Building Resilience

With Advanced Oxidation Treatment

2020 OTCO Reservoir Management Webinar

Salvador Dominguez, Product Manager, Xylem Inc.

Water Resilience in Drinking Water

All communities need safe drinking water

153,000 public drinking water systems in the U.S.

Supplying >80 percent of U.S. population

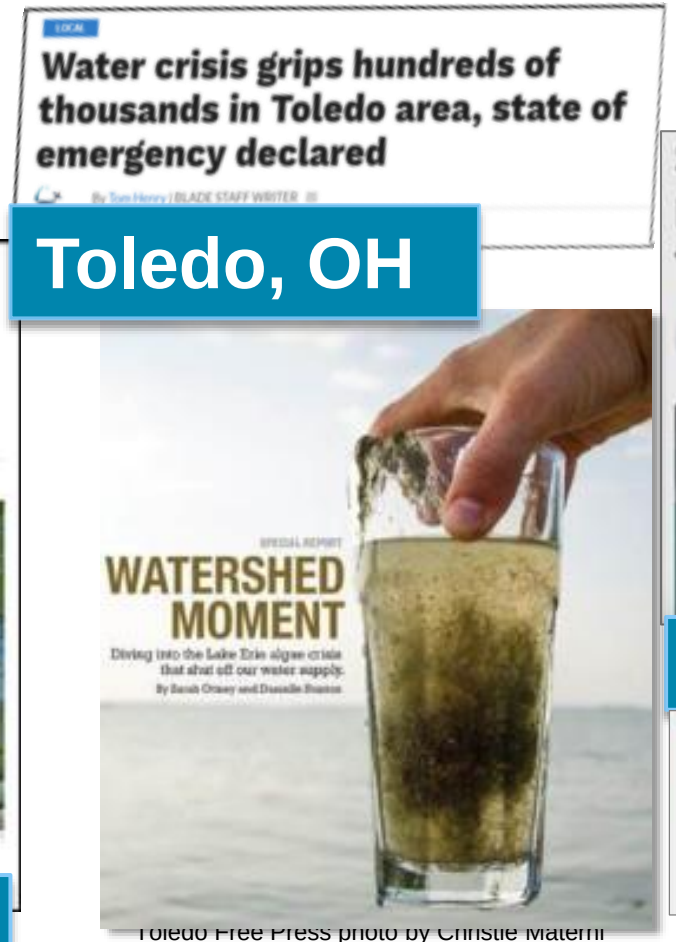
Drinking Water Resilience addresses:

- ✓ Contamination
- ✓ Physical Attacks
- ✓ Cyberattacks

xylem
Let's Solve Water

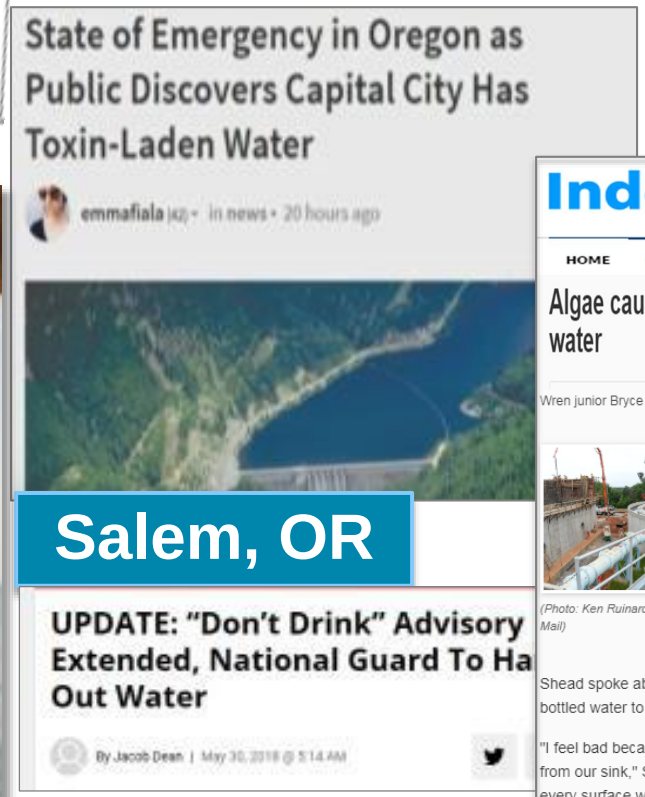
Harmful Algal Bloom Crises

Palm Beach, FL



Toledo, OH

Toledo Free Press photo by Christie Materni



Salem, OR

Anderson SC

xylem
Let's Solve Water

HAB Causes

- ✓ High Phosphorus and Nitrogen
- ✓ Climate change
- ✓ Thermal pollution


U.S. Army Corps of Engineers New Orleans District


Lake Oroville, CA Photograph: Justin Sullivan/Getty Images

Management Options

SOURCE

TREATMENT

Transport

Transport

Monitoring & control

Intake Modifications

Treatment Upgrades

xylem
Let's Solve Water

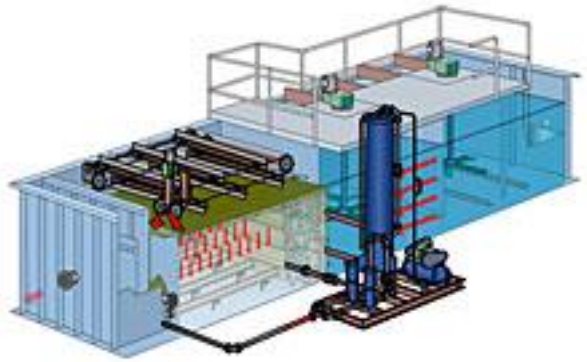
Potential HAB Treatment Modifications - Clarification

Micro-strainers:

- Headloss
- Cause cell lysing
- Uncertain removal rates

Passive Clarification:

- May grow algae
- Unknown removal rates
- Large footprint



Dissolved Air Flotation (DAF):

- No cell lysing
- Proven removal rates
- Efficient footprint

Highly Recommended for HABs

Potential HAB Treatment Modifications - Absorption

Image: www.tpomag.com

Powdered Activated Carbon (PAC):

- Can effectively remove extracellular compounds
- Absorption varies by batch
- High OpEx, hidden costs
- Dosing systems messy & prone to clogging
- Explosion risk

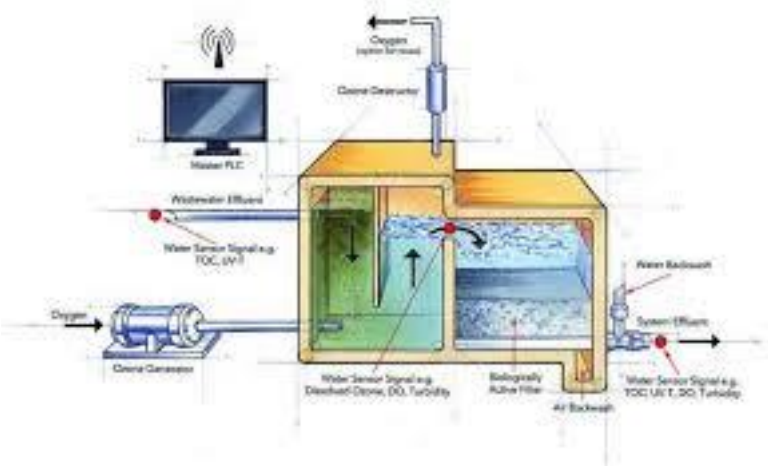
Proceed with caution – carefully quantify all costs

Granular Activated Carbon (GAC):

- Can effectively remove extracellular compounds
- Adsorption varies by batch
- High OpEx, hidden costs
- Unknown time to breakthrough
- Large footprint

Proceed with caution – carefully quantify all costs

Potential HAB Treatment Modifications - Oxidation



Ozone:

- Highly effective on extracellular HAB compounds
- Protozoa inactivation credits also possible

Highly Recommended for HABs

Advanced Oxidation (AOP):

- Highly effective on extracellular HAB compounds
- Also effective on CECs
- Protozoa inactivation credits also possible

Highly Recommended for HABs

Biologically Active Carbon (BAC):

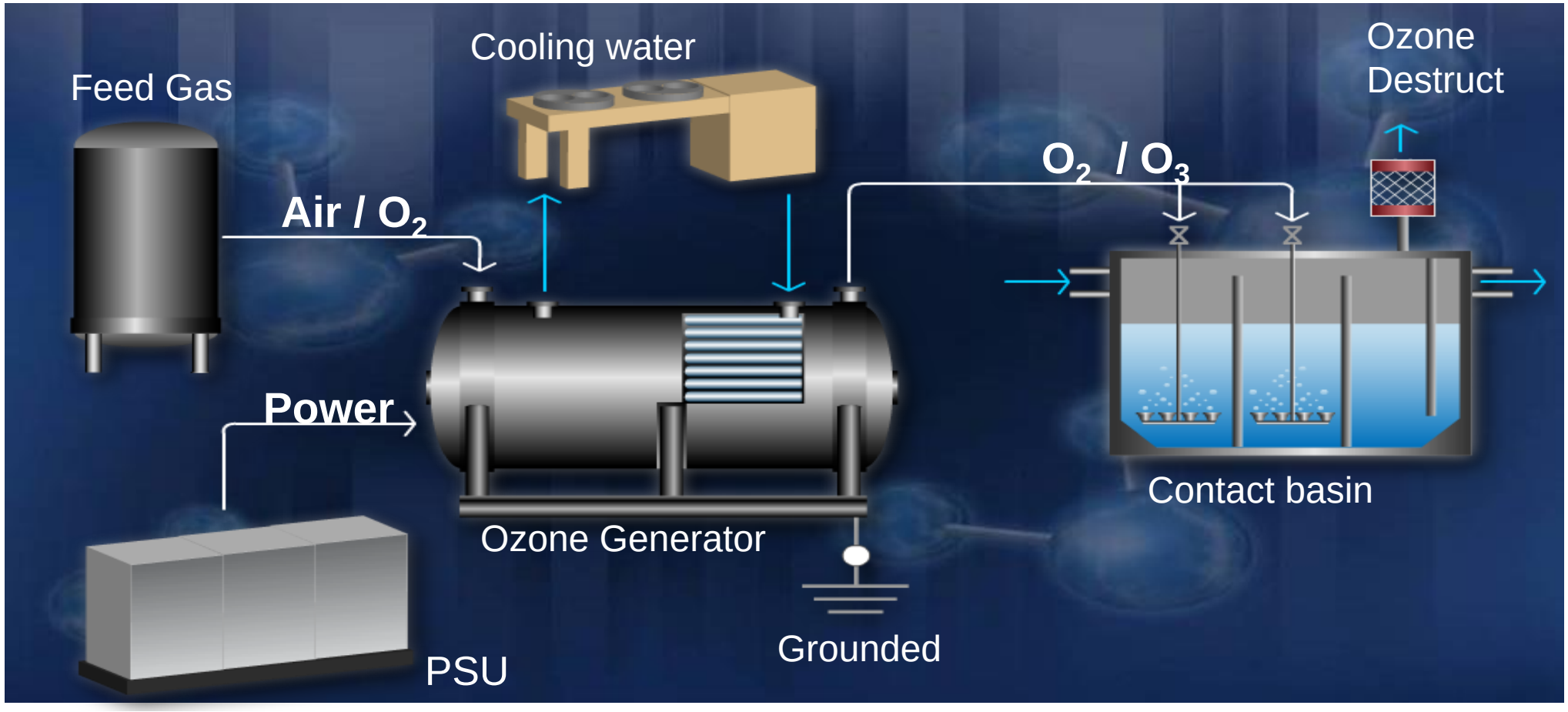
- Most effective on extracellular compounds when preceeded by ozone or AOP
- Also effective on CECs

Highly Recommended for HABs in combination with pre-oxidation step

Hydroxyl Radicals (OH)

Oxidant	Oxidation Potential (V)
Hydroxyl Radical	2.80
Ozone	2.07
Hydrogen Peroxide	1.78
Potassium Permanganate	1.70
Sodium Hypochlorite	1.49
Chlorine	1.36
Chlorine Dioxide	1.27
Oxygen	1.23

Ozone System Overview



System Overview

- ✓ Water supplier to 15 agencies, serving 200,000 citizens
- ✓ Conventional surface water plant rated at 48 MGD
- ✓ Approximately 40 miles transmission mains

xylem
Let's Solve Water

System Overview

Hartwell Lake Reservoir

xylem
Let's Solve Water

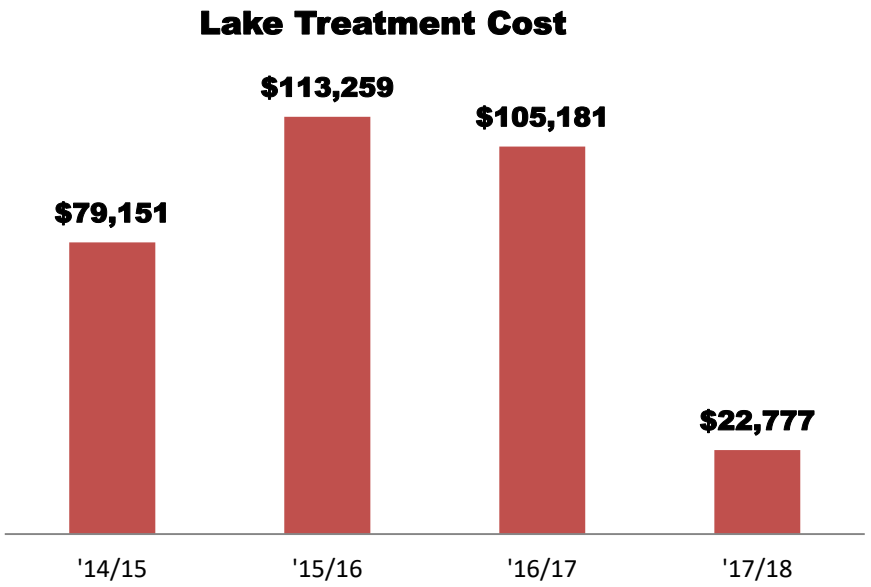
The Challenge

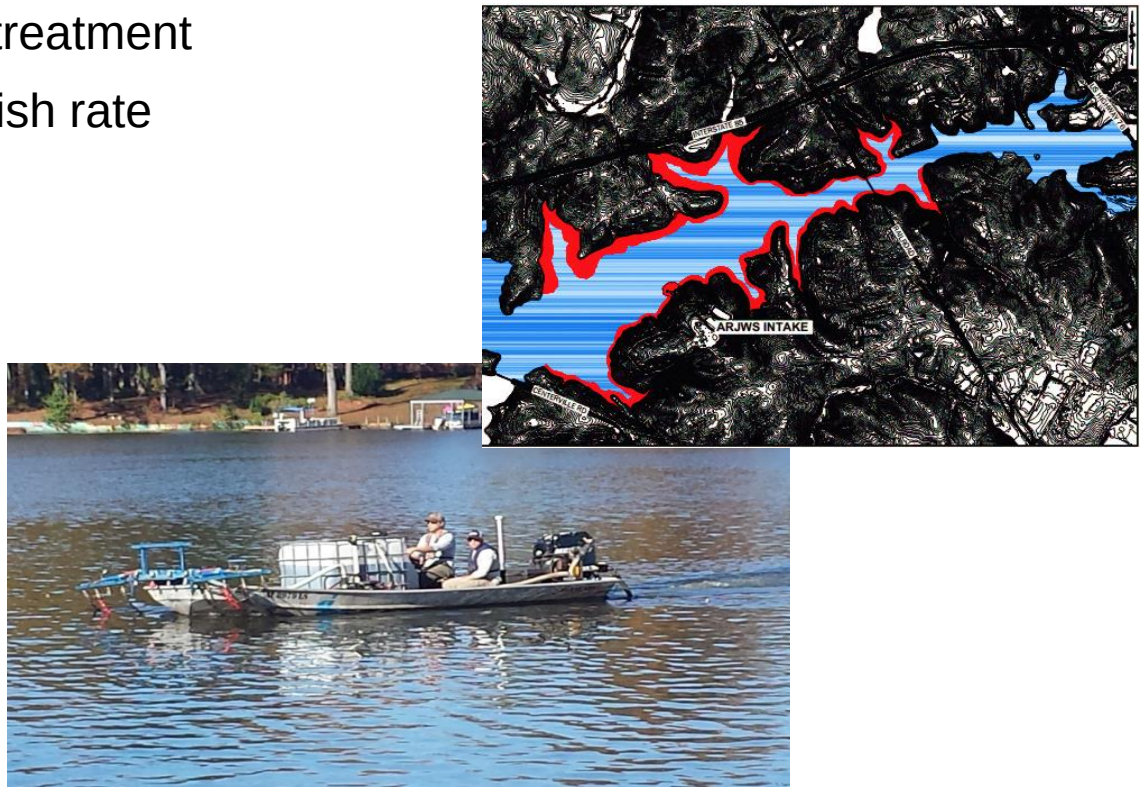
- ✓ Summer 2013 detection of 2-Methylisoborneol (MIB) and Geosmin
- ✓ Summer 2014 concentrations entering the plant were in the 300 to 700 ng/L

xylem
Let's Solve Water

Short Term Solution – Lake Treatment

- ✓ 2014-2017 Lake treatment using a copper-based and peroxide-based product
- ✓ Lake treatments successful but not sustainable and difficult to control
- ✓ 100 acres upstream of the intake was targeted for Treatment
- ✓ Reduction levels could be seen only 72 hours lake treatment
- ✓ Limited control over biology in the lake influencing fish rate

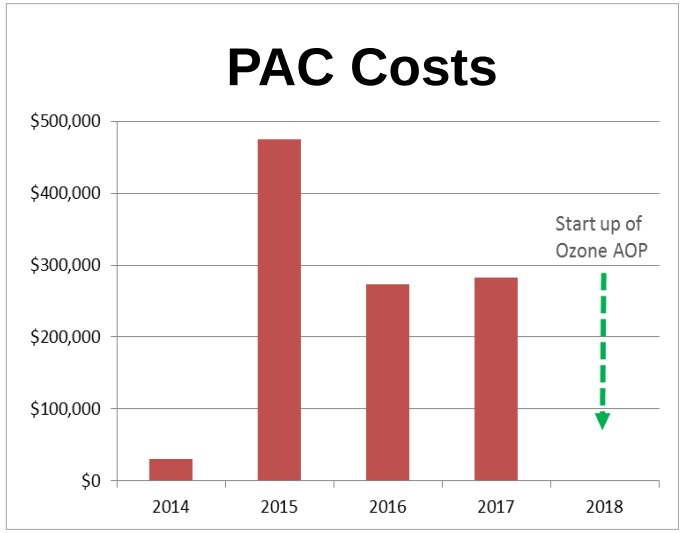




xylem
Let's Solve Water

Short Term Solution with Powdered Activated Carbon (PAC)

- ✓ Limited to ~90% removal of extracellular compounds
- ✓ Adsorption varies by batch
- ✓ High OpEx, hidden costs, accumulation in sludge system
- ✓ Dosing systems are messy & prone to clogging
- ✓ Explosion risk
- ✓ Proceed with caution – carefully quantify all costs



New Treatment Objectives

Board Decision to identify treatment technology to address the following within the plant:

- ✓ Address Taste and Odor
  - ✓ 2 log reduction 2-Methylisoborneol (MIB)
  - ✓ 2 log reduction Geosmin
- ✓ Improve Color
  - ✓ Iron
  - ✓ Manganese
- ✓ Address Emerging Contaminants (meet future regulations)
  - ✓ NDMA, MTBE, cyanotoxins
  - ✓ Pharmaceuticals

Evaluating Advanced Technologies & Designs

- ✓ Conduct Bench Scale Analyses
- ✓ Tested Ozone, Ozone + Peroxide and UV + Peroxide
- ✓ 6 iterations each with 30-45 test points MIB spiking to 1000 ppb performed
- ✓ Tested at multiple pH levels
- ✓ Engineer evaluated total of 121 testing combinations - *Treatment goal 99% removal

Treatability Testing Results

- ✓ UV AOP removed as an option
- ✓ Ozone only performed well
- ✓ Ozo[illegible] and stronger

Figure 4: Raw water sample ozone residual with 1107.0 MIB & pH set to 6.9.

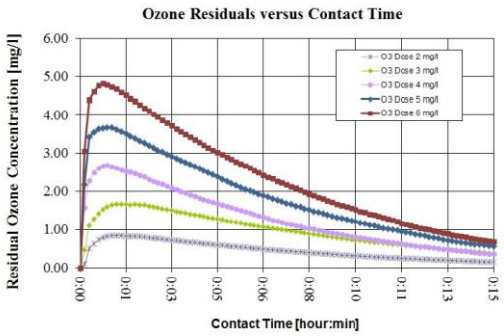


Figure 5: Raw water sample ozone residual with O_3+H_2O_2, 381.2 MIB & pH set to 6.9.

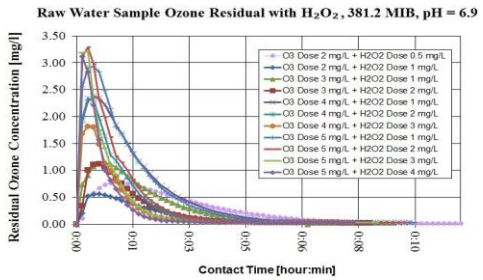


Figure 8: Impact of ozone doses on MIB concentration.

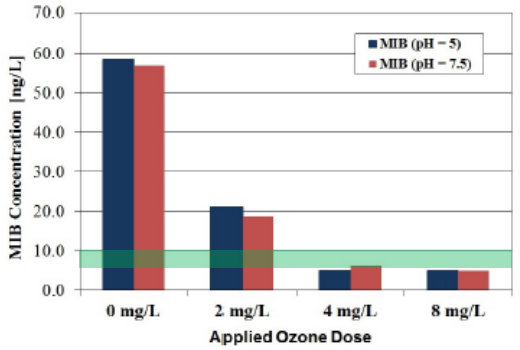
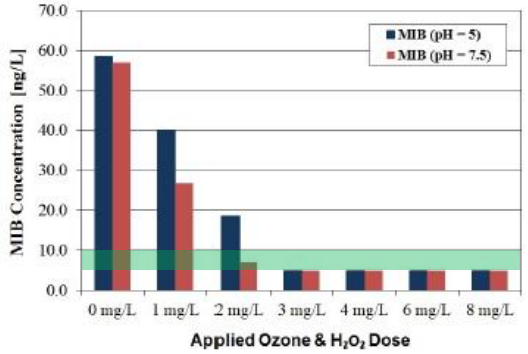


Figure 10: Impact of O_3 + H_2O_2 doses on MIB concentration.

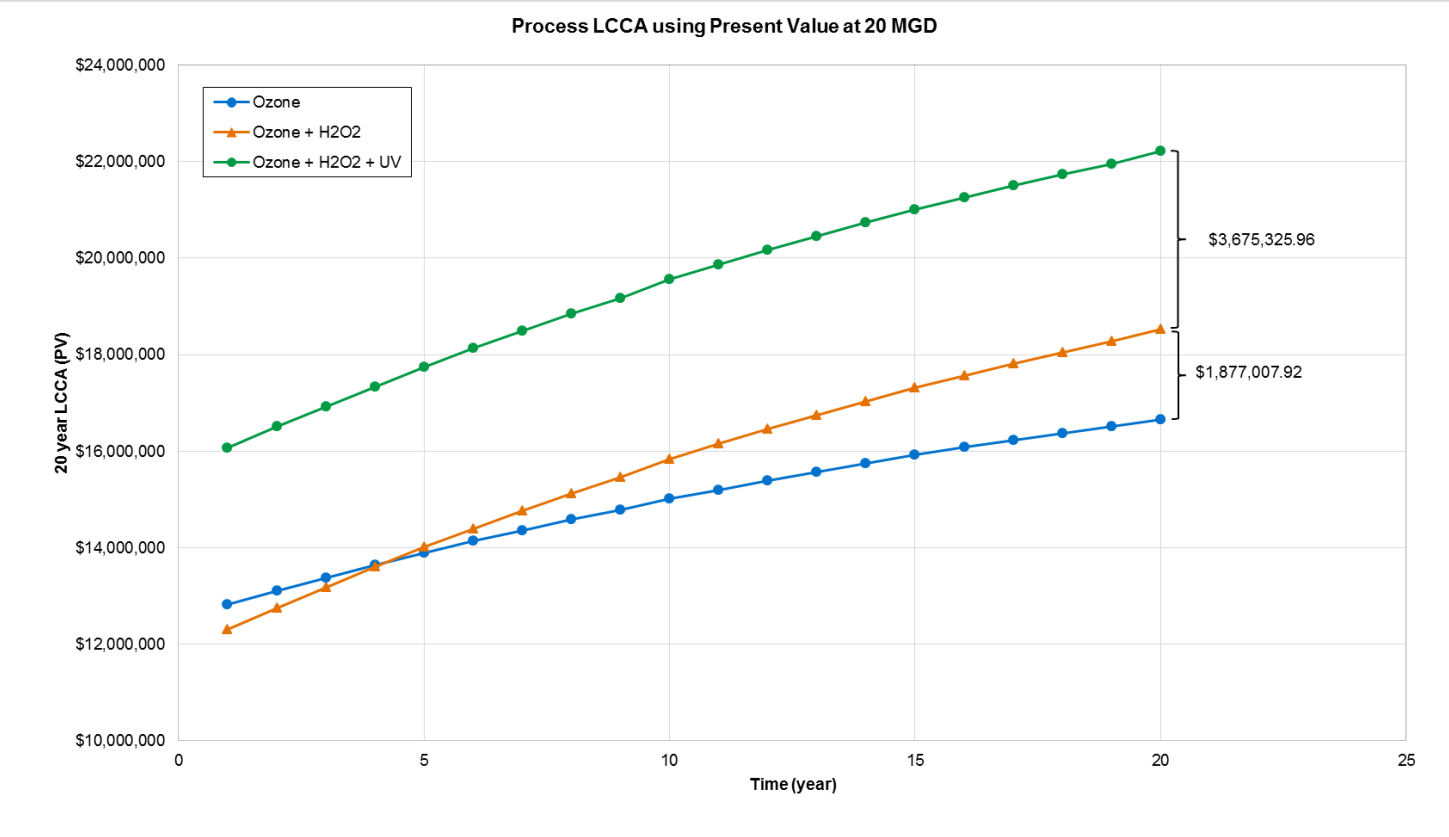


xylem
Let's Solve Water

Performance and Capex Evaluation for Anderson RJWS

	Conventional Treatment	H2O2 + UV	Ozone	H2O2 + Ozone
Taste and Odor	Minimally Effective	Highly Effective	Highly Effective	Highly Effective
Discoloration	Effective	Minimally Effective	Highly Effective	Highly Effective
Cyanotoxins	Minimally Effective	Effective	Very Effective	Highly Effective
Pharmaceuticals	Minimally Effective	Highly Effective	Highly Effective	Highly Effective
Emerging contaminants	Minimally Effective	Highly Effective	Effective	Highly Effective
CAPEX	-	$$$	$$	$

Total Lifecycle Comparison for Anderson RJWS



- ✓ Selected Design: Ozone H2O2
- ✓ H2O2 provides additional protection
- ✓ AOP addresses CECs
- ✓ Smaller Contactor with AOP design

xylem
Let's Solve Water

Project Design

- ✓ Two (2) 1,000 ppd ozone generators, with space for a future 3rd generator
- ✓ Effizon 2G Glass Core Electrode Technology (20y expected lifetime)
- ✓ Two liquid oxygen (LOX) tanks
- ✓ Peroxide dosing system for AOP and quenching
  - ✓ H2O2 can be fed at the contactor influent to treat high algal concentrations
  - ✓ H2O2 can be fed at the contactor effluent to remove residual ozone
- ✓ Designed contact time of 12 minutes at 48 MGD
- ✓ Plant feeds ~1ppm in winter and up to 2.7 ppm in summer depending on organics in the raw
- ✓ Measurement of ozone residual in second chamber and maintain level of 0.15 ppm

xylem
Let's Solve Water

Ozone / Ozone AOP: Summary

- ✓ Both can remove T&O and Toxins effectively
- ✓ Ozone requires longer retention times & higher doses compared to Ozone AOP
- ✓ Selection of process depends on available footprint, required treatment goal and other treatment challenges
- ✓ Often combined with BAC for polishing, (removal of OBPs and residual hydrogen peroxide)

Ozone Implementation

ANDERSON REGIONAL
JOINT WATER SYSTEM

xylem
Let's Solve Water

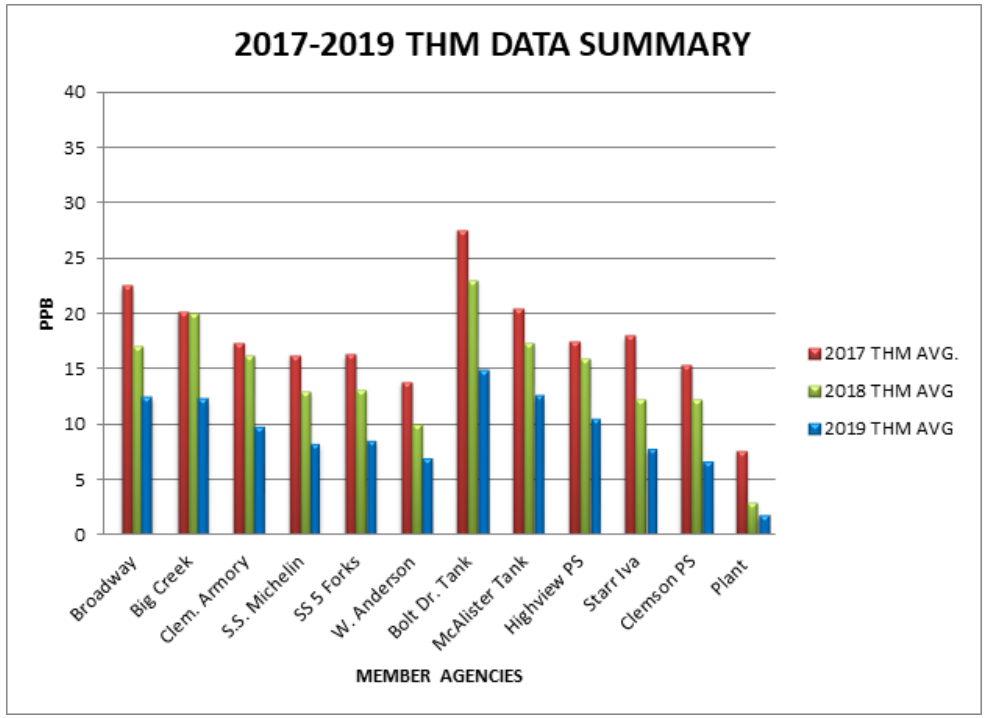
May 2018

ANDERSON REGIONAL JOINT WATER SYSTEM

xylem
Let's Solve Water

Additional Improvements

- ✓ PAC saving >$500,000 per year
- ✓ Lake treatment saving >$100,000 per year
- ✓ TOC reduction improved by ~40%
- ✓ Reduction in THM formation at WTP by 65%
- ✓ Decreased THM formation in distribution system
- ✓ Liquid lime decreased by 21% 2017-2019
- ✓ Alum reduction by 21% 2017-2019
- ✓ Annual solids loading decreased
- ✓ Zero color leaving the plant
- ✓ **Finished water is non-detect for T&O compounds MIB and Geosmin**



xylem
Let's Solve Water

Benefits of Building Resilience with Ozone AOP

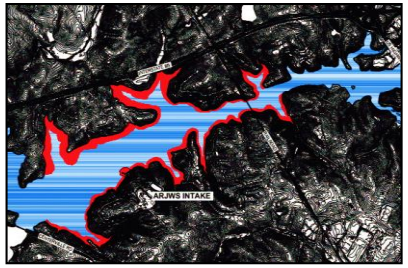
Value of Drinking Water Resilience

- Builds trust to customers and eliminates non-revenue water by adding a safe treatment barrier, eliminating any contaminants of emerging concern.

100% trust

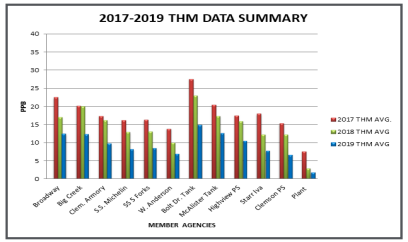
- Eliminates the cost and manpower to manage HAB complaints and short term solutions.

>$600k/a



- Improves quality of drinking water, like taste, color and reduces disinfection by-products

- 40% DBP's (THM)



- Extends the useful life of a utility's water resources, like dosing stations

- 20% chemicals

xylem
Let's Solve Water

Thank You!

Salvador.Dominguez@xyleminc.com

ANDERSON REGIONAL JOINT WATER SYSTEM

xylem
Let's Solve Water