TEXAS WEBCAST

TODD BREWER AND
BRIAN HAWS

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OUTLINE

- Introductions
- How Water Works
  - Basic Overview of Water Systems
  - Multiple Barrier Treatment Concept
- Distribution Systems
  - Key Performance Goals
  - Water Quality Parameters & Distribution System Health
  - Main Breaks & Cross Connections
- Partnership Overview
- TOP Overview
- Partnership and TOP Comparison
- Partnership for Safe Water:
  - Treatment Program
  - Distribution Program
  - Program Benefits and Takeaways
- Questions/Thoughts

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INTRODUCTIONS

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Managing Engineer
Process Engineering, Regulatory, and Lab Services Division, Austin Water

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WATER TREATMENT

These facilities feature advanced technology and employ a variety of **highly trained professionals**, including:

- Operations Technicians
- Maintenance Technicians
- I&C Technicians
- Process Engineers
- Control System Programmers
- Lab staff

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WATER DISTRIBUTION

- Water is transmitted from the plant to the customers tap through a network of pipes and storage tanks.
- Operations crews are on call 24 / 7 to ensure uninterrupted service.

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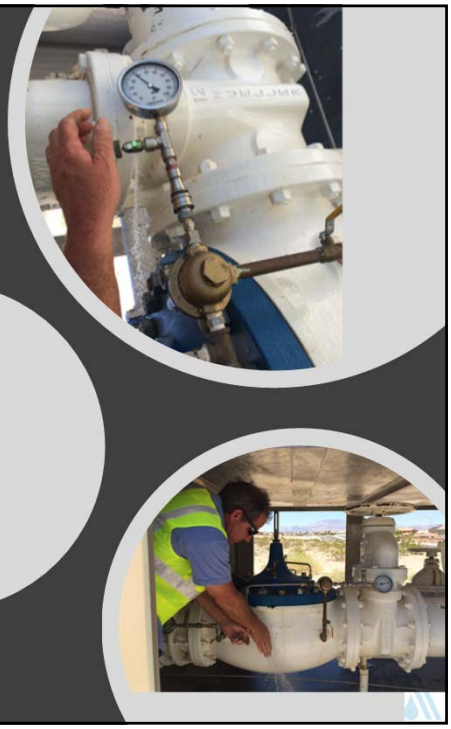
WATER SYSTEM MAINTENANCE

- A public water system has thousands of moving parts
- The durability and reliability of each infrastructure component varies
- Infrastructure Management professionals develop a strategy for timely replacement of infrastructure to minimize the potential for failure.



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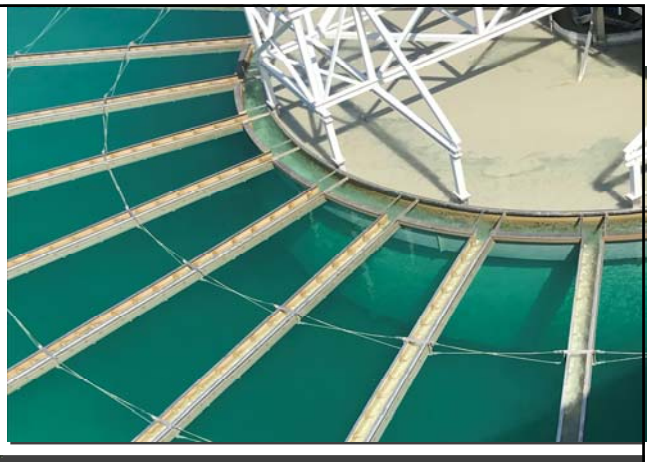

Water Treatment-Multiple Barriers

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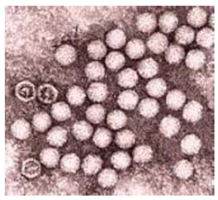
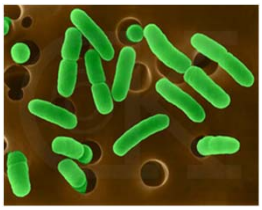
WHY DO WE NEED MULTIPLE BARRIERS?

- ***Any barrier can fail***
- Not all microbes are easily filtered (viruses)
- Not all microbes are disinfected by chlorine (e.g. Cryptosporidium)
- The cumulative effect of multiple barriers greatly reduces the likelihood of pathogens reaching the consumer

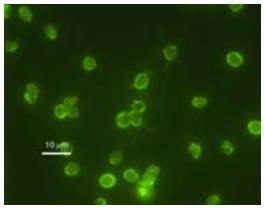
Viruses



Bacteria (e.g. *E. coli*)



Protozoa



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MULTIPLE BARRIER CONCEPT

- Source Water Protection
- Disinfection
- Coagulation, Flocculation, Sedimentation
- Filtration
- Distribution Practices

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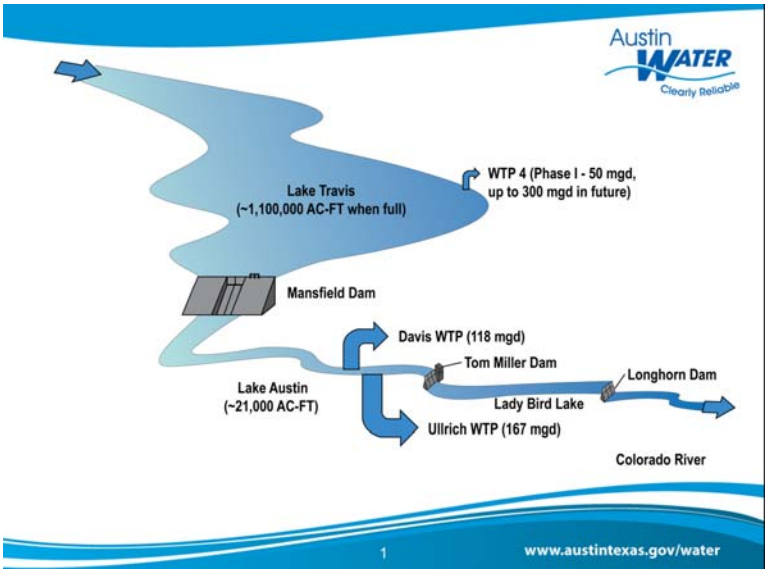
Water-From River TO TAP

Water makes **several stops** between the River and your tap.



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SOURCE WATER PROTECTION: STEPS OF ASSESSMENT

Step 1	Delineate the source water protection area (SWPA).
Step 2	Inventory known and potential sources of contamination.
Step 3	Determine the susceptibility of the PWS to contaminant sources or activities within the SWPA.
Step 4	Notify the public about threats identified in the contaminant source inventory and what they mean to the PWS.
Step 5	Implement management measures to prevent, reduce, or eliminate risks to your drinking water supply.
Step 6	Develop contingency planning strategies that address water supply contamination or service interruption emergencies.

EPA. 2019. "Basic Information about Source Water Protection." Accessed October 24, 2019. "https://www.epa.gov/sourcewaterprotection/basic-information-about-source-water-protection

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DISINFECTION

Goal: destruction / inactivation of pathogenic microorganisms

"Primary disinfection" – at the WTP

- Achieve the bulk of the "CT" credit required by regulation
- "CT" is disinfectant residual (C, in mg/L) multiplied by contact time (T, in minutes)
- Free chlorine most commonly applied.
- Ozone, chlorine dioxide can also be used
- Scheme must be balanced against disinfection byproduct (DBP) formation

"Secondary disinfection" – in the distribution system

- Prevent regrowth / biological activity in distribution piping and storage tanks
- Maintain adequate disinfectant residual throughout, all the way to the customer's tap
- Chloramine is most commonly used, as it is more persistent than free chlorine with minimal DBP formation

Regulatory standards for disinfection:

- 99.99 % inactivation of viruses
- 99.9 % inactivation of *Giardia*
- Minimum residuals are 0.2 mg/L for free chlorine or 0.5 mg/L for chloramine

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COAGULATION / FLOCCULATION AND SEDIMENTATION

Goal: To remove particulates and natural organic materials in water

Coagulation

- Adequate mixing to thoroughly disperse coagulant
- Coagulant type and dose

Flocculation:

- Gentle mixing to cause particle collisions
- Particles grow larger and heavier

Sedimentation

- Flocculated water moves slowly, allowing larger particles to settled by gravity
- Surface Overflow Rate (SOR)
- Detention time: 2-6 hours, dependent on basin design

Removal of suspended solids and turbidity: 60-80 %

Reduction of microbes

- 74-97 % Total coliform
- 76-83 % of fecal coliform
- 88-95 % of Enteric viruses
- 58-99 % of *Giardia*
- 90 % of *Cryptosporidium*

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COAGULATION Considerations

Alkalinity	Sufficient alkalinity is an essential component of precipitation reactions
Polymers	Charge can be cationic, anionic, or non-ionic Dosage is typically < 0.1 mg/L
Turbidity Addition	Recycled settled solids to "seed" coagulation/flocculation Bentonite clay
pH adjustment	To achieve optimum conditions for chemical reactions

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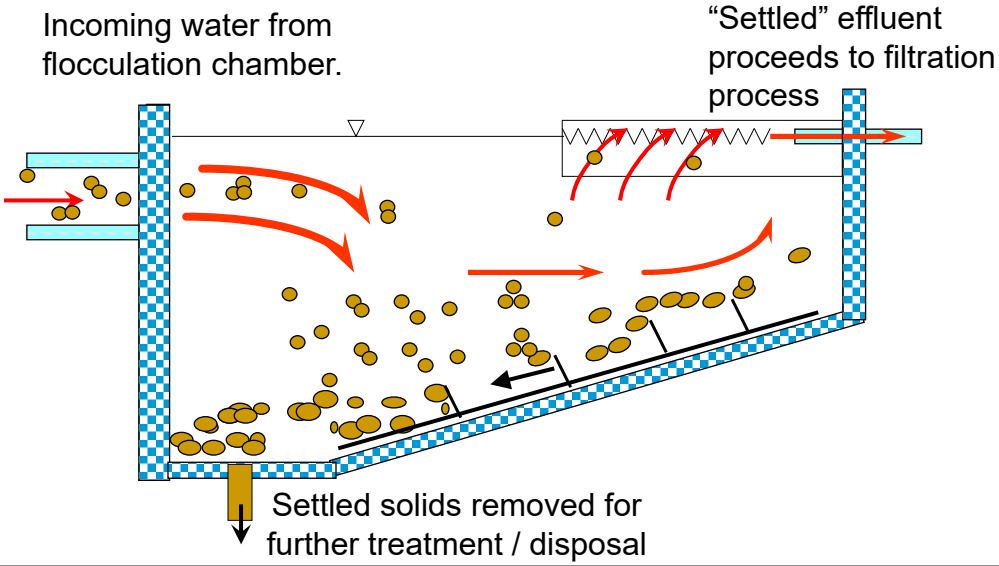
Sedimentation



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FILTRATION

Goal: To remove particulates in water

Loading rate: 2 - 5 gpm / ft^2

Turbidity: < 0.3 NTU (oftentimes < 0.1 NTU)

Reduction of microbes

- 50-98 % Total coliform
- 50-98 % of fecal coliform
- 10-99 % of enteric viruses
- 97-99.9 % of *Giardia*
- 99 % of *Cryptosporidium*

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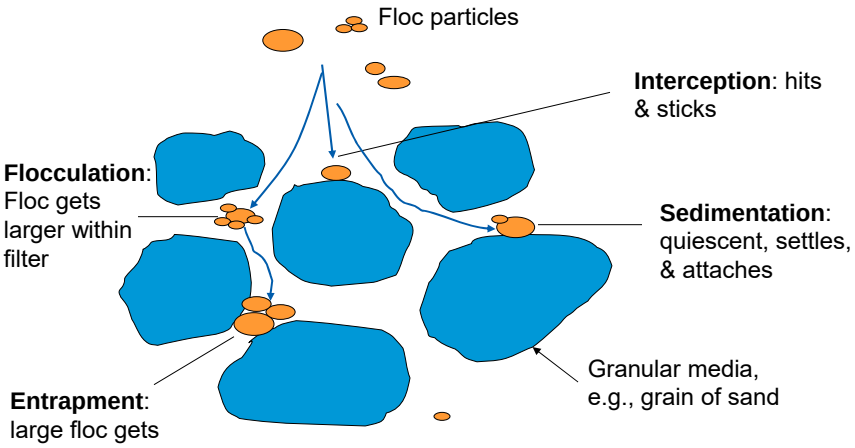
Mechanisms Involved in Filtration



Removal of bacteria, viruses and protozoa by a granular media filter requires water to be coagulated

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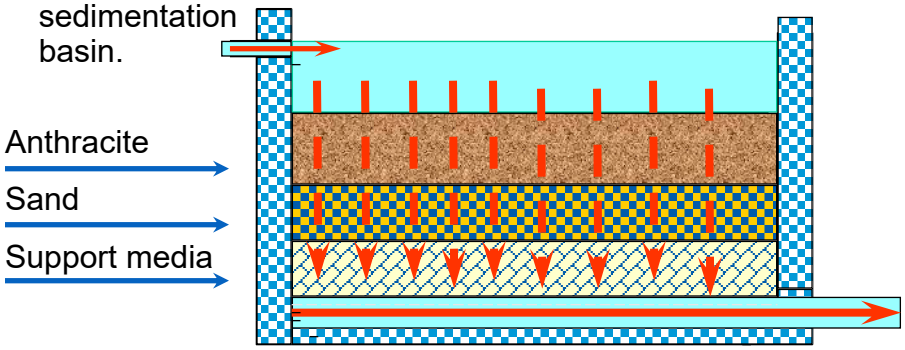
Filtration

"Settled" effluent from sedimentation basin.



Filtered water to Clearwell storage

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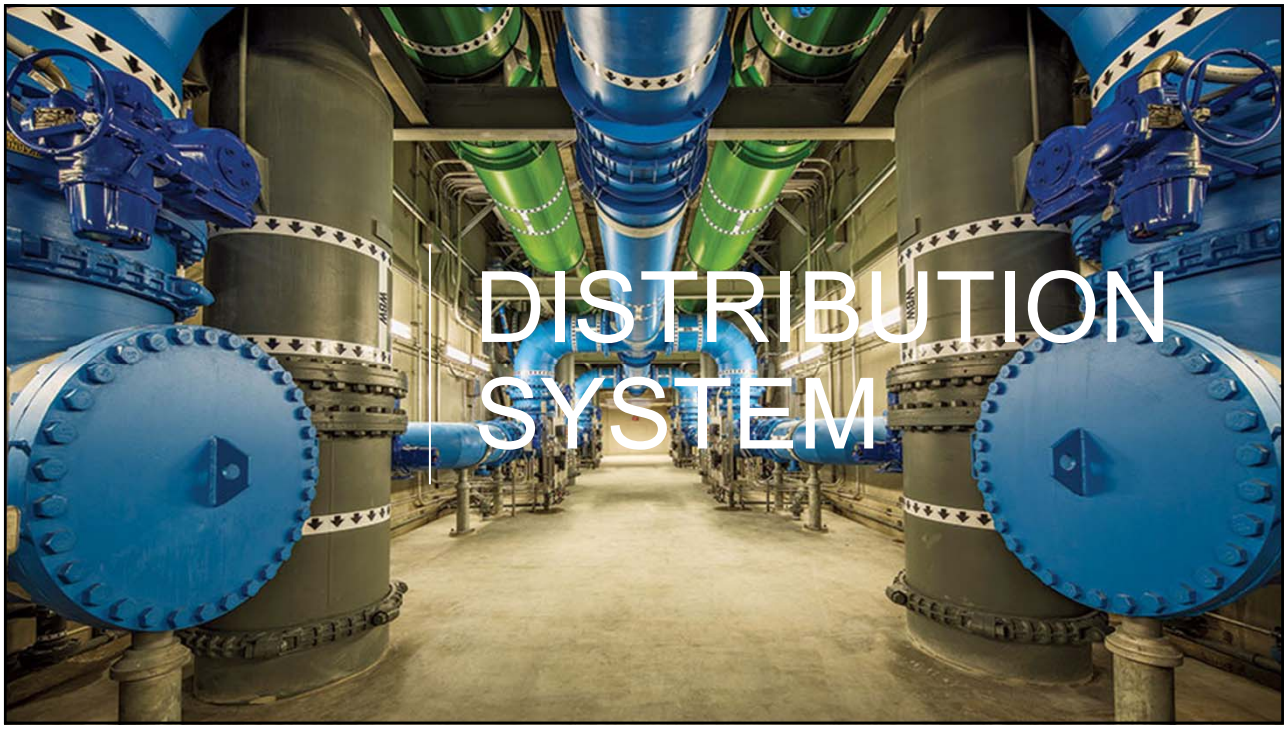

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KEY DISTRIBUTION SYSTEM MONITORING PARAMETERS

- Disinfectant residual
  - *Water quality integrity*
- Main break frequency
  - *Physical integrity*
- Pressure management
  - *Hydraulic integrity*

Identified in WRF 4109 – Criteria for Optimized Distribution Systems

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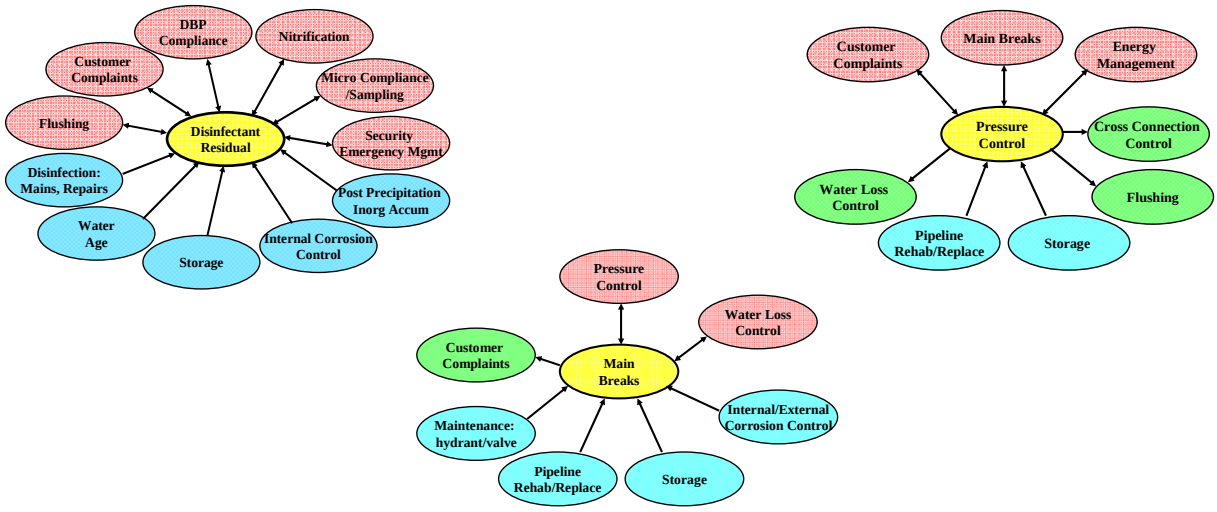
FACTORS INFLUENCING PERFORMANCE PARAMETERS



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PERFORMANCE GOALS: DISINFECTANT RESIDUAL

- Disinfectant Residual (>95% of measurements)
  - Free Chlorine: ≥ 0.20 and ≤ 4.0 mg/L
  - Total Chlorine: ≥ 0.50 and ≤ 4.0 mg/L
  - Chlorine Dioxide: ≥ 0.20 and ≤ 0.80 mg/L
- No *consecutive* residual measurements outside target range at *optimized* routine sample locations
- DBPs within regulatory requirements

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Performance Goals: Pressure Management

Minimum Pressure (≥ 99.5% of measurements)

- Pressure: ≥20 psi for daily minimum

Maximum pressure (≥ 95% of measurements)

- Does not exceed utility specified maximum

Pressure fluctuations (≥ 95% of measurements)

- Does not exceed range specified by utility

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PERFORMANCE GOALS: MAIN BREAKS AND LEAKS

≤ 15 breaks / reported leaks per 100 miles of pipe / year

Or – declining 5-year annual trend

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WHAT IS THE BIGGEST ISSUE THAT YOU ARE AWARE OF IN YOUR DISTRIBUTION SYSTEM?

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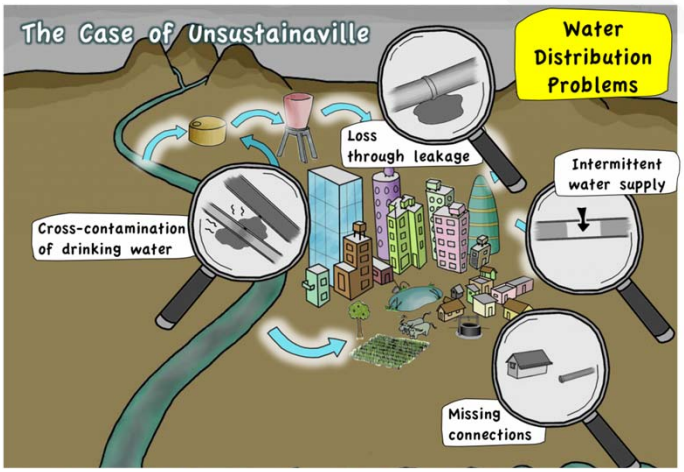
WHAT IS THE BIGGEST ISSUE THAT YOU ARE **NOT** AWARE OF IN YOUR DISTRIBUTION SYSTEM?



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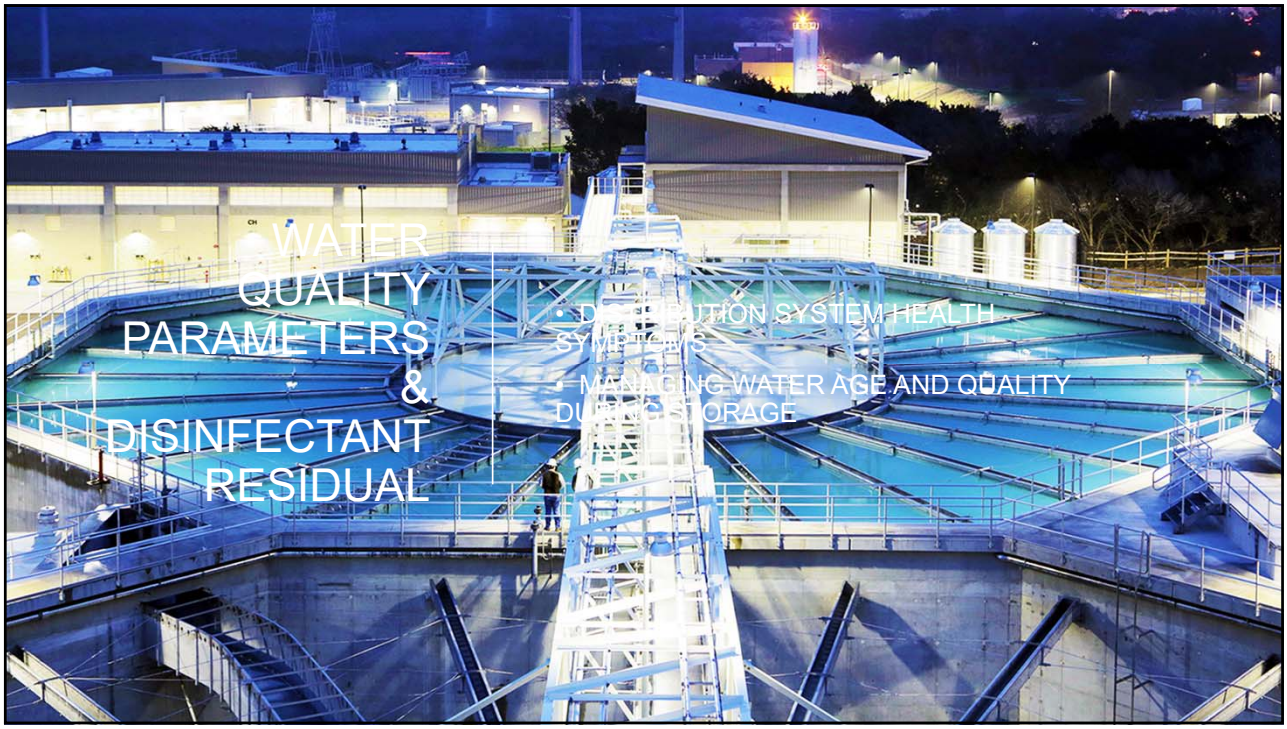

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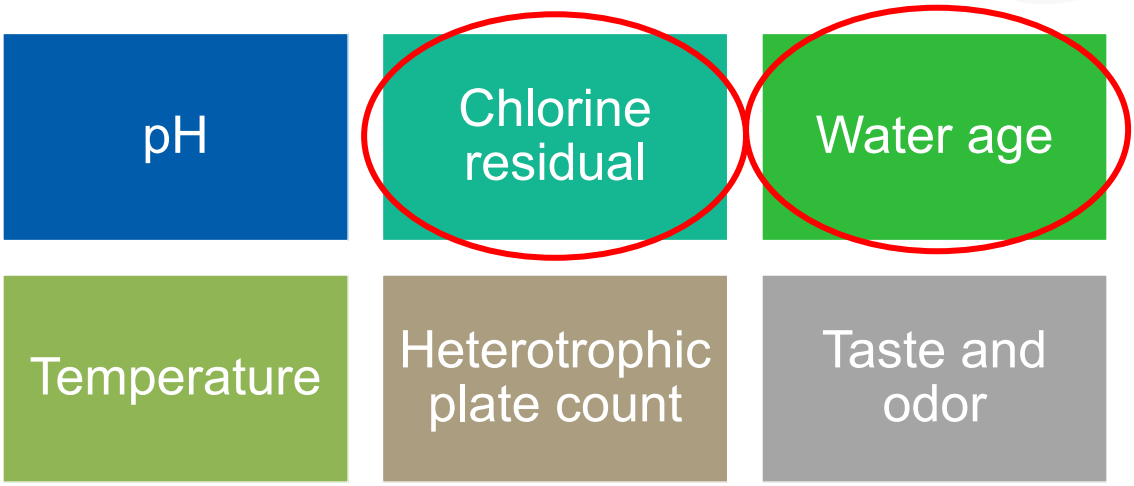
WATER QUALITY PARAMETERS WE WILL DISCUSS



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CHLORINE RESIDUAL

Maintaining a chlorine residual in the distribution system is critical to ensure pathogen-free water

Maximum Disinfectant Residual Level (MDRL):
- 4.0 mg/L for free chlorine
- 4.0 mg/L for chloramine

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RATE OF DECAY OF CHLORINE RESIDUAL IS AFFECTED BY:

- Water age
- Temperature
- Biological growth / nitrification
- Amount and type of chlorine-demanding compounds (organic and inorganic)

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WATER AGE

The residence time of water in the distribution before reaching the customers

Factors affecting water age:

- Rate of production
- Rate of usage
- Pipeline and storage tank operations

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WATER AGE

High water age:

- Loss of chlorine residual
- Increased risk of bacterial regrowth
- Increased DBP formation

**AWWA recommends water age of less than 7 days*

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MANAGING WATER AGE AND QUALITY

Manage Hydraulics in Storage Facilities

- Inlet /outlet configuration, baffling
- Increase turnover rate
- Pumping schedules (deep cycling)
- Mixing

Manage chemistry

- Increase chlorine residual
- Shock chlorination

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MAIN BREAKS – CONTRIBUTING FACTORS

- Aging infrastructure
  - "a significant water line bursts on average every two minutes somewhere in the country"
  - "$334.8 billion will be needed for pipe, treatment, storage, source, and other infrastructure over the 20 year period 2007-26"
- Frost load
- Pressure surge
- Mechanical damage

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CORRECTIVE MEASURES

Reactive

- Flushing (after break)
- Disinfection

Long-term - Asset Management

- Buried pipes are the most costly assets of most water utilities
- The rate of pipe failure is greater than the pipe renewal rate in most utilities

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OVERVIEW OF THE PARTNERSHIP PROGRAMS

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OUTLINE

- **Partnership for Safe Water**
  - -Program mission and background
    - Individual Programs
  - -Program phases
  - -Self-assessment process
- **Partnership for Clean Water**
- **Small Systems/USDA Efforts**

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PARTNERSHIP PRINCIPLES

- **"Beyond regulations"** — Goals set beyond regulations to provide an additional measure of public health protection
- **Avoiding Complacency** — Proactive measures to remain prepared and resilient
- **Data-driven** — Actions and decisions based on data and information

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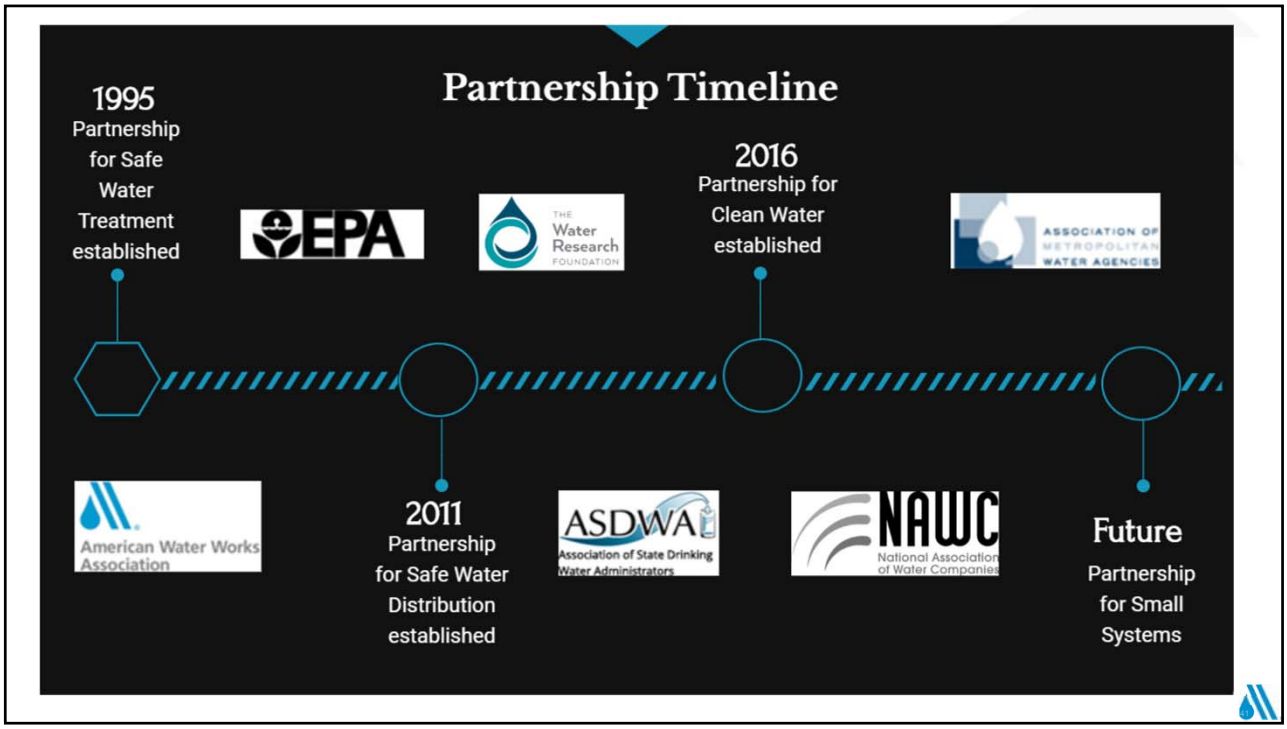

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PARTNERSHIP FOR SAFE WATER

Partnership for Safe Water mission:

- *To improve the quality of drinking water delivered to customers systems by optimizing water system operations.*

Two programs (**3rd in development)

- Treatment plant optimization (1995)
- Distribution system optimization (2011)
- Partnership for Small Systems**

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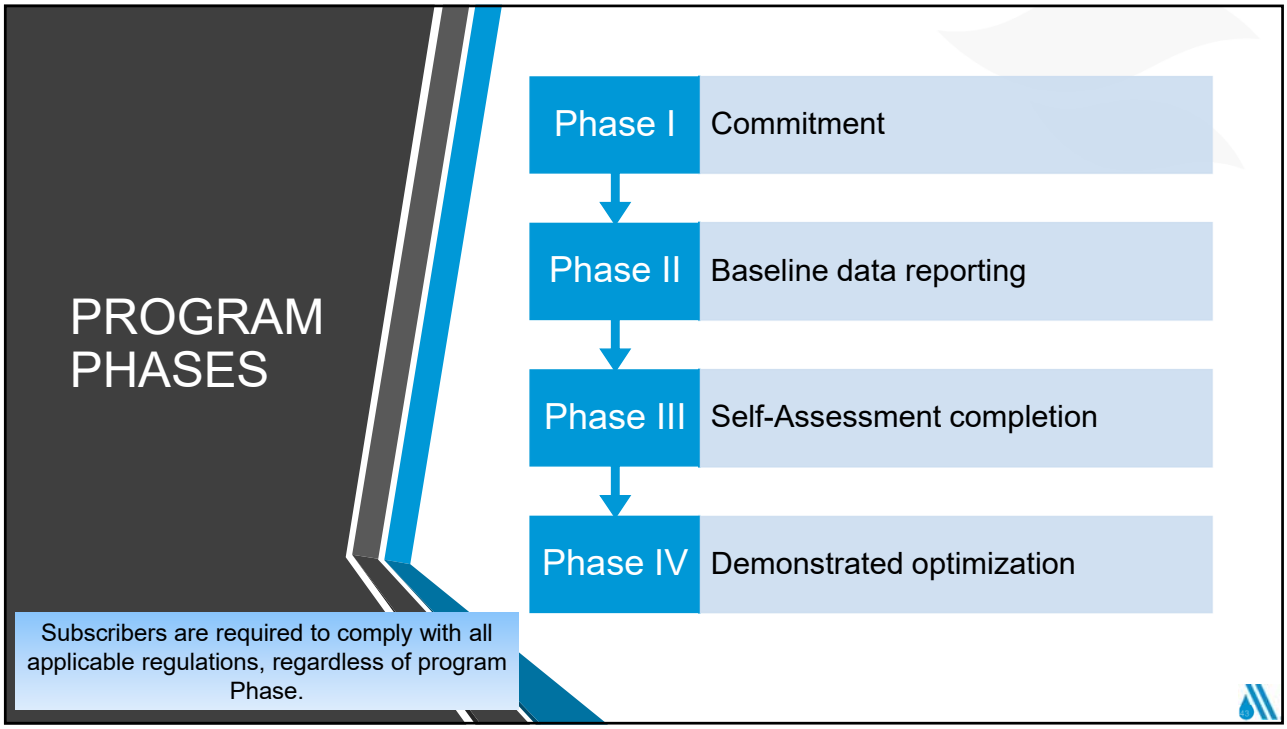
PROGRAM PHASES
Phase I
Commitment
Phase II
Baseline data reporting
Phase III
Self-Assessment completion
Phase IV
Demonstrated optimization
Subscribers are required to comply with all applicable regulations, regardless of program Phase.

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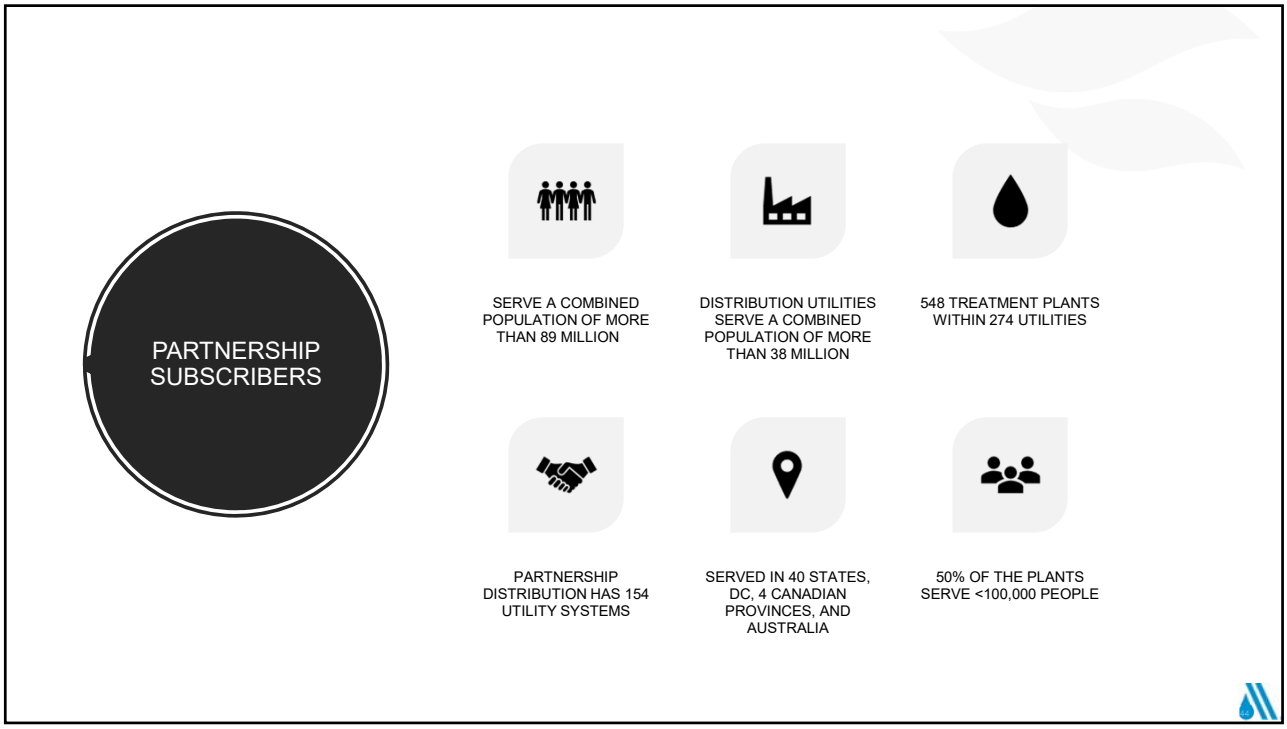
PARTNERSHIP SUBSCRIBERS
SERVE A COMBINED POPULATION OF MORE THAN 89 MILLION
DISTRIBUTION UTILITIES SERVE A COMBINED POPULATION OF MORE THAN 38 MILLION
548 TREATMENT PLANTS WITHIN 274 UTILITIES
PARTNERSHIP DISTRIBUTION HAS 154 UTILITY SYSTEMS
SERVED IN 40 STATES, DC, 4 CANADIAN PROVINCES, AND AUSTRALIA
50% OF THE PLANTS SERVE <100,000 PEOPLE

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TEXAS OPTIMIZATION PROGRAM (TOP)

A voluntary, non-regulatory program to help improve the performance of your existing surface water treatment plant. The underlying mission of the TOP is to protect the public health of Texas' citizens.

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TOP GOALS

- a settled water turbidity of 2.0 NTU or less on a continuous basis;
- a turbidity of 0.10 NTU or less at the discharge of each filter;
- a maximum turbidity spike of 0.3 NTU following the filter backwash; and
- reestablishing a filtered water turbidity of 0.10 NTU within 15 minutes after returning the clean filter to service.

https://www.tceq.texas.gov/drinkingwater/swmor/top/top_requirements.html

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SIMILARITIES BETWEEN PARTNERSHIP & TOP

- Overall goals to optimize water treatment practices for protecting public health
- Programs utilize self-assessment to optimize utility performance
- Utilize Review Team to evaluate utility performance and give feedback
- Award Recognition is given to utilities that meet their programs goals
- TOP data collection requirements most similarly matches the partnership presidents award level (individual filter data collection etc.)

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DIFFERENCES BETWEEN PARTNERSHIP & TOP

TOP:
- TOPMOR forms must be turned in each month
- Awarded every 6 consecutive months
- Post-backwash measurements
- Texas-wide program

Partnership:
- Data submitted Annually
- 3 award levels: Directors, Presidents, and Excellence
- Awarded yearly, plaques given for years 1,5,10, etc. at each award level
- Multiple levels of award recognition
- National/International-wide program
- Annual fees set by population served

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PARTNERSHIP FOR SAFE WATER TREATMENT

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TREATMENT PROGRAM

- Open to surface and groundwater filtration plants of all sizes and configurations
  - -Multiple barrier approach for turbidity reduction – <0.1 NTU
  - -Optimize all unit processes for particulate removal
    - Conventional, membrane, DAF, high rate clarification, advanced oxidation (ozone, UV)

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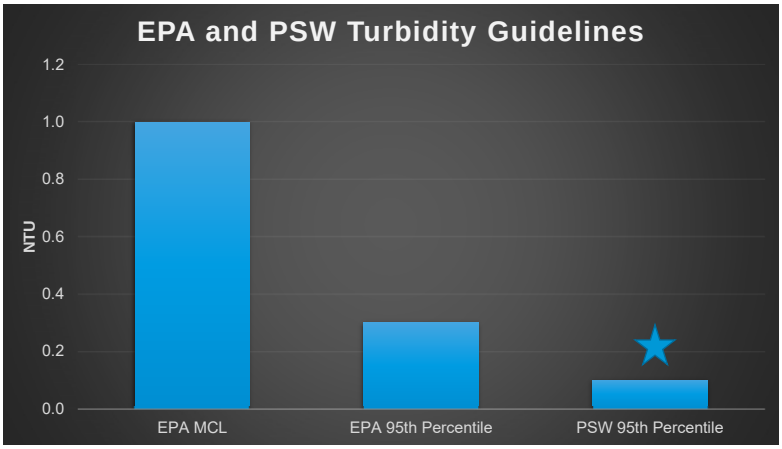
TURBIDITY REGULATIONS – SURFACE WATER TREATMENT RULE



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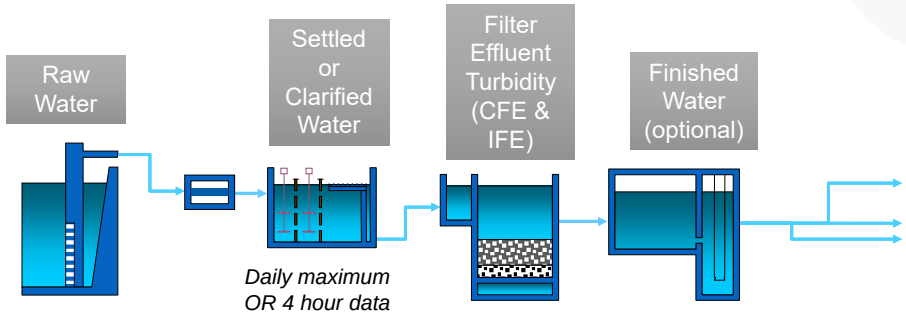
PHASE II – BASELINE DATA (TREATMENT)



Daily maximum reported.

Daily maximum OR 4 hour data reported from individual or combined basins. 95th percentile goal of 1.0/2.0 NTU depending on raw water turbidity.

4 hour CFE data, 15-minute IFE data (Phase IV), filter profiles. 95th percentile goal of <0.10 NTU.

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PHASE III - SELF-ASSESSMENT STEPS

- Complete Self-Assessment
- Submit a Self-Assessment report
- Report is peer reviewed by utility volunteers
- Successful completion achieves Phase III PSW status and Directors Award

All materials submitted to the Partnership for Safe Water are

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PHASE IV - OPTIMIZATION

Phase IV awards recognize utilities for demonstrated optimization.

- Presidents Award
- Excellence Award

Aurora Water (CO) staff accepting the Phase IV Excellence in Water Treatment Award

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PARTNERSHIP FOR SAFE WATER DISTRIBUTION

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DISTRIBUTION PROGRAM

How can utilities improve water quality and protect public health **after** the water leaves the plant?

- Multiple challenges and priorities

**Program is open to any distribution system that applies a residual disinfectant (all configurations)*

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DISTRIBUTION PERFORMANCE GOALS

- Disinfectant Residual (>95% of meas.)
  - Free Chlorine: ≥ 0.20 and ≤ 4.0 mg/L
  - Total Chlorine: ≥ 0.50 and ≤ 4.0 mg/L
  - Chlorine Dioxide: ≥ 0.20 and ≤ 0.80 mg/L
- No *consecutive* residual measurements outside target concentrations at *optimized* routine sample locations
- DBPs within regulatory requirements

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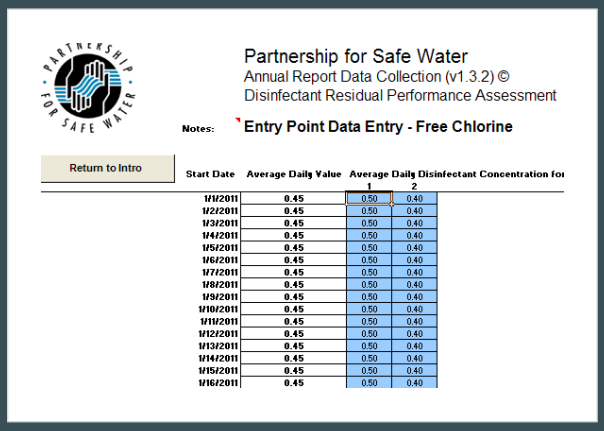

Partnership for Safe Water
Annual Report Data Collection (v1.3.2) ©
Disinfectant Residual Performance Assessment

Notes: Entry Point Data Entry - Free Chlorine

Return to Intro

Start Date	Average Daily Value	Average Daily Disinfectant Concentration for 1	2
1/1/2011	0.45	0.50	0.40
1/2/2011	0.45	0.50	0.40
1/3/2011	0.45	0.50	0.40
1/4/2011	0.45	0.50	0.40
1/5/2011	0.45	0.50	0.40
1/6/2011	0.45	0.50	0.40
1/7/2011	0.45	0.50	0.40
1/8/2011	0.45	0.50	0.40
1/9/2011	0.45	0.50	0.40
1/10/2011	0.45	0.50	0.40
1/11/2011	0.45	0.50	0.40
1/12/2011	0.45	0.50	0.40
1/13/2011	0.45	0.50	0.40
1/14/2011	0.45	0.50	0.40
1/15/2011	0.45	0.50	0.40
1/16/2011	0.45	0.50	0.40

Secondary Residual Disinfectant- free chlorine or total chlorine or chlorine dioxide
Applicable Routine Sample Goals- free chlorine ≥ 0.20 mg/L and ≤ 4.0 mg/L, total chlorine ≥ 0.50 mg/L and ≤ 4.0 mg/L, mg/L chlorine dioxide ≥ 0.20 mg/L and ≤ 0.80 mg/L

	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entry Points Residual Average (mg/L)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Number of Routine Samples	730	62	56	62	60	62	60	62	62	60	62	60	62
Number of Routine Test Results Not meeting Goals	3	3	0	0	0	0	0	0	0	0	0	0	0
% Routine Test Results Not Meeting Goals	0.41	4.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum Daily Residual Value (mg/L)	0.18	0.18	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Number of repeat non-conforming sites	0	0	0	0	0	0	0	0	0	0	0	0	0
TTHM Maximum (µg/L)													
HAA5 Maximum (µg/L)													

DISTRIBUTION PHASE II – SUBMITTING BASELINE DATA

- Entry point and distribution system disinfectant residual

Disinfection by-products

- Why? Measure improvement over time, individual and aggregate utilities

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DISTRIBUTION PHASE III - SELF-ASSESSMENT

Self-Assessment is program foundation

The self-assessment process helps utilities:

-Identify performance limiting factors
-Create action plans to address these factors
-Work towards achieving optimization
-Document and track ongoing performance

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DISTRIBUTION PHASE III - SELF-ASSESSMENT

Self-Assessment of:

- Performance and processes against optimization standards:
  - Performance criteria (disinfection, pressure, breaks)
  - Performance improvement variables
- System design
- System operation
- Administration

Guidance documentation steps utilities through the Self-Assessment process

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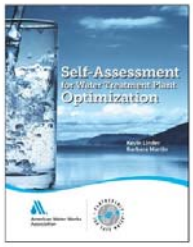

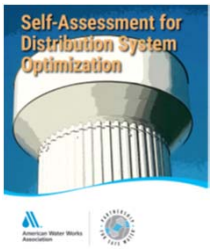

UPDATED SELF-ASSESSMENT GUIDANCE

- *Self-Assessment for Water Treatment Plant Optimization*
- Self-Assessment for Distribution System Optimization (update from Draft version) – newly available in 2018

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Phase III – Self-Assessment Data (Distribution)

Self-Assessment Data Requirements
Minimum daily disinfectant residual for 12 months at distribution system routine sample locations, storage tanks, and entry points. Use Data Collection Software provided by the PSW.
All TTHM and HAA5 routine test results for 12 months. Annual DBP trending indicating RAA. Use PSW software.
Daily minimum pressure readings from permanent sensors for the most recent 12 months – ideally at 2 locations in each pressure zone (low and high). Use PSW software.
Main break records for several years – 10 years is ideal. Use PSW software.
Records of the annual number of technical water quality complaints. Record of the number of accounts for the utility.
Flushing velocity, disinfectant residual (before and after), for procedures that are initiated to correct low disinfectant residuals.
Valve and hydrant exercise (inspection) records with the total number in the system and the number exercised annually.
Hydrant repair record and calculated time to restore service after detection.
Internal corrosion testing practices with the number of tests performed annually.
Free ammonia, nitrate, nitrite, results summary for distribution systems using chloramines.

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Distribution Self-Assessment – Hydrant/Valve Section Example

Self-Assessment Category	Questions for Gauging Optimization Status
Maintaining Valves, Hydrants, and Blowoffs	Location Records: Does the system have accurate and current records that document the location and attributes for all valves, hydrants, and blowoffs?
	Inspection and Assessment: Are all valves, hydrants, and blowoffs inspected and evaluated on a schedule?
	Exercise Program: Are all distribution system main valves and hydrants exercised and tested at least every three years (or more frequently if required by regulation)?
	Hydrant Repairs: Are all hydrant repairs scheduled within 24 hours of discovery? Are inoperable hydrants identified immediately and is this communicated to the fire protection authority?
	Hydrant Access: Does the system control access to hydrants and provide training for proper third-party use?

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Lessons Learned: Changes Don't Need to be Big to be Effective

Top Distribution System Self-Assessment Report Actions		
Hydraulic model calibration/availability	Improve valve exercise practices	Software system integration & record keeping
Pressure monitoring	Install chlorine analyzers	Reduce DS water age
Pump efficiency testing	Corrosion monitoring	Improve leak detection, DMA creation, water audit
Optimize flushing	Pipe inspection	Create, improve, update SOPs
Asset management	Post-precipitation control	Emergency response planning

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Phase III - Directors Award

Louisville Water Company *representatives accept the Directors Award At ACE13 (34 Directors Award recipients to date)*

Annual Data Submission: Maintain Directors Award status, receive date tags, and become eligible for 5-, 10-, and 15- Year "longevity" awards

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Phase III - After Completion

- Monitor progress against plan — Partnership for Safe Water annual reporting
- Adjust action plan as needed
- Submit annual data to Partnership
- Fully optimized systems can apply for Phase IV Partnership for Safe Water status — Systems demonstrate commitment to maintaining optimization and continuous improvement

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Partnership for Safe Water Benefits

Self-assessment presents a system-specific learning opportunity that can help improve:

- Operations
- Performance
- Teamwork and communications
- Water quality & public health protection

Create a "culture of excellence"

Positive recognition can build confidence in utility

Optimization has no finish line!

A JOURNEY, NOT A DESTINATION...

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LESSONS LEARNED: IT CAN CHANGE UTILITY CULTURE

- Get the entire team engaged (this is the hardest but most important part)
- Develop performance goals and tools
- Establish unit process operational guidance
- Focus on continuous improvement becomes part of the culture
- **Create a culture of excellence &**

  Be Excellent!

Utah Valley WTP performance sign - updated daily by operators

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QUESTIONS?

THANKS!

Contact Us Regarding Further Questions!

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