



Implementing the RTCR

PRESENTED BY JEFFREY ROSEN ON BEHALF OF A NUMBER OF LARGE
PENNSYLVANIA UTILITIES.

Outline

- ▶ The proposal
- ▶ The justification
 - ▶ How the Revised Total Coliform Rule (RTCR) was developed – FACA process
 - ▶ The lack of connection between the RTCR and Chlorine Residuals
 - ▶ The extensive unknowns about chlorine residuals
- ▶ The logistics of the recommendation
- ▶ The ramifications of coupling chlorine residuals to the RTCR

The Proposal

- ▶ The state of Pennsylvania should:
 1. Implement the Revised Total Coliform Rule as passed by the US EPA
 2. Convene a committee of stakeholders supported by a technical advisory work group to consider an effective policy for modifying Chapter 109 regulations related to disinfectant residual.



The Justification

The Revised Total Coliform Rule (RTCR)

- ▶ “The RTCR aims to increase public health protection through the reduction of potential pathways of entry for **fecal** [emphasis added] contamination into the distribution system of community water systems (CWSs) and non-community water systems (NCWSs)” (USEPA, Office of Drinking and Groundwater, 2014. The Revised Total Coliform Rule (RTCR) State Implementation Guidance—Interim Final, EPA 816-R-14-004)

The Revised Total Coliform Rule (RTCR)

- ▶ Was developed under a robust, well established approach called the Federal Advisory Committee Act (FACA)
- ▶ The process integrated policy considerations of stakeholders with robust and well vetted evaluation of the science related to the integrity of the distribution system
- ▶ The deliberations of the committee and the technical working group (TWG) lasted well over a year and led to a consensus on the proposed rule which did not link total coliforms or *E. coli* with chlorine residual

Goals of the RTCR FACA Process

- ▶ The goal of the RTCR committee was to move to a two tiered set of indicators which lower the impact of detection of total coliform while focusing on violations being related to the presence of *E. coli*
 - ▶ Total coliform is not necessarily an indicator of fecal contamination. It had been the primary indicator in the rule before the Revision. In the RTCR detection of total coliform leads to **actions done in consultation with the state** to resolve possible issues **not to a violation or a public notification**
 - ▶ The presence of *E. coli*, which is an indicator of fecal contamination, leads to public notification

Fecal v. Environmental Microorganisms

- ▶ The RTCR addresses fecal contaminants for which total coliform and e-coli are indicators.
- ▶ The RTCR does not address environmental microorganisms for which neither total coliforms nor *E. coli* are indicators
- ▶ The proposed changes to the Pennsylvania Rules seem to be targeting *Legionella* which is not related to fecal contamination

The Role of Chlorine Residual in the RTCR

- ▶ The only mention of chlorine residual in the original total coliform rule is in the section called: The Chlorine Substitution Policy (section 5e, page 27555, FR Vol 54, No.124, Thursday, June 29, 1989). It has nothing to do with chlorine residual levels.
- ▶ The Revised Total Coliform Rule contains no specific requirements or recommendations regarding concentrations of chlorine in the distribution system.
- ▶ Federal regulations require a detectable disinfectant residual in public water supply distribution systems, but none specify a concentration target.

How Disinfectant Residual Has Been Regulated

- ▶ Federal regulations require a detectable disinfectant residual in public water supply distribution systems, but none specify a concentration target
 - ▶ The residual disinfectant concentration in the distribution system... 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.
 - ▶ Water in the distribution system with a heterotrophic bacteria concentration less than or equal to 500/ml, measured as heterotrophic plate count (HPC) ... is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement.
- ▶ States have
 - ▶ Specified concentration requirements (what is “detectable” and what is required)
 - ▶ Defined other compliance criteria (e.g., “no more than 5% of samples”)

What We Do Know about Chlorine Residuals and Microbes in Distribution Systems

- ▶ General agreement that maintenance of a chlorine residual in the distribution system is important to control microbes
- ▶ Legionellosis (outbreak and sporadic) is primarily a premise plumbing ISSUES (Pruden et al., 2014, State of the Science and Research Needs for Opportunistic Pathogens in Premise Plumbing, Water Research Foundation Report, Denver, CO)
- ▶ Disinfectant residuals can vary widely within a distribution system.
- ▶ Total coliform and E.C. positive samples can occur when disinfectant residuals are high.

Unknowns about Chlorine Residuals

- ▶ We do not know the disinfectant concentrations and exposure time required control microbial contamination in distribution systems
 - ▶ Disinfectants don't make distribution system pipes sterile
 - ▶ Many factors determine whether pathogens grow (presence of disinfectant, temperature, presence of nutrients, water age)
- ▶ The organisms of most concern may not be controlled by disinfectant residuals in the distribution system.
 - ▶ Resistant (hard to kill) forms such as cysts
 - ▶ Protection in biofilms
 - ▶ Legionellae in encysted amoebae (Trojan horses)
- ▶ The possible unintended consequences and the real costs of the proposed regulation

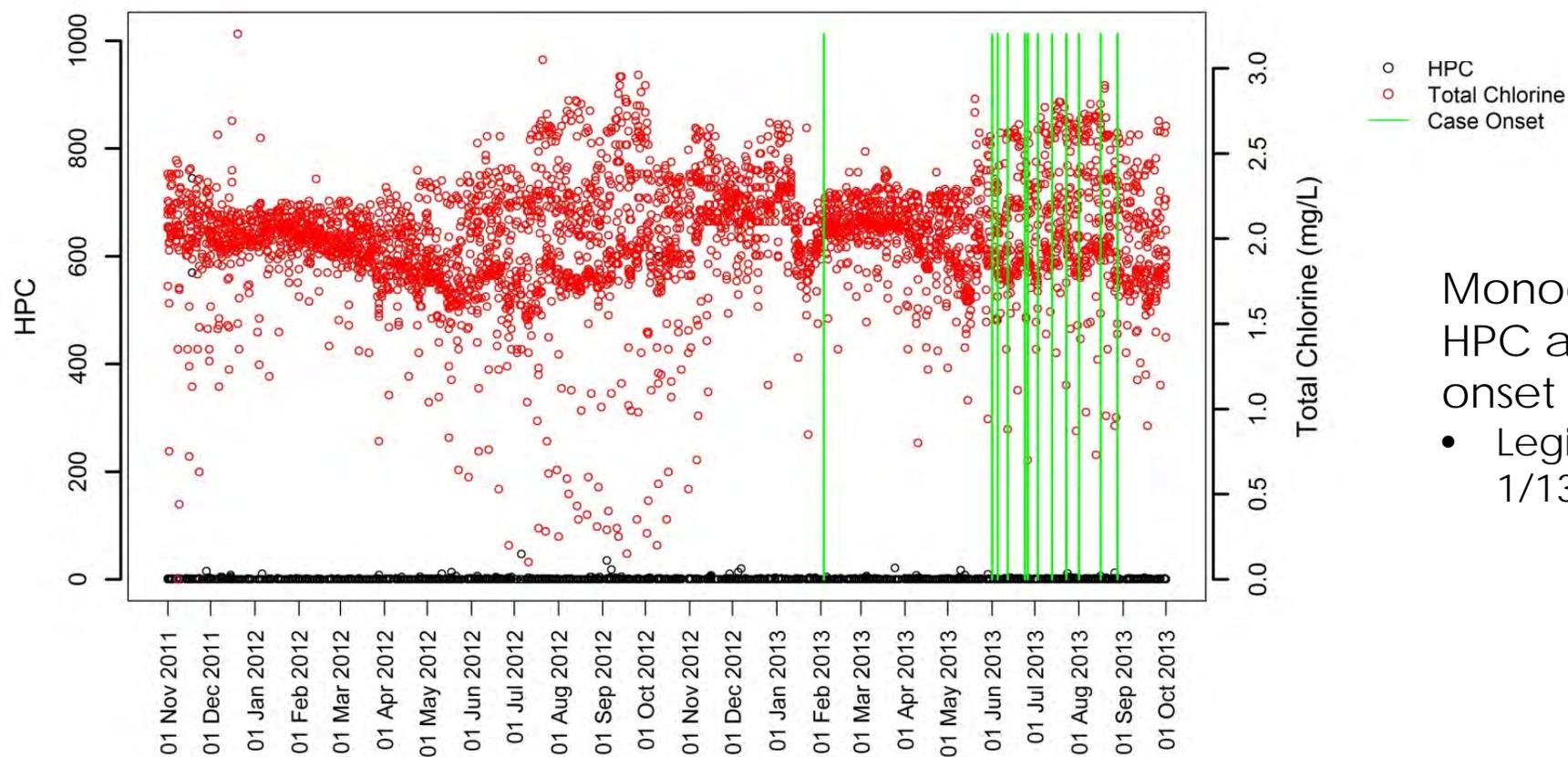


A Little Bit of Science

Legionellosis has not Been Correlated with Chlorine Residual Concentration

- ▶ There are data that demonstrate that the onset of Legionellosis can occur when there are chlorine residuals far in excess of the proposed rules
- ▶ Effective management of *Legionella* is not as simple as maintaining a chlorine residual
- ▶ Establishing an effective strategy for controlling *Legionella* will require an effective scientific process and additional research

Sporadic Legionellosis in Regions Associated with High Residual, Low HPC



Monochloramine concentration, HPC and sporadic legionellosis onset date for one major utility.

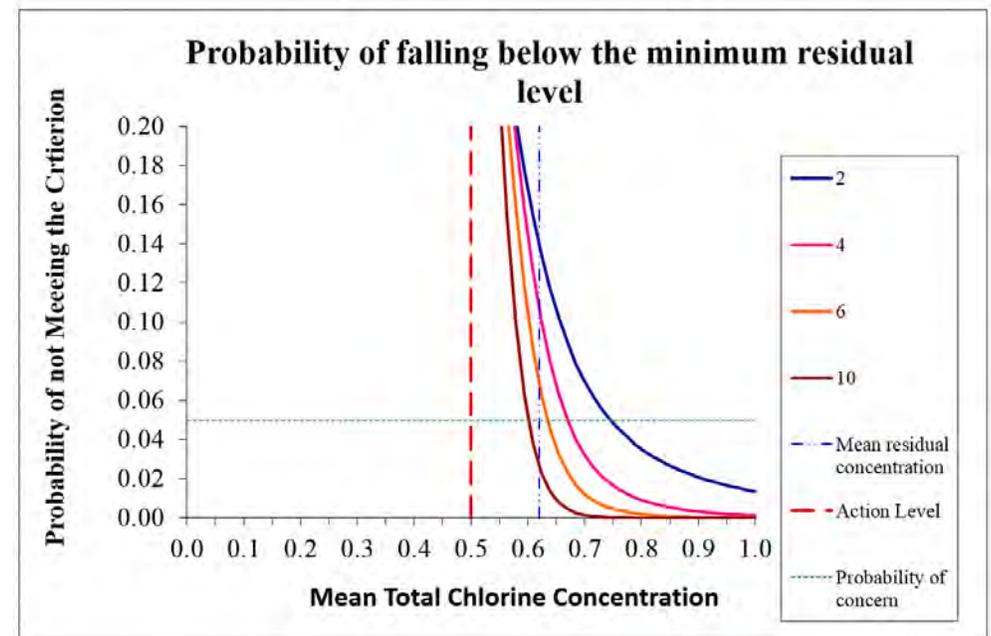
- Legionellosis cases only shown for 1/13 – 10/13

Disinfectant Performance

- ▶ Switching to chloramines from free chlorine
 - ▶ Reduced colonization of distribution systems AND connected buildings/plumbing systems by *Legionella* (Pryor, 2004, and Moore, 2006, study in Pinellas County, Florida; Flannery, 2006, study in San Francisco)
 - ▶ Reduced the incidence of legionellosis (Kool, 1999, and Heffelfinger, 2003, reduced incidence of hospital infections)
- ▶ But
 - ▶ In studies to date, we only know the disinfectant choice, not the concentration of disinfectant in the distribution systems or premise plumbing

Statistical Considerations

- From a statistical perspective it is not advisable to reach a conclusion and take action based on a single sample.

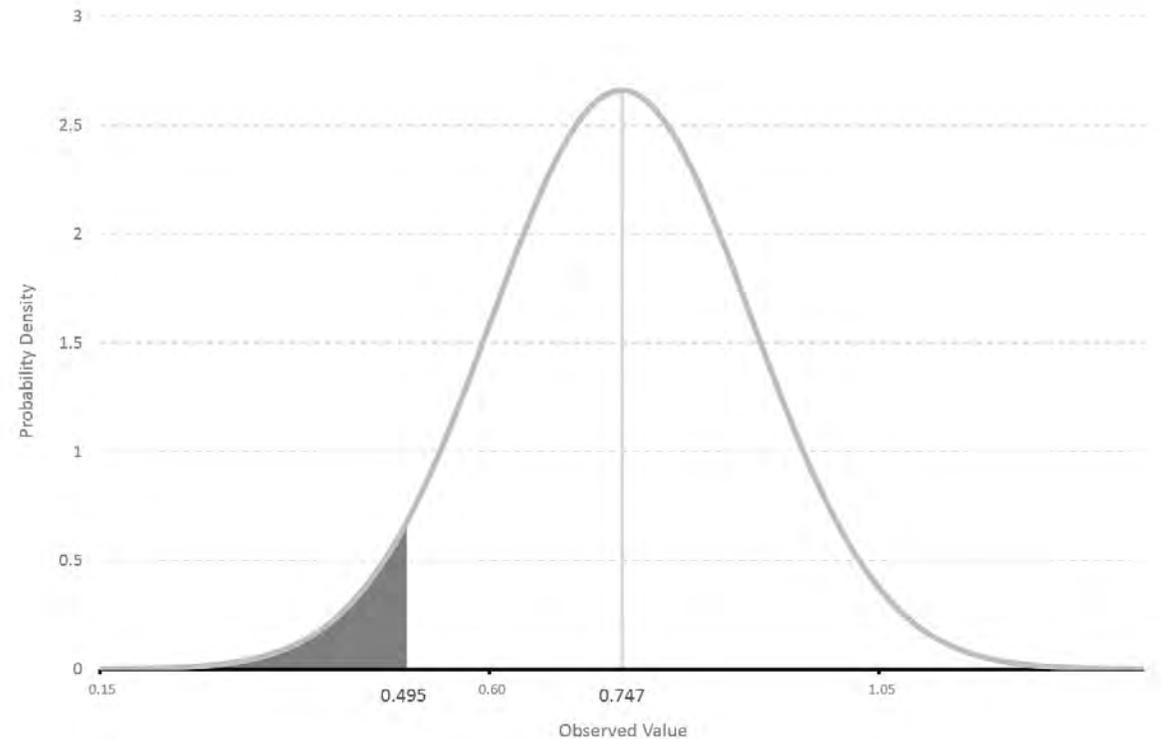


Enter the mean disinfectant residual concentration (mg/L)		0.62	User Input
Enter the Standard Deviation of the disinfectant residual concentration		0.15	
Enter level of concern		0.5	
Sample Sizes to Evaluate	Lowest	2	
	2nd	4	
	3rd	6	
	Highest	10	
Enter the probability level of concern (usually 0.05) =====>		0.05	

Statistical Consideration

- ▶ To have a 95% confidence that the true mean concentration is not below an established minimum (e.g. 0.5 mg/l) utilities will need to operate to maintain their most at-risk locations at levels far in excess of the standard.
- ▶ In the example to the right the utility would operate at a residual of 0.75

mean:	0.747
std dev:	0.15
z min:	-4
z max:	4
alpha:	0.05
critical z:	0.50



Revisions to Chlorine Residual Requirements Should Consider

- ▶ The ramifications of detecting a value below the minimum residual.
 - ▶ Big difference between *inform the state and work to improve* (Louisiana) and *public notification* (proposed PA).
- ▶ Decision on single sample results will force utilities to manage residuals throughout their distribution system at concentrations well above the established minimum residual concentrations. This may lead to:
 - ▶ Very high concentrations coming out of the plant (taste and odor complaints, increased DBPs)
 - ▶ Extensive capital expenditures for booster stations and other modifications for boosting residual concentration
- ▶ Complex science with some indications that the increased disinfectant residual requirements will not meet the intended goals (protection against *Legionella* and other non-fecal microbes).

The Logistics of the Recommendation

- ▶ The RTCR can be implemented as promulgated by the USEPA quickly. It will lead to improved protection of public health while reducing the number of spurious violations which do not protect public health and may in fact, decrease public health 🖐️ (like in the case of increased Disinfection Byproducts). 👍
- ▶ PA DEP will maintain its primacy.
- ▶ Convene a Committee of Stakeholders to discuss the objectives of changes in the requirements for chlorine residuals
- ▶ Convene a technical support group to organize, analyze and interpret the available scientific data to support the deliberations of the Committee of Stakeholders

Ramifications of Coupling Chlorine Residual Modifications with Implementation of the RTCR

- ▶ Significant increase of public notifications with little increase in public health protection
 - ▶ Erosion of public confidence
 - ▶ Significant administrative burden on the DEP and the utilities
- ▶ Potential decrease in public health protection due to increases in disinfection by products
- ▶ Increase customer taste and odor complaints
- ▶ Increase in costs for infrastructure and operations
 - ▶ Stretch severely-limited PWS capital budgets
 - ▶ Divert capital budgets away from other equally important projects

Questions

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Supporting material not enough
time to present it all.

How Other States Regulate Disinfectant Residual

– States with More Stringent Requirements (1)

State	Free (mg/L)	Total (mg/L)	Compliance Basis
Oklahoma	0.2	1.0	TITLE 252. DEPARTMENT OF ENVIRONMENTAL QUALITY CHAPTER 631. PUBLIC WATER SUPPLY OPERATION Section 3-3. Disinfection requirements.
Ohio	0.2	1.0	Not stated in code. Guidance OPR-02-002: Ohio EPA staff ... should call a water system whenever two days out of a month are below the minimum required chlorine residual within the distribution system The water system should be informed of the need to correct their chlorine problem. Failure to maintain adequate residuals in more than 5% of the samples each month for any two consecutive months will result in the district issuing a violation letter ...
Kansas	0.2	1.0	"A violation ...occurs when, during any two consecutive months, the required minimums are not maintained in more than 5% of the readings taken each month."
Iowa	Detectable	Detectable	The residual disinfectant concentration in the distribution system... 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. Water within the distribution system with a heterotrophic plate count bacteria concentration less than or equal to 500/mL... is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement. At the POE, a 0.2 mg/L free chlorine or 1.5 mg/L total chlorine residual is required.

How Other States Regulate Disinfectant Residual

– States with More Stringent Requirements (2)

State	Free (mg/L)	Total (mg/L)	Compliance Basis
North Carolina	0.2*	1.0*	<p>* Water in the distribution system at coliform sampling sites. "less than 0.2 mg/l measured as free chlorine when chlorine is the singular applied disinfectant and less than 1.0 mg/l measured as total chlorine when ammonia and chlorine are applied disinfectants."</p> <p>* at maximum residence time sites or at other locations with high water age ... residual disinfectant concentrations shall be at detectable levels as set forth and calculated in 40 C.F.R. 141.72(a)(4) and (b)(3).</p>
Florida	0.2	0.6	If at any time the residual disinfectant concentration in any portion of a distribution system falls below the required minimum level, ... increase the disinfectant dose as necessary and flush ... until the residual disinfectant concentration is restored to the required minimum level.
Louisiana	0.5	0.5	Current limits are regulated under an emergency rule developed in response to drinking water related <i>N. fowleri</i> infections. In provisions for treatment techniques, the emergency rule requires that "the residual disinfectant concentration is not less than 0.5 mg/L free chlorine or 0.5 mg/L total chlorine in more than 5% of the samples collected each month from the distribution system for any two consecutive months."

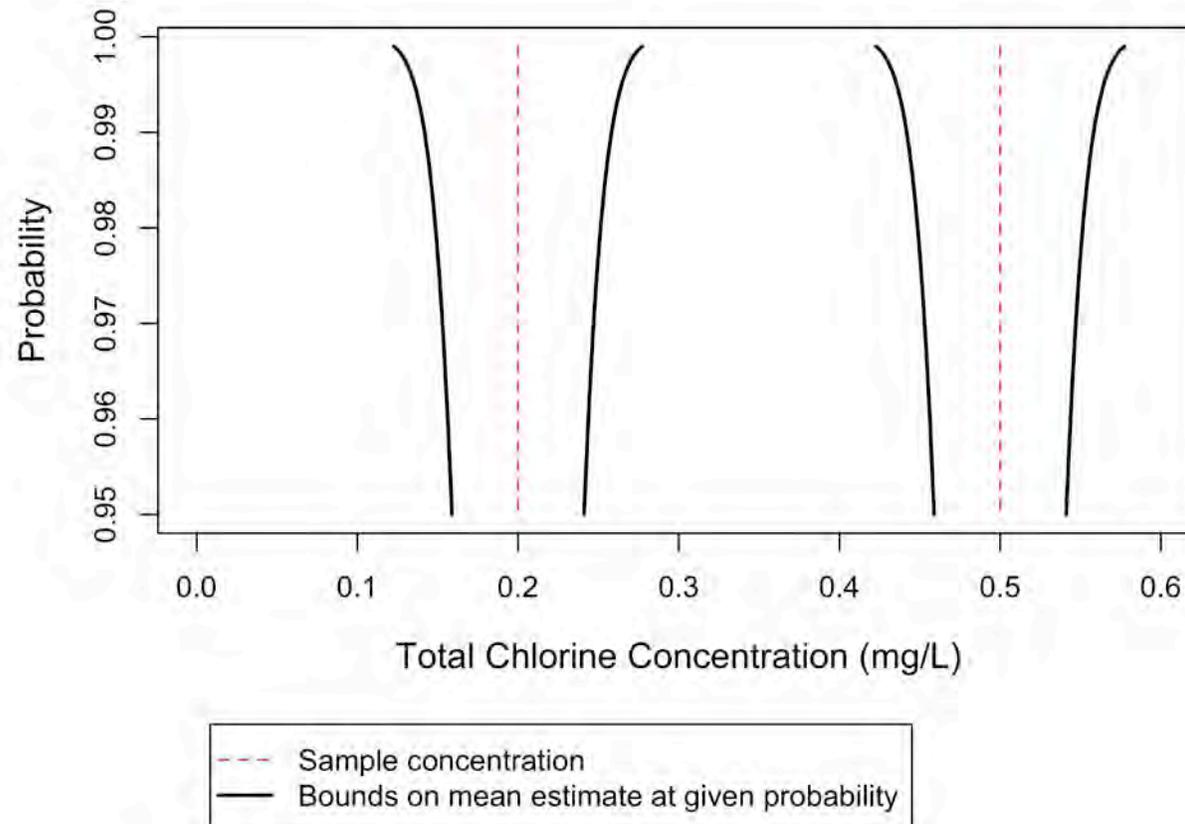
How Other States Regulate Disinfectant Residual – States with Similar Requirements

State	Free (mg/L)	Total (mg/L)	Compliance Basis
Indiana	0.2	0.5	<p>"The following requirements shall be met by the systems ... The residual disinfectant concentration in the distribution system, measured as free chlorine, combined chlorine, or chlorine dioxide, is undetectable in more than five percent (5%) of the samples each month for two (2) consecutive months.</p> <p>"Undetectable disinfectant residual" means a disinfectant residual level that is less than: (A) two-tenths (0.2) milligram per liter measured as free chlorine; (B) five-tenths (0.5) milligram per liter measured as combined chlorine (chloramines); or (C) one-tenth (0.1) milligram per liter measured as chlorine dioxide."</p>
Nebraska	0.2	0.5	<p>Disinfectant residuals must be at or above the required minimum residual limits in at least 95% of all distribution residuals taken for the month. If the system fails to meet the 95% requirement for two consecutive months, or for > 50% of the previous 12 consecutive months, the system will be deemed to be in violation of prescribed treatment techniques and will be issued a Treatment Technique violation.</p>

Why Might States Choose not to Use an Absolute Concentration?

- ▶ Maintaining a residual concentration above an absolute, fixed limit requires operating the distribution at a concentration much higher than the fixed limit
- ▶ Some disinfectant residual measurement techniques are uncertain (imprecise)
- ▶ Disinfectant concentration can vary widely with both time and space
- ▶ The jobs of secondary disinfectant are
 - ▶ inactivate organisms that gain ingress to the distribution system and
 - ▶ prevent amplification of organisms already in the distribution system
 - ▶ there is not consensus on what concentration of disinfectant achieves these goals and how consistently the disinfectant needs to be present

A Little Uncertainty Requires a Large Change in Operational Residual



Confidence bounds based on a very conservative estimate of uncertainty in methods for measuring total chlorine residual