

Reducing Disinfection Byproducts through Optimization

Webinar #1: DBP Optimization Process and Priority Setting

April 8, 2019

Webinar Series

- Primary Learning Objective: Introduce participants to disinfection byproduct (DBP) optimization tools that can be used to reduce DBPs in public water systems. These tools have been developed in partnership with state drinking water programs through the Area Wide Optimization Program (AWOP).
- Four successive webinars:
 - **April 8th – DBP Optimization Process and Priority Setting**
 - April 22nd – Approaches to Prioritize Plant Optimization Efforts
 - May 6th – Approaches to Prioritize Distribution System Optimization Efforts
 - May 13th – Implementation of DBP Control Strategies: Approach and Case Studies

Webinar Series Logistics

- All webinars will be scheduled for 1:30 pm ET, will take about 2 hours (including Q&A), and will be recorded.
- Register for EACH webinar individually through ASDWA.
- Viewers can submit questions via the Questions Panel at any time during the broadcast. A Q&A session will be held at the end of all the presentations.

Webinar #1: Learning Objectives

- Understand the relevance of the webinar series and DBP optimization control strategies
- Understand the overall process for diagnosing DBP formation and evaluating DBP control strategies; resources include:
 - Presentation 1
 - Flowchart (*Process to Reduce DBPs through Optimization*)
- Presentations related to diagnosing DBP formation intend to:
 - Introduce the distribution system influent hold study approach to assess water quality stability
 - Demonstrate the application of diagnostic monitoring within systems to assess DBP formation

Disclaimer

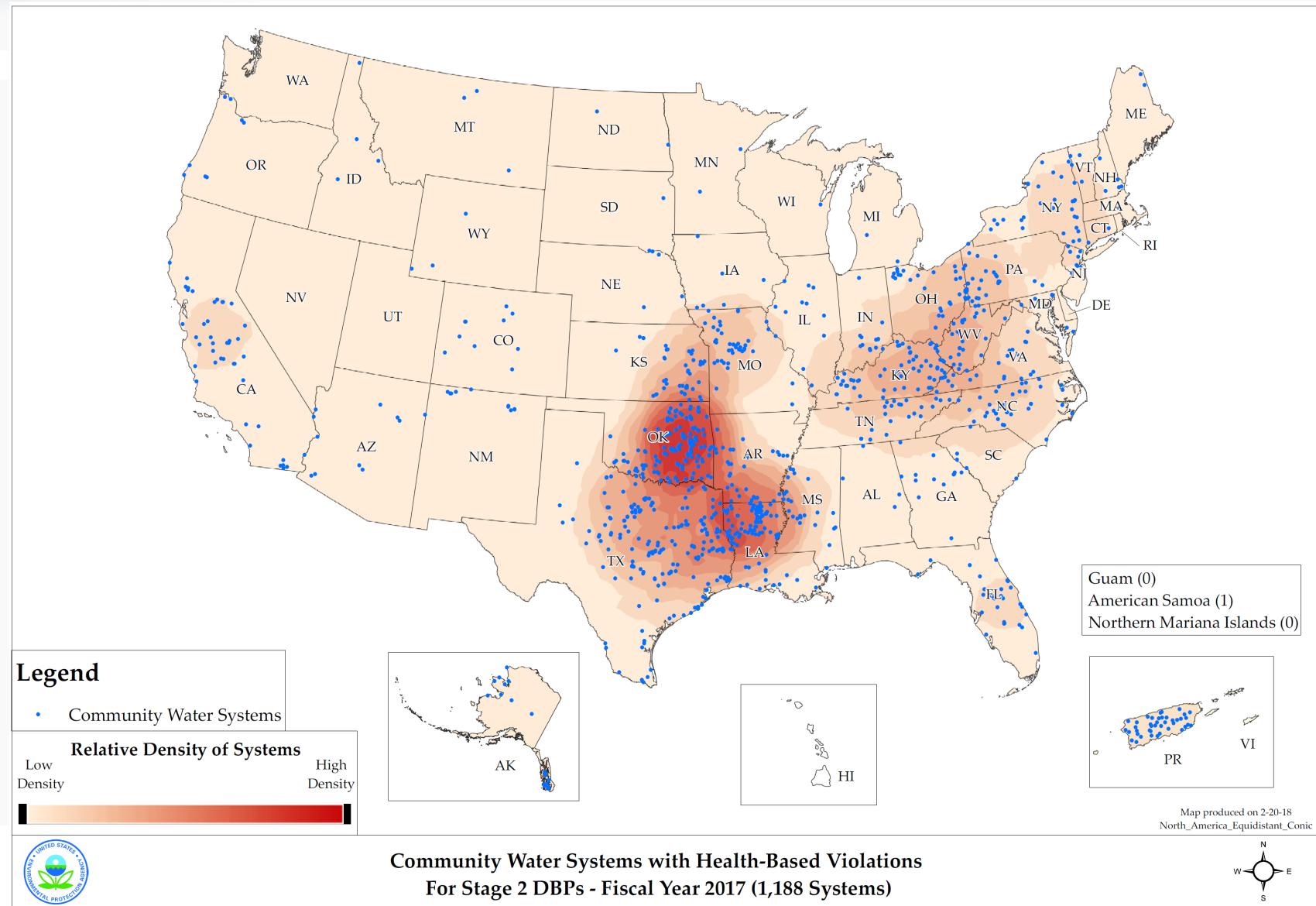
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Reducing DBP Non-Compliance

- EPA has adopted a goal to reduce the number of CWSs out of compliance with health-based standards by 25% by September 2022
- Stage 2 DBPR accounts for 31% of health-based violations, half of which are consecutive systems



Stage 2 DBPR Violation Data



Optimizing Water Quality in Drinking Water Systems

- Utilizing optimization-based tools and approaches include
 - Enhanced water quality monitoring and process control
 - Use of existing staff and facilities
 - Assessment of system performance relative to water quality goals (compliance)
- Optimization is expected to improve water system compliance and this process will support any required design or process improvements

Presentation #1 : Reducing DBPs through Optimization

Matthew T. Alexander, P.E.
Alison G. Dugan, P.E.

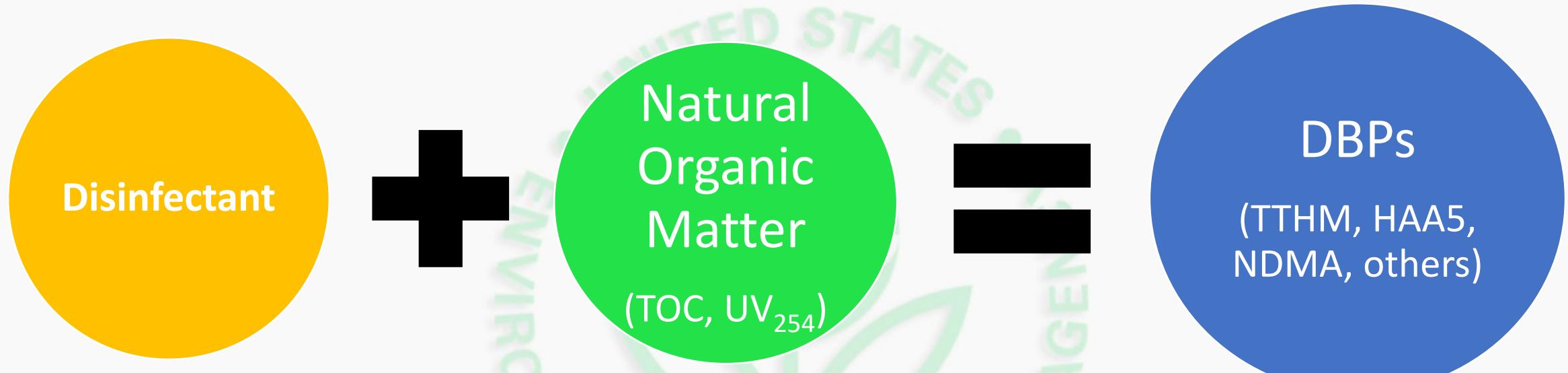
*United States Environmental Protection Agency; Office of Ground Water and Drinking Water
Standards and Risk Management Division; Technical Support Center*

Outline

- Review of formation of disinfection byproducts (DBPs)
- Process to reduce DBPs through optimization
 - Diagnosing formation to prioritize efforts
 - Evaluating control strategies



Disinfection Byproduct (DBP) Formation



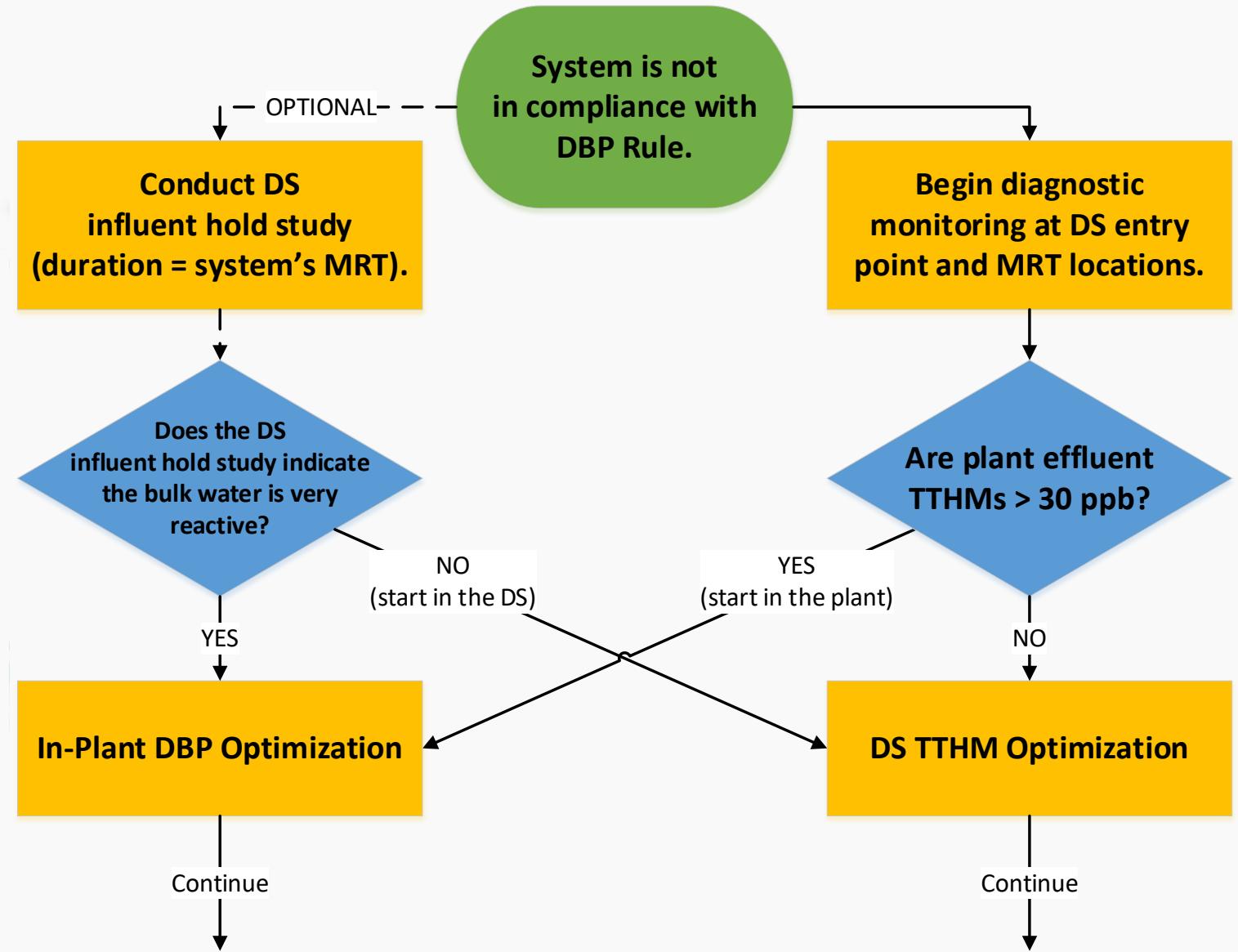
DBP formation is a function of temperature, water age, Cl₂ & NOM concentration, NOM composition, and pH

Process to Reduce DBPs through Optimization



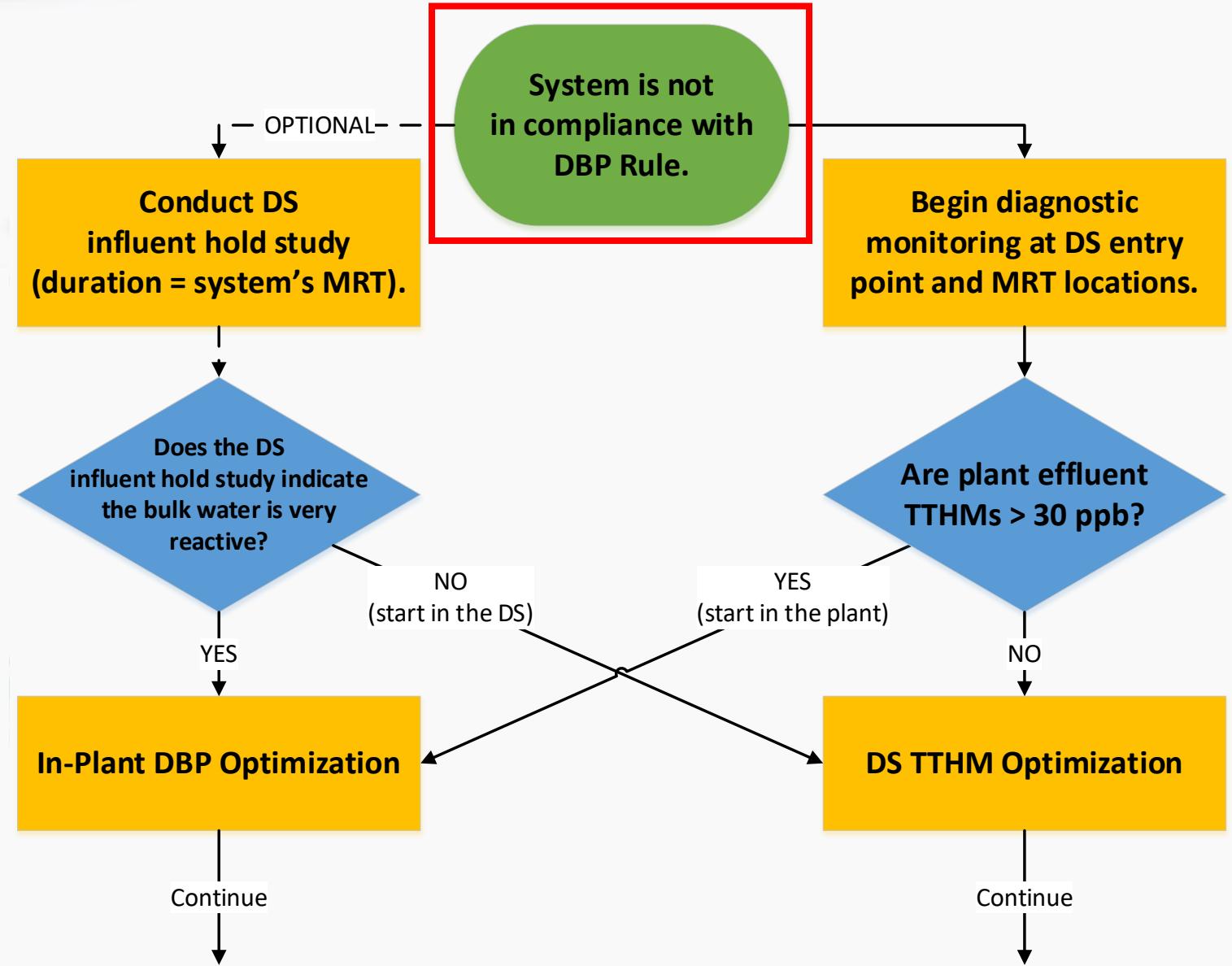
Diagnosing DBP Formation

- Process is most effective for TTHM reduction in free chlorine systems
- HAA5 may only be reduced through in-plant optimization.
- Chloramine systems may optimize treatment, which may lower DBP formation.



Diagnosing DBP Formation

**Process starts
when the system
is not in
compliance**

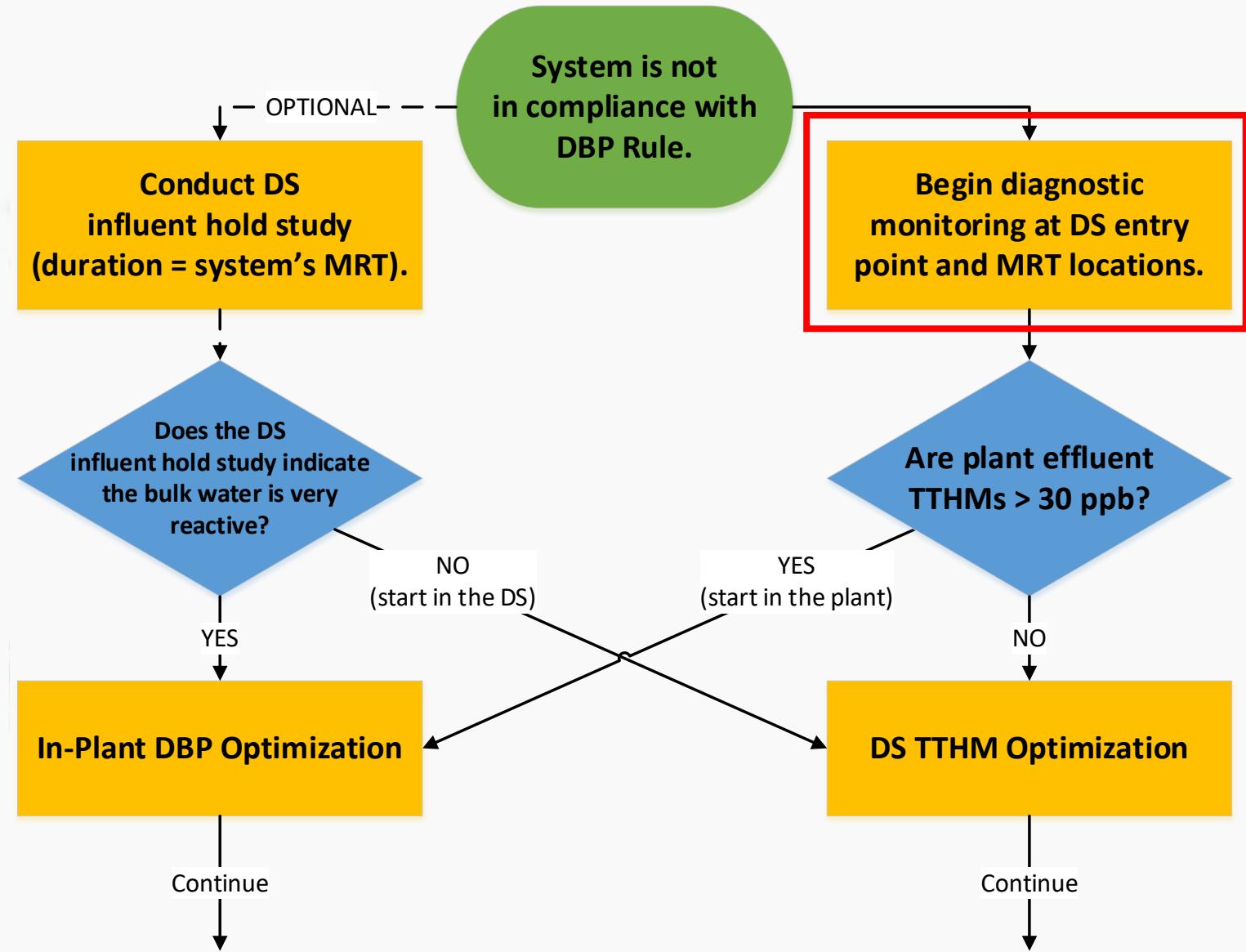


Non-Compliance with the DBP Rule

- Historical DBP data indicates elevated DBP formation, based on monitoring results at:
 - Stage 2 DBP Rule locations, including maximum residence time (MRT) site.
 - If available, entry point (EP) locations (i.e., water treatment plant (WTP) effluent, consecutive distribution system (DS) EP(s)) indicate excessive formation.

Diagnosing DBP Formation

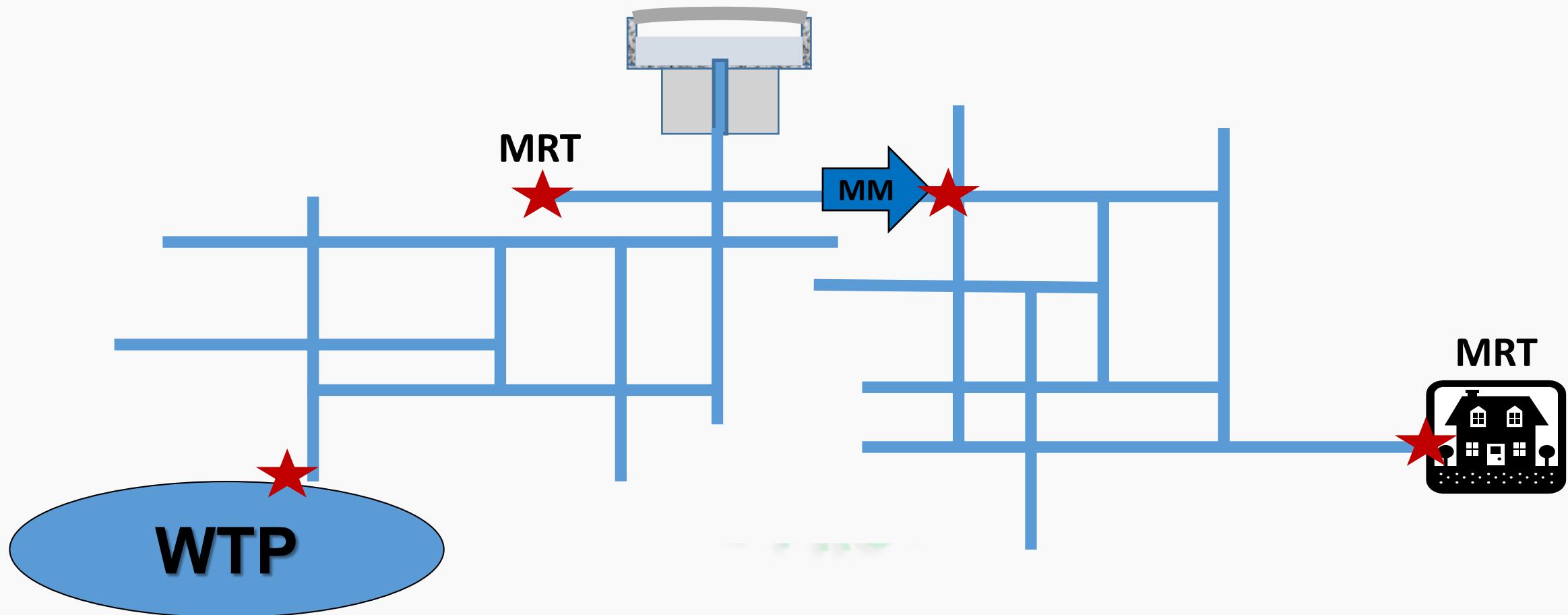
First step is to conduct diagnostic monitoring



Diagnostic Monitoring at DS EP and MRT Locations

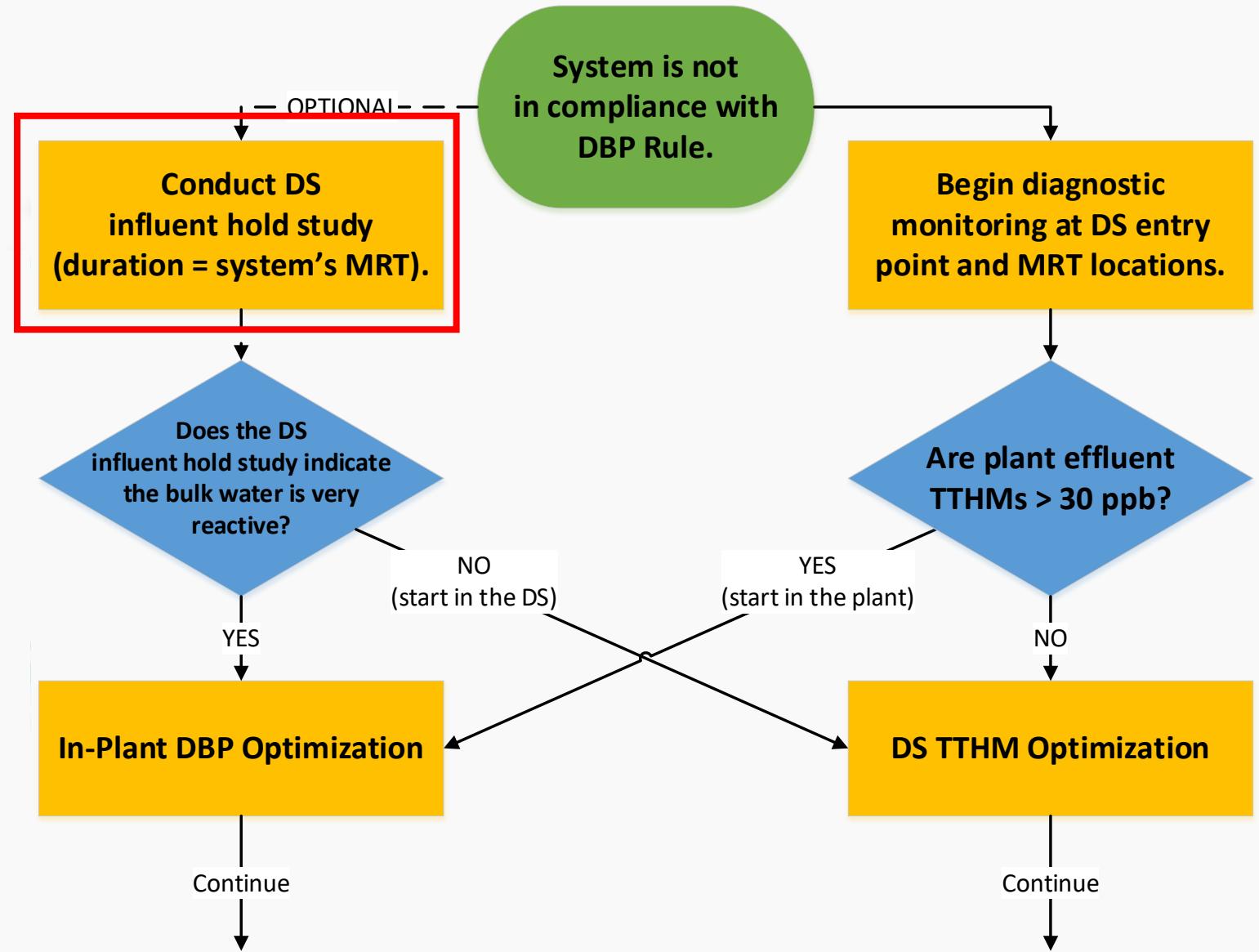
- Objective: Identify where DBP formation is occurring (i.e., WTP, parent DS, consecutive DS).
- Approach: Conduct diagnostic monitoring at DS EP and MRT locations.
 - Collect DBP samples, disinfectant residual, temperature, and pH
 - Four sets of quarterly compliance samples or three sets of consecutive monthly samples
 - HAA5 may provide insights into water age and potential biodegradation in the DS, even if they are not elevated and of concern.
 - DBP species may provide additional insights.
 - Ideally, DS EP monitoring would become routine for the system – not simply used to assess the impact of optimization efforts.

Diagnostic Monitoring in a Parent and Consecutive System



Diagnosing DBP Formation

Optional step to conduct a DS influent hold study



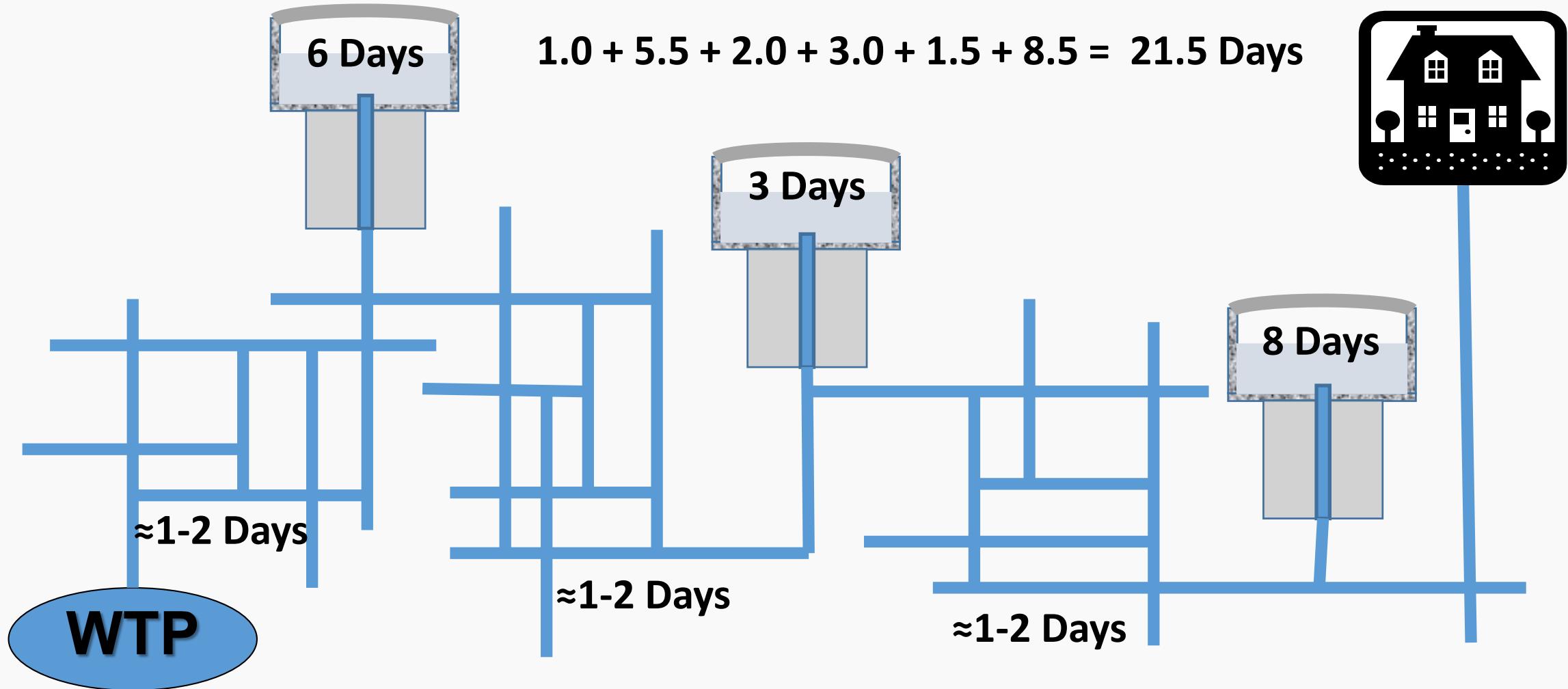
What is a DS Influent Hold Study?

- Referred to as a “hold study” because DS influent water samples are collected and held for a period of time before analysis.
 - Duration is based on study objective (e.g., assess DBP formation at MRT).
 - Measures disinfectant decay and/or DBP formation in the bulk water.
 - Does not assess pipe wall reactions.

What is a DS Influent Hold Study?

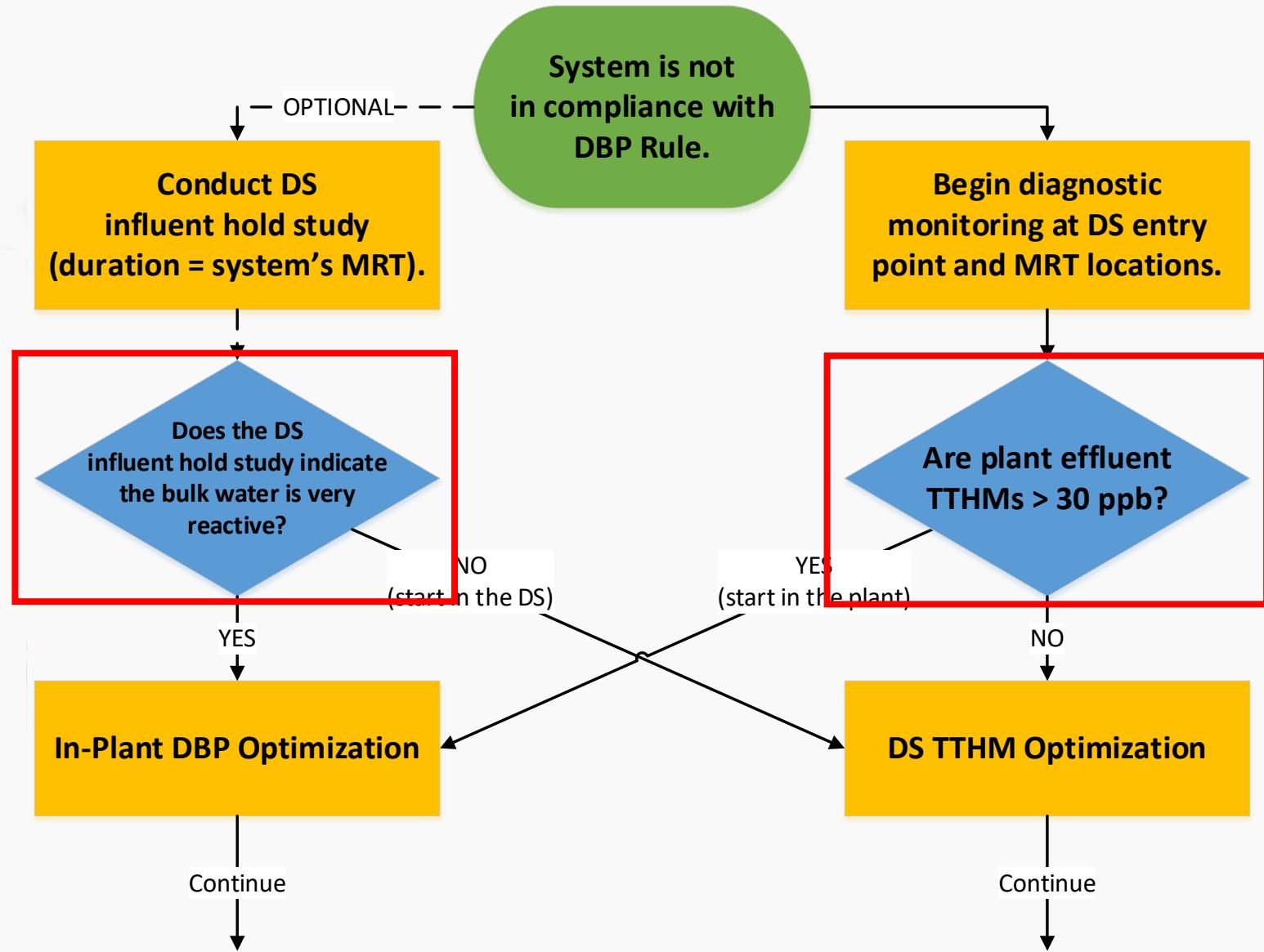
- Study assesses water quality stability.
 - Reactive plant effluent water suggests need for additional treatment
 - Reactive is subjective, will vary by season, and what is “acceptable” depends on system needs, but consider
 - How quickly a residual is lost
 - How quickly DBP formation reaches a compliance level
- Results will help prioritize optimization efforts.
- Study protocol will be available on EPA’s website
<https://www.epa.gov/dwstandardsregulations/optimization-program-drinking-water-systems>

Estimating the MRT

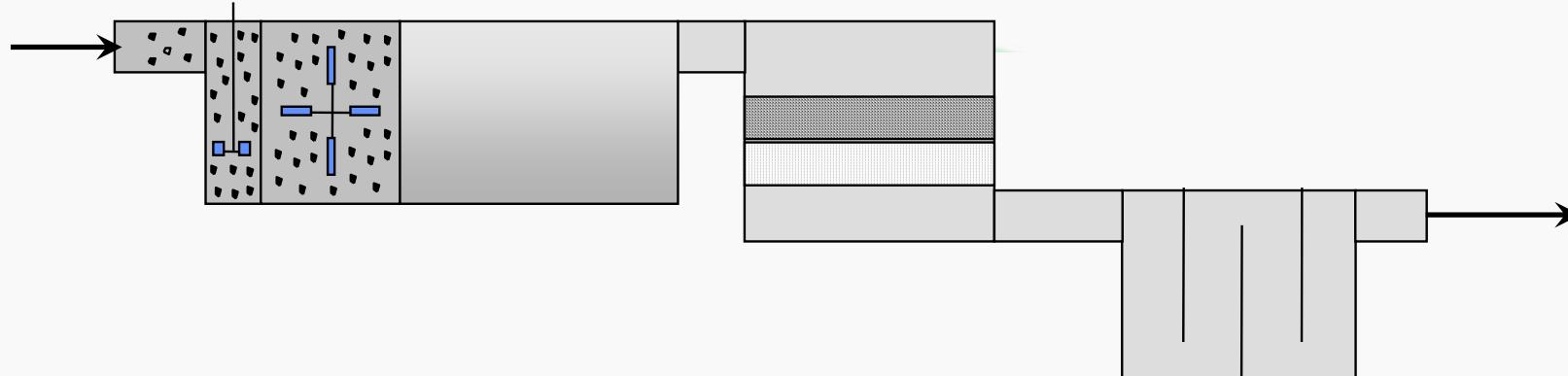


Diagnosing DBP Formation

Results from each study may be used to determine next steps



Diagnosis → Start in the Plant



- Plant effluent TTHMs > 30 ppb and HAA5 > 20 ppb*
 - Hold study shows
 - The water is very reactive and chlorine decays quickly
 - MRT TTHM sample > MCL
- **Treatment optimization** to assess oxidation/disinfection and DBP precursor removal

*This is system specific, but based on field experience an optimized plant can likely produce DBPs below this level

Diagnosis → Start in the Distribution System

- Plant effluent TTHMs < 30 ppb*
- Diagnostic sampling shows significant TTHM formation between DS EP & MRT
- Hold study shows:
 - Disinfectant residual is fairly stable
 - MRT TTHMs (hold study) < Stage 2 MRT TTHM

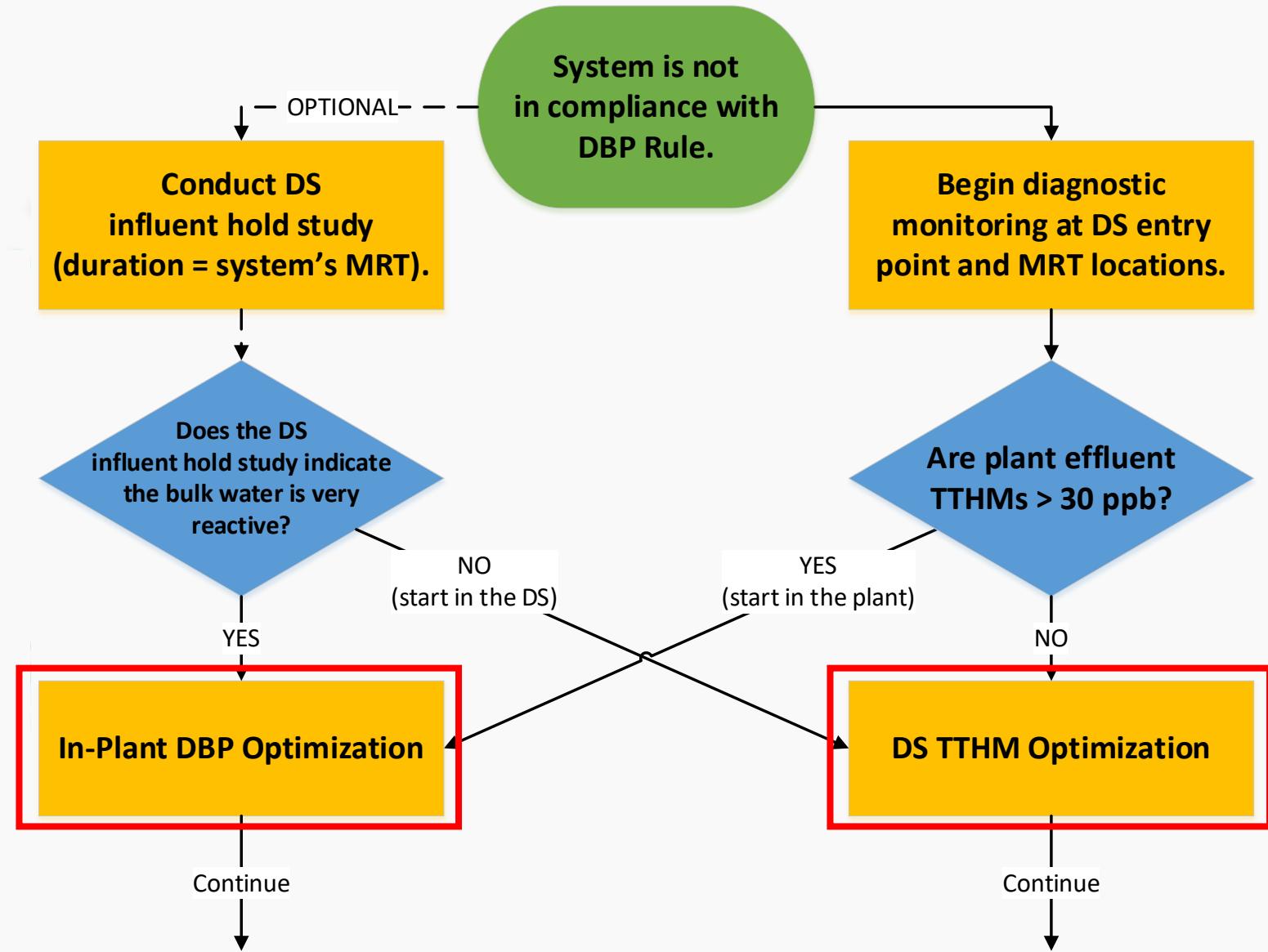
→ **DS optimization** focused on tanks, flushing and hydraulics



*This is system specific, but based on field experience an optimized plant can likely produce DBPs below this level

Diagnosing DBP Formation

Often both treatment and DS optimization are needed

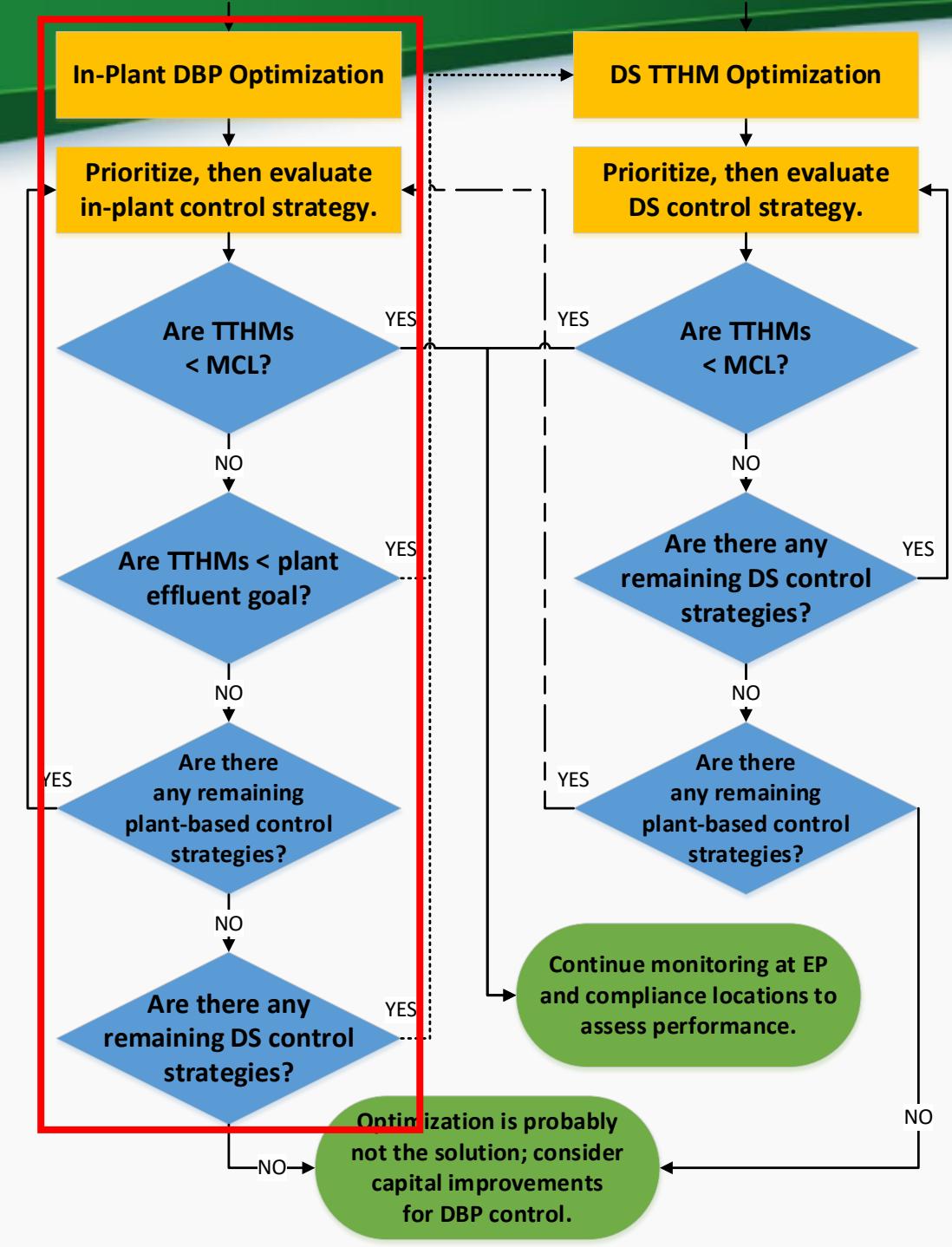


Evaluating Control Strategies

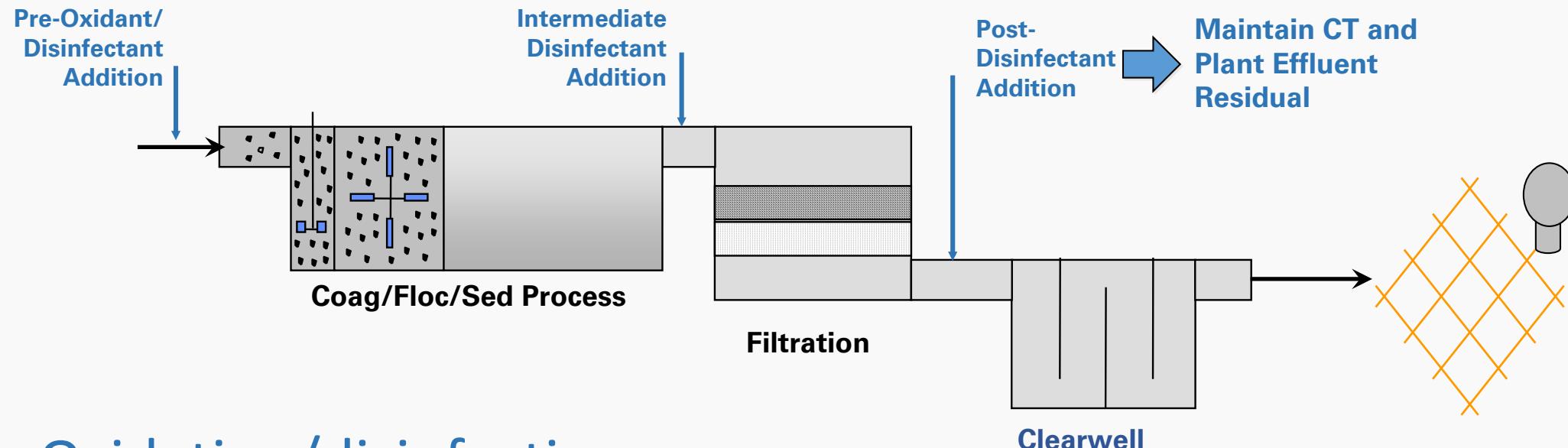


Evaluating In-Plant Control Strategies

- See *Process to Reduce DBPs through Optimization* flowchart for details.



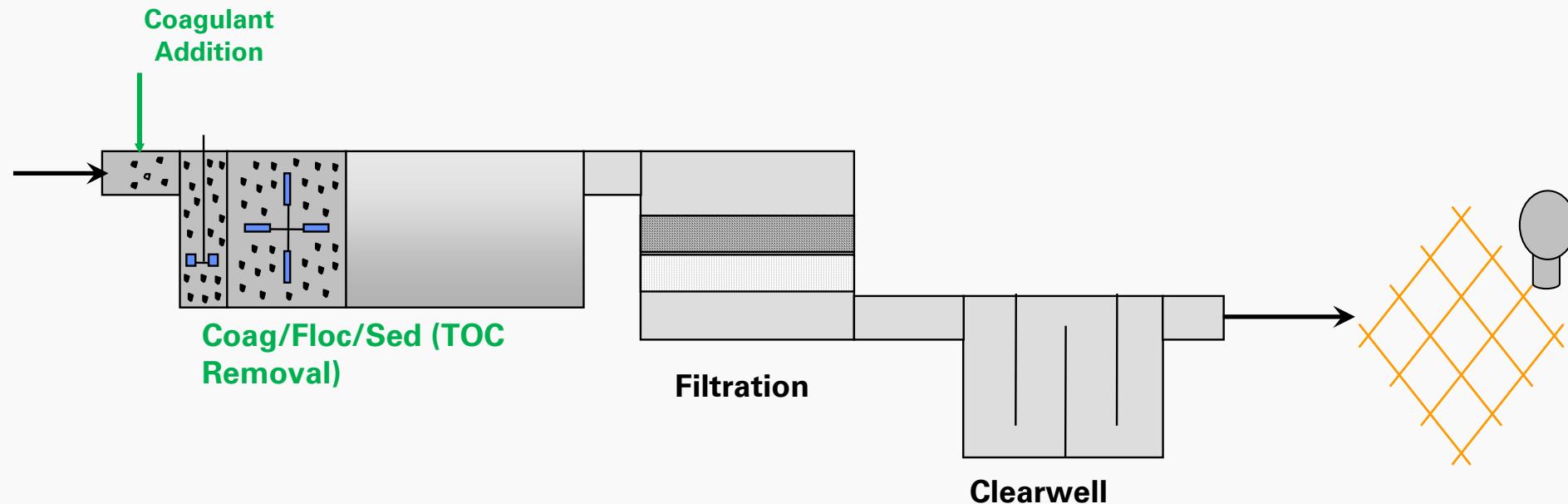
Two Main Treatment-Based Options to Reduce DBPs



1. Oxidation/disinfection:

- Pre-oxidation (prior to TOC removal/top of filters)
- Intermediate and/or post-disinfection (maintain CT and plant effluent residual)

Two Main Treatment-Based Options to Reduce DBPs



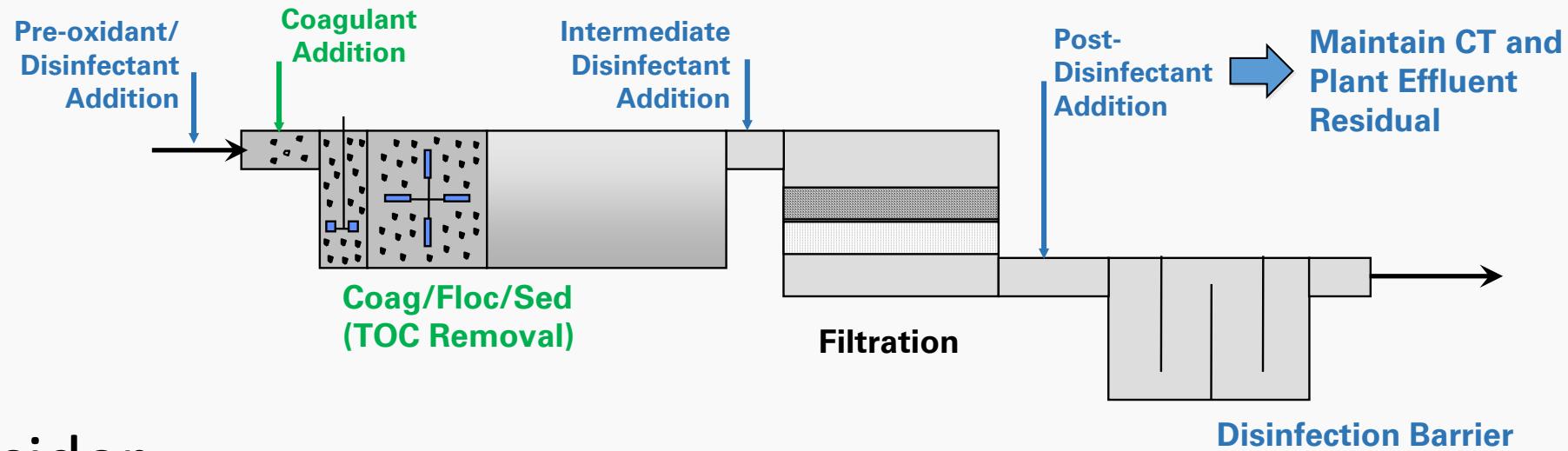
2. DBP precursor removal

- Reduce finished water TOC through optimized coagulation
- Temperature, pH, bromide and NOM composition impact DBP formation but are more difficult to control

Example Unintended Consequences of Treatment Control Strategies

Unintended Consequence	Optimize Oxidation/ Disinfection	Optimize Precursor Removal
↓ Disinfection (CT) and/or DS residual	x	
↑ In-plant bio-growth	x	
Change in quantity/quality of sludge		x
Impact inorganic oxidation and removal (e.g., Fe, Mn)	x	x
↑ Settled and filtered water turbidity	x	x
Impact treatment strategy for harmful algal blooms	x	x
Impact corrosion control treatment	x	x
Others??	x	x

Prioritizing Plant-Based Strategies: Review Treatment

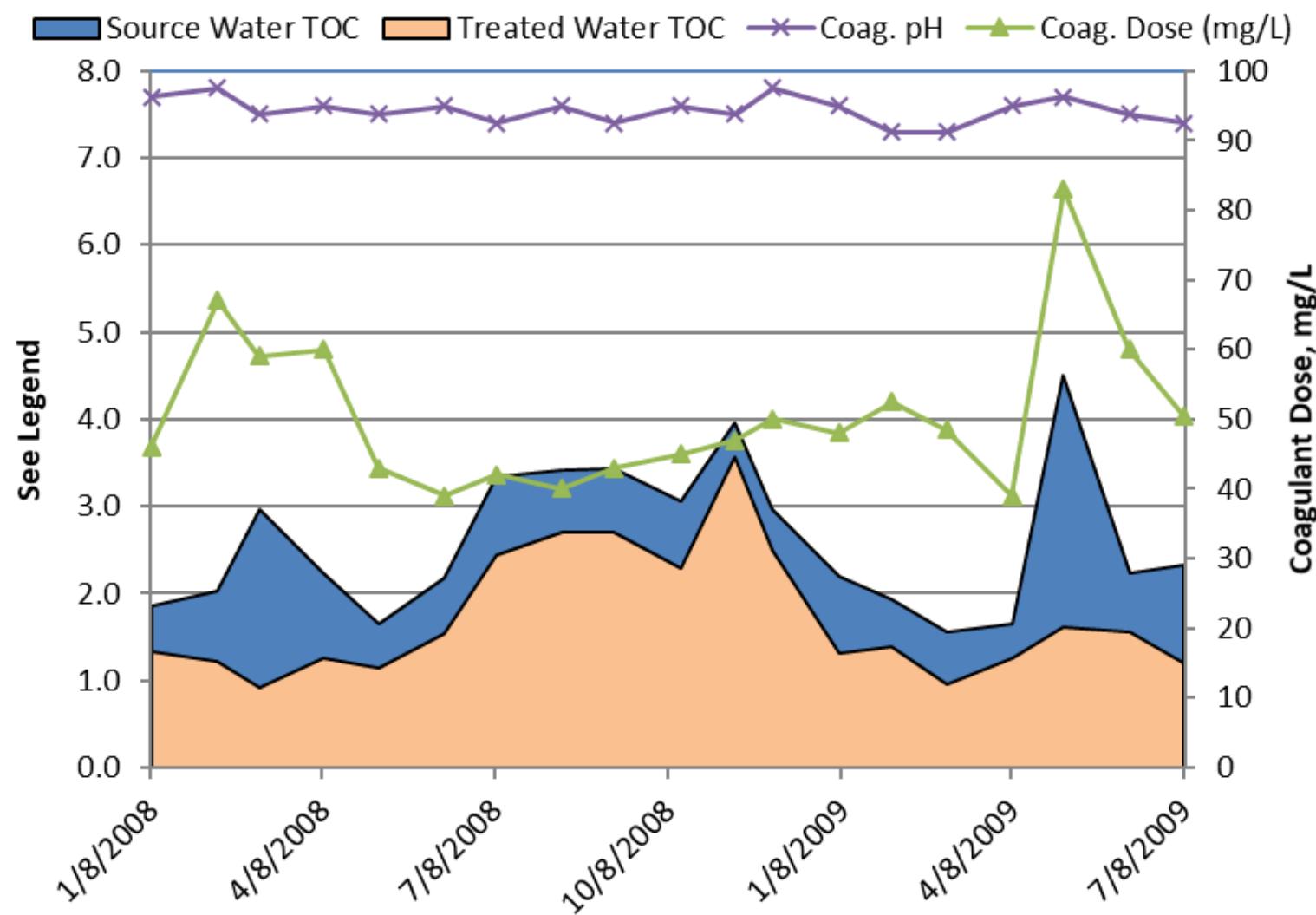


Consider

- Points of, and purpose for, oxidant addition
 - How is CT and distribution system residual achieved? What are other treatment objectives?
- What process is intended for TOC removal?
 - How is it performing?

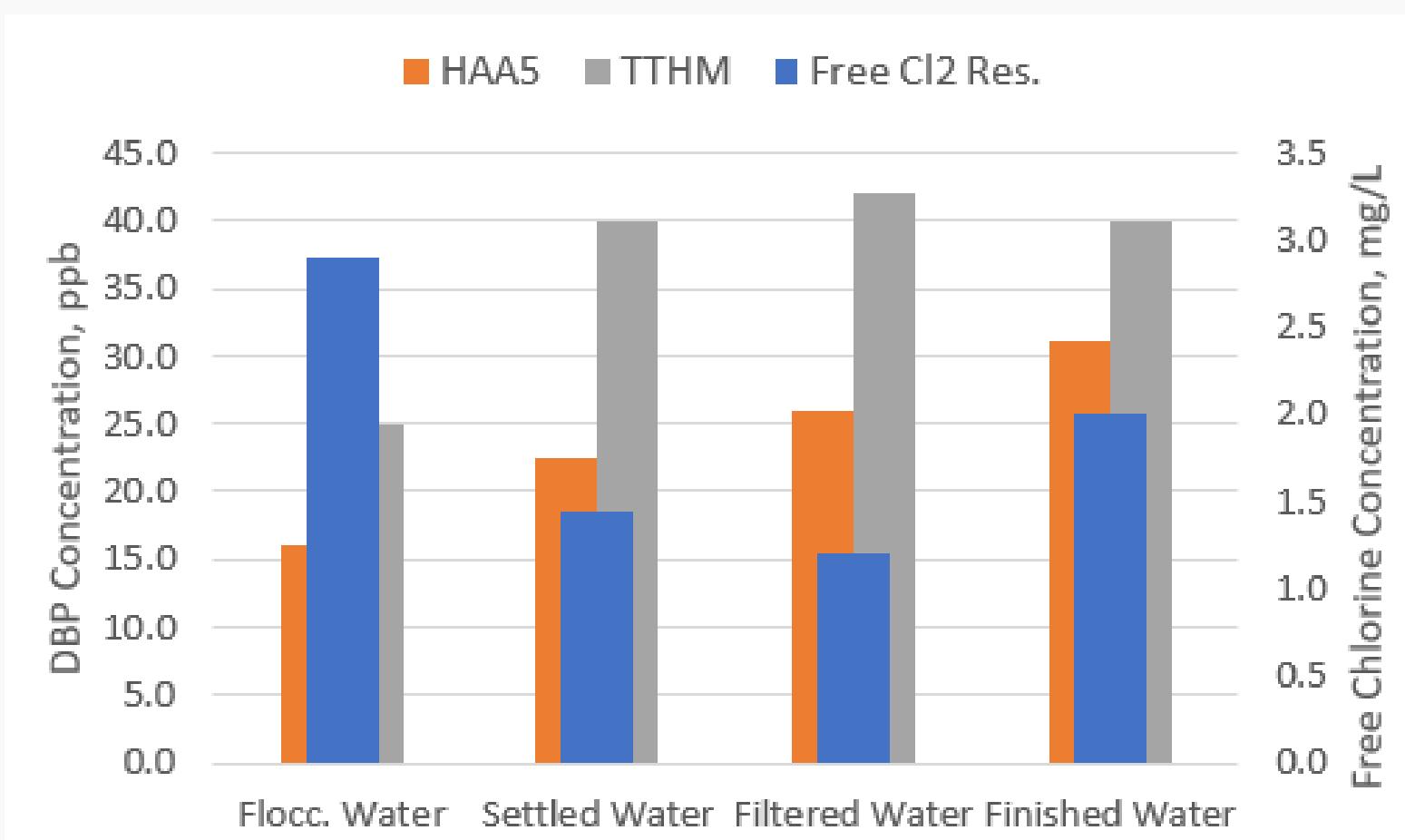
Prioritize/Identify Plant-Based Control Strategies

- Review historical water quality and treatment data (TOC, coagulant dose, coagulation pH, disinfectant dose & residual + others, e.g., bromide)
- More on this during Webinar #2



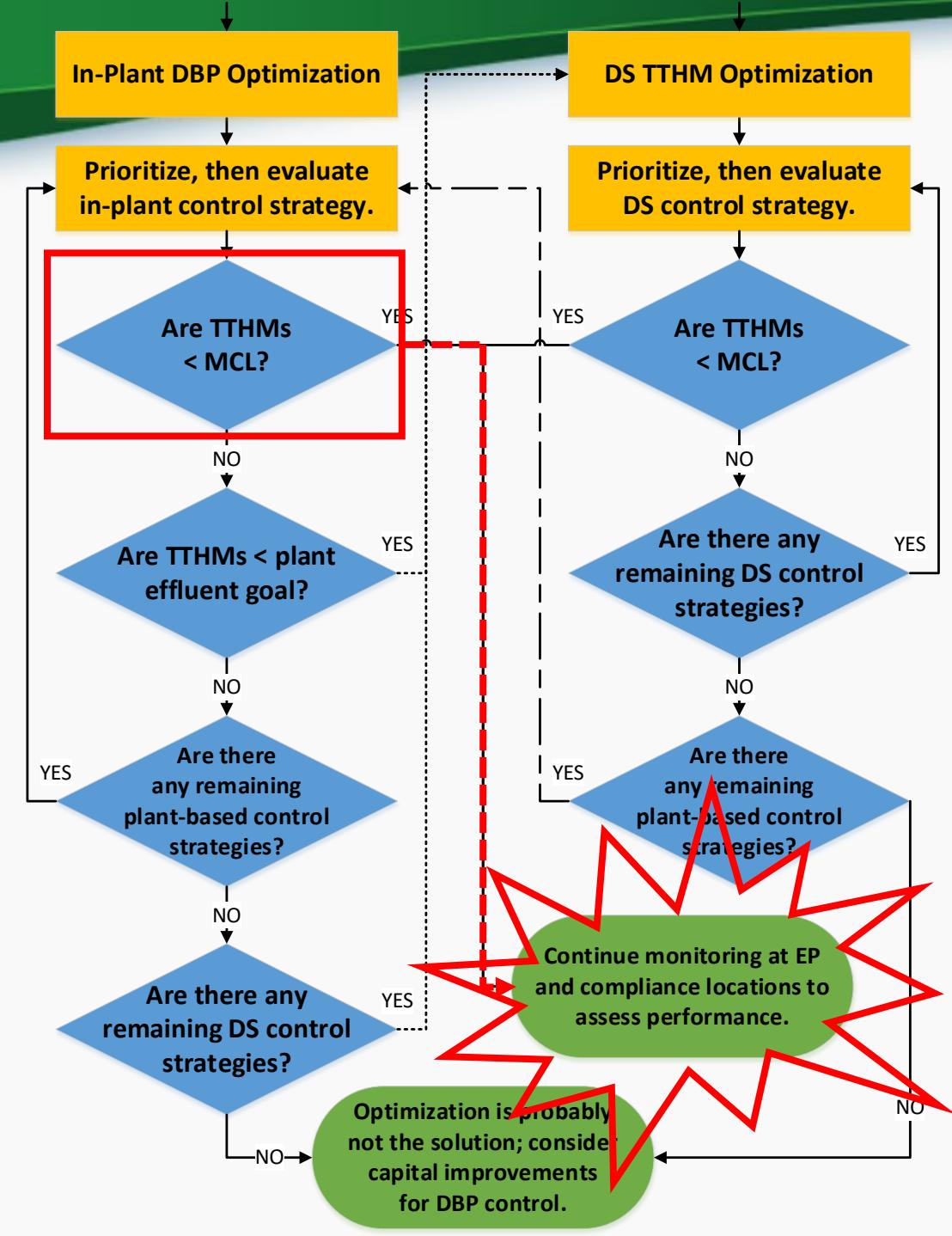
Prioritize/Identify Plant-Based Control Strategies

- Develop a plant profile (TTHM, HAA5, disinfectant, pH, temperature, TOC, UV₂₅₄)
- More on this during Webinar #2



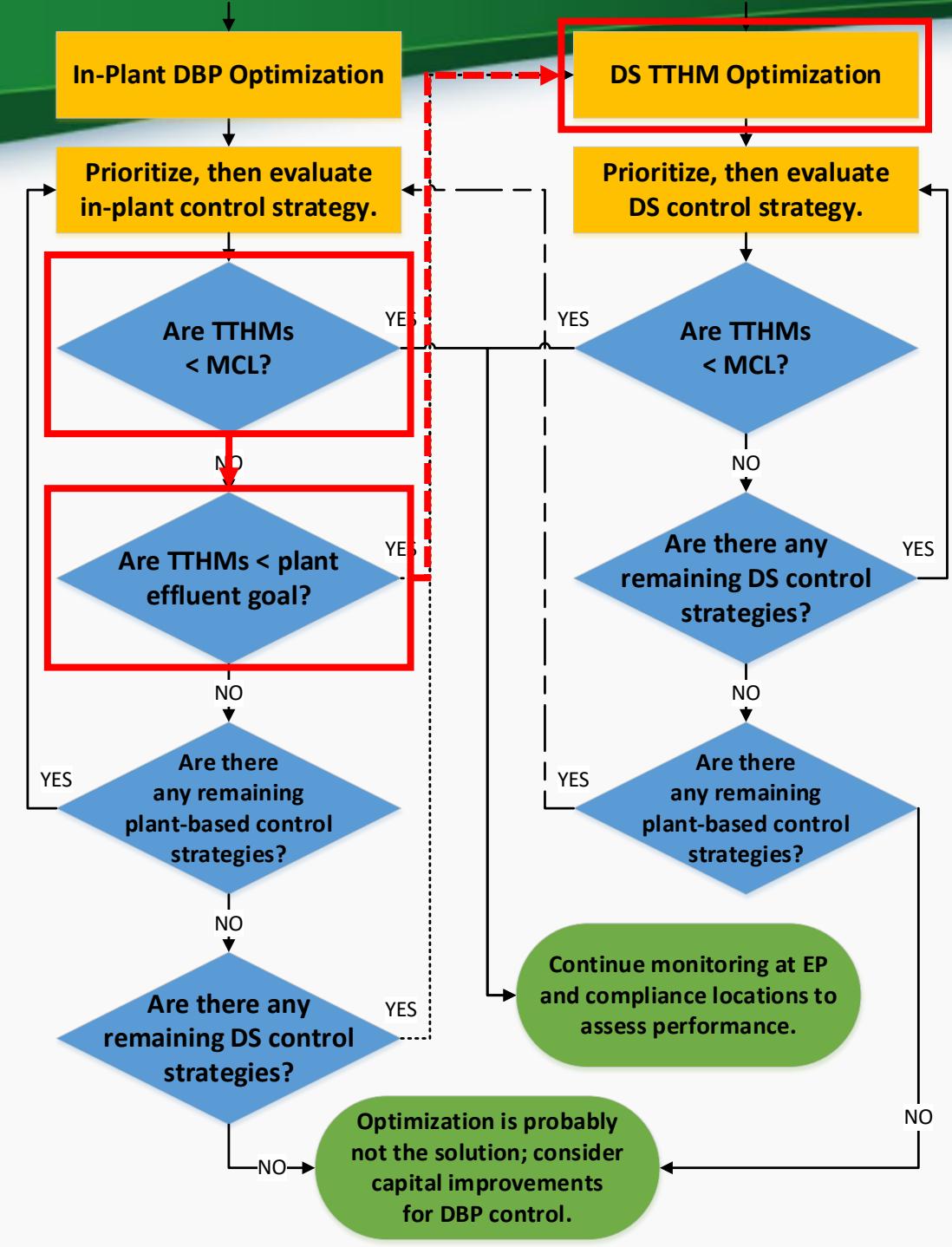
Evaluating Plant-Based Control Strategies

- After implementing each strategy, assess whether TTHM @ MRT < MCL
 - YES → continue monitoring to assess impact of optimization efforts



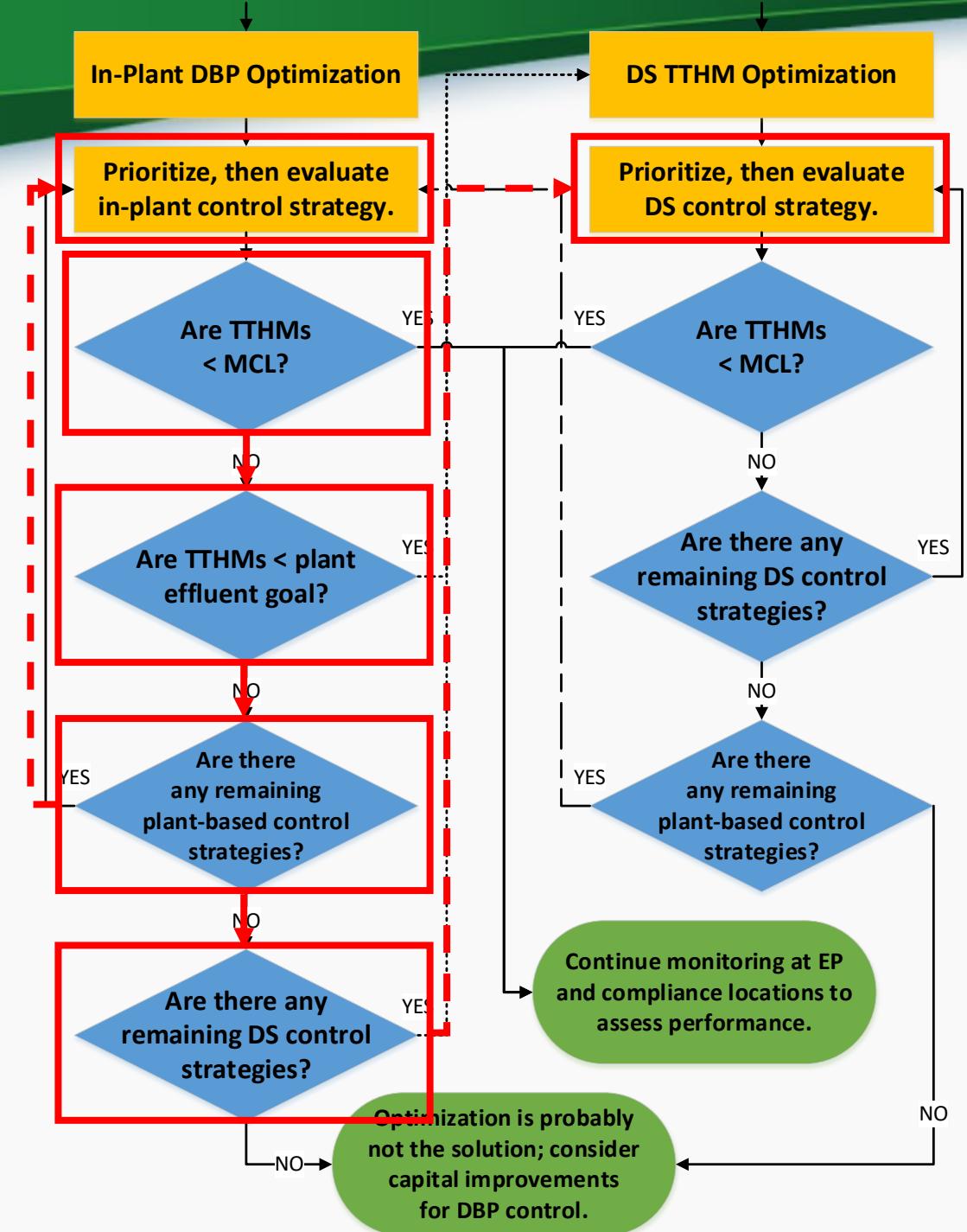
Evaluating Plant-Based Control Strategies

- Assess whether TTHM @ MRT < MCL
 - YES → continue monitoring to assess impact of optimization efforts
 - NO → assess TTHM < plant effluent goal?
 - YES → continue to DS optimization



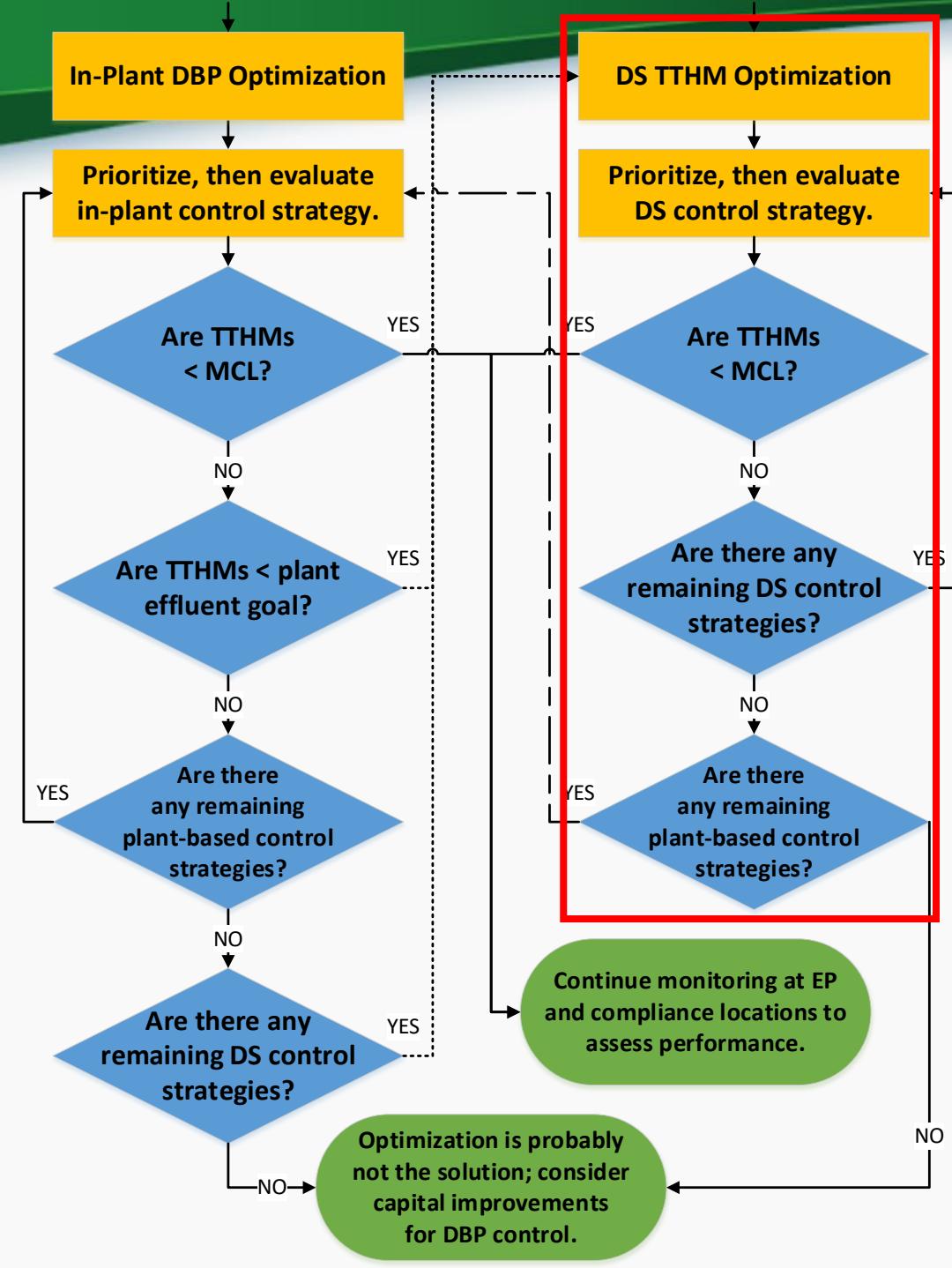
Evaluating Plant-Based Control Strategies

- Assess whether TTHM @ MRT < MCL
 - YES → continue monitoring to assess impact of optimization efforts
 - NO → assess TTHM < plant effluent goal?
 - YES → continue to DS optimization
 - NO →
 - evaluate another plant strategy (if available), OR
 - move to DS optimization



Evaluating DS Control Strategies

- See *Process to Reduce DBPs through Optimization* flowchart for details.



DS Options to Reduce DBP Formation

- **Primarily reducing water age**
- Can be utilized by parent and consecutive systems
- DS control strategies are briefly discussed on following slides; more information will be provided in Webinars #3 and #4
- Consider unintended consequences related to making DS adjustments



Distribution System Control Strategies

Managing tanks

- Modify tank levels.
- Change fill rate and/or duration.
- Remove tank(s) from service.
- Review tank maintenance – is it adequate?
- Implementing a flushing program
 - There are several approaches – all with different objectives and impacts on water quality.
 - Objective is to create “artificial demand” and reduce water age.
 - Modest flushed water volumes can help maintain an adequate disinfectant residual.



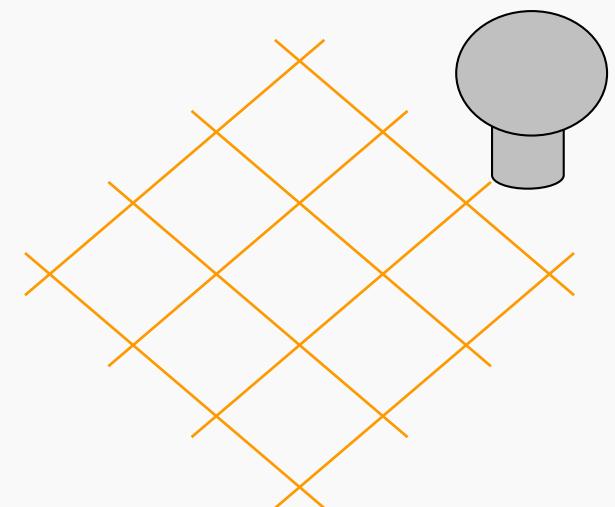
Distribution System Control Strategies

- Modifying system hydraulics
 - Effective in areas with parallel lines or flexibility for flow to be redirected (i.e., through low demand area to area of higher demand).
- Treatment and minor design changes
 - Booster disinfection can sometimes be optimized.
 - Treatment modifications are sometimes needed.
 - Capital improvements focused on impacting DS water quality may be warranted.



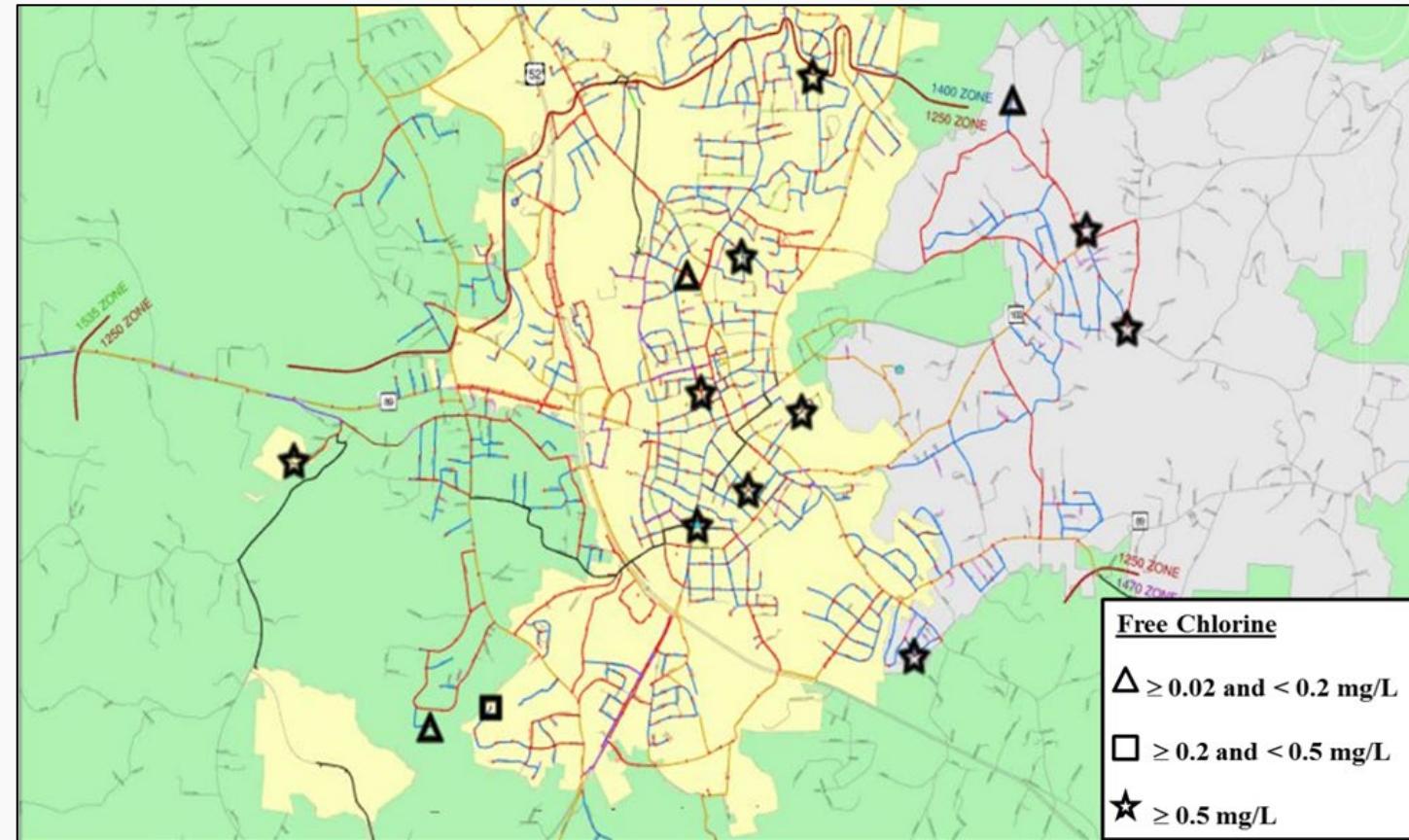
Prioritizing DS Strategies: Review the System

- Locate routine sampling locations on a map
- Consider:
 - Is there any treatment in the system?
 - Characteristics of water storage tanks (i.e., design, size, maintenance program)
 - Areas of low use/overdesign?
 - Any use of automatic flushers?



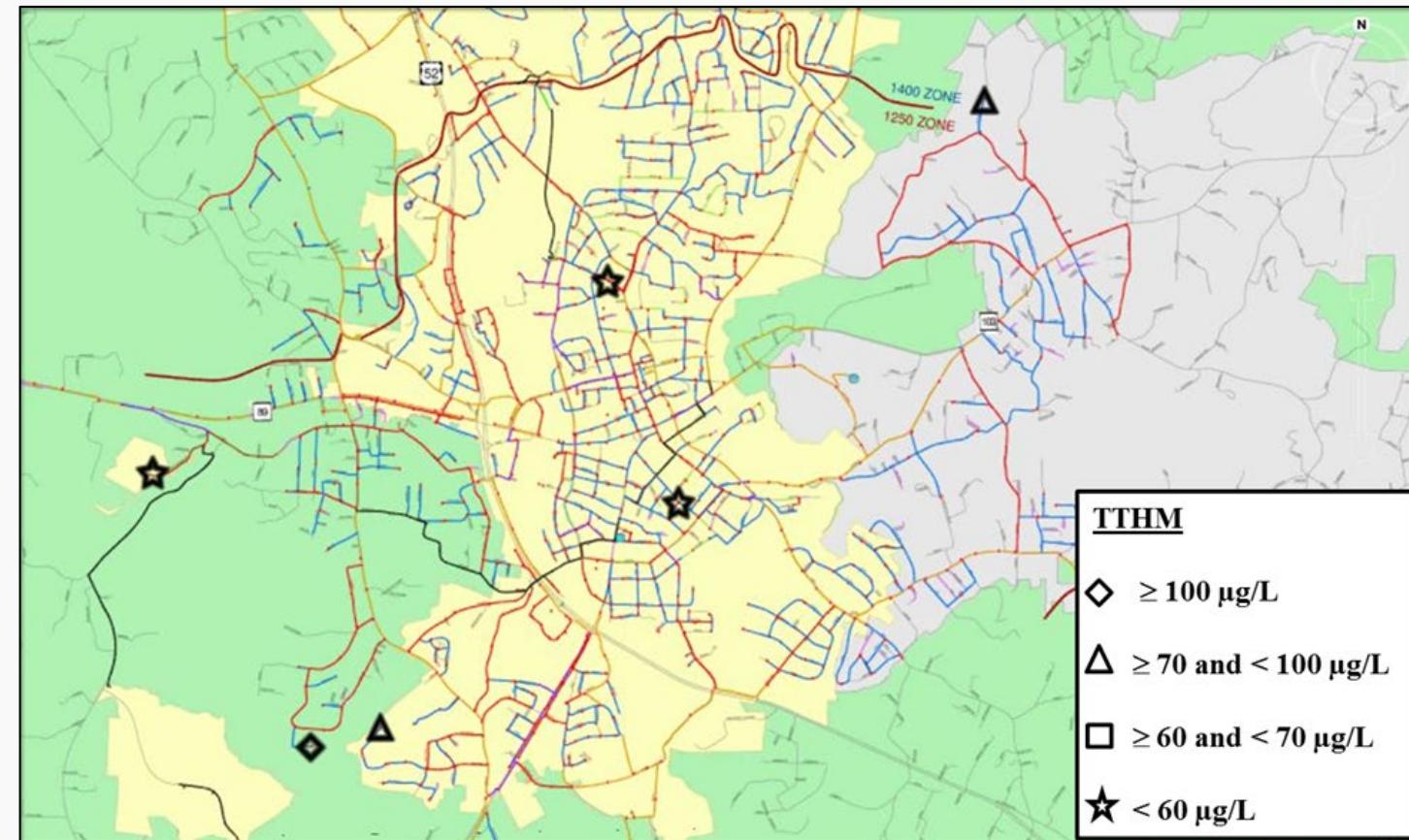
Prioritize/Identify DS Control Strategies

- Assess water quality throughout the system.
- Investigative sampling to identify critical locations: disinfectant residual



Prioritize/Identify DS Control Strategies

- Assess water quality throughout the system.
- Investigative sampling to identify critical locations: DBP formation



Prioritize/Identify DS Control Strategies

- Assess storage tank performance and water quality
 - Storage Tank Assessment Spreadsheet
 - Water Quality Monitoring
 - Investigative Sampling
 - Continuous Online Monitoring
 - In-Tank Monitoring
 - Tank overflow study
- More on this during Webinar #3



Evaluating DS Control Strategies: Unintended Consequences

- Once prioritized, evaluate strategy(s) considering unintended consequences of distribution system adjustments.
- Some examples include:
 - Concerns related to staff time (e.g., enhanced monitoring, implementing flushing programs)
 - Customer complaints, such as:
 - Discolored water may result from higher velocity flushing or changing flow patterns
 - Anti-conservation perceptions (e.g., flushing)



Evaluating DS Control Strategies: Unintended Consequences (con't)

- Examples related to modifying system hydraulics:
 - Reduced capacity for peak demands (e.g., fire, line breaks)
 - Low water pressure due to reduced tank levels
 - Political pressure opposed to removing tanks from service
 - Additional wear on pumps due to fill cycle changes
 - Potential hydraulic challenges associated with rerouting water to improve water quality.



Evaluating DS Control Strategies:

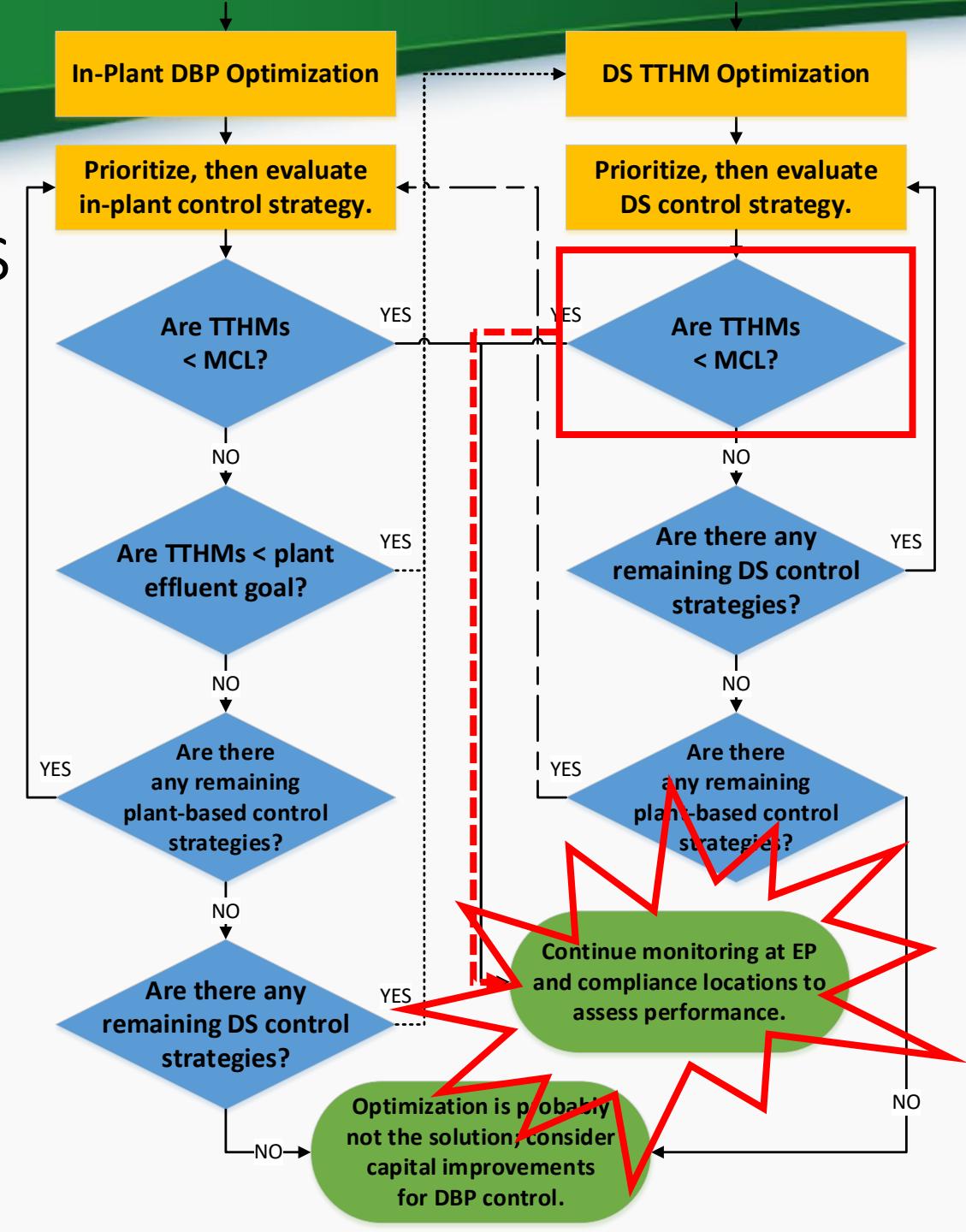
Unintended Consequences (con't)

- Examples related to cost:
 - Associated with installing treatment (e.g., booster disinfection, tank aeration) and/or other design changes (e.g., tank mixing devices)
 - Revenue lost due to unbillable water (e.g., flushing)
 - For tank maintenance services (e.g., cleaning, recoating, inspections)
 - Development and implementation of unidirectional flushing program.



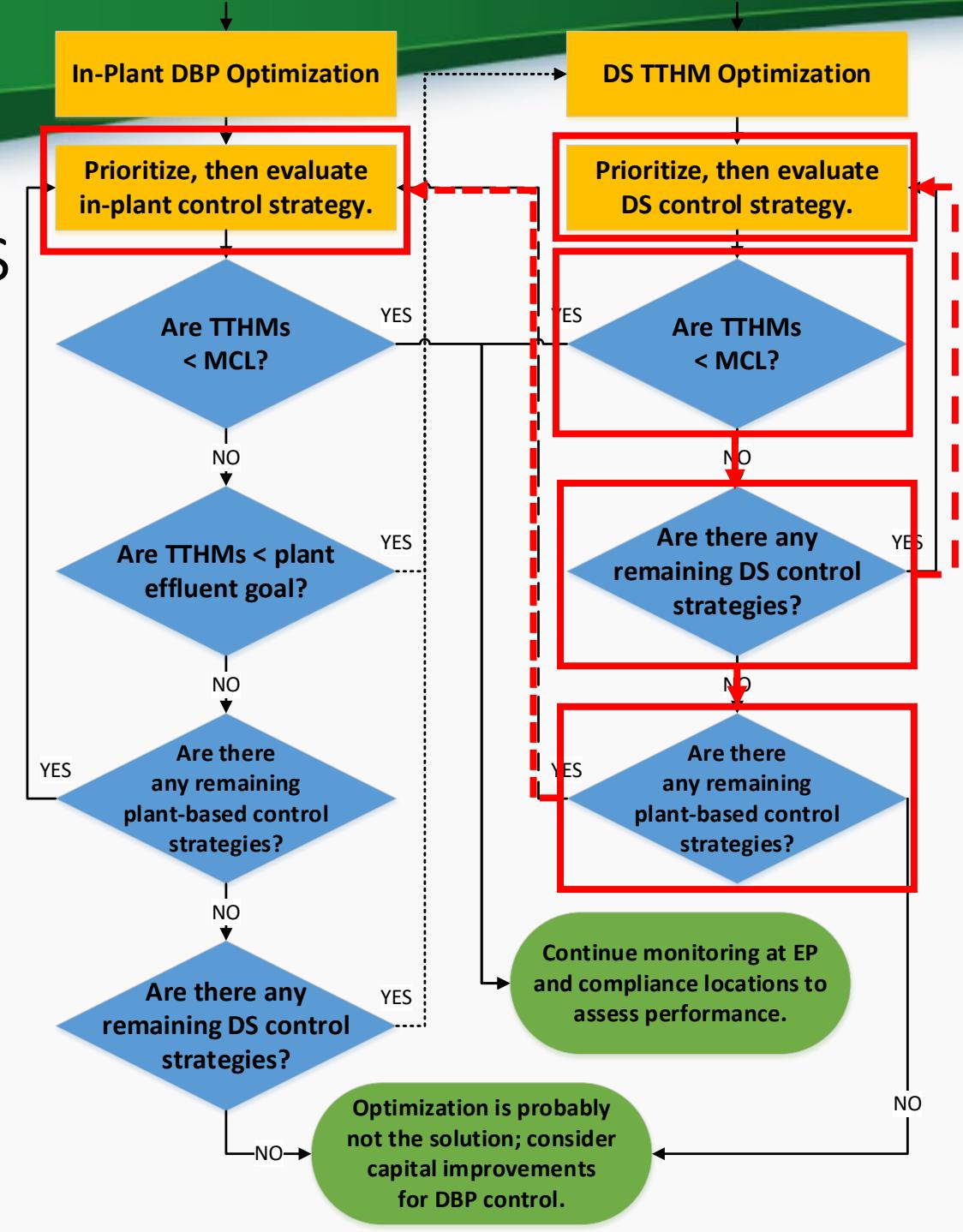
Evaluating DS Control Strategies

- After implementing a DS strategy, assess whether TTHM @ MRT < MCL
- YES → continue monitoring to assess impact of optimization efforts



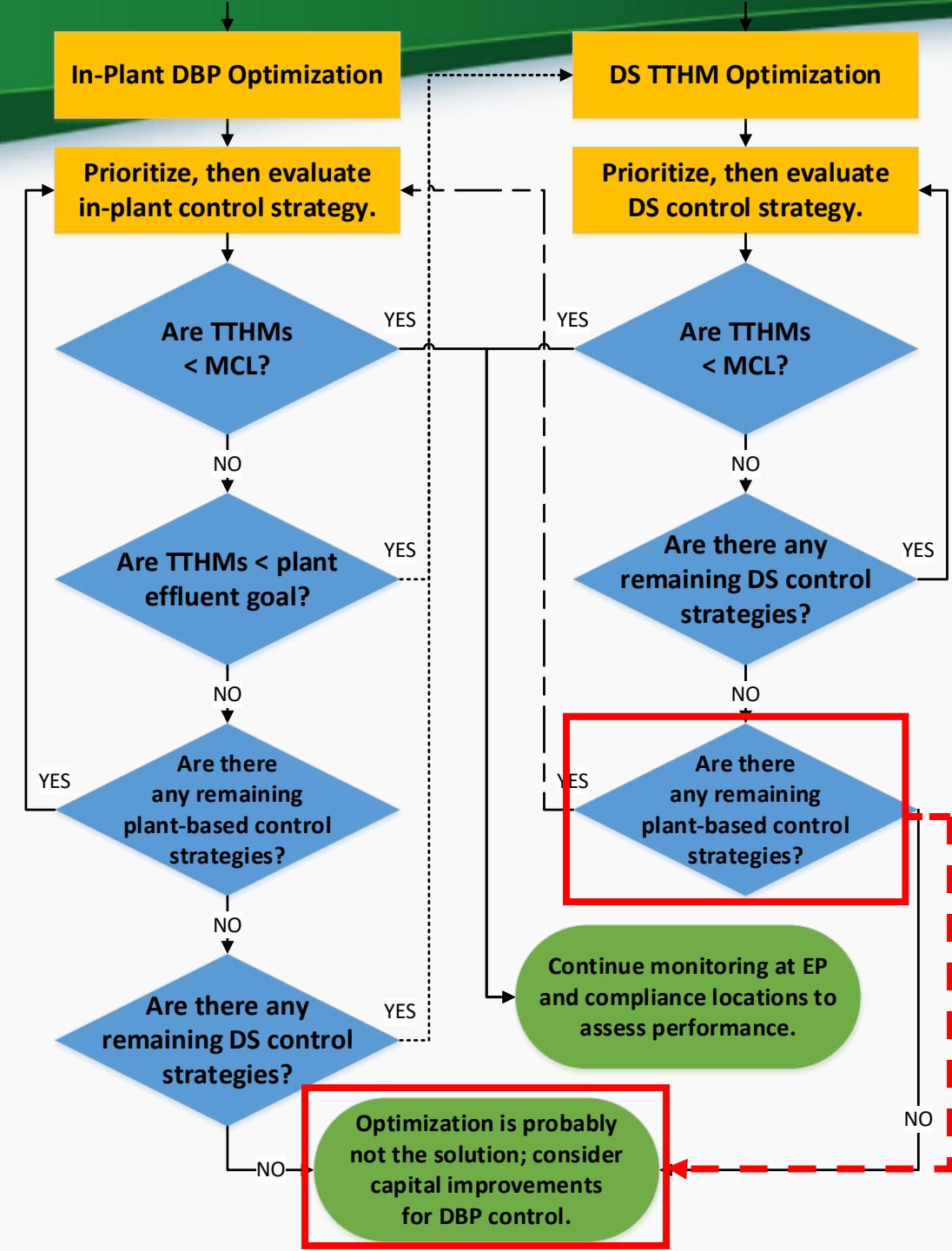
Evaluating DS Control Strategies

- After implementing a DS strategy, assess whether TTHM @ MRT < MCL
 - YES → continue monitoring to assess impact of optimization efforts
 - NO → continue to the next DS strategy
- If DS strategies are exhausted or not applicable, look at in-plant strategies (if applicable)



Final Steps

- If goals are not met after all plant and DS control strategies are evaluated, optimization may not be a viable solution.
- Optimization efforts and data will support the process of identifying and implementing any capital improvements.



Questions?

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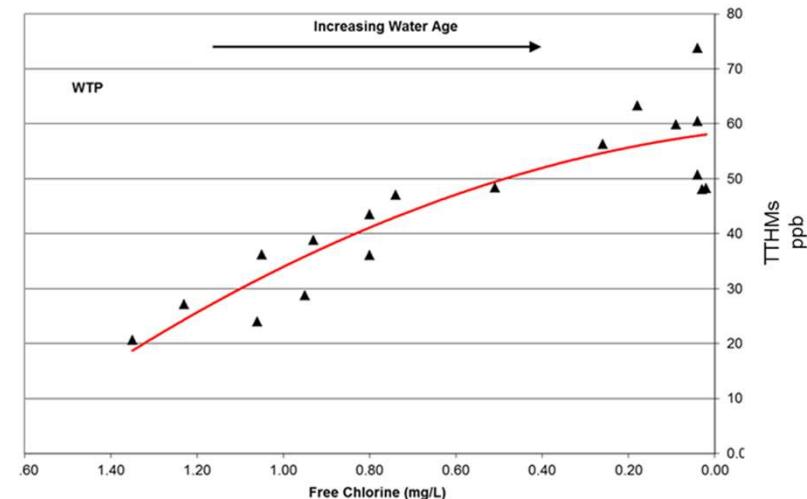
Distribution System Influent Hold Study

Paul Handke
Bureau of Safe Drinking Water



Outline

- What is a Hold Study
- Hold Study Approach
- Application of the Hold Study to Support Optimization Efforts to Reduce DBPs



What is a DS Influent Hold Study

- DS influent water samples are collected and held for a period of time before analysis.
 - Duration is based on study objective
 - Measures disinfectant decay and/or DBP formation in the bulk water
 - Does not assess pipe wall reactions.

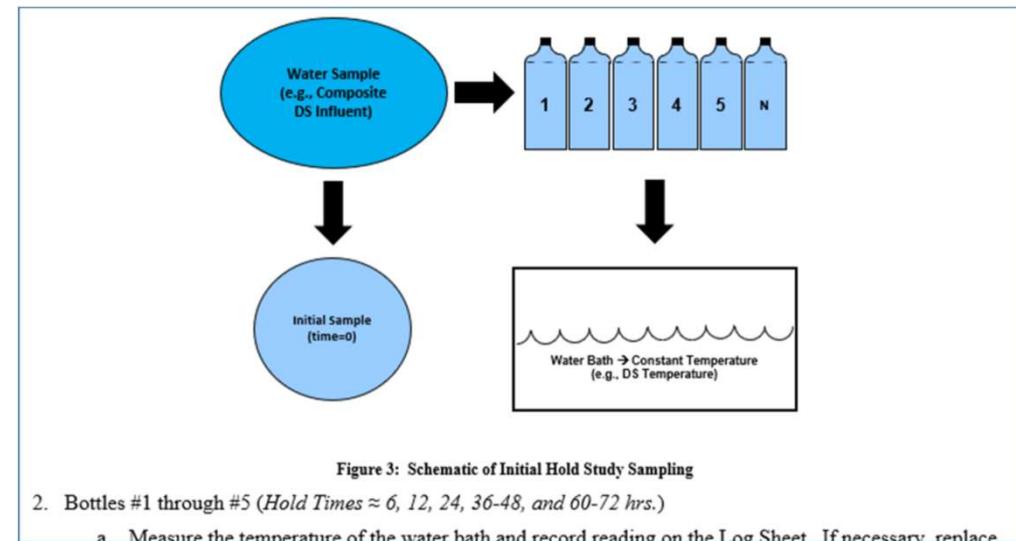


What is a DS Influent Hold Study

- Study assesses water stability
 - “Reactive” plant effluent or entry point water may suggest inefficient treatment or a need for additional treatment
 - “Reactive” is subjective based on system regulatory compliance and goals
 - Stability will vary by season, source water quality, etc.
 - What is “acceptable” depends on system needs, but consider
 - How quickly a disinfectant residual is lost
 - How quickly DBP formation reaches a compliance level or system or optimization goal

What is a DS Influent Hold Study

- Results will help prioritize optimization efforts.
- Study protocol and spreadsheet available to support this effort.





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Hold Study Approach



Equipment

- Water Quality Analysis Equipment
 - Colorimeter with reagent (free and/or total chlorine)
 - pH meter
 - Thermometer
 - Sample vials for DBPs, TOC, bromide (if applicable) or other parameters of interest
 - Log sheet and spreadsheet



Equipment

- Amber glass bottles
 - PTFE lined open top caps
 - Quantity needed based on study duration
 - Volume based on sample analysis
- Prepare bottles chlorine-demand free
 - Fill each bottle with 10-20 mg/L chlorine solution ($\frac{1}{2}$ mL of 5.65-6% bleach per liter)
 - Soak bottles for at least 24 hours
 - Rinse bottles three times with DI water



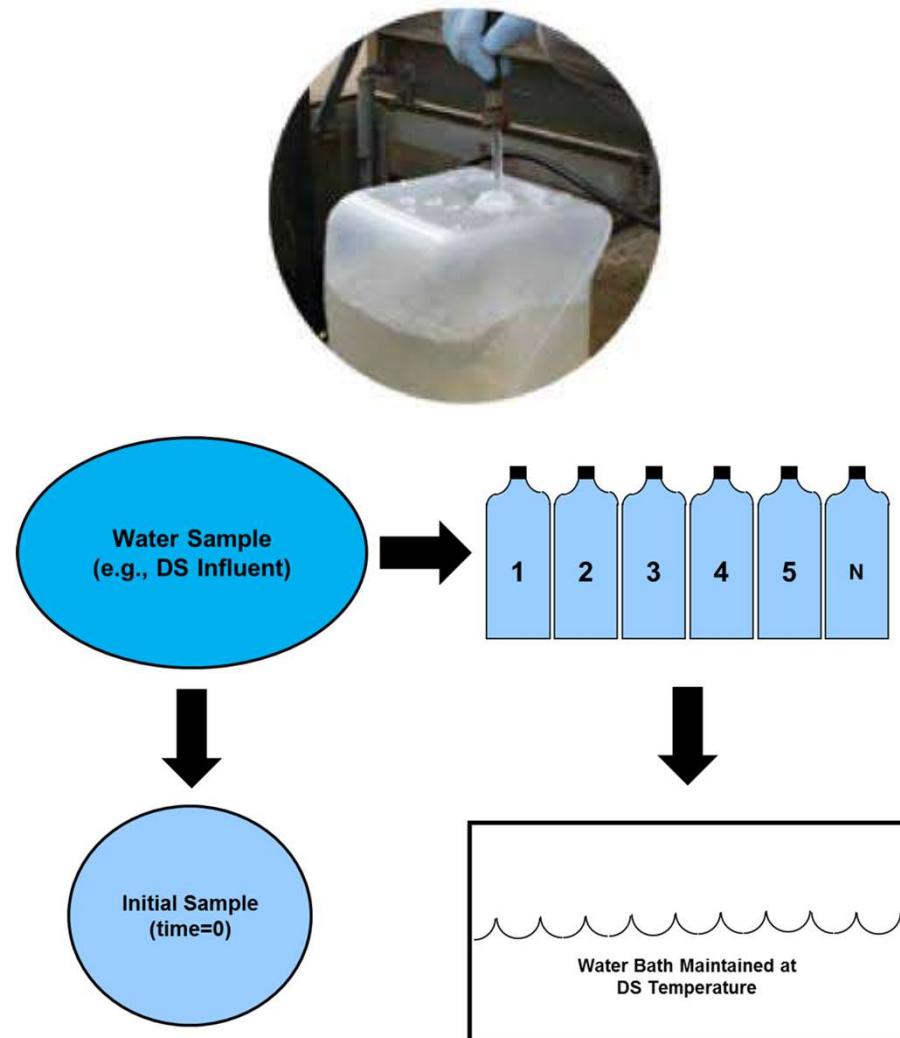
Equipment

- Water Bath
 - Used to maintain bottles at a constant temperature representative of DS
 - Various options:
 - Laboratory water bath or incubator
 - Container modified for continuous flow-through from cold water tap
 - Cooler filled with cold tap water that is periodically replaced to maintain a constant temperature



Initial Sampling Procedure

- Fill and cap bottles with water from DS influent
 - May need to collect sample in larger container first to homogenize, especially if near chlorine application point
- Collect initial sample ($t=0$) for water quality analysis directly from tap

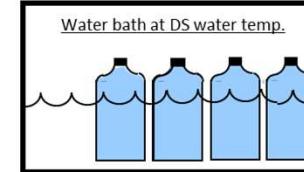


Initial Sampling Procedure

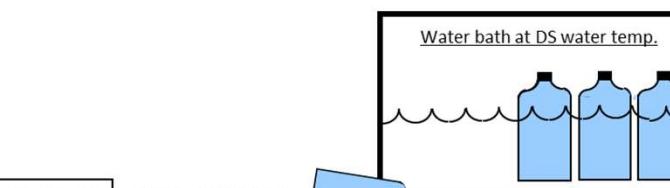
1. Measure water bath temperature
2. Collect DBP samples (if applicable)
3. Conduct water quality analysis for pH, temperature, total chlorine, and free chlorine or monochloramine (in duplicate)
4. Record all data.
5. Repeat these steps at the remaining designated sample times until the study is complete



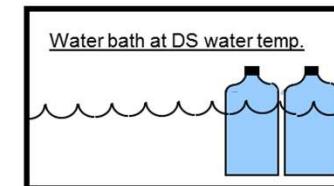
Bottle 1 Time ≈ 6 hrs.



Bottle 2 Time ≈ 12 hrs.



Bottle 3 Time = 24 hrs.



Data Analysis: Hold Study Spreadsheet

Distribution System Influent Hold Study Data Entry Worksheet

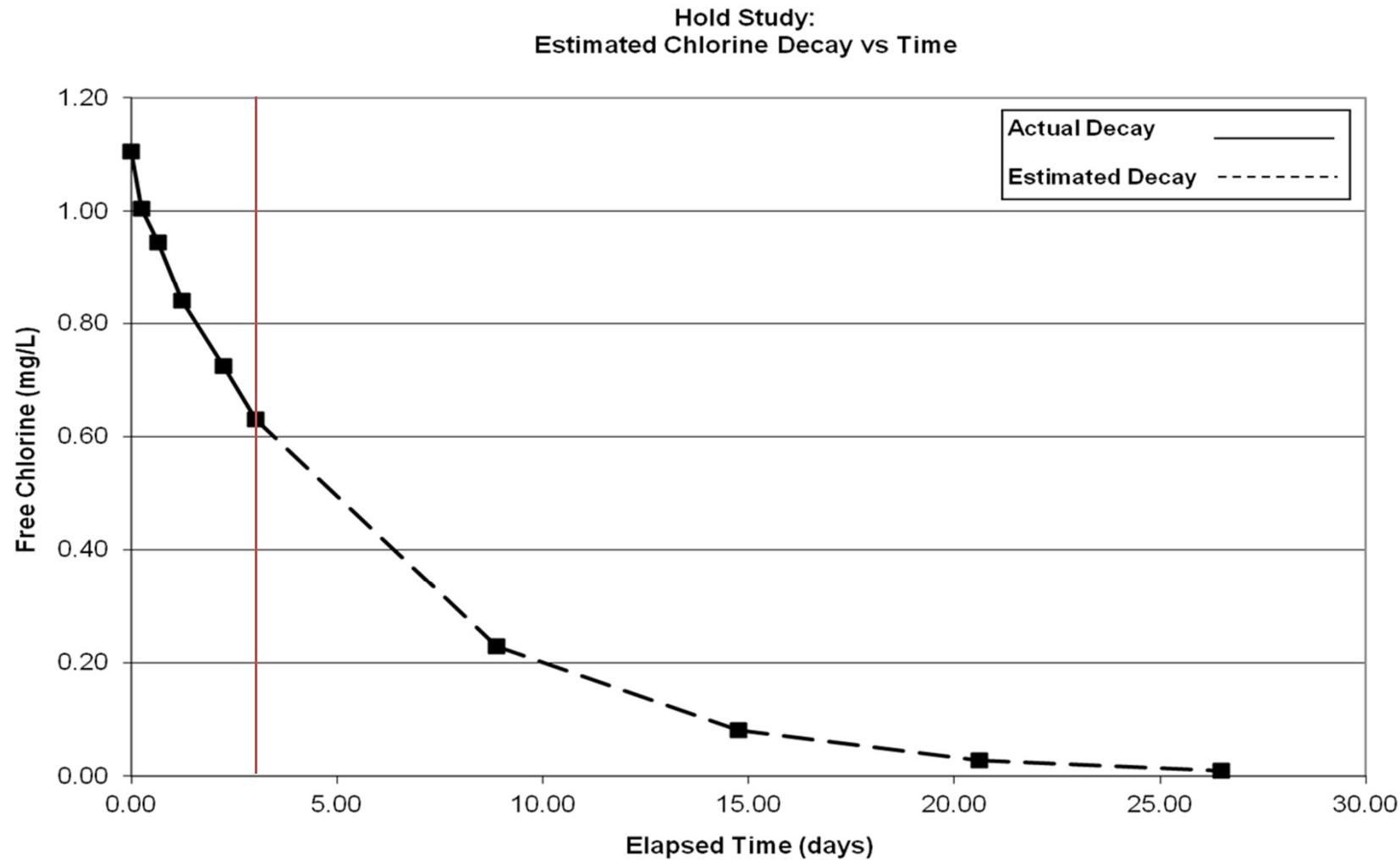
Enter data into red columns.

Raw Bromide	0.015	mg/L as Br
Raw Total Organic Carbon	2.5	mg/L as C
Finished Total Organic Carbon	1.5	mg/L as C

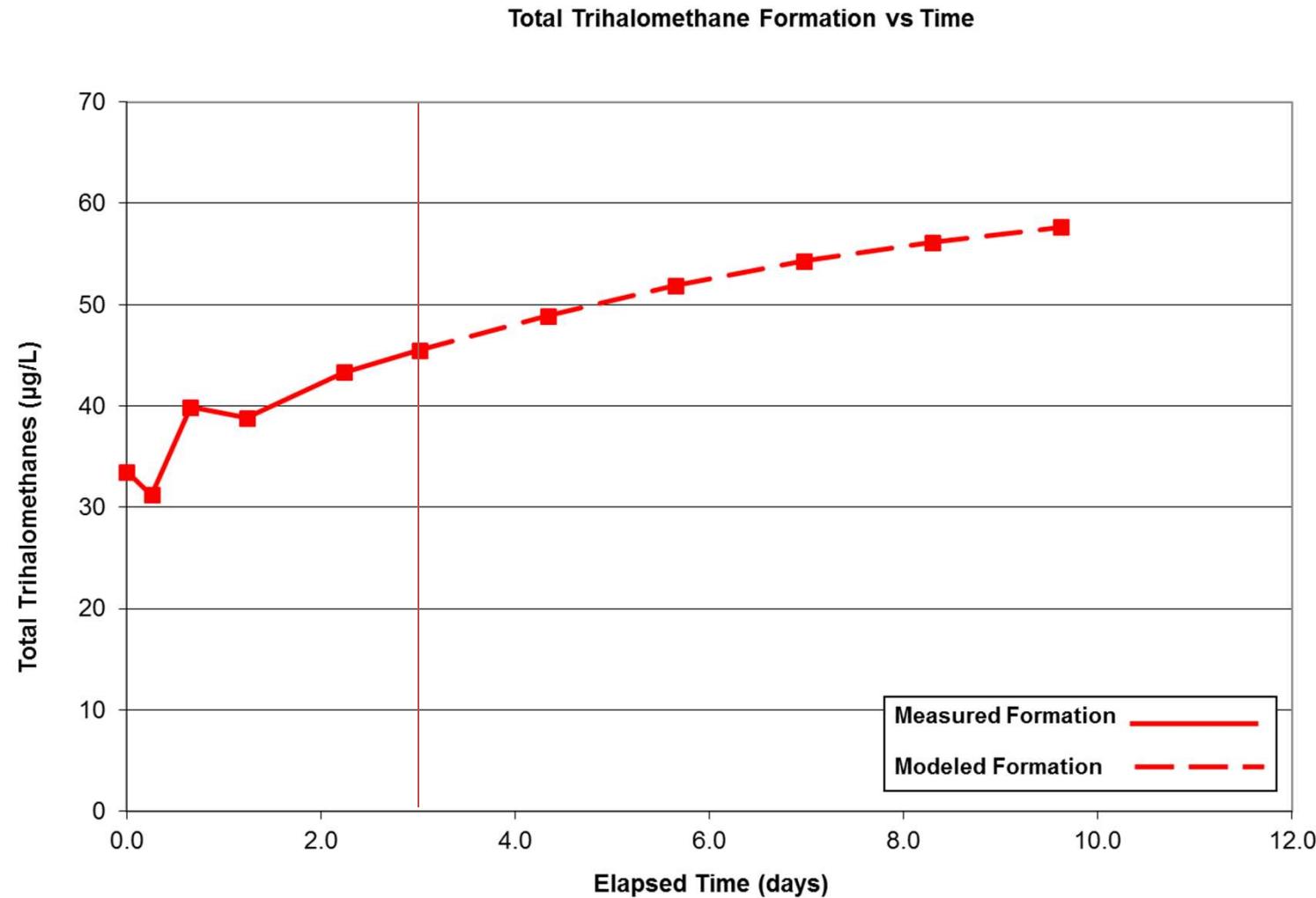
Target Free Chlorine Concentration at End of Study = 0.20 mg/L as Cl₂

Sample Identification	Sample Time & Date	Elapsed Time (days)	Free Chlorine #1 (mg/L-as Cl ₂)	Free Chlorine #2 (mg/L-as Cl ₂)	Avg. Free Chlorine (mg/L-as Cl ₂)	Chlorine Demand (mg/L-as Cl ₂)	Total Chlorine (mg/L-as Cl ₂)	Sample Temperature (°C)	Bath Temperature (°C)	pH	TTHM (µg/L)	HAA ₅ (µg/L)	Comments
													Comments
Initial Sample	9/28/09 15:45	0.0	1.12	1.09	1.11	0.00		19.4			33.5	20.3	Collected initial bottle samples from 3:35 to 3:45 PM (after first attempt when "slug" of rusty water came through.)
Bottle #1	9/28/09 22:00	0.3	1.01	1.00	1.01	0.10		22.5	22.7	7.23	31.2	28.6	
Bottle #2	9/29/09 7:30	0.7	0.94	0.95	0.95	0.16		22.6	7.22	39.9	31.9		
Bottle #3	9/29/09 21:30	1.2	0.84	0.84	0.84	0.27		21.9	22.3	7.58	38.8	32.9	
Bottle #4	9/30/09 21:30	2.2	0.72	0.73	0.73	0.38		21.6	21.8	7.42	43.3	33.9	
Bottle #5	10/1/09 16:05	3.0	0.63		0.63	0.48		21.9	21.8	7.87	45.5	36	pH meter read 8.10, 7.94, 7.87
"Model Predicted" Bottle #6		4.3			0.51	0.59				48.9			
"Model Predicted" Bottle #7		5.7			0.40	0.70				51.9			
"Model Predicted" Bottle #8		7.0			0.32	0.79				54.3			
"Model Predicted" Bottle #9		8.3			0.25	0.85				56.2			
"Model Predicted" Bottle #10		9.6			0.20	0.91				57.6			

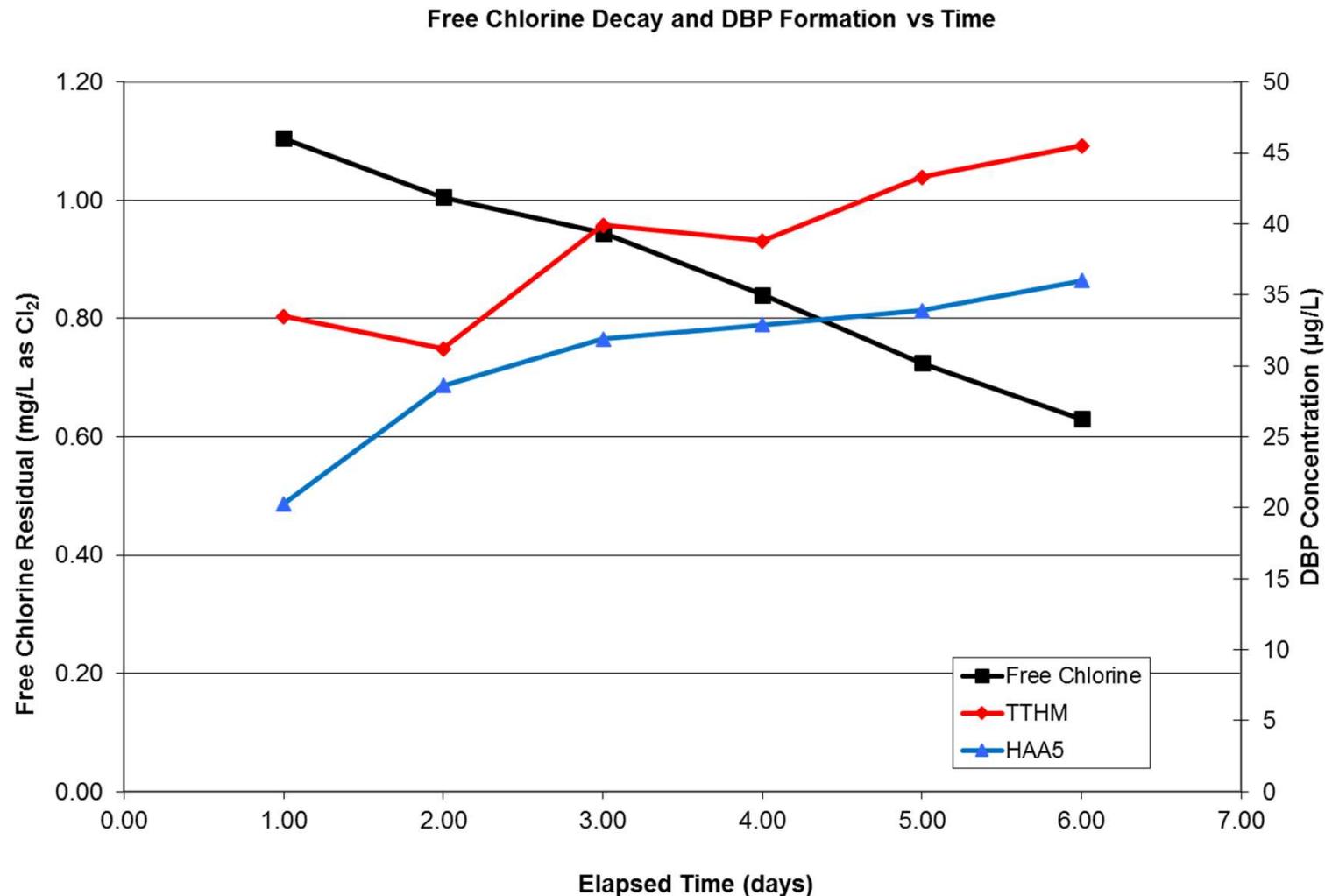
Data Analysis: Hold Study Spreadsheet



Data Analysis: Hold Study Spreadsheet



Data Analysis: Hold Study Spreadsheet





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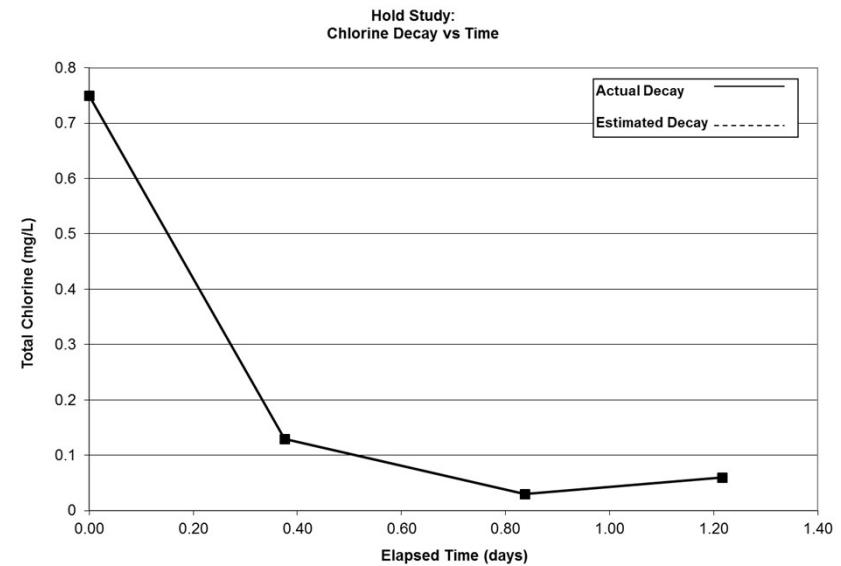


Application of the Hold Study to Support DBP Optimization



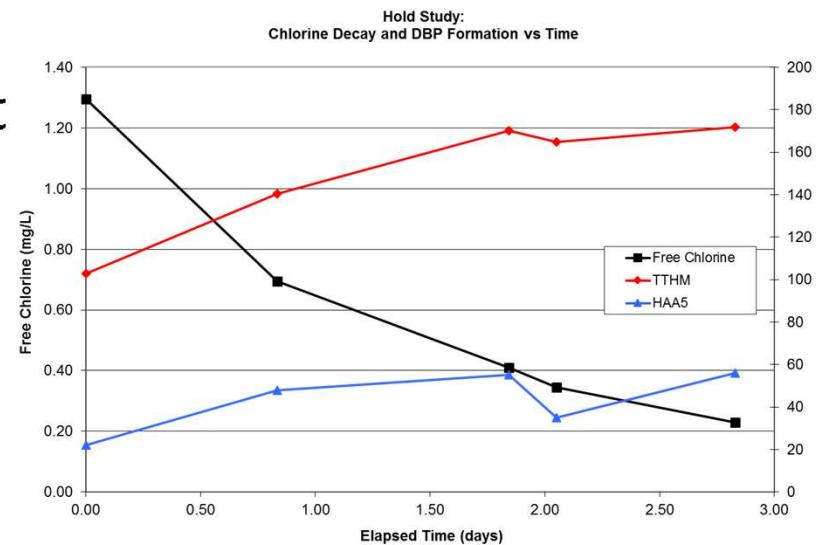
Disinfectant Stability

- Estimate the stability of disinfectant residual in the bulk water (in bottles)
- **Reactive (or very unstable) plant effluent water may require treatment optimization or upgrades**

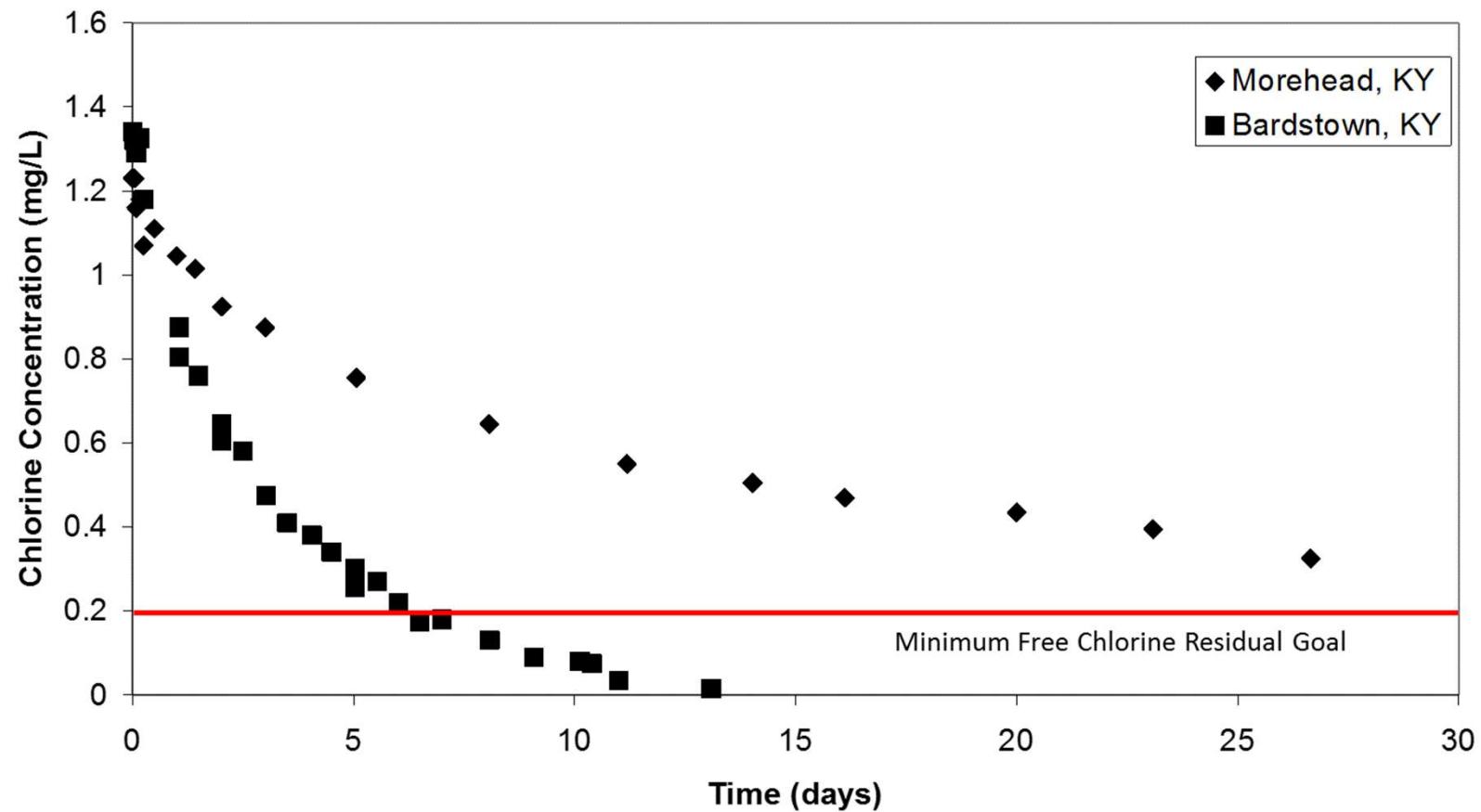


Disinfectant Stability

- Reactivity will vary, but consider:
 - Is the water quality (disinfectant residual level) entering the system adequate to meet residual goals?
 - How long can the water age (in bottles) and still meet the goal?
 - How quickly are DBPs forming (i.e., when is the compliance level reached/exceeded)
 - DS conditions will likely have a greater impact on degradation



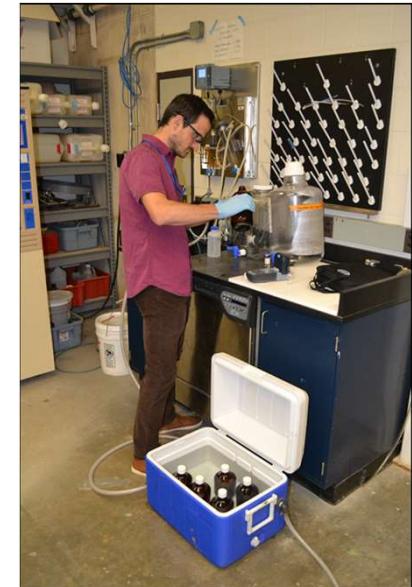
Reactivity of Different Waters



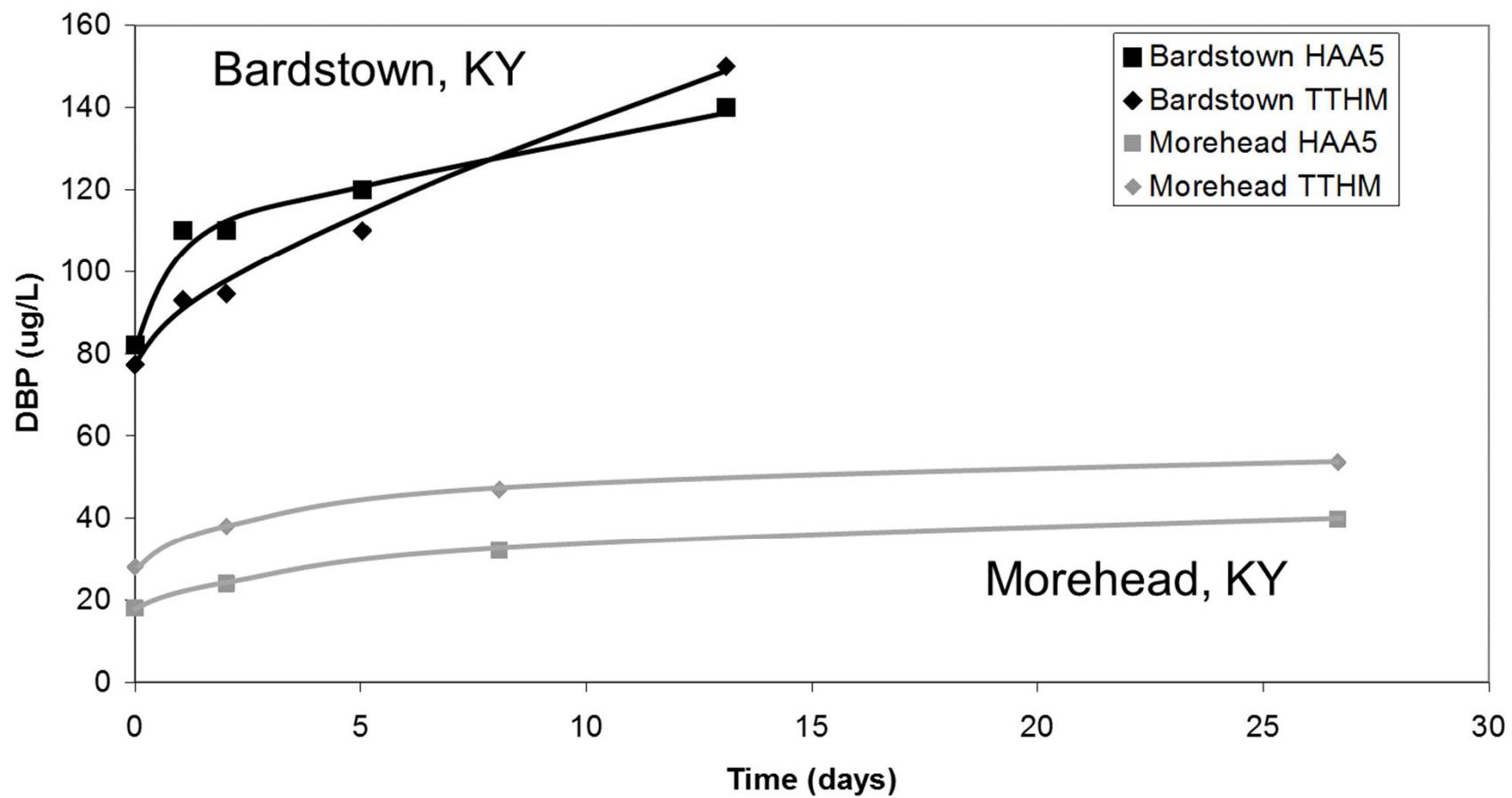
*Courtesy of EPA TSC, Cincinnati, OH

DBP Formation Potential

- Assess maximum TTHM and HAA5 formation potential of the bulk water
 - Run hold study until disinfectant residual is zero
 - Ensure that plenty of bottles are filled at the start of the study
 - May not be representative of *worst case* conditions
 - Can provide clues about potential HAA biodegradation



Reactivity of Different Waters



*Courtesy of EPA TSC, Cincinnati, OH

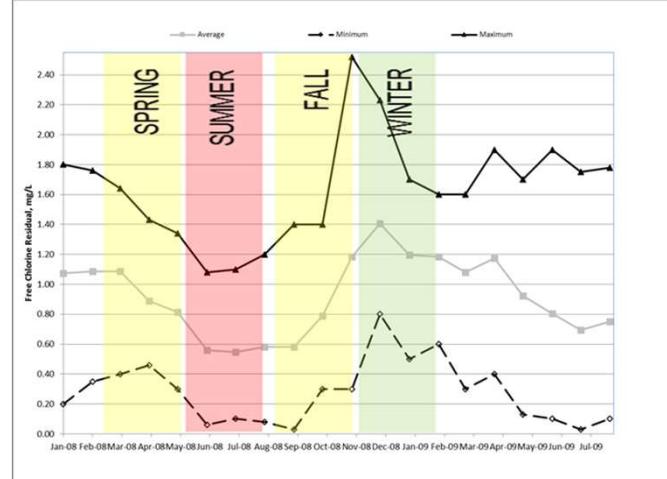
Reactivity of Same Water / Different Treatment

- Treatment plants and techniques vary:
 - Pre-Treatment
 - Oxidation
 - Coagulation / Flocculation
 - Sedimentation
 - Filtration
 - Post-Filtration
 - pH Adjustment
 - Disinfectant Type
 - Dosing Strategies

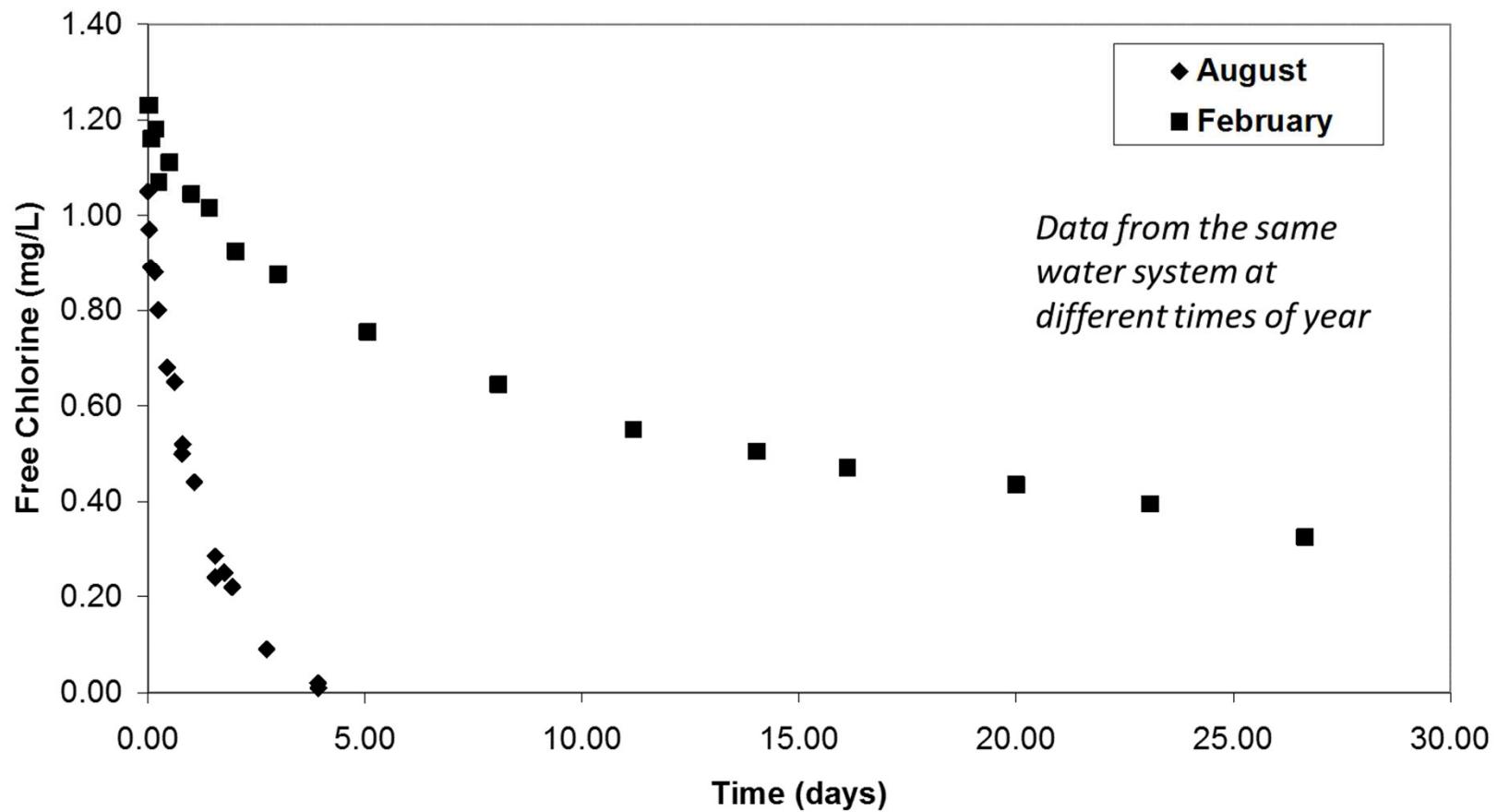


Seasonal Variability

- Assess seasonal impacts on water quality when repeated throughout the year
 - Information helps systems be proactive
 - Operational strategies related to treatment and/or the distribution system may be implemented in anticipation of seasonal changes

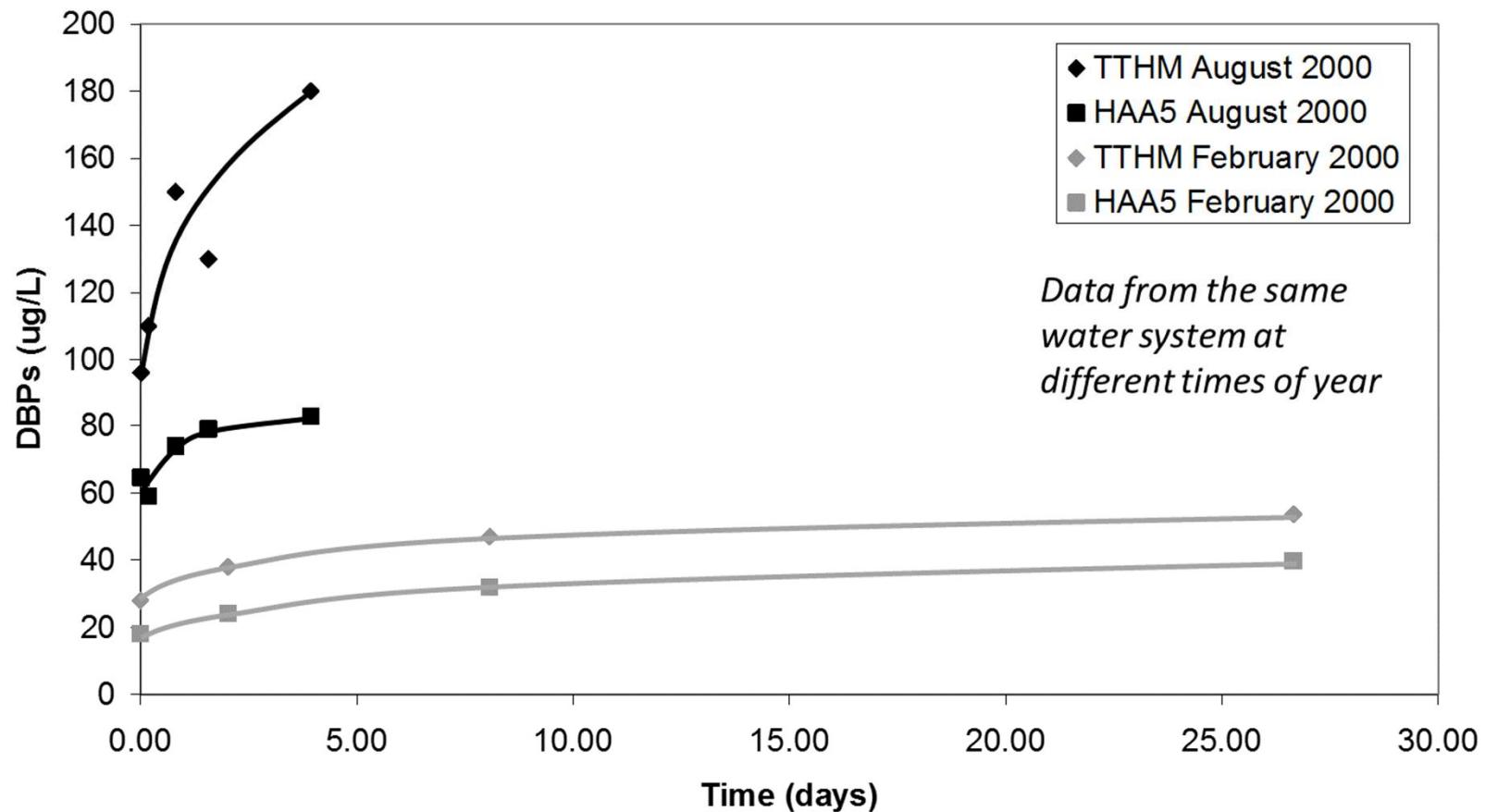


Seasonal Variability



*Courtesy of EPA TSC, Cincinnati, OH

Seasonal Variability



*Courtesy of EPA TSC, Cincinnati, OH

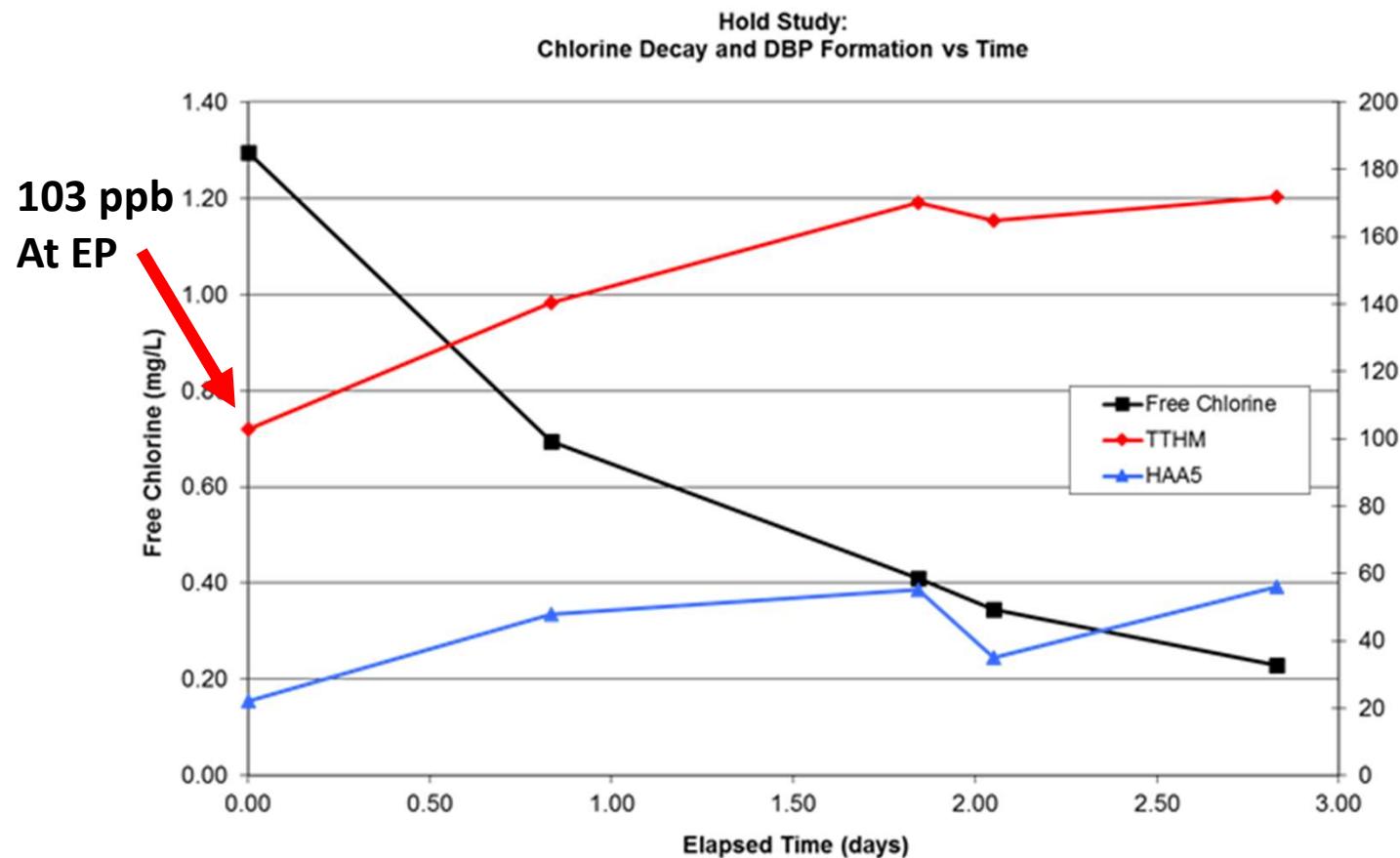
Advanced Studies

- Process control tool to assess potential treatment changes
- Hold study and DS data may be used to estimate water age in the DS, but remember:
 - High water age is system-specific (e.g., 5-day old water may be a concern in one system, but not another)
 - DS conditions may exert additional chlorine demand or contribute DBP precursors (e.g., biofilms, oxidation of pipe materials, pipe and tank sediments, etc.)



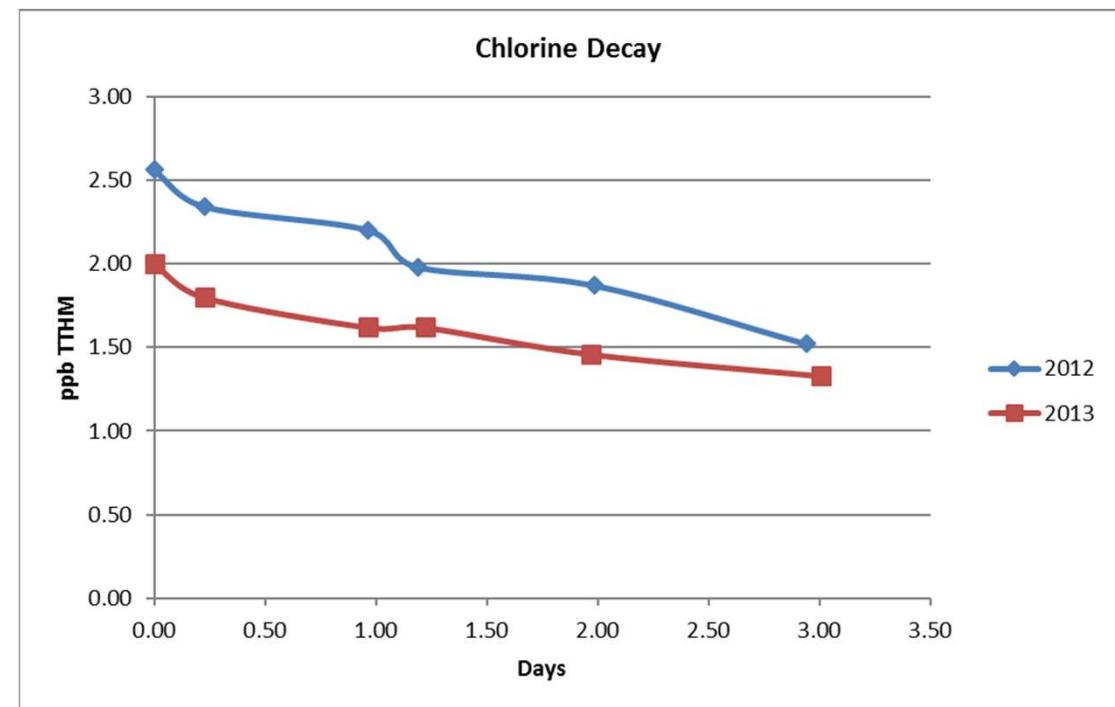
Target Optimization Efforts

- Plant or Distribution System Optimization?



Access Operational Changes

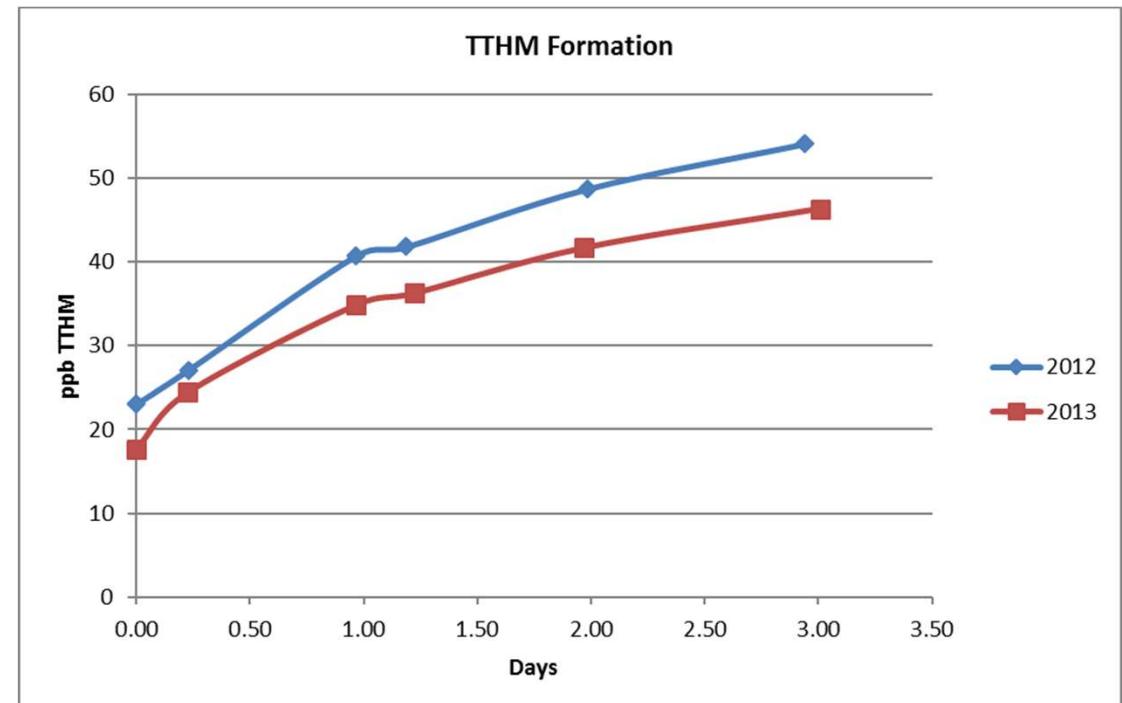
- System in NC PA evaluated the impact of reducing WTP effluent Cl₂ residual by approximately 0.5 mg/L



- Reservoir source

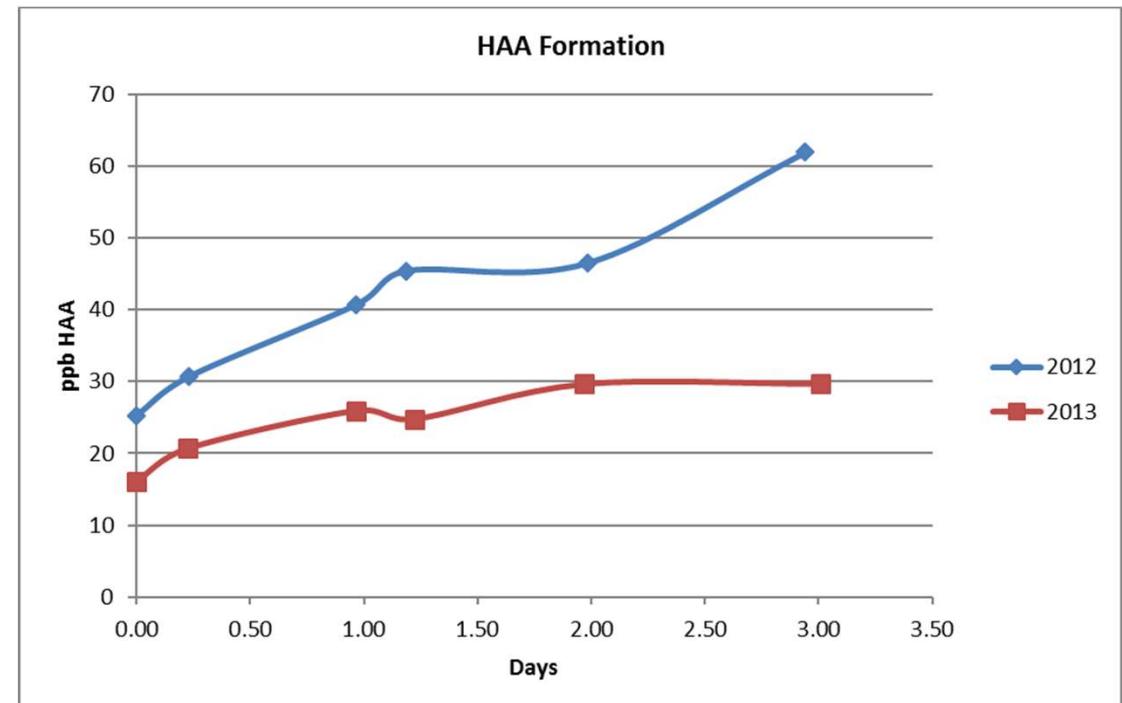
Access Operational Changes

- Reducing WTP effluent Cl₂ from 2.5 to 2.0 mg/L appeared to decrease TTHM formation



Access Operational Changes

- Reducing WTP effluent Cl₂ from 2.5 to 2.0 mg/L appeared to decrease HAA formation





Bureau of Safe Drinking Water



Thank You!

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Diagnosing DBP Formation: An Approach to Prioritize Optimization Efforts

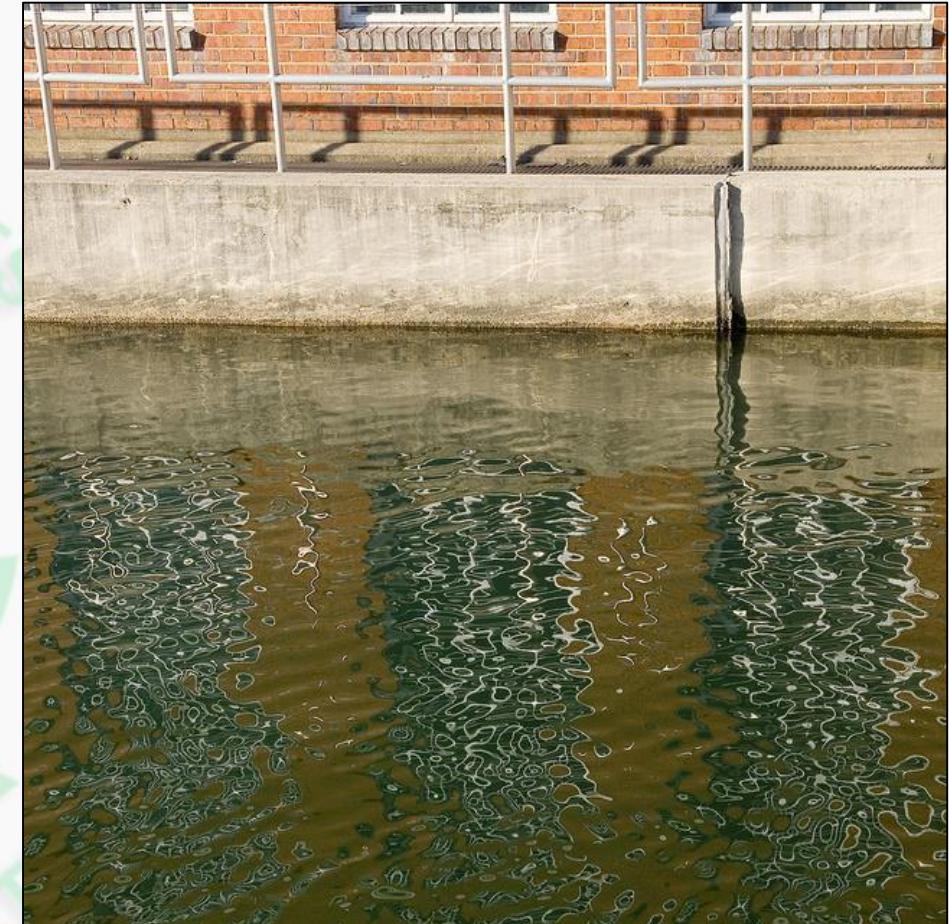
David Pratt

U.S. Environmental Protection Agency

Region 7

Characterizing DBP Formation

- DBP formation is affected by various factors (e.g., pH, time, temperature, disinfectant dose, precursors)
- Strategies to control DBP formation vary from system to system
- Characterizing where DBP formation occurs [i.e., water treatment plant (WTP), distribution system (DS), or both] can help prioritize control strategies



Diagnostic Monitoring Study

- In Kansas, from 2013 to 2017, there were ≈398 violations of the Stage 1 & 2 Disinfectants and Disinfection Byproducts Rules (DBPRs) at 188 systems
- EPA and the Kansas Department of Health and Environment (KDHE) have partnered to characterize total trihalomethane (TTHM) formation at several of those systems
- Participants included groups of parent and consecutive systems with history of non-compliance with DBPRs or operational evaluation level (OEL) exceedances



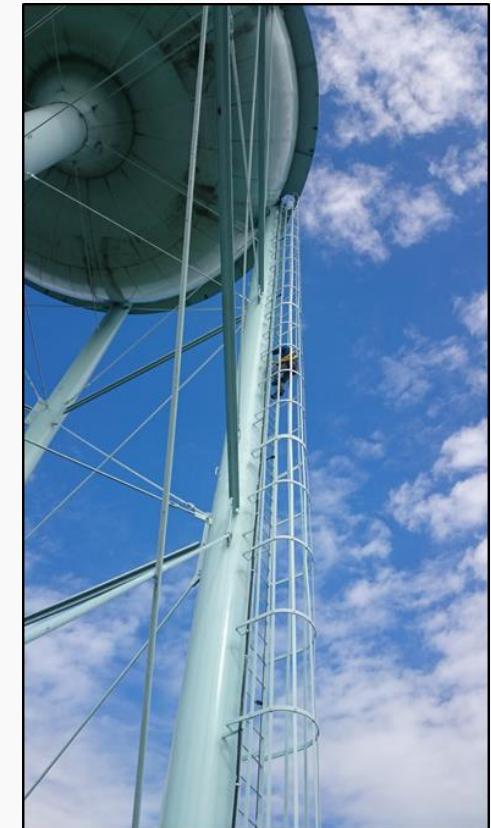
Diagnostic Monitoring Study (cont.)

- Utilized EPA Region 7 and KDHE labs for analysis
- Information from this study will be used by KDHE to direct targeted technical assistance at each system
- Supports EPA's Priority Goal of reducing non-compliance with health-based standards in community water systems by 25 percent by the year 2022



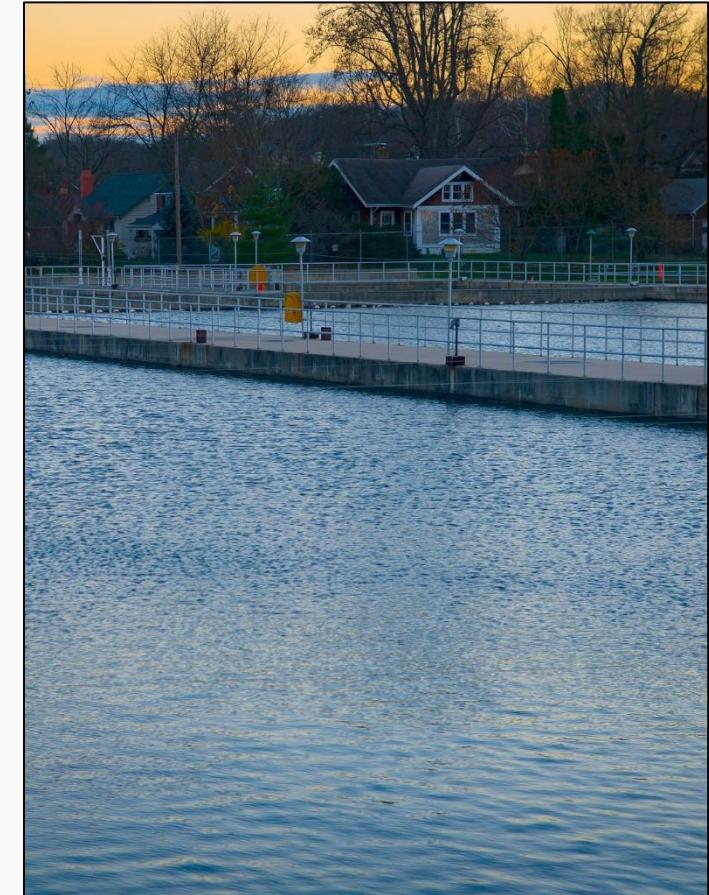
Study Approach

- Collected samples from the DS entry point (EP), maximum residence time (MRT) site, and other critical sites (e.g., storage tanks) from each system
- Samples included TTHM and disinfectant residual (free or total chlorine)
- Three rounds of sampling were completed, each 2-3 months apart
- Results were assessed to determine where TTHM formation was occurring (e.g., WTP, DS, parent system)



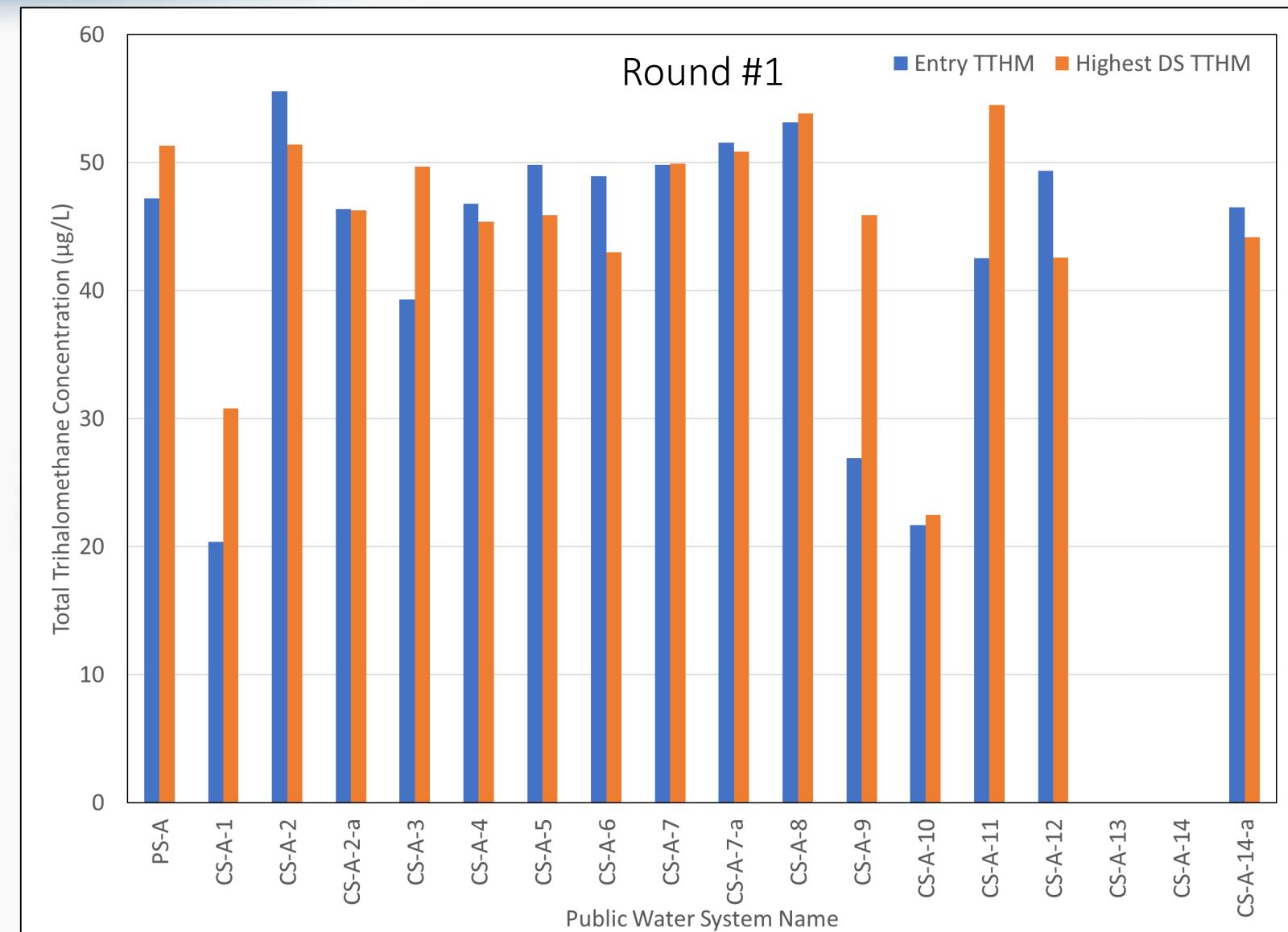
Study Results

- A total of seven parent and 36 consecutive systems participated in one or more rounds of sampling
- Data from each “family” of water systems were compiled (i.e., parent and group of consecutive systems supplied)
- Results from a few families of systems are shown on the following slides
- Note the labeling convention on the x-axis on the following slides:
 - “System Type (PS = parent, CS = consecutive)”-“System Family”-“System Number”-“Consecutive of Consecutive System (if applicable)”
 - *Example:* CS-A-1 is consecutive system #1 in system family A



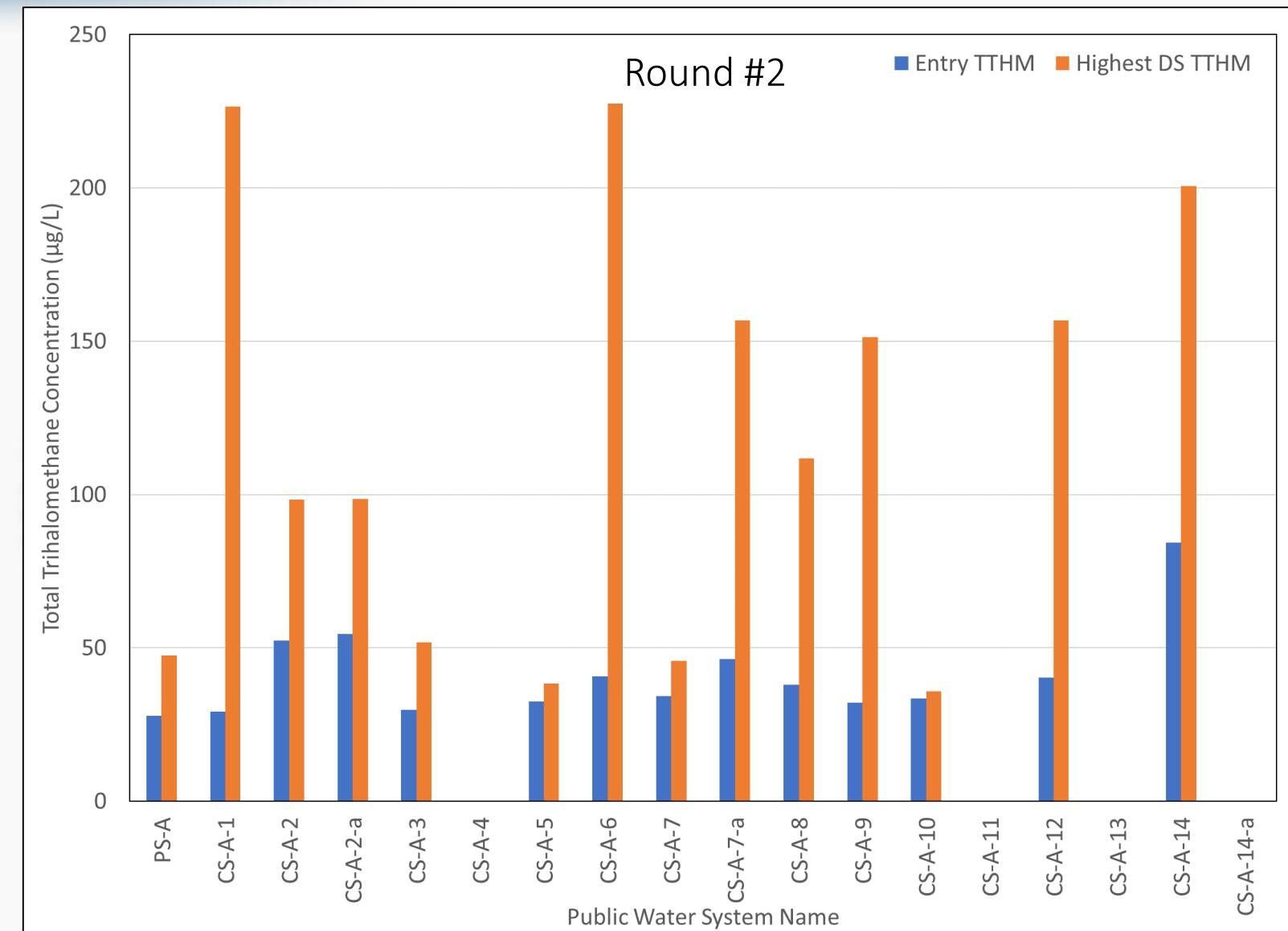
System Family A

- One parent system and 17 consecutive systems participated in study
- Surface water source
- All systems used chloramines during Round #1
- Results suggest that TTHM formation was relatively low in DS



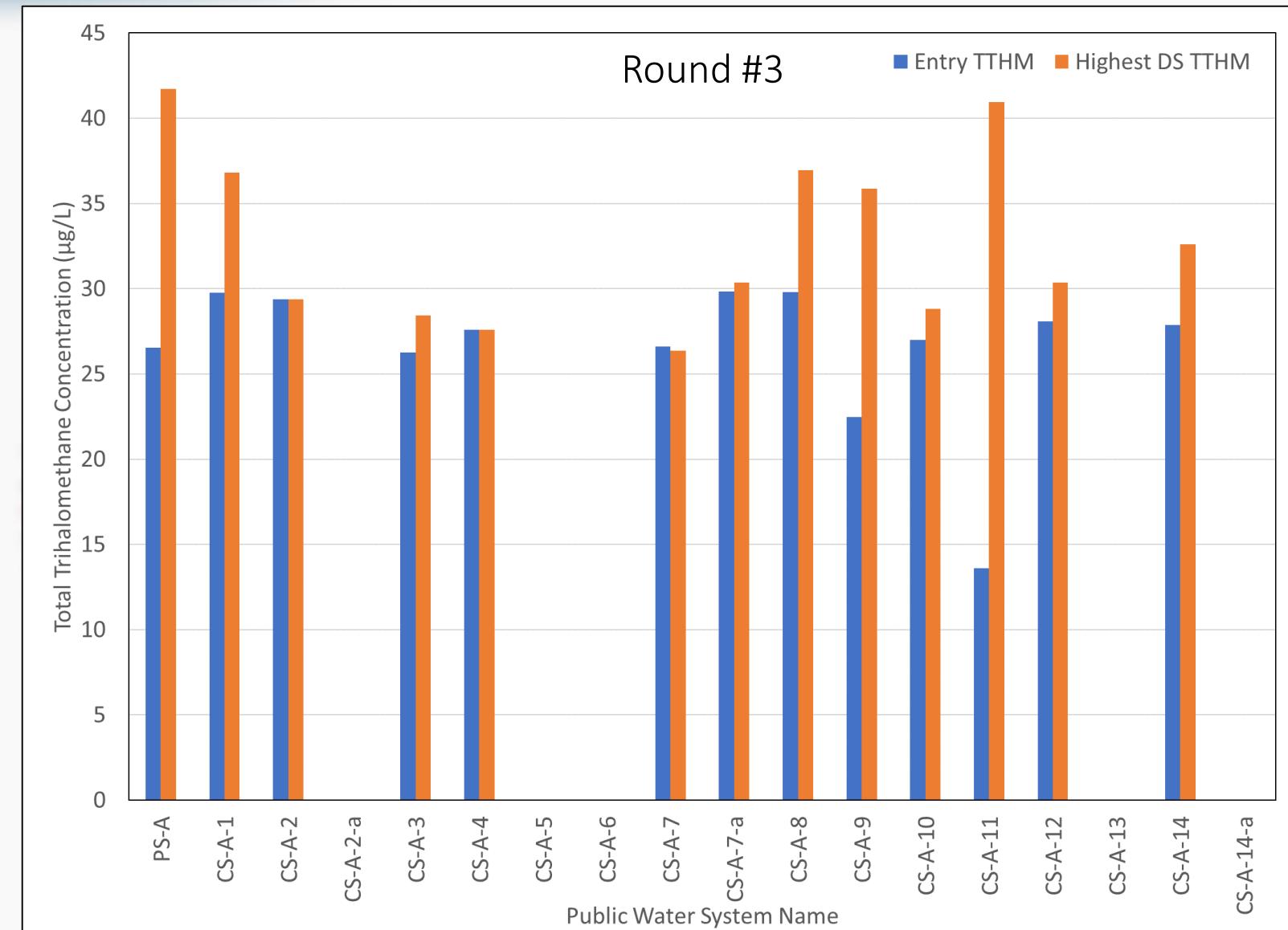
System Family A

- Parent System A concluded a free chlorine conversion prior to Round #2
- Results suggest that TTHM formation was considerably higher in the DS while using free chlorine
- If free chlorine use continued, data suggests DS optimization approaches would be needed to reduce TTHM levels



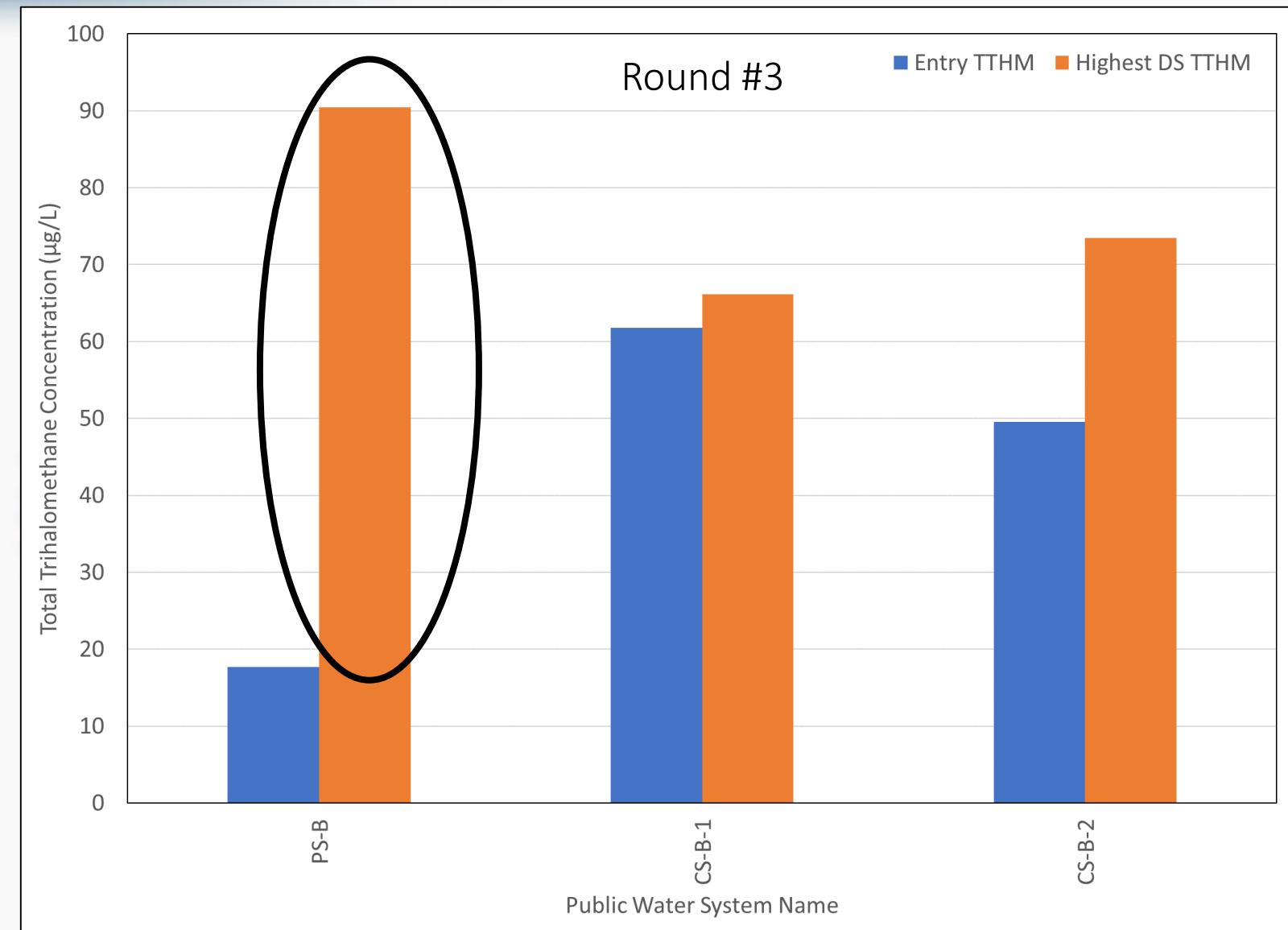
System Family A

- All systems utilized chloramines during Round #3
- Results from Rounds #1 and #3 suggest that participating systems do not have TTHM compliance issues during “normal” operation
- WTP Optimization approaches may be pursued to further reduce TTHM levels



System Family B

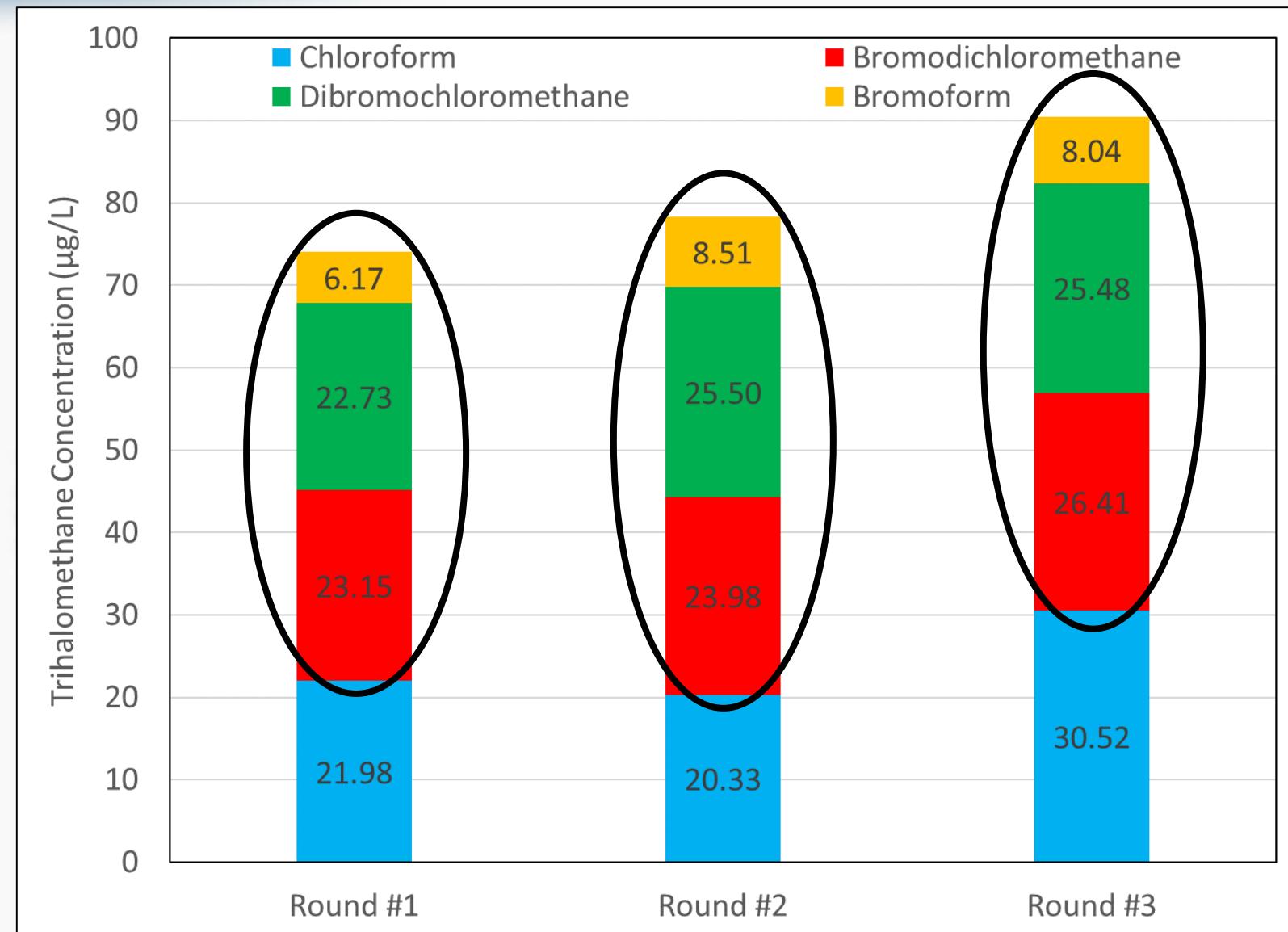
- One parent system and two consecutive systems participated in study
- Groundwater source
- All systems used free chlorine
- Majority of TTHM formation occurred in parent DS
- Results from each round were similar



System Family B

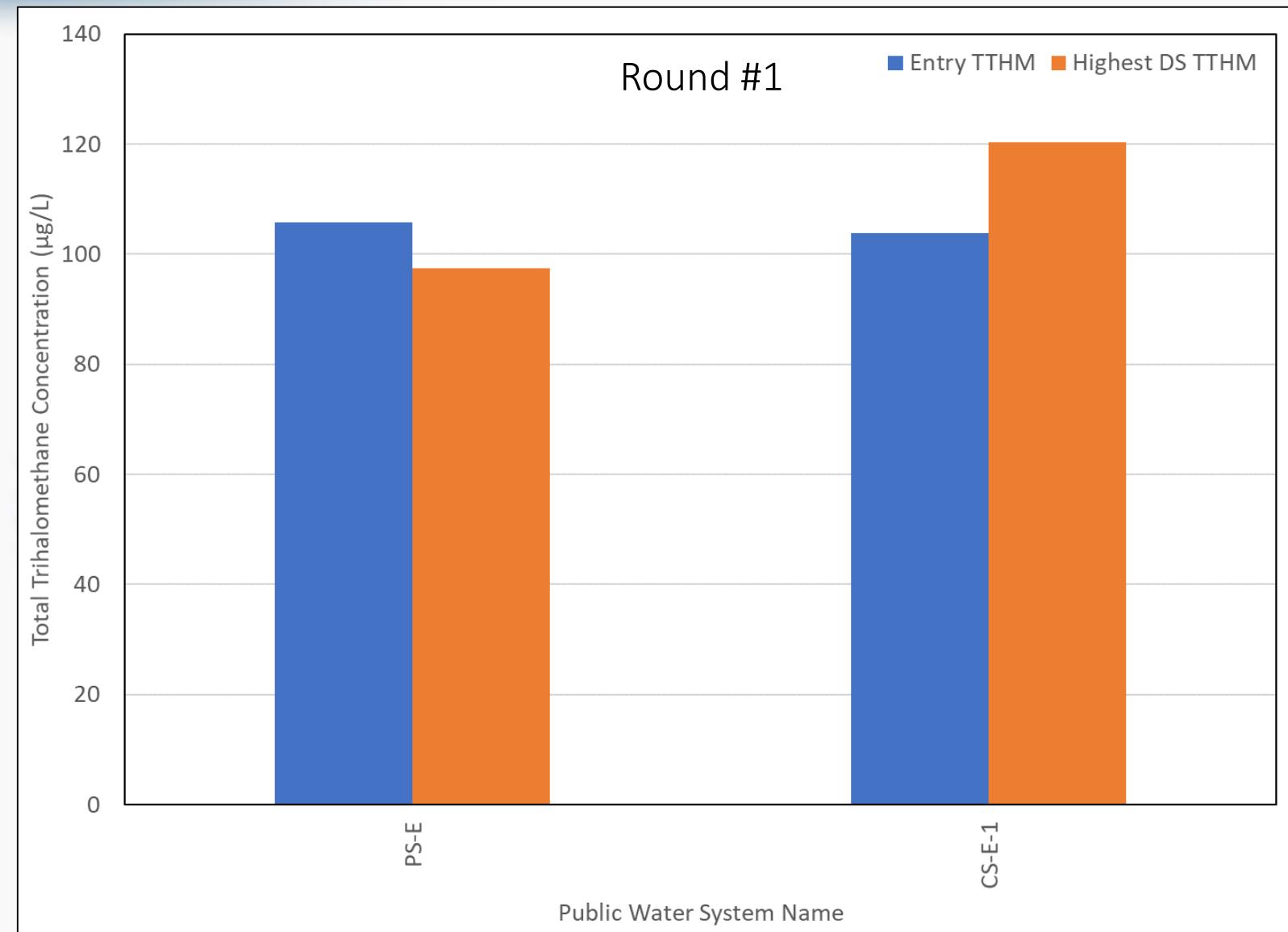
- Groundwater systems typically are not challenged by TTHM formation
- Individual THM species data were reviewed
- Relatively high levels of brominated THMs were found
- Elevated bromide levels in source water may be the cause
- Additional treatment of the current source may be necessary
- This system will not be able to reduce TTHMs through optimization

Highest DS THM Location



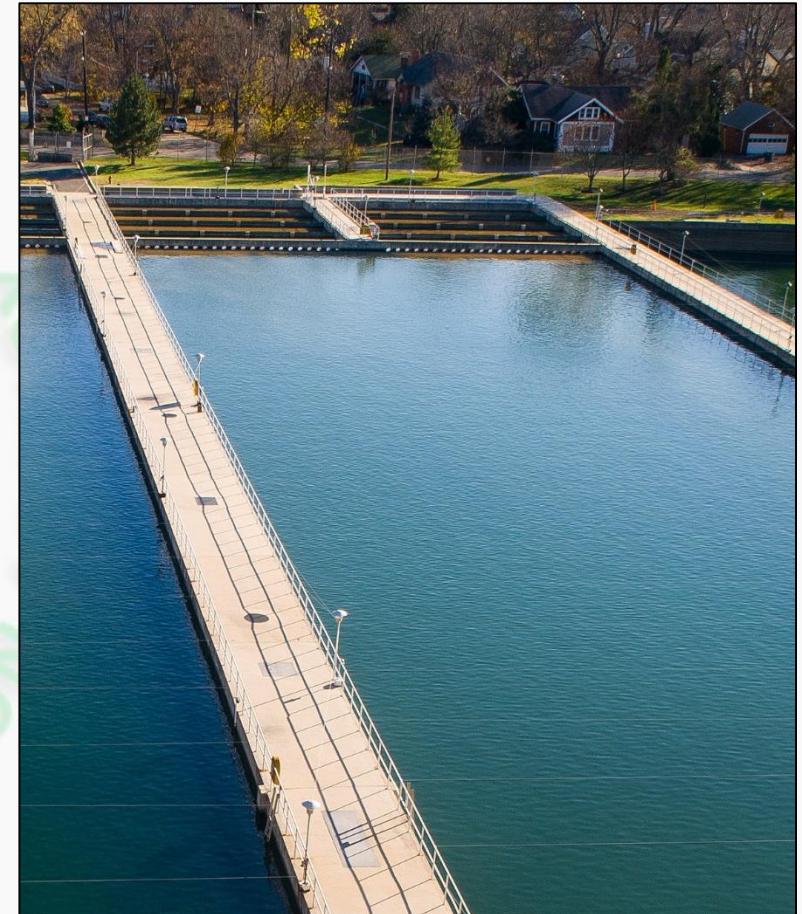
System Family E

- One parent serving one consecutive system
- Surface water source
- Both systems use chloramines
- Results suggest that majority of TTHM formation occurred in WTP
- Elevated TTHM results suggests that both systems may have compliance issues
- WTP optimization may be pursued to control TTHMs



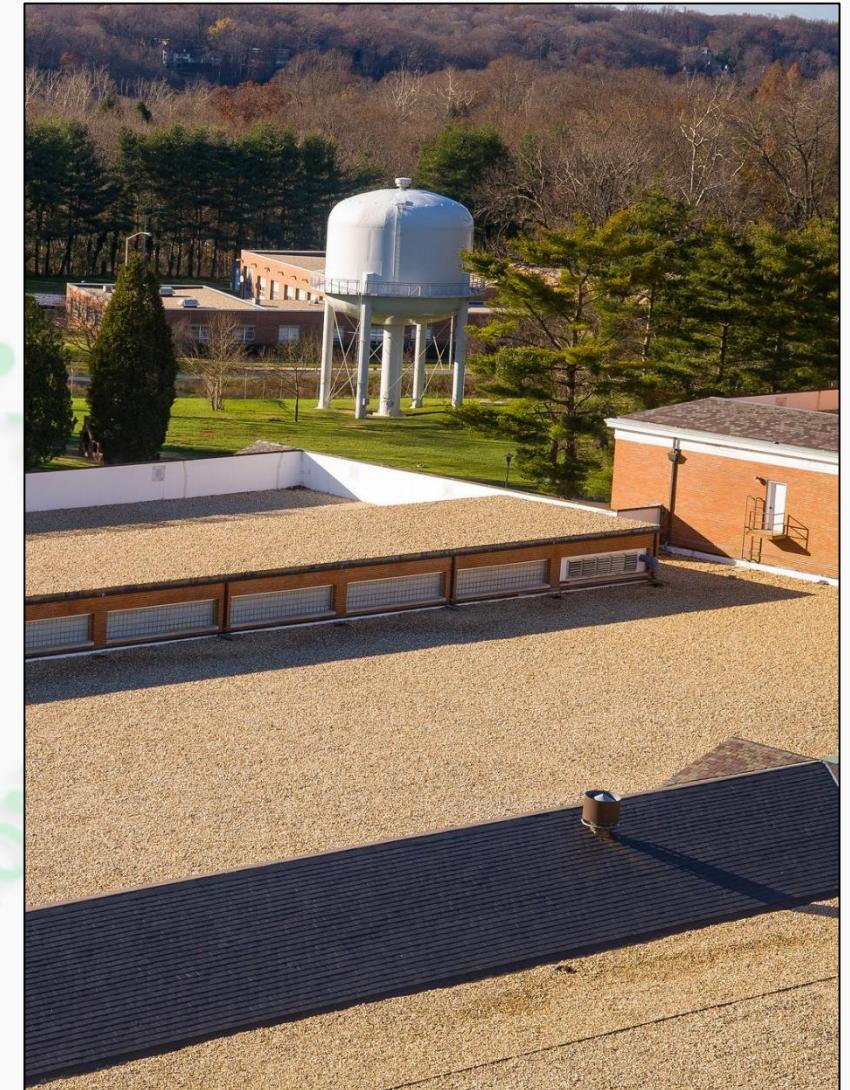
Potential Next Steps

- System Family A
 - If non-compliant, consider DBP optimization control strategies in the parent system WTP
- System Family B
 - Conduct bromide monitoring in well prior to disinfection to confirm elevated bromide
 - Determine if there are alternative sources with lower bromide levels, consider chloramination, or evaluate treatment options
- System Family E
 - Evaluate DBP optimization control strategies in the parent system WTP prior to chloramination



Diagnostic Monitoring Summary

- Approach may be used to characterize where DBP formation occurs [i.e., water treatment plant (WTP), distribution system (DS), or both]
- Results can help prioritize optimization control strategies over potential capital improvements
- Provides valuable information that allows water systems to more efficiently apply resources





Questions?

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Reducing Disinfection Byproducts through Optimization

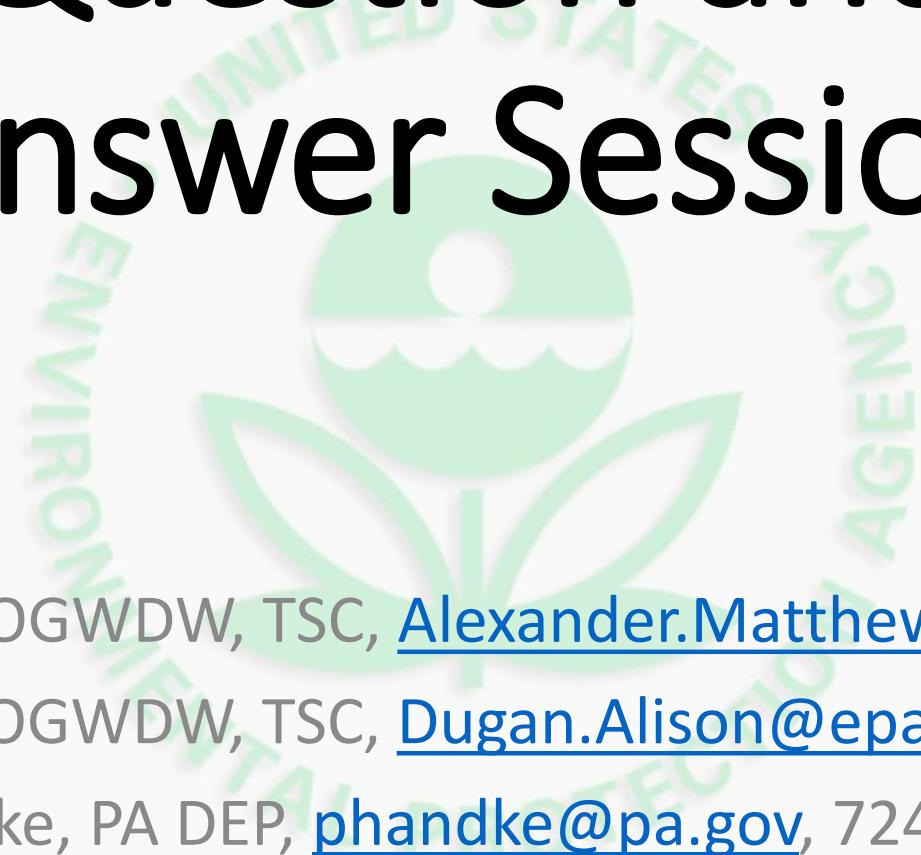
Webinar #1: DBP Optimization Process and Priority Setting

April 8, 2019

Webinar #1: Learning Objectives

- Understand the relevance of the webinar series and DBP optimization control strategies
- Understand the overall process for diagnosing DBP formation and evaluating DBP control strategies; resources include:
 - Presentation 1
 - Flowchart (*Process to Reduce DBPs through Optimization*)
- Presentations related to diagnosing DBP formation intend to:
 - Introduce the distribution system influent hold study approach to assess water quality stability
 - Demonstrate the application of diagnostic monitoring within systems to assess DBP formation

Question and Answer Session



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