Improving PAC Storage and Feed to Respond to HABs

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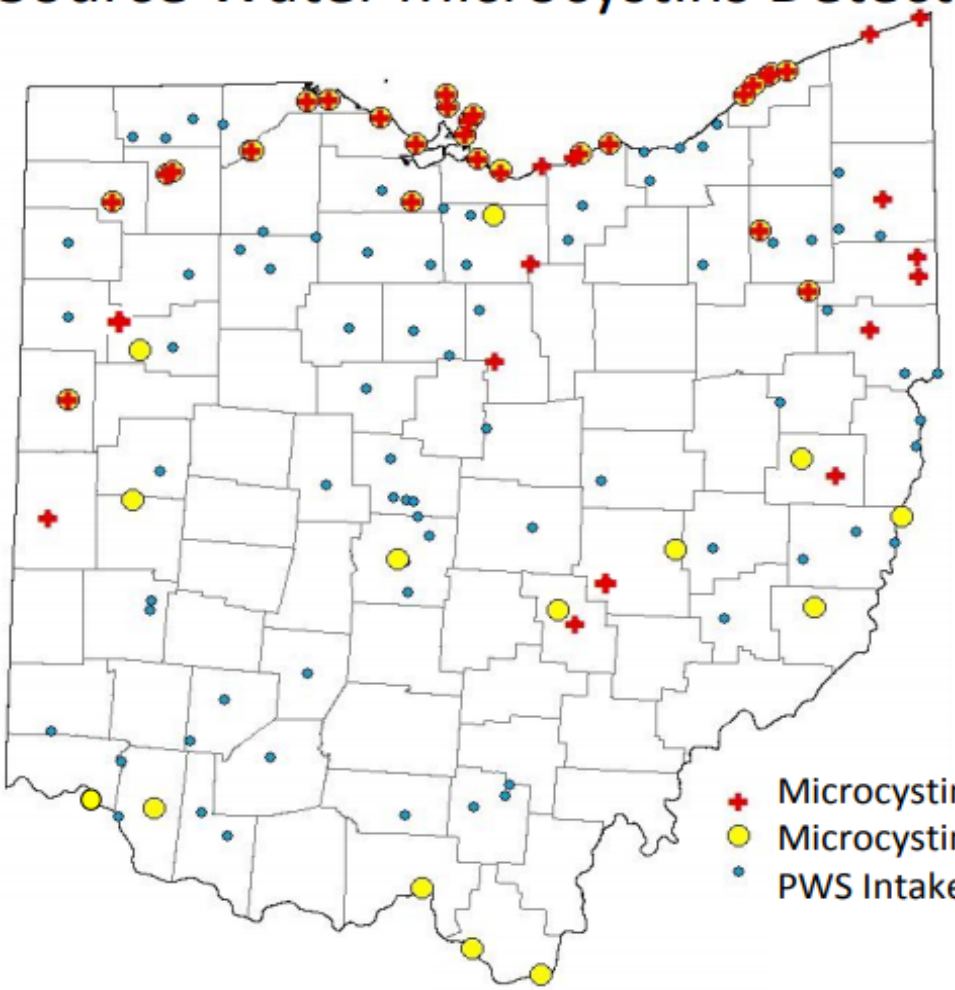
Lake County Department of Utilities

Agenda

- Background
- SOP
- PAC Screening/Testing
- Design
- Implementation
- Lessons Learned
- Conclusion

Background - Microcystin Detections

Source Water Microcystins Detections at Ohio PWSs



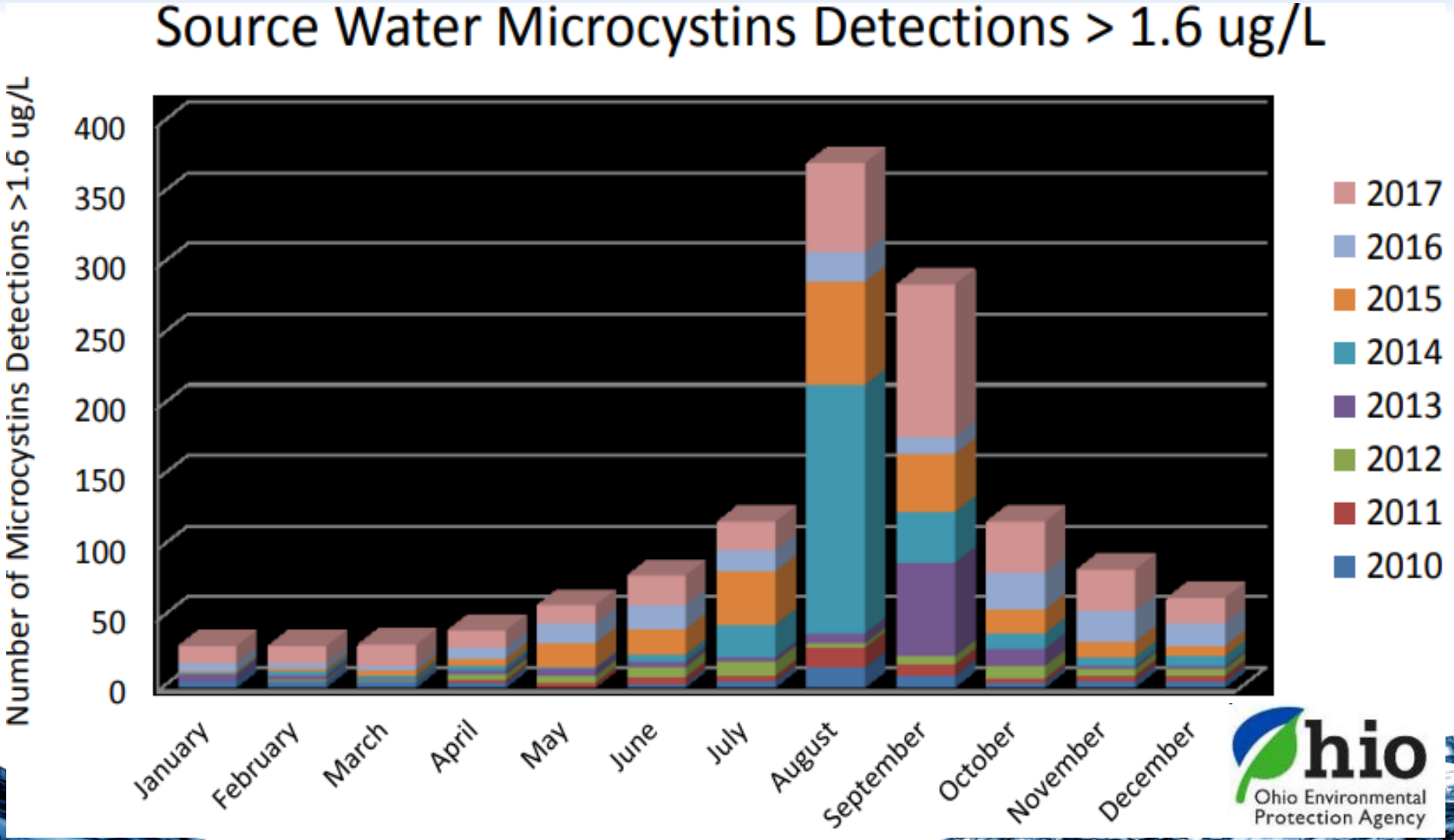
Data Available for 119 Public Water System Source Waters

(includes ~2000 compliance samples collected in 2016)

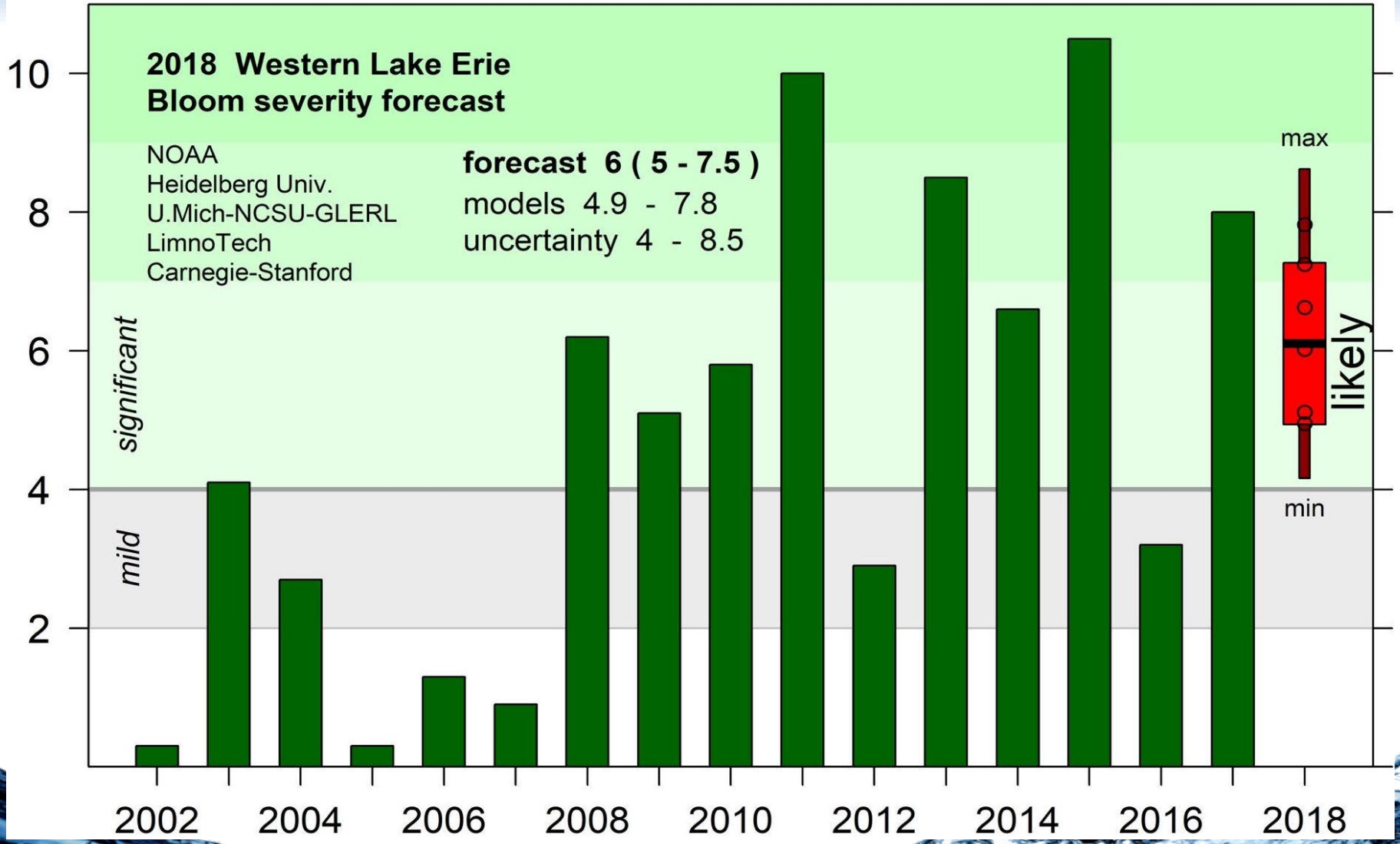
- Microcystins Detections June –Dec. 2016
- Microcystins Detections 2010-2015
- PWS Intakes

Ohio Environmental Protection Agency

Background – Microcystin Detections



Background -HAB Forecast



Background – Action Levels

Drinking Water Thresholds	Microcystins (µg/L)	Anatoxin-a (µg/L)	Cylindrospermopsin (µg/L)	Saxitoxins (µg/L)
Do Not Drink – children under 6 and sensitive populations	0.3	20	0.7	0.3
Do Not Drink – children 6 and older and adults	1.6	20	3.0	1.6
Do Not Use*	20	300	20	3

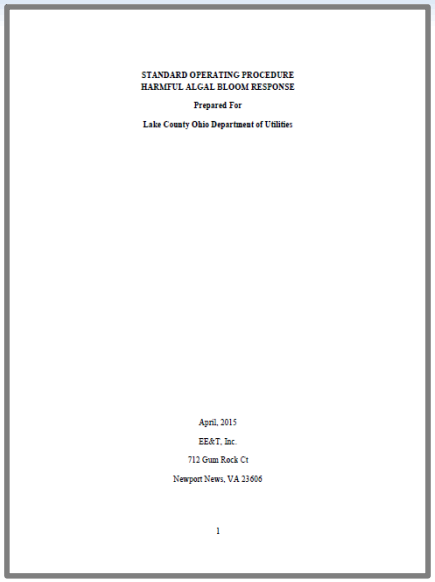
2017 Ohio PWS HAB Response Strategy

Microcystins = Action Level in Ohio Rule

Other cyanotoxins = Threshold in PWS Response Strategy

Ohio Environmental Protection Agency

Background – Aquarius WTP



STANDARD OPERATING PROCEDURE
HARMFUL ALGAL BLOOM RESPONSE

Prepared For

Lake County Ohio Department of Utilities

April, 2015

EE&T, Inc.

712 Gum Rock Ct

Newport News, VA 23606

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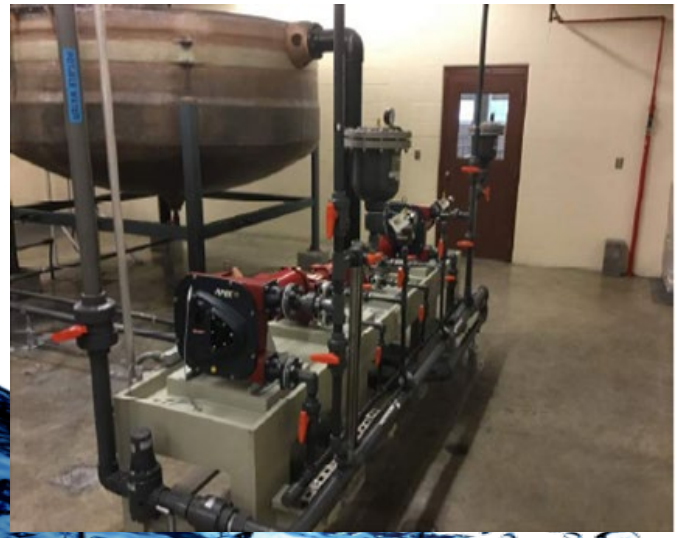
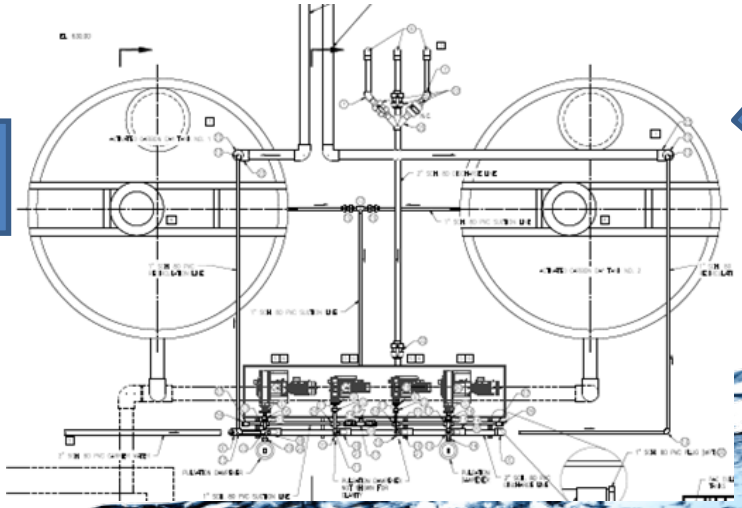
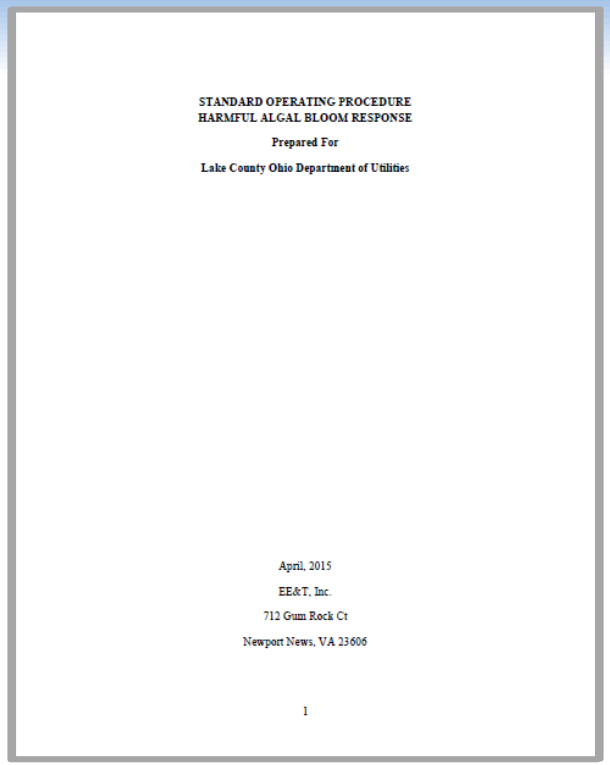




SOP – HAB Response

- SOP provided:
  - Background information on harmful algal blooms (HAB).
  - Detailed description of each plant's treatment processes and operations.
  - Monitoring and sampling of cyanobacterial (blue-green algal) cells.
  - Monitoring and sampling of cyanotoxins released from HABs.
  - Cyanobacteria and cyanotoxin treatment and control strategies.
  - Appendices contain contact information for laboratories that perform the analysis described in the SOP and info about various sampling techniques that can be used.



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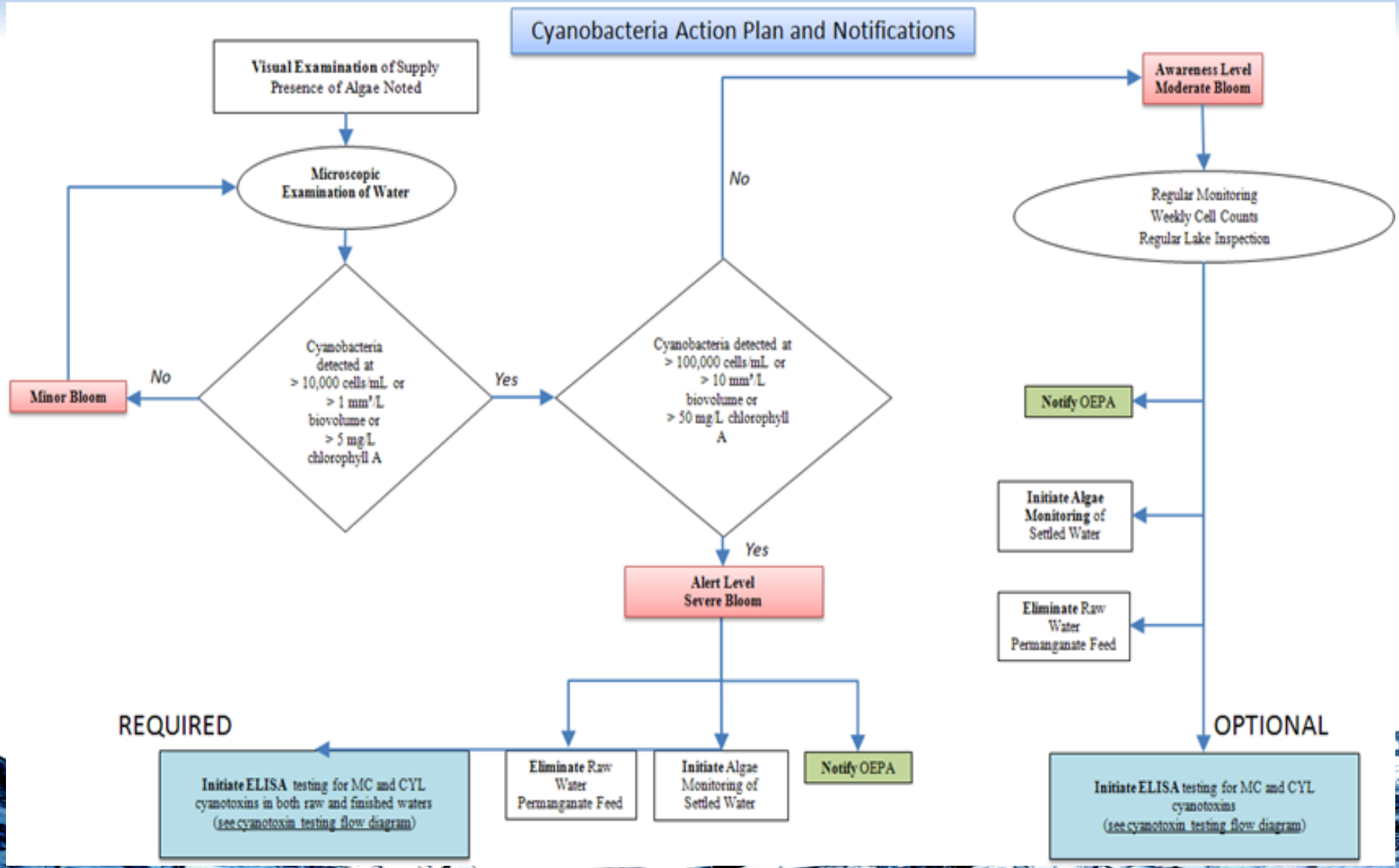
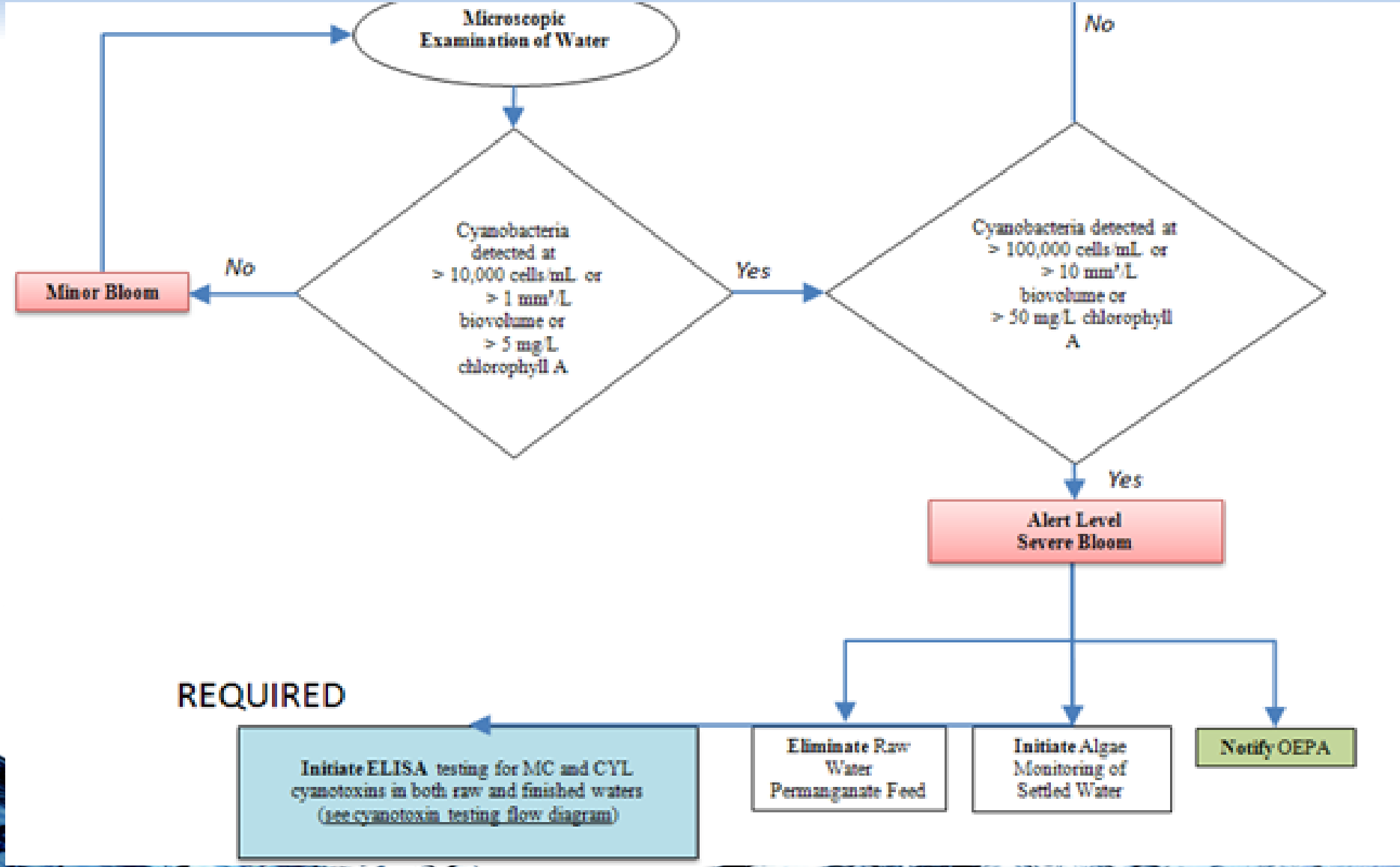
HAB Decision Matrix and Action Plan



HAB Decision Matrix and Action Plan



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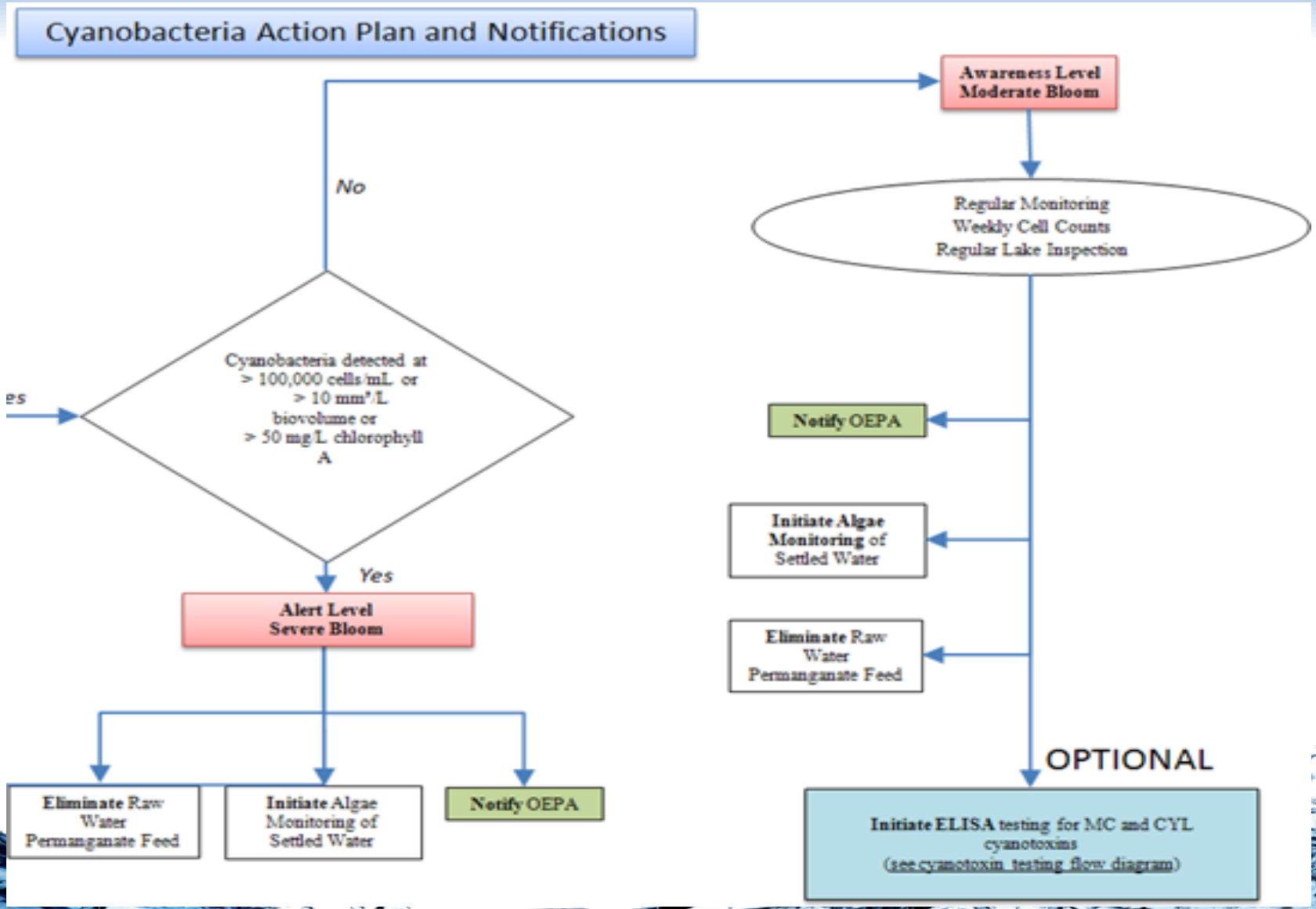


SOP – Treatment Strategies

- **TS 1:** “Remove cells without lysing them”
- **TS 2:** “Hit it hard with oxidants”
- **TS 3:** “Hit with low level preoxidation to purposefully release cyanotoxins for subsequent removal”

SOP – Treatment Strategies

❖ **TS 1:** "Remove cells without lysing them", or remove intact cells and use PAC and post-filtration oxidation for extracellular toxins

- Discontinue permanganate and pre-filter chlorination
- Increase PAC dose in rapid mix
- Remove cyanobacterial cells with coag/floc/sed and filtration
- Do not practice recycling backwash water if possible.
- Concerns:
  - Cyanobacteria (with intracellular toxins) are in sludge from sedimentation and filter backwash
  - Cells have potential to lyse on filter depending on various factors

SOP – Treatment Strategies

❖**TS 2:** "Hit it hard with oxidants"

- Use high levels of oxidant to lyse cells and oxidize all cyanotoxins
- Use appropriate and effective oxidants to both lyse open cells and oxidized the released cyanotoxins
- Concerns:
  - Increased potential for DBP formation (e.g., THM and HAA)
  - Pink coloration (for permanganate)

SOP – Treatment Strategies

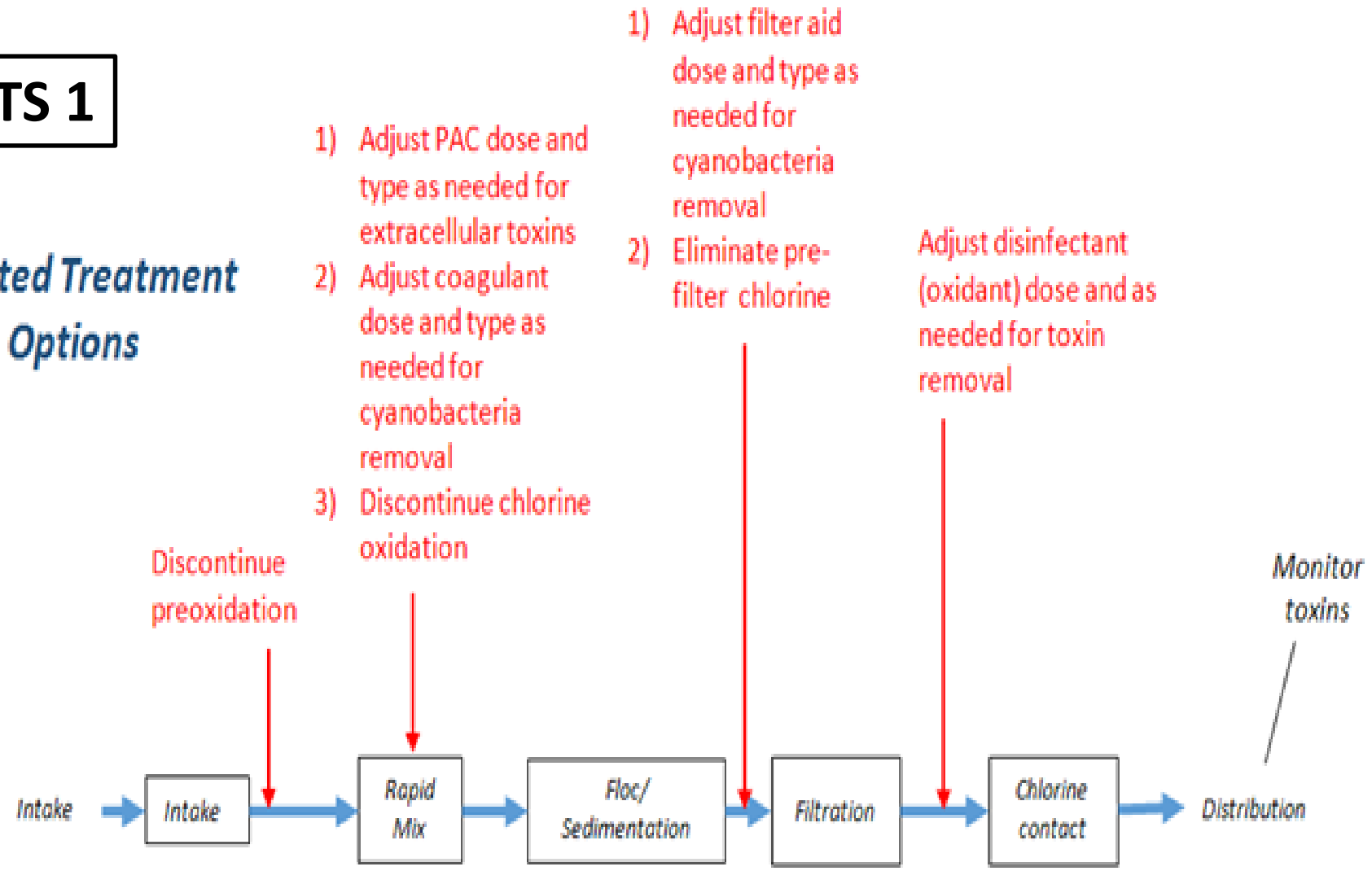
❖ **TS 3:** "Hit with low level preoxidation to purposefully release cyanotoxins for subsequent removal"

- Preoxidize with controlled and optimized low level of chlorine or permanganate to release intracellular cyanotoxins, and follow with removal by:
  - Increased PAC
  - Strong oxidation
- Concerns:
  - Chemistry and treatment is tricky and variable
  - Difficult to control
  - Considerable expertise and chemical analyses are needed

SOP – Preferred Treatment Strategy

TS 1

Selected Treatment Options



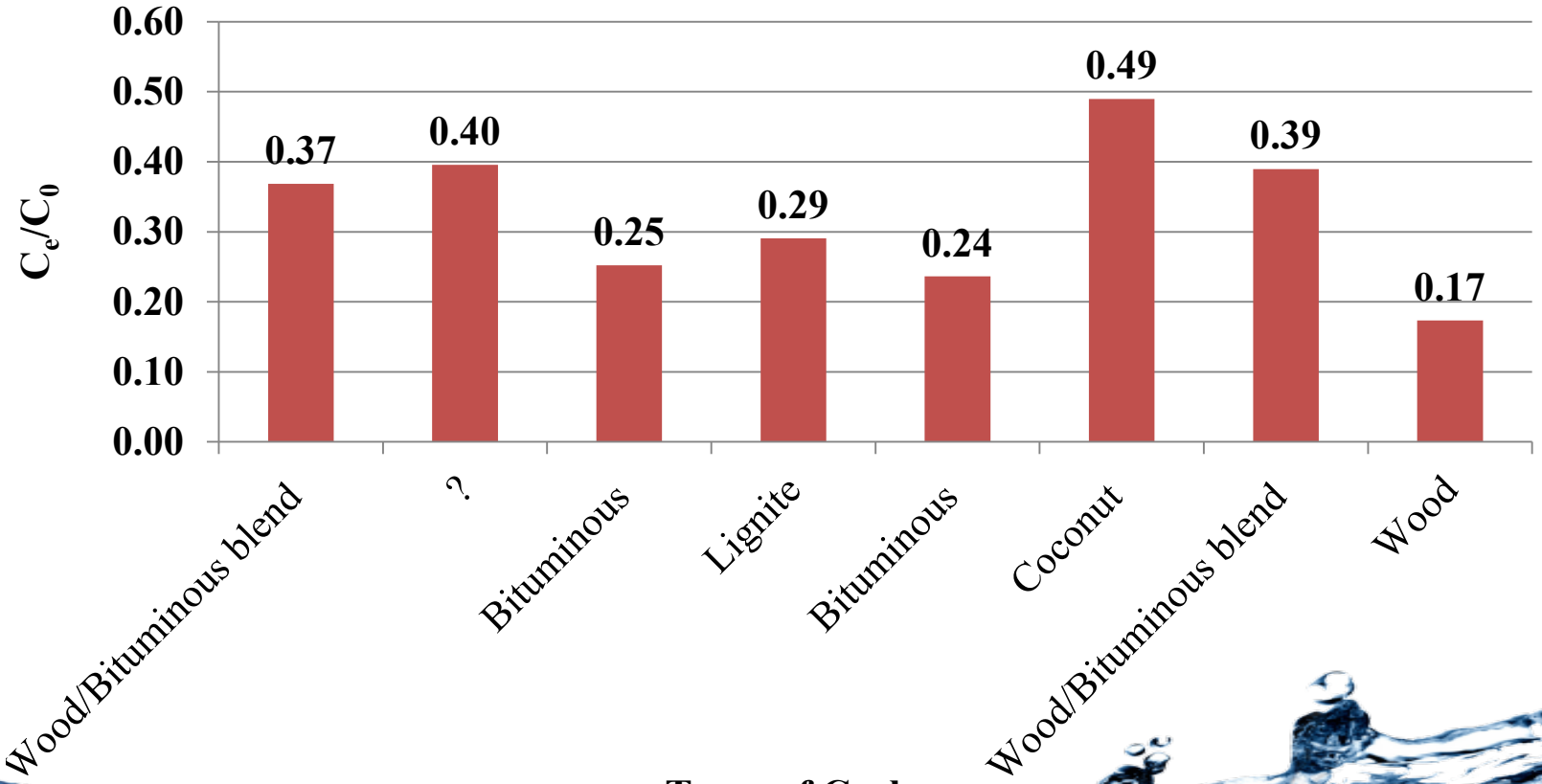
PAC Screening

→Is the right PAC being used?

- Jar Testing was performed to determine the most effective PAC treatment plan
- PAC type and dose would indicate the product most suited for toxin removal
- 8 PAC products were tested, including the current PAC
- PAC feed systems would be designed to reduce toxin concentrations to 0.2 ug/L or less at plant design flow rate

PAC Screening (cont.)

- Jars dosed with 3 ug/L of Microcystin-LR (MC-LR) and dosed with 15 mg/L of PAC
- C_e – final toxin concentration; C_o – initial spiked concentration



PAC Dose Testing

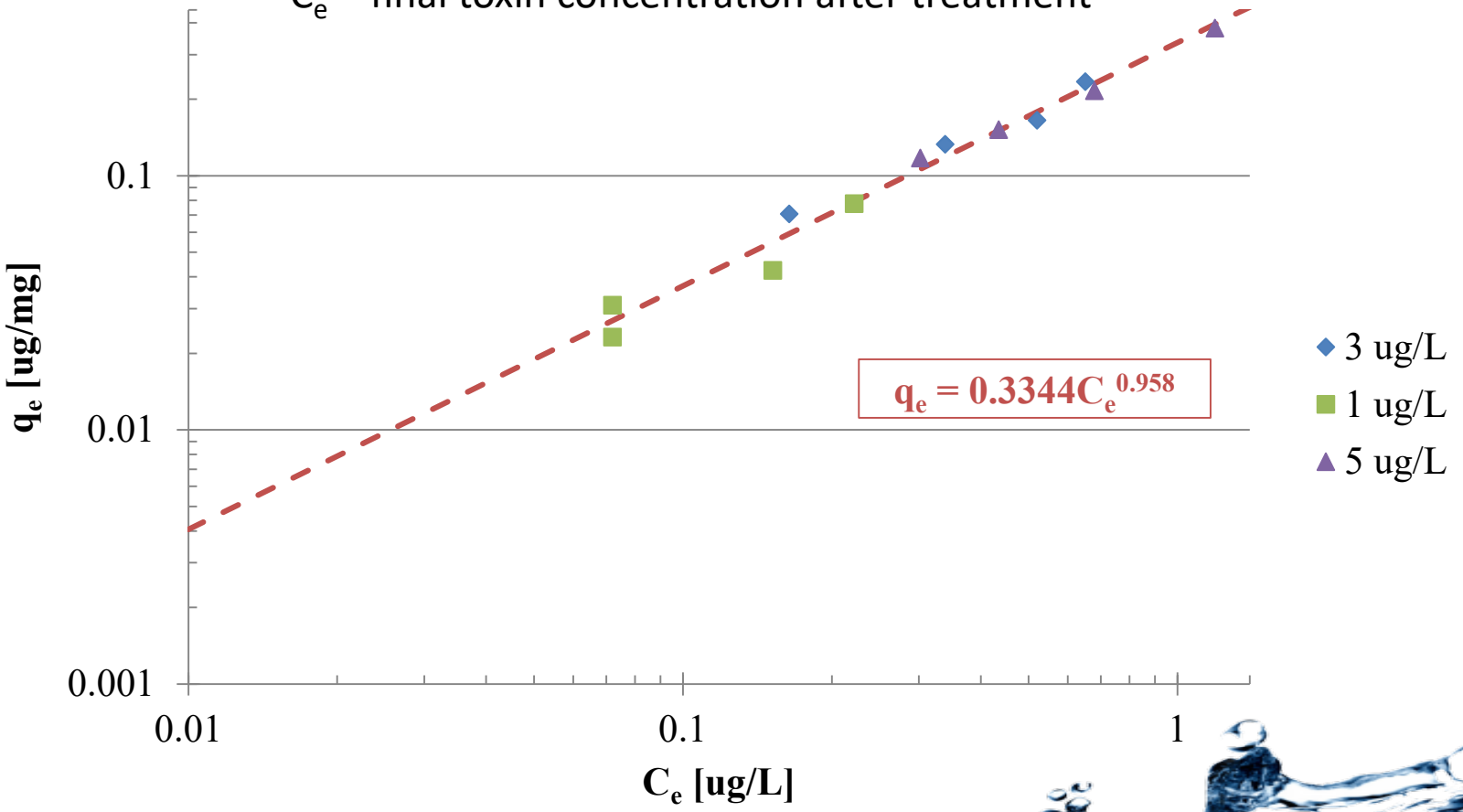
→What should the PAC dose be?

- Determine the PAC dose most effective at removing various levels of cyanotoxins
- Tested PAC doses of 10, 20, 30, and 40 mg/L
- 3 sets of jars with different initial spikes of cyanotoxin (1 ug/L, 3 ug/L, and 5 ug/L)

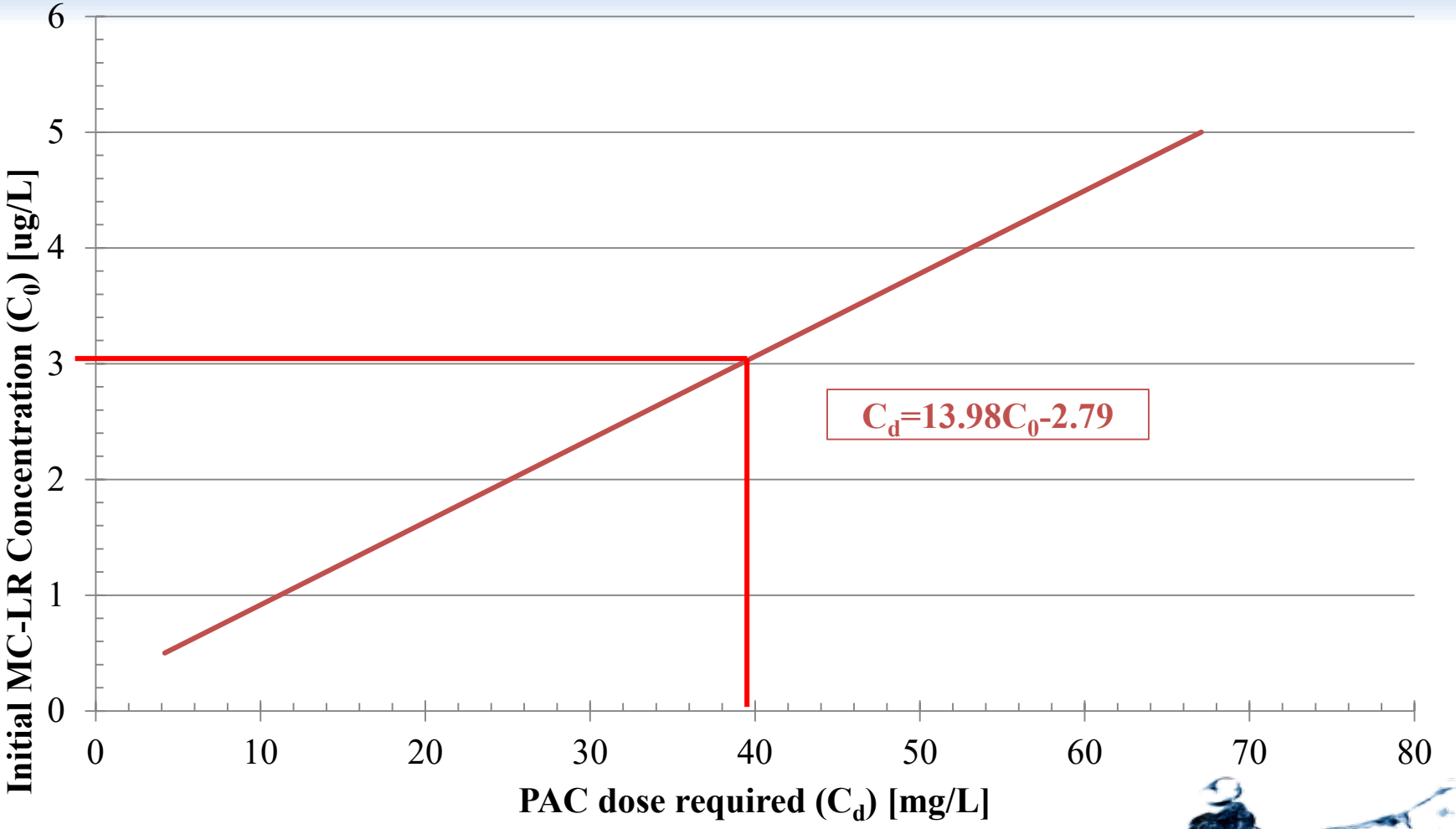
Isotherm-PAC

q_e – carbon capacity for toxin removal

C_e – final toxin concentration after treatment



PAC Dose Req'd for 0.2 ug/L



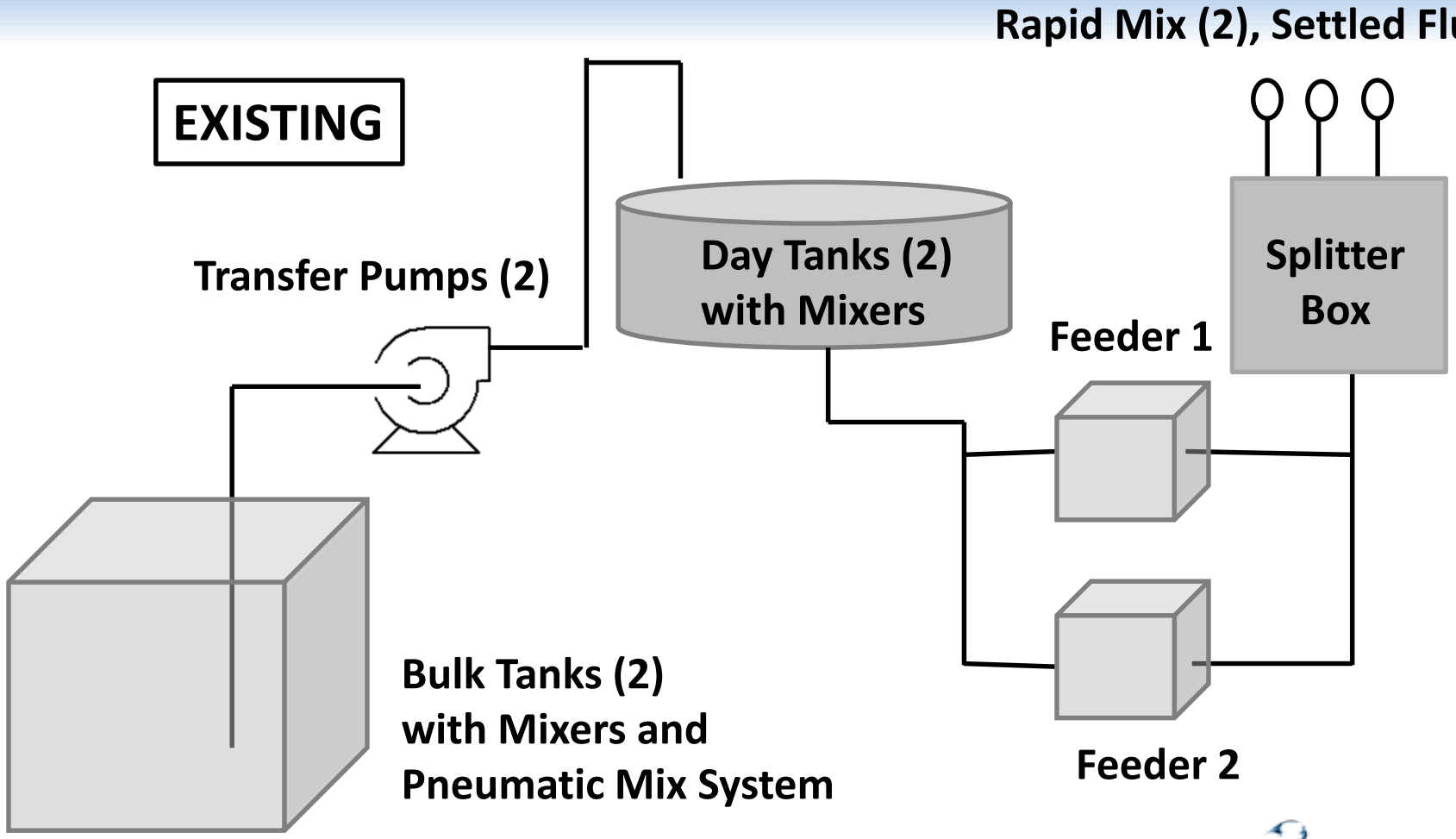
Preliminary Design Report (PDR)

What to keep and what to replace?

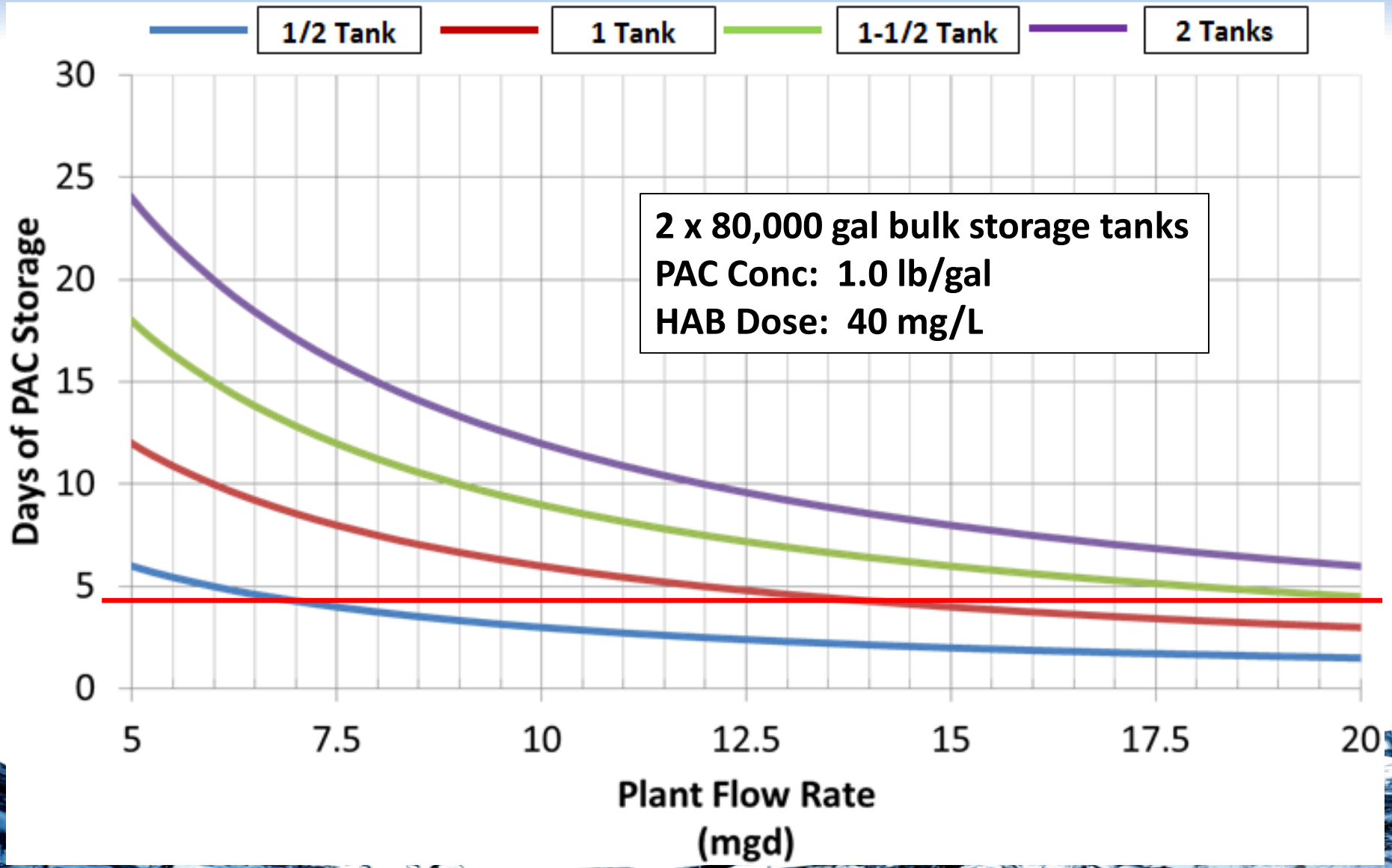
- Based on screening and dose testing, decision made to continue using PAC with wood/bituminous blend
- PAC concentration maintained at 1.0 lb/gal
- PAC dose under normal conditions would be 0.5 mg/L
- PAC dose during HABs event would be 40 mg/L

- Other factors: age of equipment/time in service; considerations for plant operators and maintenance staff

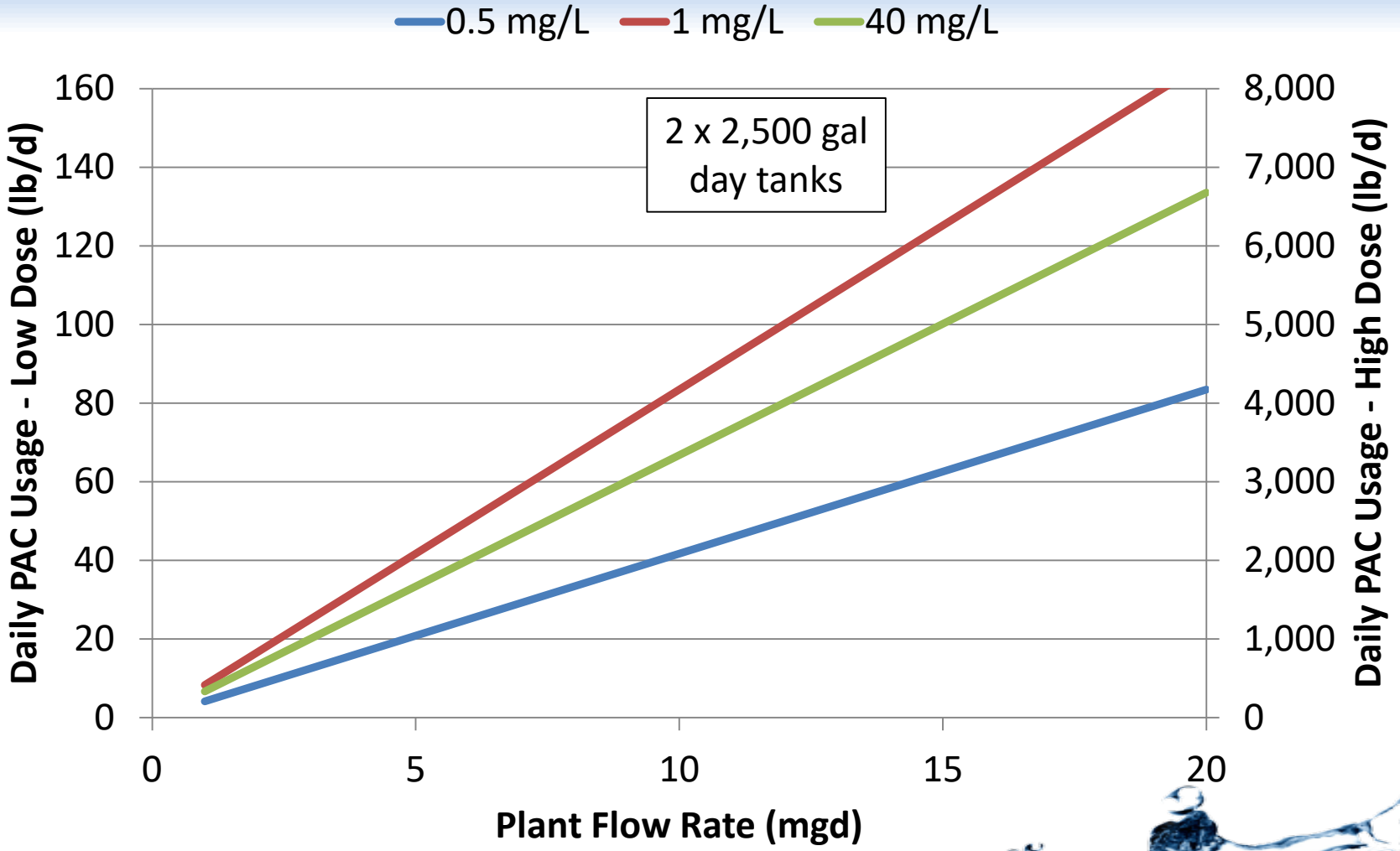
PAC Storage & Feed System Schematic



PAC Storage Curves – Bulk Storage



PAC Storage Curves – Day Tanks



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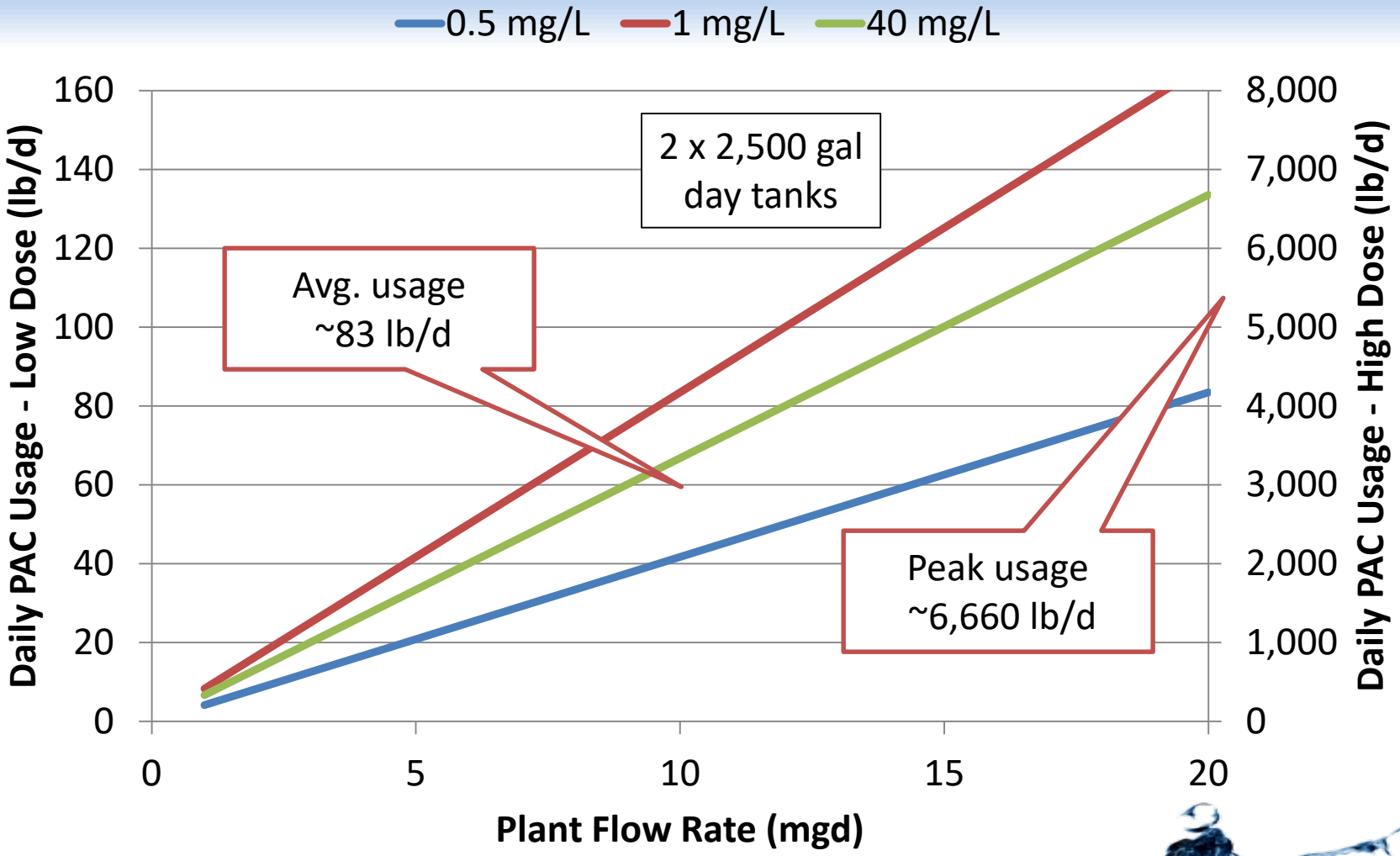


Decisions Needed at Aquarius

What to keep and what to replace?

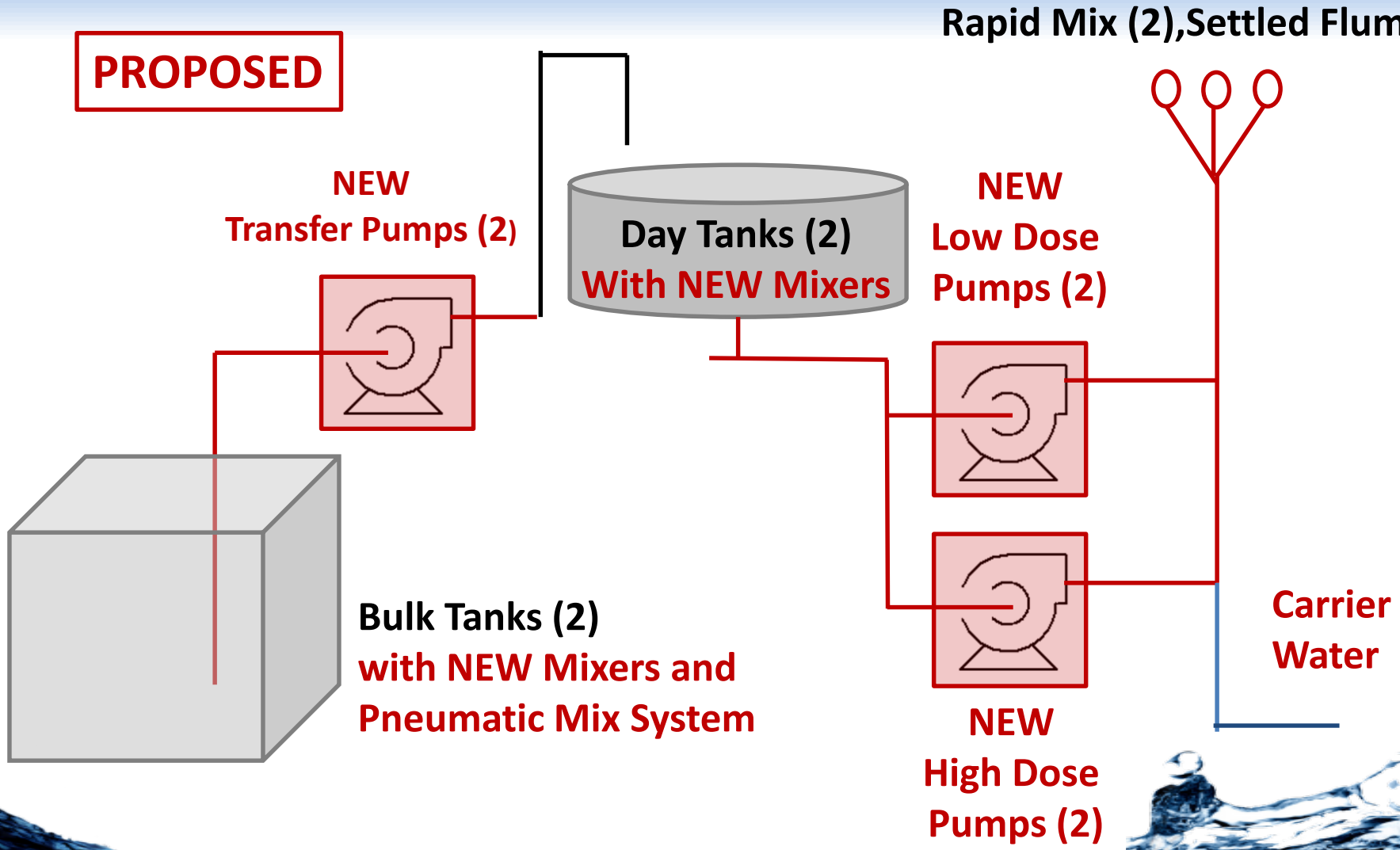
Propose keeping:

- Bulk storage tanks
- Day tanks
- Transfer piping
- Carrier water*
- Gravity piping to existing feed points

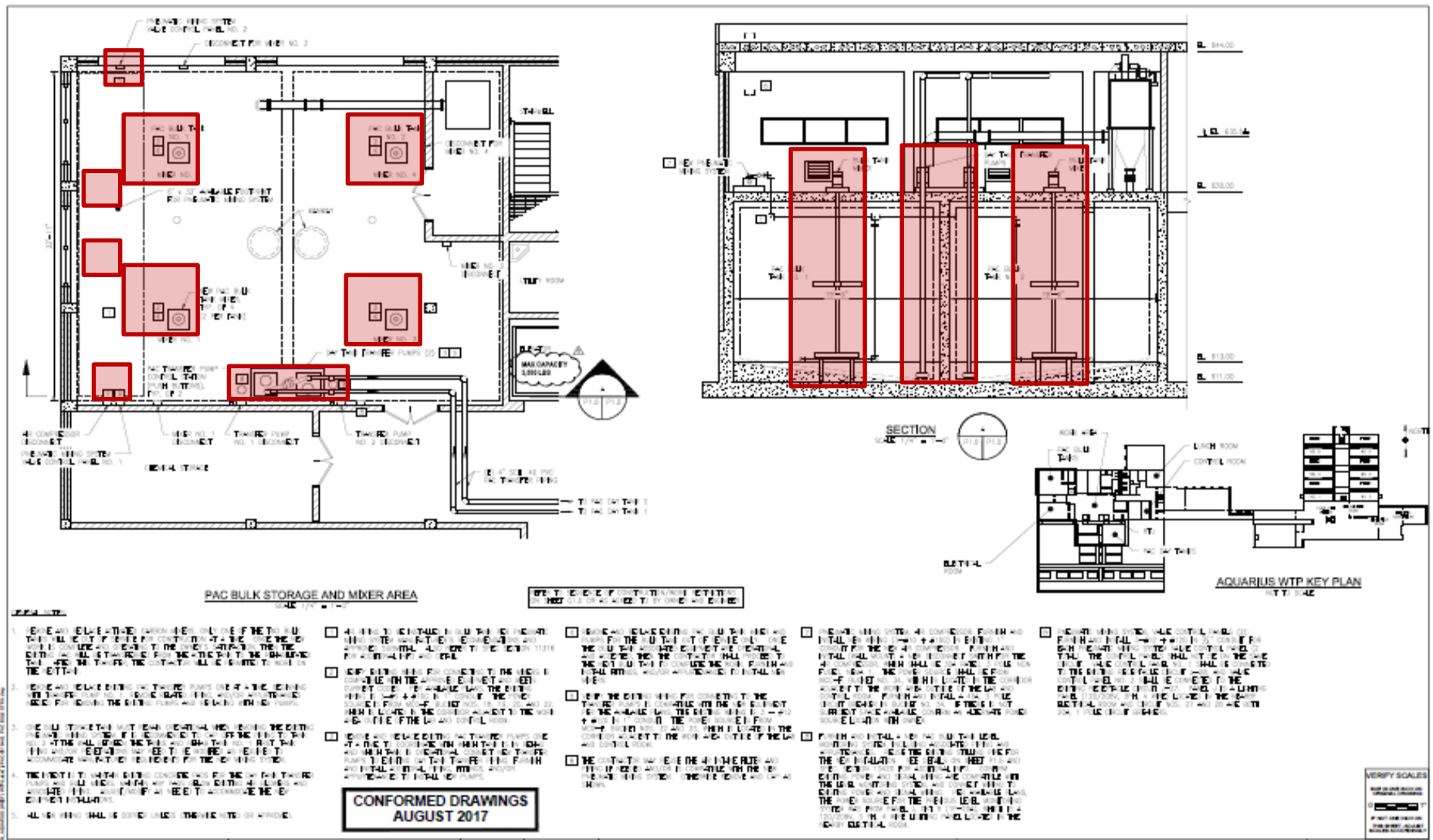
Propose replacing:

- Bulk storage mixing (pneumatic & mechanical)
- Transfer pumps
- Day tank mixers
- Volumetric feeder
- Splitter box
- Piping from day tanks to feeders to splitter box

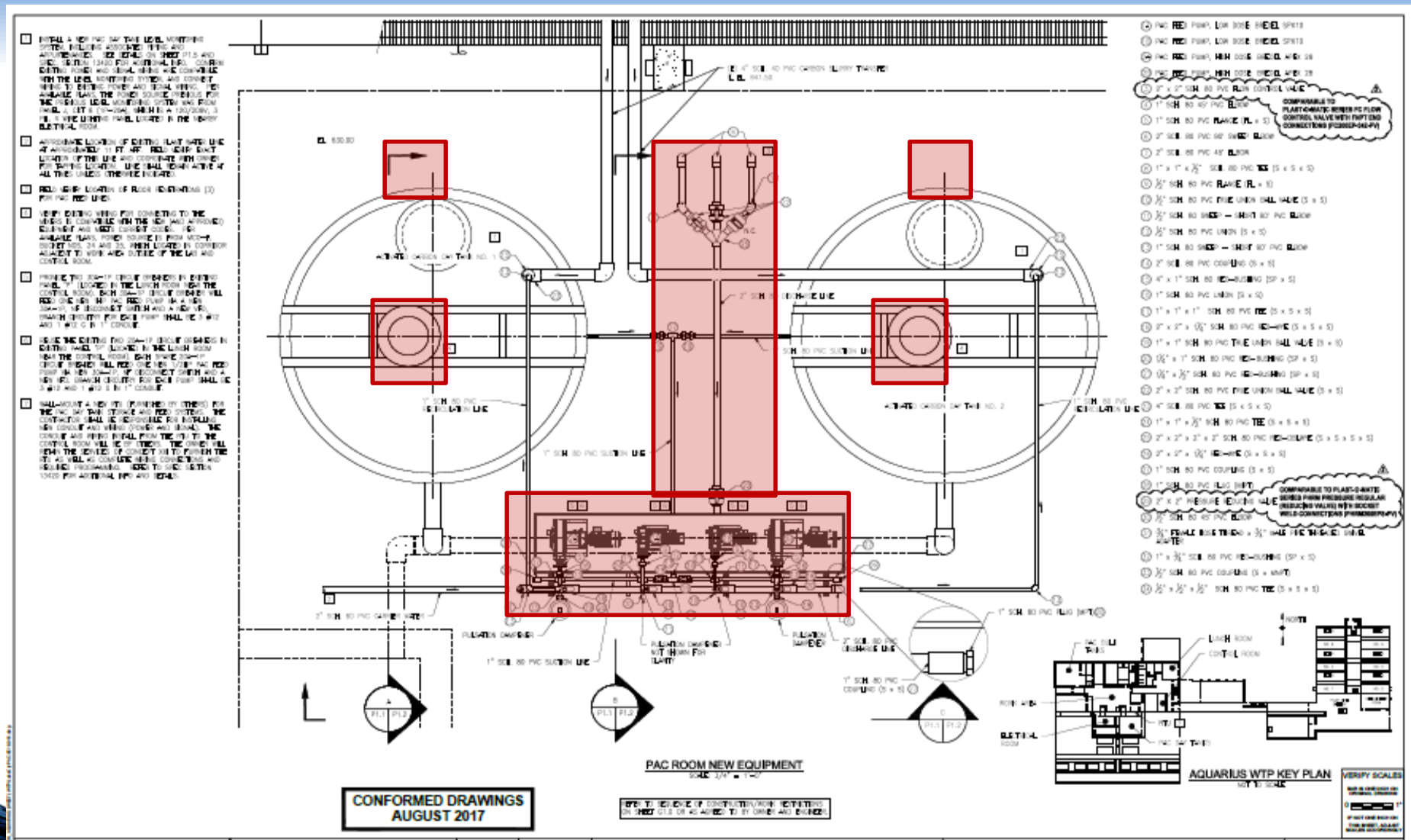
PAC Storage & Feed System Schematic



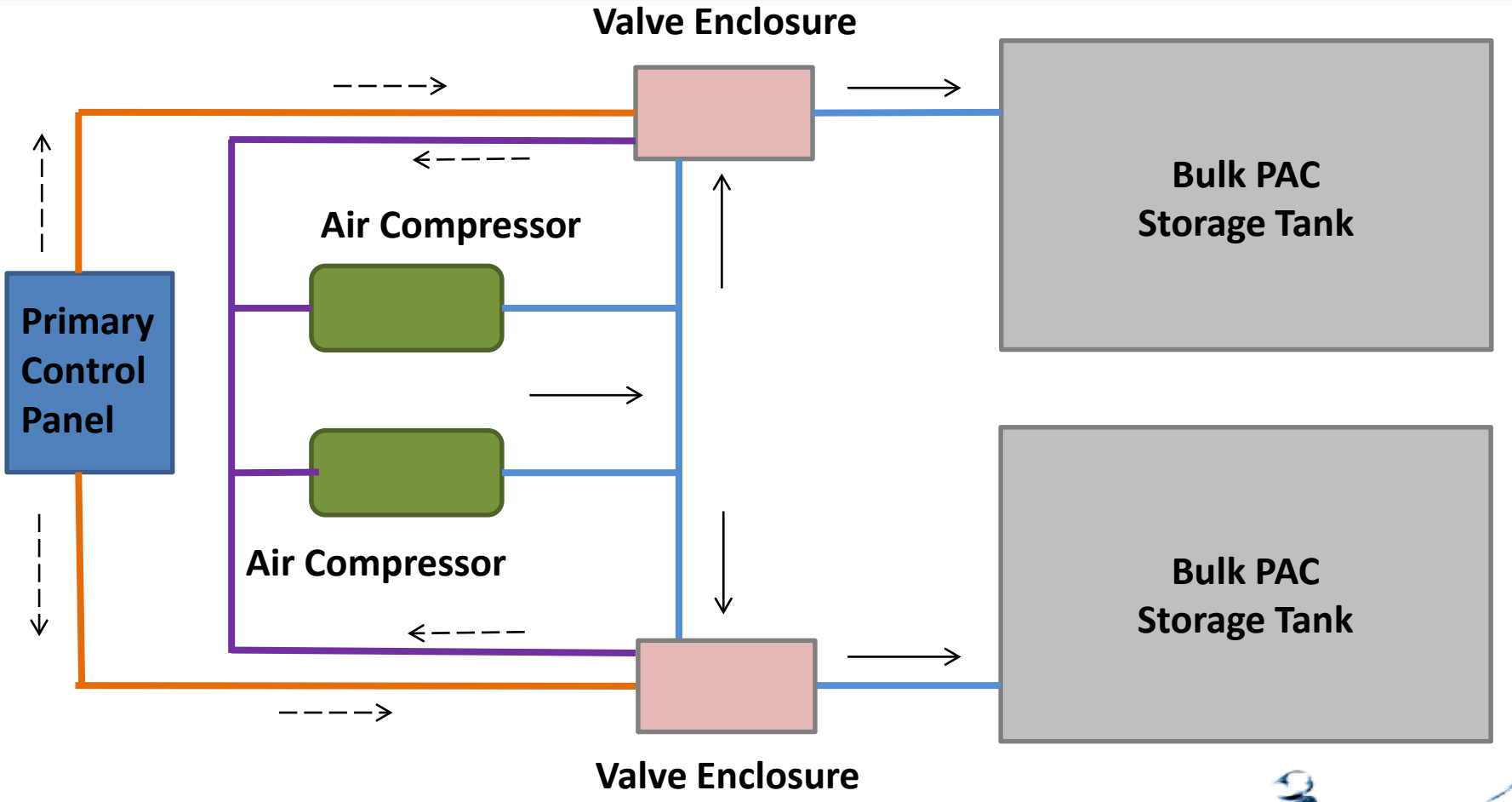
PAC Bulk Storage Area



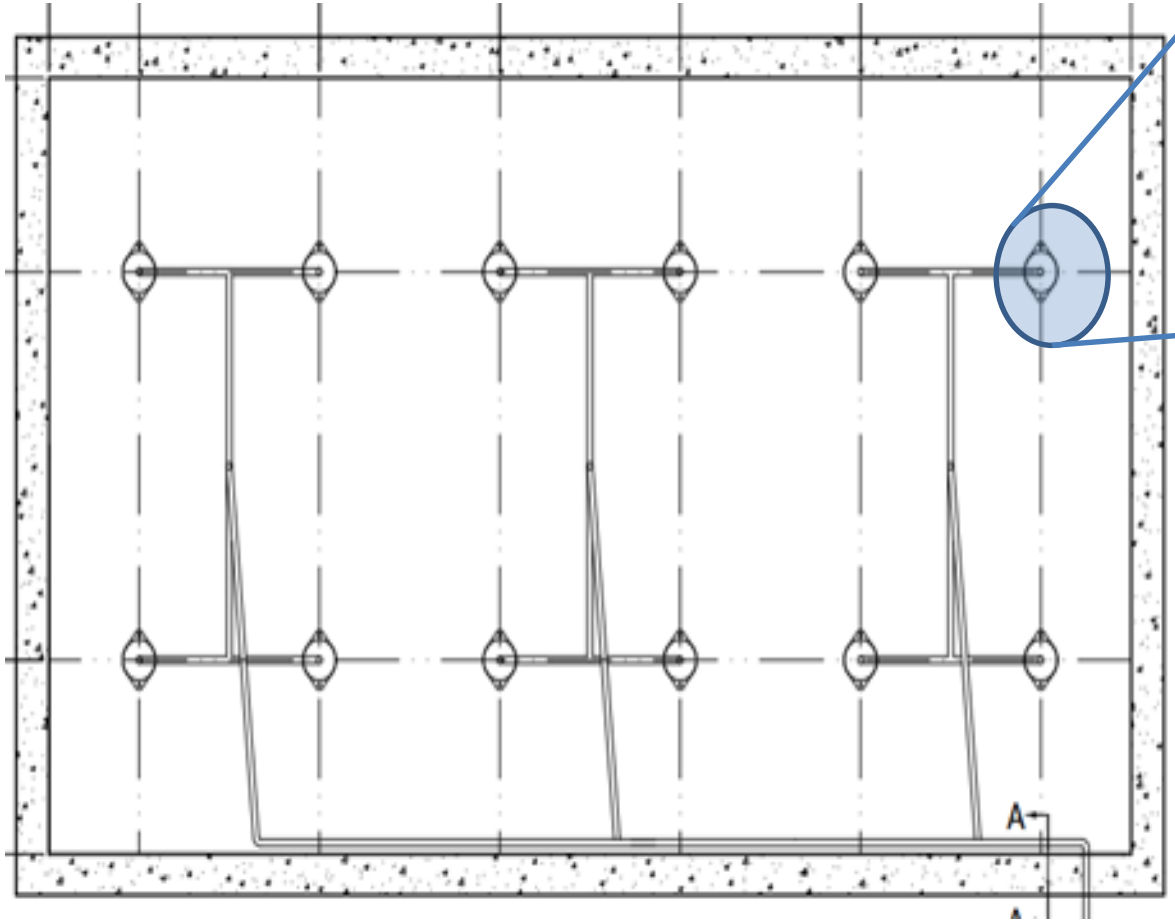
PAC Day Tank & Feed Area

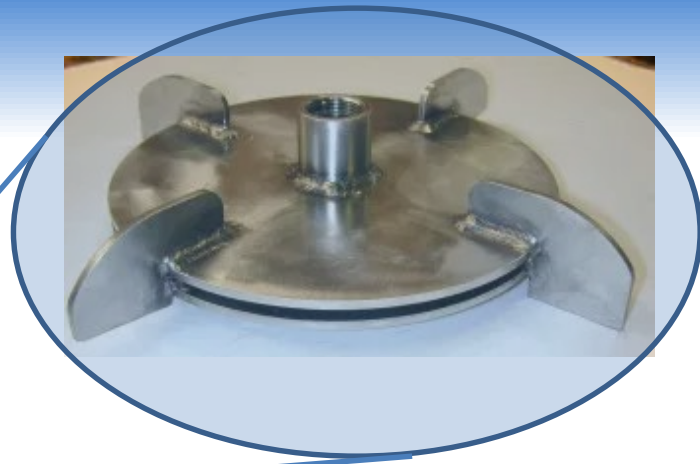


Pneumatic Mix System - Schematic



Pneumatic Mix System





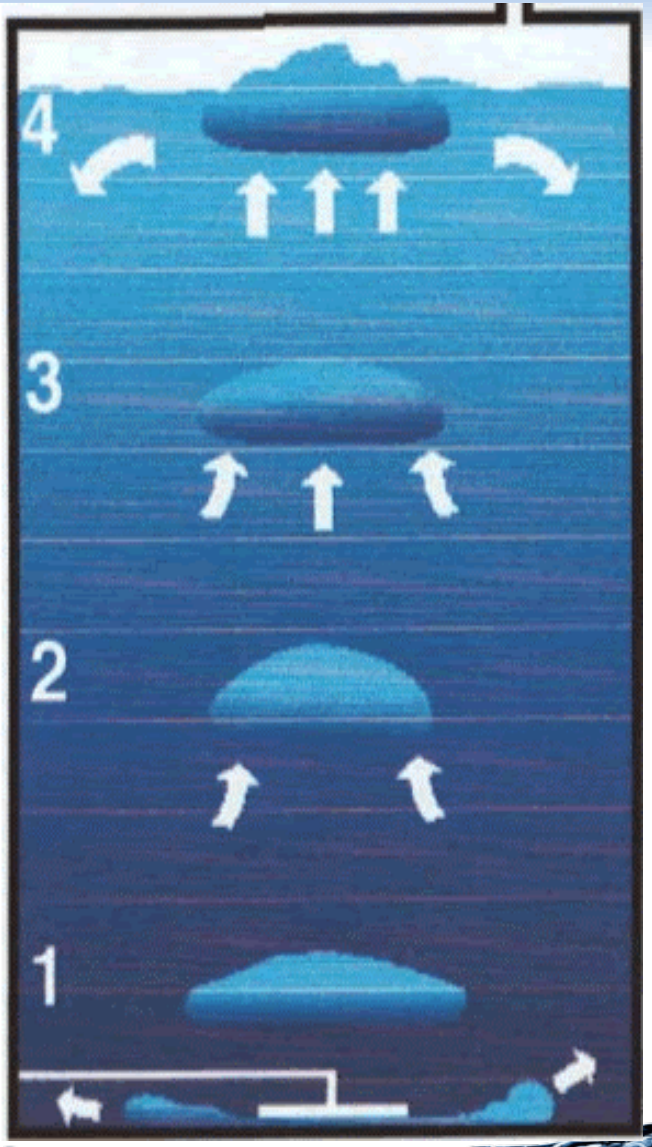
Pneumatic Mix System

4 As bubbles break the surface, they push liquids across the top of the tank and down the sides to the bottom, completing the circulation.

3 Bubbles continue to rise upward, forcing heavier particles to the surface and creating a vertical mixing action that quickly involves the entire tank contents.

2 Large, flat bubbles are formed immediately above the plates and begin rising toward the surface.

1 Pulses of air (or gas) are released beneath round, flat accumulator plates fastened 1/4 in. above tank bottom.

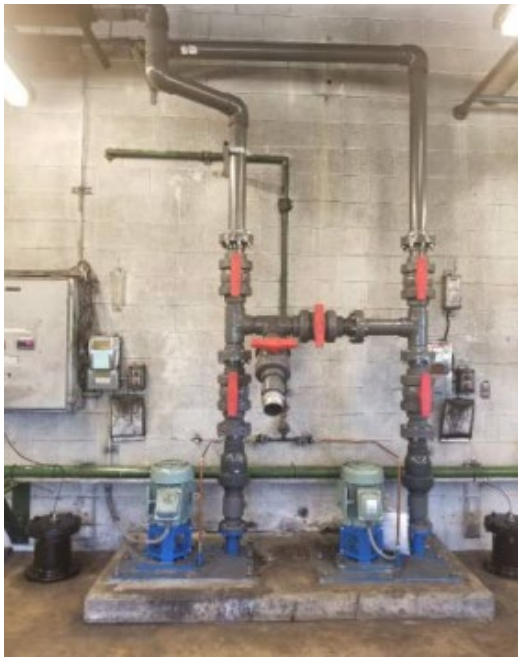


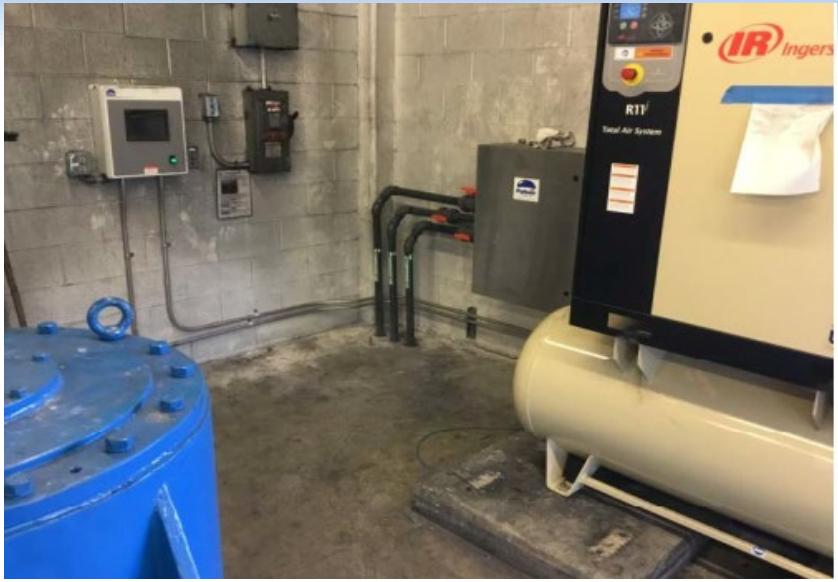
Carbon Feed Pumps

- Low Dose Pumps intended for normal daily plant operations to handle taste and odor concerns

- High Dose Pumps intended for treating HABs

Installation – Bulk Storage Area





Installation – Day Tanks & Feed Pumps Area

Lessons Learned/Reinforced

- Effective and regular communication
- Art & science to developing practical solutions
- Confirm key aspects to design
  - PAC concentration
  - Carrier water
  - Feed equipment

Conclusion

- HABs here for the foreseeable future
- Be proactive to address HAB events
- Develop a workable plan (ie, SOP) with available infrastructure and equipment
- Prepare for and implement long-term solutions

Questions?

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