



TOC, UVA, and Enhanced Coagulation Revisited

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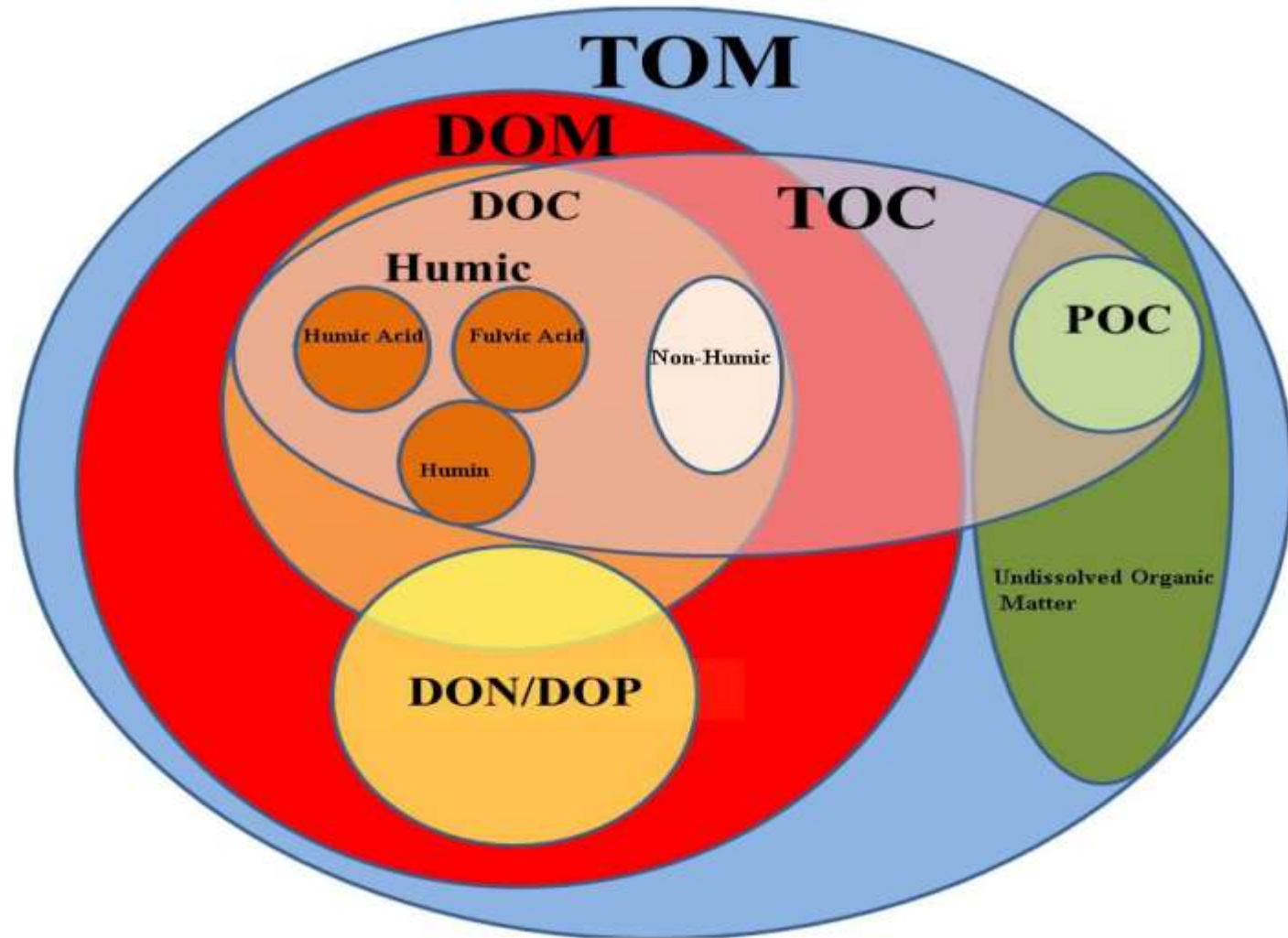
Process optimization to remove natural organic matter, minimize disinfectant byproduct formation, and protect public health

- Presentation Outline
 - Background
 - Recent and Future Challenges
 - Regulatory Standards
 - Optimization Tools
 - Strategies for Implementation

Natural Organic Matter (NOM)

- Plant and animal sources
 - Leaf matter
 - Detritus
 - Periphyton (i.e. algae, cyanobacteria)
- Properties of NOM
 - Particulate vs. Dissolved
 - Size
 - Attraction/repulsion to water
 - Acid vs. Base
 - Aromaticity (chemical structure)

Natural Organic Matter (NOM)



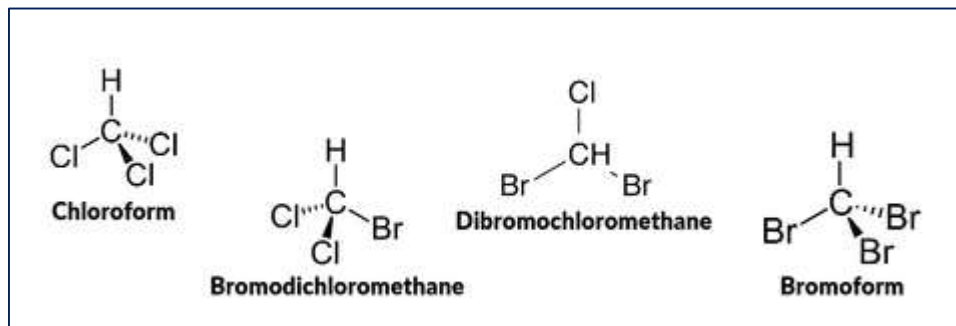
Natural Organic Matter (NOM)

- Measurement
 - Total Organic Carbon
 - Dissolved Organic Carbon
 - UVA254
- Treatability
 - Large hydrophobic NOM
 - Repulsive force to water
 - Greater ability to coagulate
 - Easier to remove
 - Small hydrophilic NOM
 - Attractive force to water
 - Less amenable to coagulation
 - Largely responsible for Disinfectant Byproduct formation (DBP)

Disinfectant/Disinfection Byproducts

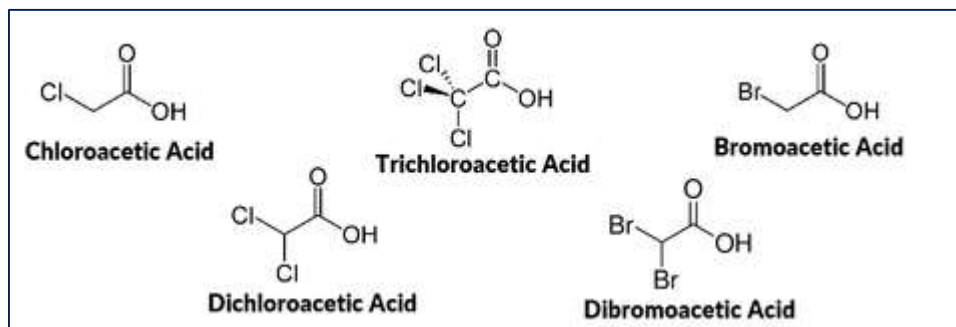
– Trihalomethanes

- 80 ppb LRAA*



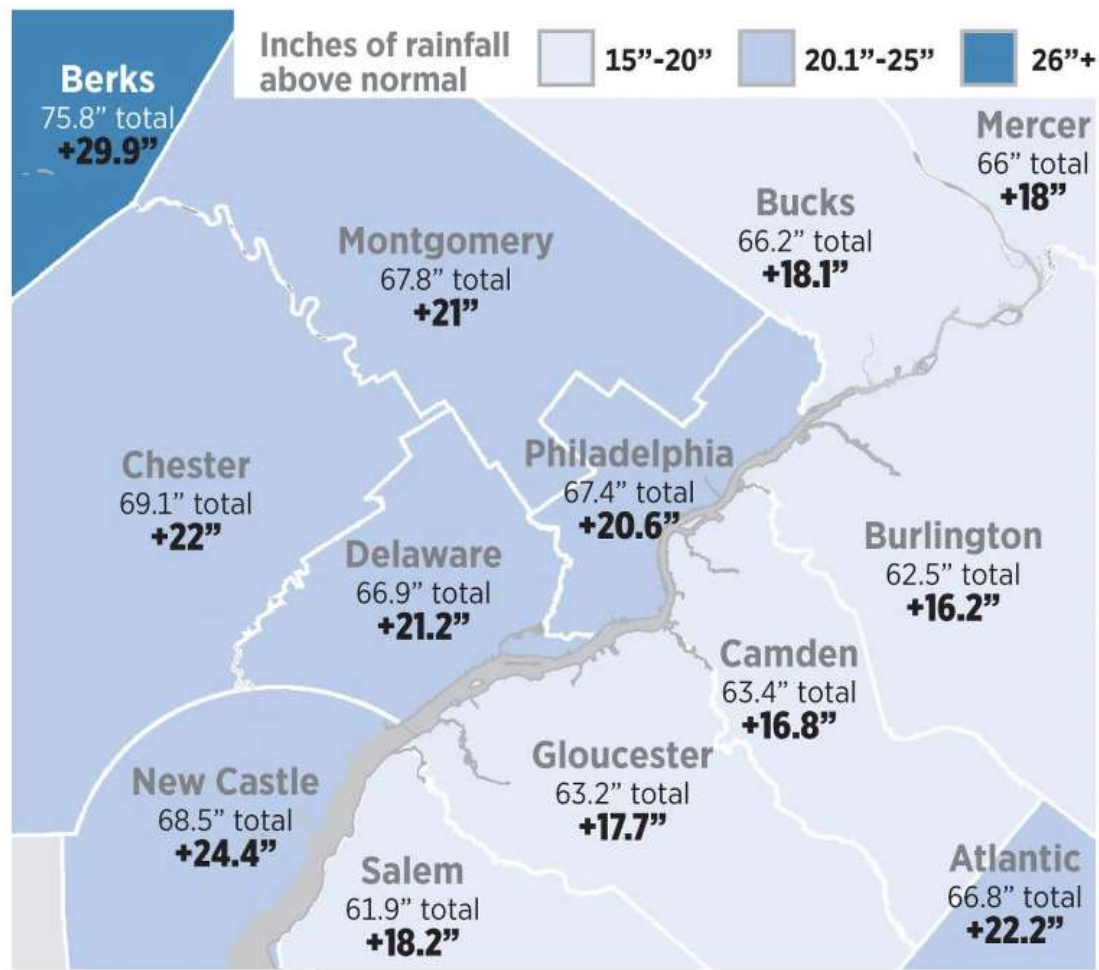
– Haloacetic Acids

- 60 ppb LRAA



*Locational Running Annual Average

Recent and Future Challenges



SOURCE: National Weather Service

Staff Graphic

STAFF GRAPHIC
National Weather Service

Recent and Future Challenges

- Increased temperatures
- Increased surface water organic loading
 - Coagulant demand
 - Residuals removal/dewatering
- Disinfection Requirements Rule
 - Giardia CT Inactivation
 - Distribution System Minimum Residual (April 29, 2019)

“...the process of obtaining improved removal of DBP precursors [NOM] by conventional treatment.”

- Treatment Technique

- Required removal percentages & Alternative Compliance Criteria
- Quarterly or monthly sampling

Step 1 TOC Table - Required % Removal of TOC			
Source Water TOC (mg/L)	Source Water Alkalinity, mg/L as CaCO₃		
	0-60	> 60-120	> 120
> 2.0 to 4.0	35.0%	25.0%	15.0%
> 4.0 to 8.0	45.0%	35.0%	25.0%
> 8.0	50.0%	40.0%	30.0%

¹ Systems meeting at least one of the alternative compliance criteria in the rule are not required to meet the removals in this table.

² Systems practicing softening must meet the TOC removal requirements in the last column to the right

Enhanced Coagulation

- Alternative Compliance Criteria

1. Source Water TOC < 2.0 mg/l
2. Treated Water TOC < 2.0 mg/l
3. Raw Water SUVA \leq 2.0 L/mg-m
4. Treated Water SUVA \leq 2.0 L/mg-m
5. Raw Water TOC < 4.0 mg/l; Raw Water Alkalinity > 60 mg/l; TTHM < 40 μ g/l; HAA5 < 30 μ g/l
6. TTHM < 40 μ g/l and HAA5 < 30 μ g/l with only chlorine for disinfection

Enhanced Coagulation

DBP Precursor Removal

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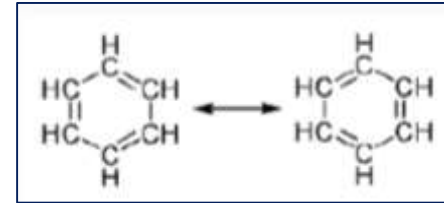
THM/HAA Compliance in the Distribution

Optimization Tools

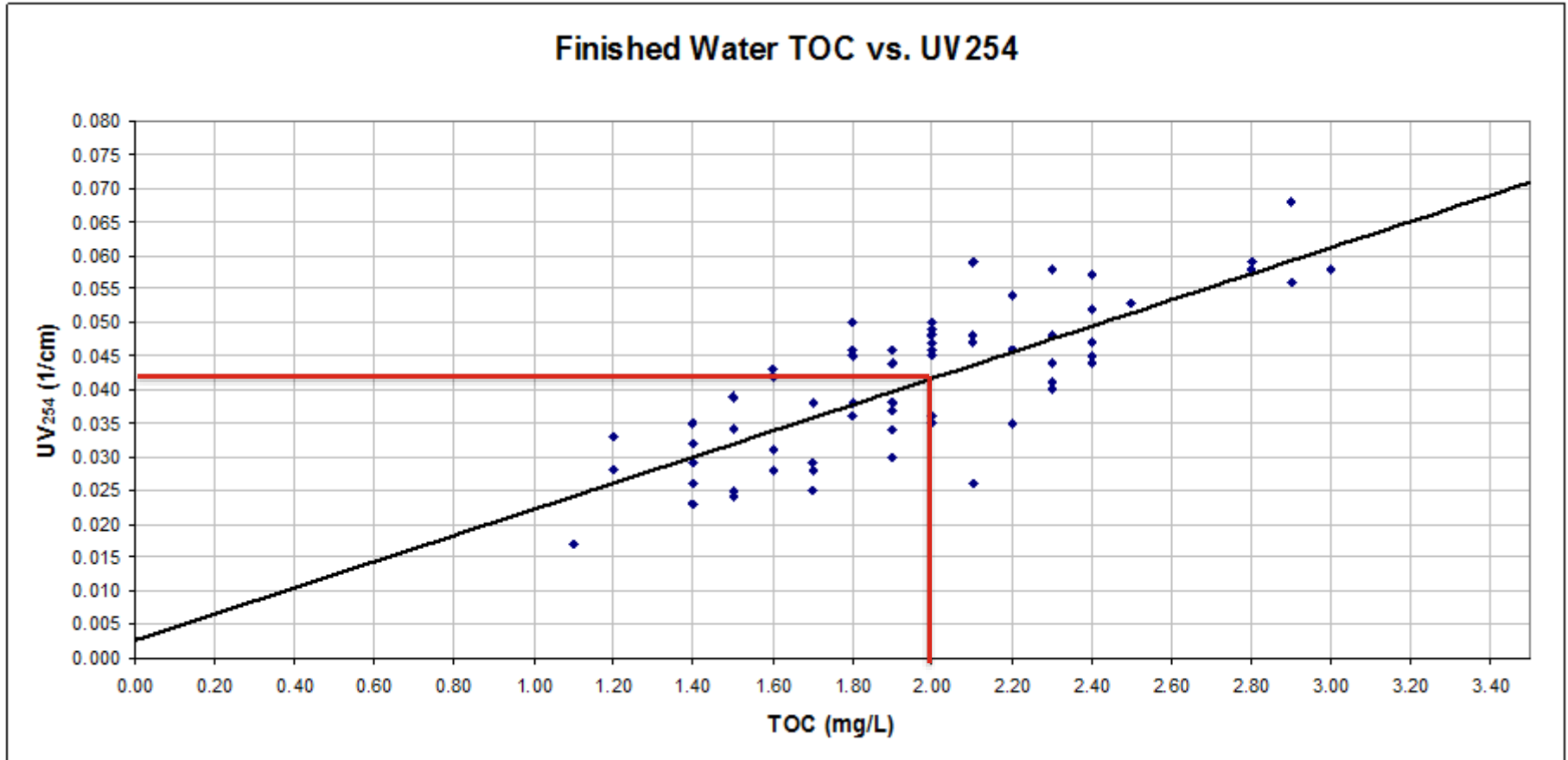
- UVA254
- Jar testing & coagulant dosing strategy
- Chlorination strategy
- Powdered activated carbon
- Increased sampling

UVA254

- Cheap, quick, and easy test
- Quantifies aromatic nature of organics
- Predictor of DBP formation potential
- Process monitor only—not for compliance
- Assist in predicting TOC concentrations



UV254 Optimization Targets



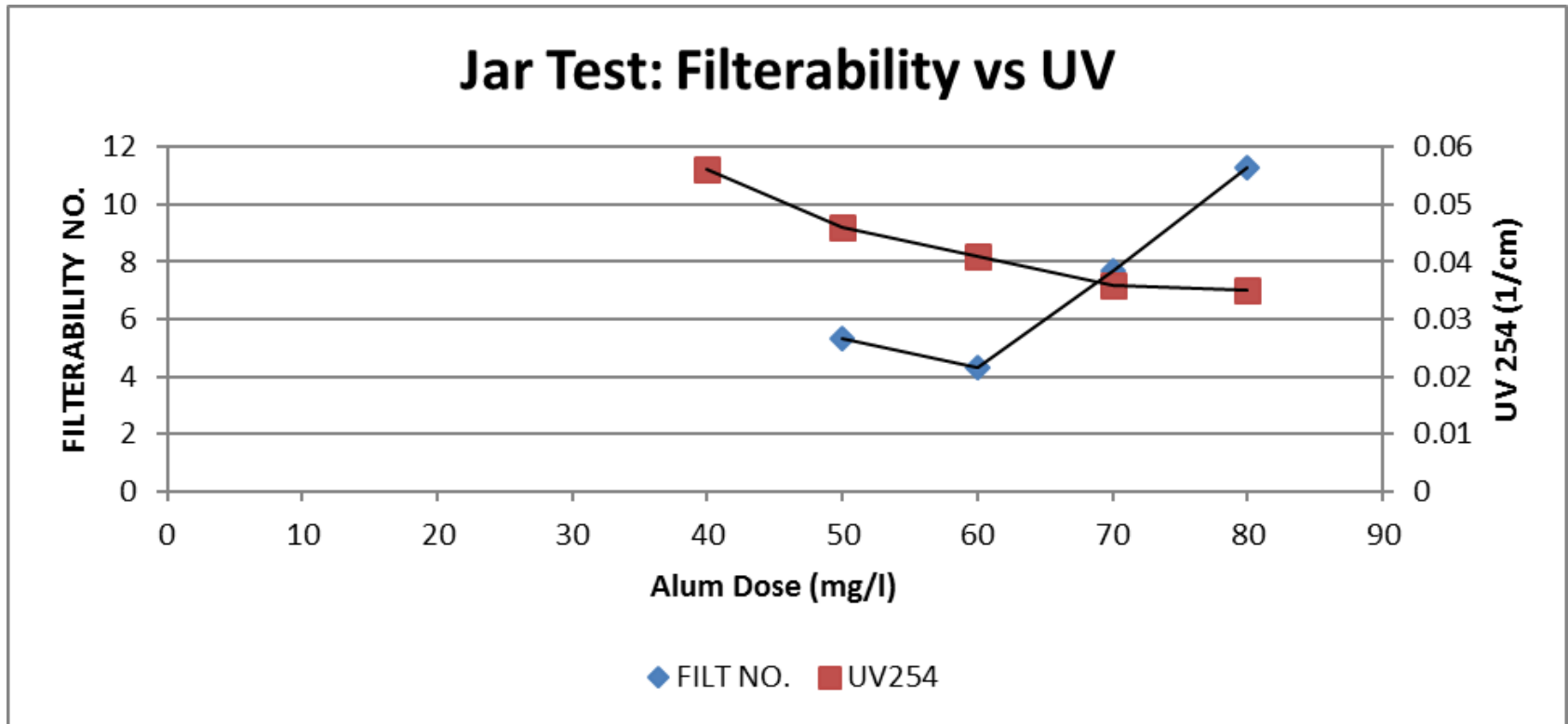
Jar Testing & Coagulant Dosing

- UVA, TOC, and filterability drive coagulant dose

Aqua PA							
Point of Diminishing Returns (PODR) Jar Test Report							
JAR TEST RESULTS							
Jar No.	Coagulant Dose (alum eq.) (mg/L)	Alkalinity	pH	UV254 (1/cm)	TOC (mg/L)	Incremental TOC Removal (mg/L TOC removed per 10 mg/L alum)	Cumulative TOC Removal (%)
RAW		34	7.30	0.180	5.1		
1	30	29	7.01	0.115	4.4	0.2	13.7
2	40	27	6.99	0.056	3.65	0.8	28.4
3	50	25	6.90	0.046	2.4	1.3	52.9
4	60	24	6.80	0.041	2.1	0.3	58.8
5	70	22	6.72	0.036	1.9	0.2	62.7
6	80	20	6.60	0.035	1.9	0.0	62.7
Target pH (based on raw alkalinity)		TOC, % Removal at Apparent PODR:				62.75	
5.5							

Jar Testing & Coagulant Dosing

- UV, TOC, and filterability drive coagulant dose

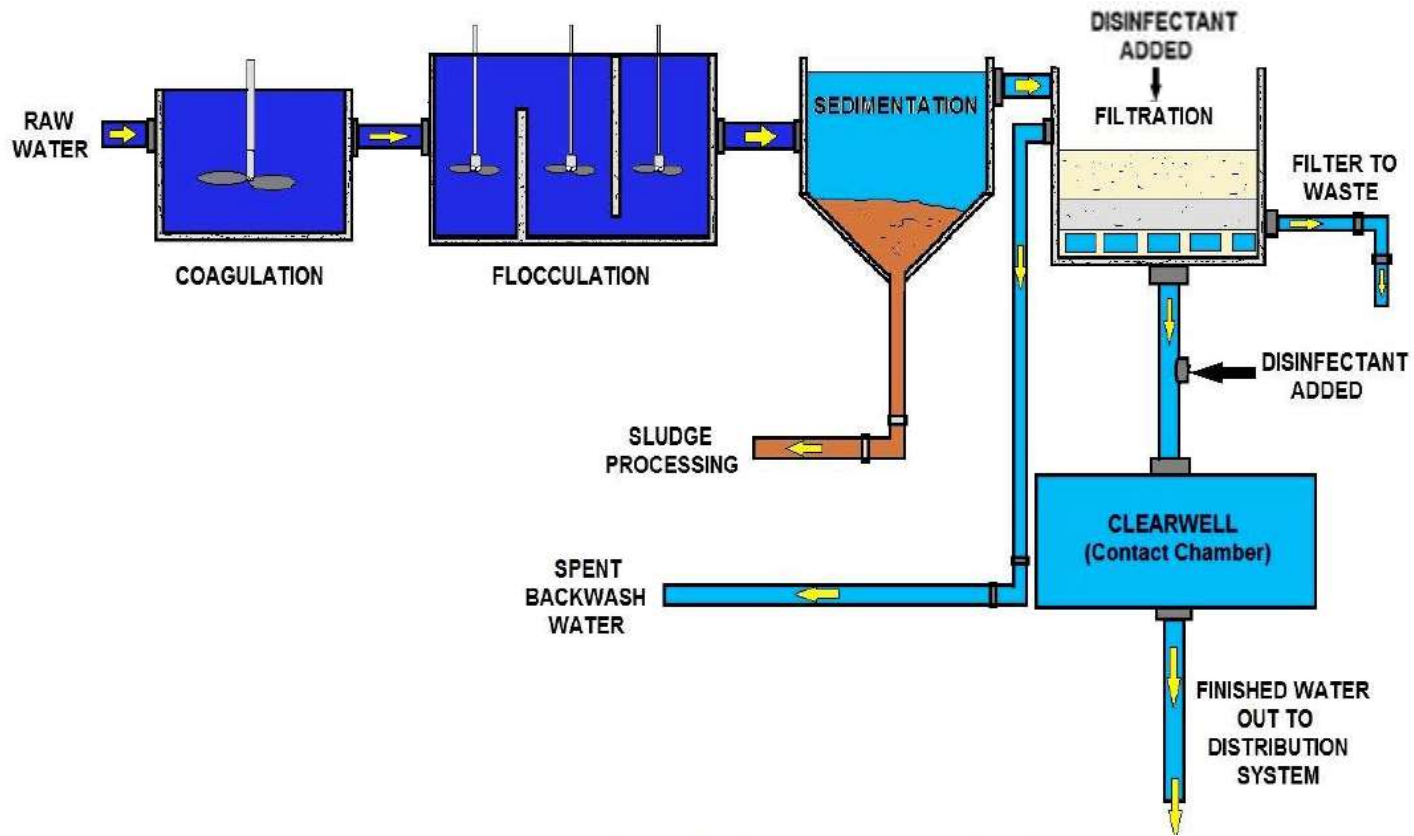


Chlorination Strategy

- Minimize chlorine through plant
 - Filters
- CT Inactivation Removal
 - Excessive CT is...excessive
- Boost chlorine on Plant Effluent

Chlorination Strategy

GOAL = Maximum removal of TOC *before chlorination* AND without negatively affecting downstream processes

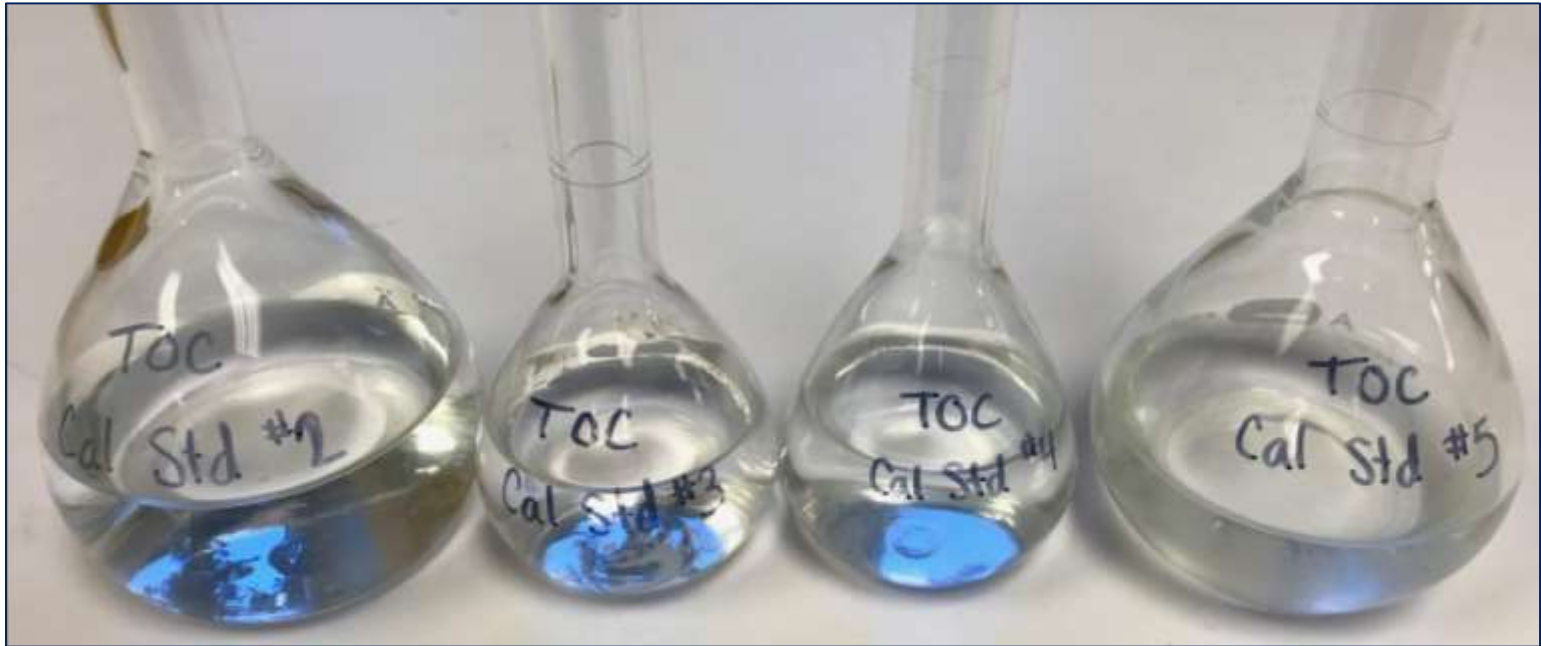


Other Tools

- Powdered Activated Carbon (PAC)
 - Reduce TOC
 - Contact Time
 - Jar Test
- Increased Sampling
 - Weekly sampling for precursor removal
 - Trend THM/HAA through plant
- Optimize TOC all year
 - Reduce LRAAs as much as possible

Keep Your Eyes Open!

- Turbidity does not always indicate TOC concentration



Keep Your Eyes Open!

- TOC does not always predict DBP formation potential
 - Total mass of organic material
 - Does not describe reactivity with chlorine
- Some organic compounds do not absorb at 254nm
- Utilize all available tools
 - UVA254
 - Streaming Current Detectors
 - Turbidimeters



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