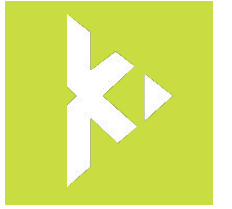


Amador Water Agency Disinfection Byproduct Study

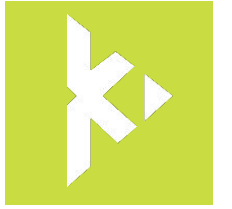
PNW Section – American Water
Works Association

May, 8 2025



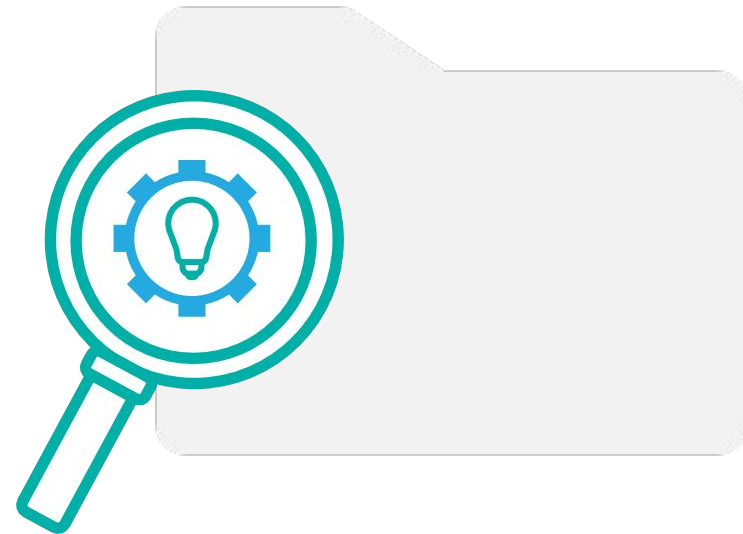


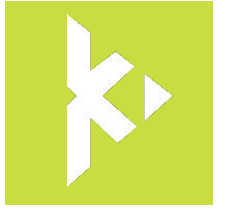
- **Education:** Master of Science Civil Engineering, University of Wyoming
- Bryan came from a ranching background in Wyoming where he learned the difference between theory and “real life”
- Experience in planning and analysis, design, and construction of source water, water treatment, transmission/distribution, water storage, water reuse, raw water irrigation, and wastewater treatment



OVERVIEW

- AWA Disinfection Byproduct Study
- Disinfection byproduct (DBP) risks and regulations
- DBP formation potential
- DBP mitigation strategies
 - Short-term solutions
 - Long-term solutions





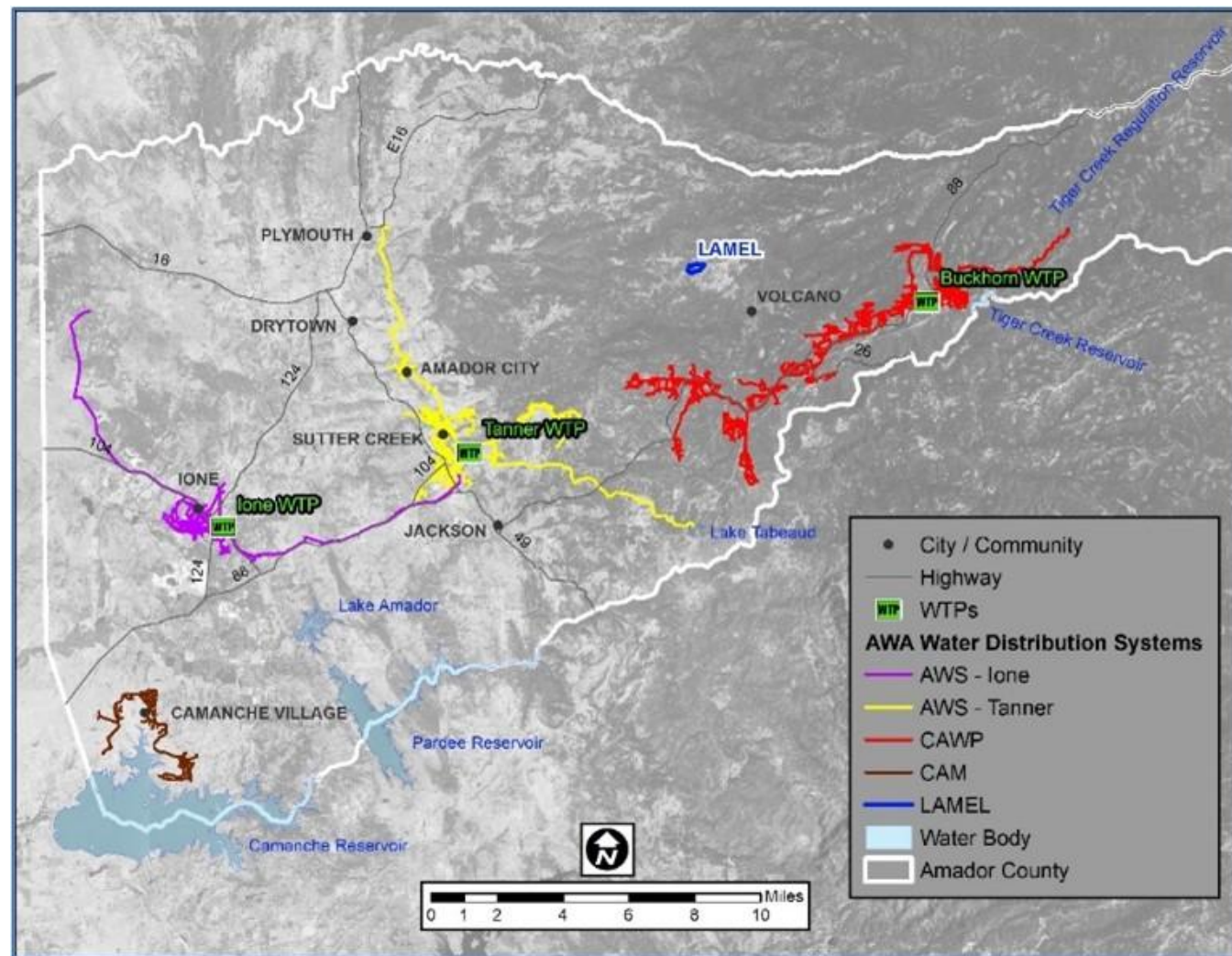
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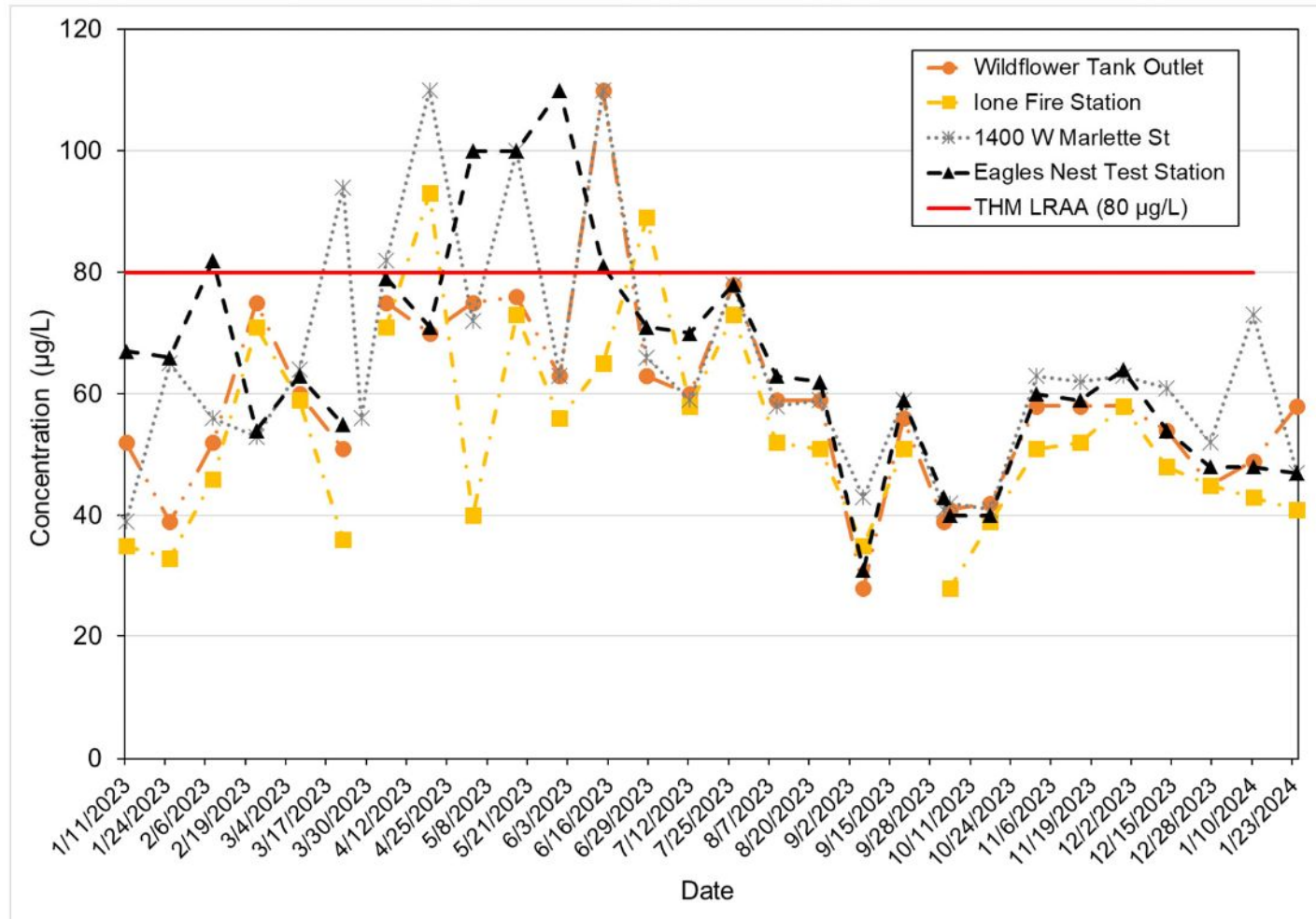
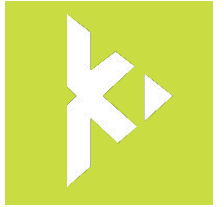
AMADOR WATER AGENCY

- Service Population: 40,000
- 6 Distribution Systems
- 4 Water Treatment Plants
- 1 Water Stabilization Facility
- 60+ pressure zones
- 19 pump stations
- 30+ storage tanks
- 200+ miles of pipe





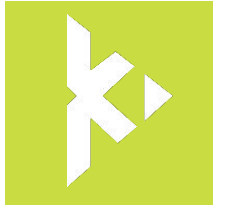
TRENDS IN DBPS



Ione, CA
Distribution System



OVERVIEW

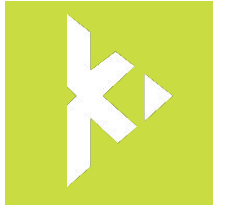


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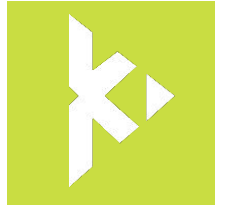
DBP BASICS



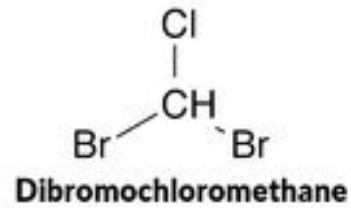
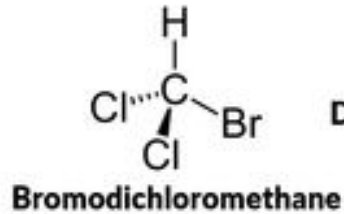
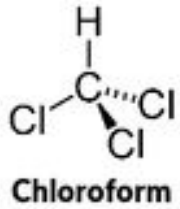
THM₄
HAA₅

**Natural
Organic Matter
(NOM)**

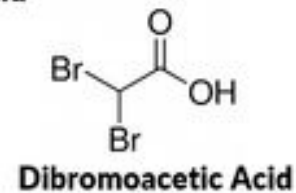
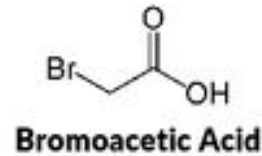
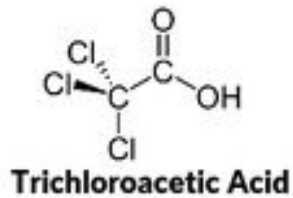
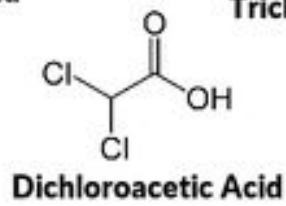
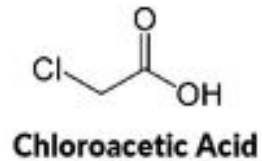
**Disinfectant
(Cl₂)**



CURRENTLY REGULATED DBPS



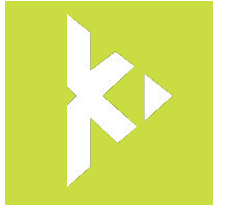
Trihalomethanes - THM₄



Haloacetic Acids - HAA₅



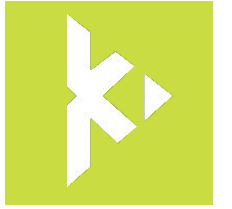
EPA STAGE 2 DBPR



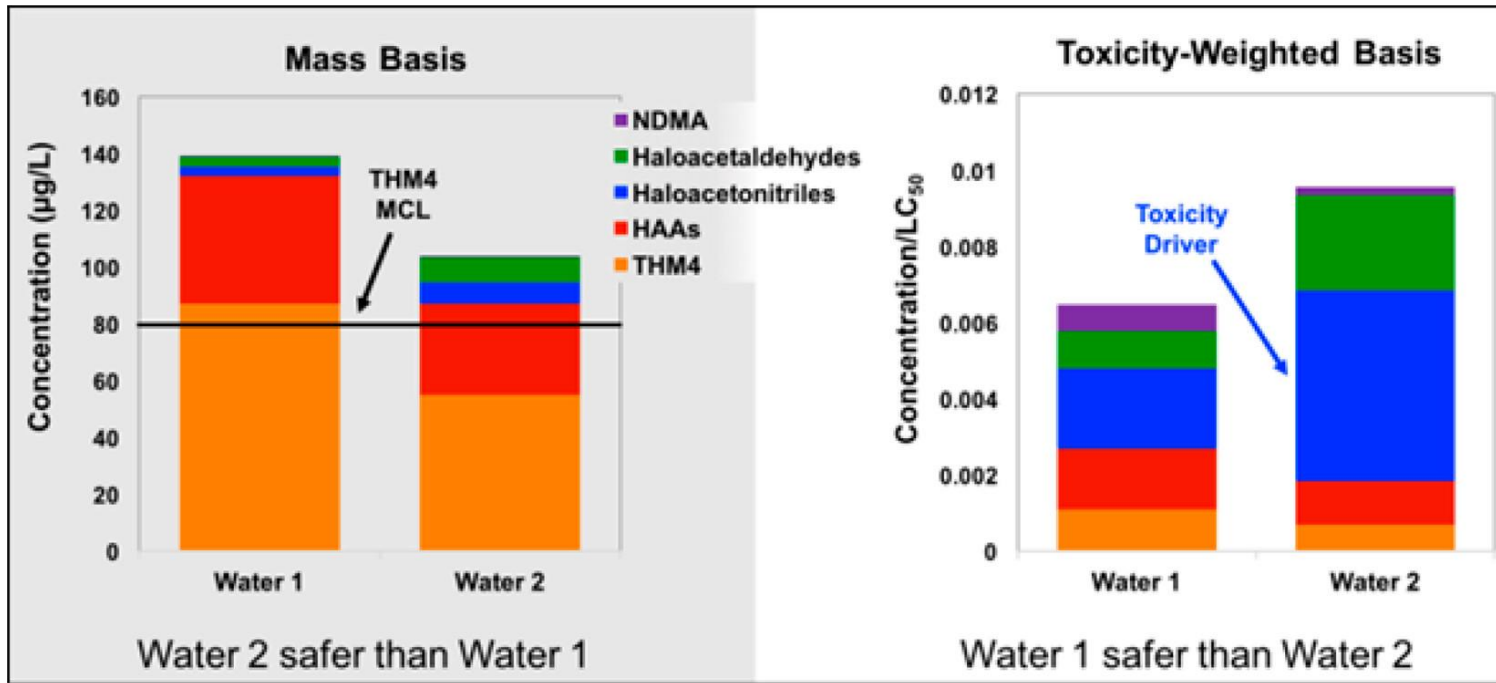
Stage 2 DBPR Regulated Contaminates		
Regulated Contaminants	MCLG (mg/L)	MCL (mg/L)
Total Trihalomethanes (TTHM)		0.080 LRAA
Chloroform	0.07	
Bromodichloromethane	zero	
Dibromochloromethane	0.06	
Bromoform	zero	
Five Haloacetic Acids (HAA5)		0.060 LRAA
Monochloroacetic Acid	0.07	
Dichloroacetic Acid	zero	
Trichloroacetic Acid	0.02	
Bromoacetic Acid	-	
Dibromoacetic Acid	-	

- Bromate = 0.010 mg/L
- Chlorite = 1.0 mg/L
- Based on Locational Running Annual Averages (LRAA)

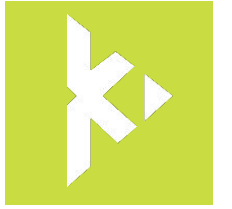
Note: Brominated DBPs will result in regulatory violations sooner due to high molecular weight (2 times heavier than Cl)



TOXICITY ASSOCIATED WITH DBPS

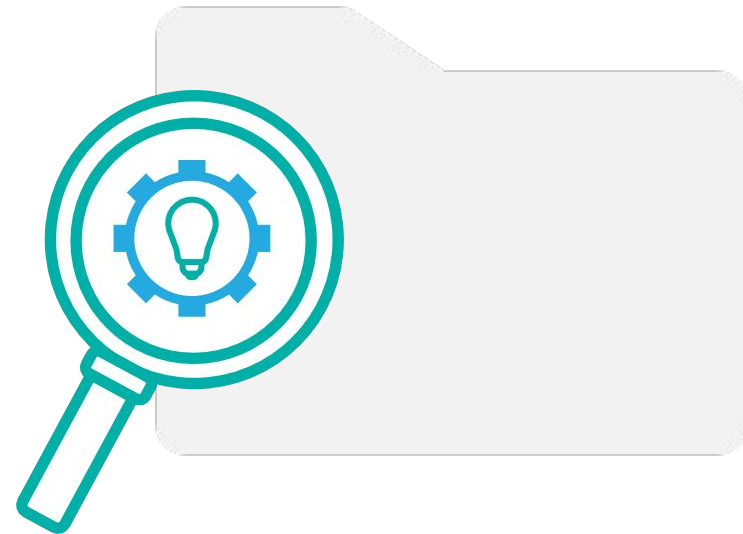


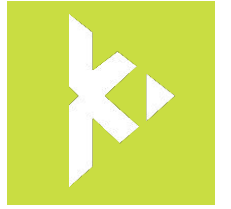
- Chronic Exposure
- Endocrine Disruption:
 - Carcinogenic Effects/Genotoxicity
 - Birth Defects and Developmental Disorders
 - Cytotoxicity
- Nitrogenous DBPs have a higher toxicity



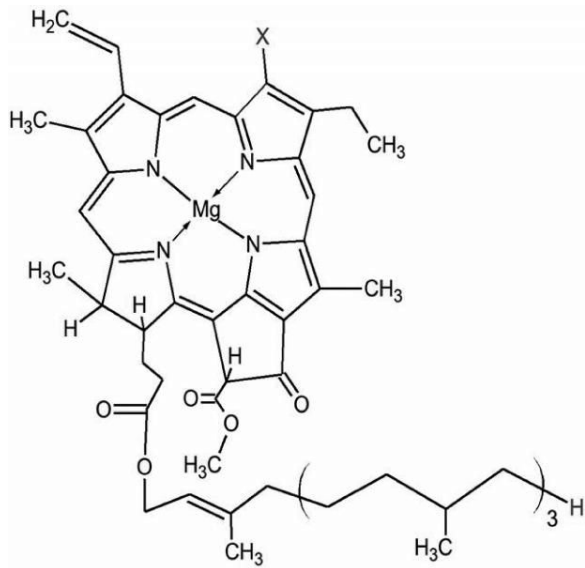
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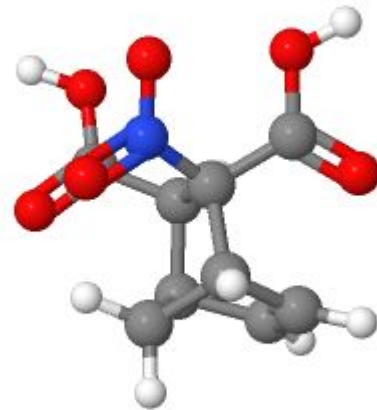




▶ DBP FORMATION POTENTIAL



Chlorophyll

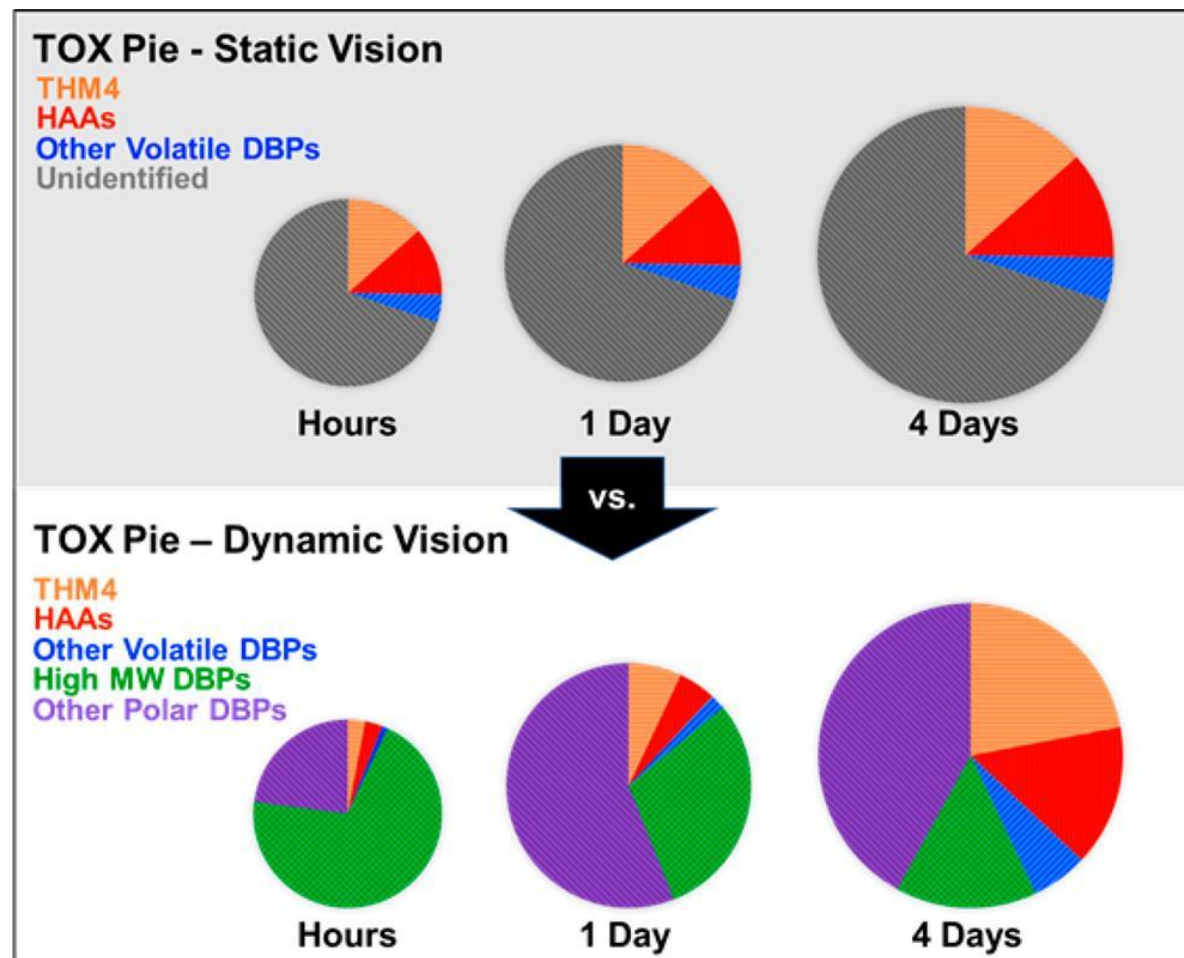
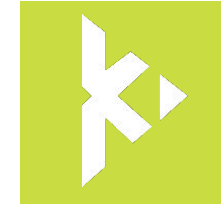


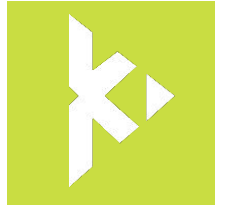
Humic Acid

- NOM – TOC/DOC
 - DBP Precursors
- Chlorine dose (mg/L)
- Time in contact
- Temperature and pH of water
- SUVA – specific ultraviolet absorbance ($100 \times \text{UV}_{254}/\text{DOC}$)

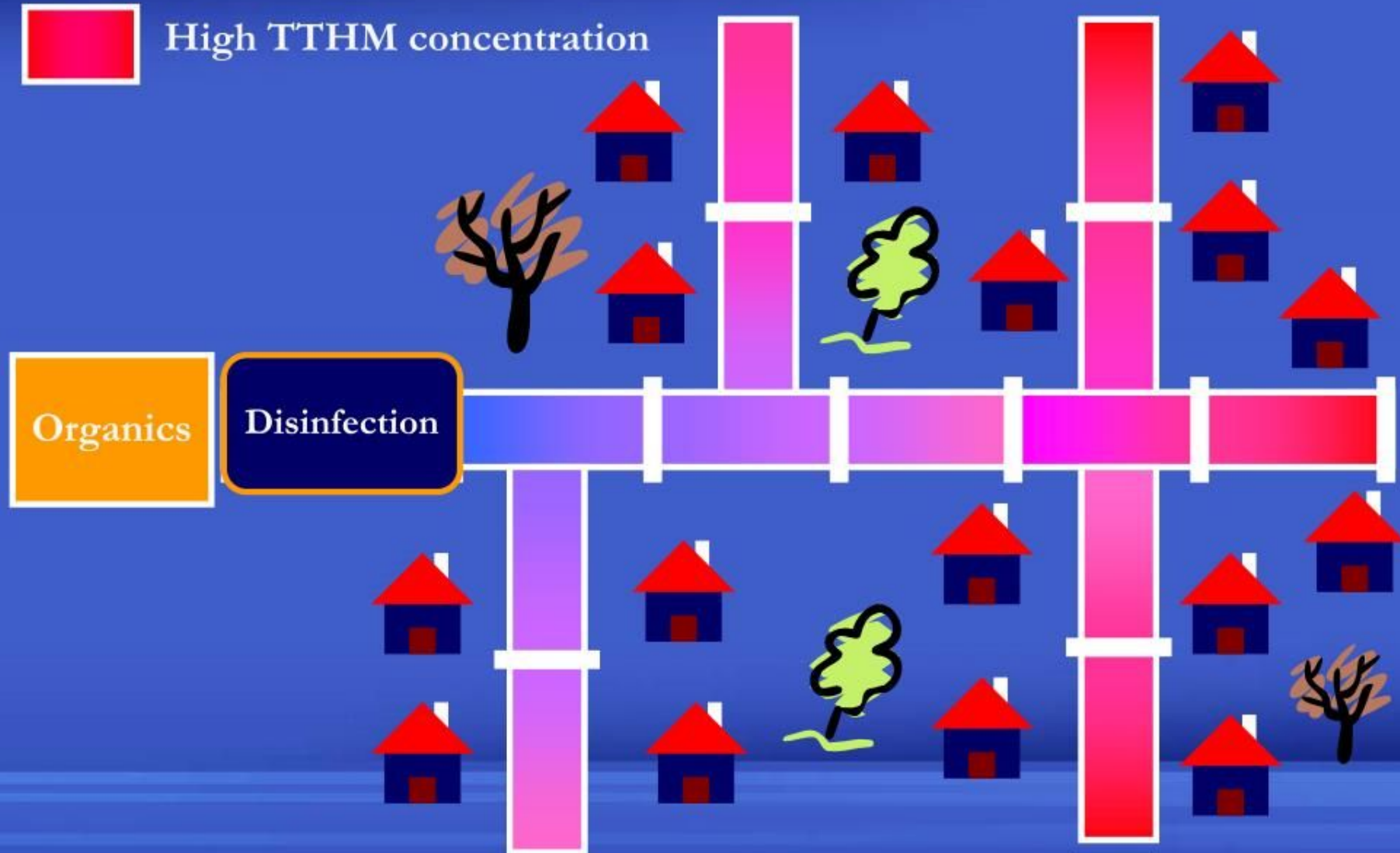


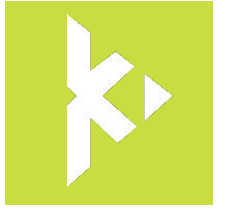
DBP FORMATION POTENTIAL





EVOLVING OUR UNDERSTANDING

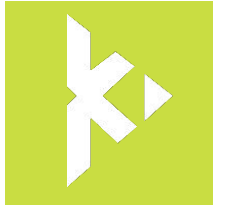




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DATA COLLECTION

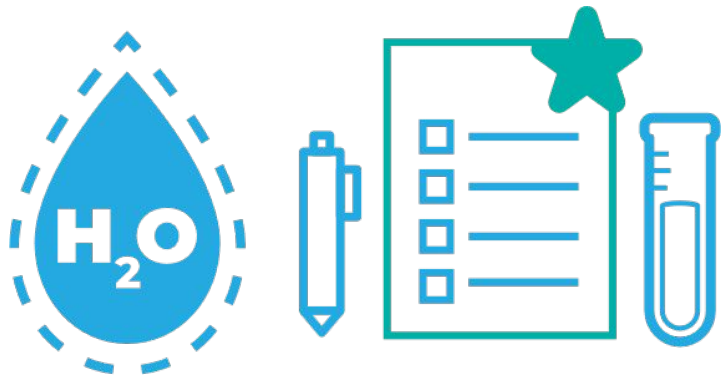
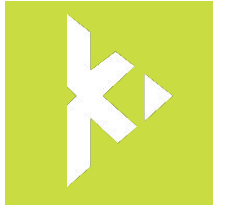
IN THE WTP

1. Raw Water Intake
2. Chemical Dosing
3. Clarifier/Filter Effluent
4. Backwash Stream
5. Finished Water



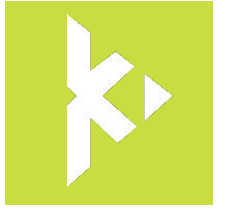


DATA COLLECTION



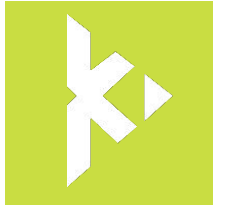
IN THE DISTRIBUTION SYSTEM

1. Existing testing stations
2. Furthest extents of the system
3. Storage tanks



SAMPLING PARAMETERS

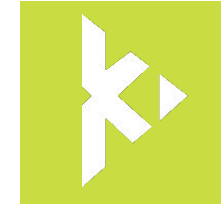
1. THM, HAA — *Disinfection Byproducts*
2. pH — *High Chemical Addition*
3. Temperature — *Not Controllable Parameter*
4. Chlorine Dose/Residual — *Must Maintain an Effective Residual*
5. TOC/DOC Concentrations — *Requires Enhanced Coagulation*
6. Alkalinity — *Hard to Control*
7. Bromide — *Specific to Brominated DBPs*
8. SUVA — *Monitoring and Tracking*



SAMPLING PARAMETERS

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8. **SUVA — *Monitoring and Tracking***

SOLUTIONS



- Monitor SUVA/TOC&DOC
- Characterize NOM in Raw Water
- Improve Enhanced Coagulation
- Be aware of Pre-forming DBPs
- Evaluate Disinfection Strategies





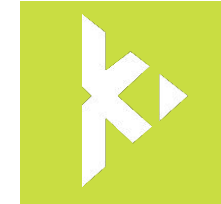
JAR TESTING RESULTS



Coagulant/ Flocculant	Composition	Raw Water UVA, cm ⁻¹	Raw Water Turbidity, NTU	NaOCl Dose, mg/L	Coagulant Dose, mg/L	Filtrate UVA, cm ⁻¹	UVA Reduction, %	10 min Settle NTU	25 min Settle NTU	pH	Flocs	Date
SWT 8809	25% ACH; 25% POA	0.065	1.89	1.5	6.5	0.024	60.0	-	1.82	7.24	Pin	4/10/2023
				0.0	6.5	0.030	50.0	-	2.28	7.33	Pin	
961	32% Polyaluminum Hydroxychlorosulfate 2% PolyDADMAC			1.5	29.0	0.018	70.0	-	0.87	6.89	Good	
				0.0	29.0	0.016	73.3	-	1.76	-	Good	
Pro Pac 9810	45-50% ACH; 5% polyamine			1.5	12.0	0.018	70.0	-	1.72	7.17	Pin	
				1.5	15.0	0.017	71.7	-	1.42	7.16	Pin	
905	45-55% ACH (~49%) 2% PolyDADMAC	0.065	1.89	0.0	15.0	0.020	66.7	-	1.66	-	Pin	4/10/2023
960	33% Polyaluminum Hydroxychlorosulfate			1.5	20.0	0.028	51.7	-	1.82	-	Pin	
		0.068	1.17	0.0	15.0	0.038	44.1	-	0.83	-	Pin	8/29/2023
Pro Pac 926	30-40% ACH	0.068	1.17	0.0	15.0	0.055	19.1	-	1.14	-	None	
ACH	ACH	0.065	2.0	0.0	20.0	0.012	81.5	0.12	-	-	Unknown	6/9/2023
Blend 1	ACH + 8809			0.0	20.0 + 2.0	0.013	80.0	0.11	-	-	Unknown	
Blend 2	ACH + 8809			1.0	20.0 + 2.0	0.015	76.9	0.08	-	-	Unknown	

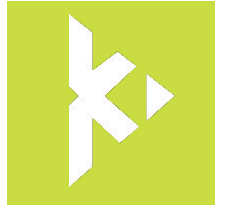
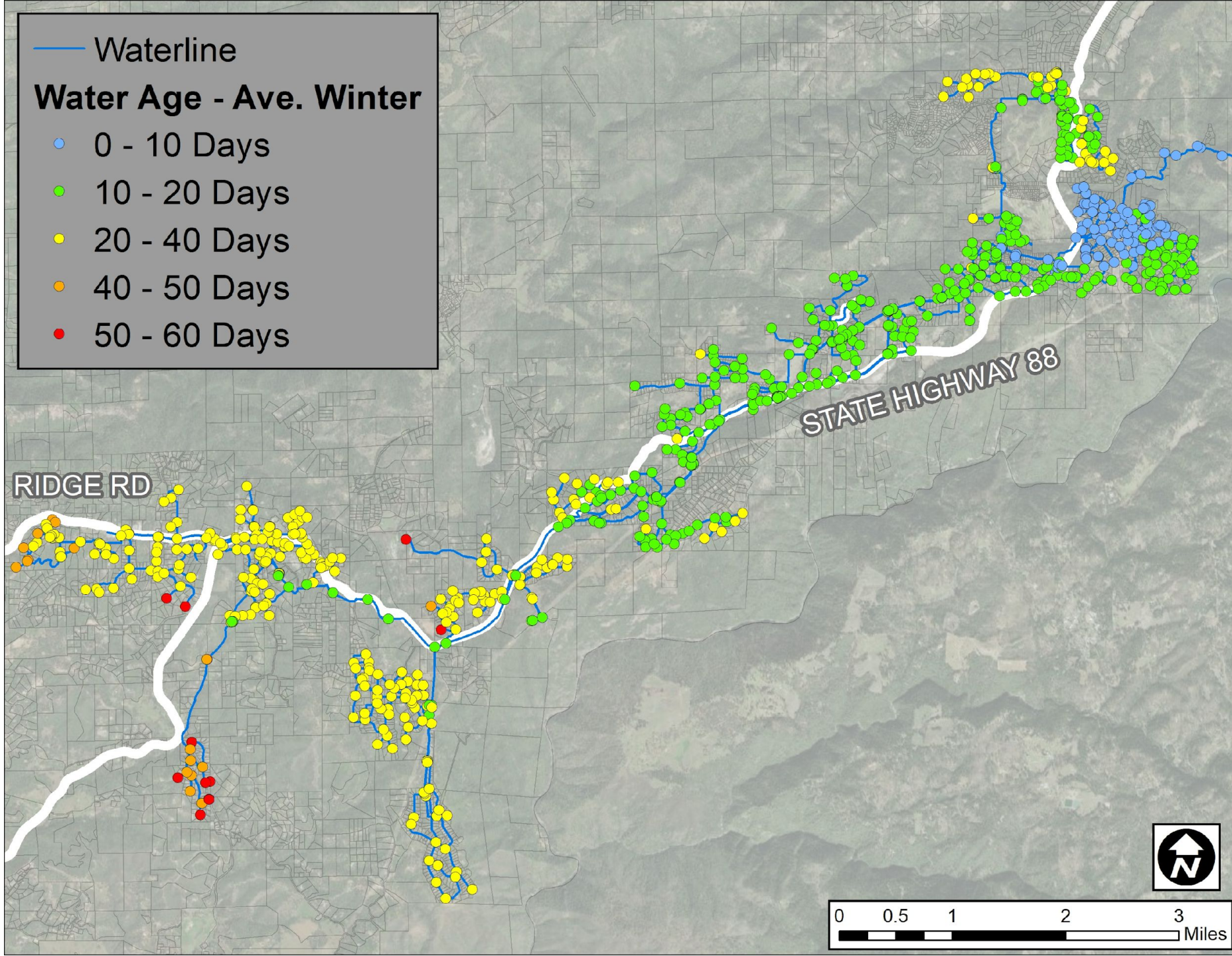


SOLIDS HANDLING UPGRADES



- Low Coagulant Dose Due to Solids Handling Constraints

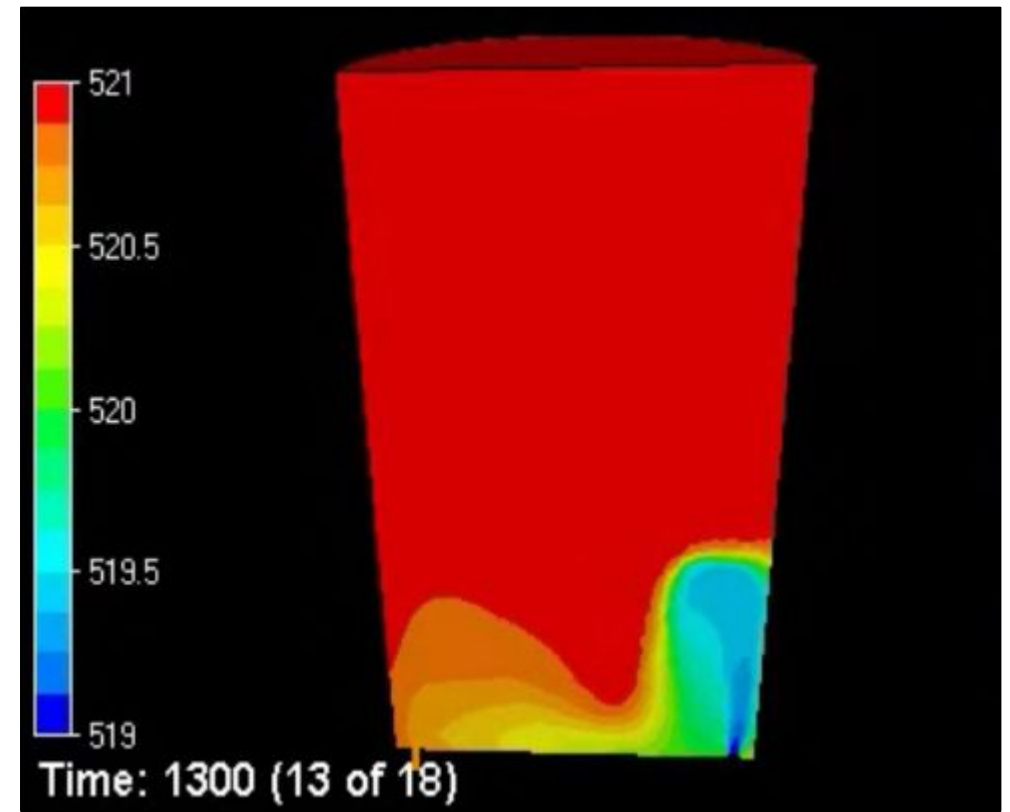
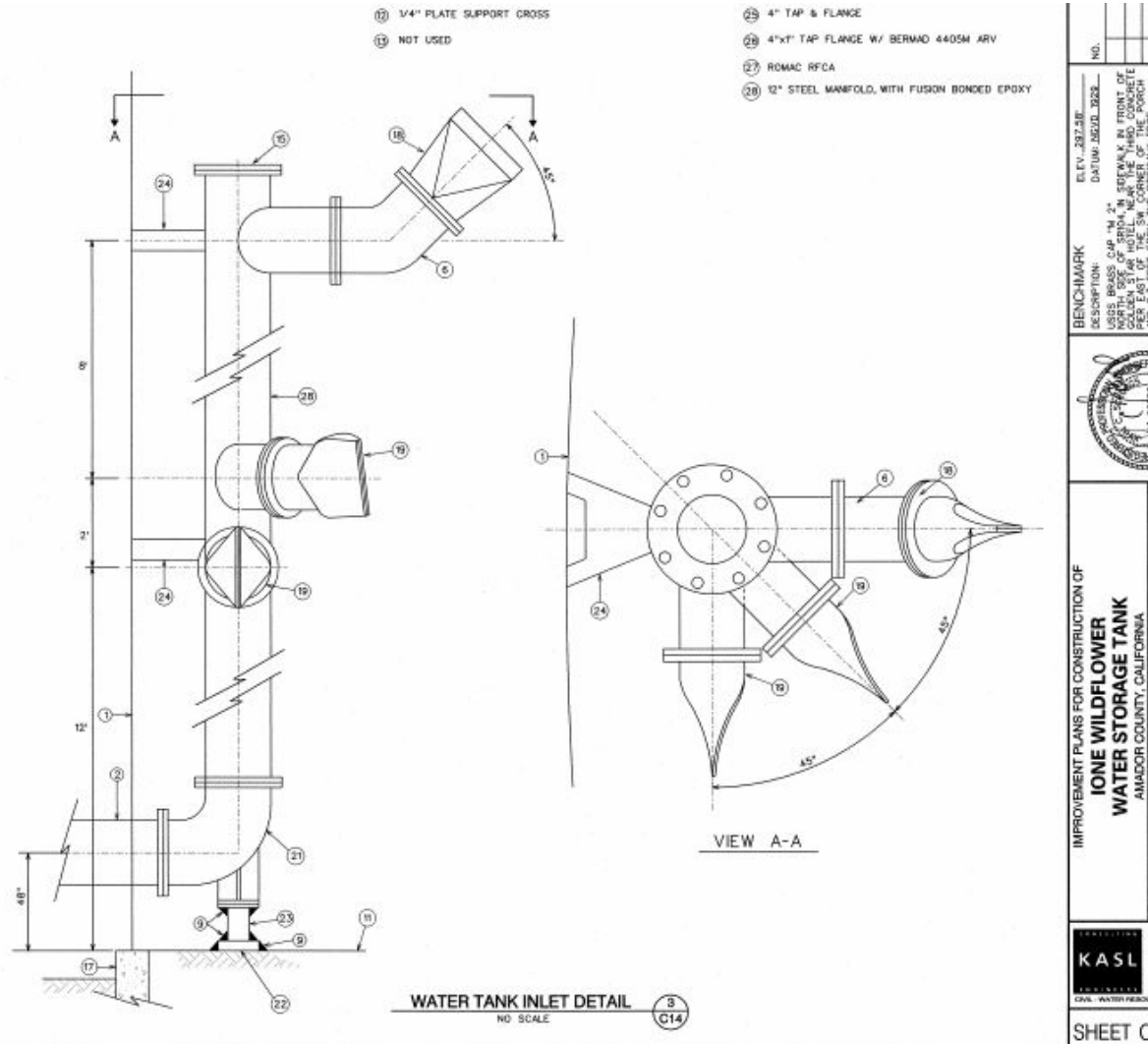
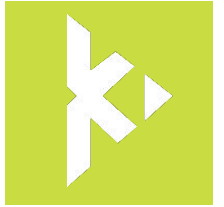




WATER AGE ANALYSIS

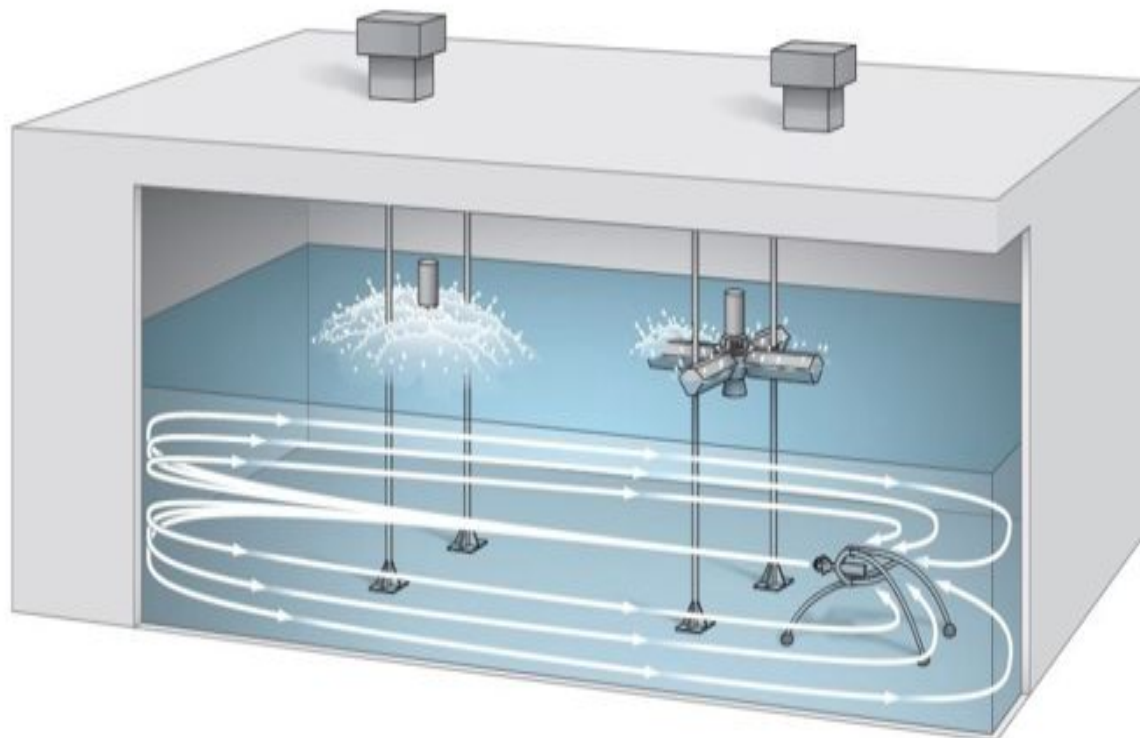
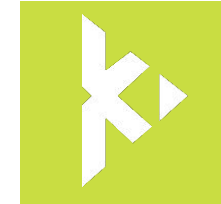


TANK MIXING

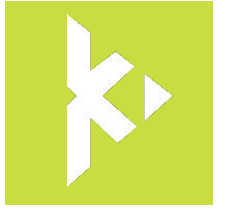




CHLORINE BOOSTING



- Automated residual boosting system
- **Advantages**
 - Maintain residual chlorine
 - Minimize DBP formation potential
- **Disadvantages**
 - Chemical storage/treatment on site
 - Requires SCADA to automate dosing



SUMMARY

- Water authorities are having to look beyond single point chlorination
- DBP formation is highly source specific
- DBPs are and will be a class of emerging contaminants
- Monitoring TOC, DOC, & UV_{254} can inform operations



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