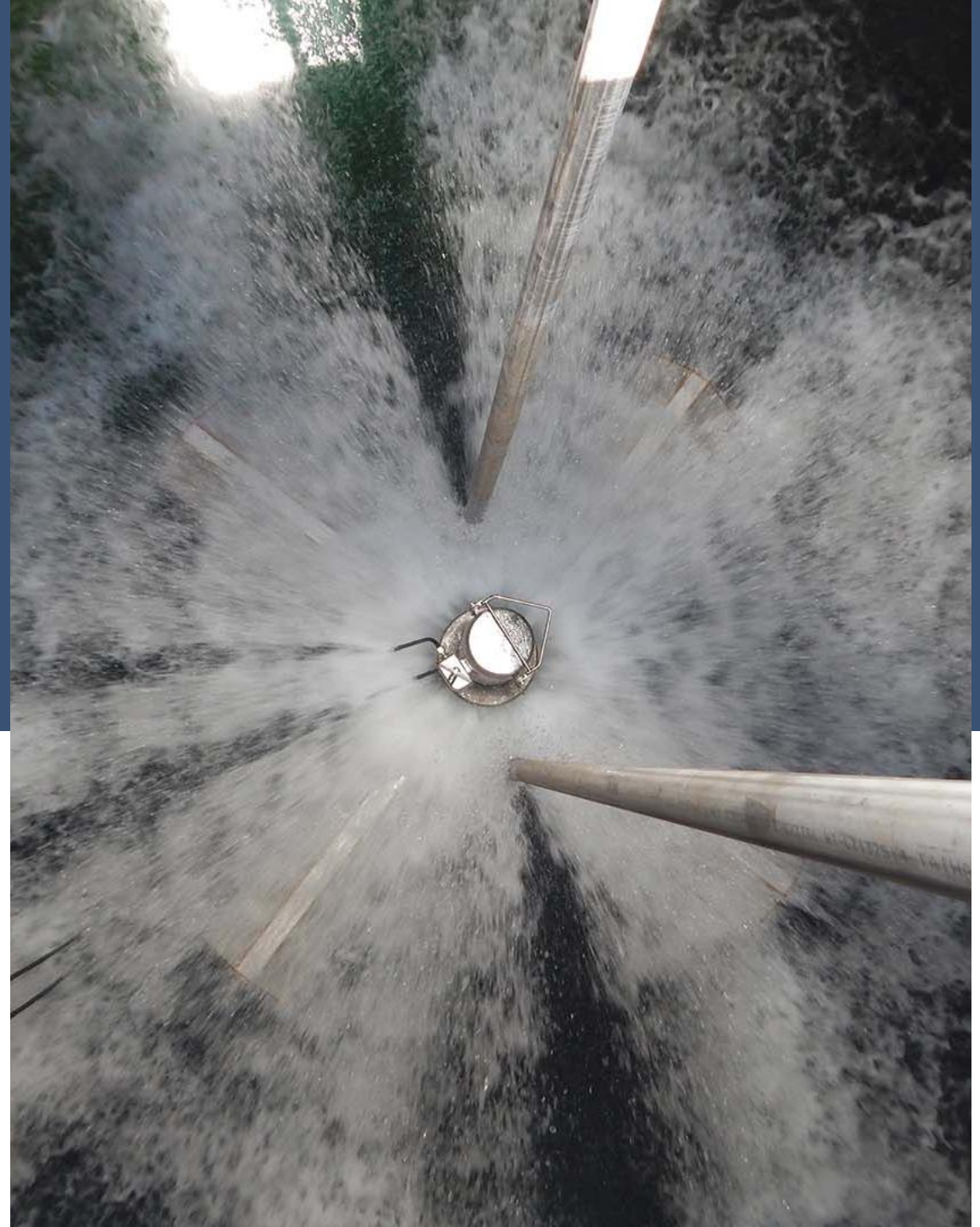
Hazen

Potential Water Regulatory Landscape Changes – What Utilities in Alabama Can Plan For

Jeremy T. Hise, PE | Christine Owen



Introductions



Jeremy Hise, PE

Associate Vice President

Co-Mid-Atlantic Drinking Water Treatment Lead



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Associate Vice President,

Director of Water and Reuse Innovations

Trustee and technical advisor for the AWWA Water Science and Research Division (WSRD)

Overview

- Background
  - Disinfection
  - Disinfection byproducts
  - Drinking Water Regulations
  - MDBP revisions
  - Perchlorate regulation
- Potential upcoming regulatory requirements/ changes
  - Microbials
  - Disinfectants
  - DBPs
  - Operations and management
- How to prepare and what can you do now
  - Data review
  - Distribution system optimization
  - Treatment plant optimization

Key Takeaways

- ✓ Residual Impacts on DBPs (THMs and HAAs)
- ✓ Data Gathering for Preparation
- ✓ Compliance Toolbox

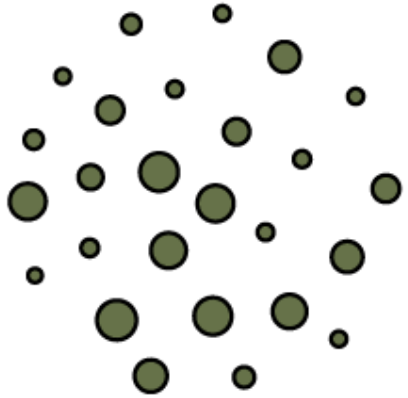
Background

Chlorinated DBP Formation



Free Chlorine

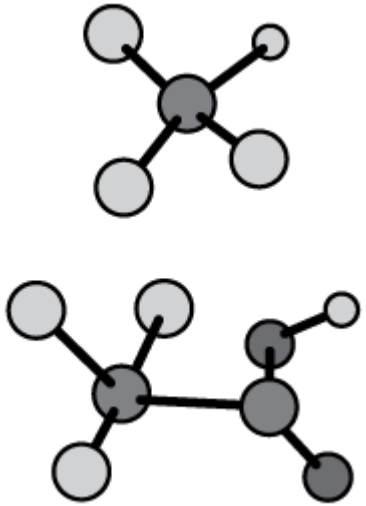
+



Organic Matter



Time
Temperature
pH
Bromide



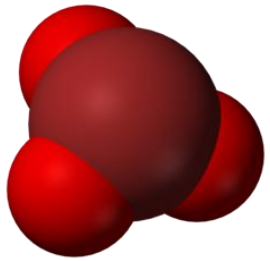
Chlorinated DBPs

- THMs
- HAAs

Other Regulated DBPs

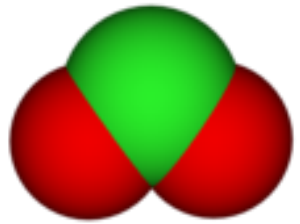
Bromate

- Bromate = BrO_3^-
- Formed during ozonation of water containing bromide – not in large use in Alabama
- Limited bromide in Alabama source water.



Chlorite

- Chlorite = ClO_2^-
- Formed during use of chlorine dioxide



National Primary Drinking Water Regulations

Select Categories

Key Takeaway

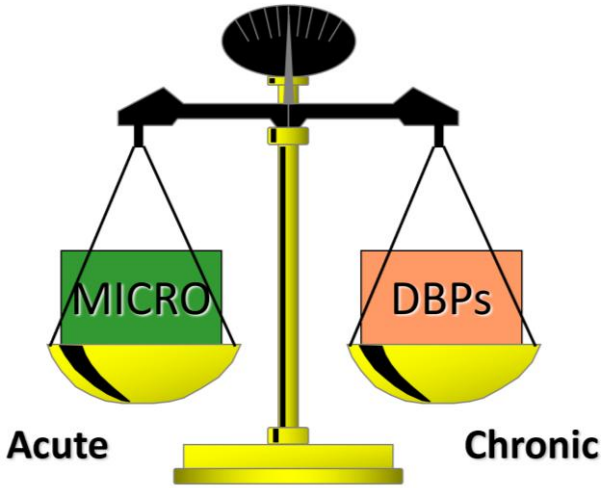
✓ **Balance water quality regulations – e.g. LCRI/Corrosion Control**

Microorganisms

Contaminant	MCLG	MCL or TT
Cryptosporidium	Zero	TT
Giardia Lamblia	Zero	TT
HPC	N/A	TT
Legionella	Zero	TT
Total Coliforms	Zero	5.0%
Turbidity	N/A	TT
Viruses	Zero	TT

Disinfectants

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Chloramines	4.0	4.0
Chlorine	4.0	4.0
Chlorine Dioxide	0.8	0.8



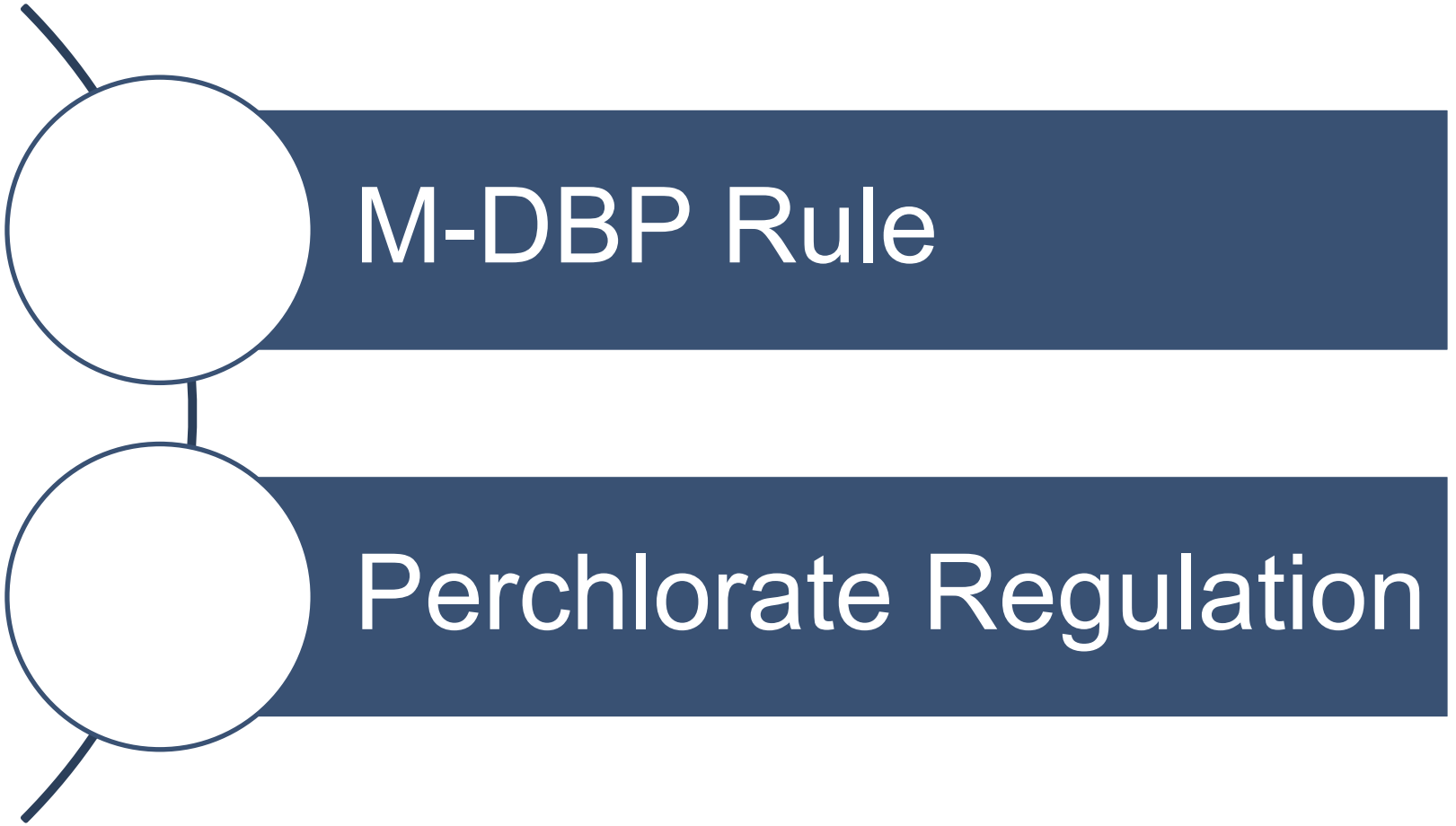
Disinfection Byproducts

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Bromate	Zero	0.010
Chlorite	0.8	1.0
HAA5	N/A	0.060
TTHMs	N/A	0.080

MCL: Maximum Contaminant Level
MCLG: Maximum Contaminant Level Goal
TT: Treatment Technique

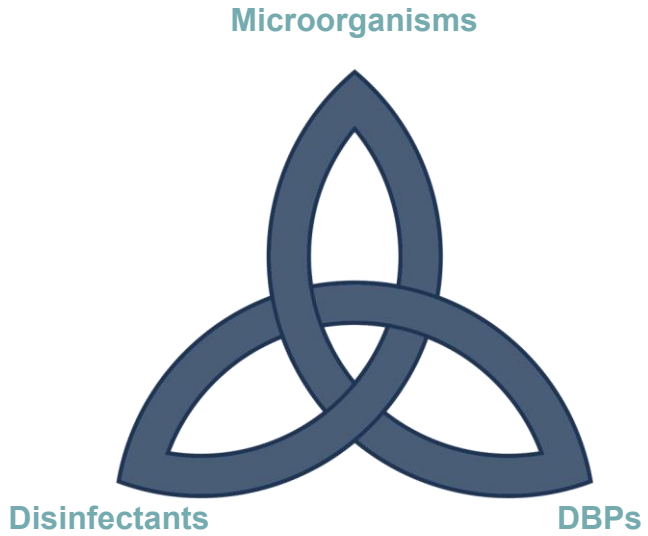
Source: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

Regulatory Horizon



M-DBP Background

- 1998: Stage 1 Disinfection and Disinfection Byproducts Rule
- 2006: Stage 2 Disinfection and Disinfection Byproducts Rule
- 2017: Six-Year Review 3
  - **Examined Stage 1 and 2 Disinfectants and Disinfection Byproducts Rules, Surface Water Treatment Rule, Long Term 1 Enhanced Surface Water Treatment Rule**
  - **Identified 8 possible contaminants: chlorite, haloacetic acids (HAAs), trihalomethanes (THMs), *Cryptosporidium*, heterotrophic bacteria (HPC), *Giardia lamblia*, *Legionella*, and viruses**
- 2020: Waterkeeper Alliance vs. EPA settlement
  - **Suit filed in 2019 alleging that EPA was not performing mandatory obligations under the Safe Drinking Water Act in a timely manner**
  - **EPA agreed to timeline to propose revisions**
- 2022-2023: National Drinking Water Advisory Council (NDWAC) meetings
  - **Formed by EPA to explore specific issues and identify potential revision options for the MDBP rules**
  - **Included stakeholders from states, tribes, utilities of all sizes, environmental and public interest groups**
- 2027, Summer: Anticipated timeline for EPA to propose revisions



It's a Balancing Act – M-DBP Rules

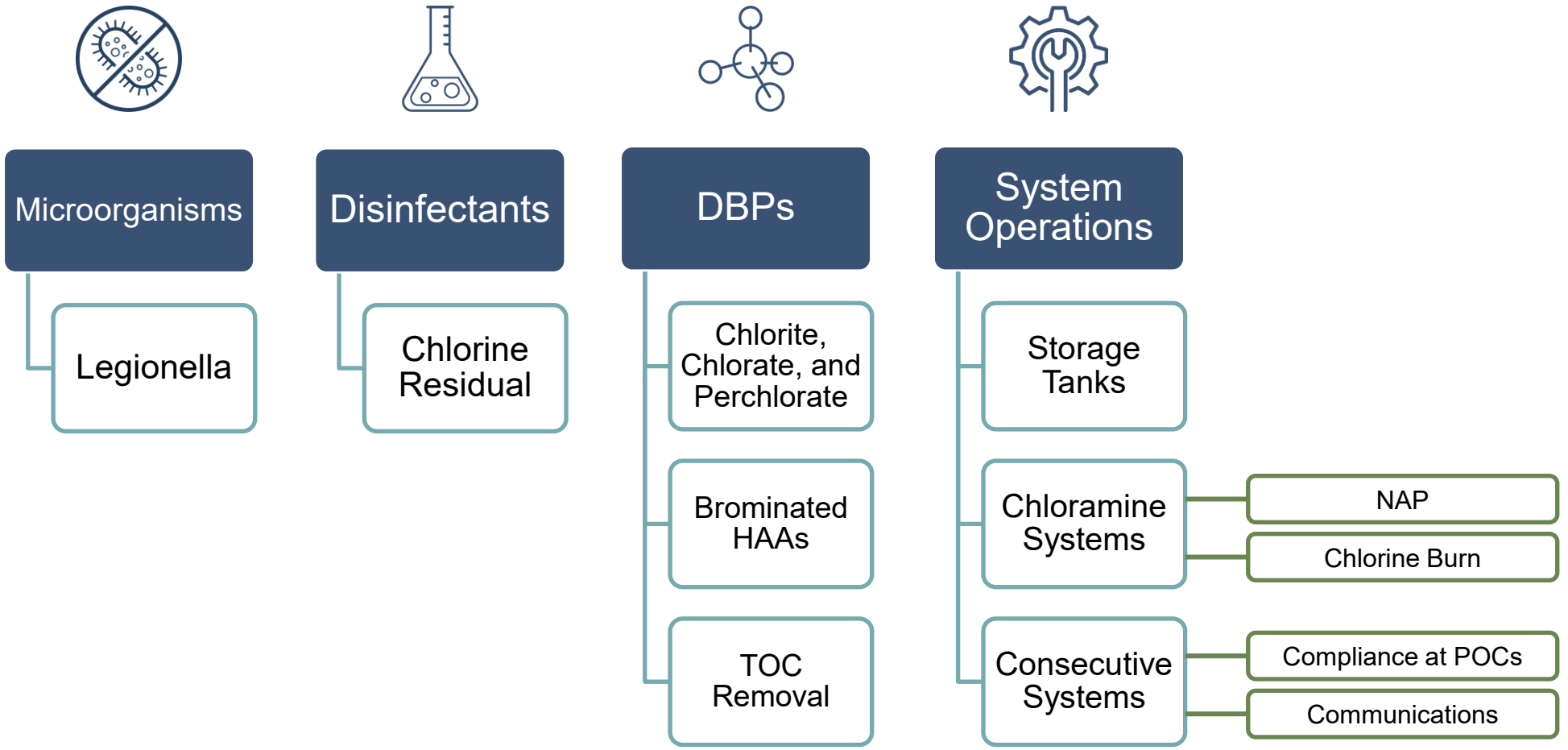
Regulatory Outlook for Perchlorate

- 1998 – Perchlorate listed on Contaminant Candidate List
- 2001-2003 – Perchlorate sampling conducted under UCMR 1
- 2007 – States like California (2007) and Massachusetts promulgated their own regulations
- 2008 – EPA published a negative preliminary regulatory determination for perchlorate
- 2011 – USEPA made a positive determination to regulate perchlorate
- July 21, 2020 – EPA withdrew its determination to issue a drinking water regulation for perchlorate
- May 2023 – Decision in NRDC v. Regan that found the EPA needed to promulgate a regulation for perchlorate
- January 2, 2026 – EPA proposed NPDWR and MCLG for perchlorate
- March 9, 2026 – public comment period ended
- May 21, 2027 – last date for EPA to sign a final rule

	Perchlorate
Current Regulations	**Proposed MCL of 20, 40, or 80 µg/L**
Potential Regulations	Potential new MCL
Health Levels	**MD HAL = 1 µg/L** (non-enforceable)
Health Effects	Endocrine disrupting compounds that impacts thyroid function
Sources	• Source water • NaOCl degradation

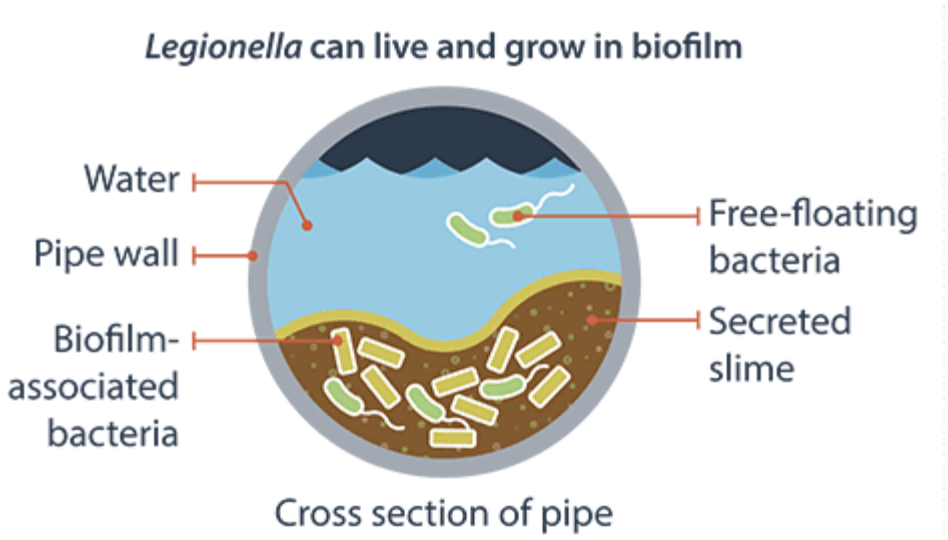
Potential M-DBP Rule Revisions

Microbial and Disinfection Byproducts (MDBP) Rules Potential Revisions



Legionella Control

- Current regulations
  - Manage *Legionella* via disinfection and disinfectant residual requirements
- Health concerns
  - *L. pneumophila* causes Legionnaire's disease and Pontiac fever
  - Opportunistic pathogen!
  - Exposure via inhalation of water droplets
  - Found in premise plumbing – warmer temperatures, stagnant conditions, etc.
- Potential regulation
  - Regulation of water mains vs. premise plumbing?
  - Responsibility on utility to maintain water quality within premise plumbing?





Chlorine Residuals

Existing Federal Regulations and Potential Changes

Existing Regulations

- Detectable in 95% of samples
- Alternative compliance criteria: HPC < 500 cfu/mL
- Cannot be non-detect at same location for more than 2 months in a row

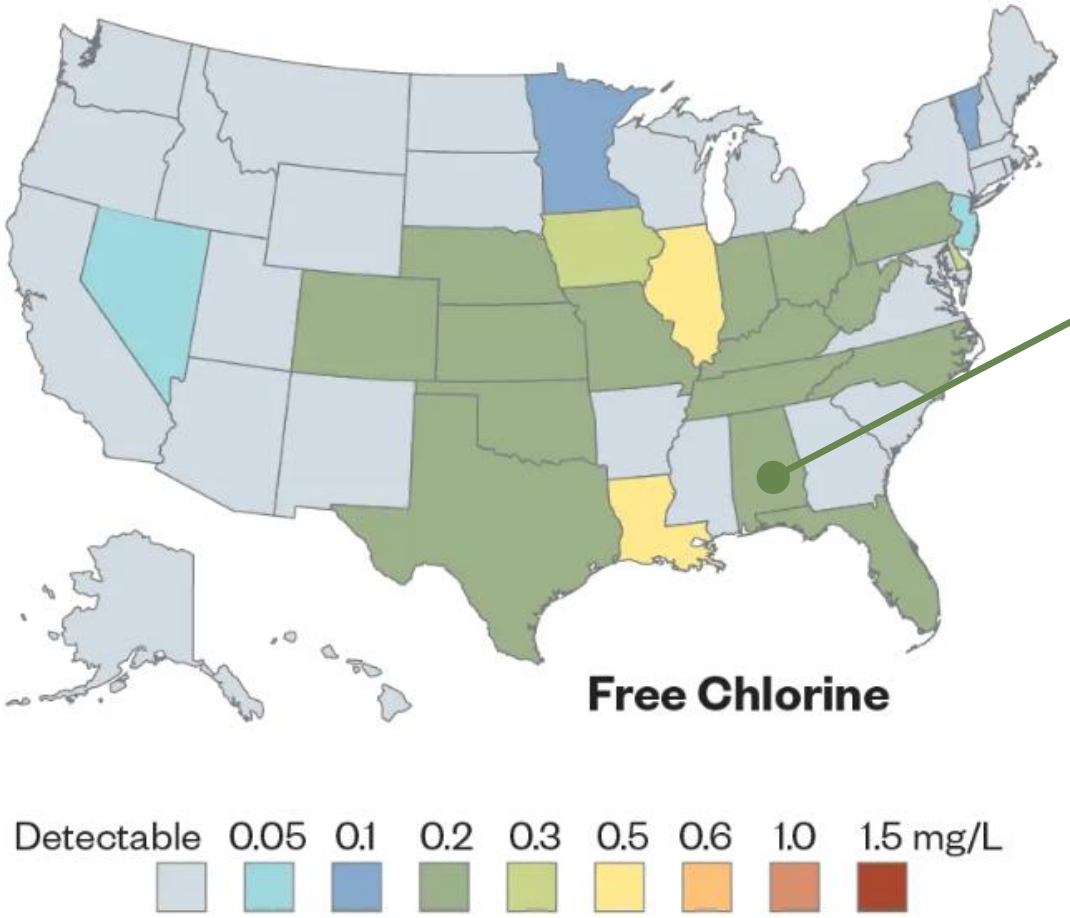


Potential Changes

- Minimum numeric values for free chlorine (0.2-0.5 mg/L) and chloramine (0.2-1.0 mg/L) – 0.2 mg/L required in Alabama
- Alter the frequency or allowable percentage of samples below minimum level
- Add requirements to address storage tanks, dead ends, and other problematic areas

Potential Implications of Chlorine Residual Requirement

Free Chlorine Residual Requirements



AL utilities required to meet 0.2 mg/L

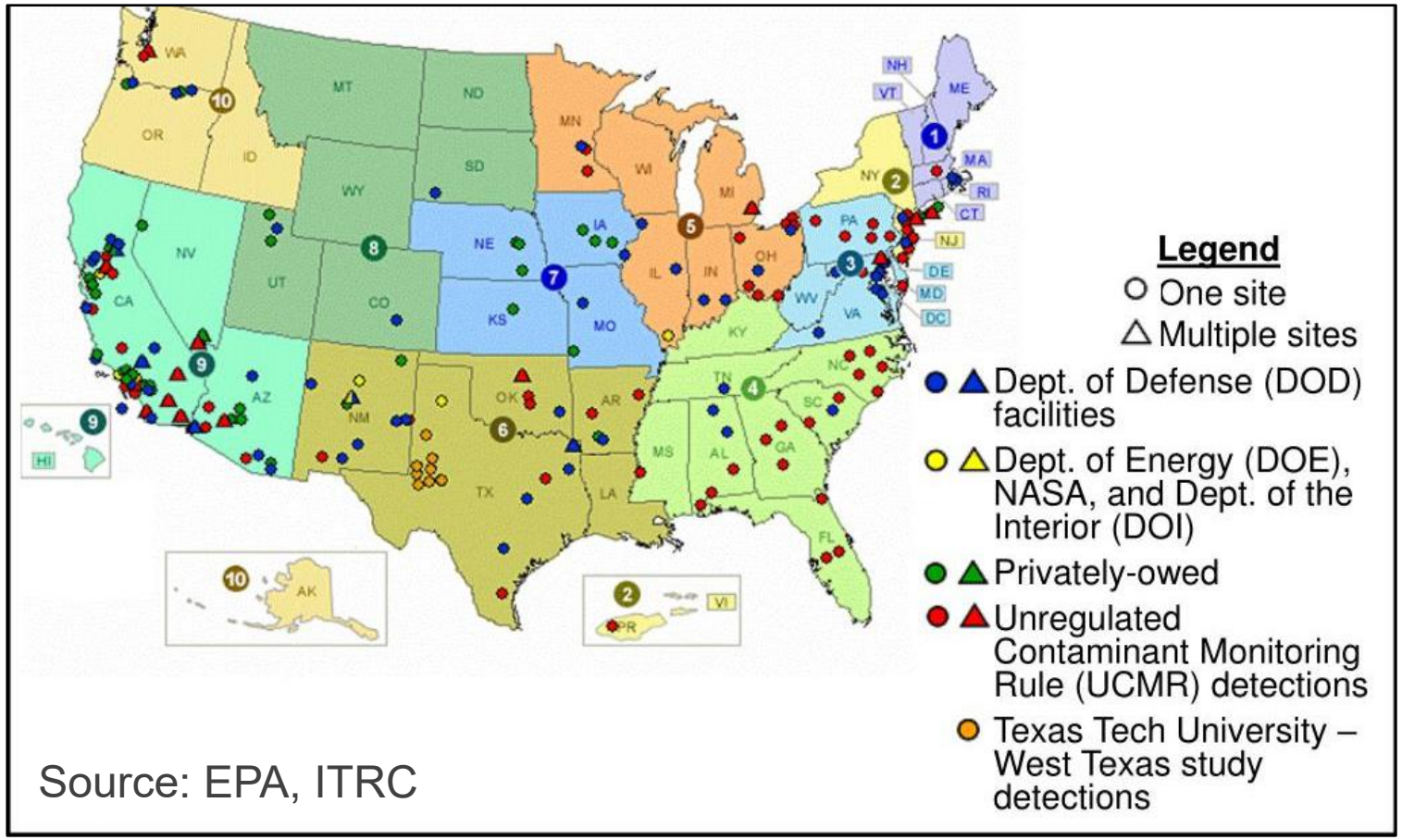
- Utilities will need to maintain chlorine residual above the regulatory levels
- Utilities will need to dose higher levels of chlorine at the WTP
- Increased chlorine dose at the WTP is expected to lead to higher DBP formation in the distribution system
- HAA concentrations may increase in some systems that experience biodegradation of HAA's in low residual environments

Intrinsic DBPs

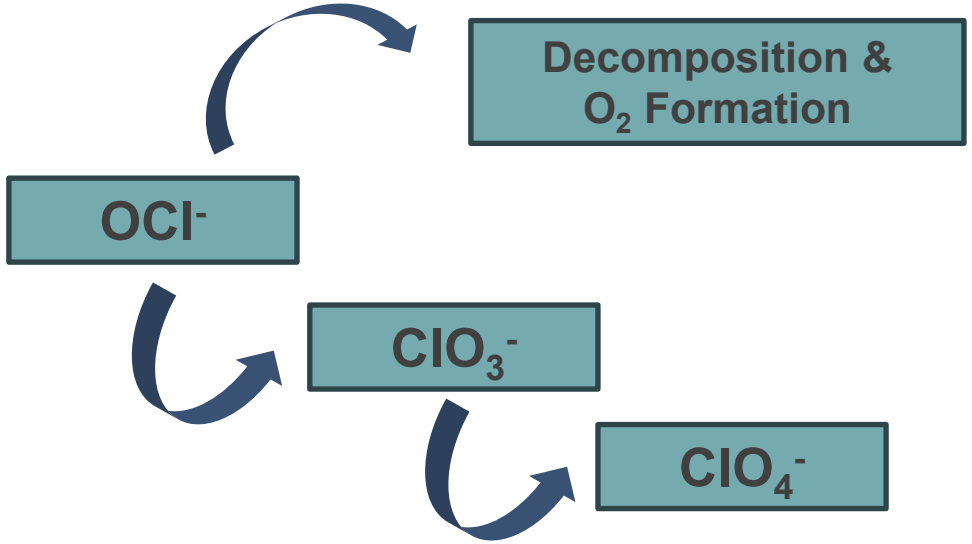
	Chlorite	Chlorate	Perchlorate
Current Regulations	**MCL = 1.0 mg/L** ONLY systems using chlorine dioxide have to monitor	Not regulated	**Proposed MCL of 20, 40, or 80 µg/L**
Potential Regulations	All systems might have to comply with MCL	Potential new MCL	Potential new MCL
Health Levels		**HAL = 210 µg/L**	**MD HAL = 1 µg/L** (non-enforceable)
Health Effects	Endocrine disrupting compounds that impacts thyroid function		
Sources	• ClO_2 degradation	• ClO_2 degradation • NaOCl degradation	• Source water • NaOCl degradation

Perchlorate Occurrence

- Perchlorate was included in UCMR 1



Hypochlorite Feedstock Decomposition



Chlorite – low-level intermediate

Storage Time
Storage Temperature
Hypo wt%
Cl_2 Dose

Hypo degradation
Chlorate formation
Perchlorate formation

Days to Chlorate Residual >210 µg/L @ 5 mg/L Cl_2 Dose

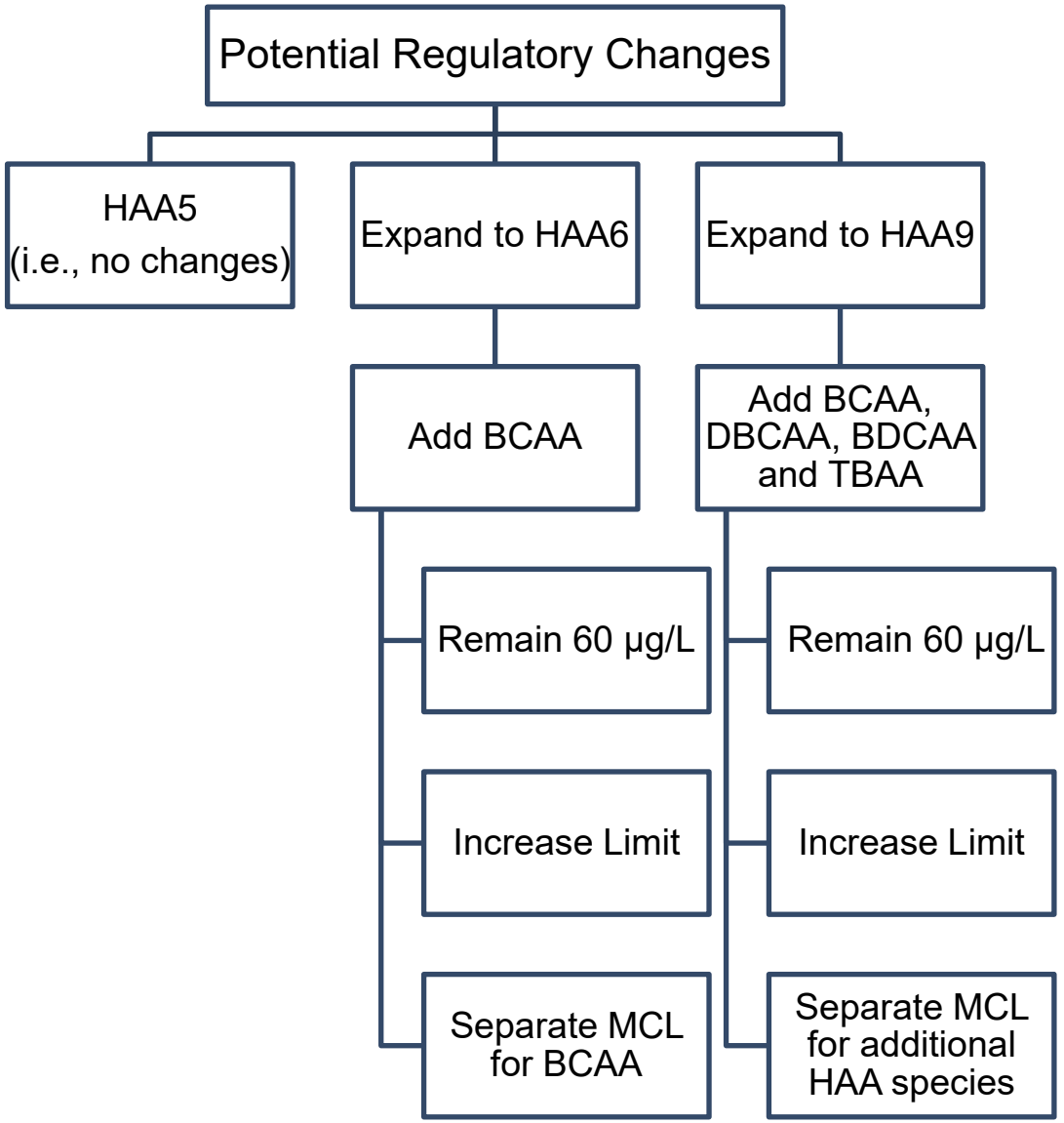
Temp. / Hypo wt%	15 °C	25 °C	35 °C
5%	> 365	114	29
12.5%	75	18	<5
16%	35	9	<3

Perchlorate residual always < 5 µg/L within 30 days

Developed by https://hypochlorite.awwa.org/

Potential Changes to HAA Regulations

HAAs	HAA5	HAA6	HAA9
Monochloroacetic acid	✓	✓	✓
Dichloroacetic acid	✓	✓	✓
Trichloroacetic acid	✓	✓	✓
Monobromoacetic acid	✓	✓	✓
Dibromoacetic acid	✓	✓	✓
Bromochloroacetic acid		✓	✓
Bromodichloroacetic acid			✓
Dibromochloroacetic acid			✓
Tribromoacetic acid			✓



Impacts of Potential HAA9 Regulations

- **Dataset to Evaluate:** UCMR3 Measured both HAA5, HAA6 and HAA9 for utilities throughout the Country
  - Average HAA9:HAA5 Ratio = 1.38
  - 90th Percentile HAA9:HAA5 Ratio = 1.91
- **Potential Implications:** What could this mean (if HAA9 MCL stays at 60 μg/L)?

Example HAA5 LRAA	HAA9 (For an Average Utility)	HAA9 (For a 90th %ile Utility)
20	27.6	38.2
30	41.4	57.3
40	55.2	76.4
50	69	95.5
60	82.8	115

Increased TOC Removal Requirements

- Current requirements
  - **Subpart H systems using conventional treatment use 3x3 matrix to determine TOC removal requirements**
  - **Exemptions via alternative criteria are possible**
- Potential changes
  - **Require greater TOC removal**
- How to prepare
  - **Analyze historical TOC removal**
  - **Measure organics characteristics**
  - **Evaluate TOC removal options**

Stage 2 D/DBPR

Table 7. TOC Removal

Subpart H systems that use conventional filtration treatment are required to remove specific percentages of organic materials, measured as total organic carbon (TOC), that may react with disinfectants to form DBPs. Removal must be achieved through a treatment technique (enhanced coagulation or enhanced softening) unless a system meets alternative criteria. Systems practicing softening must meet TOC removal requirements for source water alkalinity greater than 120 mg/L $CaC0_3$.

Source Water TOC (mg/L)	Source Water Alkalinity, mg/L as $CaCO_3$		
	0 - 60	> 60 to 120	> 120
> 2.0 to 4.0	35.0%	25.0%	15.0%
> 4.0 to 8.0	45.0%	35.0%	25.0%
> 8.0	50.0%	40.0%	30.0%

Storage Tank Requirements

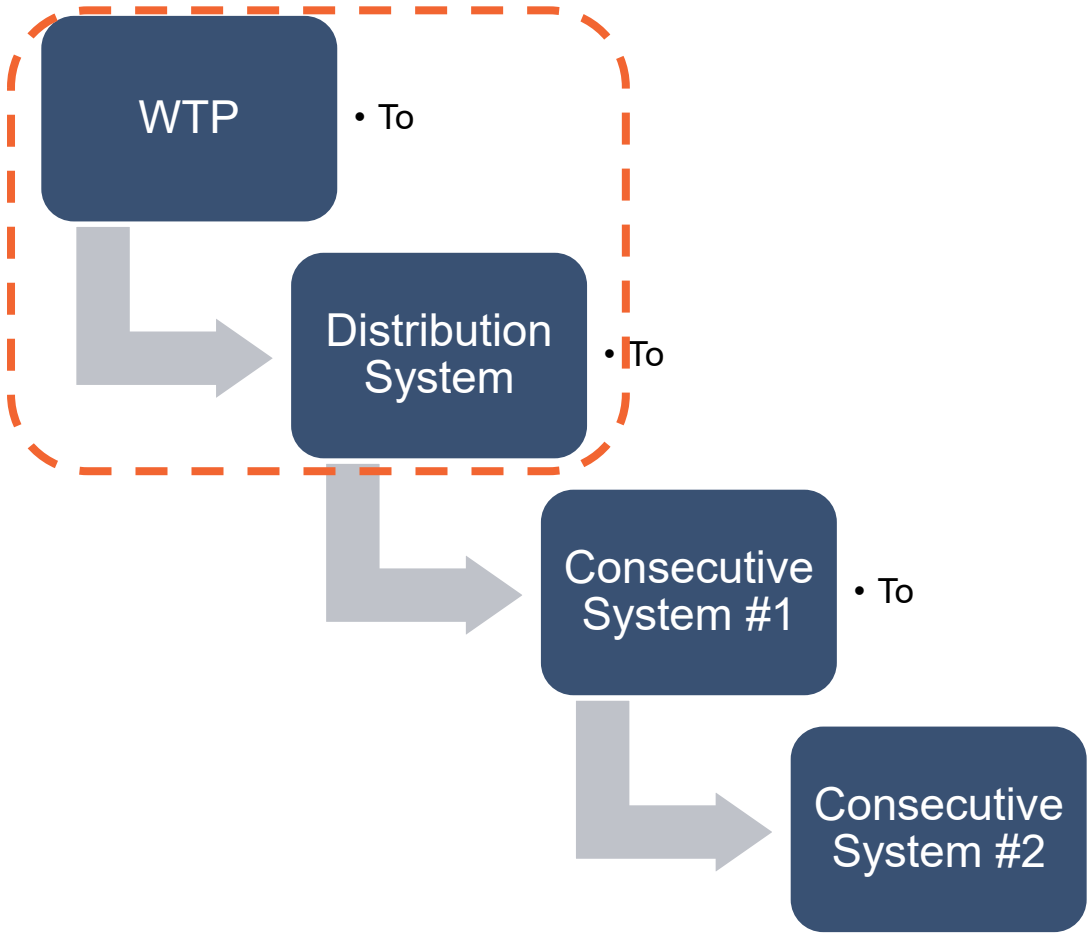
- Importance
  - Long water age → low disinfectant residual
  - Sediment accumulation → microbial regrowth, metals accumulation
- Current regulations
  - No federal regulations on inspection or cleaning frequency
  - Alabama requires periodic tank clean outs (effective in 2022)
- Potential changes
  - 10 States' Standards recommends inspection every 3-5 years and cleaning as needed.
  - Alabama has an initial deadline of 12/31/27 for first inspections and washouts being completed – to be completed on a 5 year cycle.
- How to prepare
  - Continue efforts with tank inspections and cleaning
  - Evaluate existing piping and turnover
  - Evaluate water quality in and around the tank
  - Hydraulic modeling for water age



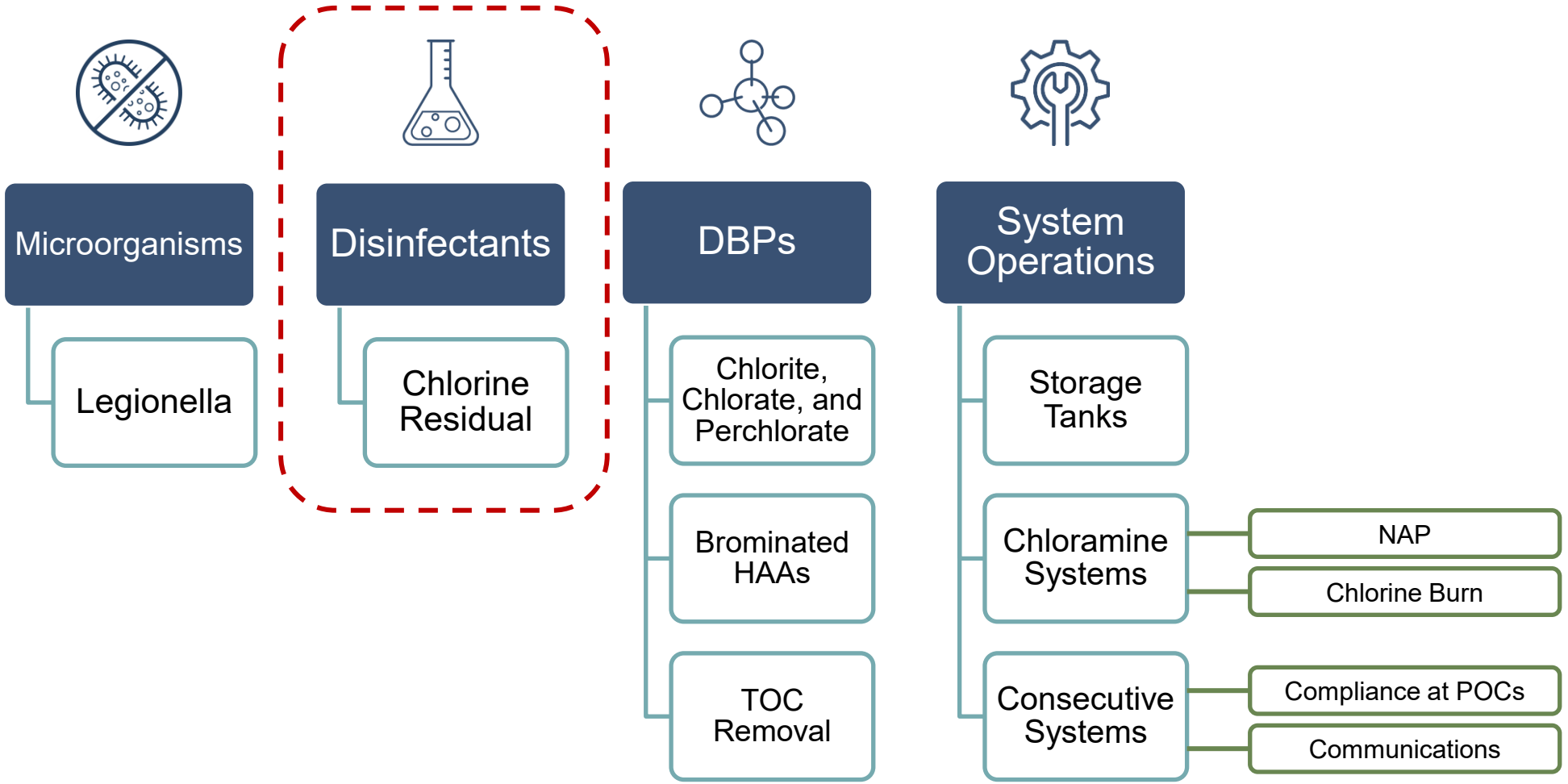
Potential Agency Efforts for Consecutive Systems

Requires a change as to how EPA views wholesale water systems

- No monitoring requirements under current regulations for wholesalers
- May require reporting or compliance at points of connection
  - **DBPs**
  - **Disinfectant residual**
  - **Corrosion control**
  - **Total coliform**
- Potential overlaps with contractual agreements between wholesaler and consecutive system
  - **Encourage communications**



Microbial and Disinfection Byproducts (MDBP) Rules Potential Revisions



How to Prepare

What you can do NOW?

What should I do to prepare for this?

Increase in Detectable Residual Requirement

Things that are in discussion:

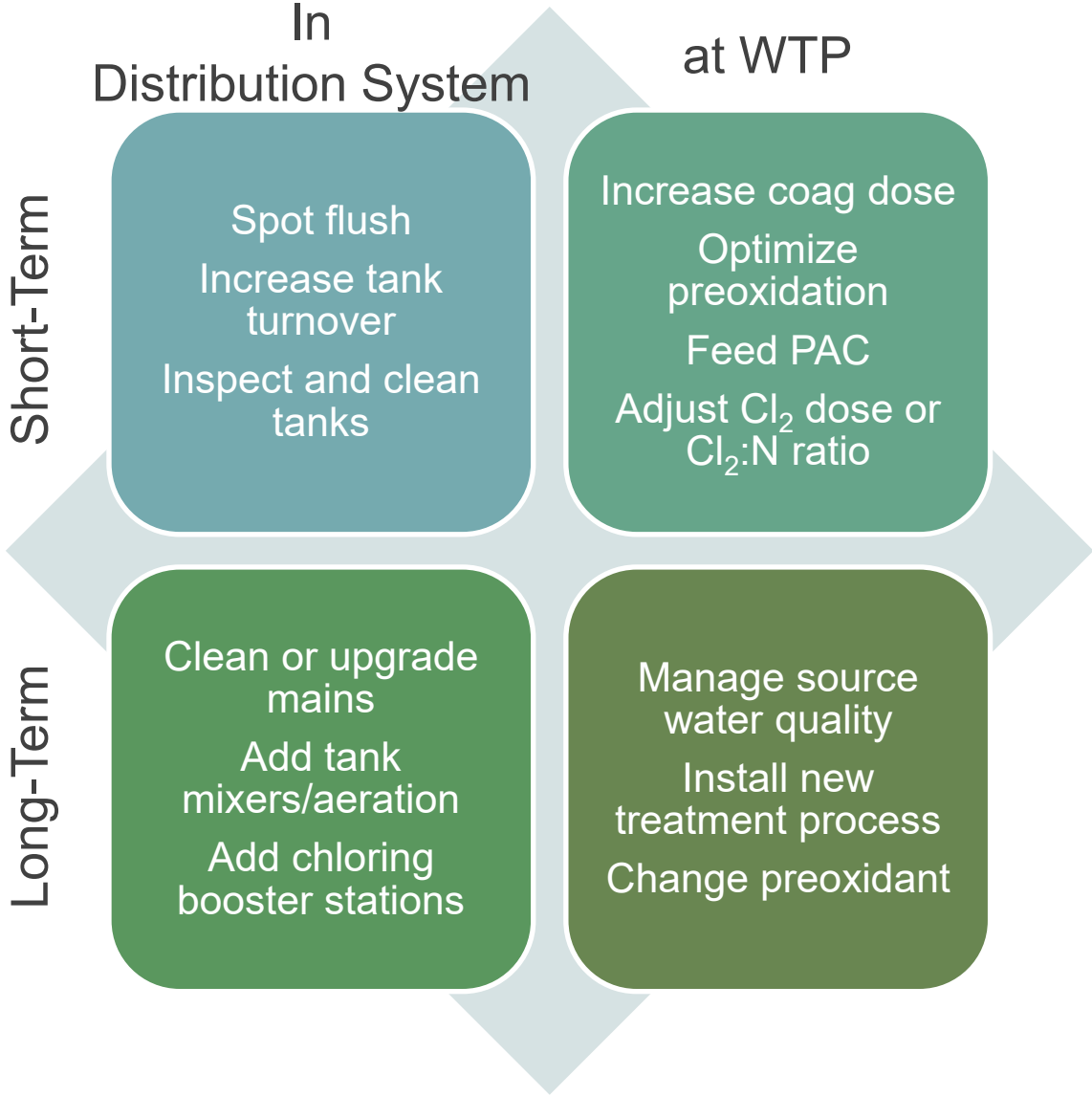
- Is it going to be required to comply at all places at all times?
- Is it acceptable to record higher value after flushing?
- Is there going to be an increase in sampling locations?
- Is there going to be a change in regulatory compliance triggers?



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How to Prepare

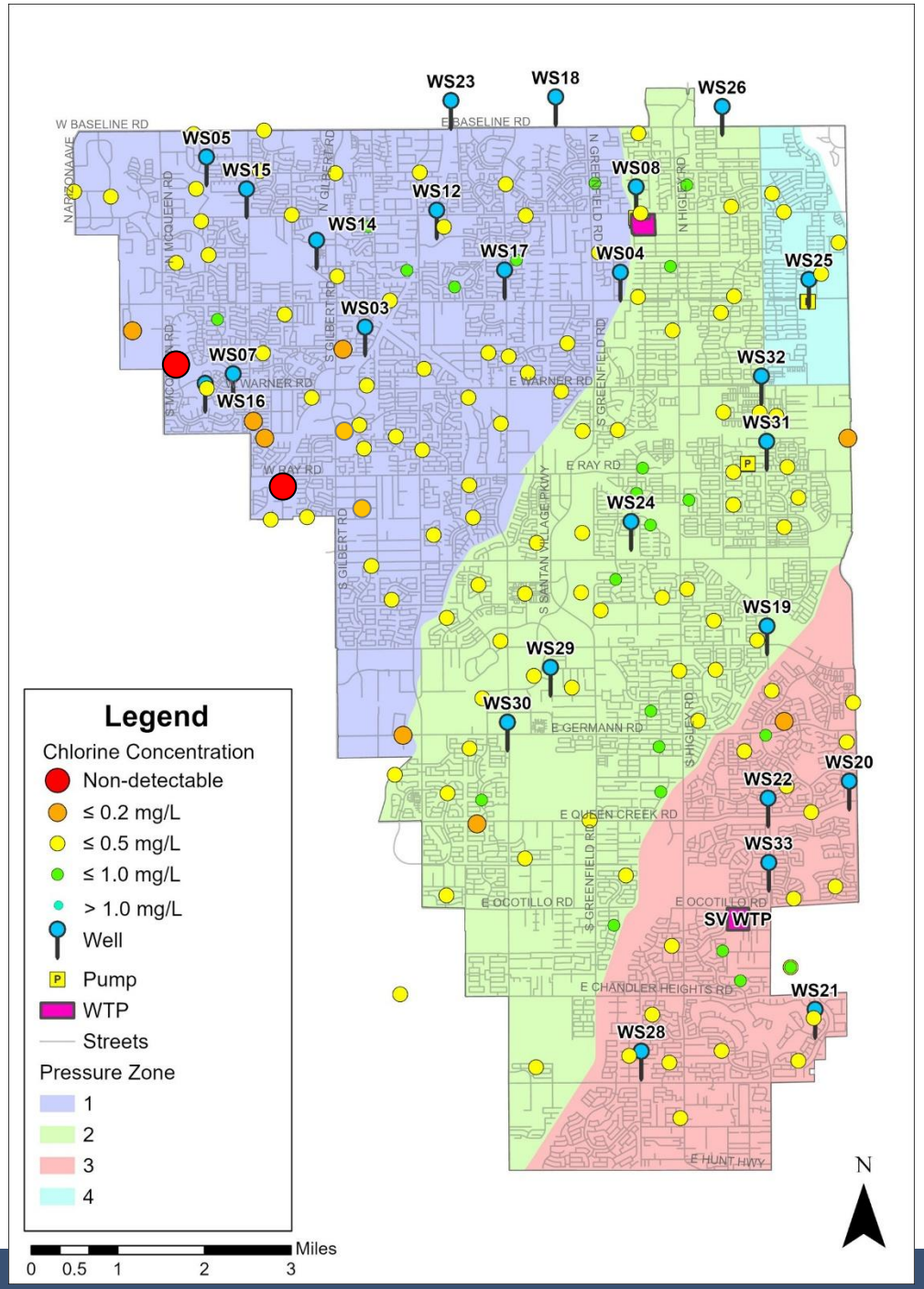
- Review monitoring data
- Conduct additional sampling (e.g. SDS DBP Sampling)
- Determine new target chlorine dose
- Assess DBP impacts (see sampling above)
- Optimize distribution system
- Optimize plant operations



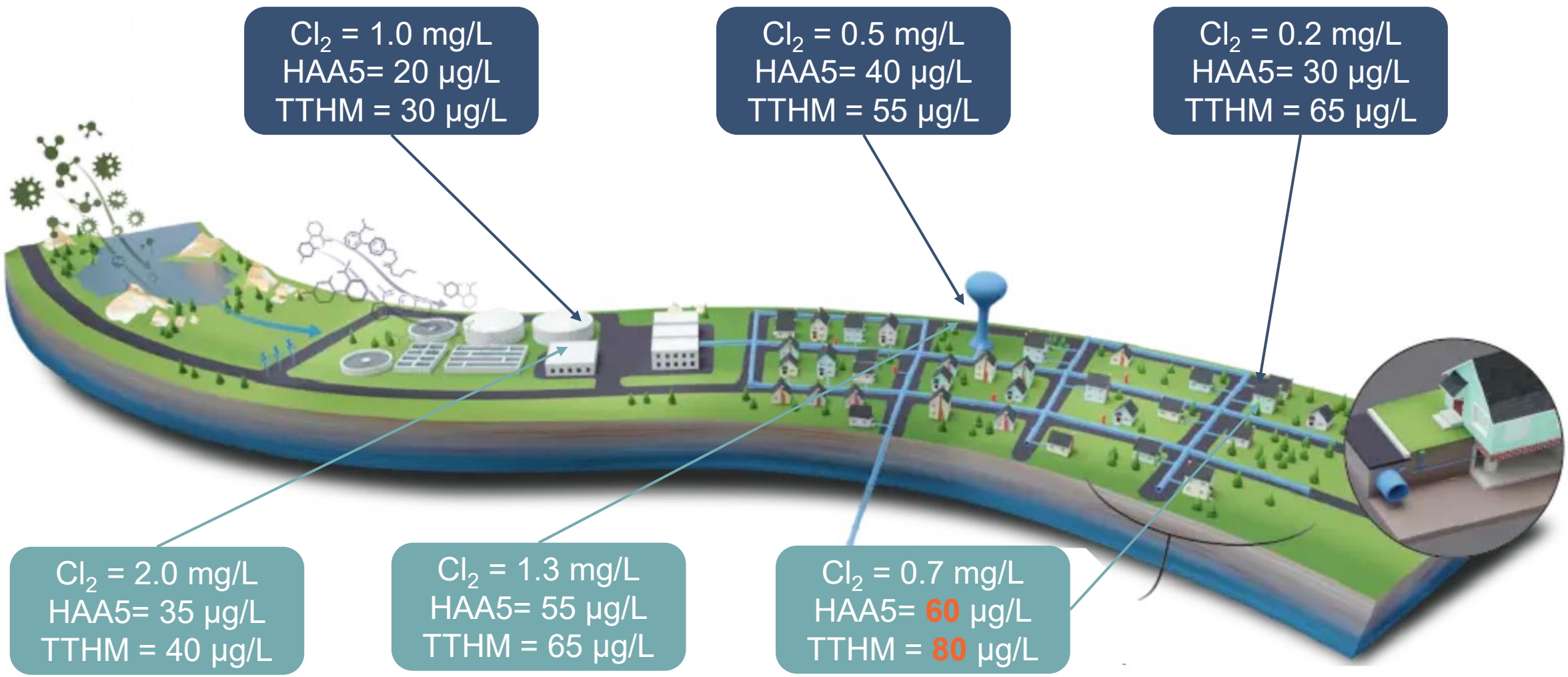
Adapted from AWWA (2025) “Maintaining a Numeric Minimum Disinfectant Residual in the Distribution System: A framework for strategy selection and evaluation”

Review Existing Data

- **Dataset: Cl_2 at TCR sites**
- Map data to understand breadth of challenge, patterns, and trends
- Look at number and locations of points with
  - **Free Cl_2 < MRDL**
  - **Free Cl_2 < 0.2 mg/L**
  - **Free Cl_2 < 0.5 mg/L**
- Local or systemic?
  - **Assess relationship between water age and chlorine residual with a hydraulic model (if available)**
- Timeseries
  - **Seasonal issues?**
  - **Repeat offenders?**
- Consider conducting additional sampling at
  - **Storage tanks**
  - **Dead ends**



Assess DBP Level Implications



What Can a Utility Do NOW?

Historical Data/Resources Review

- Review your TCR data
  - Identify areas of low residual
  - Determine if low residuals are persistent, localized
  - How effective is flushing?
- Review tank operation and maintenance SOPs
- Review distribution system SOPs
- CDC Legionella tracking and reporting database
- Review DBP data and OEL Report – assess potential DBP impacts

Additional Data Resources

- Distribution system water age
  - Modeling is a great tool!
- Expand sample collection
  - Dead ends
  - Stagnant loops
  - LIFO tank cycles
- Chlorine decay test
- DBP formation tests (SDS to achieve residual goal)
- Understand seasonal impacts

How to Control

What do you need to plan for?

Controlling Intrinsic DBPs

Hypochlorite feedstocks

- Manage hypo storage
  - Cool down storage space
  - Decrease the storage age
  - Dilute upon delivery
- Switch to gas
  - Concerns with safety
- Switch to onsite generation
  - Generate a lower concentration (0.6-1%)
  - Much shorter storage time (maybe 1 day)
  - Quality of the salt used for generation can impact bromine, chlorite, chlorate, and perchlorate
  - Salt now has NSF standard for bromate



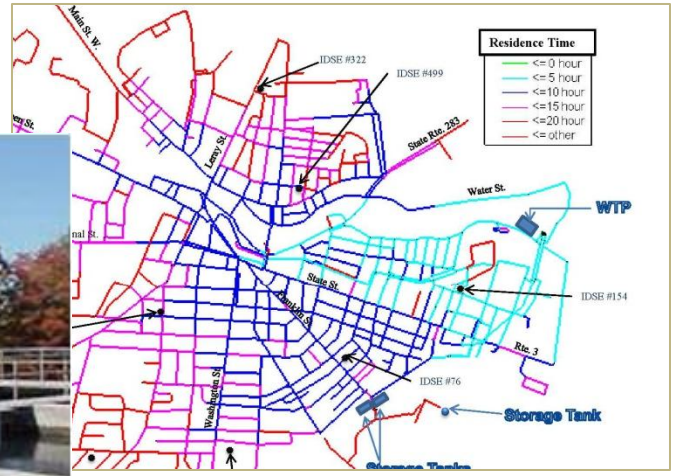
Controlling DBP Formation



Source



Treatment Plant



Distribution System

Treatment Control

Parameter	Source Water	Treatment	Distribution
TOC	✓	✓	
Chlorine		✓	✓
Time		✓	✓
Temperature	✓		
pH		✓	✓

✓ : Locations where parameters can be affected

Toolbox for DBP Control

Source

- Source Water Monitoring
- Blending
- Switching Sources

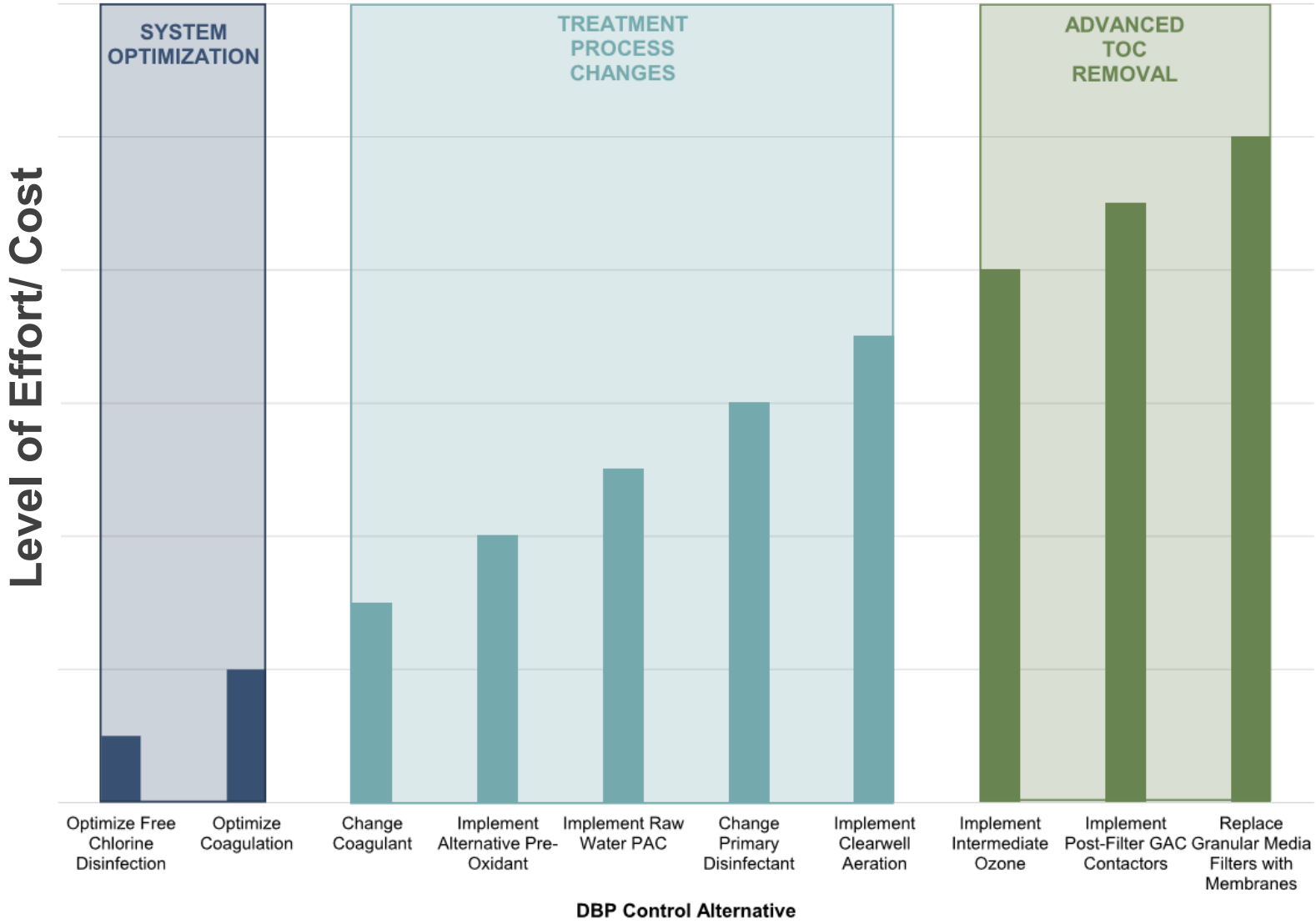
Treatment Plant

- Alternative preoxidants
- Alternate post-oxidants
- Alternate Coagulants
- Optimization of coagulation
- PAC
- GAC
- Biofilters (Not in use in Alabama)
- Membranes
- MIEX®
- UV Disinfection (Not in use in Alabama)
- Clearwell Improvements

Distribution System

- THM Removal
  - Aeration
  - In-line treatment
- HAA Removal
  - In-line treatment
- Flushing
- Looping
- Switching Pump Settings
- Adjusting Tank Elevations

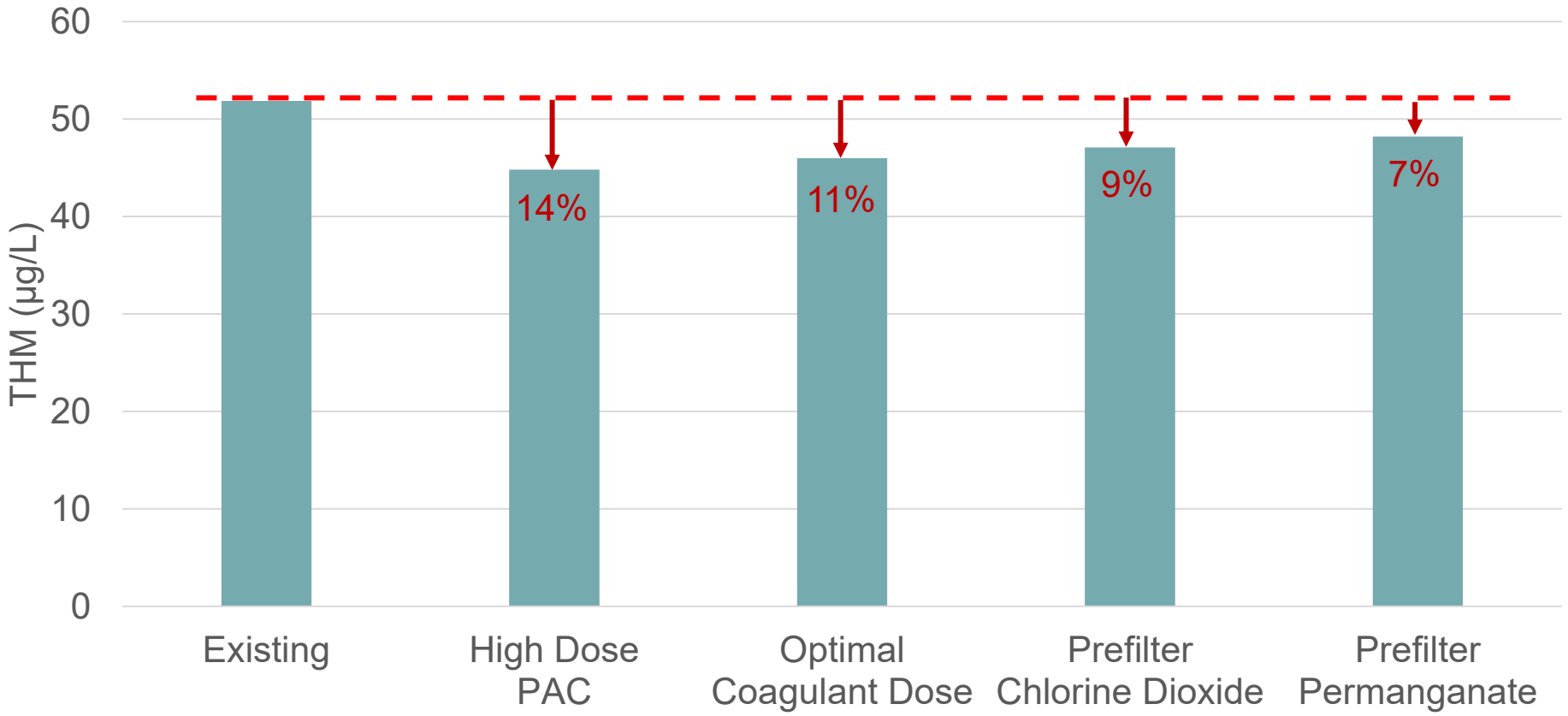
Further Optimize WTP Operations – Consider Consecutive System Treatment Strategies



Treatment Process Changes



- Test dose and type of
  - **PAC**
  - **Coagulant**
  - **Preoxidant**
- Cost/ Benefit analysis to inform decision



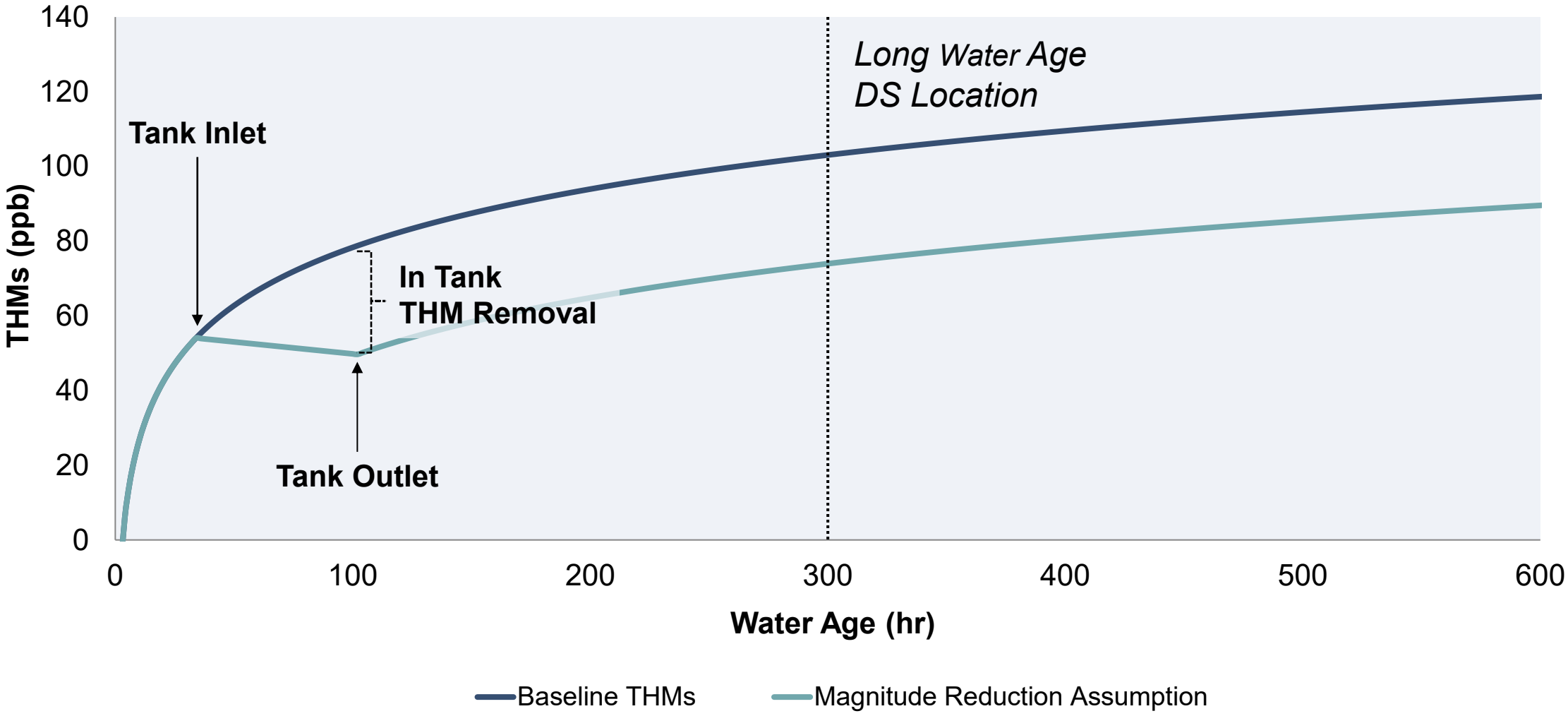
Distribution System Optimization
Improve Water Age and Maintain Chlorine Residual

1. Flush at optimal locations and flows
2. Bleed water at zone boundaries
3. Increase tank turnover (reduce water age)
4. Control VFDs advantageously
5. Use ground storage and control valves to circulate water
6. Consider closing valves to change flow patterns
7. Change operating methods to increase low flows
8. Reduce storage volume in low demand zones
9. Eliminate dead-ends
10. Use multiple supply sources



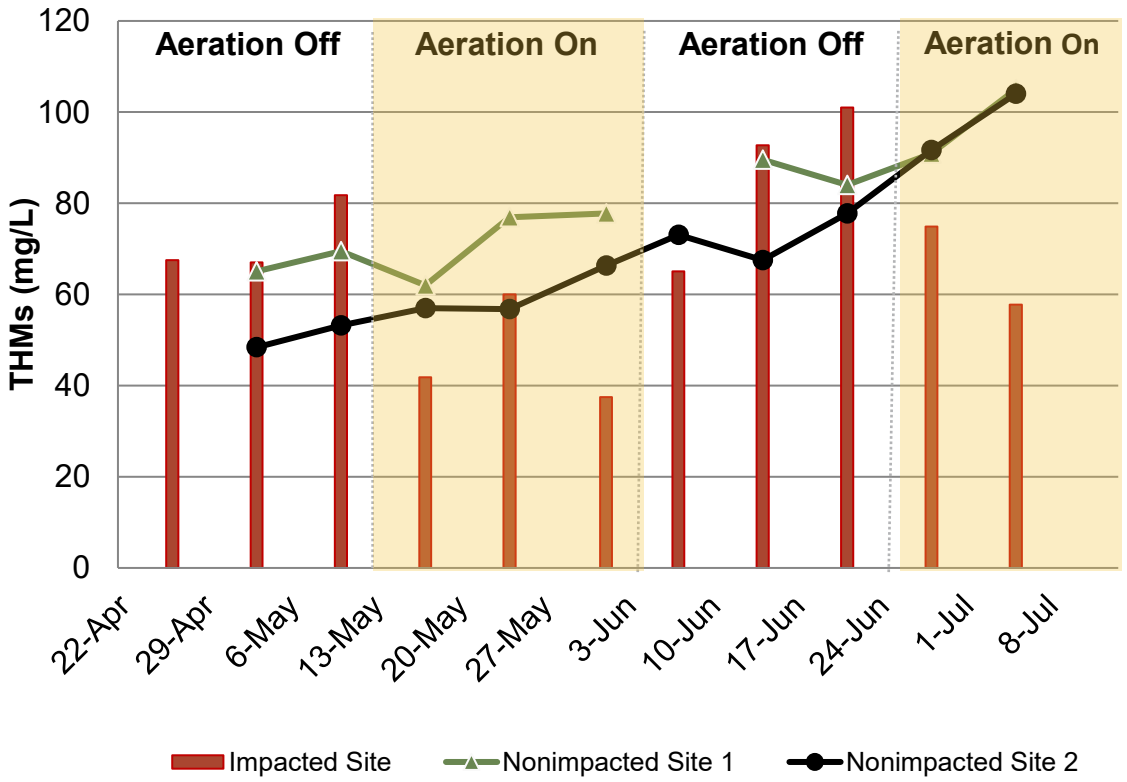
System Impacts, Modeling, and Case Studies

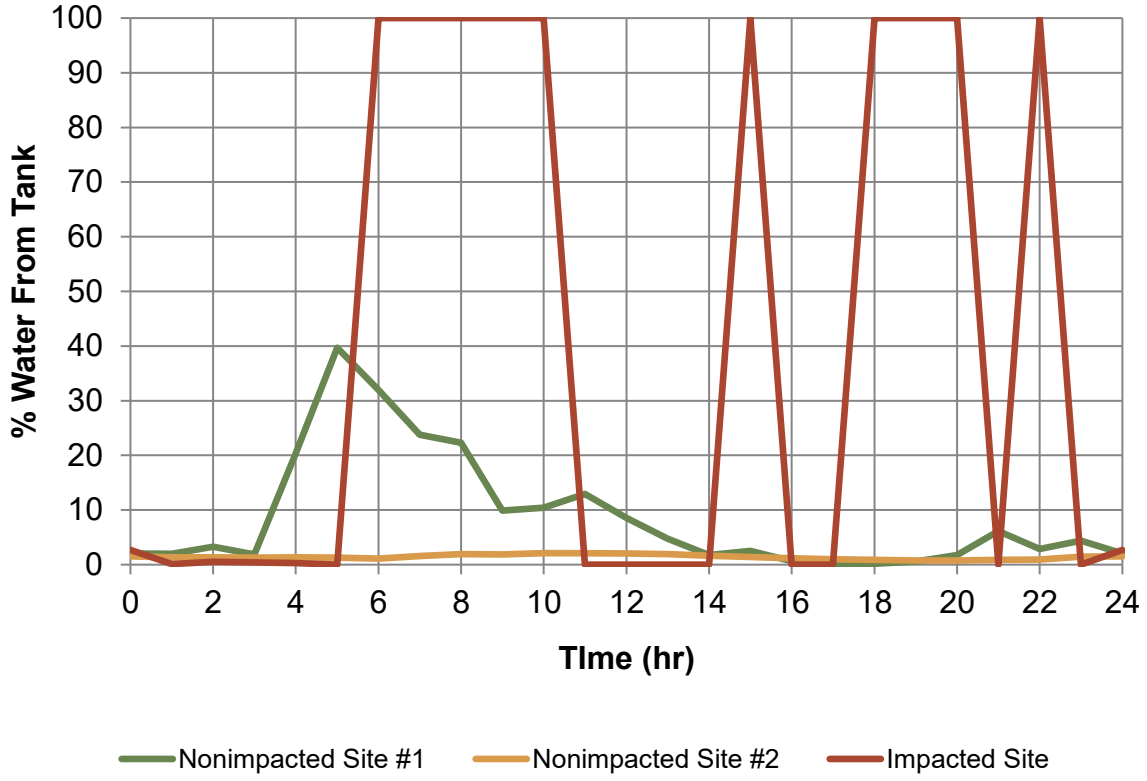
What happens after the tank…??



Impact of Aeration Beyond the Tank

Tracer studies and models can provide insight into expected impact of water quality improvement





Case Studies

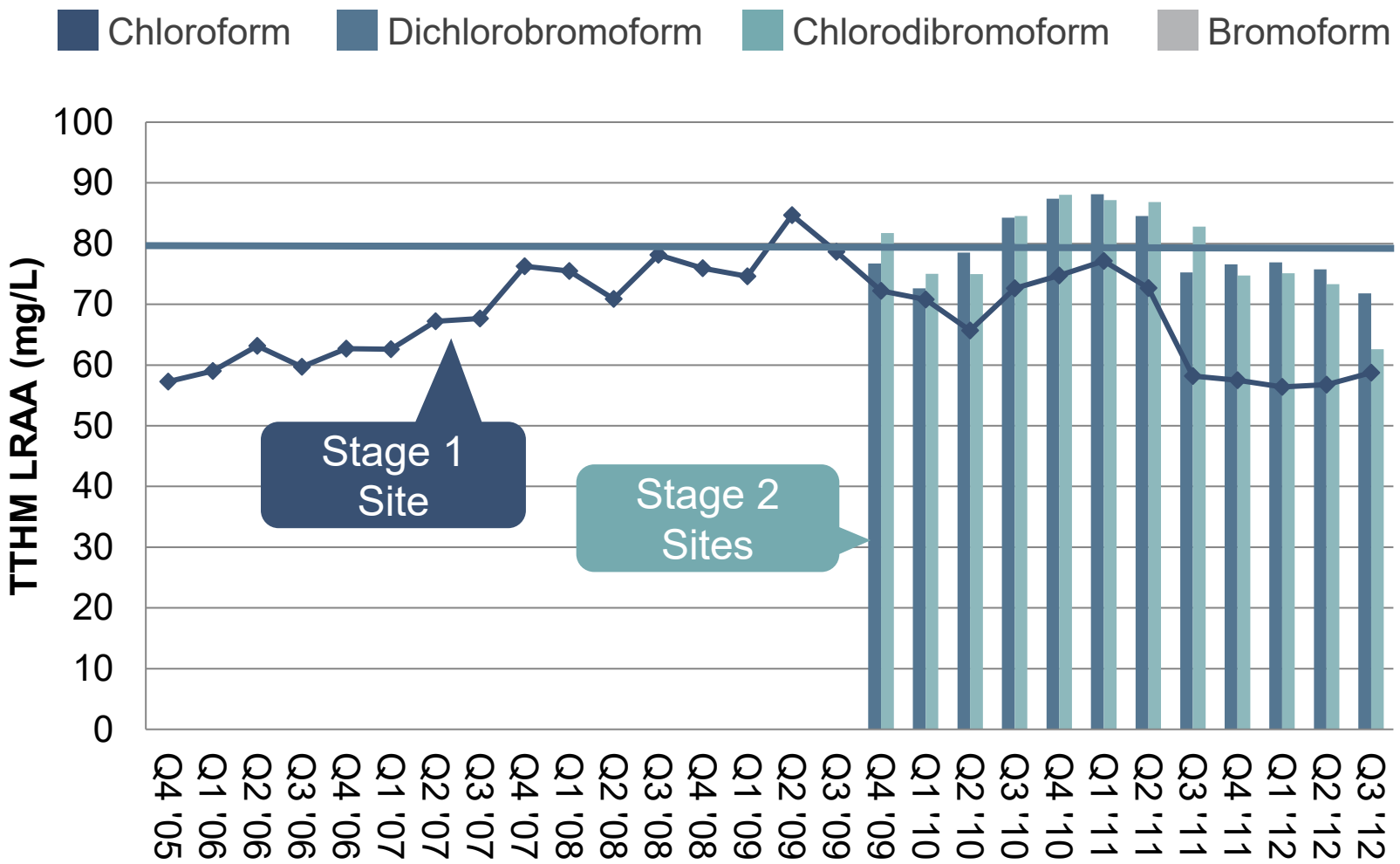
Case Study 1: Localized THM Issues

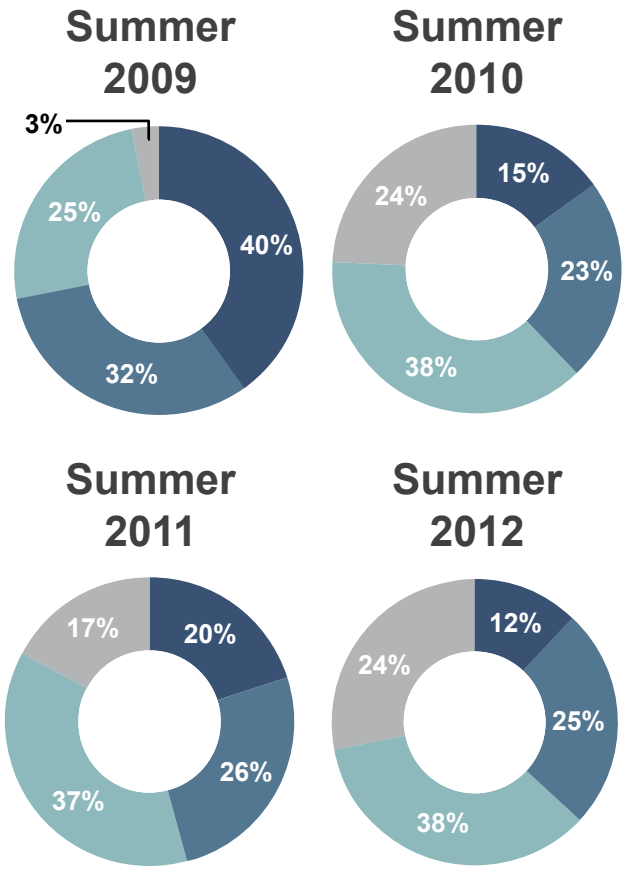
PWSA
THE PITTSBURGH WATER & SEWER AUTHORITY
Quality Water Quality Service

- Serves over 500,000 people

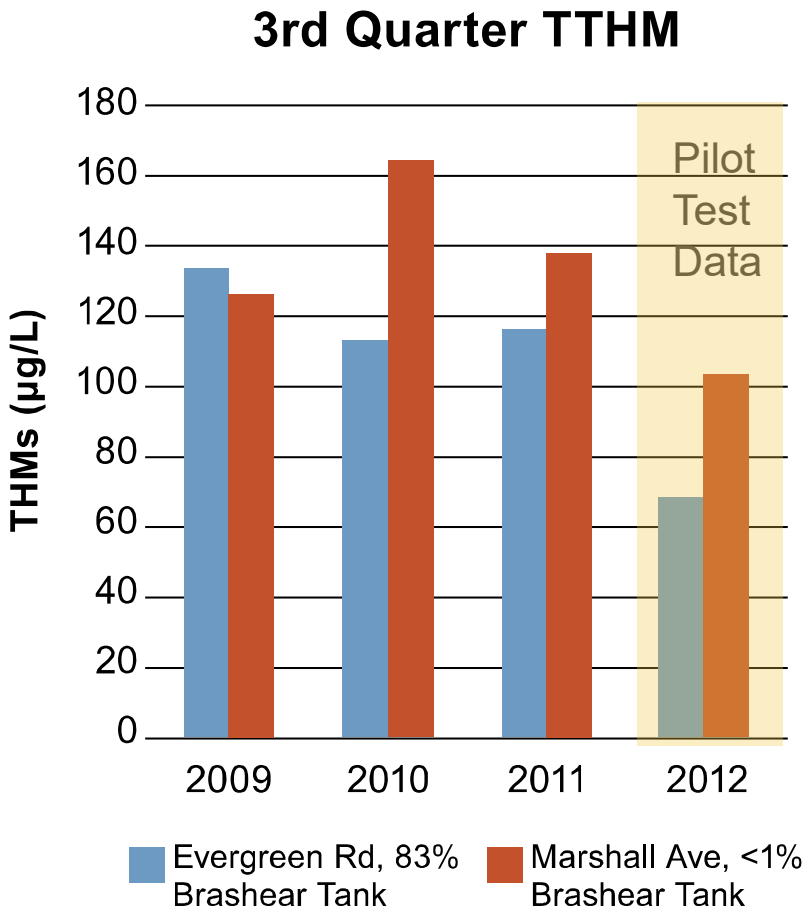


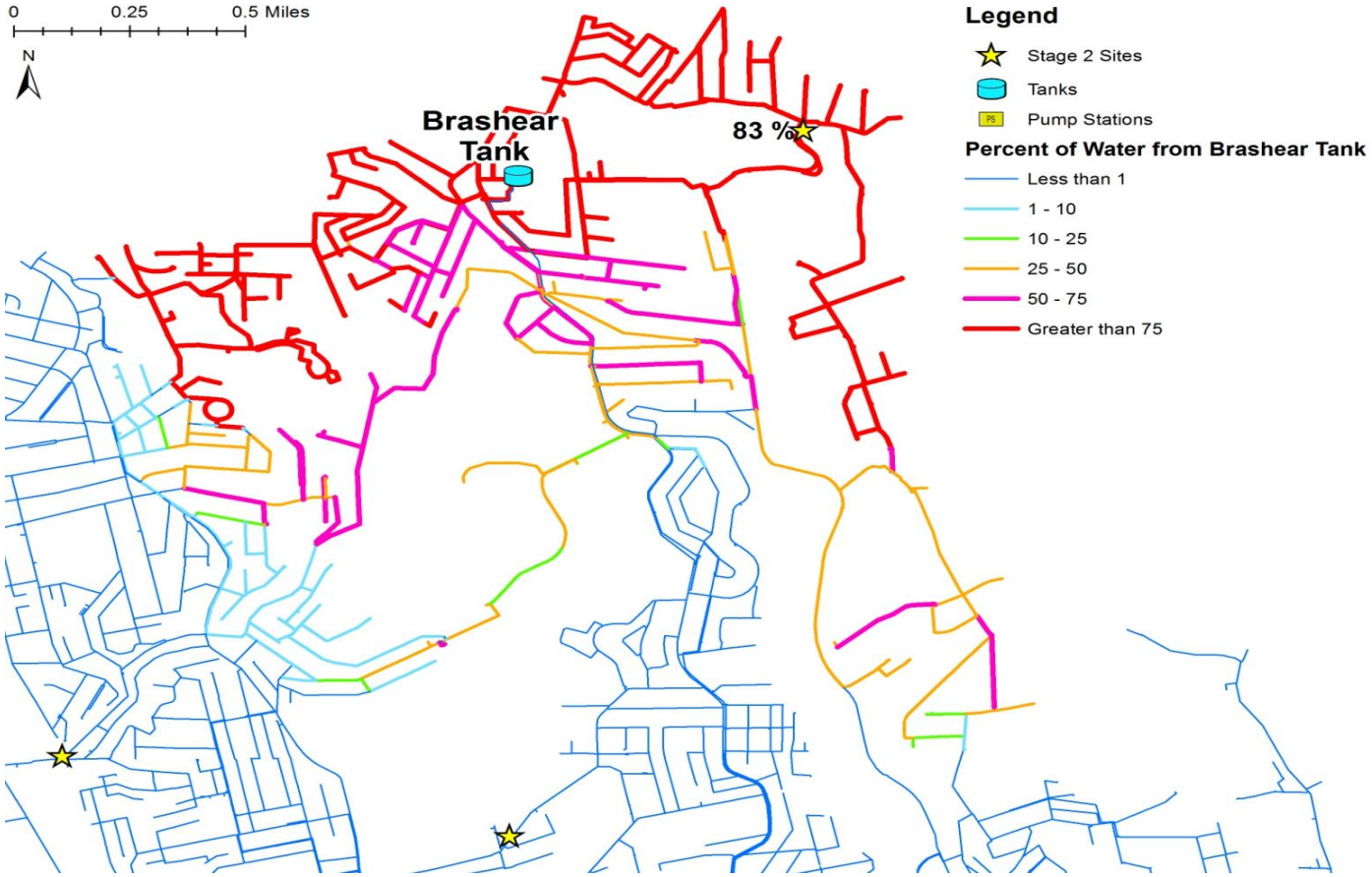
THM LRAA at Troubled Locations





Consider Tank Area of Influence





TTHM Reduction Goals at Tank 1

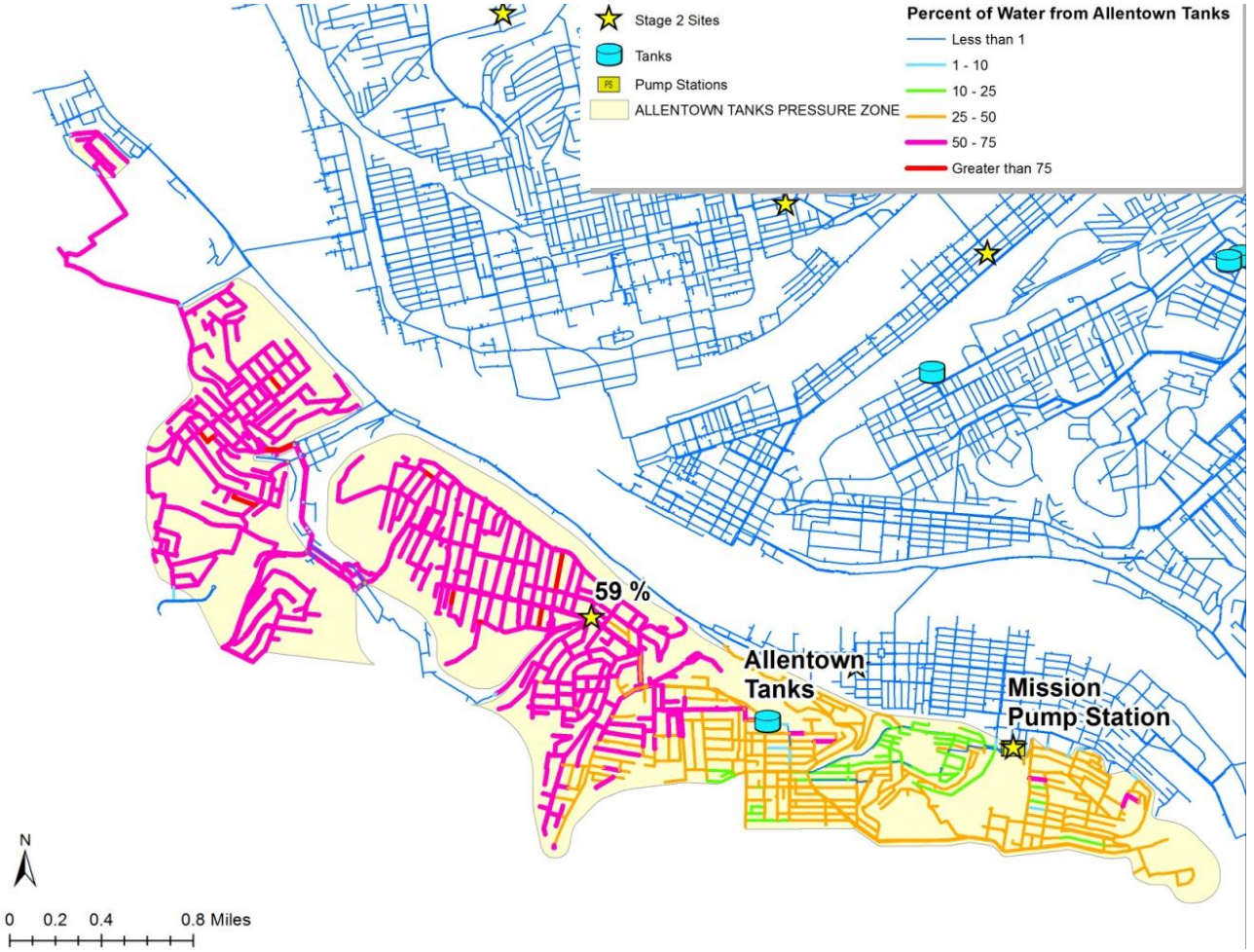
- Potential to save $$ on capital cost vs O&M
- Impacts System Design: the SIZE /capacity of the aeration equipment.

Quarter	Minimum % Reduction to Achieve LRAA Values < 64 µg/L
Summer Only	**64%**
Summer and Fall Only	**31%**
Summer and Spring Only	**37%**
Summer and Spring and Fall Only	**23%**
Year-Round	**18%**

20% buffer for LRAA because:
- Want to avoid operational evaluations
- Measurements of TTHM are +/- 20%
- Variability in source water and treatment

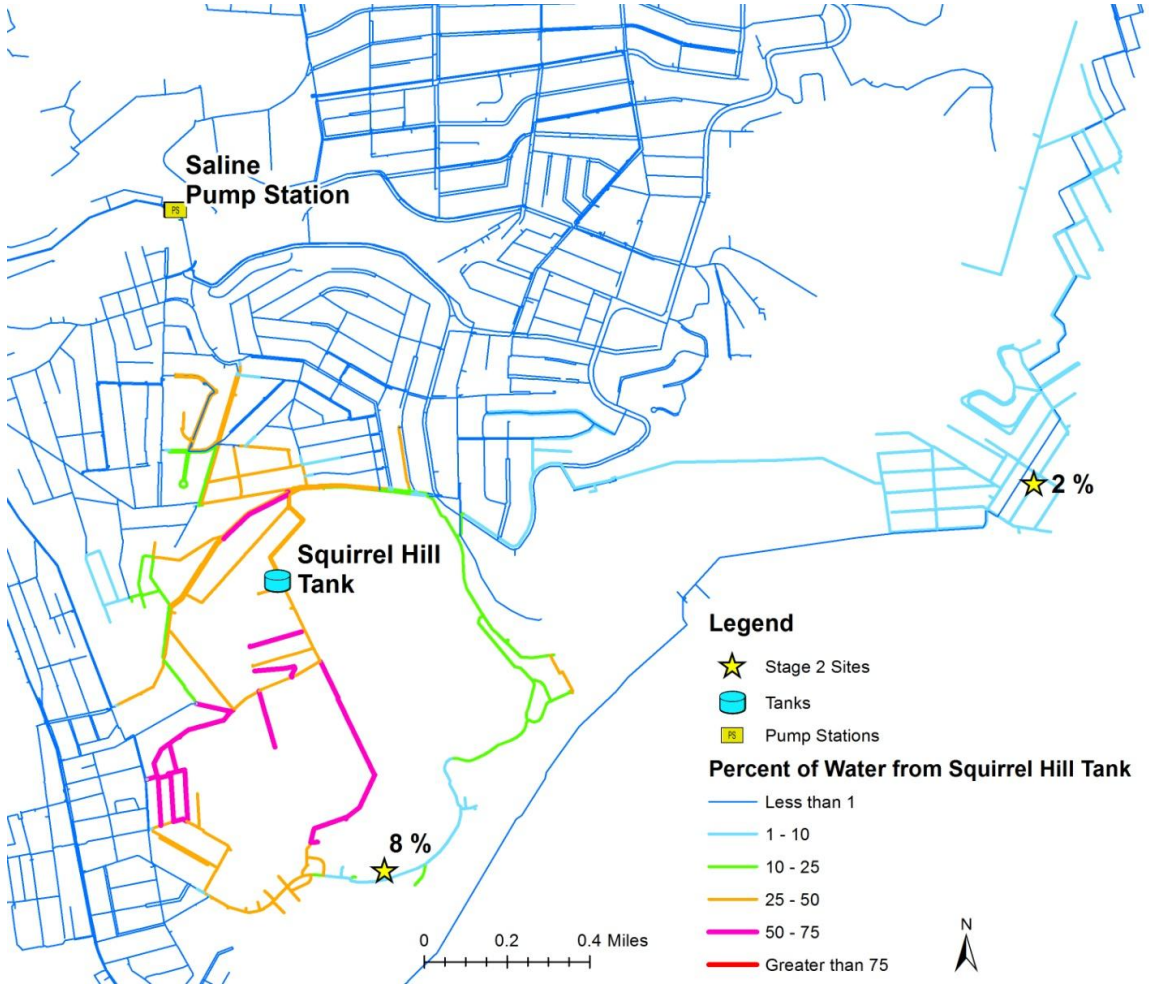
Consider Tank Area of Influence

- On average, 59% of water at DBP sample site came from tanks, the rest from the pump station, bypassing tanks.
- Tanks would be a reasonable candidate for aeration



Consider Tank Area of Influence

- On average, <10% of the water at DBP sample sites came from tank.
- Tank would be a poor candidate for improving water quality at sample sites without changes in distribution system operations.



Recommendations for PWSA

- Install tank aeration at both Brashers and Allentown tanks
- Adjust tank operations at Squirrel Hill to reduce formation potential in the tank



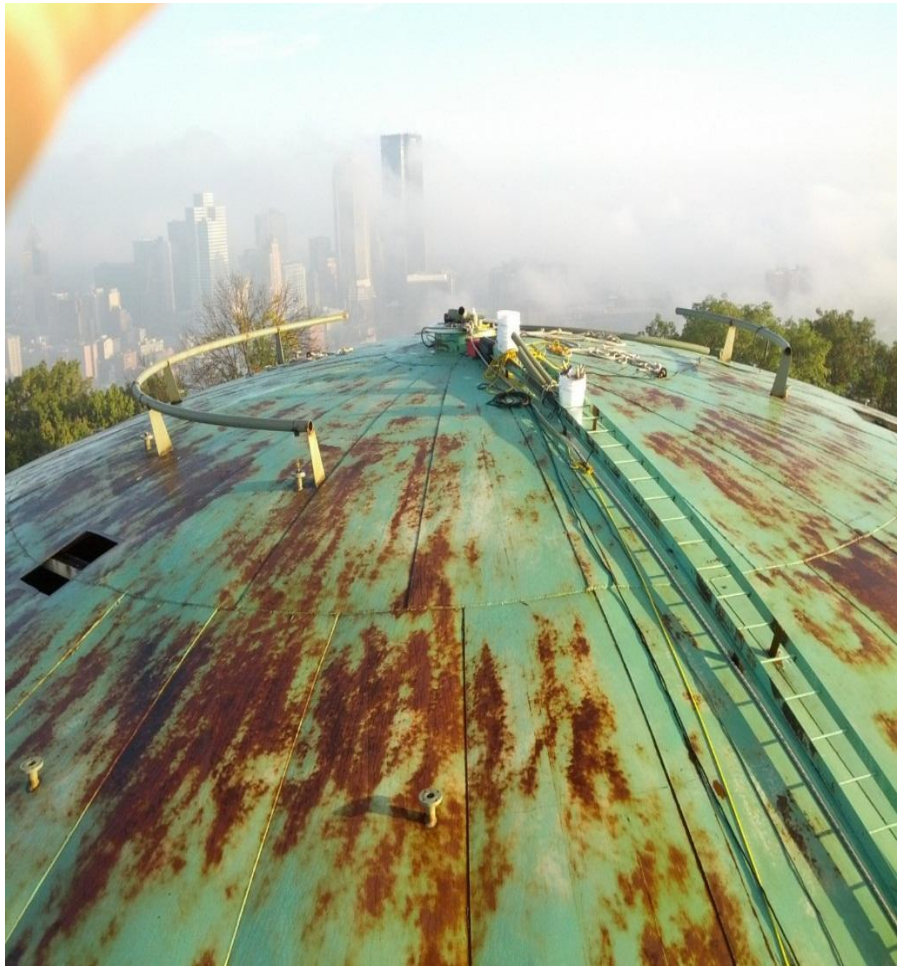




Summary

Multiple aspects should be considered before installing mixing and/or aeration:

- Effectiveness for THM Reduction
  - **Modeling of THM reduction available and helpful**
  - **Consider speciation of TTHM in selecting an aeration system**
- Impact of WQ Improvement must be considered
  - **At Stage 2 sites**
  - **Area of influence**
  - **Improvement possible?**
- Must weigh localized treatment vs. full treatment
  - **Cost implications and efficiencies**
  - **Obligations for improved WQ to entire system**
  - **Both localize and full treatment?**
  - **Remember: Only effective for THMs**



Summary

Summary & Looking Ahead

- D/DBP rules may change within the next few years
- Water industry has extensive knowledge and experience with DBPs
  - **Established “Toolbox” for mitigation strategies**
- Recommend preparing for potential changes by developing a roadmap
  - **Analyzing existing data and conducting additional sampling for better planning**



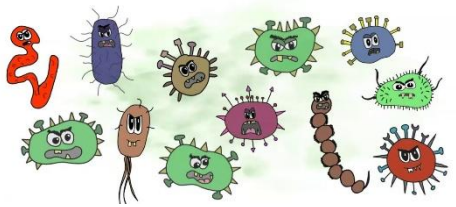
Questions and Discussion

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813-682-1215

Bullpen

Disinfection





Contact Time

Disinfection

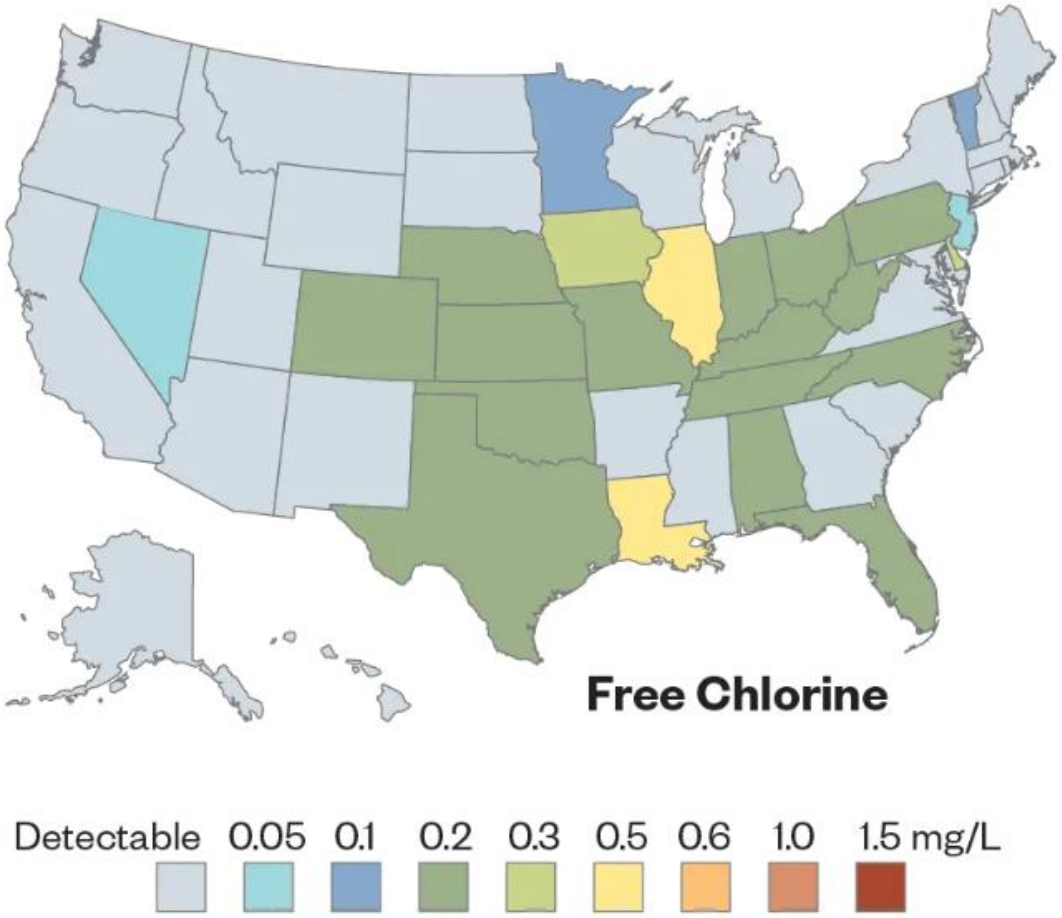
Pathogens + Free Chlorine (or O_3, ClO_2, UV)

Potential Chlorine Residual Requirement

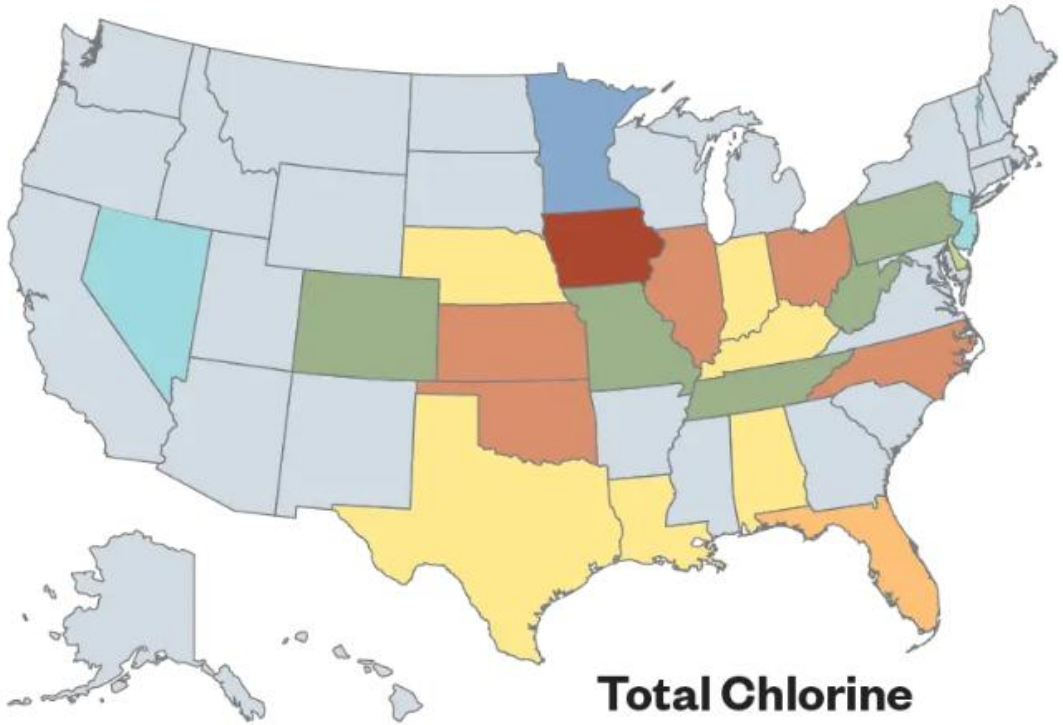
States with Residual Requirements

Potential Rule Range:
- Free Chlorine 0.2 to 0.5 mg/L
- Total Chlorine 0.2 to 1.0 mg/L

Free Chlorine Residual Requirements



Total Chlorine Residual Requirements



Fundamentals of THM Removal

Post-Treatment Aeration

- Air-stripping principle
  - **Mass transport from liquid to gas phase via a concentration gradient**
- Governed by Henry's Law
  - **$P_A = k_H \times C_A$**
  - **Compounds with smaller K_H values are more difficult to strip**
- Critical design parameter –Air:water ratio
  - **Describes air volume needed for mass transport goals**
  - **Governed by equilibrium/saturation in the air**

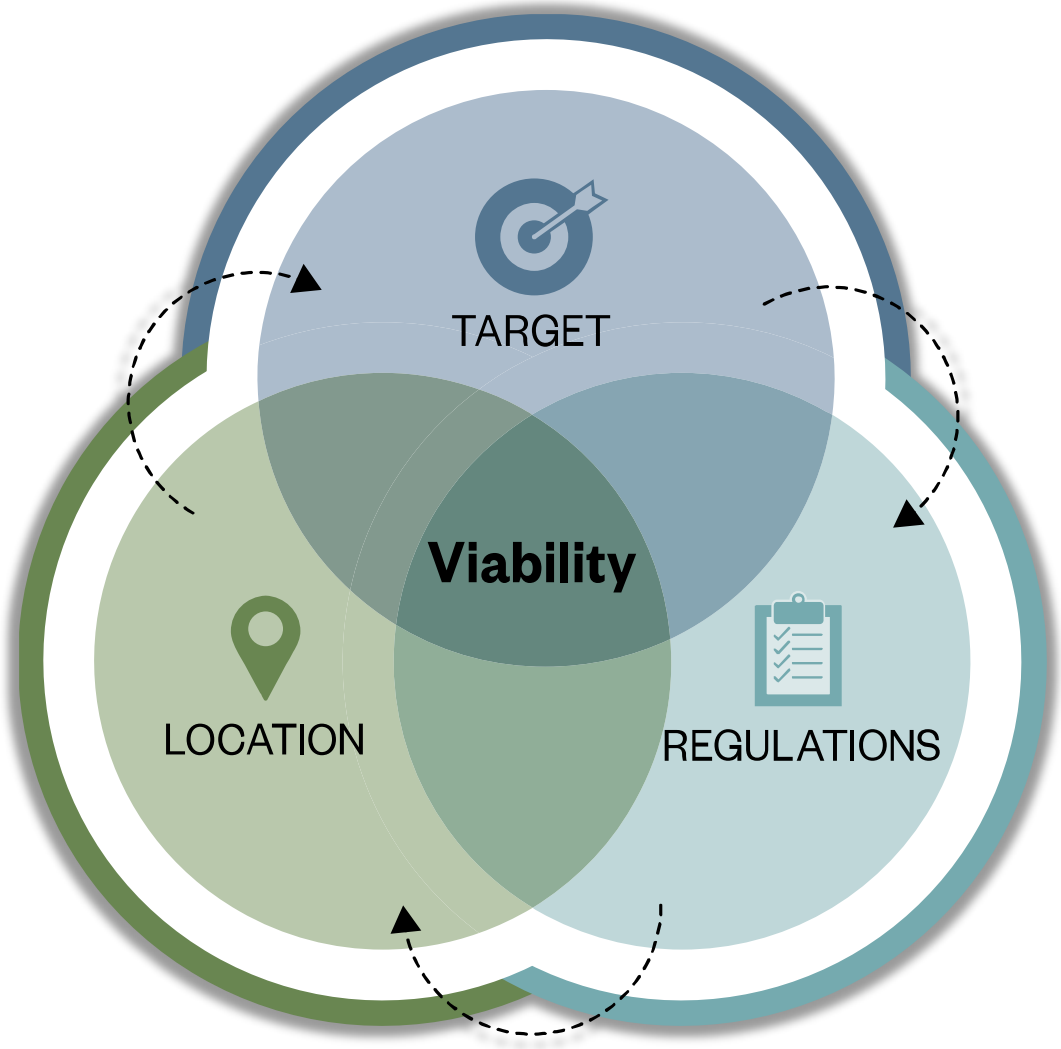


Compound	K_H at 25°C
Chloroform	0.1270
Bromodichloromethane	0.0760
Dibromchloromethane	0.0350
Bromoform	0.0175

C = concentration of the dissolved gas in the liquid
k_h = Henry's law constant (depends on the gas + temperature)
P = partial pressure of the gas above the liquid

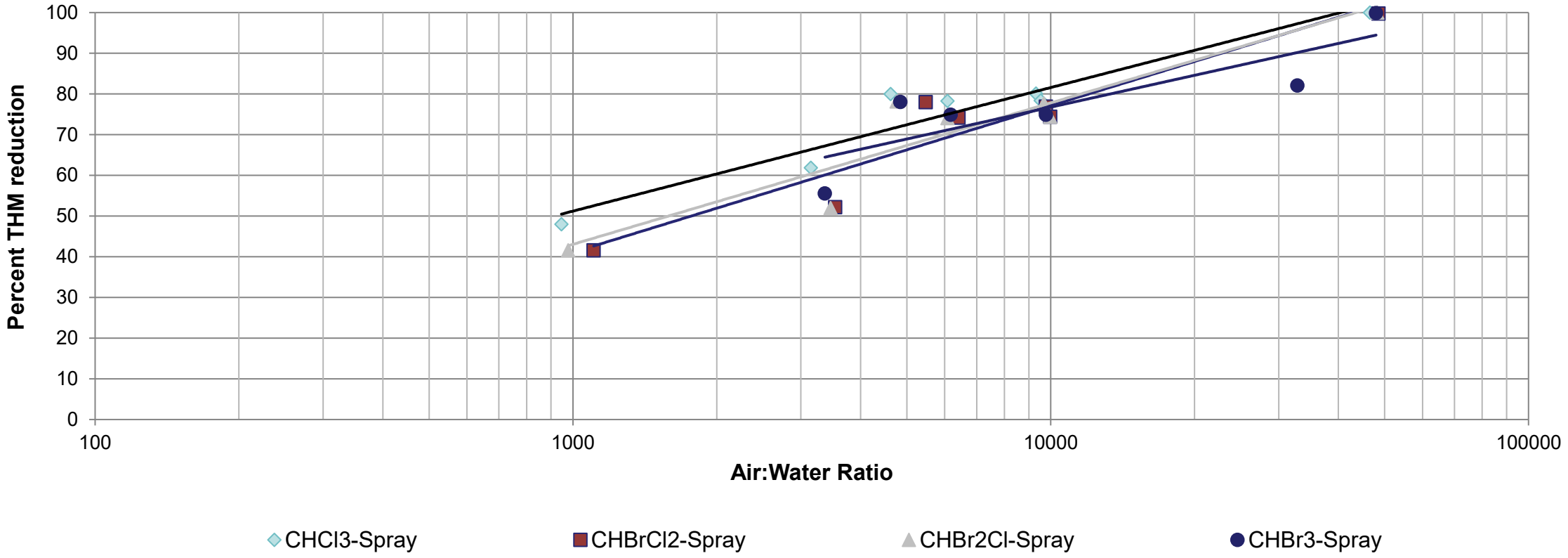
Viability of Aeration

1. TTHM must be the target for compliance that aeration will address
2. The reductions through aeration must be high enough to meet regulations
3. The location of aeration should ideally address compliance locations



Pilot Data from THM Reduction Systems Shows Effectiveness

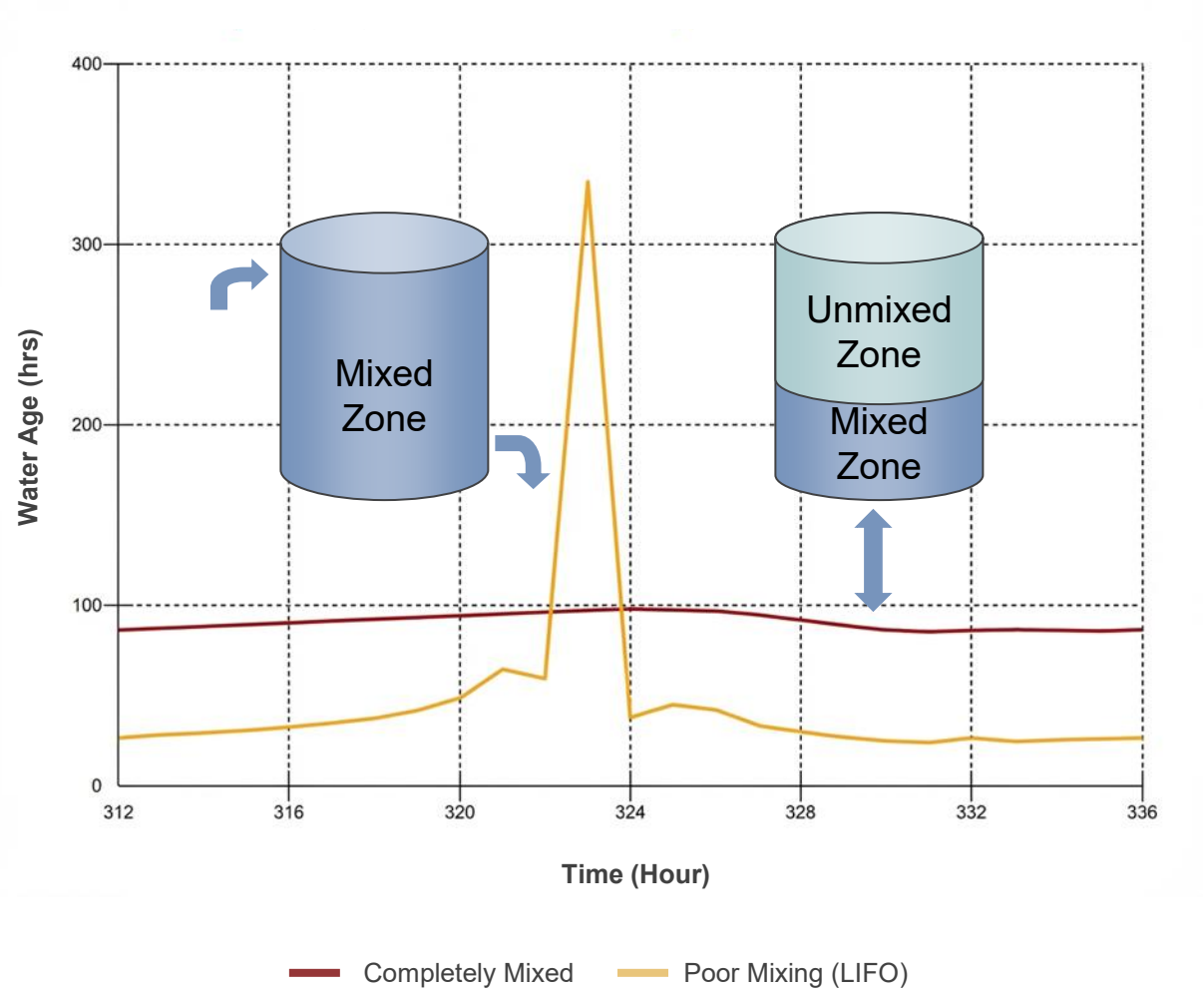
Ethan Brooke and Robin Collins – UNH, Spray aeration testing



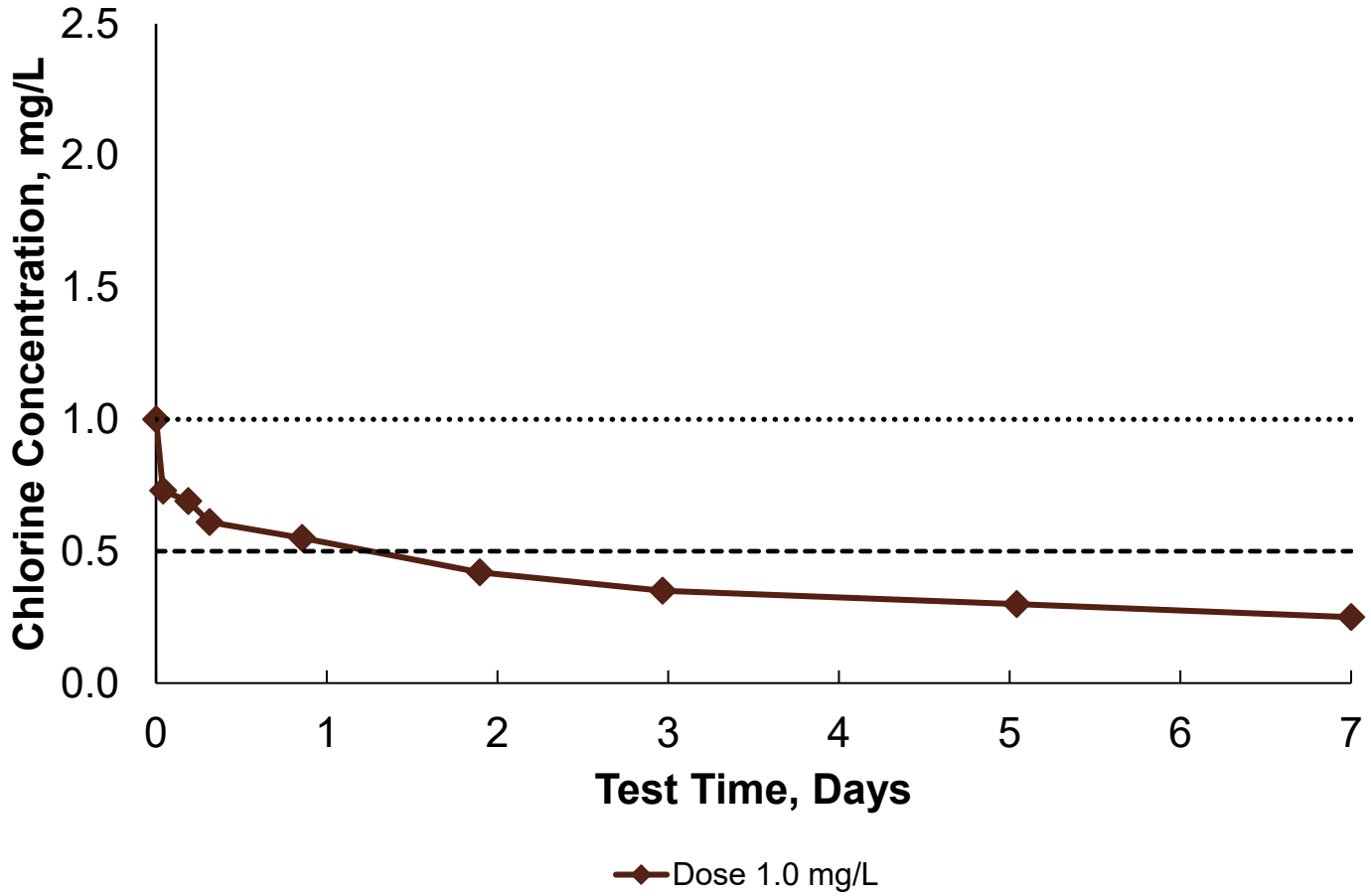
Effective even for **brominated** TTHMs

Aeration is Not Mixing

- Mixing is important to ensure consistent water quality throughout the tank. Especially if tank:
  - **Is prone to thermal stratification**
  - **Inlet/outlet configuration leads to poor mixing**
- THM Removal systems typically include mixing systems
- Mixers alone do not reduce THMs!

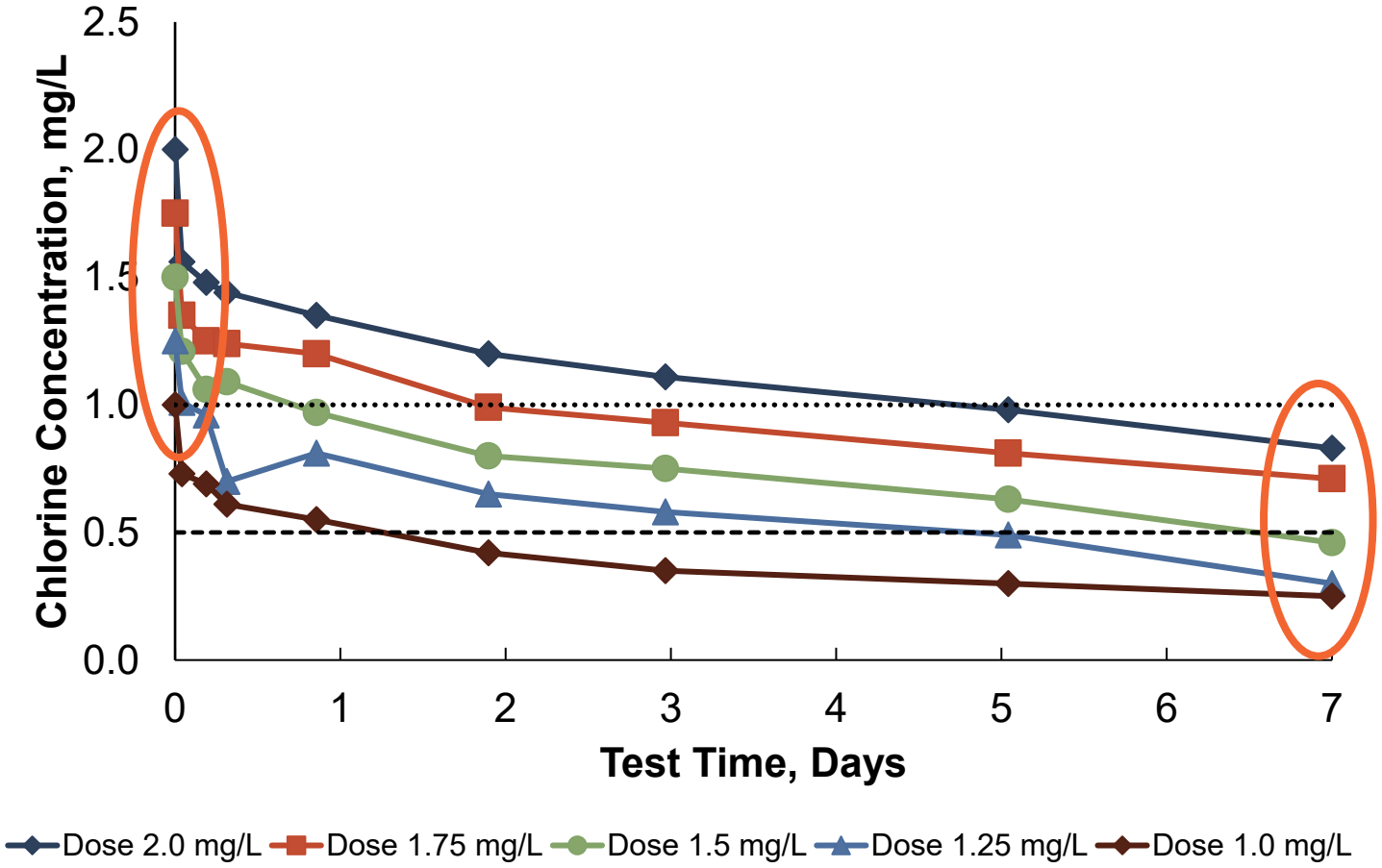


Existing Chlorine Dose



- Alabama utilities required to meet >0.2 mg/L

Determine New Chlorine Dose



- With the new regulations, Alabama utilities may need to aim for >0.5 mg/L
- Chlorine dose will need to increase at the WTP
- Impacts on chlorine storage sizes

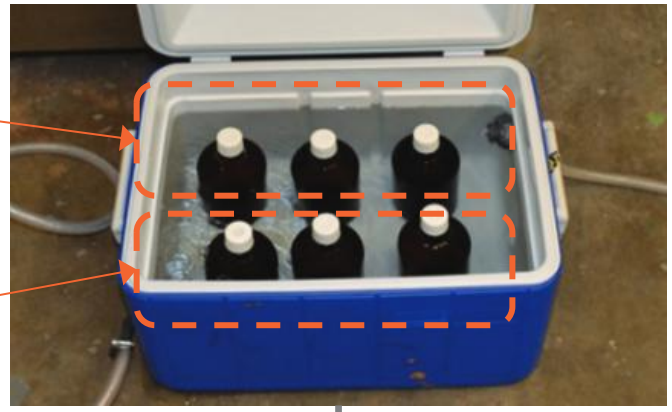
Assess DBP Level Implications

Bench Testing

- DBP formation not linearly dependent on Cl_2 dose

Test #1
Current Cl_2 Dose

Test #2
New Cl_2 Dose



Cl_2, THMs, HAA5s
@ t = 1, 5, 10 days

USEPA (1998) EPA 815-R-98-005

Empirical Models

- Several factors are important: TOC, UV254, pH, temperature

$$[TTHM]\left(\frac{\mu g}{L}\right) = 3.296 * [DOC]^{0.801} * [Cl_2]^{0.261} * [Br^-]^{0.223} * t^{0.264}$$

$$[HAA6]\left(\frac{\mu g}{L}\right) = 5.22 * [DOC]^{0.585} * [Cl_2]^{0.565} * [Br^-]^{0.031} * t^{0.153}$$

- **2x Cl_2 → 10-20% increase in TTHM**
- **2x Cl_2 → 20-30% increase in HAA5**

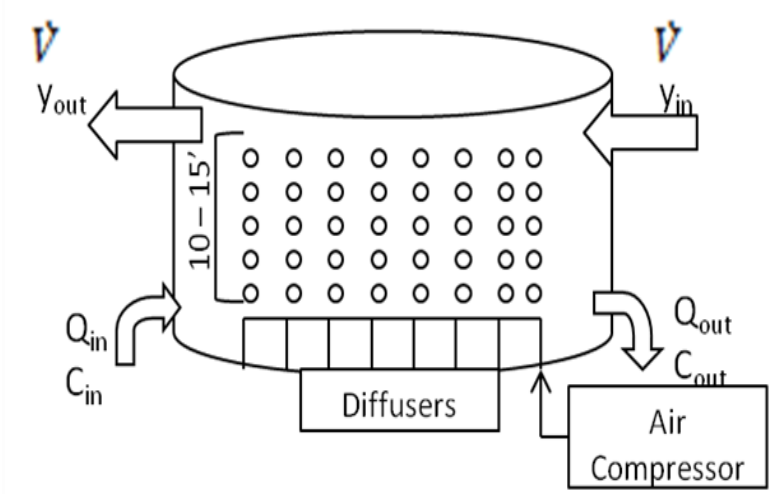
Aeration Technologies & Performance

- Diffused bubble vs spray
- Fixed vs floating
- Performance data

Common Post-Treatment Aeration Systems

Aeration Type #1: Diffused Bubble

- Air to water contact along bubble surface in water column
- Finite volume of bubble
  - Achieve saturation quickly
- More effective for chlorinated DBPs
  - Lower air/water ratio requirements

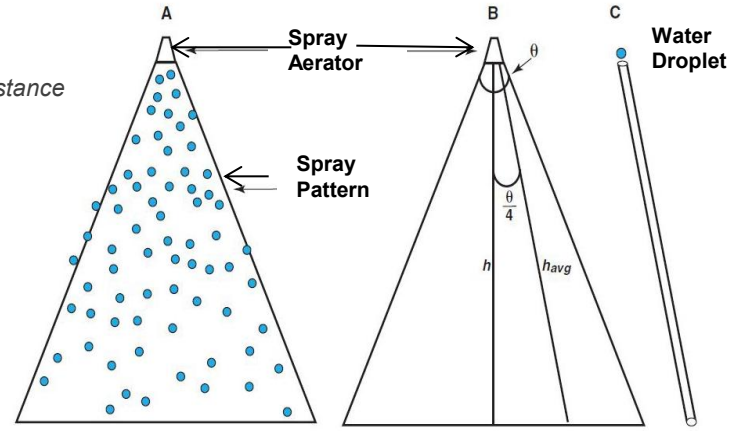


Aeration Type #2: Spray Aeration

- Pumped recirculation nozzle system
- Air to water contact through water dispersion in tank headspace
- Larger air volume
  - Slower saturation
- More effective for brominated DBPs

h - height of nozzle

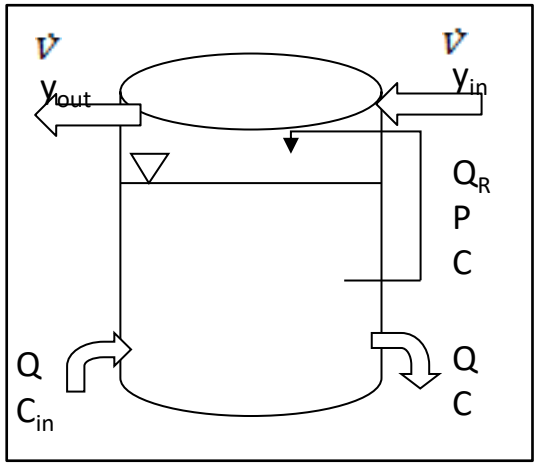
h_{avg} - average droplet travel distance

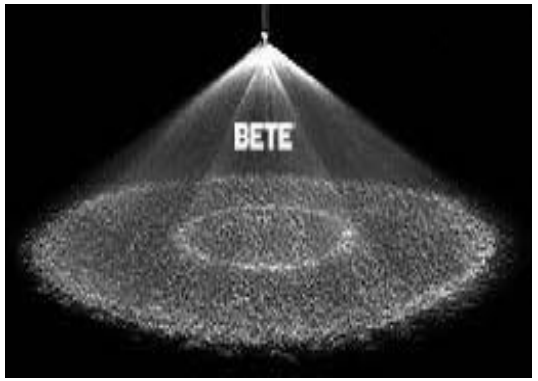


Brooke and Collins – University of New Hampshire (2011)

Spray Aeration Options

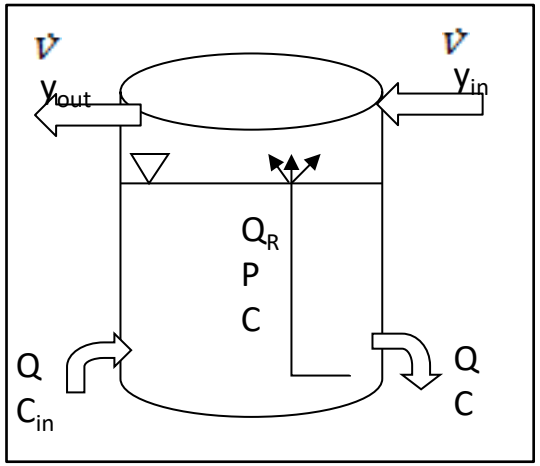
Fixed Spray Aeration (Water-in-air)

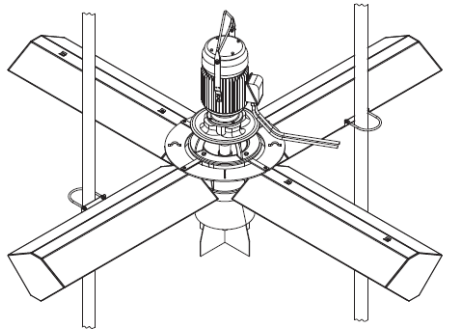


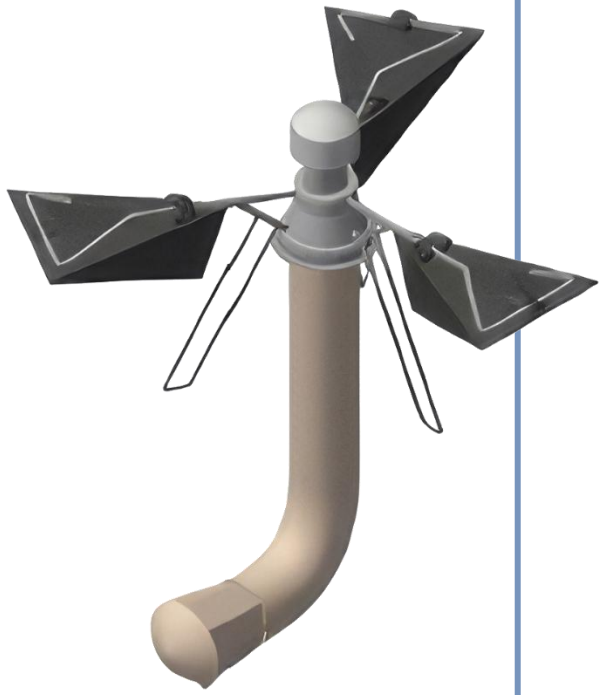




Floating Spray Aeration (Water-in-air)

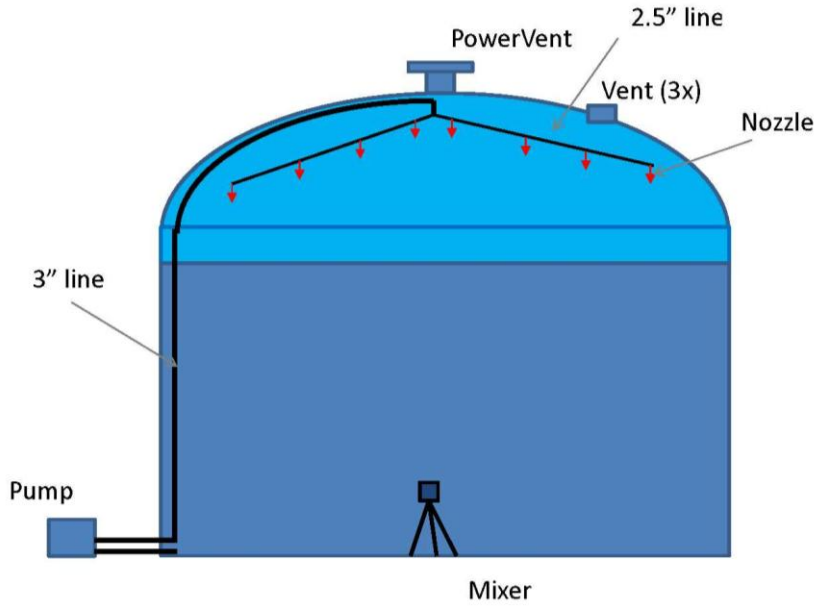






Fixed Grid Spray Aeration

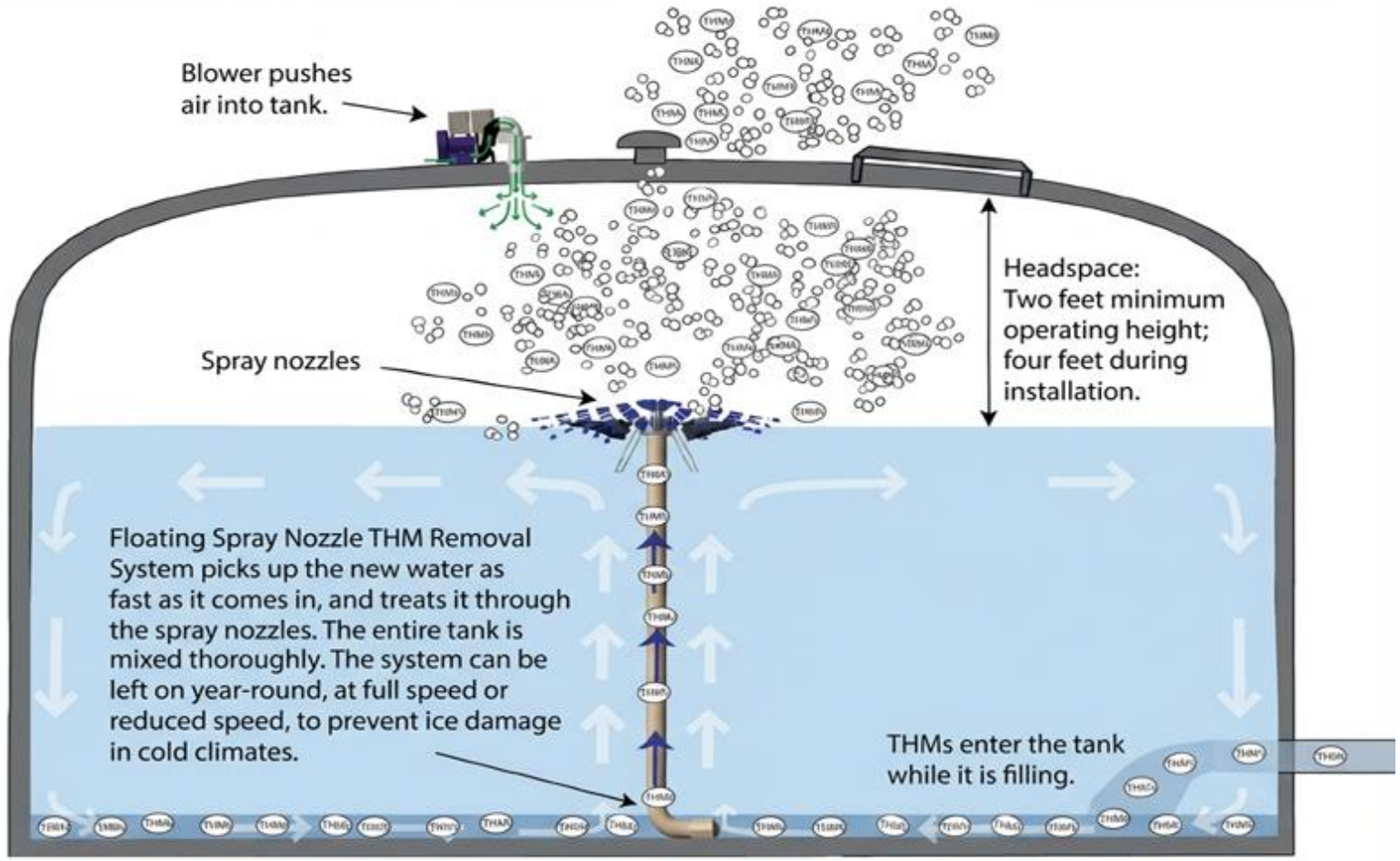
- Not really on the market any longer
- PAX may provide a system but not actively marketing





Floating Spray Aeration

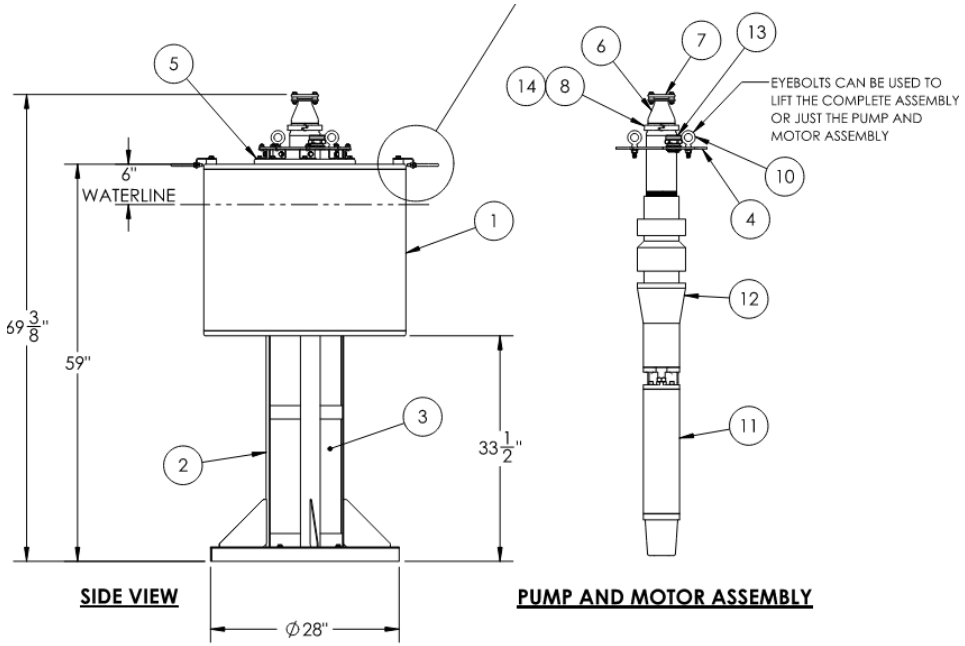
- Industry has shifted towards floating aerators
- Typically up to 35% - 40% THM removal



Floating Spray Aeration



IXOM Gridbee



Cleanwater1 (PAX)

Spray Aeration Performance Factors



- Recycle rate (or design rate) of aeration system
- Hydraulic detention time through tank
- Number and design of nozzles or aerators
  - **Smaller droplets more effective**
  - **Need to achieve high air:water ratio**
- Distance from nozzle to max water surface - “hang time”
- Active ventilation of head space
  - Prevent accumulation of TTHM
  - Maximize TTHM gradient from water to air
- Temperature

In-Tank Spray Aeration

Benefits and Concerns

- Benefits
  - Proven technology with many installations
  - Can be used seasonally
  - Minimal equipment installation time (~2 weeks)
- Concerns
  - Construction within an existing clearwell
  - Difficult to access in future
  - Sufficient time to develop THMs prior to aeration?





Elevated Tank Aeration System Construction

- Often requires 480V power at each supply
- Location to house electrical and controls (e.g. pre-cast building)
- Blower is often installed on top of tank
- Confirm existing tank vent is suitable for exhaust
- Number of floating aerators and submersible mixers dependent on THM removal goals, throughput, etc.





Elevated Tank Aeration System Construction



Equipment Installation



Disconnect switches



Used magnetic conduit supports on tank bowl to reduce tank downtime

Elevated Tank Aeration System Construction

- Equipment installed in 2 days
- Maintained sanitary conditions so no post-disinfection necessary
- 2 BacT samples before tank placed online
- Tanks offline ~4 days
- Important to clean out tank before installation of equipment → Significant increase in energy imparted into the tank and sediment can cause clogging issues





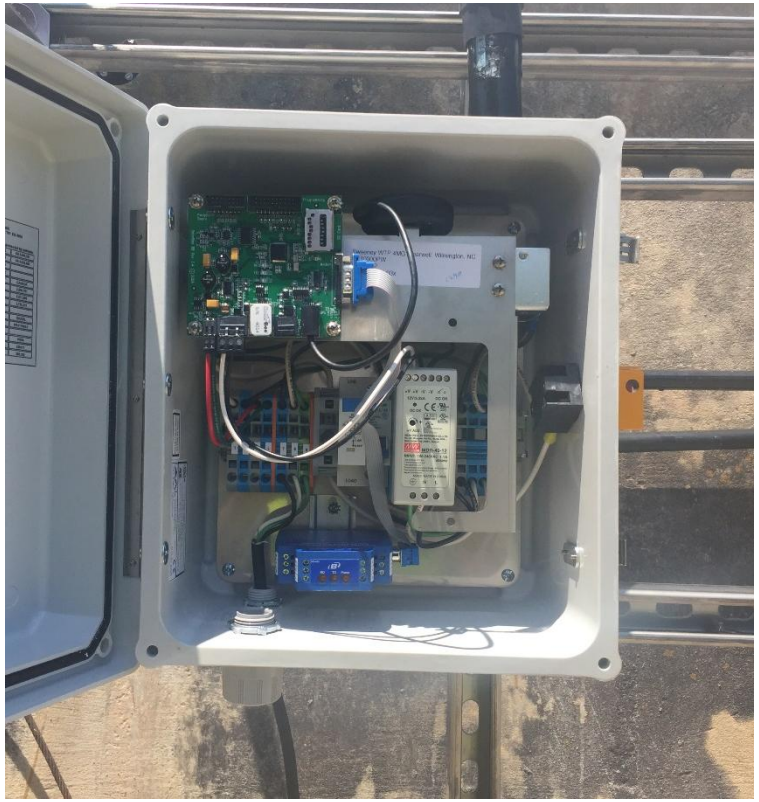
Clearwell Aeration System Construction

- MCC section to house blower and aerator starters and controls or utilize vendor supplied control panels
- Blowers to turnover headspace - two 5-hp blowers
- May need to enlarge existing passive tank vents for exhaust
- Floating mixer may be needed prior to aerators
- Number of floating aerators dependent on THM removal goals, throughput, etc.





Clearwell Aeration System Construction

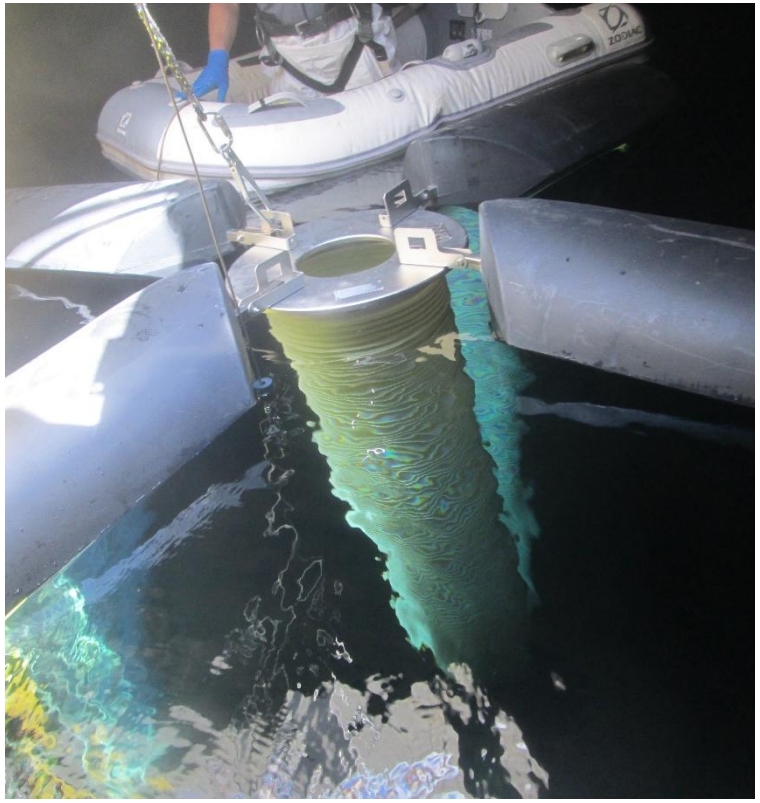






Clearwell Aeration System Construction

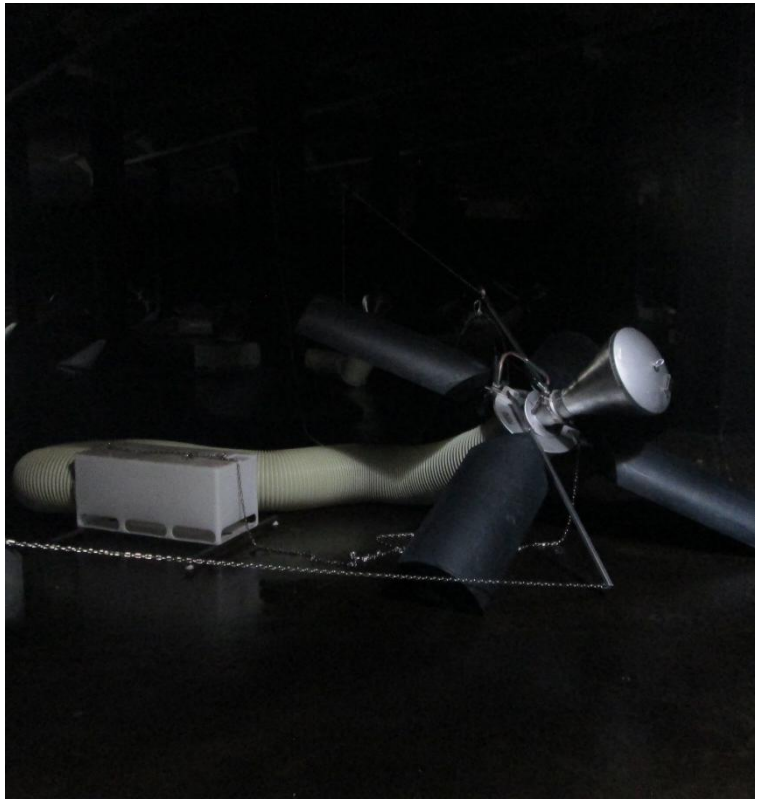






Clearwell Aeration System Construction

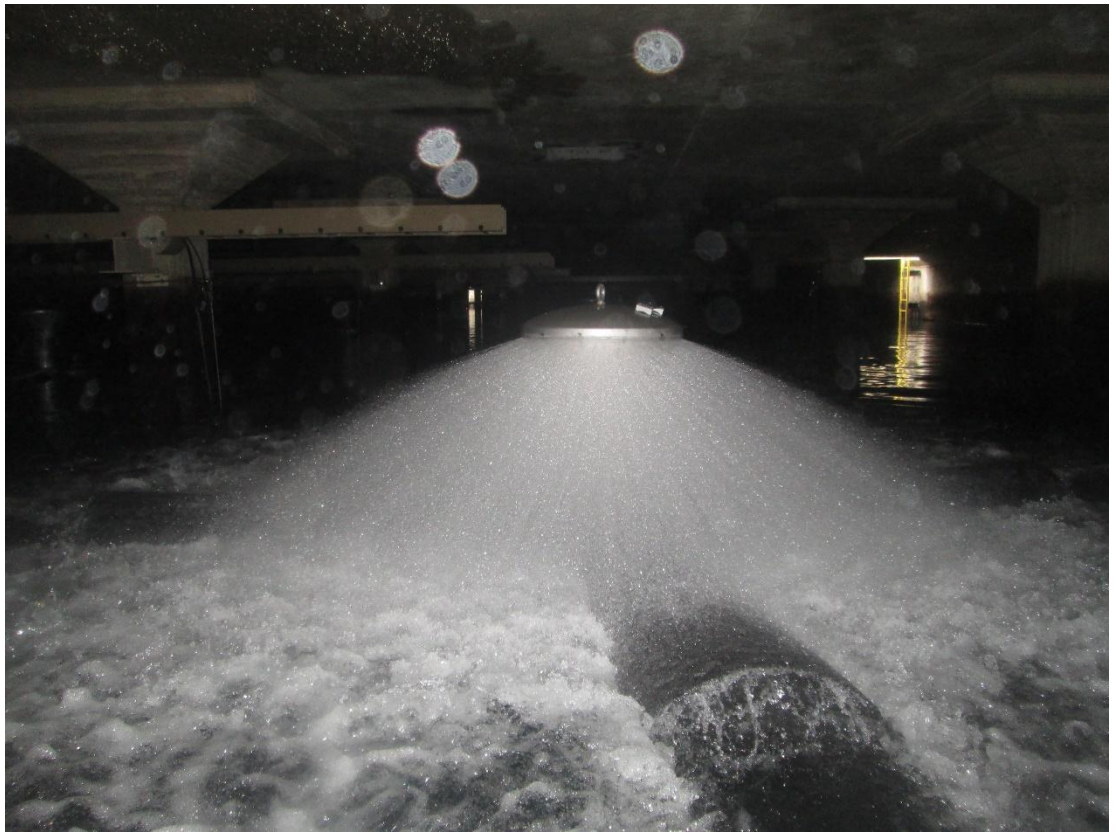






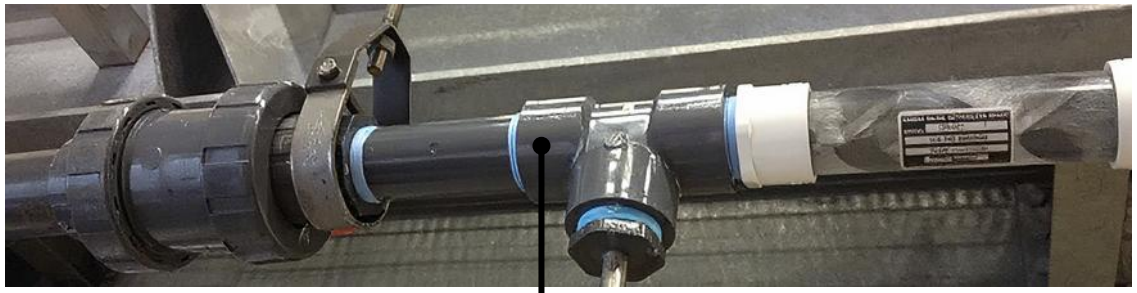
Construction

- Installed equipment in ~2 weeks
- Drained and re-filled clearwell following installation since Cl2 residual could not be assured



In-Line Spray Aeration

At WTP



Horizontal In-Line

Vertical In-Line



Photos from Megan McCowan, student of Dr. Robin Collins, Univ of New Hampshire

In-Line Spray Aeration

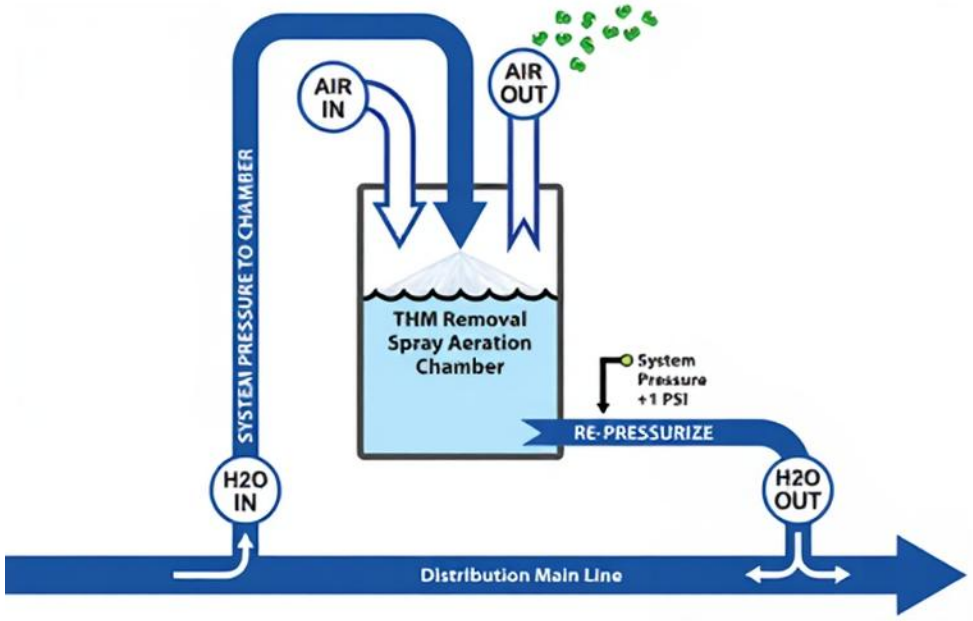
Performance Modeling –
Results from Dr. Robin Collins

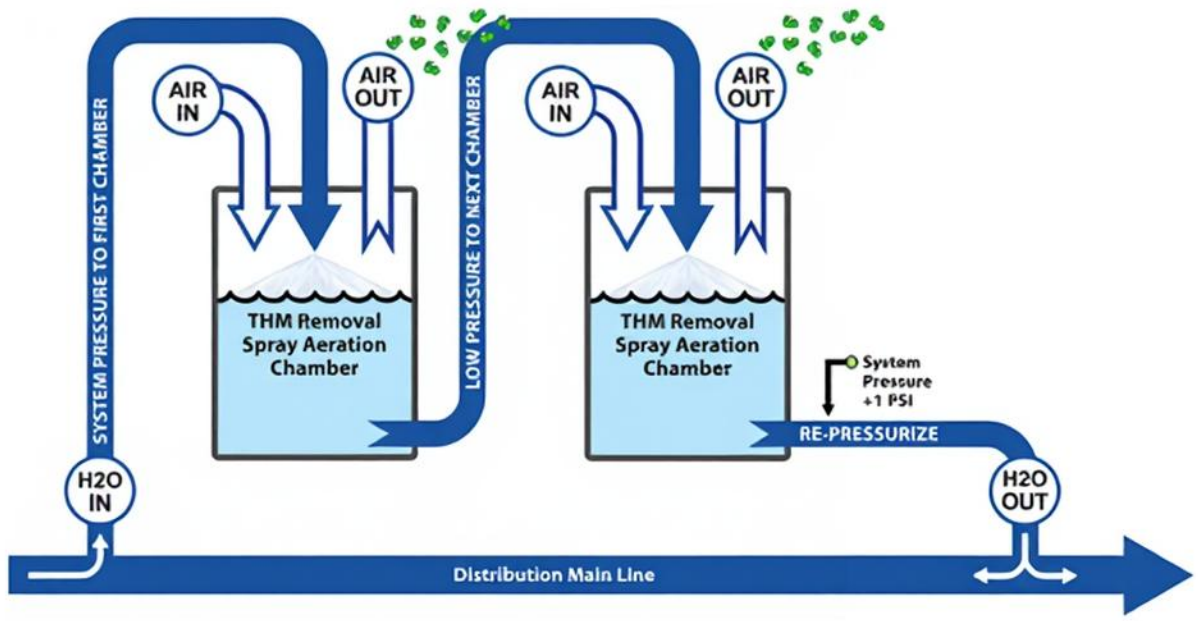
- Approximately 31%, 46%, and 62% THM reduction
  - **Based on Air to Water ratios of 5, 10, and 20, respectively**
  - **6.5 psi**
- Water Quality Parameters
  - **20 deg C (historical average)**
  - **50 ug/L THM**

In-Line Spray Aeration

ixom

- Ixom In-Line THM Removal Stations
- Target specific regions with THM challenges in distribution system, not at WTP or distribution tank
- Max flow of 600 gpm





In-Line Spray Aeration

Benefits and Concerns

- Benefits
  - Equipment is outside, often remote
  - Minimal moving parts / equipment
- Concerns
  - Number of current installations
  - Turbulent flow under all flow conditions?
  - Sufficient time to develop THMs?



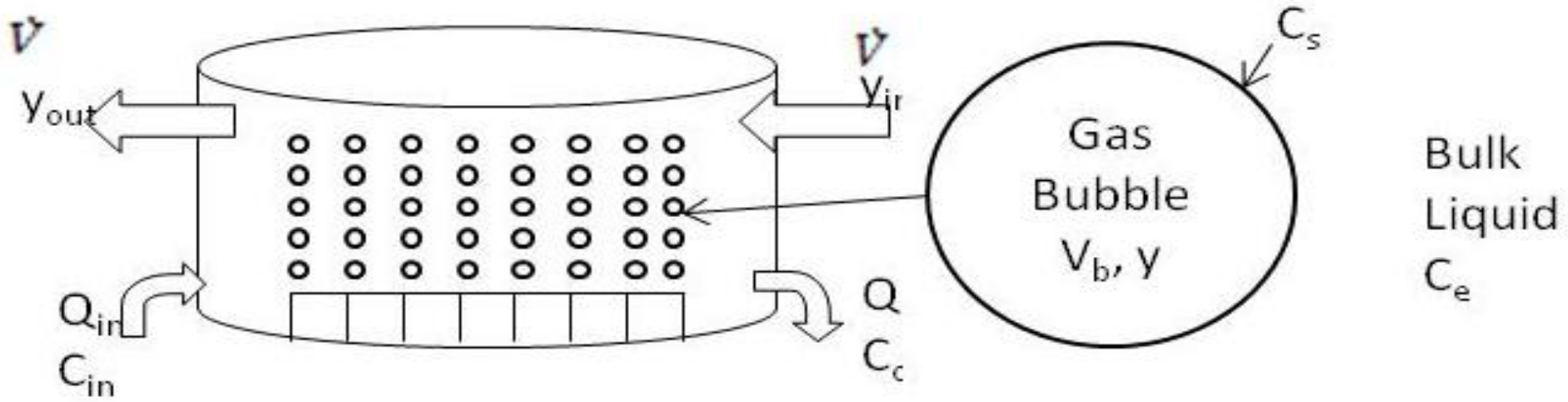
Aeration

- “Stripping” contaminants from water, using contact with air
  - **Mass transfer process**
  - **Governed by equilibrium Air/Water mass transfer: Henry’s Law**

Quarter	Henry’s Law Constant at 20°C
Chloroform	**0.127**
Bromodichloromethane	**0.076**
Dibromchloromethane	**0.035**
Bromoform	**0.0175**

Diffused Bubble Aeration

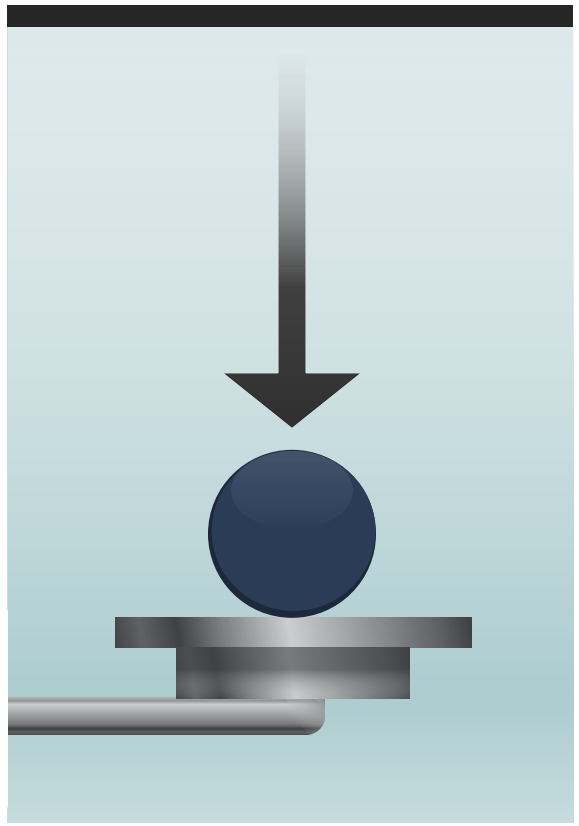
- Passes compressed air through water, to remove volatile compounds
- Combines tank mixing benefits with THM removal
- Bubble size and volume of air are important design criteria



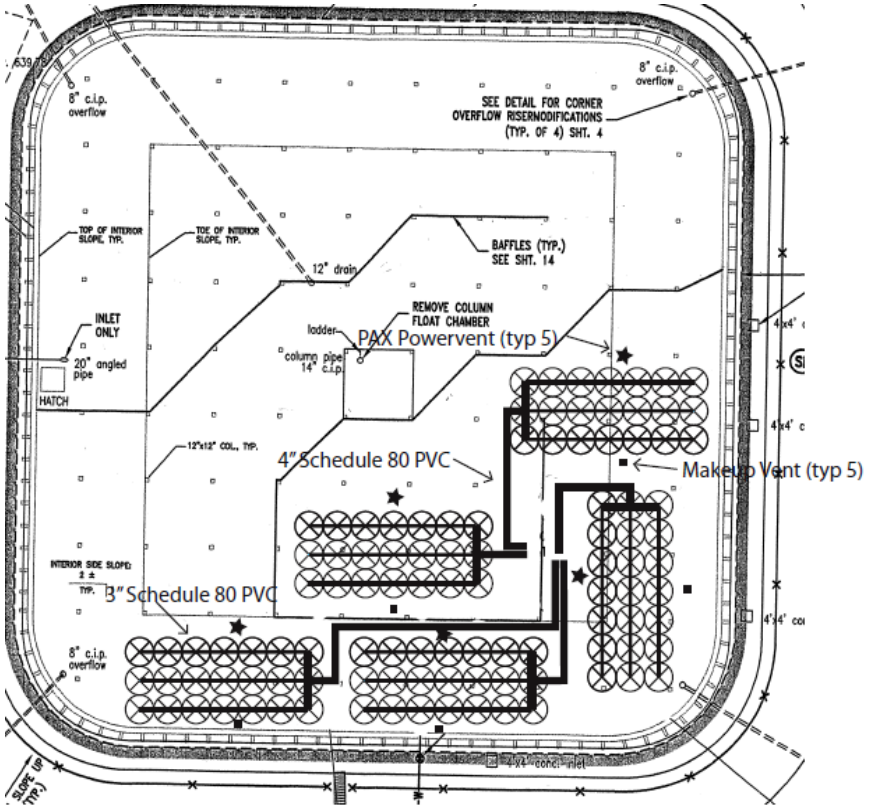
Diffused Bubble Aeration Disadvantage

Energy required to push against water pressure to grow bubble

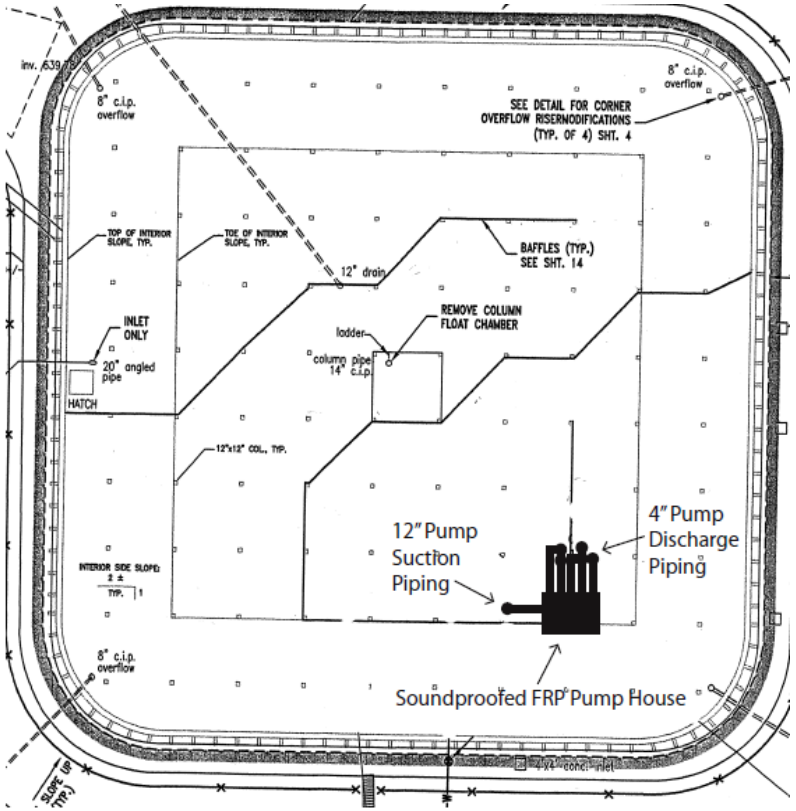
Pressure from Hydrostatic Head



Reservoir – Concept PAX Layout



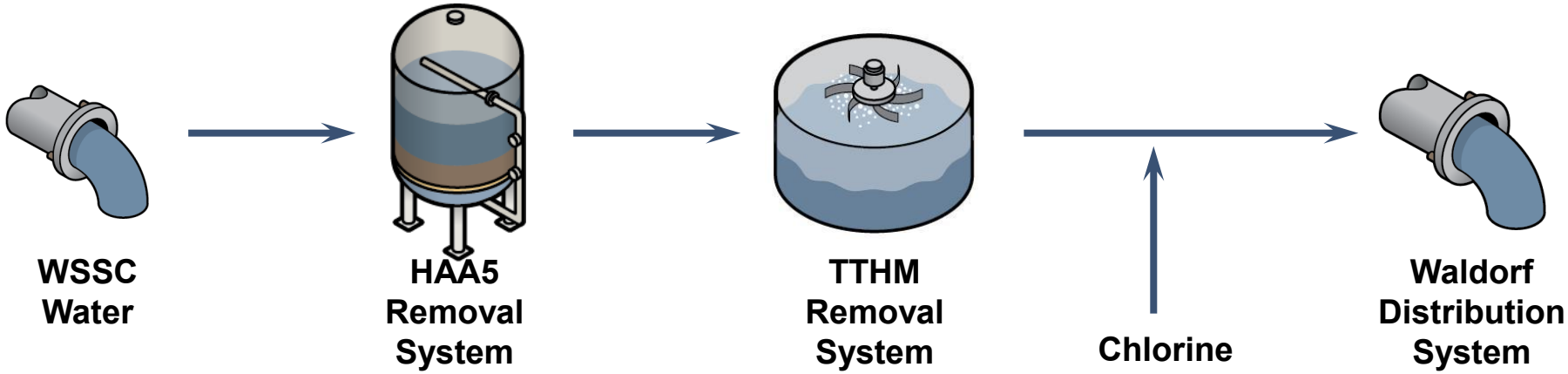
Interior Piping and Nozzle Plan



Exterior Piping and Pump House Plan

Case Study 1: HAA Removal
Proposed Treatment Process and Treatment Goals

Route 301 Interconnection Concept



The goal is to remove both THMs and HAAs.

Biologically active GAC (BAC) will remove HAAs present in the water.

Aeration system will remove THMs present in the water.

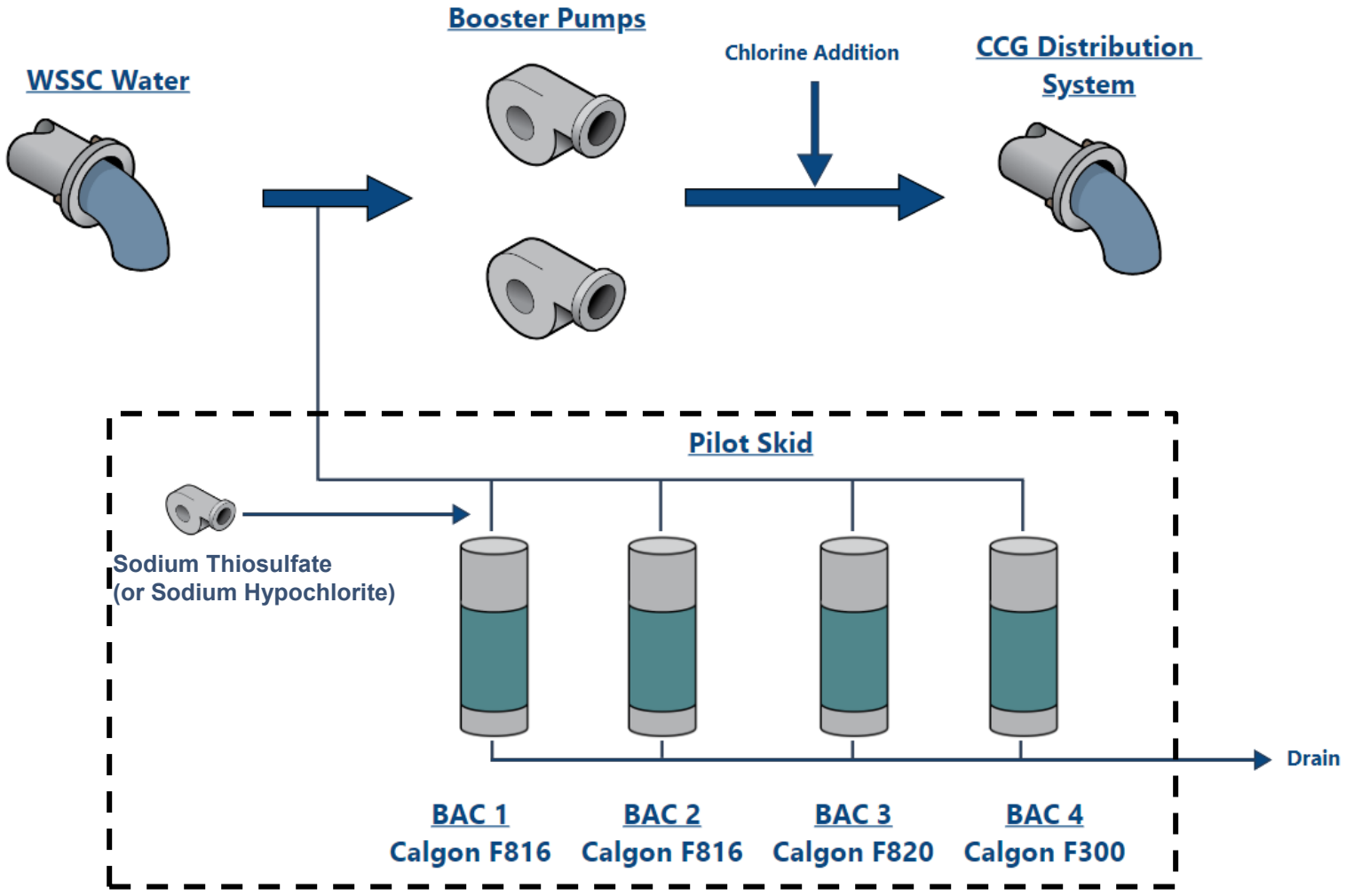
Treated water will be re-chlorinated and supplied to Charles County's distribution system.

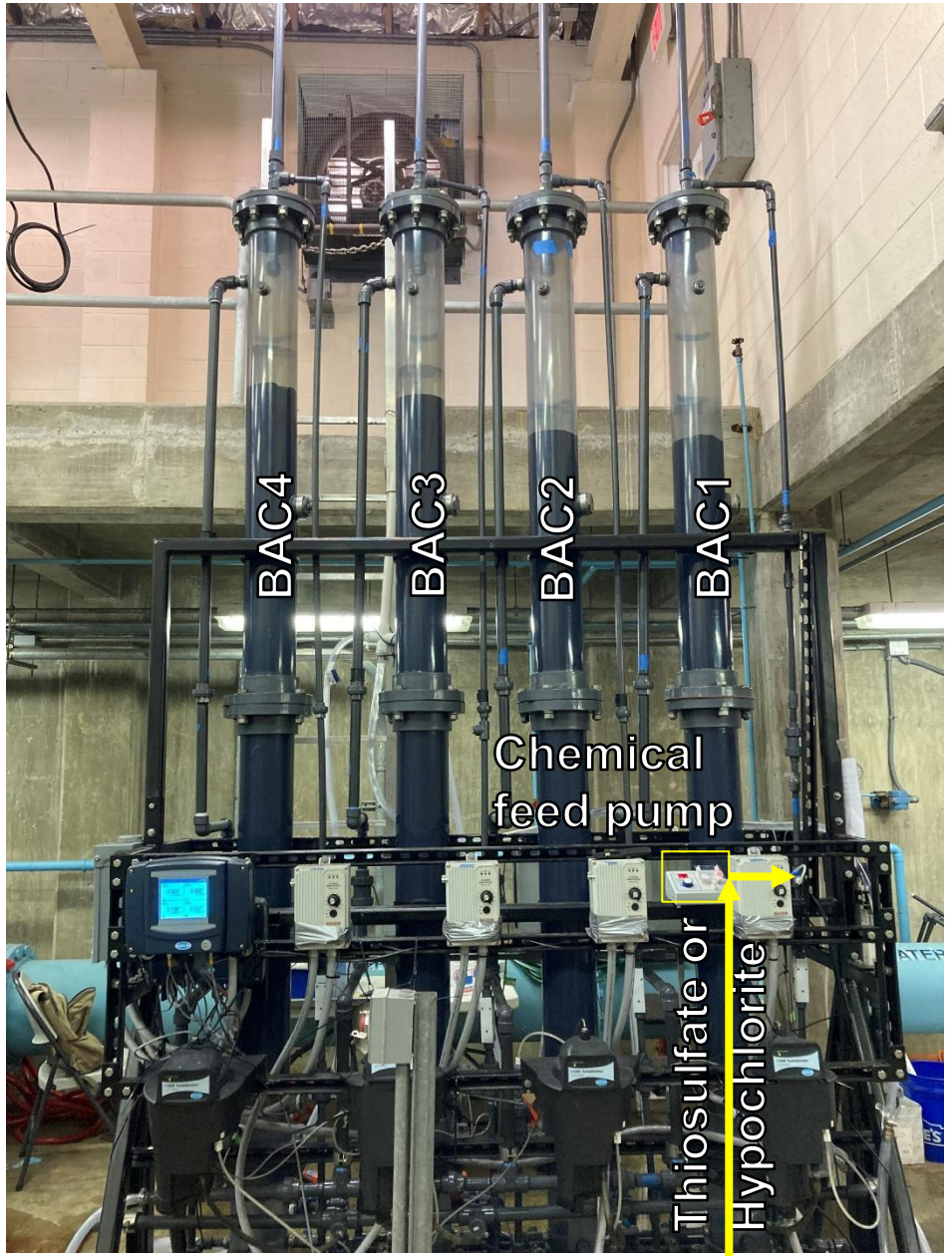
Determine chlorine demand post BAC treatment

Evaluate TTHM and HAA5 formation via simulated distribution system (SDS) testing

Pilot Schematic

Pilot Photo: 8/25/23 – Post Backwash





Pilot Testing Objectives

BAC Treatment

- 1. Proof of concept that BAC can remove HAA5
- 2. Determine acclimation time required to establish an active stable biome that will reliably remove HAA5 via BAC
- 3. Determine most efficient empty bed contact time (EBCT) to optimize HAA5 removal via BAC
- 4. Determine most effective carbon media size that facilitates HAA5 removal via BAC
- 5. Assess impact of chlorine residual in water purchased from WSSC on HAA5 removal via BAC
- 6. Evaluate effect of intermittent operation on BAC
- 7. Investigate the impact of BAC on water quality