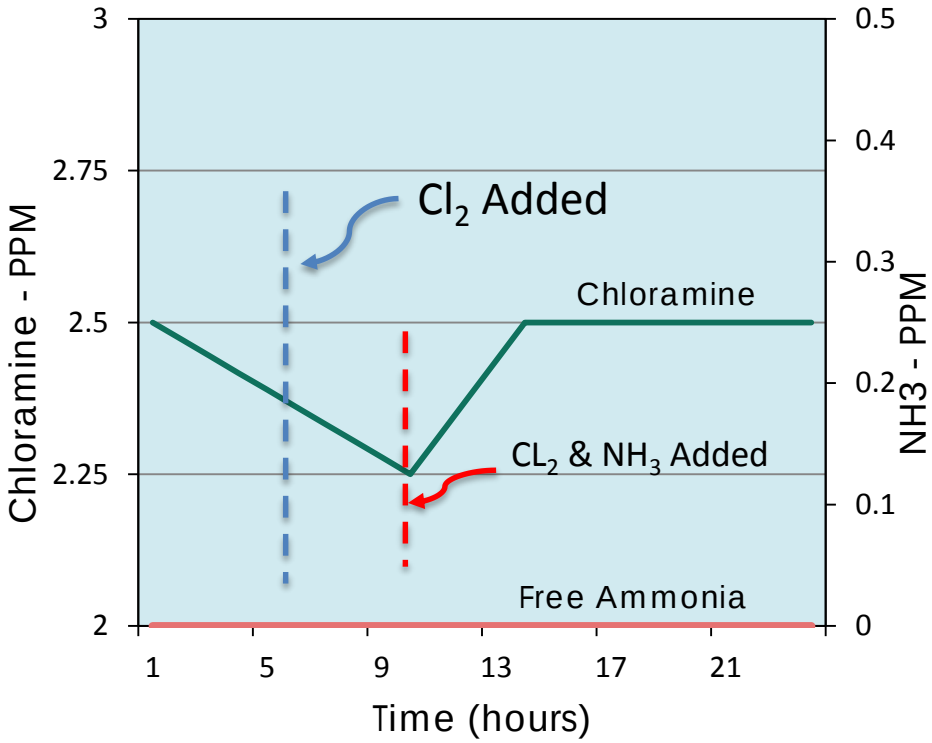


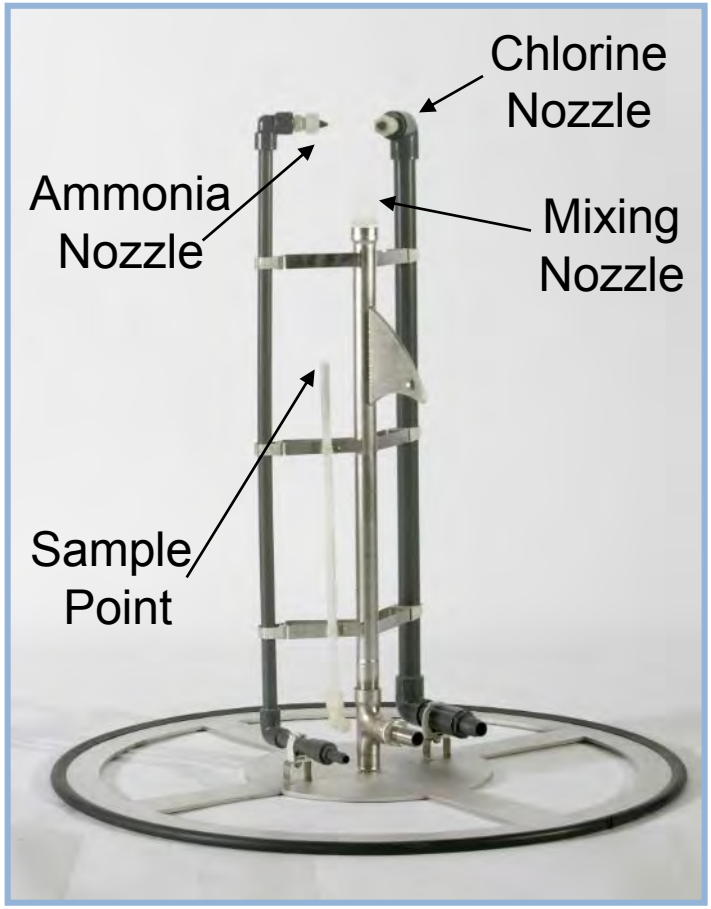


San Jose Water (CA) –Monoclor™ trailer at San Jose Water 1 MG reservoir

Case Study #1

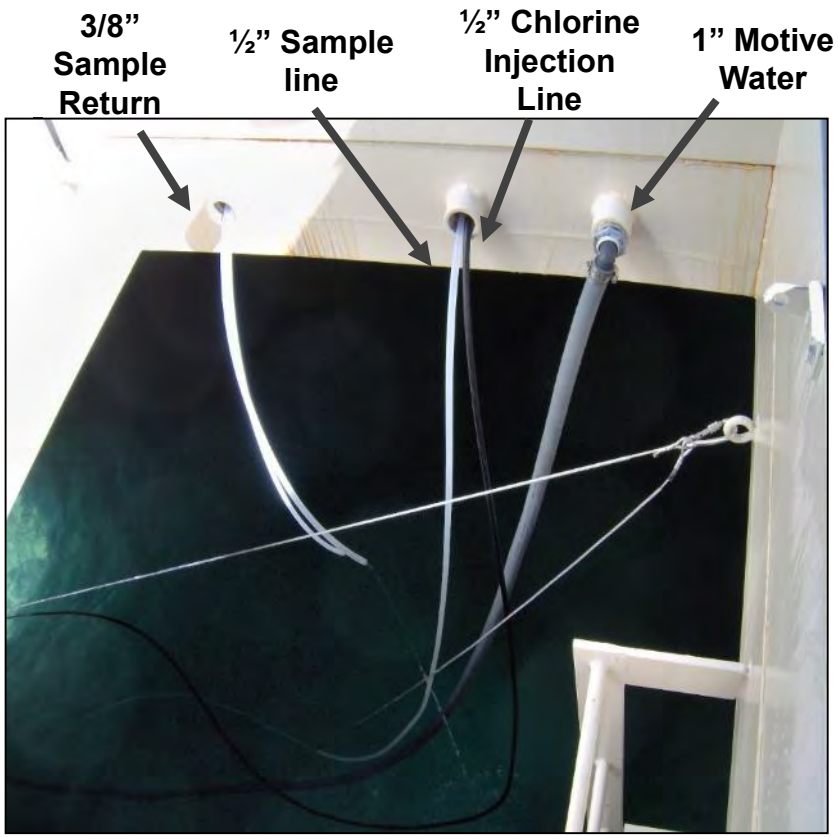
Tank Size: 1 MG
Turnover: 4 days
Problem: Chronically low residual (<0.2 mg/l)
Solution: Monoclor™ System

Tank Shark™ hardware is simple and easy to maintain



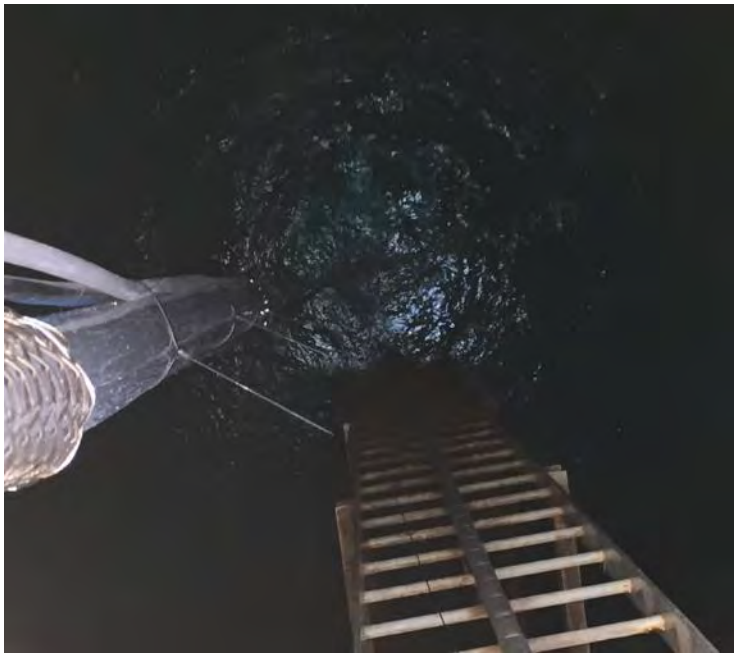
- **Mixing – no electrical service**
- **Integral Sampling Point**
- **Chemical Injection**
  - **Onsite Sodium Hypochlorite (0.8%)**
  - **Commercial Bleach (12%)**
  - **Chlorine Gas**
  - **Aqueous Ammonia or Liquid Ammonium Sulfate (LAS)**

Tank Shark™ mixer and injection device was installed while the tank was in service

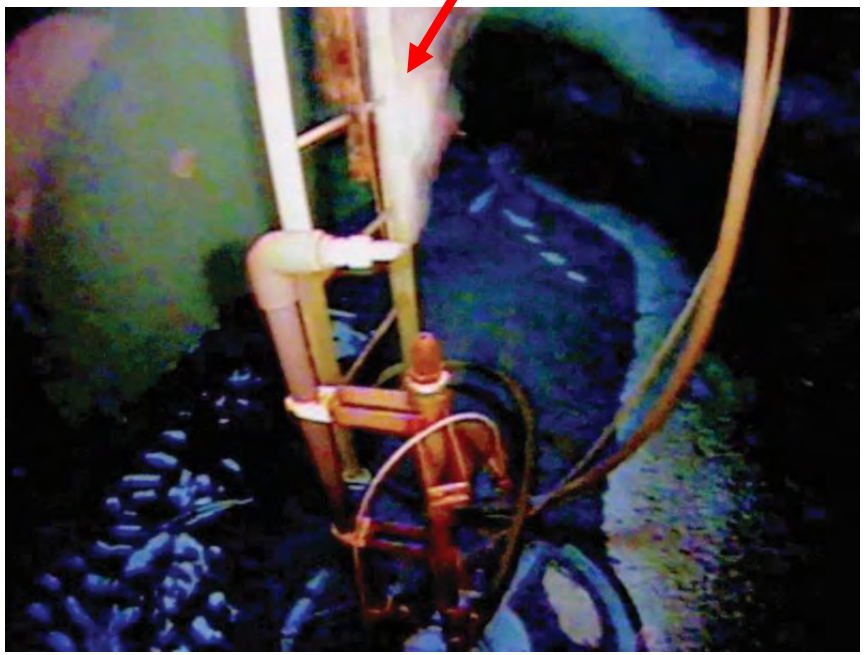


TANK & HATCH PENETRATIONS

Introduction of chemicals into the high energy mixing zone ensures instantaneous reaction

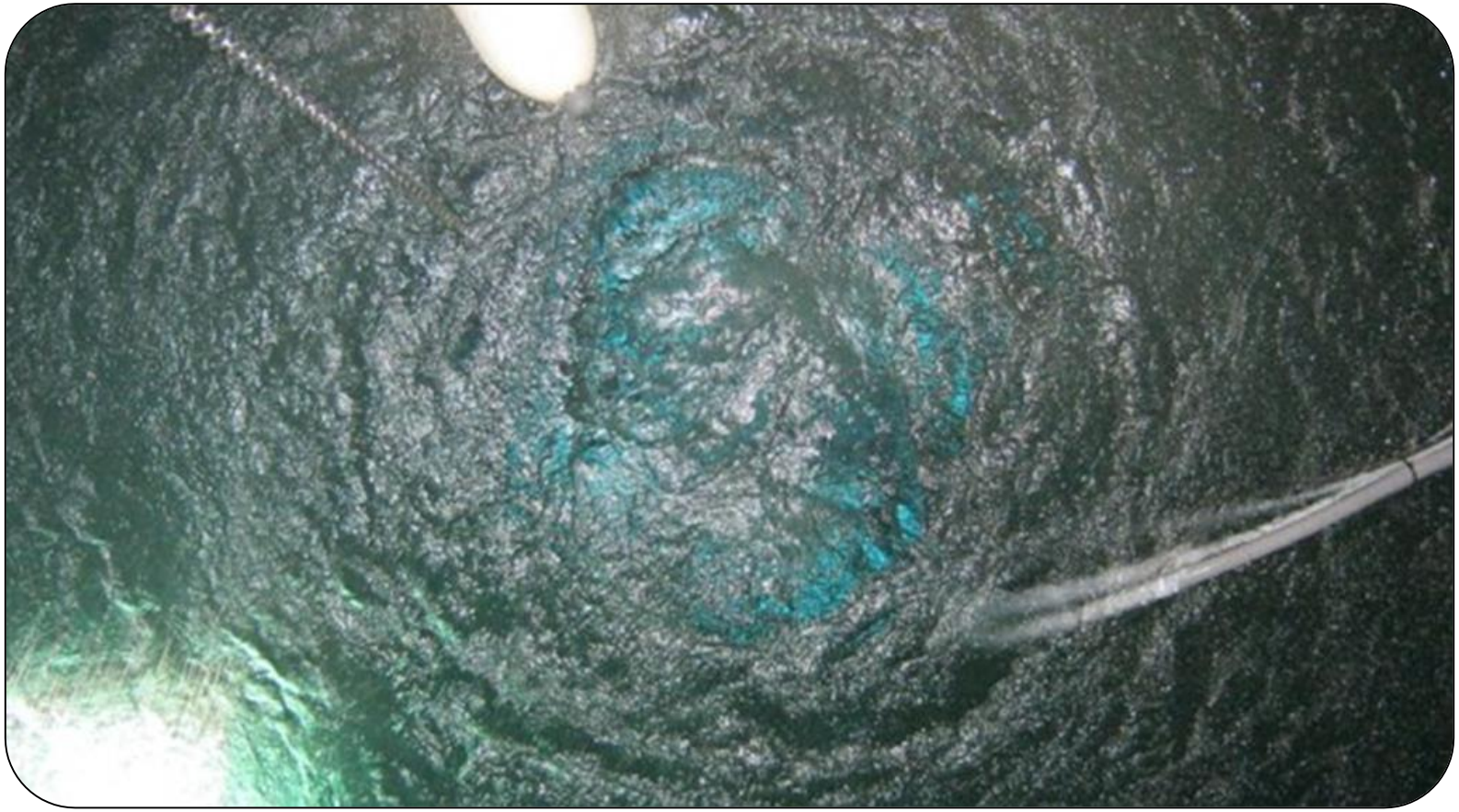


Through Hatch Photo – Evidence of High Energy Plume



Underwater Photo - Chemical Introduction

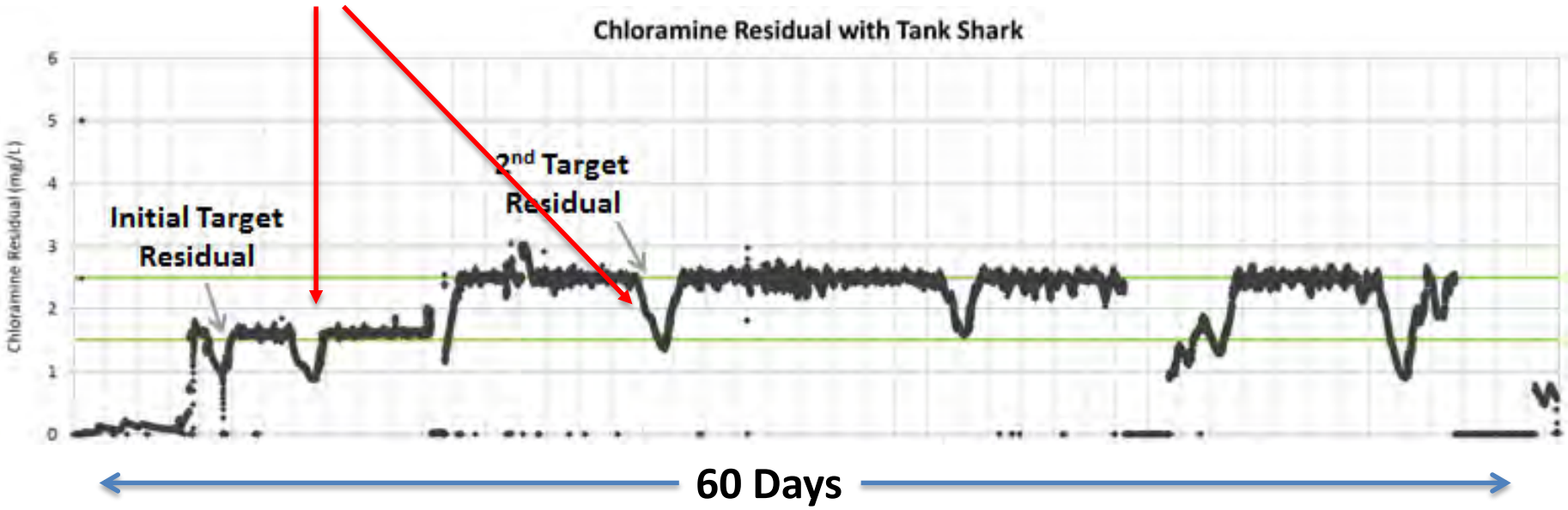
Moving water on the tank surface indicates active and energetic mixing



San Jose Tank Surface 2014

Monoclor™ Chloramine Management System Results

Introduction of "challenge water" volumes



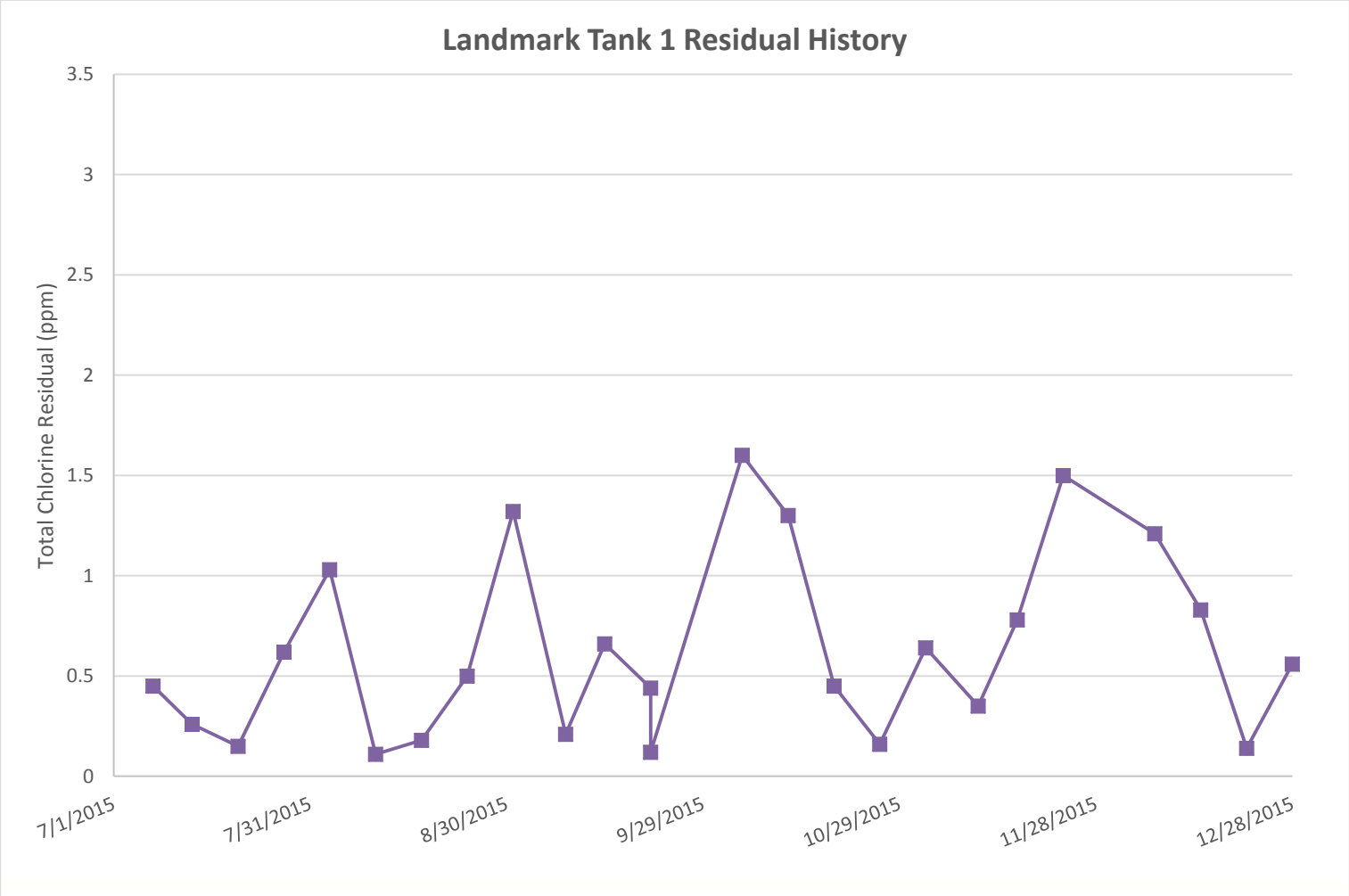
Imported water introduced in high quantities throughout the trial caused momentary and intermittent concentration changes followed by quick recovery

San Jose Water: Benefits of the Monoclor™ Chloramine Management System

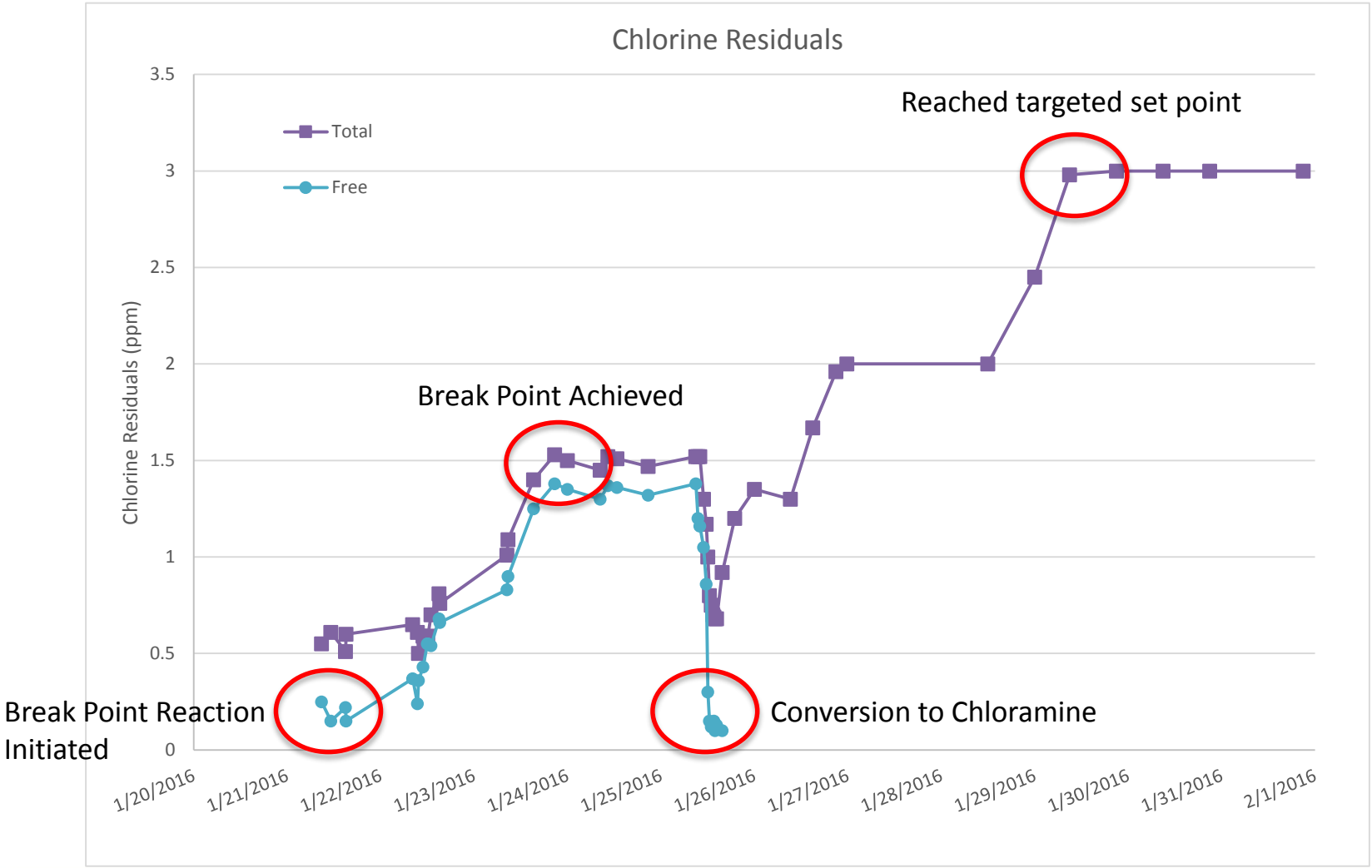
- Installation was accomplished in a day
- No internal energy supply required
- No penetration of the tank roof required
- Positive results occurred within 24 hours
- Maintained set points automatically
- Handled difficult imported water spikes quickly

Eastern Municipal Water District (Southern CA) 5.8 MG Landmark Tank had historically variable chloramine levels which made residual management in the distribution system challenging

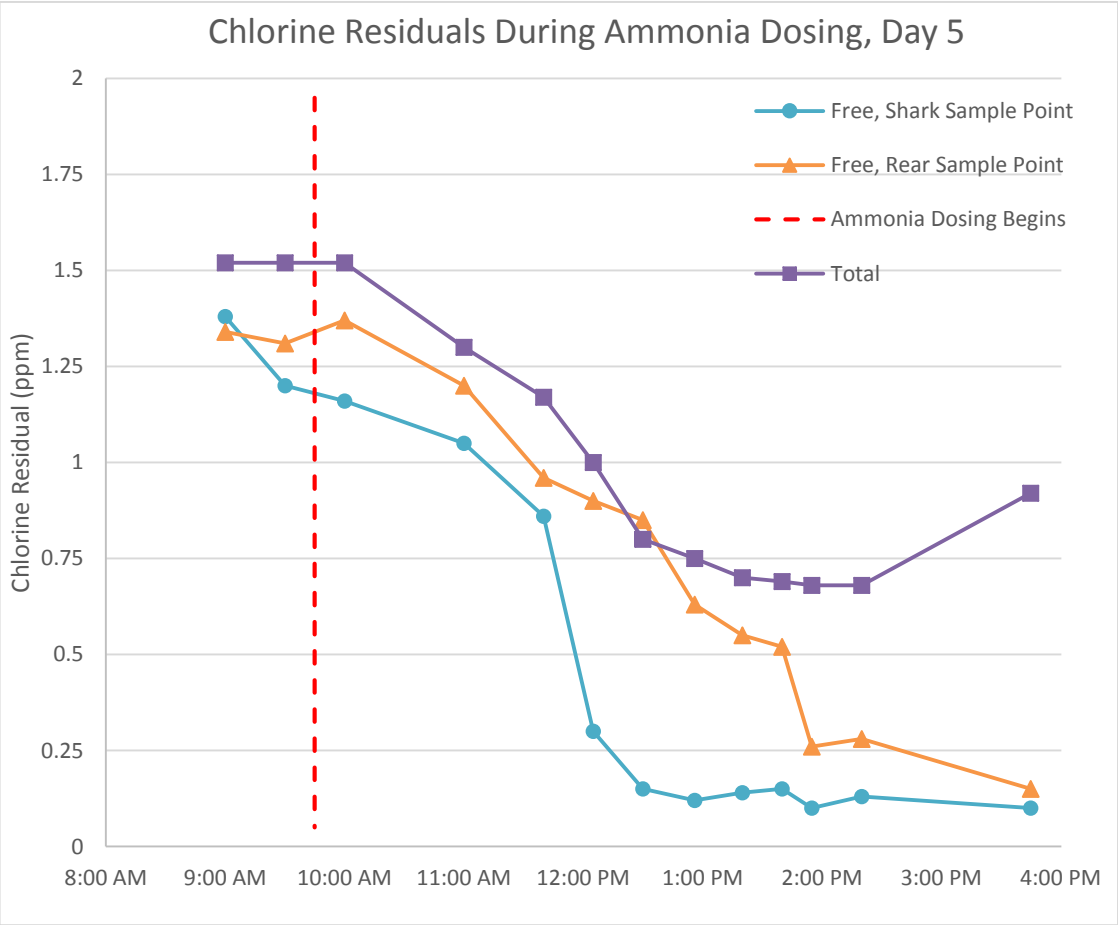
Case Study #2

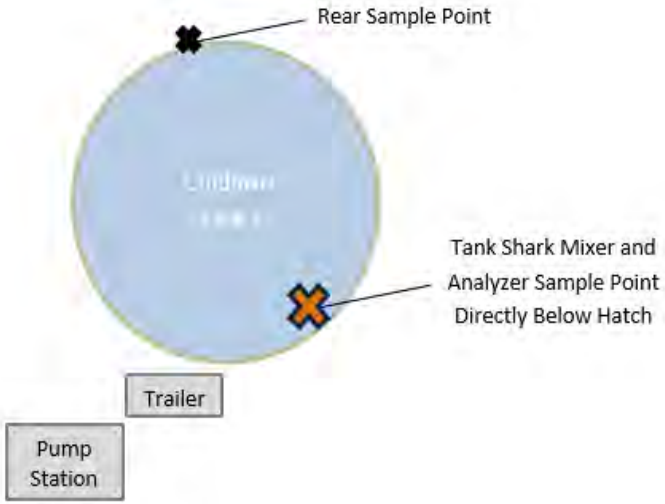


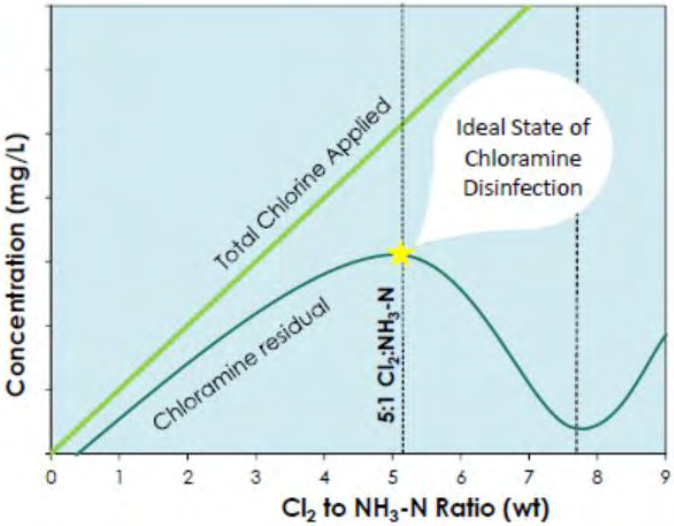
The Monoclor™ system achieved and maintained the 3.0 ppm set-point after 4 days from start-up



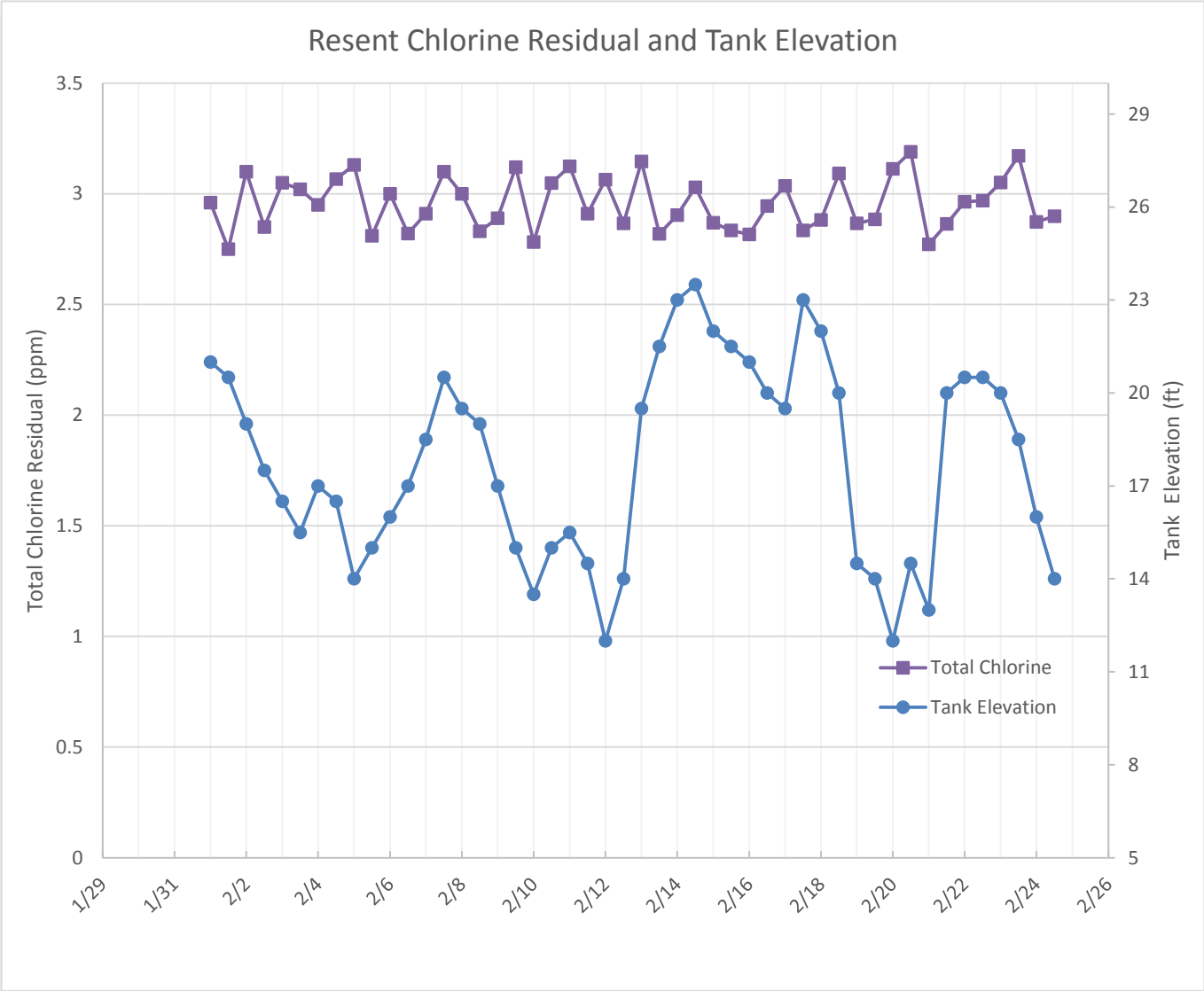
Chloramine generation and uniform tank mixing verified by two separate sample points on 5th day as ammonia is introduced



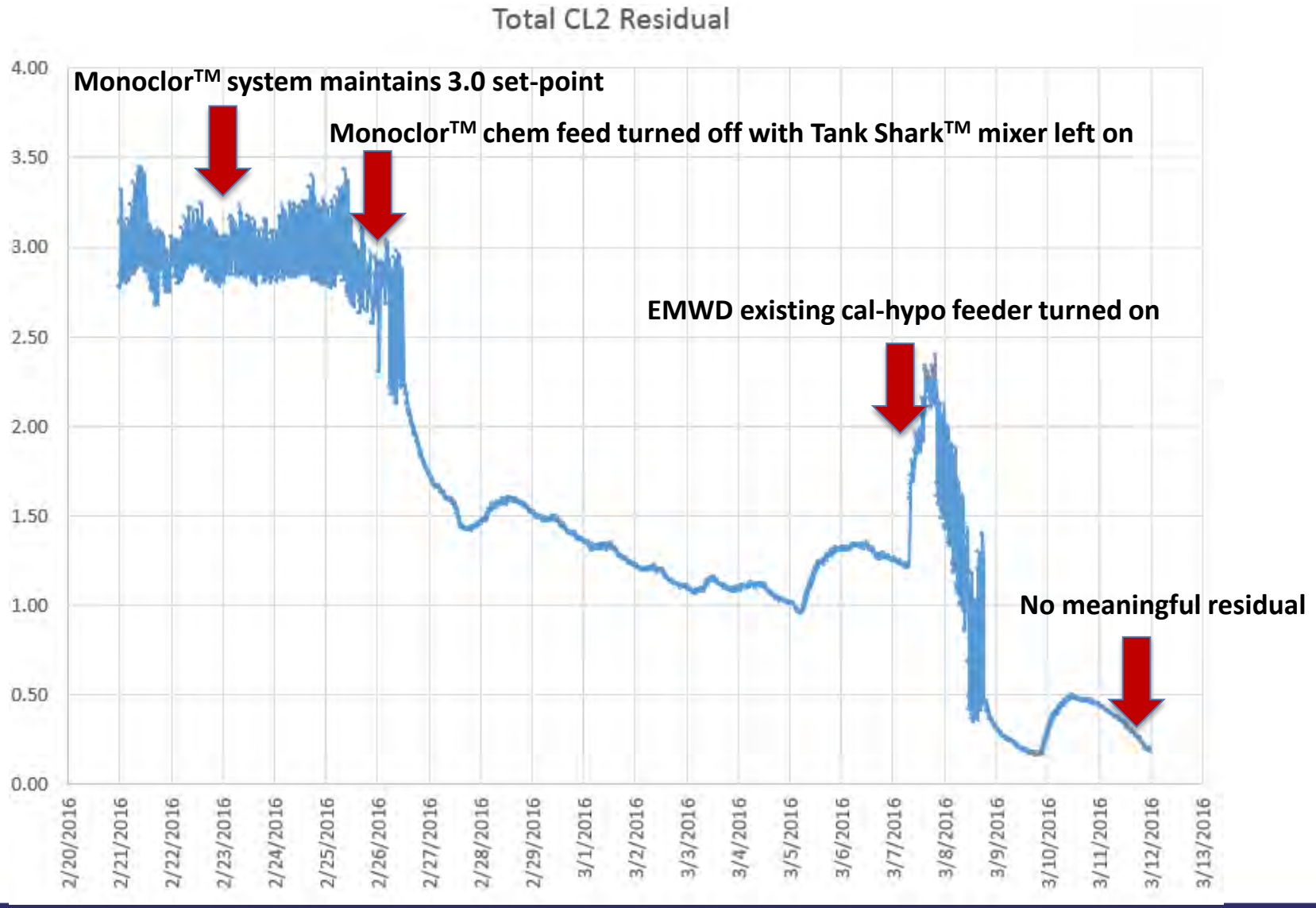




Total chlorine residual from recent study maintaining 3.0 ppm set-point at corresponding Tank Elevations

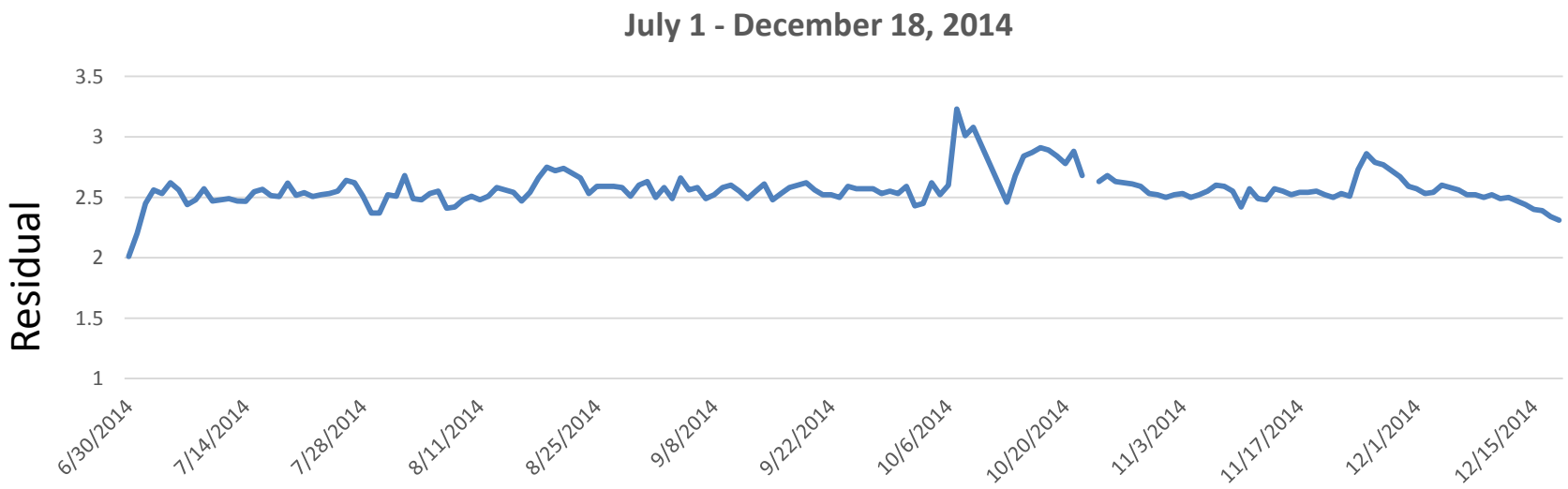


Chemical Feed algorithm was turned off and here is what happened:



Case Study: East Bay Municipal Utility District (EBMUD) – 10 MG reservoir in six month pilot

Case Study #3



Six month pilot of 10 million gallon above ground storage reservoir

Chloramine management does not have to be complicated

Equilibrium
- Mixing & Motive Energy to Attain Homogeneous Tank Conditions

Kinetics
- Energetic Mixing Zone at Point of Chemical Introduction

Sampling
- Real Time Sampling - Representative Samples from Reservoir to Assess Conditions

Algorithm
- Algorithm that Adds Appropriate Quantities of Reactants at the Right Time to Maintain Reservoir Residual

Low Maintenance
- Minimize Mechanical Parts and Need for Maintenance within Tank

Residual Control

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Questions?

THANK YOU