National Drinking Water Advisory Council
Microbial and Disinfection Byproducts
Rule Revisions Working Group

Meeting 2: August 17, 2022: 11:00am-6:00pm ET

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AND DRINKING WATER

WELCOME

Elizabeth Corr, Designated Federal Officer, U.S. EPA

Eric Burneson, Director, Standards and Risk Management Division, U.S. EPA

OPENING REMARKS

Lisa Daniels & Andy Kricun, WG Co-Chairs

Segment 1: Agenda Review & Meeting Procedures

Rob Greenwood, Ross Strategic

August 17, 2022

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Today's Virtual Meeting: Zoom Controls

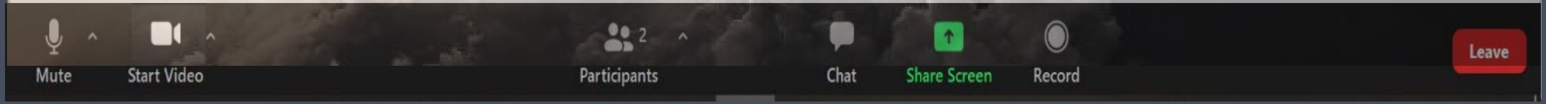
This meeting is **not** being recorded

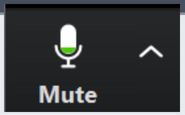
The Zoom menu bar appears at the bottom of the Zoom window once the meeting begins.

If you don't see the menu bar, move your mouse slightly and the bar will appear.

Working Group Member Participation

- **Names:** Click on **participants** then (...) to update with your name, organization
- **Videos** During introductions and discussion, please keep video on. OK to turn off during presentations.
- **Chat:** During presentations, feel free to chat in your questions throughout to be discussed at the conclusion of the presentation.





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Public Attendees

- You are in listen only mode and will not be able to unmute. If you are having audio difficulties send an email to **taner.durusu@cadmusgroup.com**
- Any comments you may have can be sent to **MDBPRevisions@epa.gov** or to Public Docket: www.regulations.gov / Docket ID Number: EPA-HQ-OW-2020-0486

EPA AND FACILITATION TEAM

Eric Burneson
EPA OGWDW, Standards and Risk Management Division Director

Ken Rotert
EPA OGWDW

Rich Weisman
EPA OGWDW

Ryan Albert
EPA OGWDW, Chief Standards and Risk Management Division

Rob Greenwood
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Today's Agenda

11:00-12:30

- Agenda Review and Meeting Procedures
- Regulatory Framework Related to Surface Water Treatment Rules

30 Minute Break (12:30-1:00pm ET)

1:00-3:30

- Problem Characterization Scope, Content, and Approach
- Problem Characterization on Opportunistic Pathogens

30 Minute Break (3:30-4:00pm ET)

4:00-6:00

- Problem Characterization on Disinfectant Residuals
- Meeting 3 Agenda & Next Steps

Topics

1 Principles, Priority Areas, Challenge Areas

2 Problem Characterization

3 Interventions

4 Implementation Mechanisms

5a Findings

5b Recommendations

6 Final Report

Meeting Series

We Are Here

1 Introductions, Priorities, & WG Goals

2 Problem Characterization Areas

3 Problem Areas in More Detail (Part 1)

4 Problem Areas in More Detail (Part 2)

5 Stepping Back – Wrap Up of Problem Characterization

6 Intervention Scoping & Evaluation Approach

7 Intervention Characterization (Part 1)

8 Intervention Characterization (Part 2)

9 Connect Preferred Interventions to Implementation

10 Translate Interventions to Recommendations

11 Draft Recommendations

12 Final Refinements to Recommendations

13 Final Report

Segment 2: Regulatory Framework Related to the Surface Water Treatment Rules

Richard Weisman, U.S. EPA OGWDW
Rob Greenwood, Ross Strategic

August 17, 2022

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Presentation Overview

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- Overview of MDBP Regulatory Framework
- Overview of Key Existing Requirements for Surface Water Treatment Rules (SWTRs)
- Considerations for Public Health Protection Goals in Drinking Water
- Number and Type of Public Water Systems Addressed by SWTRs
- Considerations for Environmental Justice/Disadvantaged Communities

Overview of MDBP Regulatory Framework

- MDBP regulatory framework addresses balancing risks resulting from pathogen and disinfection byproduct exposures.
- Working Group charge addresses the following regulations:
  - Surface Water Treatment Rule (SWTR);
  - Interim Enhanced SWTR;
  - Long-Term 1 Enhanced SWTR;
  - Stage 1 Disinfectants and Disinfection Byproducts Rule; and
  - Stage 2 Disinfectants and Disinfection Byproducts Rule.
- Draft summary provides overview of key existing requirements for these MDBP rules.
- Today's meeting to consider all three SWTRs.

Key Existing Requirements for SWTRs

Today's Presentation

Drinking Water Value Chain	Contaminants of Concern		
	Microbials	Interdependencies	DBPs
Source Water			
Treatment			
Distribution			
Premise			

Key Existing Source Water Requirements for SWTRs

- Requires that watershed protection programs address *Cryptosporidium* for systems that are not required to provide filtration.
  - Applies to all public water systems using surface water, or ground water under the direct influence of surface water (GWUDI), that serve 10,000 or more persons (IESWTR 1998; 63 FR 9478).
  - Applies to all public water systems using surface water, or GWUDI, serving fewer than 10,000 persons (LT1ESWTR 2002; 67 FR 1812).

Key Existing Treatment Requirements for SWTRs

- Includes treatment technique (TT) requirements for removal or inactivation of at least 99.9% (3 log) of *Giardia lamblia* and 99.99% (4 log) of viruses for all PWSs using surface water or GWUDI as a source (i.e., Subpart H systems). Presumed that *Legionella* risks will also be removed or inactivated.
  - Includes specific numeric requirements for turbidity and disinfection/CTs.
- Sets a minimum 2-log *Cryptosporidium* removal requirement for systems that provide filtration.
- For filtered systems using conventional treatment or direct filtration, must meet a turbidity performance standard.
- Perform continuous (every 15 minutes) individual filter effluent (IFE) monitoring to assist treatment plant operators in understanding and assessing filter performance.
- Requires IFE monitoring to be conducted continuously with results recorded at least every 15 minutes, except systems with two filters which have the option to continuously monitor the combined filter effluent instead of monitoring each individual filter. Systems with one filter must conduct continuous monitoring of the one filter.

Key Existing Distribution System Requirements for SWTRs

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- Establishes requirements that the disinfectant concentration entering the distribution system (i.e., at the Entry Point) cannot be less than 0.2 mg/L for more than 4 hours.
- Requires that the residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine, or chlorine dioxide, cannot be undetectable in more than 5 percent of the samples each month, for any two consecutive months that the system serves water to the public.
- Allows use of heterotrophic bacteria as an alternative for demonstrating the presence of a residual disinfectant, as a heterotrophic plate count (HPC) of less than or equal to 500/ml.
    - Applies to all public water systems using surface water sources or GWUDI (SWTR 1989; 54 FR 27486).

Key Existing Premise Plumbing Requirements for SWTRs

- While premise plumbing (e.g., at a nursing home or school) may be an important part of the distribution to consumers, it may not be subject to EPA's PWS regulations in many cases.
  - EPA's PWS regulations may apply where infrastructure consists of more than distribution and storage.
  - Described in Water Supply Guidance (WSG) 8A "Application of the SDWA to Persons Adding Corrosion Reducing Chemicals to Drinking Water".

Source: WSG 8A available at https://www.epa.gov/dwreginfo/public-water-system-supervision-program-water-supply-guidance-manual.

Considerations for Public Health Protection Goals in Drinking Water

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- Under the SDWA, every six years, EPA must review all National Primary Drinking Water Regulations and adhere to an anti-backsliding provision.
  - "Any revision of a national primary drinking water regulation shall be promulgated in accordance with this section [Section 1412(b)(9)], except that each revision shall maintain, or provide for greater, protection of the health of persons."
- Long-term performance goal in EPA's Strategic Plan for FY 2022 – FY 2026: By September 30, 2026, reduce the number of community water systems still in noncompliance with health-based standards since September 30, 2017 from 3,508 to 600.

Inventory of Surface Water Systems Based on Population Served

Type of System	Count (Active Systems)	Percentages by Size		
		<10,000 (Small)	10,000 – 100,000 (Medium)	≥ 100,000 (Large)
Community water systems (CWSs)	11,599	76.0%	20.8%	3.2%
Population Served – CWSs	220,723,474	9.1%	33.6%	57.4%
Non-transient non-community water systems (NTNCWS)	773	97.4%	2.5%	0.1%
Population Served – NTNCWSs*	1,373,039	51.8%	33.6%	14.8%
Transient community water systems (TNCWS)	2,195	99.7%	0.2%	0.1%
Population Served – TNCWSs*	2,492,498	16.3%	3.5%	80.2%

Sources: SDWIS (calendar year 2019), U.S. Census (national population in 2019, from https://www.census.gov/newsroom/press-releases/2019/popest-nation.html)

* The population served for NCWSs includes some double-counting since some people regularly consume water from more than one type of system.

Number of Surface Water CWSs and Population Served Based on Percentages of Purchased Water

Percentages of Purchased Water	#Systems	#Population	%Systems	%Population
100%	5,675	41,731,044	48.9%	18.9%
>0% & <100%	1,669	67,480,872	14.4%	30.6%
0%	4,255	111,511,558	36.7%	50.5%
All	11,599	220,723,474	100%	100%

Sources: SDWIS (calendar year 2019)

Considerations for Environmental Justice/Disadvantaged Communities

- "Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. This goal will be achieved when everyone enjoys:
  - The same degree of protection from environmental and health hazards, and
  - Equal access to the decision-making process to have a healthy environment in which to live, learn, and work."

Source: https://www.epa.gov/environmentaljustice

Environmental Justice Executive Orders

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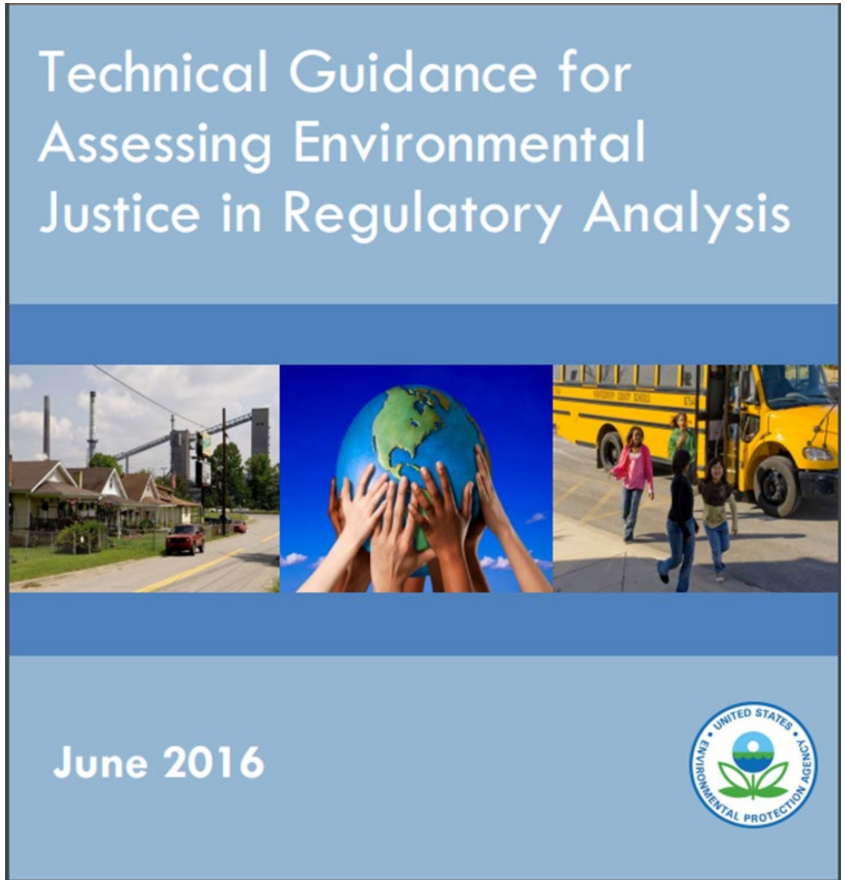
- Executive Order 12898 (59 FR 7629; February 16, 1994)
- Executive Order 14008 (86 FR 7619; January 27, 2021)
- Other recent executive actions that relate to environmental justice include:
    - Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (86 FR 7009; January 20, 2021)
    - Executive Order 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis (86 FR 7037; January 20, 2021)
    - Memo on Modernizing Regulatory Review (January 20, 2021)

EPA Guidance on Analyzing Differential Impacts

Analysis of potential EJ concerns for regulatory actions should address three questions:

- Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern in the baseline?
- Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern for the regulatory option(s) under consideration?
- For the regulatory option(s) under consideration, are potential EJ concerns created or mitigated compared to the baseline?



Source: https://www.epa.gov/sites/default/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf

Regulatory Framework for SWTRs: Discussion Topics

- Are there further features or aspects of the SWTR regulatory framework you would like to highlight for Working Group consideration?
- Are there other aspects of the SWTR regulatory framework you would like to further explore?

BREAK (30 MINUTES)
12:30 TO 1:00 PM EASTERN

Segment 3: Problem Characterization Scope, Content, and Approach

Rob Greenwood, Ross Strategic

August 17, 2022

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Problem Characterization – Overview

Drinking Water Value Chain	Microbial	Interdependencies	DBPs
Source Water	Source water conditions Cyanotoxins	Source water conditions Variable requirements	Source water conditions
Treatment	Treatment efficacy Nutrient removal	Tradeoffs and unintended consequences	Total organic carbon (TOC) System operations Chlorate and chlorite
Distribution System	Microbial contamination Disinfectant residual level Analytical methods Finished water storage	DBP formation System conditions Consecutive systems Finished water storage Booster chlorination	Residual DBP risks Consecutive systems Nitrosamines Tradeoffs and unintended consequences System operations
Premise	Residual risks Methods and analysis Limited influence	N/A	Potential increased formation

Overview of Working Group Member Input

- Provided Table 1 (Existing Regulations) and Table 2 (Problem Characterization) for WG member review on July 27th.
- Table 1 Feedback:
  - Requirements related to the "path to public knowledge" (e.g., reporting requirements, public notice requirements).
  - Relationship to Groundwater Rule, Total Coliform Rule, and Lead and Copper Rule.
  - SWTR - citations related to qualification of operators.
  - Interim Enhanced SWTR – clarify "turbidity performance standard" and add individual filter effluent continuous turbidity monitoring requirements.
  - Long-Term 1 Enhanced SWTR – add individual filter effluent continuous turbidity monitoring requirements.
- Table 2 Feedback:
  - Is the content of the table better characterized as "issues for exploration"?
  - Interdependency of MDBP decisions and corrosion outcomes/control in DS and premise plumbing.
  - Small system challenges related to staff capacity, technical skills and training, and resource constraints.
  - Scope and targeting of sampling procedures (relative to high-risk water).
  - Insufficient cross-connection control.
  - Adequacy of current DBP compliance sampling plans.

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Topics

1. Principles, Priority Areas, Challenge Areas
2. Problem Characterization
3. Interventions
4. Implementation Mechanisms
5a. Findings
5b. Recommendations
6. Final Report

Meeting Series

1. Introductions, Priorities, & WG Goals
2. Problem Characterization Areas
3. Problem Areas in More Detail (Part 1)
4. Problem Areas in More Detail (Part 2)
5. Stepping Back – Wrap Up of Problem Characterization
6. Intervention Scoping & Evaluation Approach
7. Intervention Characterization (Part 1)
8. Intervention Characterization (Part 2)
9. Connect Preferred Interventions to Implementation
10. Translate Interventions to Recommendations
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12. Final Refinements to Recommendations
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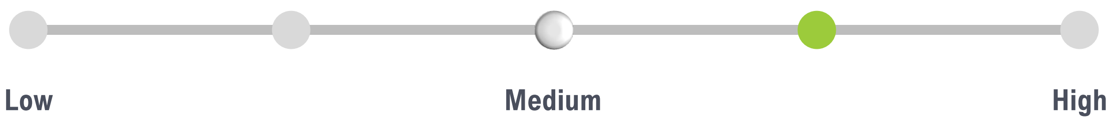
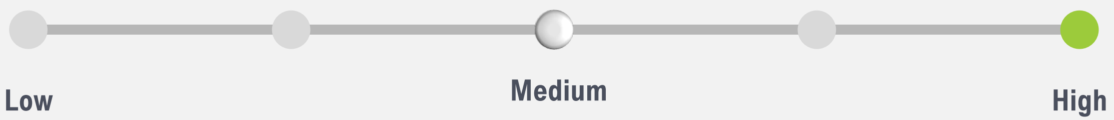
Problem Characterization

Information to gather for each topic

What is the problem?	Category 1: Public Health — Category 2: Compliance — Category 3: EJ — Category 4: Burden Complexity/Cost
What are the root causes?	
What is the magnitude?	Low — Medium — High
What degree of certainty do we have regarding root causes and magnitude?	Low — Medium — High

Problem Characterization: Example

Example	Legionella Exposure
What is the problem?	**Category 1: Public Health** In recent years, opportunistic pathogens – notably *Legionella*, Nontuberculous *Mycobacteria* (NTM), *and Pseudomonas aeruginosa* – have become an increased concern for water systems, with Legionella identified as the most common cause of waterborne disease outbreaks in the U.S (NASEM, 2020).
What are the root causes?	Several investigators have noted the occurrence of *Legionella* in distribution system samples and at least two legionellosis outbreaks have been presumptively linked with the presence of *Legionella* and low chlorine residuals in distribution system storage tanks. Sediments accumulated in storage tanks may increase chlorine demand, provide a favorable habitat for microbial growth, and high-water age may deplete disinfectant residuals.
What is the magnitude?	
What degree of certainty do we have regarding root causes and magnitude?	

Note: Example shown only for explanatory purposes and does not represent the official stance of the agency.

Problem Characterization: Example

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Example	Legionella Exposure
What is the problem?	**Category 1: Public Health** — In recent years, opportunistic pathogens – notably *Legionella*, Nontuberculous *Mycobacteria* (NTM), *and Pseudomonas aeruginosa* – have become an increased concern for water systems, with Legionella identified as the most common cause of waterborne disease outbreaks in the U.S (NASEM, 2020).
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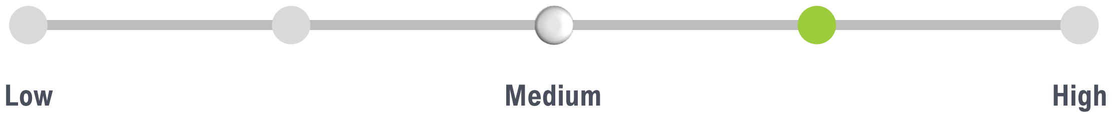
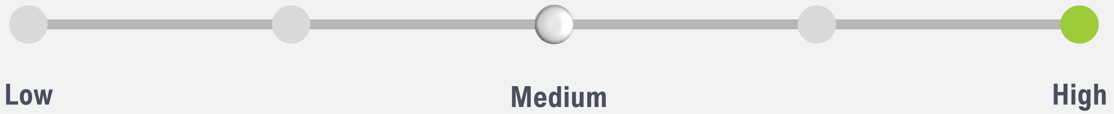
Type

What is the magnitude?



What degree of certainty do we have regarding root causes and magnitude?



Note: Example shown only for explanatory purposes and does not represent the official stance of the agency.

Problem Characterization: Example

Type 1

Magnitude: Medium to High
Certainty: Medium to High

Type 2

Magnitude: Medium to High
Certainty: Low to Medium

Type 3

Magnitude: Low
Certainty: High

Legionella

Problem Characterization Profile

Example	Legionella Exposure
What is the problem?	**Category 1: Public Health** In recent years, opportunistic pathogens – notably *Legionella*, Nontuberculous *Mycobacteria* (NTM), and *Pseudomonas aeruginosa* – have become an increased concern for water systems, with Legionella identified as the most common cause of waterborne disease outbreaks in the U.S (NASEM, 2020).
What are the root causes?	Several investigators have noted the occurrence of *Legionella* in distribution system samples and at least two legionellosis outbreaks have been presumptively linked with the presence of *Legionella* and low chlorine residuals in distribution system storage tanks. Sediments accumulated in storage tanks may increase chlorine demand, provide a favorable habitat for microbial growth, and high water age may deplete disinfectant residuals.

Type 1

What is the magnitude?	Low – Medium – High (rated between Medium and High)
What degree of certainty do we have regarding root causes and magnitude?	Low – Medium – High (rated High)

Note: Example shown only for explanatory purposes and does not represent the official stance of the agency.

Problem Characterization: Example

Topic	Category				Root Causes	Type		
	PH	Compliance	EJ	Burden Complexity/ Cost		1	2	3
Legionella	●		●			○		
Example	●		●	●		○		
Example		●	●				○	
Example	●		●				○	
Example			●	●				○
Example			●					○
Example	●	●	●					○
Example			●					○

*Environmental Justice is a cross-cutting issue that will be considered across all topic areas.

Problem Characterization: Example

Topic	Category				Root Causes	Type		
	PH	Compliance	EJ	Burden/ Complexity/Cost		1	2	3
Legionella	●		●			○		
Example 1	●		●	●		○		
Example 2		●	●				○	
Example 3	●		●				○	

Type 1: consensus that interventions should be considered = during recommendations phase of discussions, screen intervention options, hopefully reach consensus recommendation on specific interventions
Type 2: mixed opinion – more evidence may be needed (magnitude or root cause uncertain) = during recommendation phase of discussions, explore recommendation on additional problem characterization work
Type 3: consensus that intervention not needed (magnitude low and high certainty), clearly does not meet the need for intervention) = finding and recommendation will be no further action

*Environmental Justice is a cross-cutting issue that will be considered across all topic areas.

Problem Characterization to Intervention

This step may happen in multiple ways

Topic	Category				Root Causes	Type
	PH	Compliance	EJ	Burden/ Complexity/ Cost		1 – 2 – 3
Legionella	●		●			○ (1)
Example 1	●		●	●		○ (1)
Example 2		●	●			○ (2)
Example 3	●		●			○ (2)

What interventions can address the problem of *Legionella* exposure?

Cross-Cutting: What interventions can address one or more of these root causes?

*Environmental Justice is a cross-cutting issue that will be considered across all topic areas.

Problem Characterization Scope, Content, and Approach: Discussion Topics

- Do you have additional problem areas to include as part of the problem characterization (Table 2)?
- Which of these problem areas are of most interest to you and why?
- Are there any refinements to the problem exploration approach that will be helpful?

Segment 4: Problem Characterization – Opportunistic Pathogens

Ken Rotert, U.S. EPA OGWDW
Jasen Kunz, CDC
Rob Greenwood, Ross Strategic

August 17, 2022

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Opportunistic Pathogens

- Pathogens that typically do not cause disease in healthy persons; instead, they cause severe infections in those with weakened immune systems.
- They are naturally occurring in aquatic or moist environments and ubiquitous in the environment.
- Small numbers of some that survive treatment or enter the distribution system through other pathways may proliferate to relatively high levels in the distribution system and plumbing, due to their ability to grow there.

Opportunistic Pathogens

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- Known Opportunistic Pathogens of Concern in Drinking Water Distribution Systems
  - *Legionella*
    - Can cause Legionnaires' Disease (LD) – a severe form of pneumonia, and Pontiac Fever, a milder flu-like illness. Risk factors for developing an infection include age (>50 years), smoking, and lung conditions (e.g., asthma).
  - *Mycobacterium avium* Complex (MAC)
    - Primary diseases include lymphadenitis in children; respiratory infection in the elderly; and respiratory, intestinal, and disseminated disease in HIV-positive patients and those with immunocompromising conditions.
  - *Pseudomonas*
    - Can cause a variety of health effects, including pneumonia, septicemia, and meningitis, particularly in those immunosuppressed or immunocompromised, and having human tissue compromised by illness or injury.

Legionnaires' Disease – Additional Information

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- Most healthy people exposed to water that contains these germs do not get sick. However, there are certain groups of people who are more at risk for illness, such as individuals who are older than 50, are current or former smokers, have an underlying lung condition or a weakened immune system.
- Information about the proportion of the population at an increased risk of illness from opportunistic pathogens is available at Population-Based Assessment of Clinical Risk Factors for Legionnaires' Disease.
- Information about how susceptibility varies across different demographic groups (e.g., age, race, income) is available at CDCs Legionnaire's Disease Surveillance Summary Report, United States, 2016.
- In the United States, the rate of reported cases of Legionnaires' disease has grown by nearly nine times since 2000.
- It is unclear whether this increase represents artifact (due to increased awareness and testing), increased susceptibility of the population, increased *Legionella* in the environment, or some combination of factors.

Information sources: nih.gov; cdc.gov.

Legionnaires’ Disease – CDC Data

- Numbers of outbreaks of Legionnaires’ Disease, along with the numbers of cases of illness.
  - 2001 to 2020
  - 585 outbreaks
  - 3,770 illnesses
  - 1,954 hospitalizations
  - 250 deaths

Disclaimer – Materials Not Developed or Provided by EPA

The following fourteen slides were not developed or provided by EPA. As such, they have not been subject to review by EPA. The content of these slides do not necessarily reflect EPA policies or positions.

National Waterborne Disease Outbreak Surveillance

CDR Jasen Kunz, MPH

Waterborne Disease Prevention Branch

Centers for Disease Control and Prevention

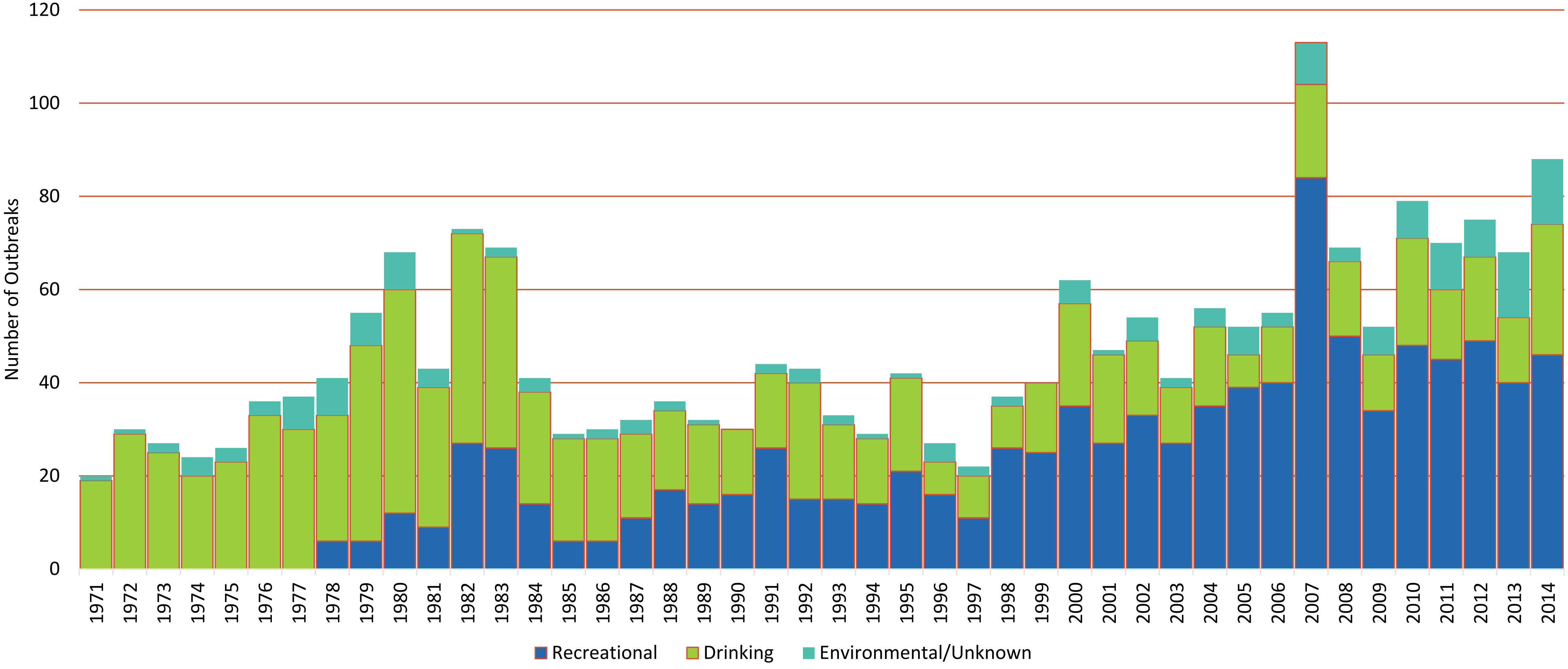
EPA National Drinking Water Advisory Council, Disinfection Byproducts Working Group

August 12, 2022

Surveillance for Waterborne Disease Outbreaks

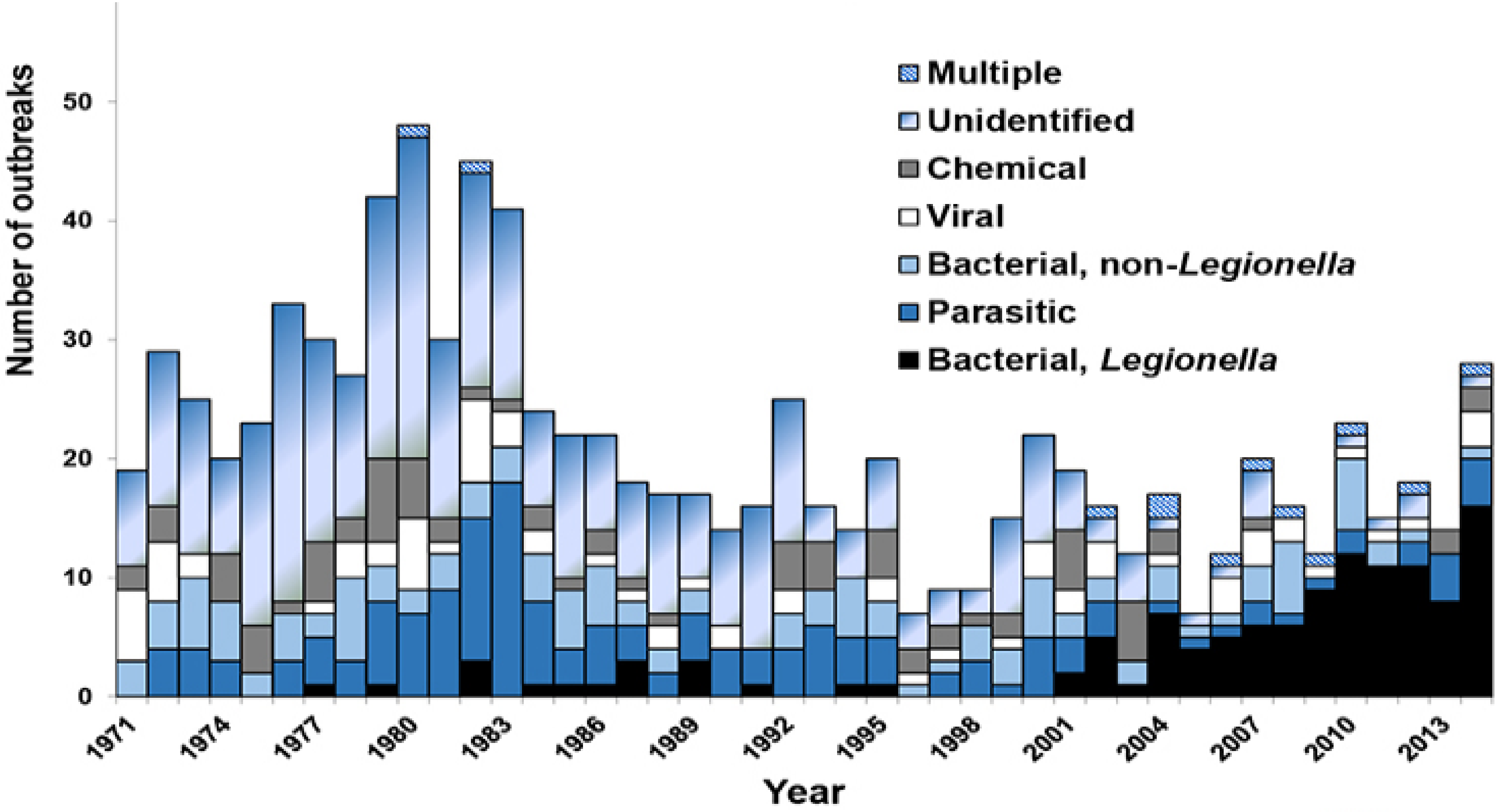
- Types: drinking water, recreational water, environmental/other (e.g., water used for agricultural purposes or in a cooling tower)
- Routes: ingestion, inhalation, intranasal, or contact
- Agents: microbe, chemical, or toxin
- Water testing: demonstrates contamination or identifies the etiologic agent is preferred, but not required for inclusion
- Volatized chemicals (including disinfection byproducts) leading to poor air quality are included

Waterborne Disease Outbreaks Reported to CDC – 1971 – 2014



N=2077; Recreational Water n=971; Drinking Water n=928; Environmental/Unknown Water n=178)

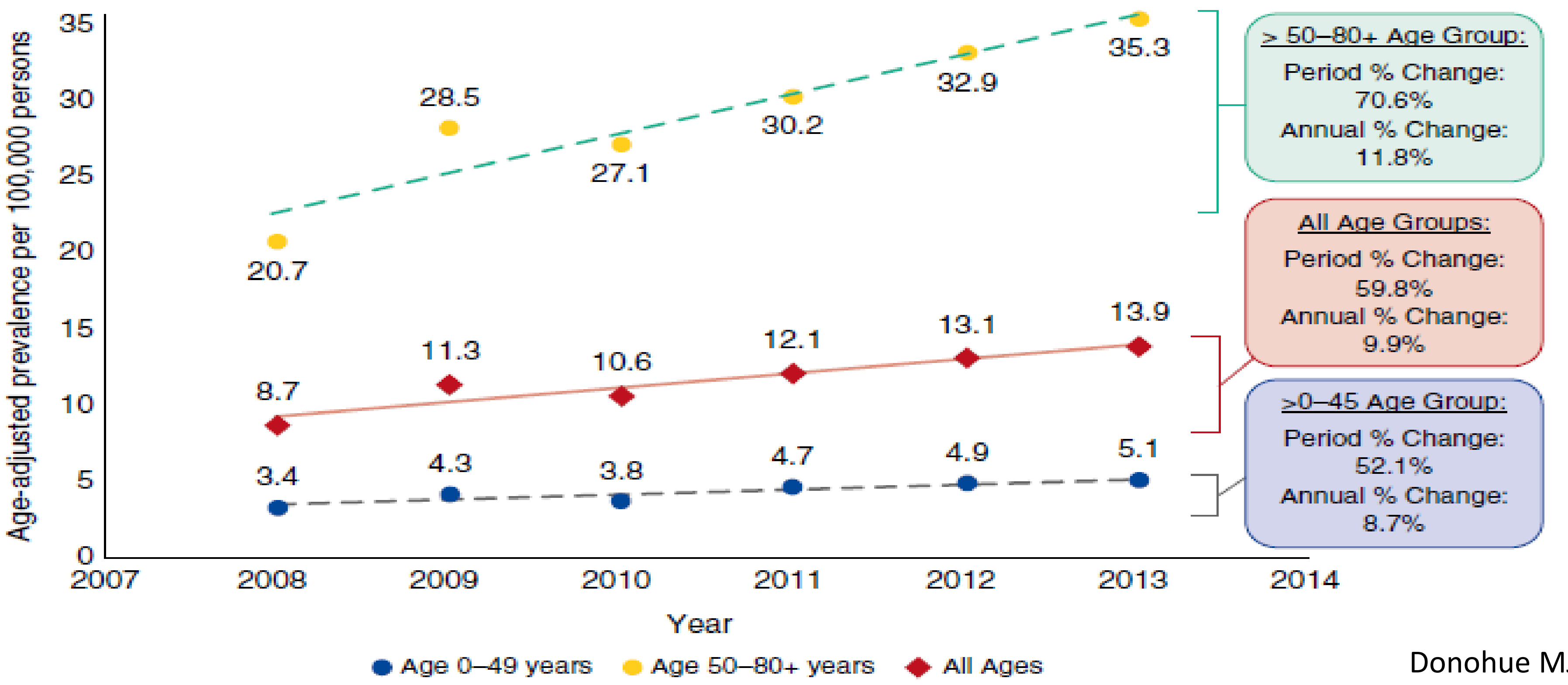
Chlorine-tolerant pathogens emerged; *Legionella* became a common cause of drinking water outbreaks



Opportunistic Pathogens Associated with Water

- *Pseudomonas aeruginosa*
- **Nontuberculous mycobacteria**
- *Legionella*
- *Acinetobacter baumannii*
- *Burkholderia cepacia* complex
- *Elizabethkingia spp.*
- *Enterobacter cloacae*
- *Stenotrophomonas maltophila*
- Fungi
- Free living amebae

Non-tuberculous mycobacteria cases are increasing



- **All cases increased 60% over 6 years**
- **2008: 8.7 cases per 100,000 persons**
- **2013: 13.9 cases per 100,000 persons**

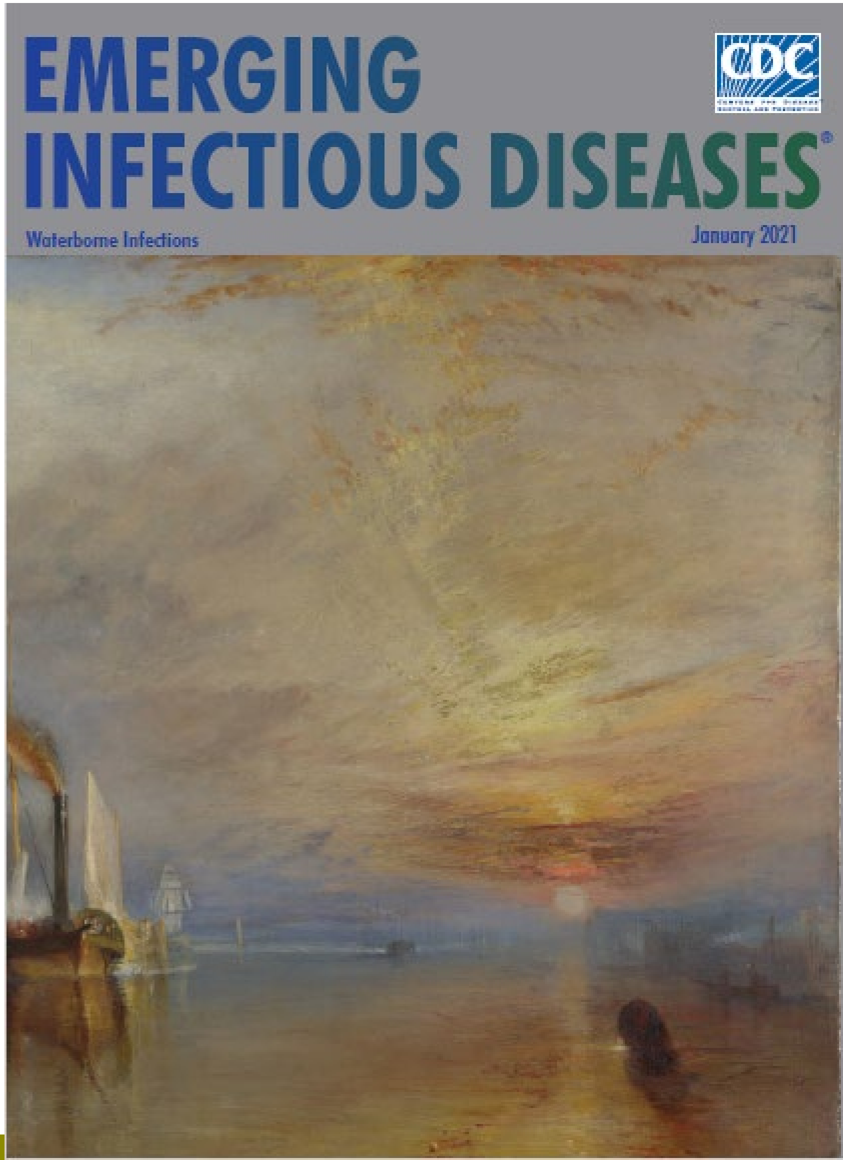
Donohue MJ and Wymer L. Ann Am Thorac Soc 2016

Biofilm pathogens associated with tap water are increasing in multiple settings

- Legionella outbreaks and infections continue to increase
  - Increases occur in healthcare settings, hotels, and community settings
- Multiple pathogens associated with increase in healthcare associated infections and outbreaks
  - Use of tap water in medical settings and devices has been implicated
- These issues are expected to increase with a changing climate and aging infrastructure

Each year, an estimated **7.2 million people get sick, 120,000 are hospitalized,** and **7,000 die** from a

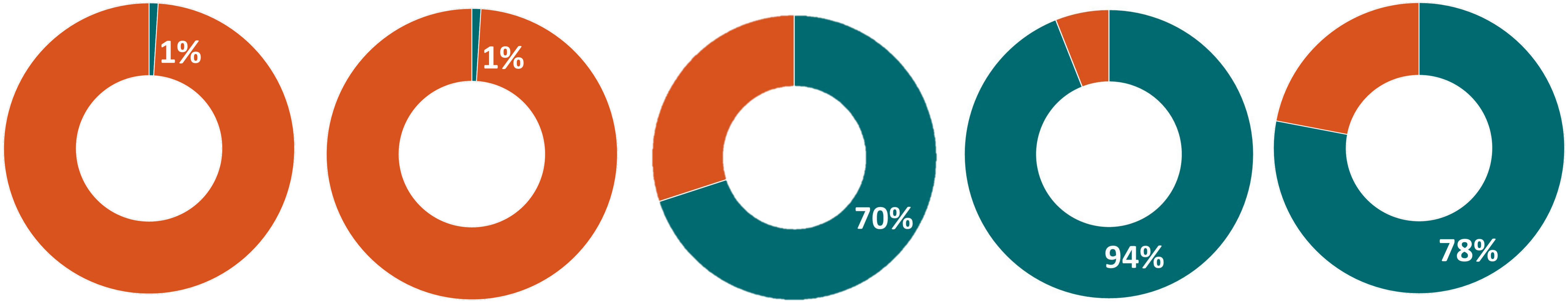
WATERBORNE DISEASE



Biofilm-associated:

1. NTM infection
2. Legionnaires' disease
3. *Pseudomonas* pneumonia
4. *Pseudomonas* septicemia

Infectious waterborne disease in the United States



7.2 million
illnesses

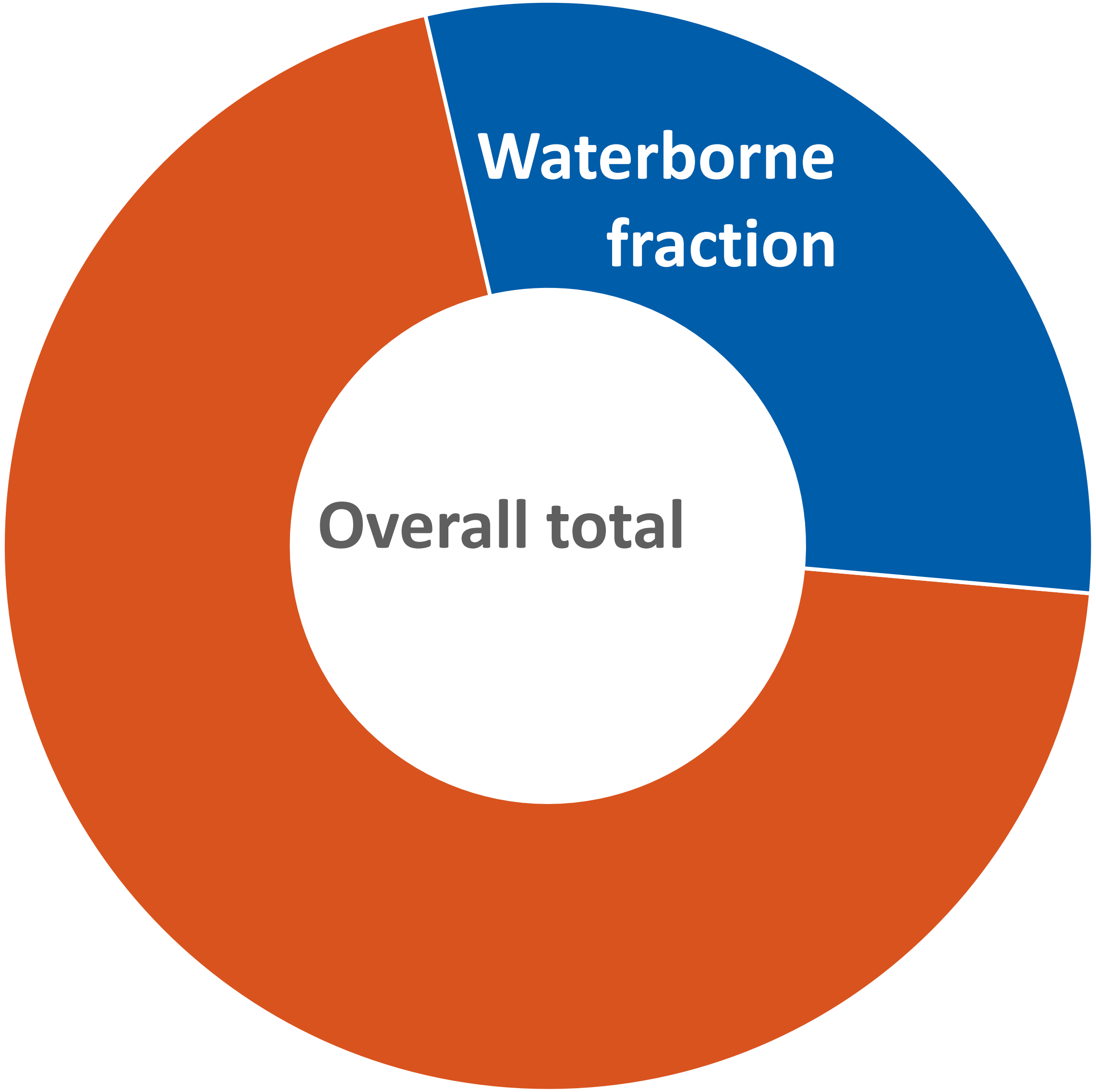
600,000
ED visits

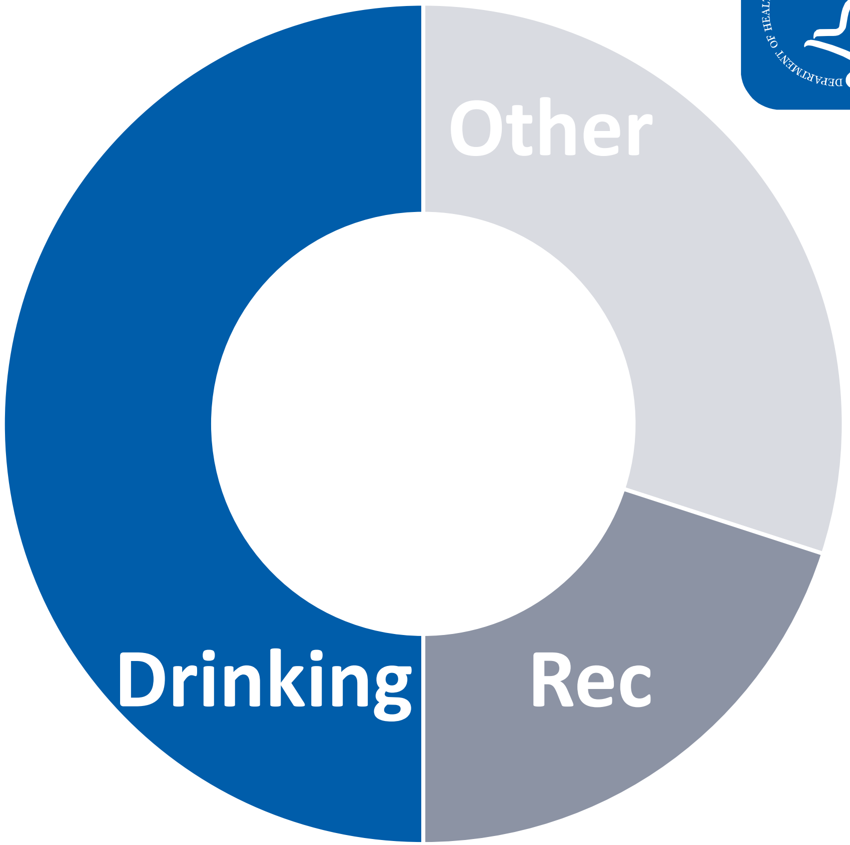
120,000
hospitalizations

7,000
deaths

3.3 billion
$US

% Biofilm-associated rises in more severe outcomes





Coming soon!

CDC Has Existing Guidance for Biofilm Pathogens

- Facility Water Management Program Toolkits:
  https://www.cdc.gov/legionella/wmp/overview.html

- Healthcare water pages (From Plumbing to Patients):
  https://www.cdc.gov/hai/prevent/environment/water.html

- Preventing Waterborne Germs at Home:
  https://www.cdc.gov/healthywater/drinking/preventin
  waterborne-germs-at-home.html

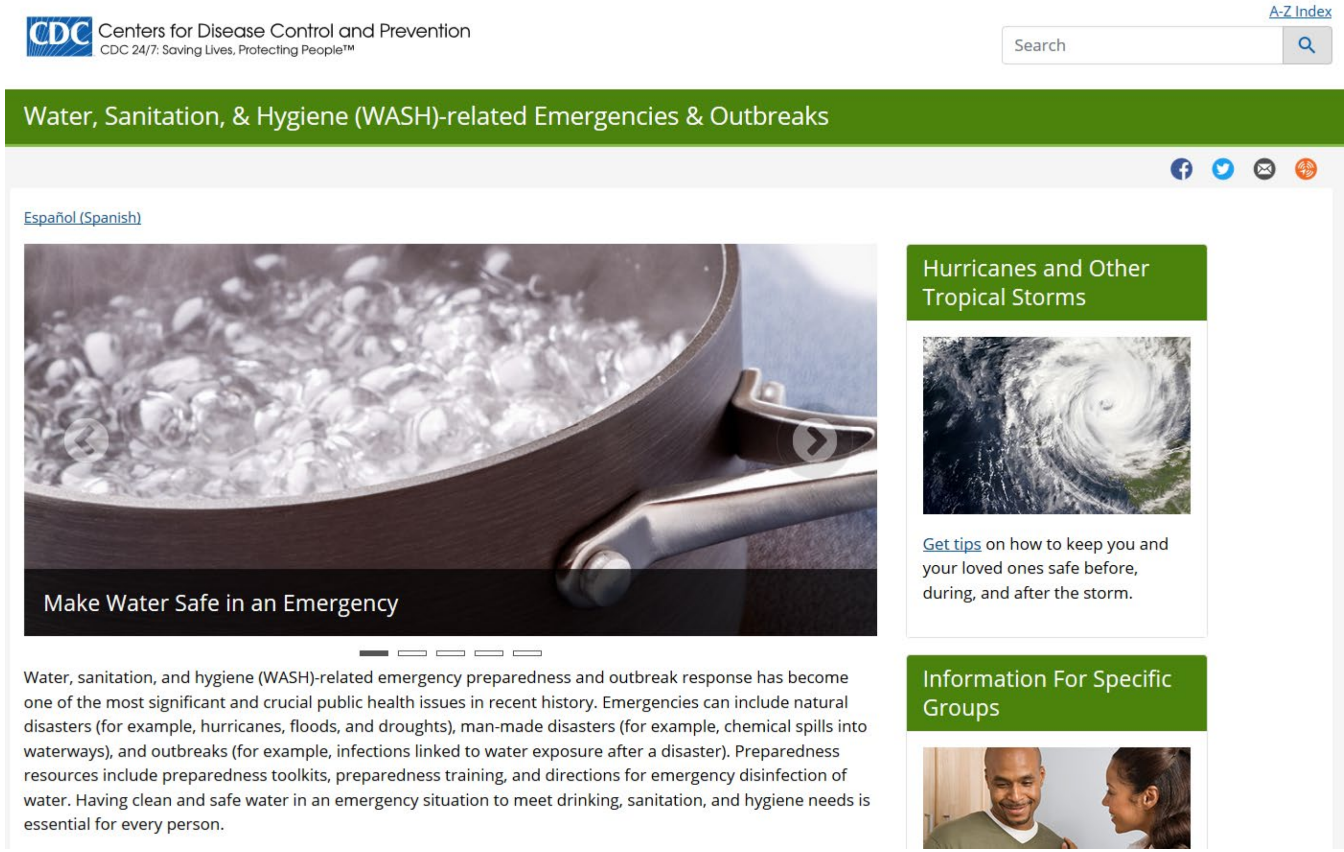
Additional Efforts are Needed to Prevent These Infections

- Multistakeholder efforts are needed to reduce incidence and burden of biofilm associated disease

- Important to understand system-wide factors associated with infection

Thank you!

www.cdc.gov/healthywater
www.cdc.gov/healthywater/emergency



For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Summary of *Legionella* spp. Occurrence Studies by Source Water and Secondary Disinfectant Type

- In Surface water-Chlorine, *Legionella* spp. was detected on average in 82% of samples, using molecular methods.
- In Surface water-Chloramine, *Legionella* spp. was detected on average in 50% of samples, using molecular methods.
- In Groundwater-Chloramine, *Legionella* spp. was detected on average in 100% of samples, using molecular methods.

***Legionella* spp. Occurrence Studies Focused on Distribution Water**

Source Water-Secondary Disinfectant	# Studies	# Total Distribution Systems	# Distribution Systems with a positive sample	*Legionella spp.* %, # positive samples (Molecular methods)
Surface water-Chlorine	1	1	1/1	82%, 448/544
Surface water-Chloramine	2	2	2/2	50%, 67/134
Groundwater-Chloramine	1	1	1/1	100%, 16/16
Blended-Chloramine	1	1	1/1	83%, 45/54
Unknown	1	1	1/1	56%, 23/41

References: Surface water-Chlorine: Omoregie et al. 2022, Surface water-Chloramine: Wang et al. 2012, Lu et al. 2021, Groundwater-Chloramine: Lu et al. 2021, Blended-Chloramine: Wang et al. 2012, Unknown Lu et al. 2015

Summary of *Legionella pneumophila* Occurrence Studies by Source Water and Secondary Disinfectant Type

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- In Surface water-Chlorine, *Legionella pneumophila* was detected on average in 2% of samples, using culture methods.
- In Surface water-Chloramine, *Legionella pneumophila* was detected on average in 0.2% of samples, using culture methods.
- In Groundwater-Chloramine, *Legionella pneumophila* was detected on average in 2% of samples, using culture methods.

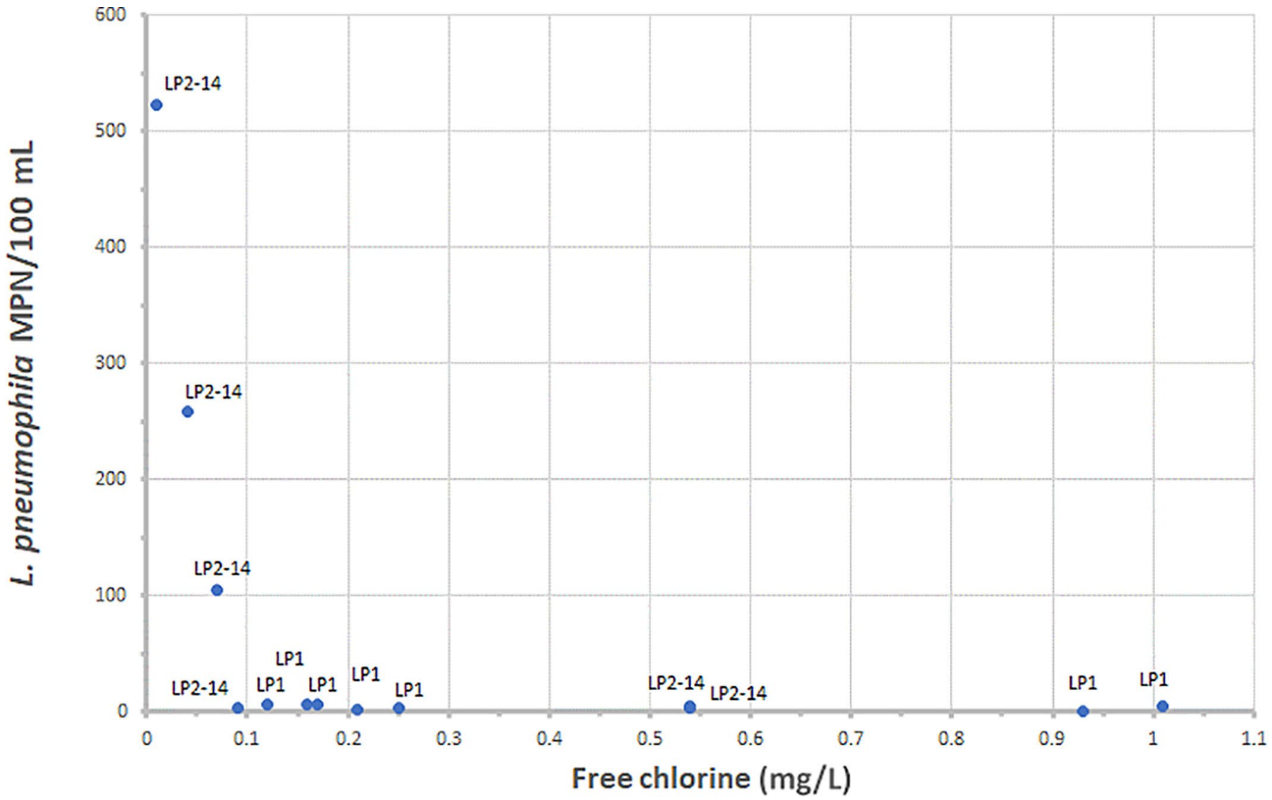
Legionella pneumophila **Occurrence Studies Focused on Distribution Water**

Source Water-Secondary Disinfectant	**# Studies**	**# Total Distribution Systems**	**# Distribution Systems with a positive sample**	**%, *L. pneumophila* # positive samples (Culture methods)**	**%, *L. pneumophila* # positive samples (Molecular methods)**
Surface water-Chlorine	4	13	38%, 5/13	2%, 29/1235	*
Surface water-Chloramine	4	14	7%, 1/14	0.2%, 1/499	4%, 6/134
Groundwater-Chlorine	1	1	1/1	2%, 1/53	*
Blended-Chloramine	1	1	1/1	*	6%, 3/54
Unknown	1	1	1/1	*	2%, 1/41

* No Data

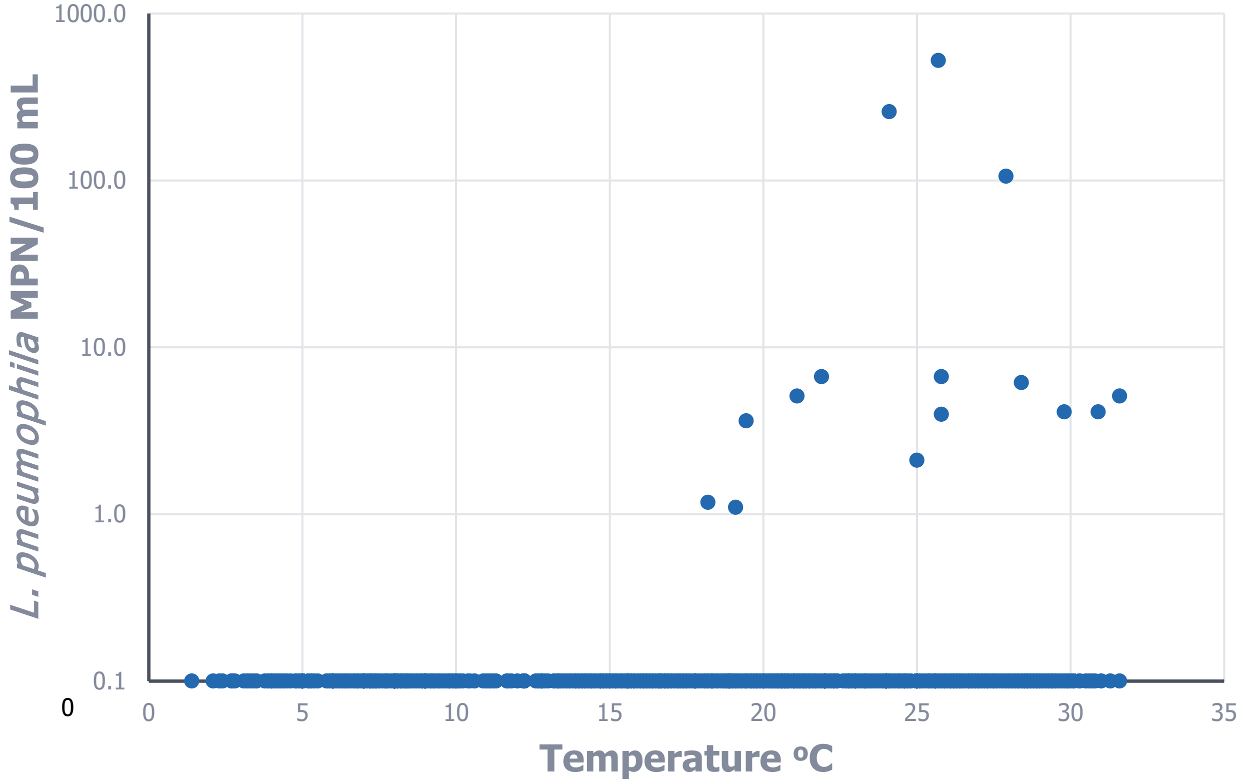
References: Surface water-Chlorine: LeChevallier 2018, LeChevallier 2019, Atkinson et al. 2022, Omoregie et al. 2022, Surface water-Chloramine: Wang et al. 2012, LeChevallier 2018, LeChevallier 2019, Lu et al. 2021, Groundwater-Chlorine: LeChevallier 2018, Groundwater-Chloramine: Lu et al. 2021, Blended-Chloramine: Wang et al. 2012, Unknown: Lu et al. 2015

Relationship between *Legionella pneumophila* Concentration and Free Chlorine Residual - Summer/Fall Study



Source: Occurrence of culturable *Legionella pneumophila* in drinking water distribution systems Mark W. LeChevallier. JAWWA. June 2019. https://doi.org/10.1002/aws2.1139.

Relationship between temperature and concentration of *Legionella pneumophila*.



Source: Occurrence of culturable *Legionella pneumophila* in drinking water distribution systems Mark W. LeChevallier. JAWWA. June 2019. https://doi.org/10.1002/aws2.1139.

Summary of *Pseudomonas aeruginosa* Occurrence Studies by Source Water and Secondary Disinfectant Type

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- In Surface water-Chloramine, *Pseudomonas aeruginosa* was detected on average in 1% of samples, using molecular methods.
- In Blended-Chloramine, *Pseudomonas aeruginosa* was detected on average in 6% of samples, using molecular methods.…

***P. aeruginosa* Occurrence Studies Focused on Distribution Water**				
Source Water-Secondary Disinfectant	**# Studies**	**# Total Distribution Systems**	**# Distribution Systems with a positive sample**	***P. aeruginosa* %, # positive samples (Molecular methods)**
Surface Water-Chlorine	*	*	*	*
Surface water-Chloramine	1	1	1/1	1%, 1/90
Groundwater-Chloramine	*	*	*	*
Blended-Chloramine	1	1	1/1	6%, 3/54
Unknown	1	1	1/1	24%, 10/41
* No Data				

References: Surface water-Chloramine: Wang et al. 2012, Blended-Chloramine: Wang et al. 2012, Unknown: Lu et al. 2015

Summary of Nontuberculous *Mycobacterium* (NTM) Occurrence Studies by Source Water and Secondary Disinfectant Type

- In Surface water-Chlorine, NTM was detected on average in 3% of samples, using culture methods.
- In Surface water-Chloramine, NTM was detected on average in 44% of samples, using culture methods.
- In Groundwater-Chlorine, NTM was detected on average in 29% of samples, using culture methods.
- In Groundwater-Chloramine, NTM was detected on average in 50% of samples, using culture methods.

NTM Occurrence Studies Focused on Distribution Water

Source Water-Secondary Disinfectant	# Studies	# Total Distribution Systems	# Distribution Systems with a positive sample	NTM %, # positive samples (Culture methods)	NTM %, # positive samples (Molecular methods)
Surface water-Chlorine	1	3	2/3	3%, 3/106	*
Surface water-Chloramine	3	7	Culture: 6/6 Molecular: 4/4	44%, 68/154	89%, 63/71
Groundwater-Chlorine	1	1	1/1	29%, 10/34	94%, 85/90
Groundwater- Chloramine	2	2	Culture: 1/1 Molecular: 1/1	50%, 8/16	81%, 13/16
Blended-Chloramine	1	1	1/1	*	94%, 75/80
Unknown	1	1	1/1	*	88%, 79/90

* No Data

References: Surface water-Chlorine: Falkinham et al. 2001, Surface water-Chloramine: Falkinham et al. 2001, Wang et al. 2012, Waak et al. 2019, and (Pfaller et al. 2021 and Lu et al. 2021), Groundwater-Chlorine: Falkinham et al. 2001, Groundwater-Chloramine: Wang et al. 2012, (Pfaller et al. 2021 and Lu et al. 2021), Blended-Chloramine: Wang et al. 2012, Unknown Lu et al. 2015

Summary of *Mycobacterium avium* Complex (MAC) Occurrence Studies by Source Water and Secondary Disinfectant Type

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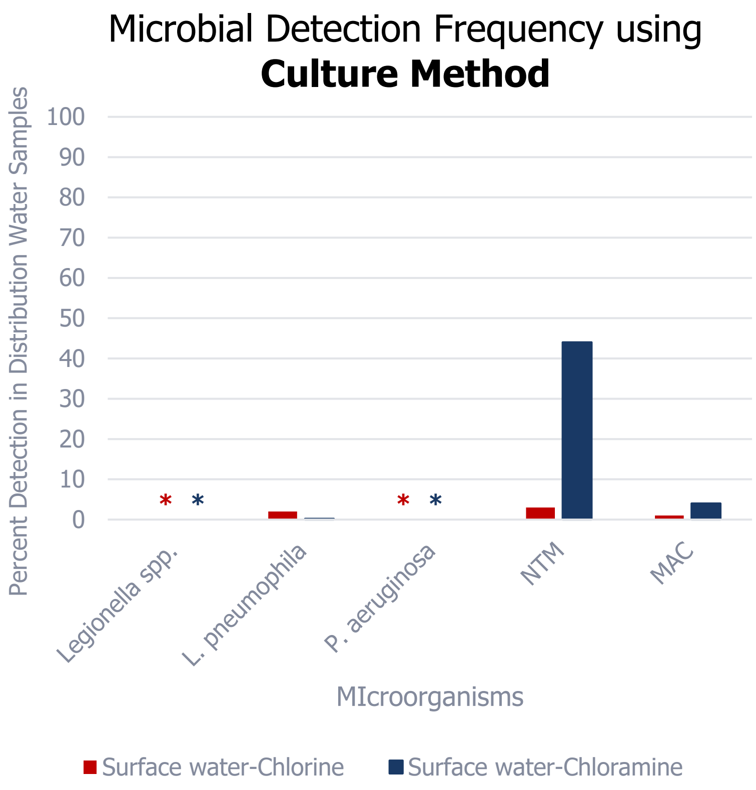
- In Surface water-Chlorine, MAC was detected on average in 1% of samples, using culture methods.
- In Surface water-Chloramine, MAC was detected on average in 4% of samples, using culture methods.
- In Groundwater-Chlorine and Chloramine, MAC was detected on average in 0% of samples, using culture methods
- MAC molecular detection is 15X greater than culture detection.

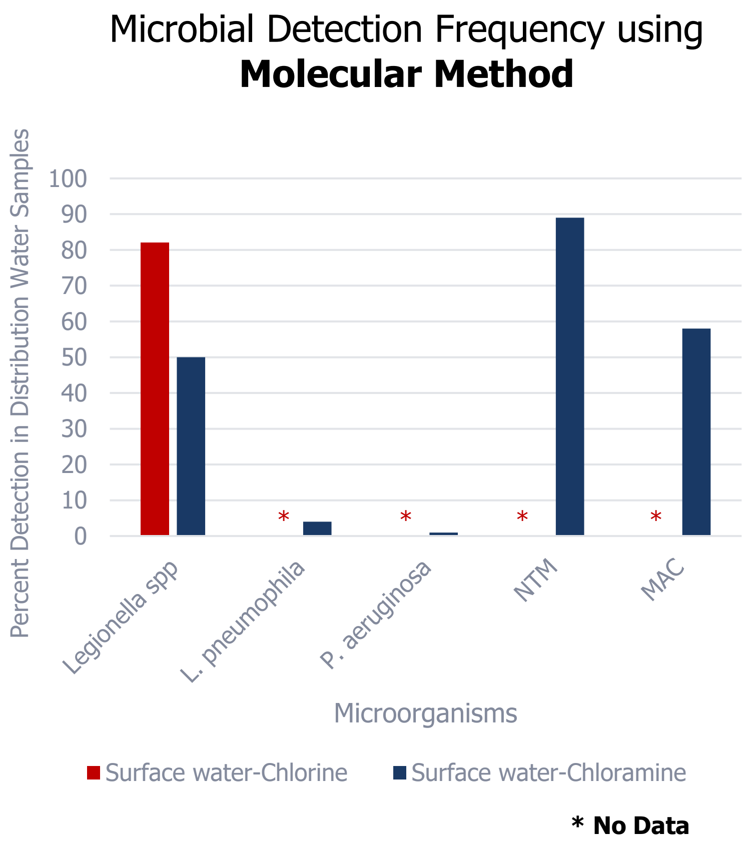
MAC Occurrence Studies Focused on Distribution Water					
Source Water-Secondary Disinfectant	**# Studies**	**# Total Distribution Systems**	**# Distribution Systems with a positive sample**	**MAC %, # positive samples (Culture methods)**	**MAC %, # positive samples (Molecular methods)**
Surface water-Chlorine	1	3	1/3	1%, 1/106	*
Surface water-Chloramine	2	4	Culture: 4/4 Molecular: 3/3	4%, 6/154	58%, 28/48
Groundwater-Chlorine	2	2	Culture: 1/1 Molecular: 1/1	0%, 0/34	9%, 8/90
Groundwater- Chloramine	1	1	1/1	0% 0/16	19%, 3/16
Blended-Chloramine	1	1	1/1	*	10%, 8/80

* No Data

References: Surface water-Chlorine: Falkinham et al. 2001, Surface water-Chloramine: Falkinham et al. 2001, Wang et al. 2012, Waak et al. 2019, and (Pfaller et al 2021 Lu et al. 2021), Groundwater-Chlorine: Falkinham et al. 2001 Groundwater-Chloramine: Wang et al. 2012, (Pfaller et al. 2021 and Lu et al. 2021), Blended-Chloramine: Wang et al. 2012, Unknown Lu et al. 2015

Comparison of Microbial Detection Frequencies in Surface Water using Culture and Molecular Methods





Surface water:

In chlorine treated water, NTM has the highest detection frequency of 3% by culture methods, and *Legionella spp.* has the highest detection frequency of 82% by molecular methods.

In chloramine treated water, NTM has the highest detection frequency of 44% and 89%, by culture and molecular methods.

Summary of Available Occurrence Data for Opportunistic Pathogens in Storage – Examples

- *Legionella* spp. was detected in 66.7% of 87 sediment samples from 18 municipal drinking water storage tanks across 10 states. (Lu, Journal of Applied Microbiology, 2015)
- Sampling at a major city distribution system using qPCR found 57% of samples to be positive for *Legionella*, 88% positive for *Mycobacteria*, and 24% positive for *Pseudomonas*. (Lu, Journal of Applied Microbiology, 2016)
- *Legionella* evidence using qPCR in 50% and *Mycobacteria* in 88% of sediment and water samples, and *Pseudomonas* in 50% of water samples from eight storage tanks. (Qin, Pathogens, 2017)

Relative contribution of factors to the entry or growth of opportunistic pathogens in PWS

Factors that can contribute to opportunistic pathogen growth in PWSs include inadequate disinfectant residuals, nutrient availability, high water age, corrosion and infrastructure condition, and sediment accumulation.

- Inadequate disinfectant residuals can be caused by high residence time (e.g., in storage tanks), reactions with distribution system materials, demand from contaminants entering the distribution system, and excess biofilms.
- Nutrients can enter through a variety of sources, including from the source water, and the distribution system (e.g., pipe and storage breaches).
- *Legionella* can grow in parts of a distribution system with high water age, such as storage tanks with inadequate water turnover, dead ends, and near closed valves.
- Iron corrosion may deplete disinfectant residuals, increase iron bioavailability, increase *Legionella* virulence, enhance biofilm growth, and create a habitat where *Legionella* is protected from disinfection.
- Distribution systems (e.g., main breaks) may seed premise plumbing with *Legionella* and lead to Legionnaires' Disease outbreaks or sporadic cases.

Opportunistic Pathogens – Considerations for Disinfectant Residuals and Microbial Indicators

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- Next three slides show concentrations of disinfectant residual and additional microbial indicators over approximate 10-year period.
  - Time periods considered were prior to Stage 2, after Stage 2, and after Revised Total Coliform Rule (RTCR).
- The percentage of systems meeting certain Free chlorine (FCL) and total chlorine (TCL) thresholds has improved over time.
- FCL and TCL results show that disinfectant residual is not the only parameter relevant to consider in the control of opportunistic pathogens.
- Total coliform (TC) and *E. coli* (EC) concentrations found to increase slightly over those time periods.
- TC and EC results show that these indicators may be less relevant to consider in the control of opportunistic pathogens.

Three-year Averages of Free Chlorine (only) Measurements among Common Community Systems for 2009-2019

System Size	Systems >= 10k				Systems< 10k		
Time Period	2009-2011	2013-2015	2017-2019		2009-2011	2013-2015	2017-2019
Regulatory Period	Before Stage 2 DBPR	After Stage 2 DBPR & before RTCR	After RTCR		Before Stage 2 DBPR	After Stage 2 DBPR & before RTCR	After RTCR
% FCL Measurements w Non-Detect (i.e., 0)	0.15%	0.05%	0.06%		0.81%	0.50%	0.19%
% FCL Measurements w Levels < 0.1 mg/L	1.14%	0.52%	0.45%		2.74%	2.60%	2.02%
% FCL Measurements w Levels < 0.5 mg/L	12.0%	10.0%	8.2%		21.5%	21.3%	20.1%

Three-year Averages of Total Chlorine (only) Measurements among Common Community Systems for 2009-2019

System Size	Systems >= 10k				Systems< 10k		
Time Period	2009-2011	2013-2015	2017-2019		2009-2011	2013-2015	2017-2019
Regulatory Period	Before Stage 2 DBPR	After Stage 2 DBPR & before RTCR	After RTCR		Before Stage 2 DBPR	After Stage 2 DBPR & before RTCR	After RTCR
% TCL Measurements w Non-Detect (i.e., 0)	0.06%	0.04%	0.01%		0.16%	0.18%	0.11%
% TCL Measurements w Levels < 0.2 mg/L	0.94%	0.50%	0.37%		1.84%	2.13%	2.30%
% TCL Measurements w Levels < 1.0 mg/L	24.2%	17.1%	12.6%		26.6%	28.1%	27.9%

Three-year Averages of TC/EC Positive Rates among Common Community Systems for 2009-2019

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System Size	Systems >= 10k				Systems< 10k		
Time Period	2009-2011	2013-2015	2017-2019		2009-2011	2013-2015	2017-2019
Regulatory Period	Before Stage 2 DBPR (after Stage 1)	After Stage 2 DBPR & before RTCR	After RTCR		Before Stage 2 DBPR	After Stage 2 DBPR & before RTCR	After RTCR
%RTTC+	0.17%	0.20%	0.19%		0.60%	0.59%	0.59%
%RTEC+	0.008%	0.013%	0.007%		0.031%	0.040%	0.049%

- Only included system months with ≥ 90% of RTTC monitoring records per requirements under RTCR to reduce any biases from uncompleted reporting.
- RTTC+ – routine total coliform – positive result; RTEC+ – routine *E. coli* – positive result.

Opportunistic Pathogens: Discussion Topics

- Clarifying questions for technical presenters?
- What additional information will be helpful to further understand opportunistic pathogen-related problems?
- Within the drinking water value chain, what do you believe are the most prominent root causes?
- Given the information in front of you today, how do you perceive the magnitude of the public health concern?
- What degree of certainty do we have regarding root causes and magnitude of the problem?

BREAK (30 MINUTES)
3:30 TO 4:00 PM EASTERN

Segment 5: Problem Characterization – Disinfectant Residuals

Richard Weisman, U.S. EPA OGWDW
Chad Seidel, Corona Environmental
Rob Greenwood, Ross Strategic

August 17, 2022

EPA
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Disinfectant Residual Types – Introduction

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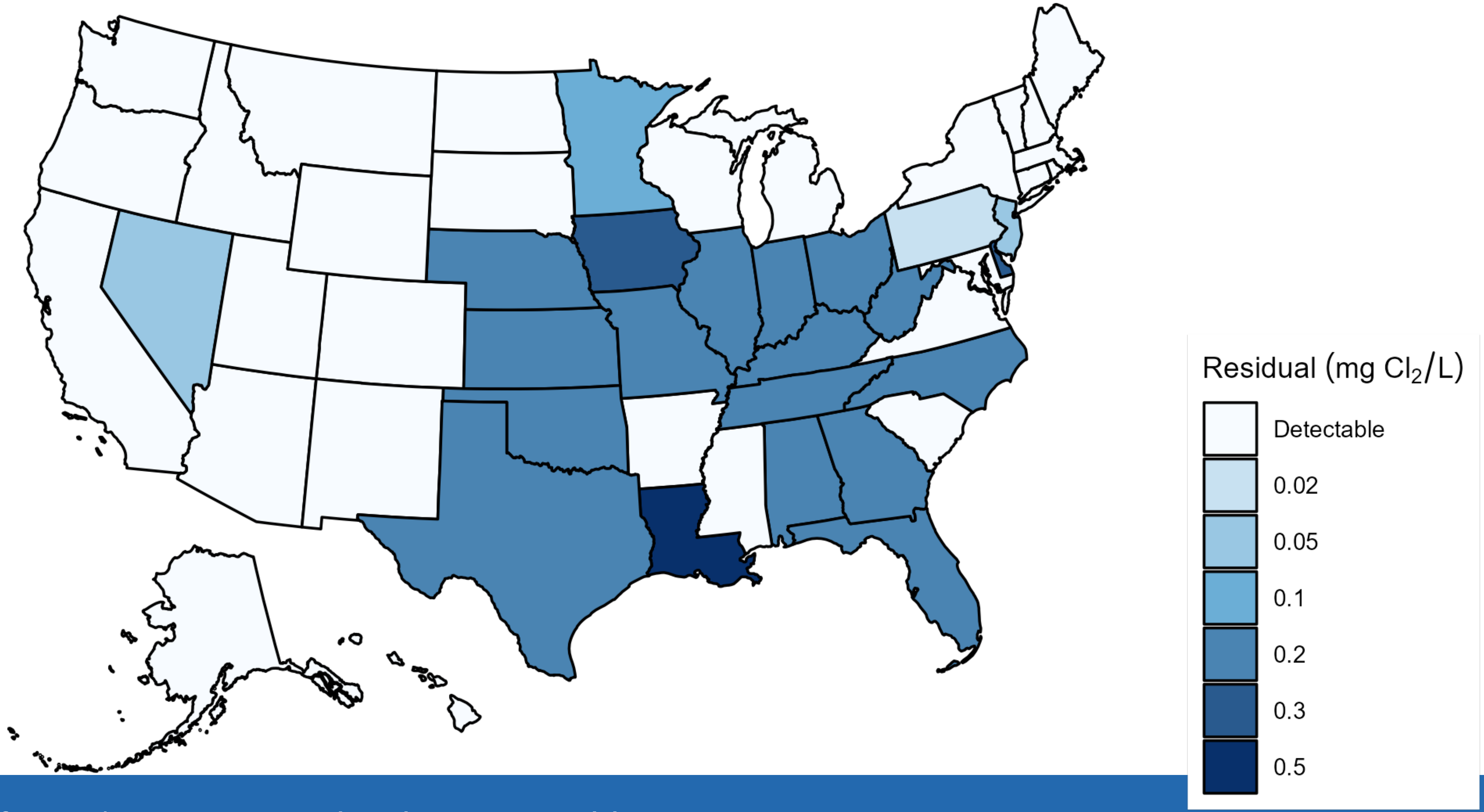
- Free chlorine (used as primary and secondary disinfection)
  - Is the most commonly used disinfectant in the US.
  - In a 2017, AWWA Water Utility Disinfection Survey, 259 respondents (70% of total respondents) reported using chlorine as the disinfectant (AWWA Disinfection Committee, 2021).
- Chloramines (used as secondary disinfection and after primary disinfection):
  - Are most commonly formed when ammonia is added to chlorine to treat drinking water.
  - Provide longer-lasting disinfection as the water moves through pipes to consumers.
  - Have been used by water utilities since the 1930s.
  - Generally less disinfecting power than free chlorine.
  - Reported as more prevalent use among survey respondents in Florida, South Carolina, Texas, and Virginia (AWWA Disinfection Committee, 2021).
  - Produces lower concentrations of regulated DBPs because it is less reactive than chlorine with natural organic matter but may produce different unregulated DBPs.

Number of Surface Water CWSs and Population Served Based on Type of Residual

System Size	Disinfectant Residual Type	No. of Systems	Total Population (million)	Percent of Systems	Percent of Population
Large	Free Chlorine	175	63.2	47.6%	49.9%
	Chloramine	192	63.4	52.4%	50.1%
Medium	Free Chlorine	1,649	49.0	68.3%	66.2%
	Chloramine	765	25.1	31.7%	33.8%
Small	Free Chlorine	5,683	13.2	64.4%	65.9%
	Chloramine	3,135	6.8	35.6%	34.1%

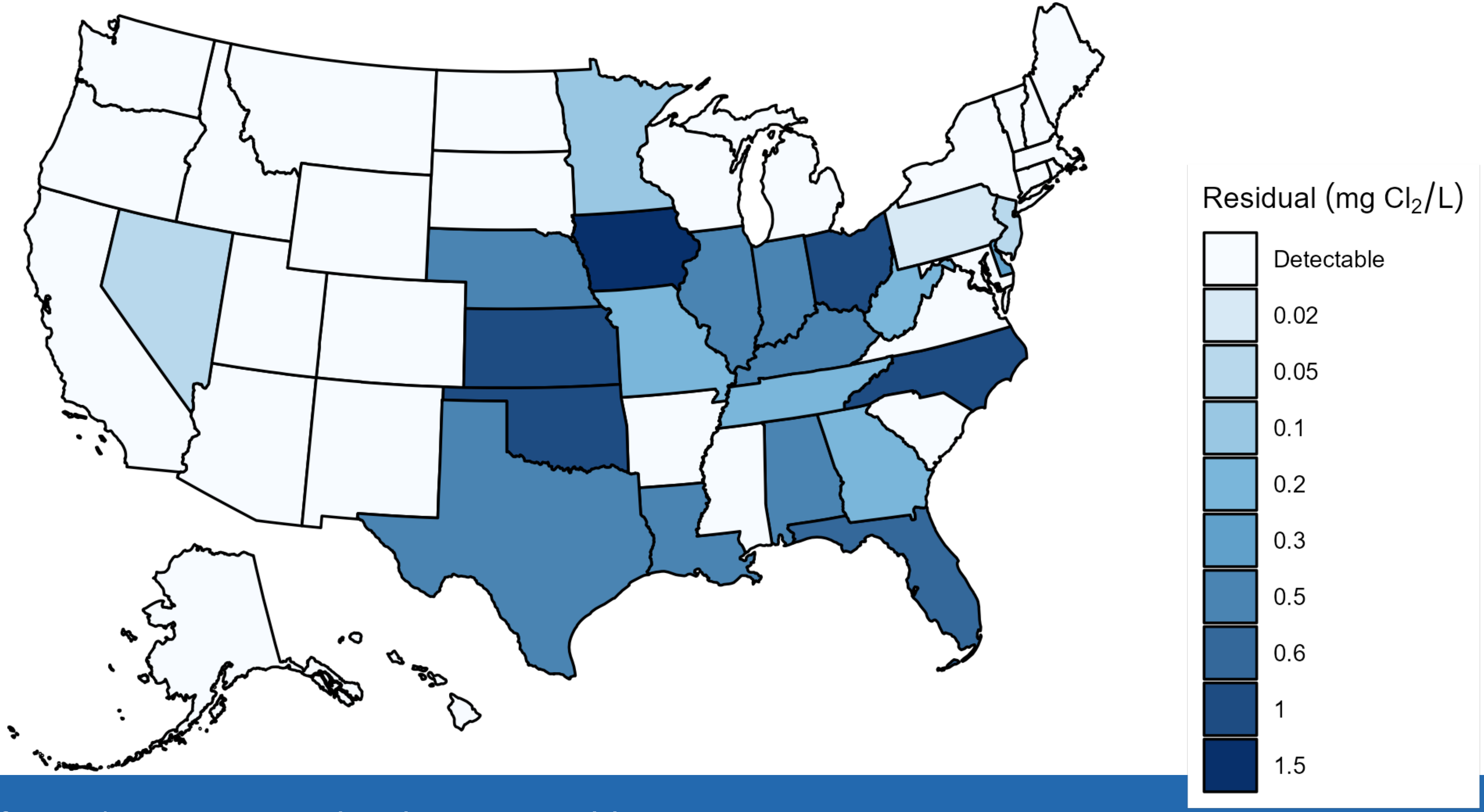
Sources: SDWIS (calendar year 2019), SYR4 ICR, and UCMR4.
Approach used to identify type of residual: For PWSs included in UCMR4, identify if any indication of chloramine identify such PWS as chloramine system. For PWSs not included in UCMR4, identify if PWS only reported total chlorine residuals in calendar year 2019; identify such PWS as chloramine system. If PWS only reported free chlorine residuals in calendar year 2019; identify such PWS as free chlorine system. If reported both free and total chlorine, or did not report free or total, consider as unknown. For PWSs identified as unknown, proportionally extrapolate from the known systems for a national estimate within same system type, system size, and source water type.

Free Chlorine Residual Requirements (01/20/2015)



Source: Adapted from Wahman & Pressman (2015). *JAWWA,* 107(8), 53–63

Total Chlorine Residual Requirements (01/20/2015)



Source: Adapted from Wahman & Pressman (2015). *JAWWA,* 107(8), 53–63

Residual Requirement Changes Since 2015

State	Effective Date	Residual Change	Free Chlorine (mg Cl_2/L)	Total Chlorine (mg Cl_2/L)
Colorado	04/01/2016	Detectable to numeric	0.2	0.2
Illinois	06/26/2019	Raised numeric	0.5	1
Louisiana	03/20/2016	Promulgated emergency numeric initiated on 02/01/2014	0.5	0.5
Pennsylvania	04/29/2019	Raised numeric	0.2	0.2
Washington	01/14/2017	Detectable to numeric by defining detectable as numeric value	0.2	0.2

- Only Colorado changed from detectable to numeric during years of six–year review data set (2012–2019)

Disinfectant Residuals – Considerations about Analytical Methods

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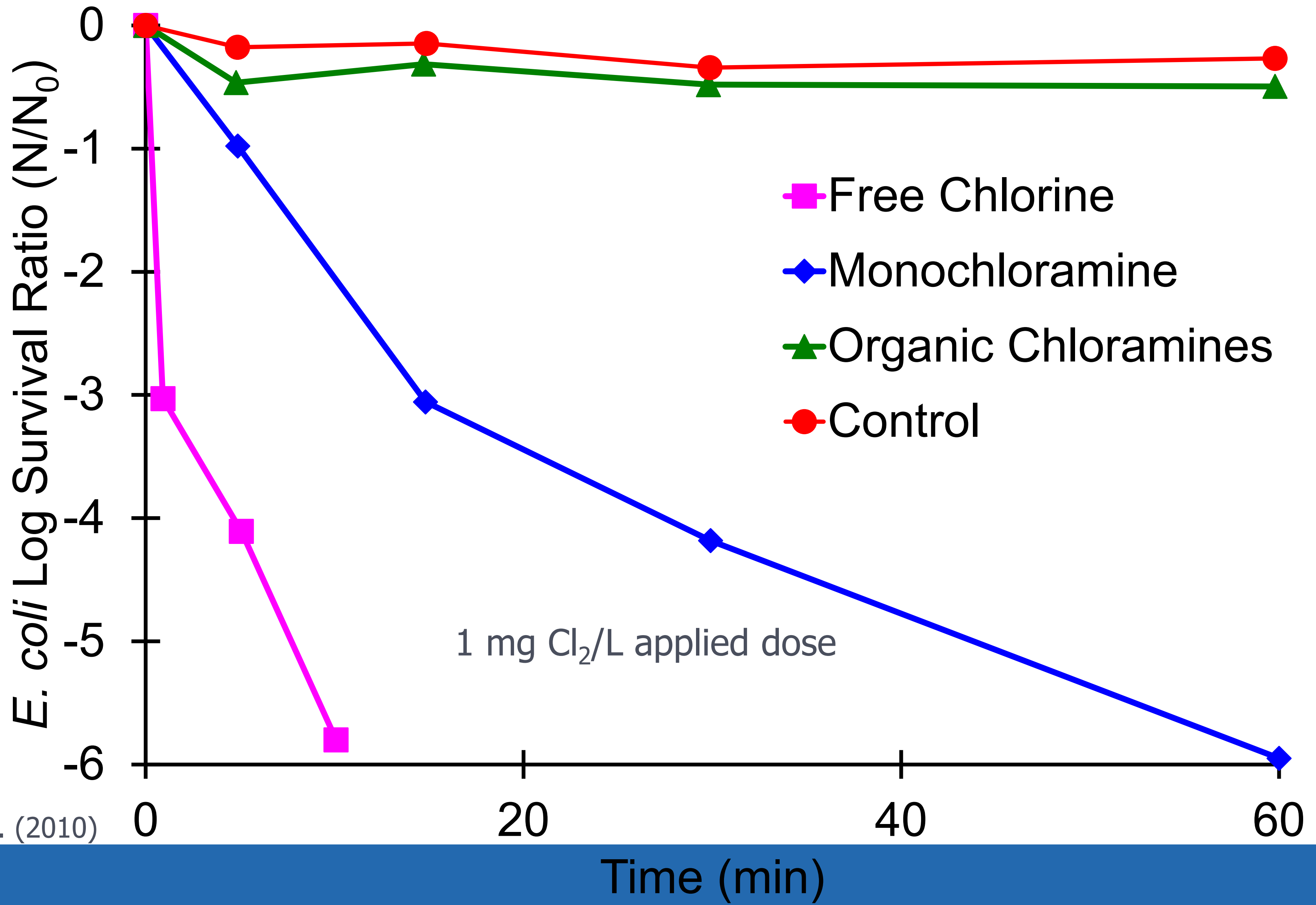
- EPA evaluated information under Six-Year Review 3 related to the maintenance of a minimum disinfectant level in distribution systems and determined that an unquantified detectable concentration of disinfectant residual in distribution systems may not be adequately protective of public health with respect to exposure to microbial pathogens.
- False positives may be of concern when organic chloramines are detected rather than the presence of an active disinfectant residual (i.e., monochloramine).
- Recent addition to approved analytical methods:
  - EPA Method 127 published on the determination of concentrations of monochloramine in drinking water.

Sources: Westerhoff et al., 2010; Wahman and Pressman, 2015

Organic Chloramines - Poor Disinfectants

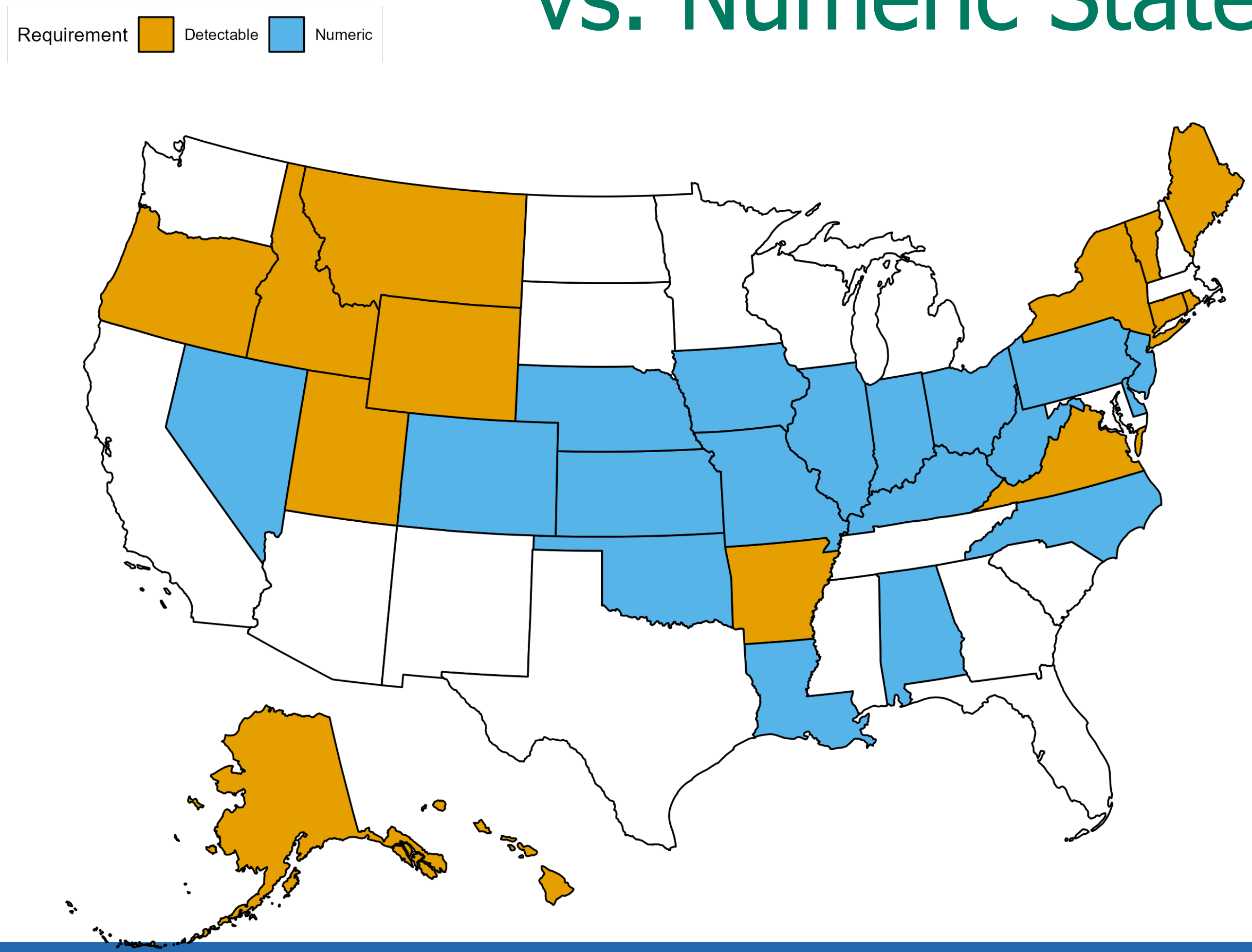


Source: Westerhoff et al. (2010)

Disinfectant Residuals – Additional Considerations

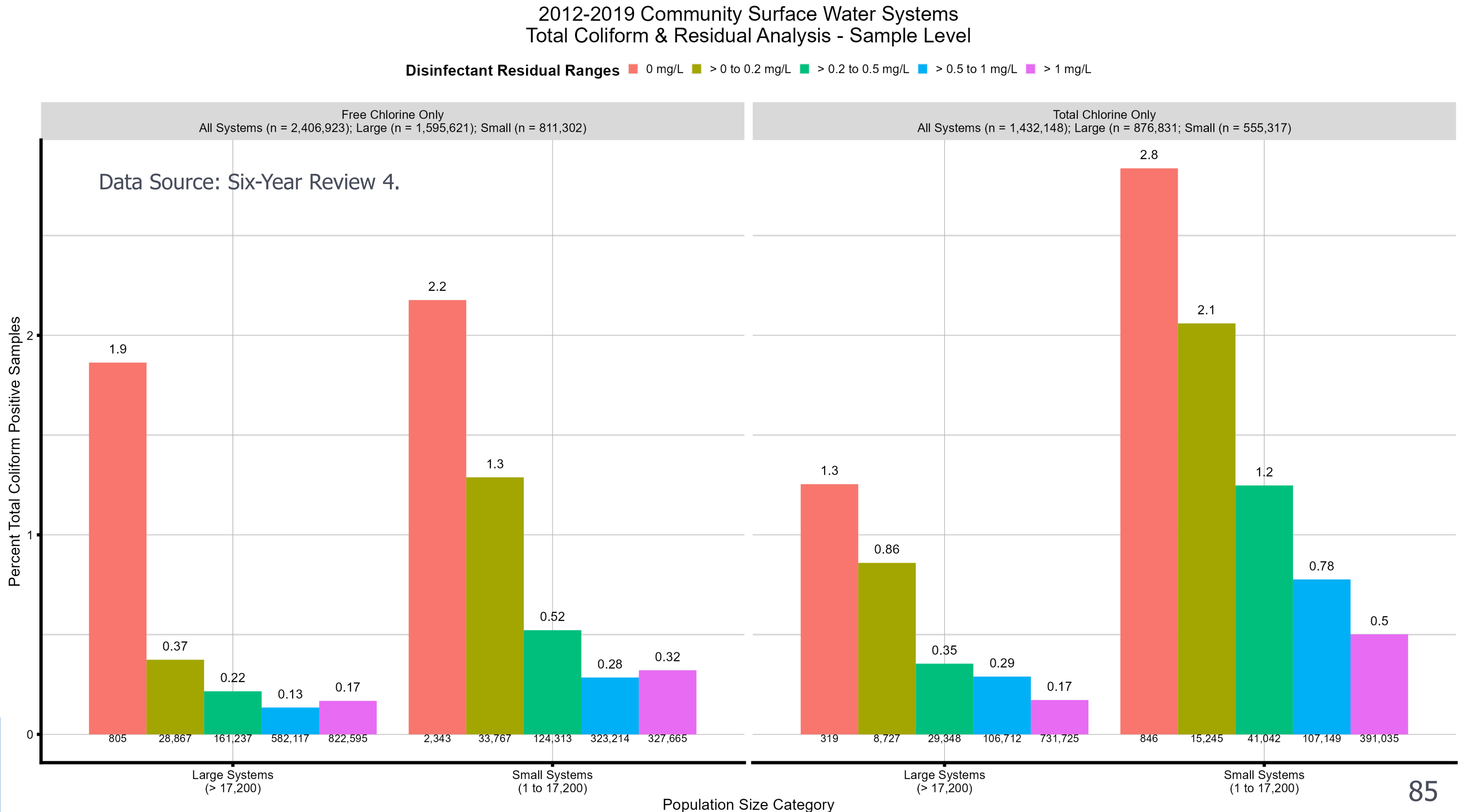
- Increasing the disinfectant dose to raise disinfectant residual levels may lead to potentially increased DBP risks.
- Disinfectant residuals may not remain at far reaches of the distribution system.
- Chloramine as a disinfectant residual may increase nitrification risks.
- Organic chloramines may be formed based on organic–N + Monochloramine or organic–N + Free chlorine.
    - Positive interference on colorimetric methods (e.g., DPD)
    - Increase % of total chlorine with time
    - Precursors in the distribution system lead to more formation over time

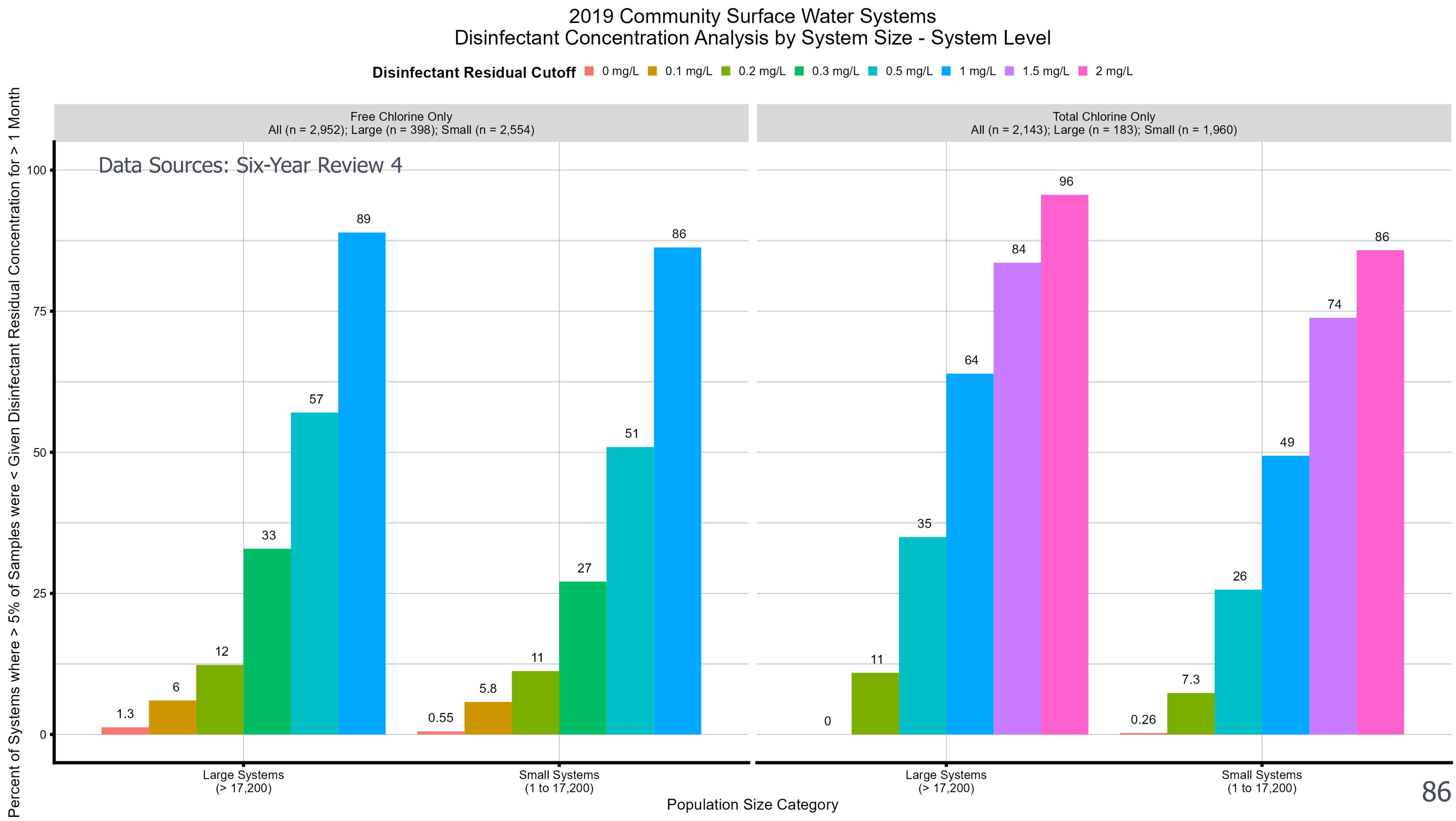
Analysis – Disinfectant Residual Related to Microbial Indicators and Detectable vs. Numeric States



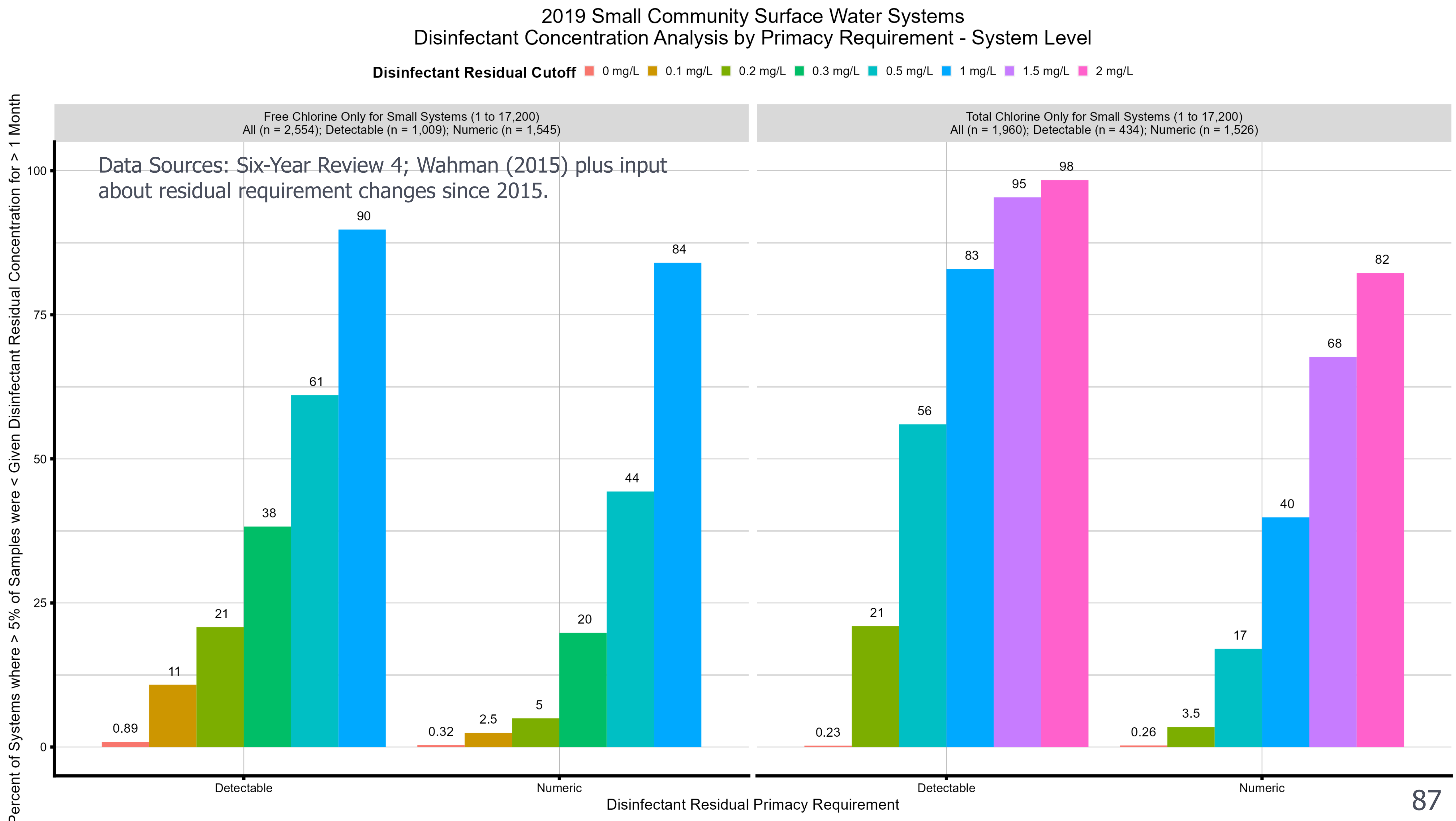
Data processing:

- Based on data collected from states under Six-Year Review 4.
- 8,423,326 records
  - 6,355,722 free chlorine reported
  - 3,851,129 total chlorine reported
- Free chlorine only considered as free chlorine system.
- Total chlorine only considered as chloramine system.

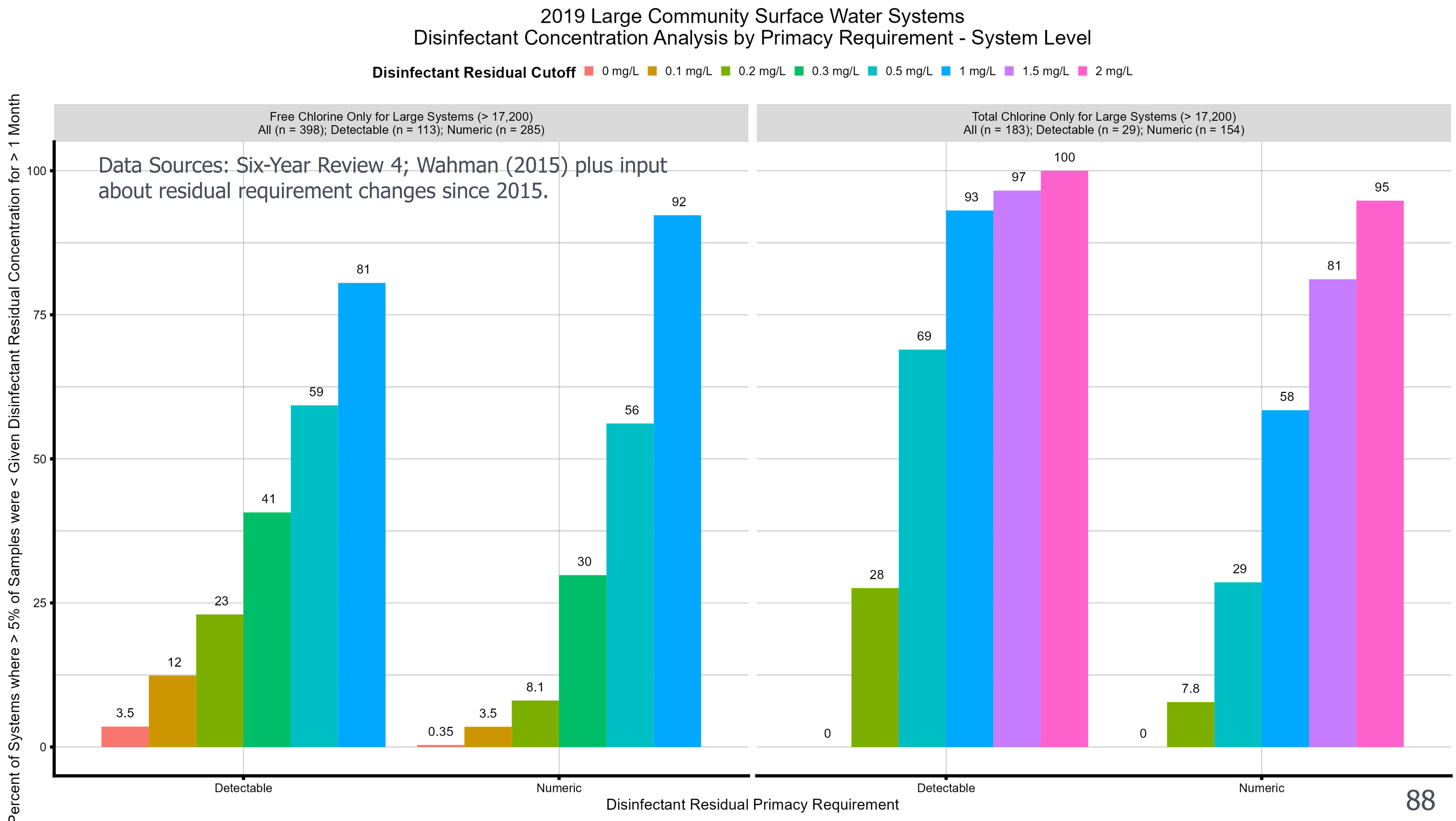

2012-2019 Community Surface Water Systems
Total Coliform & Residual Analysis - Sample Level
Disinfectant Residual Ranges
0 mg/L
> 0 to 0.2 mg/L
> 0.2 to 0.5 mg/L
> 0.5 to 1 mg/L
> 1 mg/L
Free Chlorine Only
All Systems (n = 2,406,923); Large (n = 1,595,621); Small (n = 811,302)
Total Chlorine Only
All Systems (n = 1,432,148); Large (n = 876,831; Small (n = 555,317)
Data Source: Six-Year Review 4.
Percent Total Coliform Positive Samples
0
1
2
1.9
0.37
0.22
0.13
0.17
805
28,867
161,237
582,117
822,595
2.2
1.3
0.52
0.28
0.32
2,343
33,767
124,313
323,214
327,665
1.3
0.86
0.35
0.29
0.17
319
8,727
29,348
106,712
731,725
2.8
2.1
1.2
0.78
0.5
846
15,245
41,042
107,149
391,035
Large Systems
(> 17,200)
Small Systems
(1 to 17,200)
Large Systems
(> 17,200)
Small Systems
(1 to 17,200)
Population Size Category



2019 Community Surface Water Systems
Disinfectant Concentration Analysis by System Size - System Level
Disinfectant Residual Cutoff
0 mg/L
0.1 mg/L
0.2 mg/L
0.3 mg/L
0.5 mg/L
1 mg/L
1.5 mg/L
2 mg/L
Free Chlorine Only
All (n = 2,952); Large (n = 398); Small (n = 2,554)
Total Chlorine Only
All (n = 2,143); Large (n = 183); Small (n = 1,960)
Data Sources: Six-Year Review 4
Percent of Systems where > 5% of Samples were < Given Disinfectant Residual Concentration for > 1 Month
100
75
50
25
0
1.3
6
12
33
57
89
0.55
5.8
11
27
51
86
0
11
35
64
84
96
0.26
7.3
26
49
74
86
Large Systems
(> 17,200)
Small Systems
(1 to 17,200)
Large Systems
(> 17,200)
Small Systems
(1 to 17,200)
Population Size Category



2019 Small Community Surface Water Systems
Disinfectant Concentration Analysis by Primacy Requirement - System Level
Disinfectant Residual Cutoff
0 mg/L
0.1 mg/L
0.2 mg/L
0.3 mg/L
0.5 mg/L
1 mg/L
1.5 mg/L
2 mg/L
Free Chlorine Only for Small Systems (1 to 17,200)
All (n = 2,554); Detectable (n = 1,009); Numeric (n = 1,545)
Total Chlorine Only for Small Systems (1 to 17,200)
All (n = 1,960); Detectable (n = 434); Numeric (n = 1,526)
Data Sources: Six-Year Review 4; Wahman (2015) plus input about residual requirement changes since 2015.
Percent of Systems where > 5% of Samples were < Given Disinfectant Residual Concentration for > 1 Month
0
25
50
75
100
0.89
11
21
38
61
90
0.32
2.5
5
20
44
84
0.23
21
56
83
95
98
0.26
3.5
17
40
68
82
Detectable
Numeric
Detectable
Numeric
Disinfectant Residual Primacy Requirement


2019 Large Community Surface Water Systems
Disinfectant Concentration Analysis by Primacy Requirement - System Level
Disinfectant Residual Cutoff
0 mg/L
0.1 mg/L
0.2 mg/L
0.3 mg/L
0.5 mg/L
1 mg/L
1.5 mg/L
2 mg/L
Free Chlorine Only for Large Systems (> 17,200)
All (n = 398); Detectable (n = 113); Numeric (n = 285)
Total Chlorine Only for Large Systems (> 17,200)
All (n = 183); Detectable (n = 29); Numeric (n = 154)
Data Sources: Six-Year Review 4; Wahman (2015) plus input about residual requirement changes since 2015.
Percent of Systems where > 5% of Samples were < Given Disinfectant Residual Concentration for > 1 Month
0
25
50
75
100
3.5
12
23
41
59
81
0.35
3.5
8.1
30
56
92
0
28
69
93
97
100
0
7.8
29
58
81
95
Detectable
Numeric
Detectable
Numeric
Disinfectant Residual Primacy Requirement

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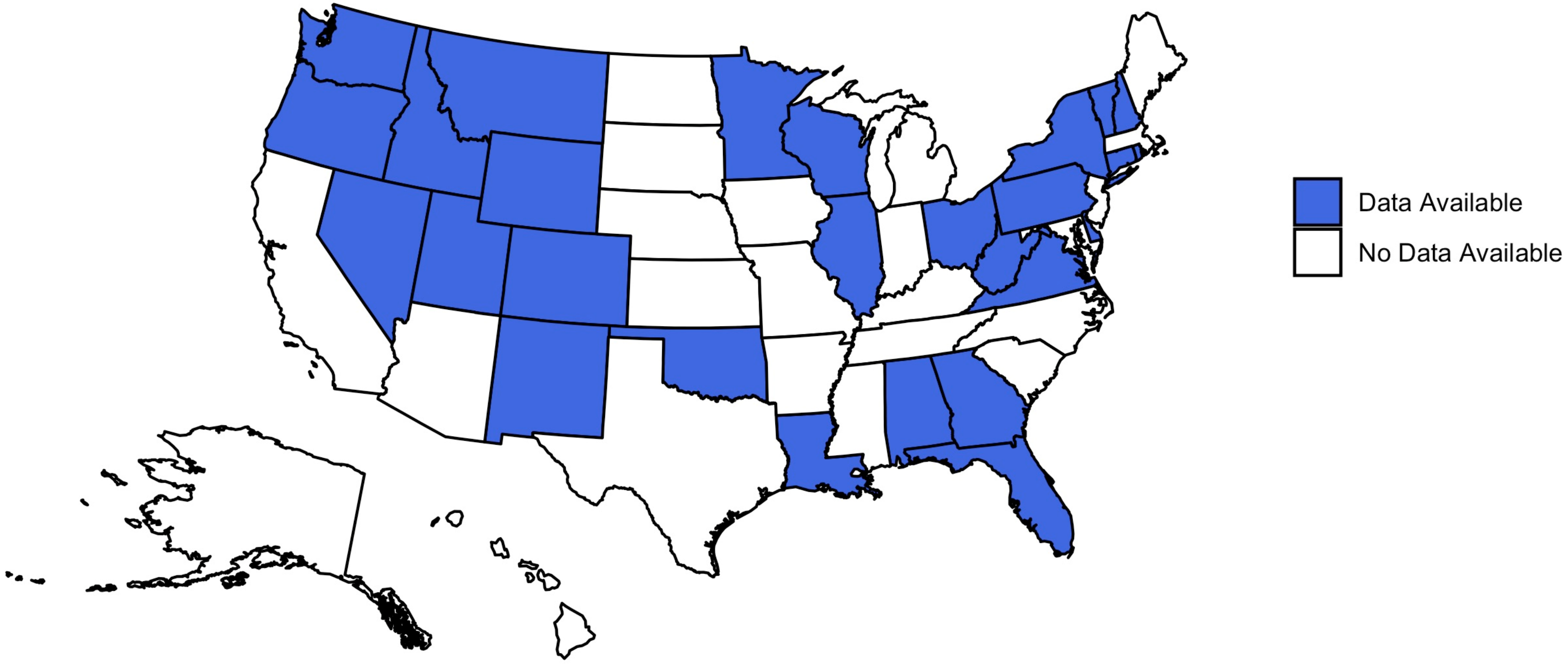
The following nine slides were not developed or provided by EPA. As such, they have not been subject to review by EPA. The content of these slides do not necessarily reflect EPA policies or positions.

AWWA WITAF 054 Task 1 Overview

- Task 1: Potential federal minimum numeric disinfectant residual level
  - Research state requirements for minimum disinfectant residual level
  - Use available data collected from states to understand the implication of setting a minimum numeric disinfectant residual level
- Key observations
  - States do not necessarily manage disinfectant residual data in the same way as other drinking water compliance data
    - Drinking water quality data collected from 46 states, but disinfectant residual data available for analysis limited to public water systems (PWSs) in only 23 states
    - Disinfectant residual data have various naming conventions (i.e., chlorine, chlorine residual, free chlorine residual, total chlorine, combined chlorine, chloramine)
      - Some indicate free vs. total chlorine, but some are ambiguous (i.e., chlorine, chlorine residual)

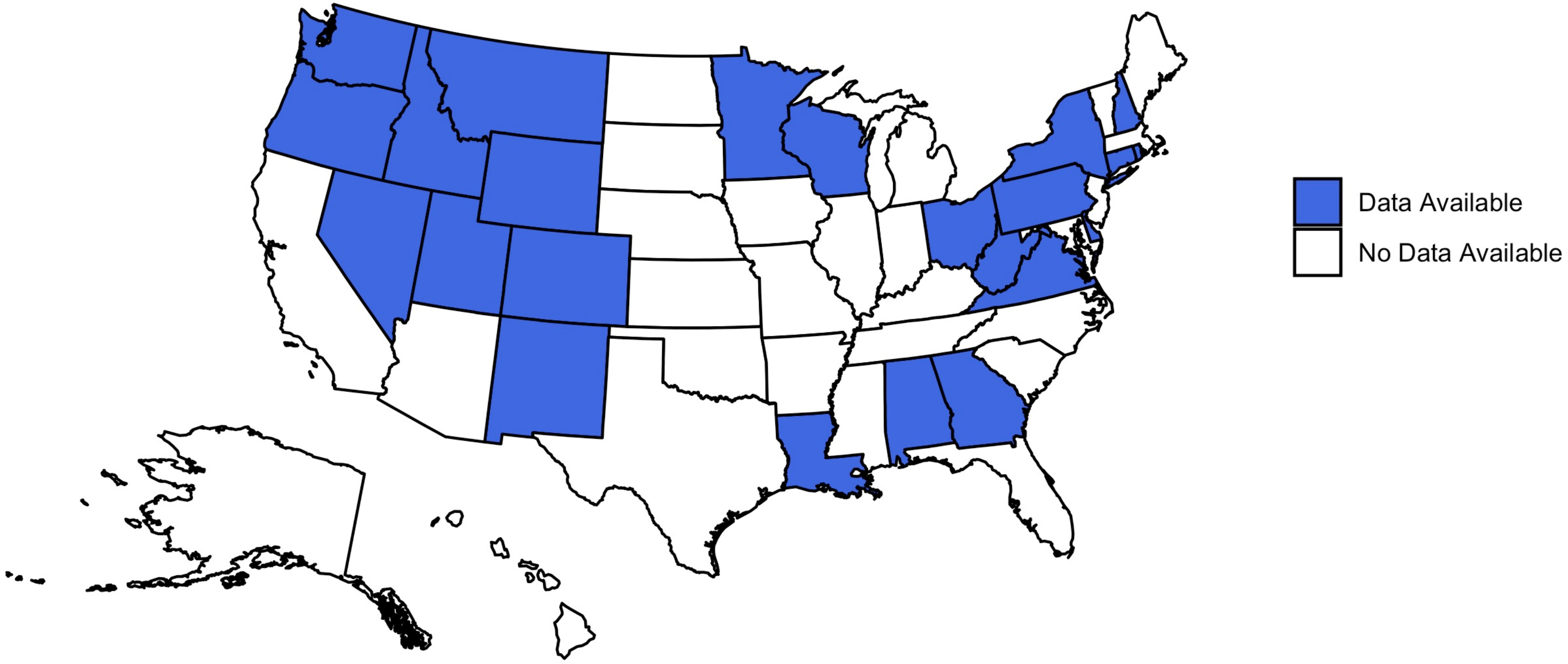
Disinfectant Residual Data Availability

- Disinfectant residual data for distribution system samples available for PWSs in **27 states out of 46 states sharing**



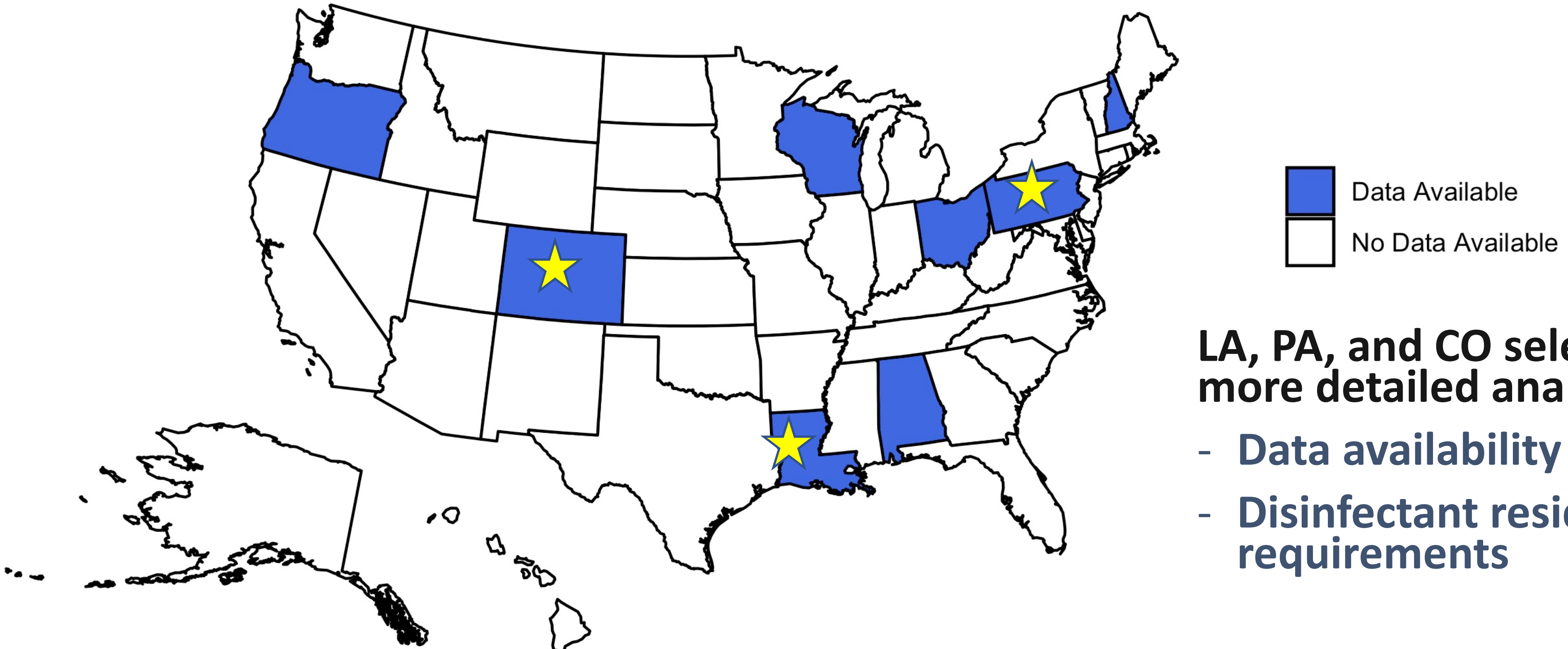
Disinfectant Residual Data Availability

- Disinfectant residual data for distribution system samples available for PWSs since Stage 2 DBPR implementation (April 1, 2012) in **23 states**



Disinfectant Residual Data Availability

- “Reliable” disinfectant residual data for distribution system samples available for PWSs since Stage 2 DBPR implementation (April 1, 2012) in **8 states**



LA, PA, and CO selected for more detailed analysis

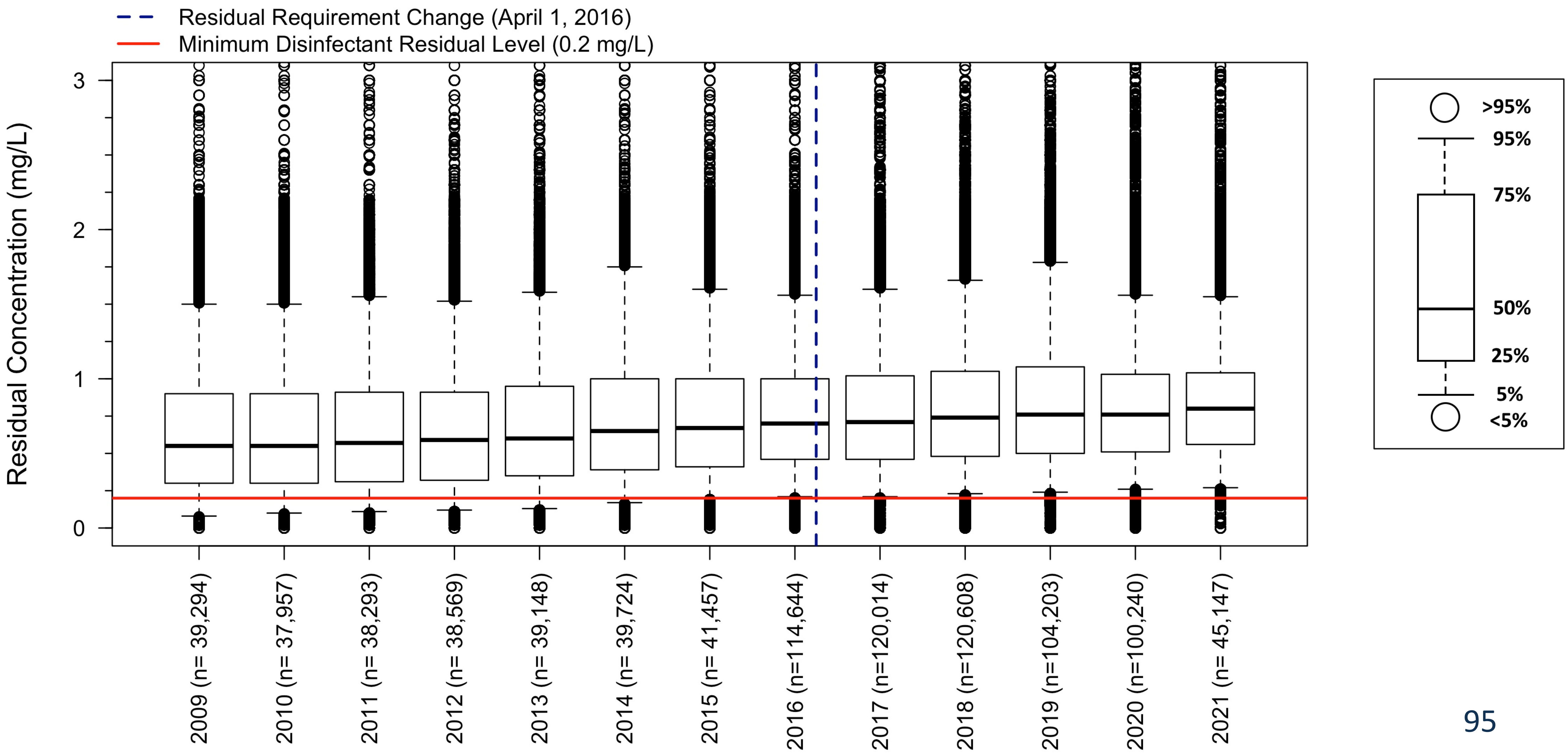
- **Data availability**
- **Disinfectant residual requirements**

“Reliable” = >50 data records on average per PWS per year

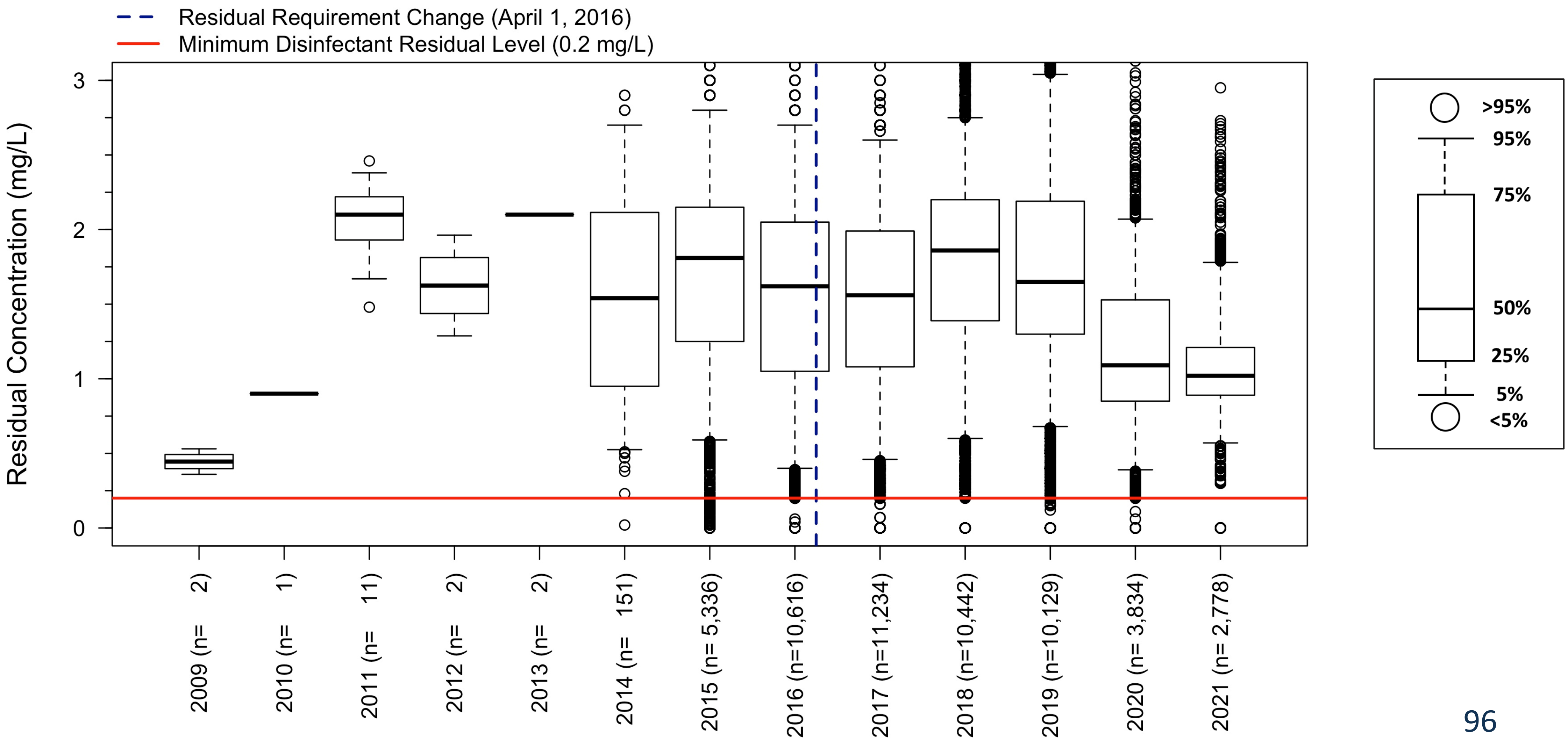
Case Study: Colorado

- Change to numeric minimum disinfectant level
  - As of April 1, 2016, requires minimum of 0.2 mg/L disinfectant residual throughout DS
  - After requirement change:
    - Increase in free chlorine residual levels
      - Consistent increasing trend over time based on available data
    - No clear trend in total chlorine/chloramine levels

CO: Free Chlorine Residual by Year



CO: Total Chlorine/Chloramine Residual by Year



Primary Conclusion/Recommendation

- Data management of disinfectant residuals varies state by state; for some states, current data management practices may not allow for meaningful analysis to understand compliance challenges
- Need to standardize data management practices and support states in achieving this

Forthcoming Updates

- Detailed analysis and peer reviewed publication of minimum numeric disinfectant residual requirements implemented and outcomes in CO, LA, PA
  - Disinfectant residuals
  - Coliform occurrence and TCR/RCTC compliance
  - DBP occurrence and DBPR compliance

Disinfectant Residuals: Discussion Topics

- What additional information will be helpful to further understand disinfection residual-related problems?
- How widespread are problems with maintaining disinfectant residual levels that are adequately protective against opportunistic pathogens?
- What is your sense of the importance of problems related to inadequate disinfectant residuals versus other factors that contribute to opportunistic pathogen growth (e.g., accumulation of sediments)?
- Within the drinking water value chain, what do you believe are the most prominent root causes (what challenges exist for PWSs to be able to maintain these levels)?
- How can disinfectant residual data compared to the presence of microbial indicators be used to inform control of opportunistic pathogens while considering other distribution system water quality factors (e.g., differing growth conditions, sediment accumulation, high water age)?

Segment 6: Meeting 3 Agenda & Next Steps

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August 17, 2022

EPA
OFFICE OF GROUND WATER AND DRINKING WATER

Presentation Overview – Teeing Up DBPs

- Unregulated haloacetic acids (HAAs) (e.g., carcinogenicity)
- Residual DBP risks (e.g., bladder cancer)
- Developmental/reproductive concerns
- Occurrence of DBPs and precursors – include UCMR4 data for HAA9, SYR4 data for THM4
- Total organic carbon (TOC) in treated water
- Factors affecting DBP occurrence – include source water (e.g., about bromide, wastewater, other precursors); disinfectant type and concentration; water age

Meeting #3 Agenda Discussion Topics

OFFICE OF GROUND WATER AND DRINKING WATER

- Do you have additions or refinements to the proposed topics?
- What background materials, presentations, or other resources will be helpful to you to prepare for the Meeting 3 discussions?
- Mindful of time and resource limitations prior to the next meetings, what supplemental technical analyses would you like on the topics to help inform discussions?

Next Steps

- Provide Meeting 1 final summary.
- Update Tables 1 and 2 and provide to WG members.
- Prepare Meeting 2 draft summary for WG member review.
- Respond to WG member requests in preparation for Meeting 3.
- Initiate scheduling for meeting 6 and 7 (target mid-to-late January, early-to-mid March).
- Complete presentation materials and identify relevant background resources.
- Facilitation Team strongly encourages WG members to provide feedback on facilitation and overall approach to convening WG meetings.

FUTURE MEETINGS REMINDER

- Meeting 3: September 20
- Meeting 4: November 3
- Meeting 5: December 13
- Meeting 6: Late January (scheduling to start next week)
- Meeting 7: Early March (scheduling to start next week)

MEETING CLOSURE

Appendix

PWS Inventory Information by System Type

System Category[1]	#Systems	#Population	%Systems	%Population[2]
CWSs	49,610	310,539,259	34.0%	94.6%
NTNCWs	17,515	6,558,734	12.0%	2.0%
TNCWSs	78,644	12,458,066	54.0%	3.8%
All PWSs	145,769	Cannot be counted	100%	
National population in 2019		328,239,523[2]		

Notes:

1. Includes only active systems. CWSs – Community water systems; NTNCWS – Non-transient noncommunity water systems; TNCWSs – Transient noncommunity water systems
2. Based on the national population in 2019 (from https://www.census.gov/newsroom/press-releases/2019/popest-nation.html)

Information Categories related to Working Group Discussion Topics

Information Categories	Use
Percentages of Purchased Water • *100%* • >0% and <100% • 0%	To support discussion of consecutive systems
Disinfectant Residual Type* • Free chlorine • Chloramines	To support discussion of: • Minimal disinfectant residual levels • Current distribution system management practices

SDWIS

- Safe Drinking Water Information System (SDWIS): Up-to-date system inventory and violation information, informing the following:
  - Characterization of violations related to MDBP rules
  - Number of systems and population served
    - by system type, source water type, system size, and state/region
  - Consecutive systems
  - Limited treatment characterization

UCMR4

- <u>Unregulated Contaminant Monitoring Rule (UCMR4, 2018-2020)</u>: Nationally representative monitoring program for selected unregulated contaminants
- HAA5, HAA6Br, and HAA9 and source water precursors (i.e., bromide and TOC)
- Disinfectant type/residual type and treatment processes
- Covering a 12-month period
- Including all systems ≥ 10k and randomly selected 800 systems < 10k

SYR4 ICR

- Six-Year Review 4 Information Collection Request (SYR4 ICR, 2012-2019): Compliance monitoring data reported under existing MDBP Rules as well as Revised Total Coliform Rule (RTCR), voluntarily provided by states/primary agencies to inform the following:
  - National occurrence/exposure of Total Coliform and *E. coli*
  - Disinfectant residuals
  - Regulated DBPs and treatment performance per TOC removal requirements under Stage 1 DBPR

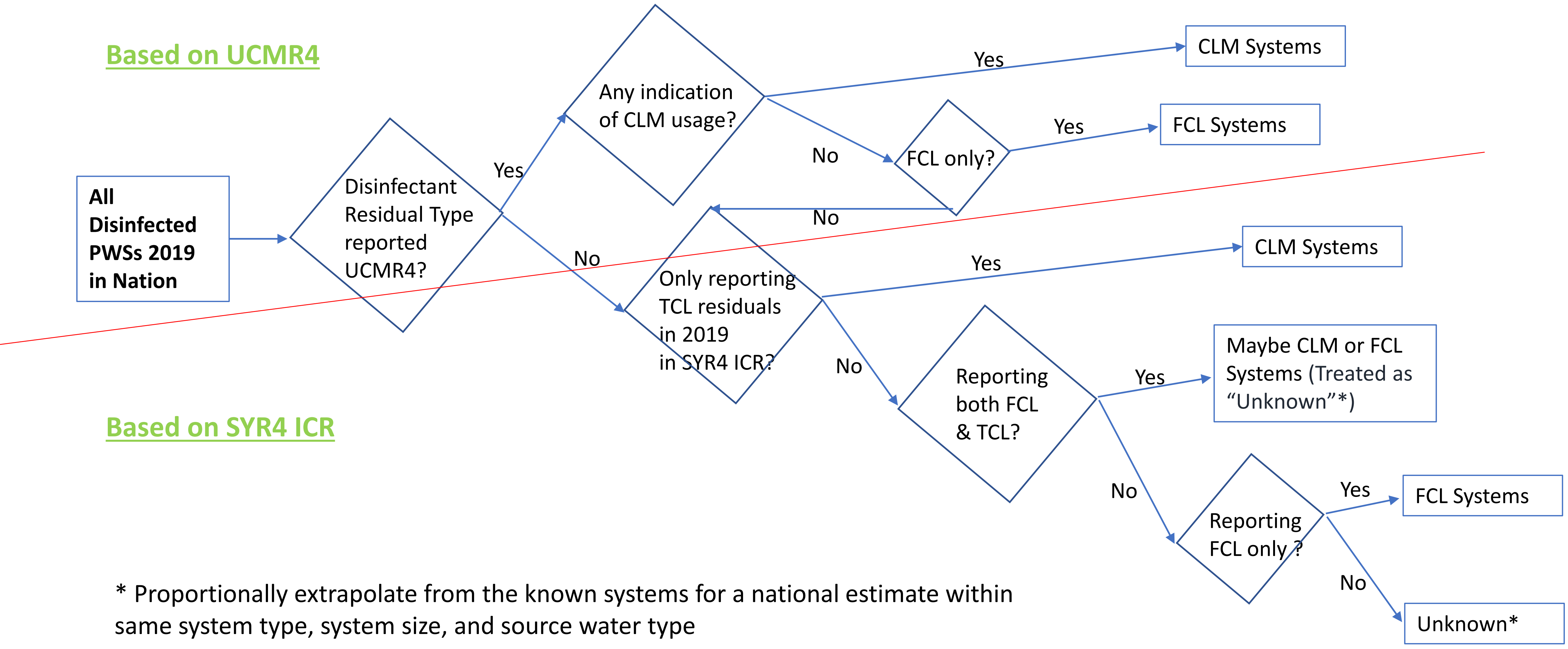
Weblinks for Relevant Data Sources for Inventory Analysis

SDWIS: https://www.epa.gov/ground-water-and-drinking-water/safe-drinking-water-information-system-sdwis-federal-reporting

UCMR4 Data: https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule

SYR4 ICR Data: TBD

Framework for Identifying System Disinfectant Residual Types



* Proportionally extrapolate from the known systems for a national estimate within same system type, system size, and source water type

Summary of Available Occurrence Data for Opportunistic Pathogens – Examples

- Nearly half of 68 public and private water taps sampled across the United States showed the presence of *L. pneumophila* Sg1 in one sampling event, and 16% of taps were positive in more than one sampling event. (Donohue et al., EST, 2014)
- *L. pneumophila* was detected in 26% of chlorinated tap water samples and 22% of chloraminated tap water samples. (Donohue et al., Appl Environ Microbiology, 2019)
- Tap water samples (n = 358) collected across the United States were tested for *L. pneumophila* by both culture and qPCR. *L. pneumophila* had the highest prevalence and concentration in the chlorinated water samples. In total, 24% (87/358) of the samples were positive for *L. pneumophila* either by qPCR or 3% (11/358) were positive by culture. (Donohue et al., SOTE, 2021)

Summary of Available Occurrence Data for Opportunistic Pathogens – Examples

- A winter/early spring study of 12 utilities were analyzed using Legiolert; 53 of the raw water, 50 from the plant effluent, and 576 from the distribution system. *L. pneumophila* was detected in 3 of 5 raw water samples at one utility and was not detected in untreated samples at any of the other utilities. *L. pneumophila* was not detected in any of the treated plant effluent samples, and in only one distribution sample. (LeChevallier, AWWA Water Science, 2018)
- A summer/fall study of 10 utilities showed distribution system samples with detections of *L. pneumophila* = 2.4% (14 of 576). Most systems used their existing Total Coliform Rule monitoring locations, but at least 36 (6.3%) of the 573 distribution system samples were from finished water reservoirs or storage tanks. *L. pneumophila* was detected in 14 distribution system samples. Of the 10 systems examined, 5 had at least one positive *L. pneumophila* sample with an average concentration (including non-detections) ranging from 0.09 to 14.8 MPN/100 mL. For the 14 distribution systems samples that were positive for *L. pneumophila*, individual sample concentrations ranged from 1 to 522 MPN/100 mL. (LeChevallier, AWWA Water Science, 2019)

Summary of Available Occurrence Data for Opportunistic Pathogens – Examples

- Monitoring *Legionella* in the New York City water distribution system using IOS 11731:2017 and Legiolert culture-based methods and PCR showed that 85 percent of water samples were positive for *Legionella* DNA. Despite this, *Legionella* bacteria were detected in only 2.8% of water samples using culture methods. All L. pneumophila culture-positive samples were recovered from a single distribution site, which was undergoing a street reconstruction project. The site had conditions indicative of stagnation, and an adjacent building's service line was periodically backflowing. (Omoregie et al., AWWA Water Science, 2021)
- Water samples from 40 sites collected from three water types (groundwater disinfected with chlorine and surface water disinfected with chlorine or monochloramine) showed that M. avium and M. intracellulare were molecularly detected in 25% and 35% of samples. The mean concentrations of M. avium and M. intracellulare were 2.8 × 103 and 4.0 × 103 genomic units (GU) L-1. (Pfaller et al, Appl Microbiol Biotechnology. 2022)
- *Legionella* was detected in nontreated groundwater (61 of 61 wells) but was below detection in chlorinated reservoirs and distribution piping. (Atkinson et al. Water Research, 2022)

Data Categorization – Disinfection Residual Analysis Related to Microbial Indicators and Detectable vs. Numeric States

- Population category
  - Used retail population served
  - Cutoff based on TCR monthly sample requirements and a 95% compliance rate
    - Small (≤ 17,200): all samples must comply (≤ 15 required samples)
    - Large (> 17,200): at least one sample may not comply (≥ 20 required samples)
- Source water category
  - Groundwater only (n = 2,691,189)
  - Surface water and groundwater under the direct influence (n = 3,948,612)
- System level analysis requirements
  - 50% of required TCR samples collected = valid sample-month
  - Required valid sample-months:
    - One-year analysis = 6 months
    - All year analysis (i.e., 2012 to 2019) = 36 months
  - Residual requirements
    - 5% of samples allowed to fail residual concentration cutoff per month
    - 1 month allowed to fail compliance in a year