

**Rise above!**

# Ozone Design for a changing surface water at the Green River Filtration Facility

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PNWS AWWA

May 8, 2025

# Agenda

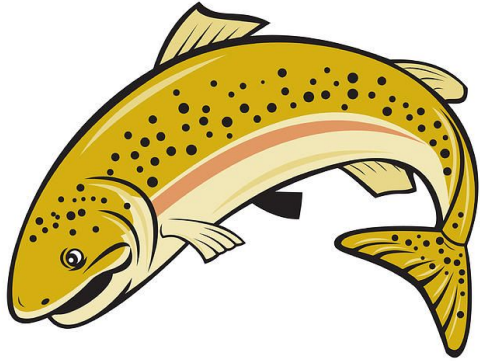
- Background
  - What's that smell?
  - Environmental impacts on T&O
- Changes In Source Water
- Green River Filtration Facility Plan



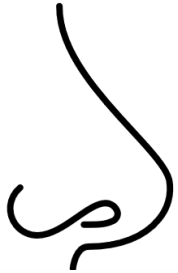
Background

# What's that smell?

## Common Taste and Odor Compounds



- 2t, 4c, 7c-decatrinal: fishy odor



- 2-Methylisoborneol (MIB): musty odor



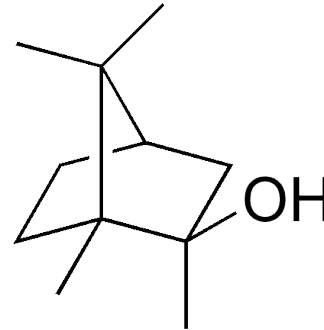
- Geosmin: earthy or grassy odor

# Where does it come from?

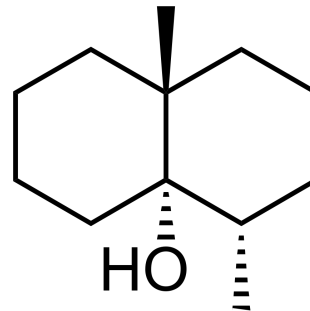
- 2t, 4c, 7c-decatrienal: fishy odor



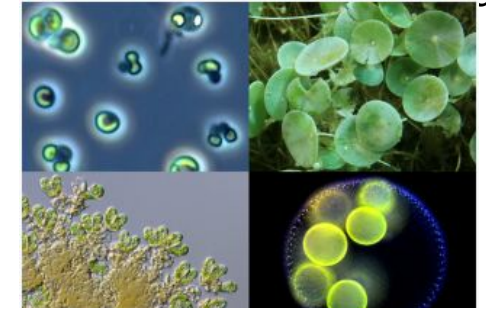
- 2-Methylisoborneol (MIB): musty odor



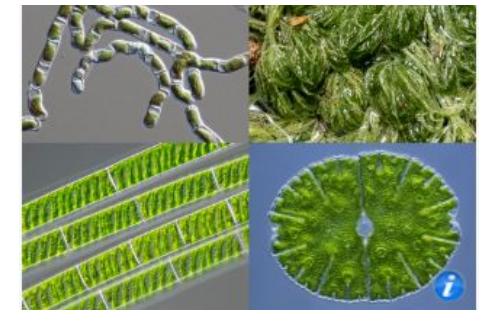
- Geosmin: earthy or grassy odor



Cyanobacteria (Blue-green algae)



Green algae





# How is Taste and Odor Quantified?

- A trained panel is responsible for taste and odor tests Raw and Treated water using the Flavor Rating Assessment (FRA) noted (Scale 0-10)
- Standard Method for Water and Wastewater 2110 recently revised (2022)
- Target treated FRA < 2

## Example Report:

**Seattle Public Utilities**  
Water Quality Laboratory - Report  
800 South Stacy, Seattle WA 98134  
Phone: (206) 233-0048

### Taste & Odor Report

Client: Tacoma Public Utilities

Contact: [REDACTED]

Phone: [REDACTED]

Email: [REDACTED]

ID Number: 86800N

Fax: [REDACTED]

Narrative: The samples were received in good condition.

METHOD: 2160 (FRA), 2170 (FPA)

COLLECTION DATE: 3/4/25

DATE ANALYZED: 3/5/25

COLLECTED BY: DB

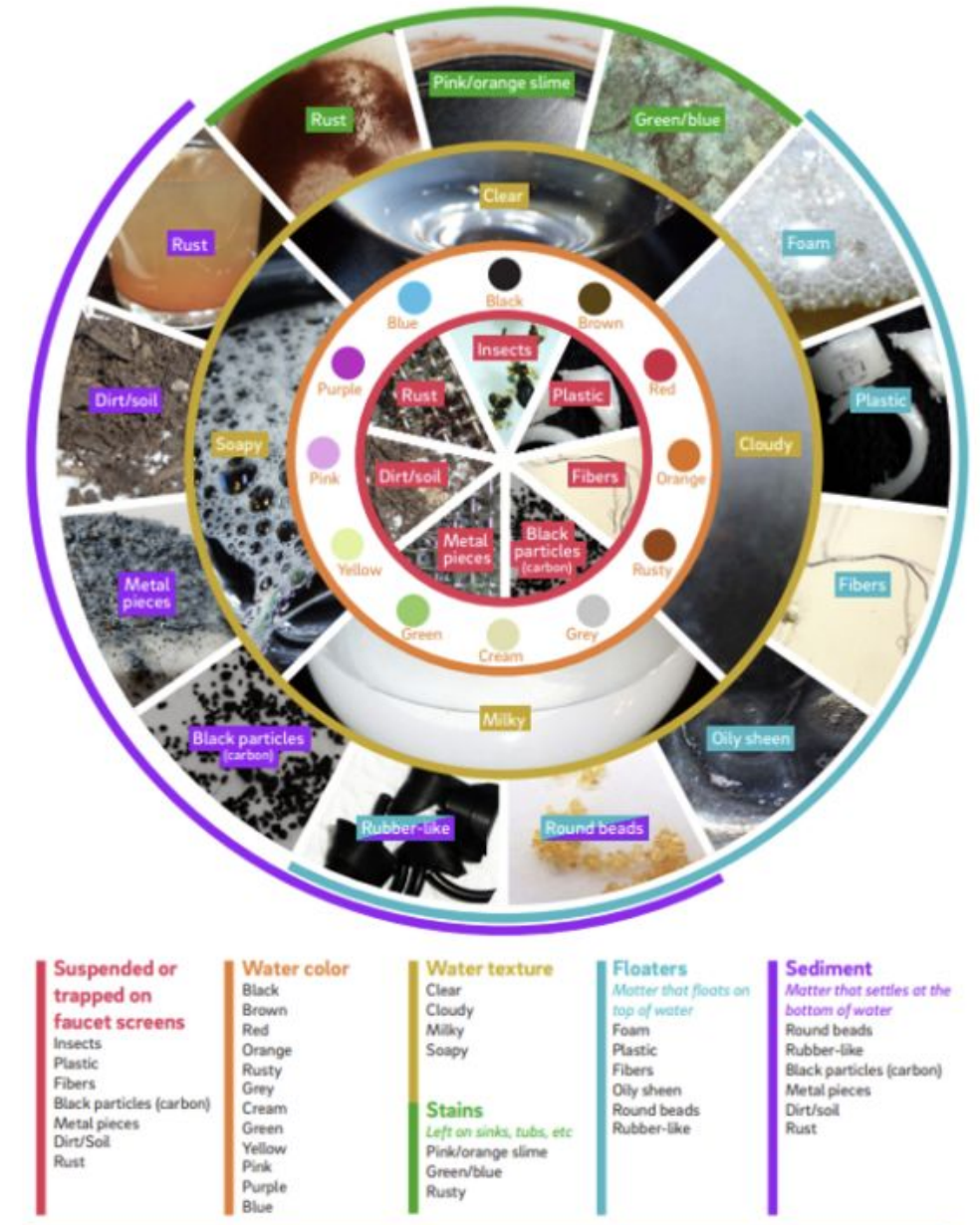
ANALYSTS: SPU Flavor Profile Panel

Sample	Scale	Average	Description	
			Odor	Taste
Finished	FRA:	1.0	-	chlorine
Intake	FRA:	4.0	earthy	earthy

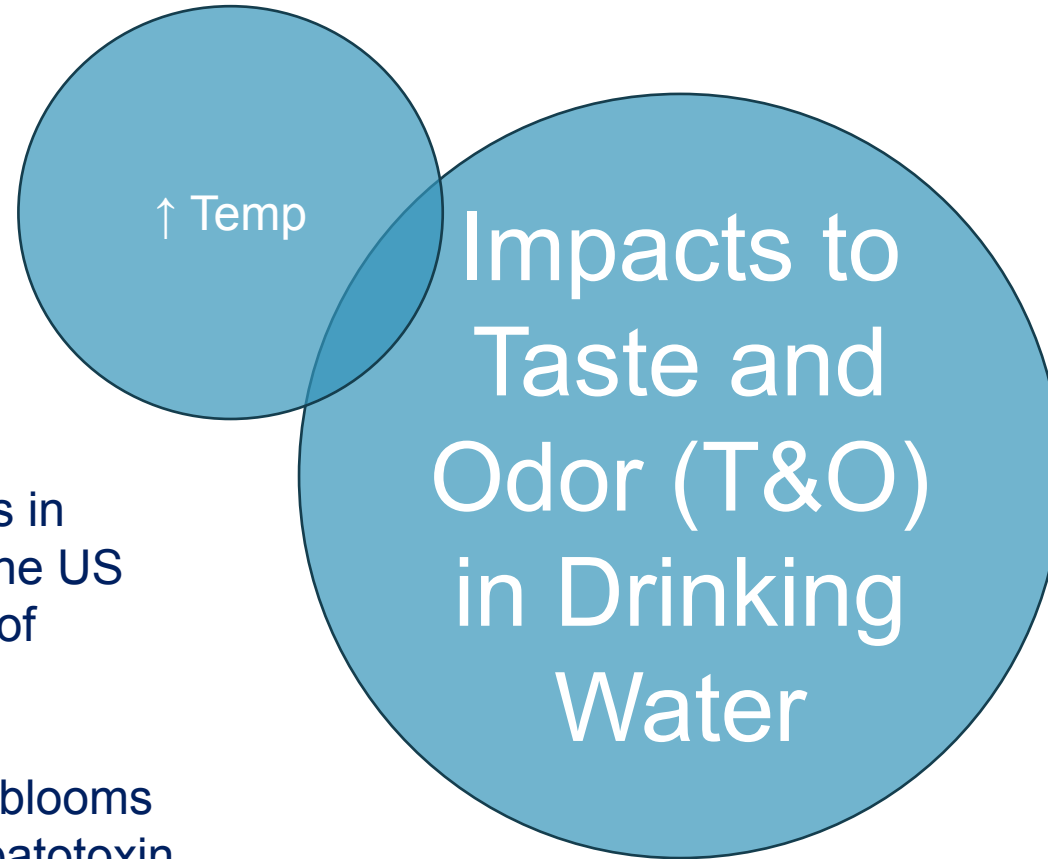
Flavor Rating Assessment (FRA) rates the offensiveness of a sample on a scale of 1-9 with 9 indicating very poor tasting water.

# How is Taste and Odor Quantified?

- Color and appearance is also noted and evaluated.
- Discoloration and sediments are typically not a concern for treated drinking water but is noted raw water samples.



# Environmental Impacts



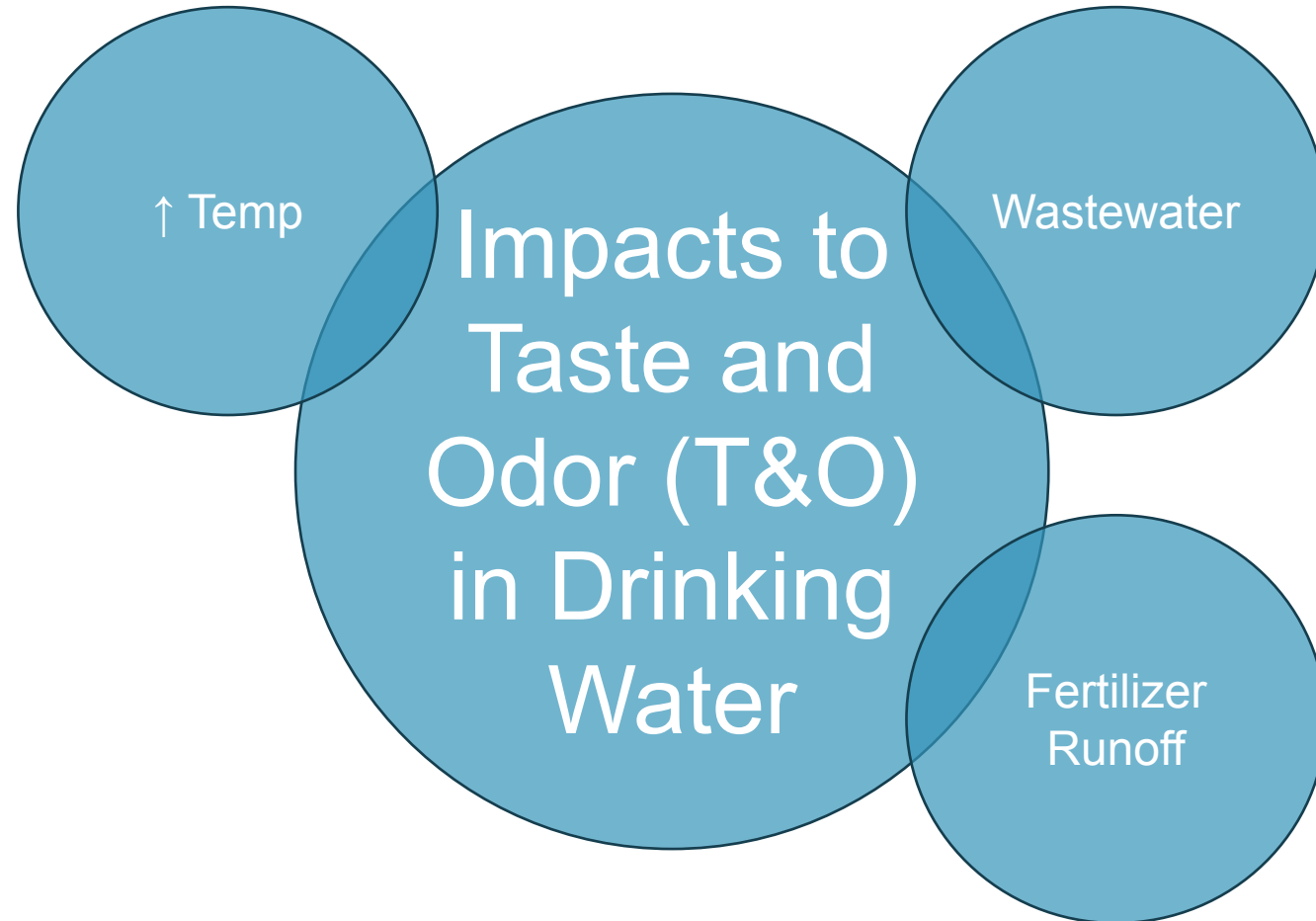
Increasing temperatures in surface waters across the US increase the frequency of cyanobacteria blooms

Including Harmful algal blooms with neurotoxin and hepatotoxin risks

S. Chapra, B. Boehlert, C. Fant, V. Bierman Jr., J. Henderson, D. Mills, D. Mas, L. Rennels, L. Jantarasami, J. Martinich, K. Strzepek, and H. Paerl. **Climate Change Impacts on Harmful Algal Blooms in U.S. Freshwaters: A Screening-Level Assessment.** *Environmental Science & Technology* **2017** 51 (16), 8933-8943



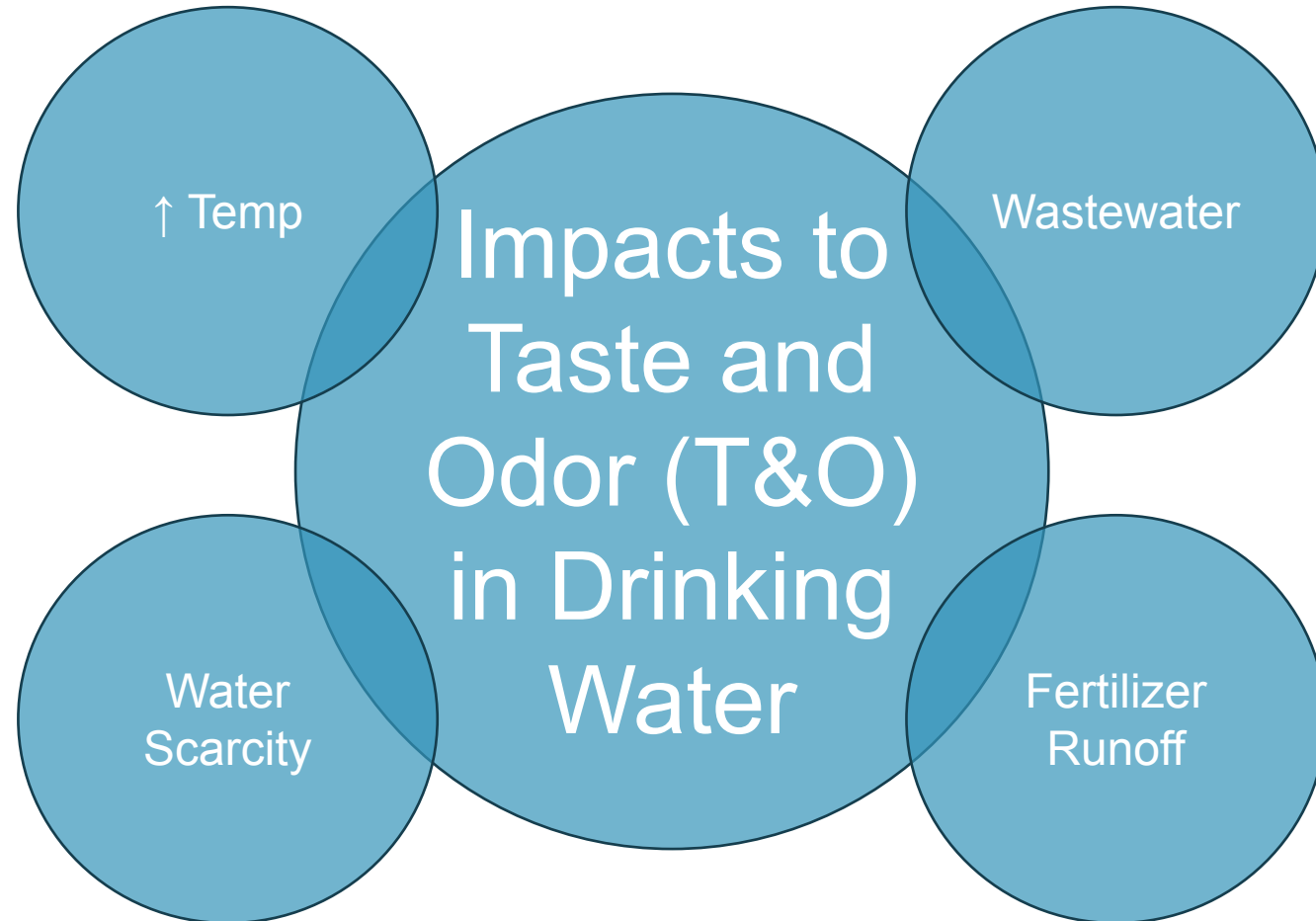
# Environmental Impacts



Municipal and Agricultural sources add scarce nutrients such as nitrogen and orthophosphate

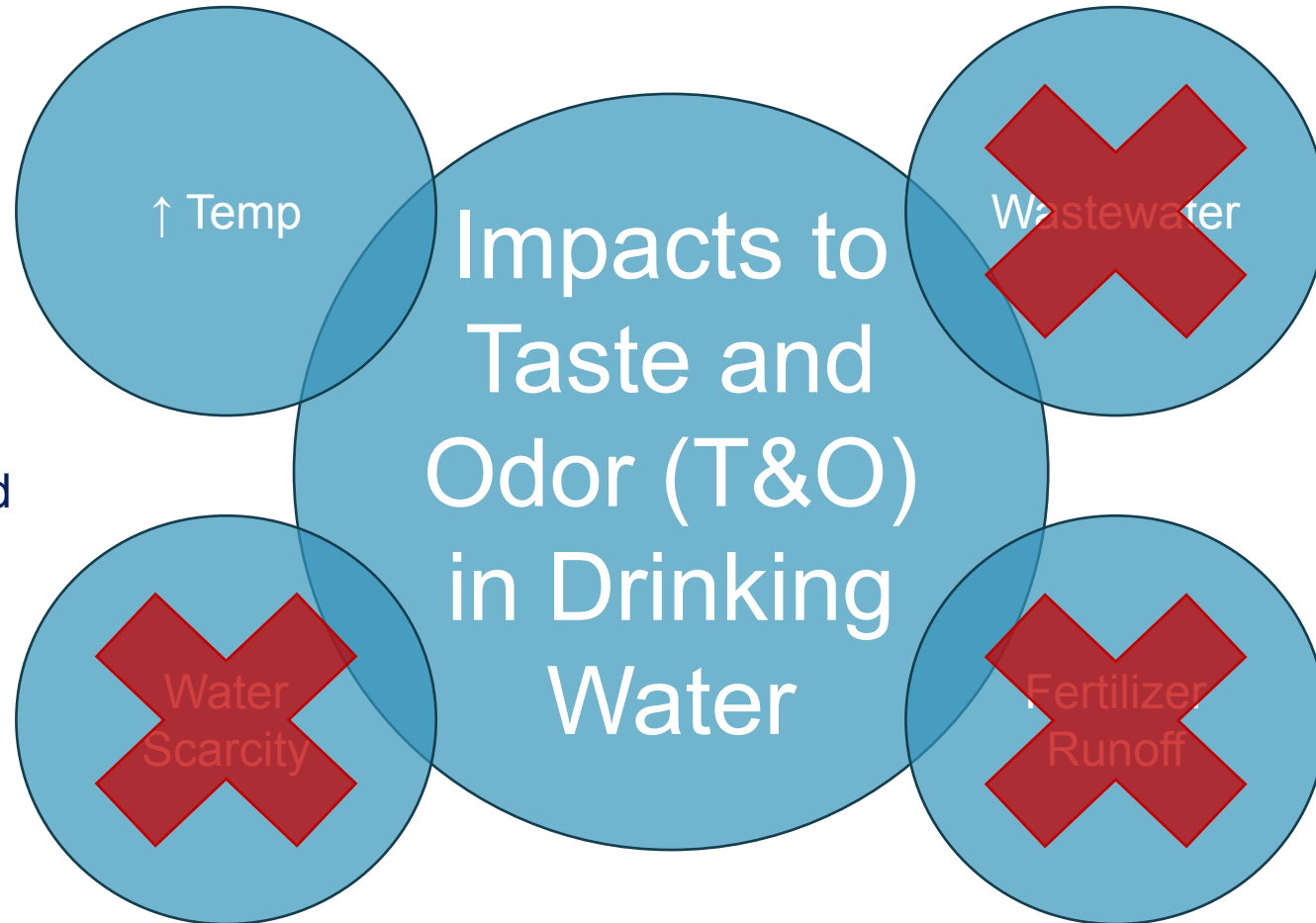
# Environmental Impacts

Depleting groundwater sources force utilities to lean on surface waters

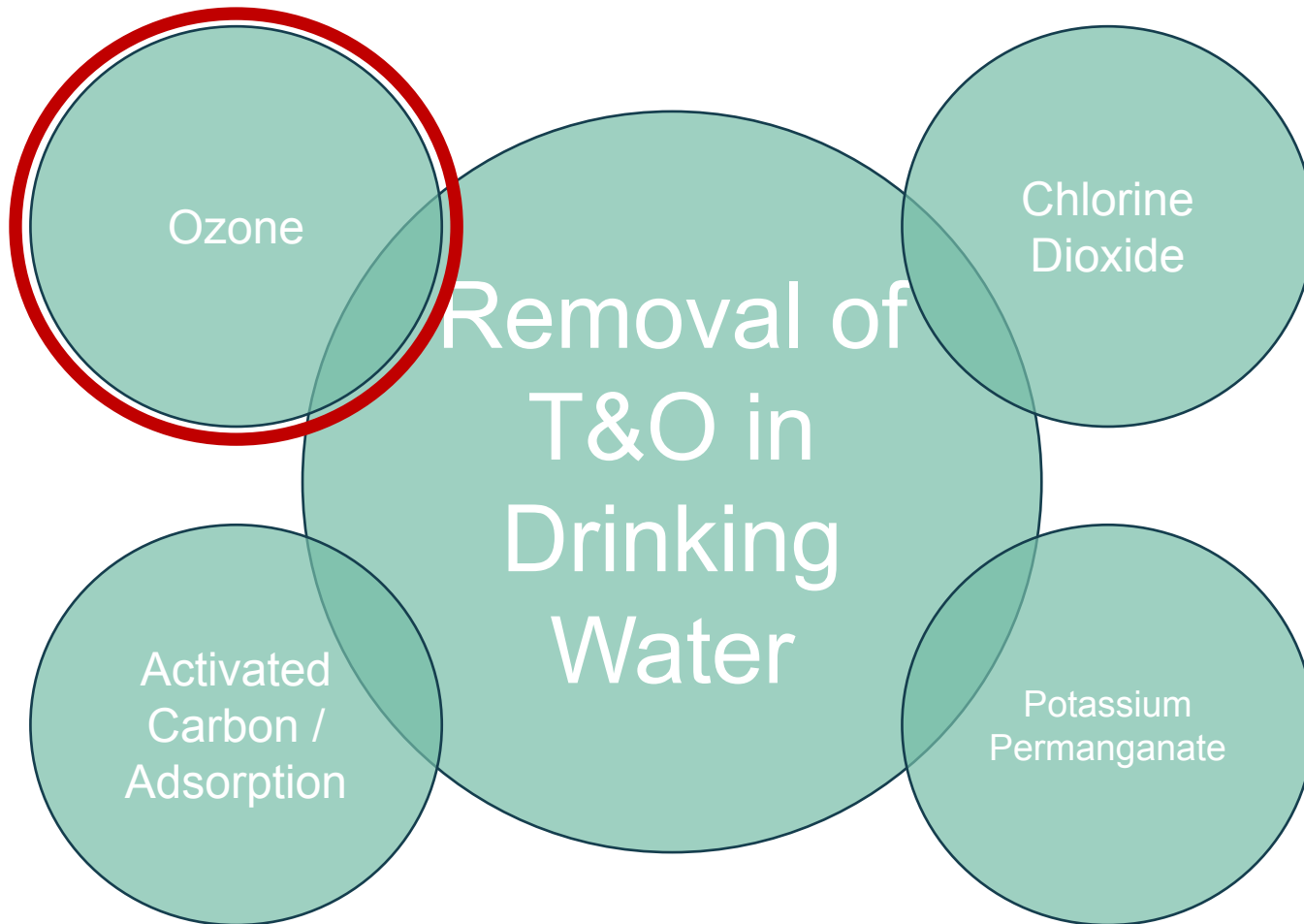


# Environmental Impacts

Green river filtration facility is protected from Wastewater, Fertilizer runoff, and is a dedicated surface water treatment plant



# Treatment Options



# Changes in Source Water

Green River



# Changes to the Green River

## Addition of a Fish Passage

### Anticipated Changes:

- Dam will include a multiport collector to help fish move down stream.

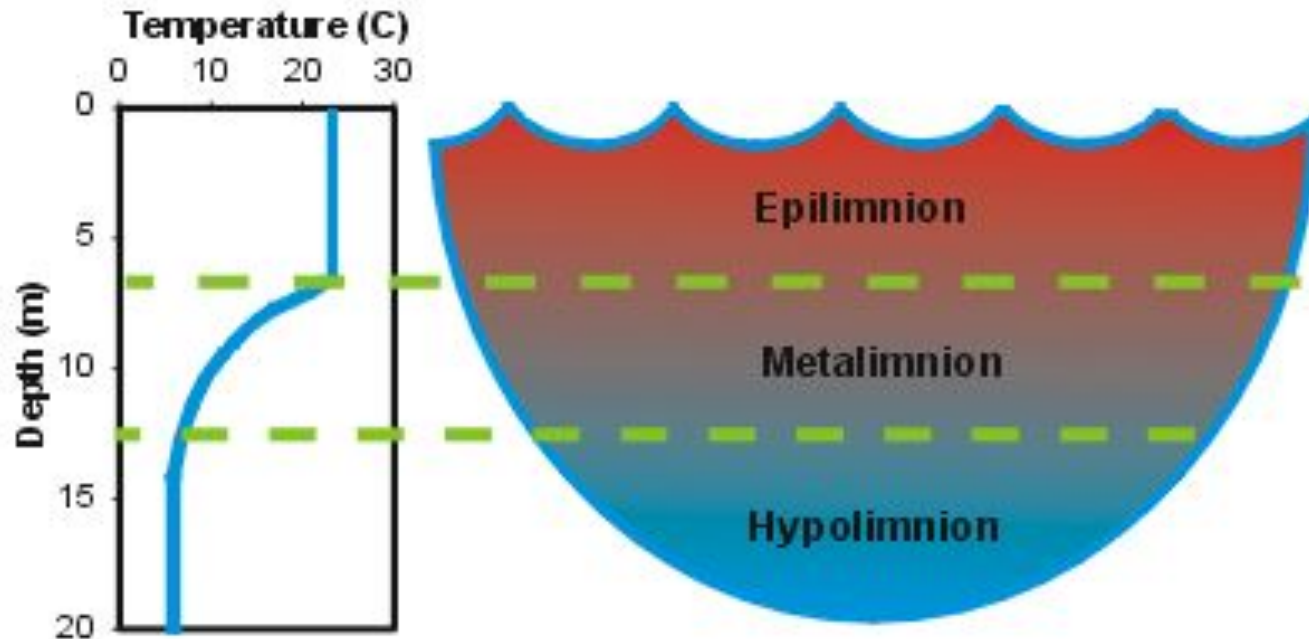


Howard Hanson Dam

# Changes to the Green River

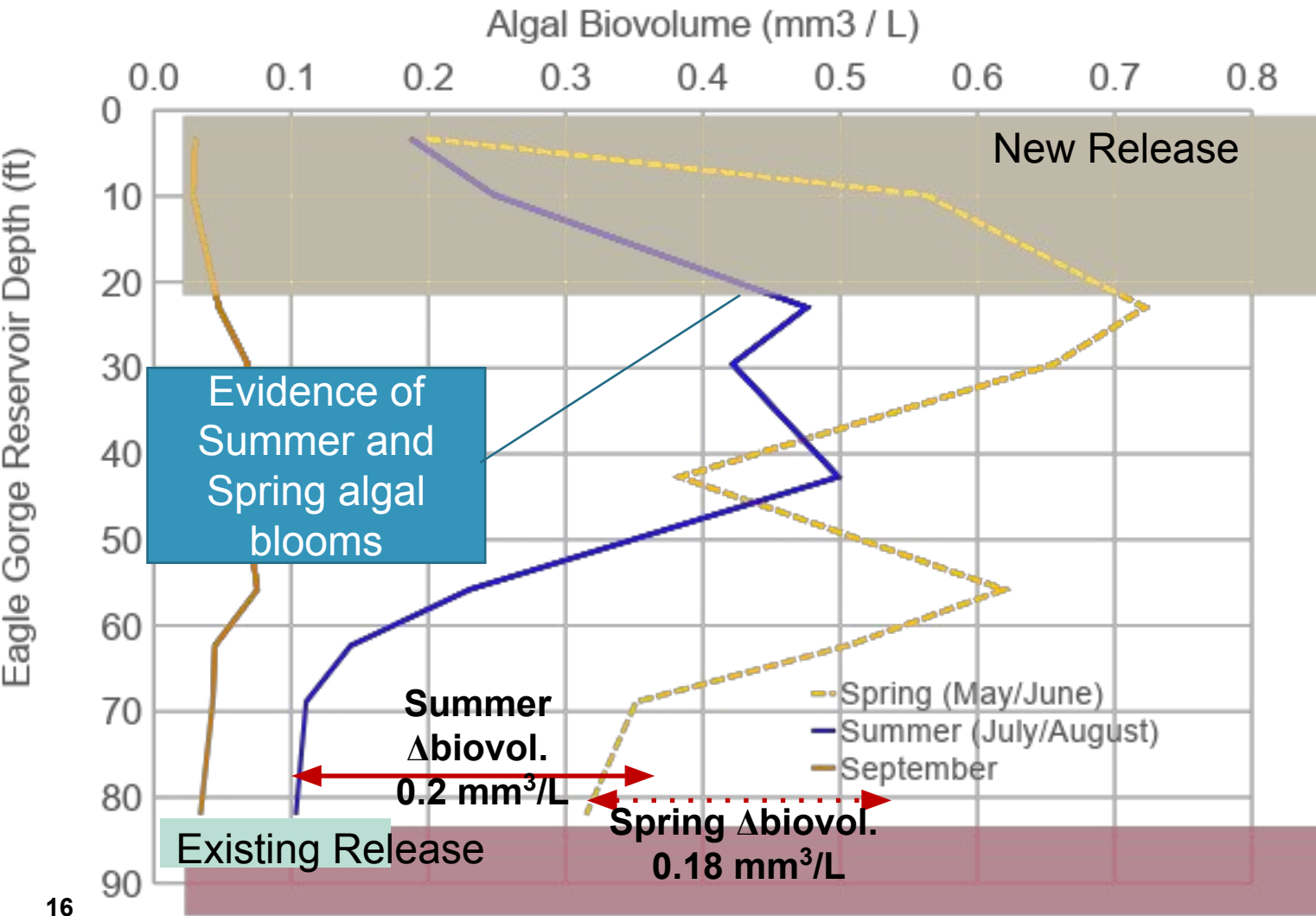
Dam will release more often from the top of the water column, rather than always from the bottom.

- Potentially passing more algae biomass downstream
- Increase temperature with stratification



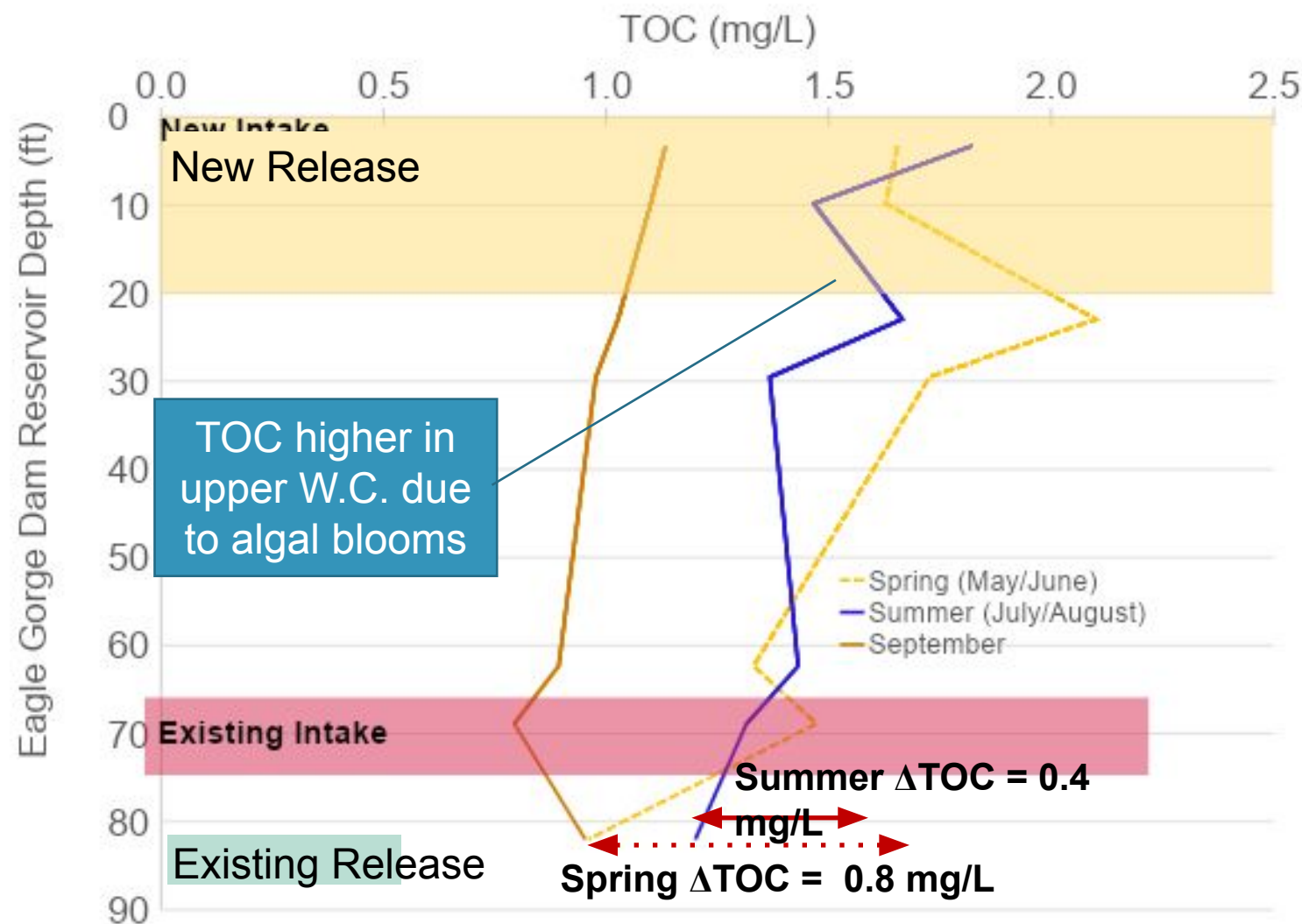
Lake Stratification in Ontario lakes - Deice Air Canada

# Within the Green River: Future Impacts



Increased biovolume with new release  
(average +0.2 mm<sup>3</sup>/L)

# Within the Green River: Future Impacts



Increase TOC with new release  
(average +0.5 mg/L)

# Green River Filtration Facility Plan



# Green River Filtration Facility

Production Capacity: 150 MGD

Summer operation: Direct Filtration

Winter operation: Conventional Treatr





# Green River Filtration Facility

## Treatment Processes:

- Ozone
- Flocculation
- Sedimentation
- Filtration
- Chlorine Disinfection





# Tools for Green River Filtration Facility

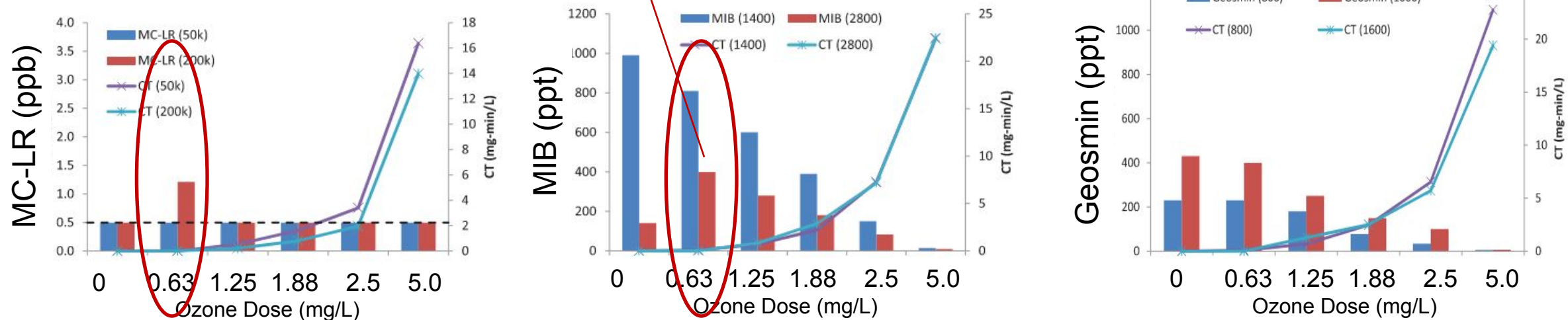
- Ozone is a strong oxidant which benefits coagulation and provides additional disinfection (no credit taken)
- Ozone can react directly with Algal Organics
  - Increase ozone dose
- Hydroxyl radical is a strong non-selective oxidant for organic degradation
  - Increase pH
  - Add hydrogen peroxide

Peter, A., & Von Gunten, U. (2007). Oxidation kinetics of selected taste and odor compounds during ozonation



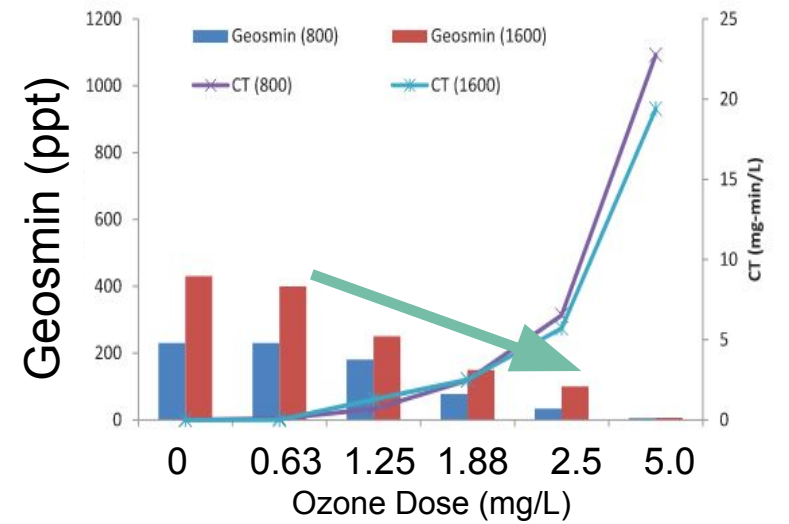
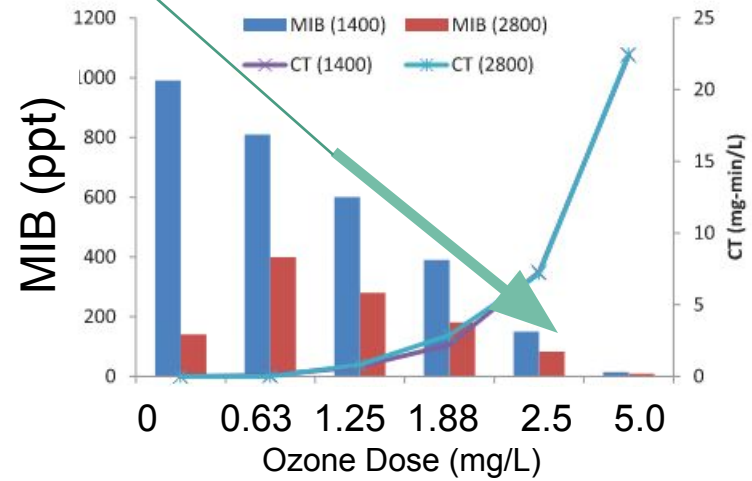
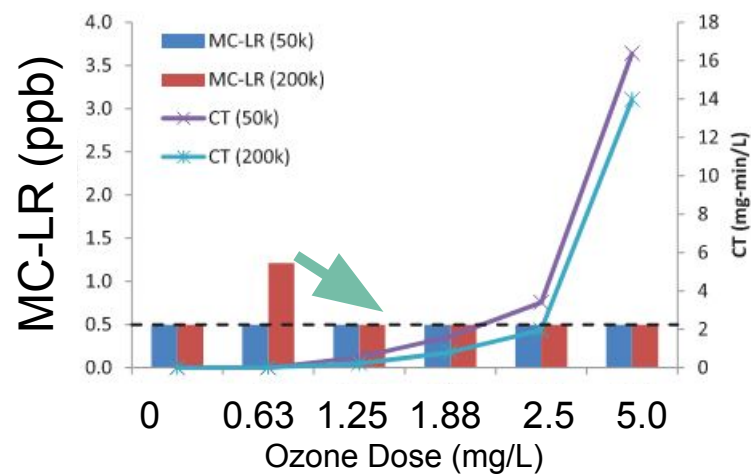
# Ozone Dose Oxidation Effects

Low ozone dose oxidizes algal cells and releases intracellular T&O



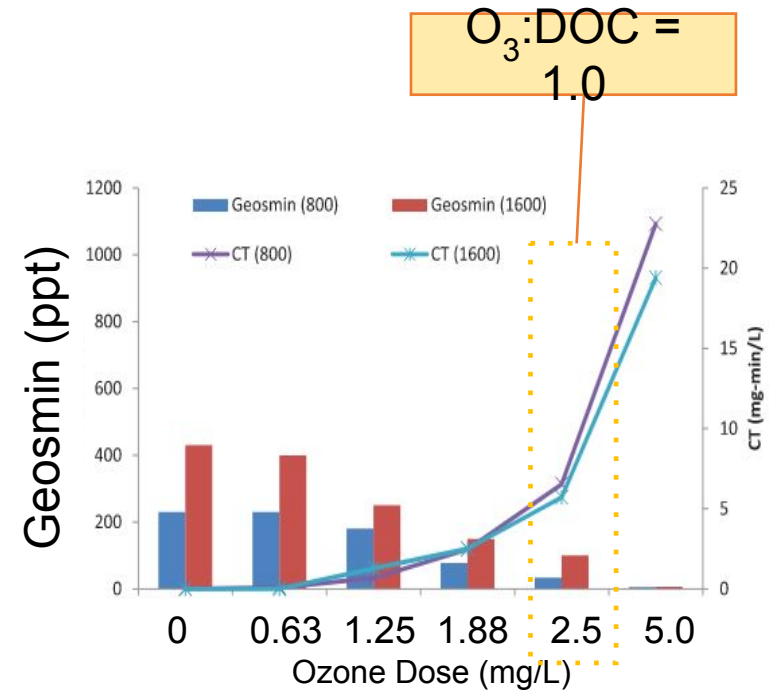
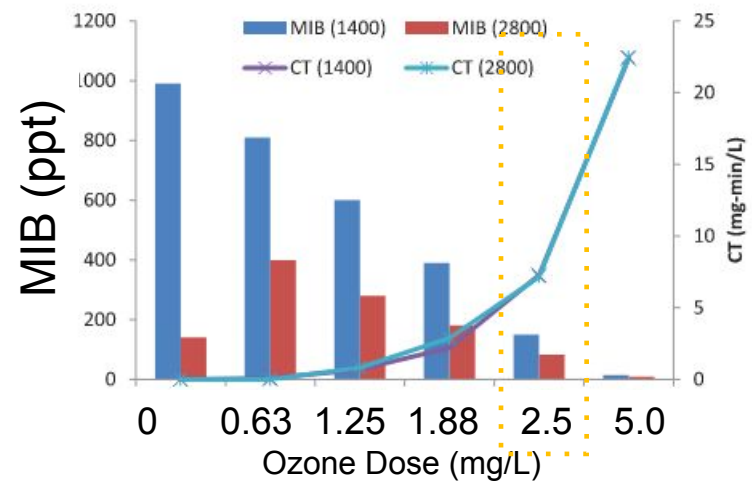
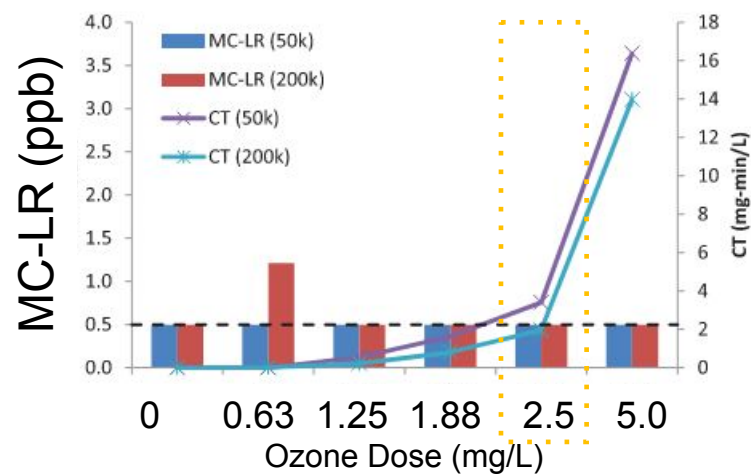
# Ozone Dose Oxidation Effects

Greater Ozone CT  
treats released  
intracellular T&O





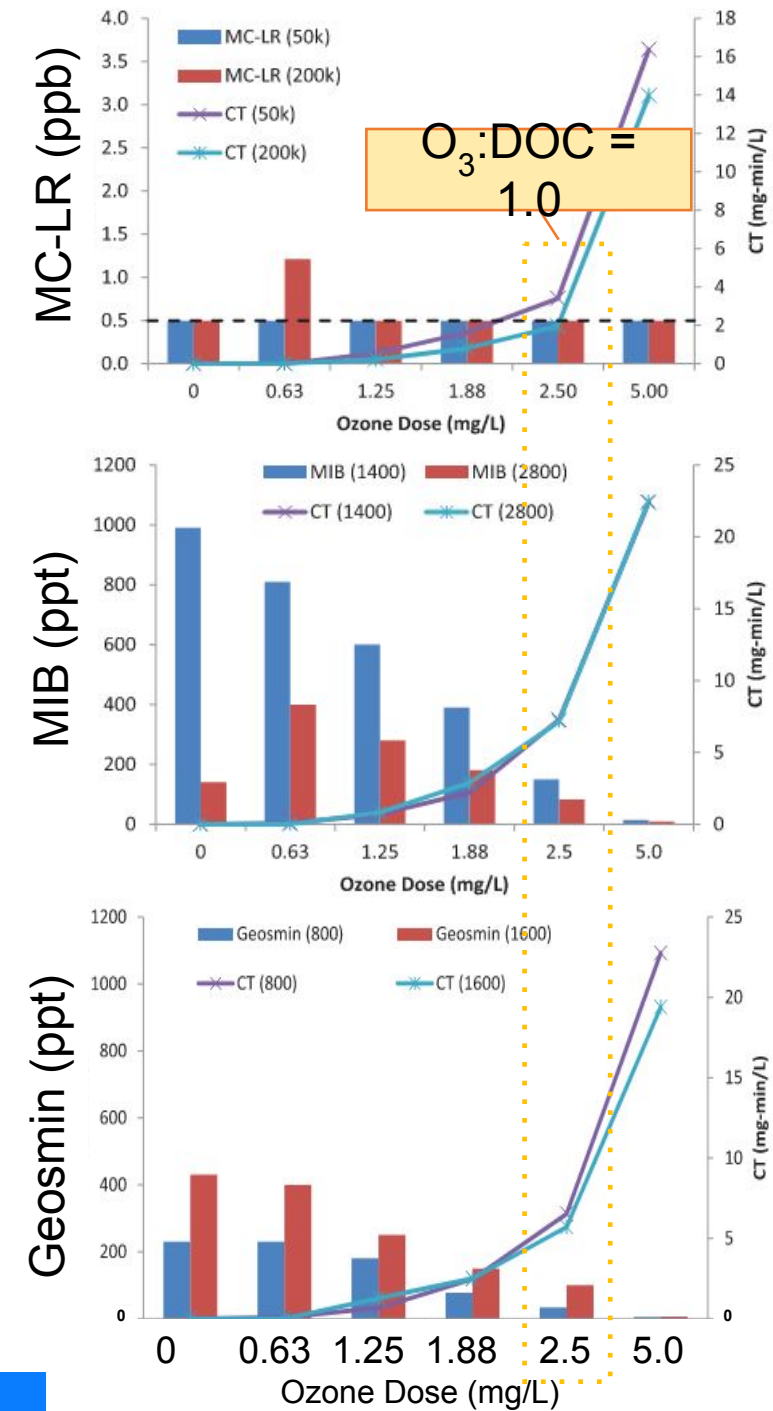
# Ozone Dose Oxidation Effects



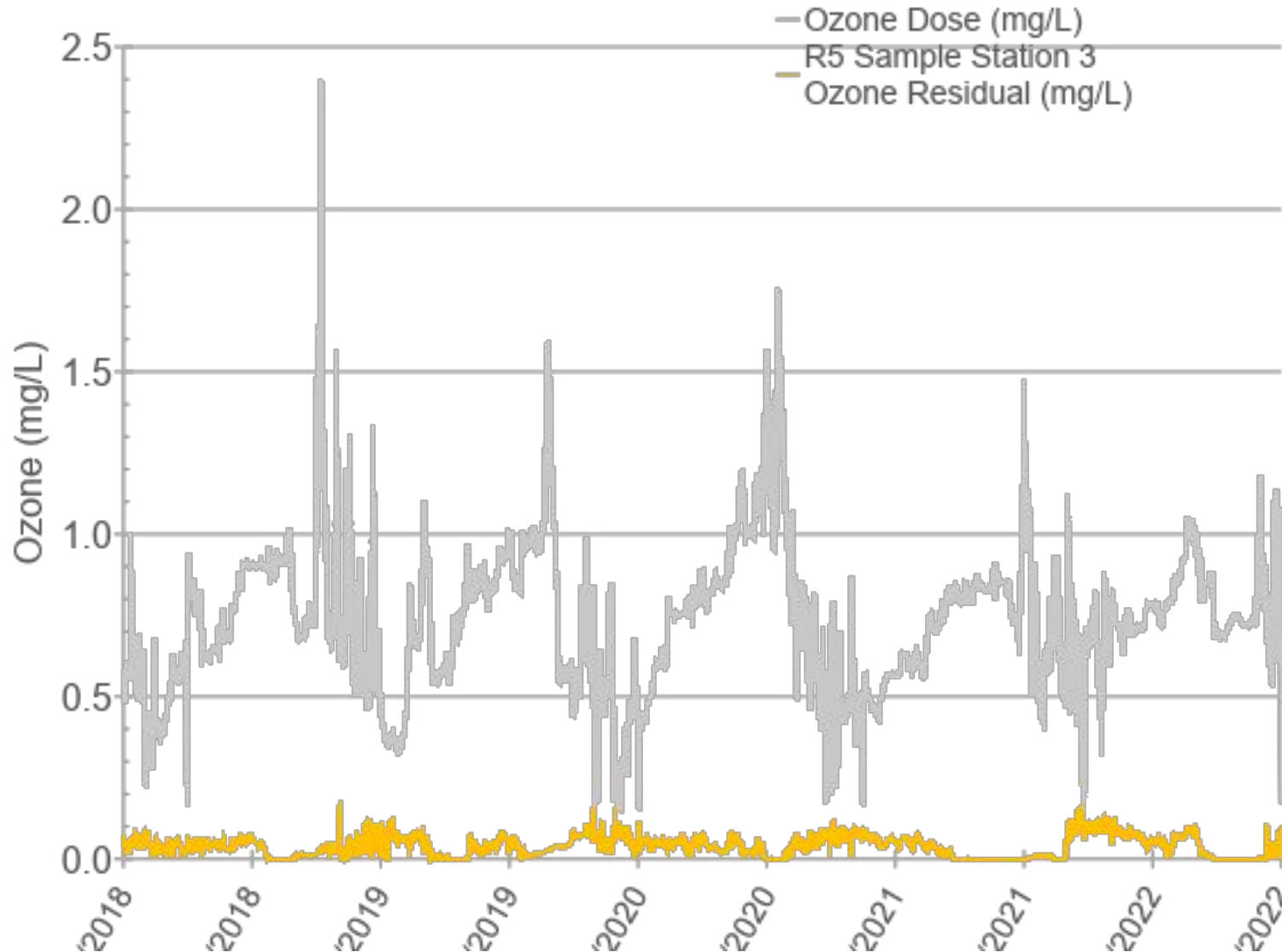
# Ozone Dose Oxidation Effects

- Recommended Ozone to DOC ratios:
  - $O_3:DOC \geq 1$  for T&O control
  - $0.5 \leq O_3:DOC \leq 1$  to improve biofiltration by making NOM assimilable

Citation: Wert et al. (2014)



# Generator Capacity: Historical Ozone Dosing at GRFF



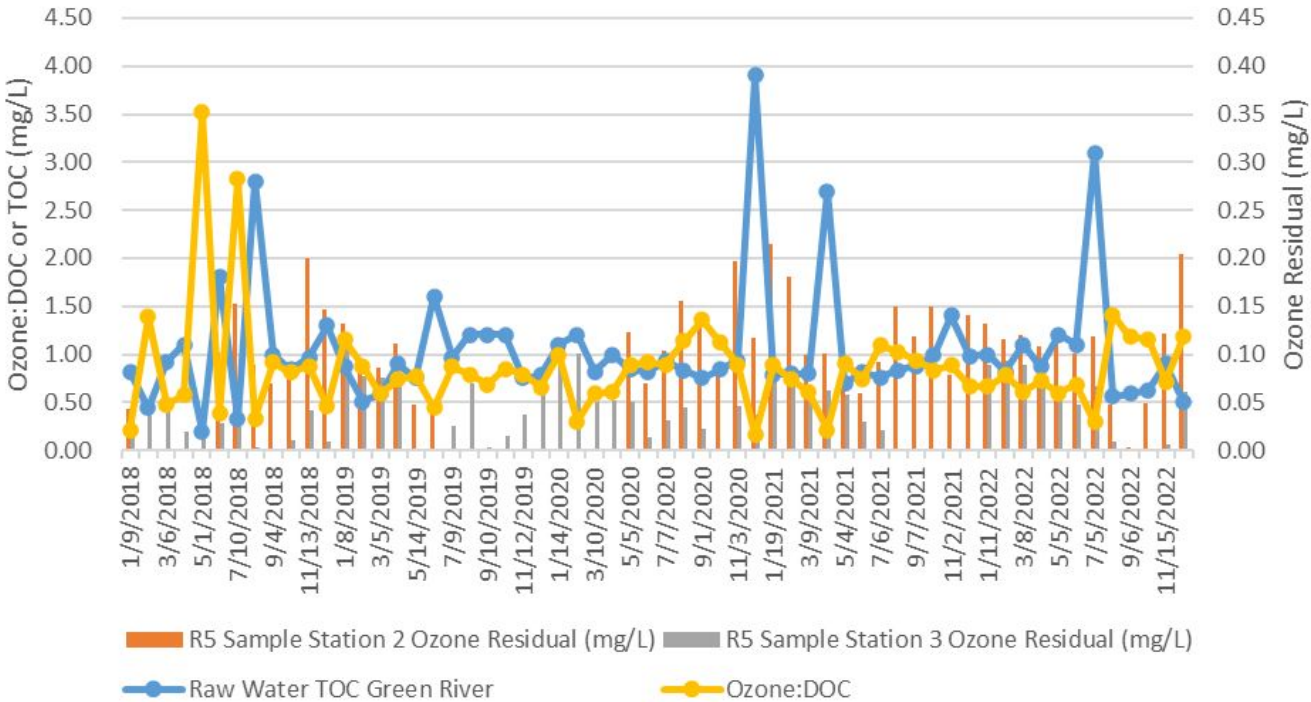
- Ozone dose has varied between 0.25-2.0 mg/L
- Summer doses typically higher due to higher temperatures and higher TOC

# Generator Capacity: Historical Ozone Dosing at GRFF

	Ozone Dose	O <sub>3</sub> :TOC <sup>1</sup>	Target Ozone Dose
Average	0.7 mg/L	0.6 (mg/mg)	1.1 mg/L
95 <sup>th</sup> percentile	1.1 mg/L	1.0 (mg/mg)	2.5 mg/L
<sup>1</sup> Average TOC = 1.1 mg/L			

Next let's look at the impacts of high TOC conditions on Taste and Odor (T&O) compounds

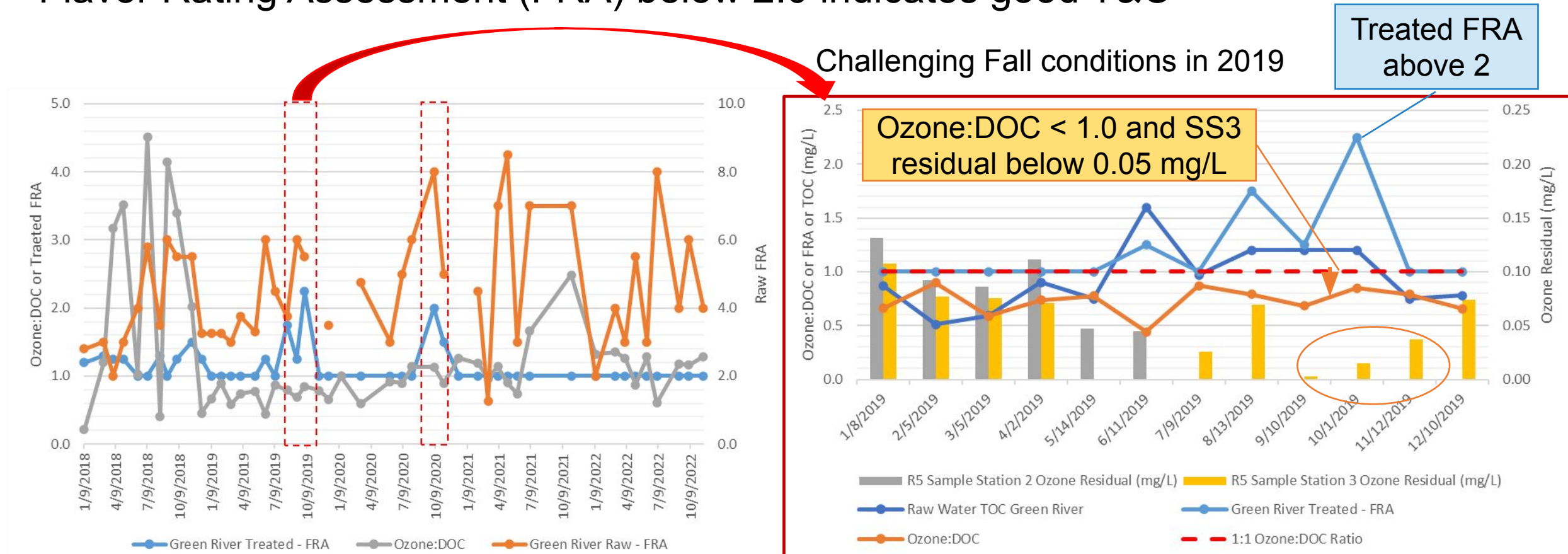
Typically operate with detectable ozone residuals at downstream reactor sample station 2





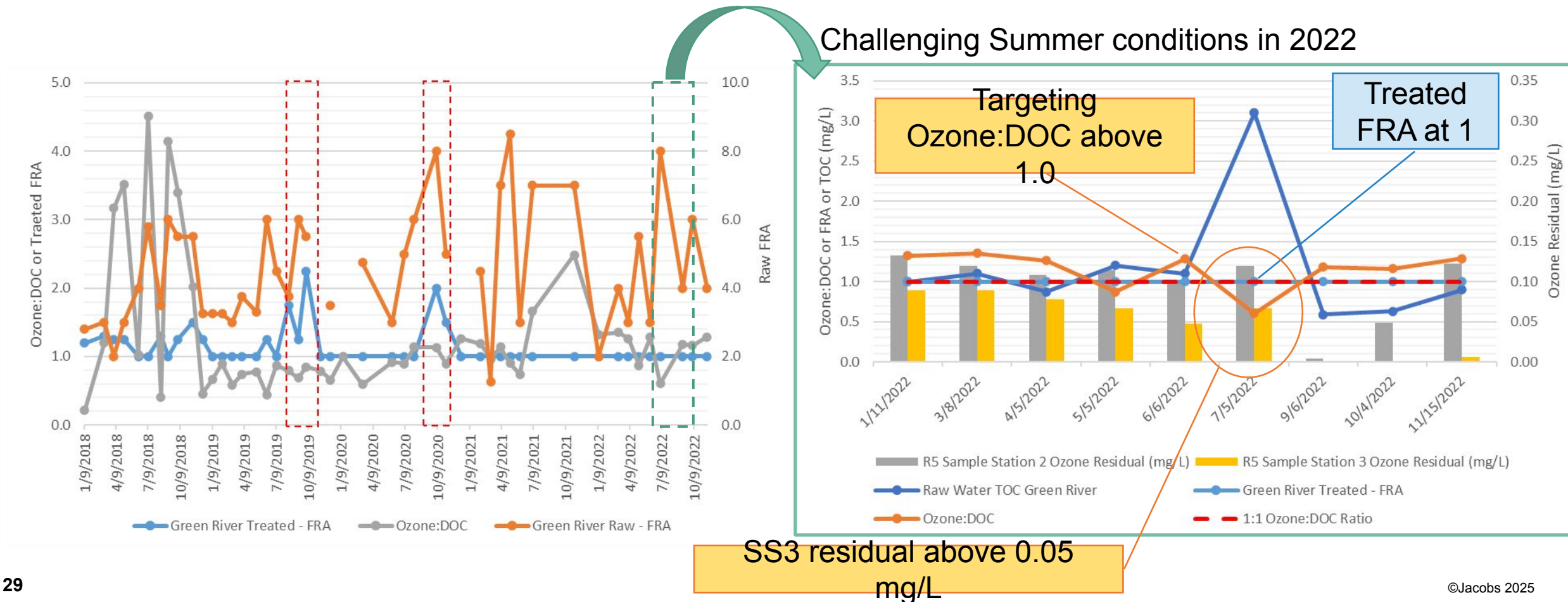
# Generator Capacity: Flavor Rating Assessment (FRA)

- 2019 – 2020 GRFF was operated with lower  $O_3$ :DOC ratio and measured FRA > 2
- Flavor Rating Assessment (FRA) below 2.0 indicates good T&O

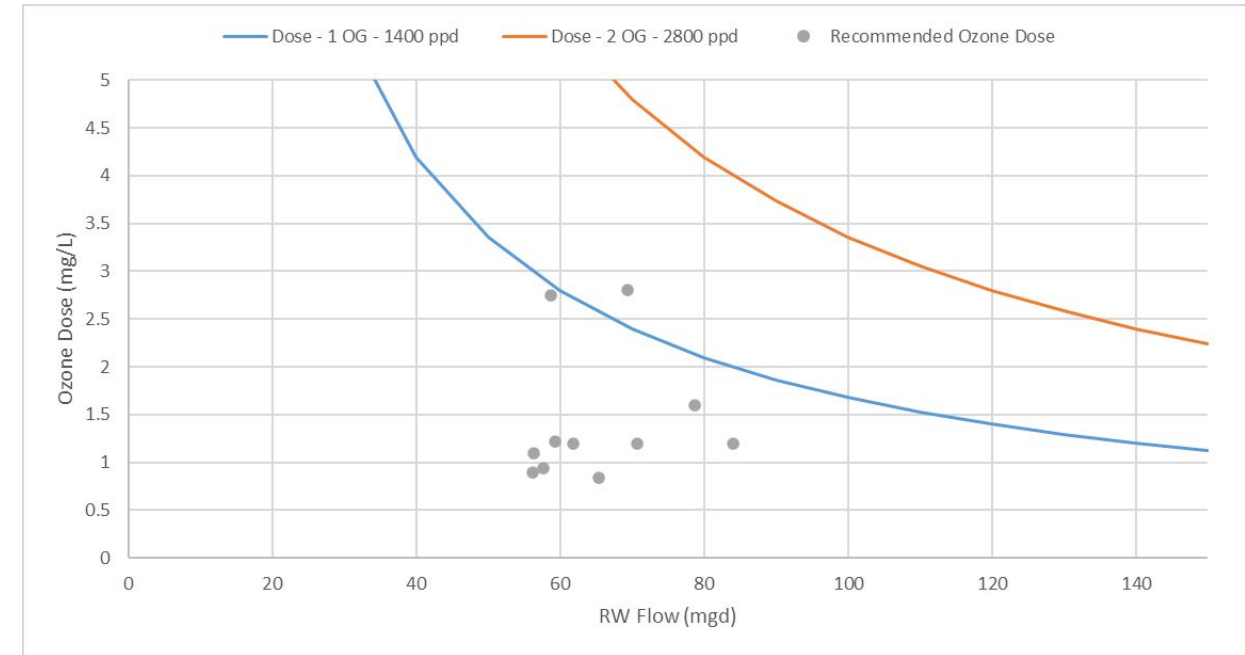
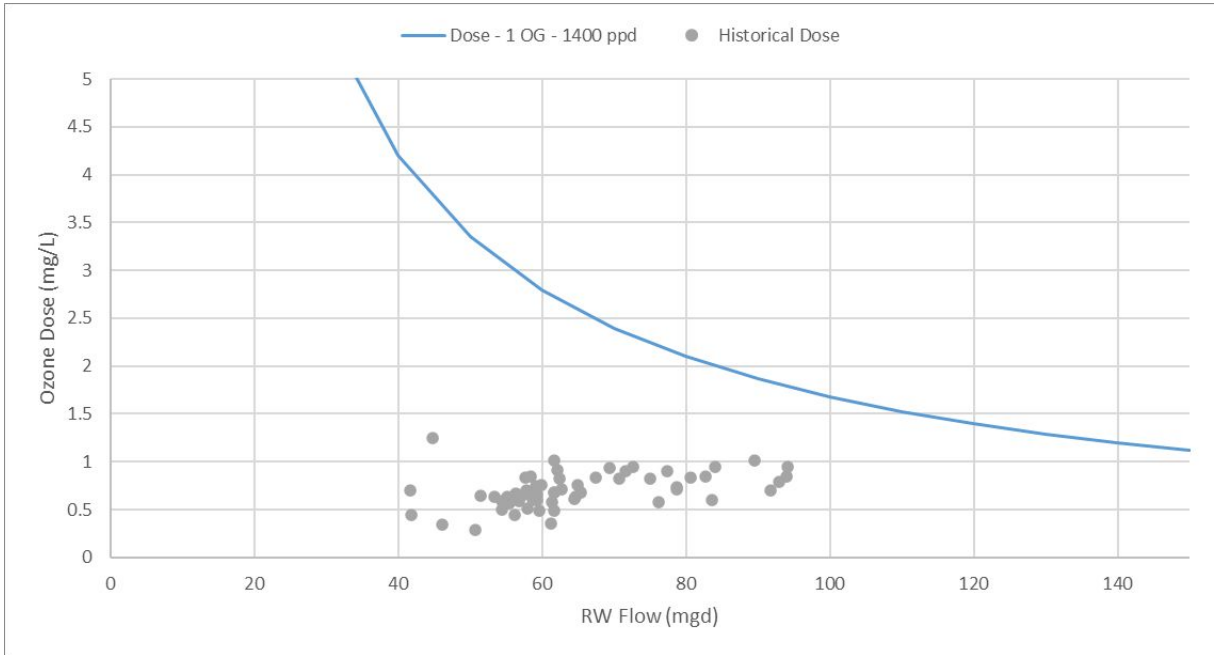


# Generator Capacity: Flavor Rating Assessment

- 2022 recorded even higher Raw Water TOC than 2019 but higher ozone doses control T&O compounds



# Existing Ozone Generator Capacity



- Current water quality: Recommended ozone dose based on 1:1  $O_3$ :DOC ratio is generally within existing ozone generator capacity

# Ozone Replacement Project



- Replace Power Supply Unit (PSU) for both Generators
- Cooling Water System
  - Install automatic cleaning strainer
- Replace all Ozone System Control Backpanels
- Replace all cooling water and injection pumps
- Replace critical instrumentation and valve actuators.
- Replace Ozone destruct equipment and catalyst media
- At a future date, increase generator capacity to 1,750 ppd @ 10% Ozone
  - Replace dielectrics for increased capacity



# Ozone Replacement Project – Phased Approach



- Ozone System Supplier (OSS) equipment with long lead times was designed and contracted in a Prepurchase agreement
  - Power Supply Unit (PSU) for both Generators
  - Master Ozone Control Panel, Injection RIO, and ozone Destruct RIO
  - Gas quality and ozone safety equipment and instrumentation
- Plan to receive OSS equipment at end of summer 2026
- General Contractor Award bid beginning of 2026
- Target construction Fall 2026 – Spring 2027

# Conclusions



- While water demand may plateau or change slowly over time, changes to raw water quality can push the boundaries of existing equipment.
- Good news! Operational adjustments can tackle the taste and odor water quality changes described in this presentation.
- Online monitoring of raw water and automatic dose control with ozone residual feedback can strike the balance between operation costs and consumer satisfaction.

Questions?



# Thank You



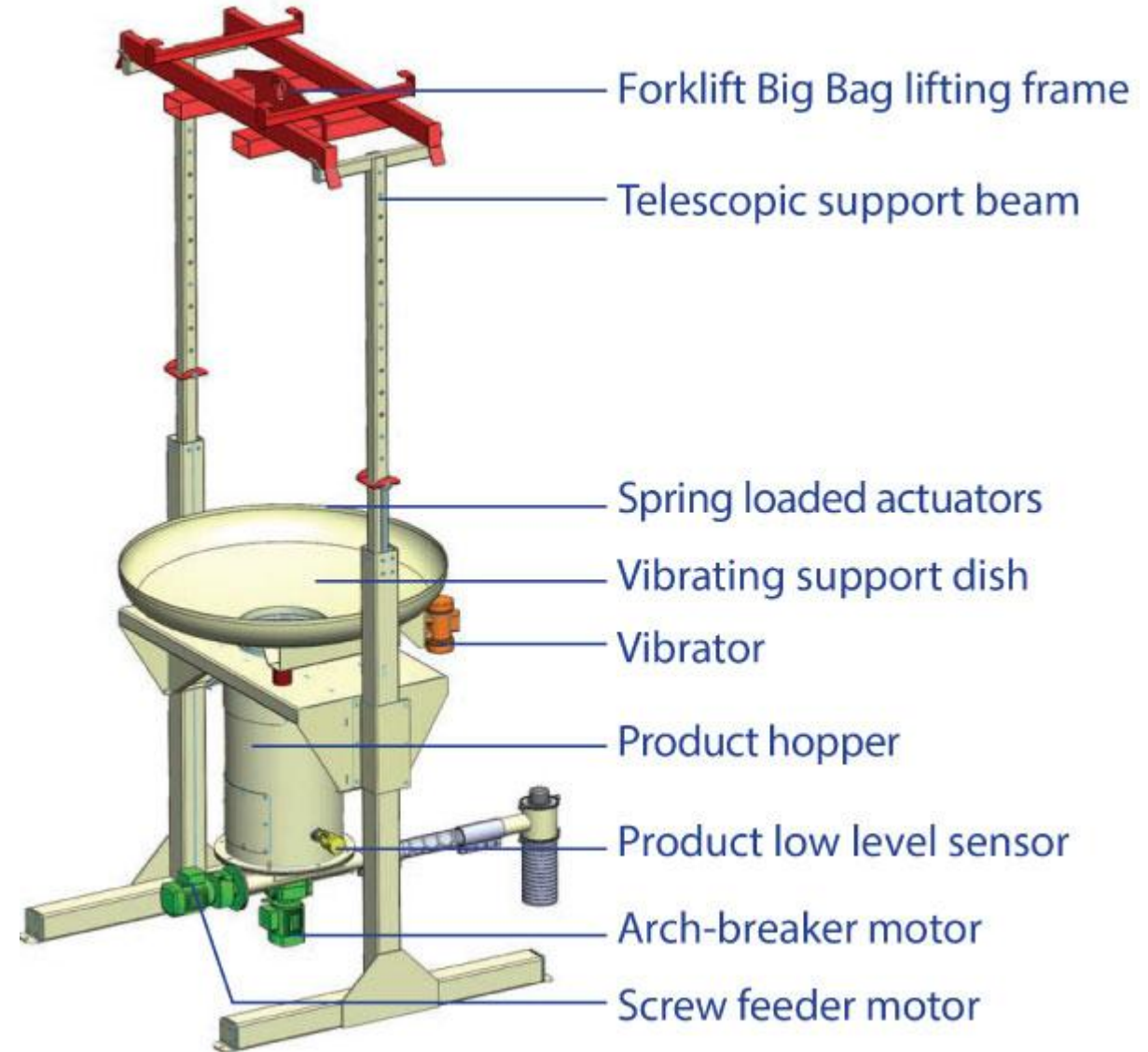
# Emergency Operations

# Impacts to Operations

Treatment Affected	Impact	Mitigation
<b>Taste and odor</b>	<ul style="list-style-type: none"> <li>T&amp;O unlikely to be removed through the treatment process without ozone.</li> </ul>	<ul style="list-style-type: none"> <li>Develop a public relations plan and implement as required.</li> <li>Consider alternative temporary treatment.</li> </ul>
<b>Coagulation and filtration performance</b>	<ul style="list-style-type: none"> <li>Small rise in turbidity and particle counts, shorter filter runs.</li> <li>Biological filtration decreased performance</li> </ul>	<ul style="list-style-type: none"> <li>Adjust polymer and/or coagulation dose. Most frequently this would be an increase in dose but could also potentially be a decrease.</li> <li>Add a small amount of chlorine for pre-oxidation. Consider DBP formation impacts.</li> </ul>
<b>Disinfection</b>	<ul style="list-style-type: none"> <li>Ozone is unavailable to provide disinfection</li> </ul>	<ul style="list-style-type: none"> <li>Chlorine must be used as primary disinfection.</li> </ul>
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>Manganese carry-over</li> <li>Impacts to distribution and DBPs</li> </ul>	<ul style="list-style-type: none"> <li>As indicated above, add a small amount of chlorine for pre-oxidation and precipitation of manganese.</li> <li>Bench test for chlorine decay and DBP formation without ozone.</li> </ul>

# T&O Treatment Alternatives

- During event without ozone recommend shifting supply to wells
- Ozone, UV/AOP, GAC, and other technologies not practical for temporary use
- Powdered Activated Carbon
  - 1x or 2x 3,500 ppd feed systems likely required
  - Rental or permanent options
  - Bench testing with flavor profile analysis recommended if considering this option
  - Roughly \$1.5-2 M for one summer of operation



# Recommendations and Next Steps

- Prioritize replacement of Generator 1 PSU
- Develop SOP for operation without ozone
  - Bench test for DBP formation potential without ozone
  - Consider running a GRFF full-scale test without ozone
- PAC system
  - Bench test to determine design PAC dose
  - Consider cost/benefit of having PAC as backup
- Develop public relations plan for if the ozone system were to fail