ACE19

Innovating the FUTURE of WATER

Working Together to Identify and Implement the Optimal Groundwater Treatment Solution for PFAS

Mark Wetzel, P.E. *(Town of Ayer, MA)*

Ji Im, P.E. *(CDM Smith)*

June 11, 2019, 2:00 pm

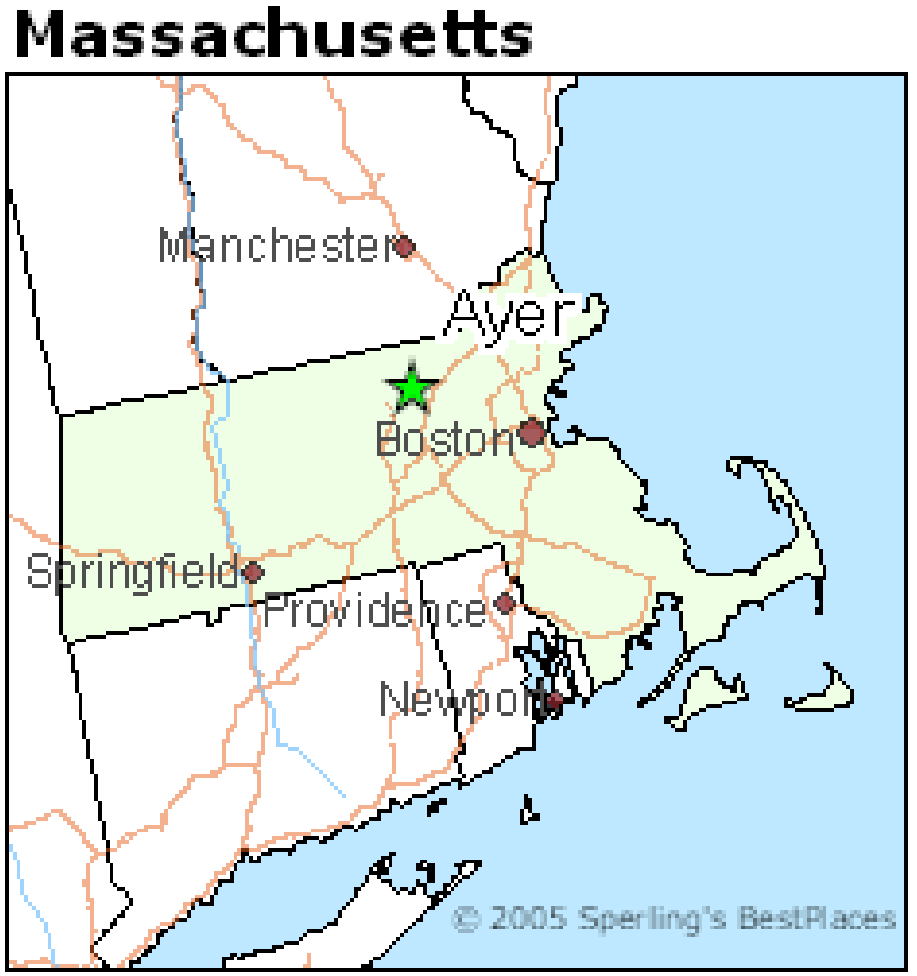
Water Partnership with CDM Smith

Presentation Outline

1. Background
2. PFAS Discovery and Response
3. Grove Pond WTP
4. Spectacle Pond WTP
5. Alternative Water Supply
6. Summary

Community Background

- Located in central Massachusetts
- 9.5 square miles
- Population 7,600
- Dept. of Public Works – water, wastewater, stormwater, roads & bridges, solid waste, Snow plowing, street lights



Town of Ayer, Massachusetts

Railroad Town

Army Town

Movie Town?

Ayer's Water Supply

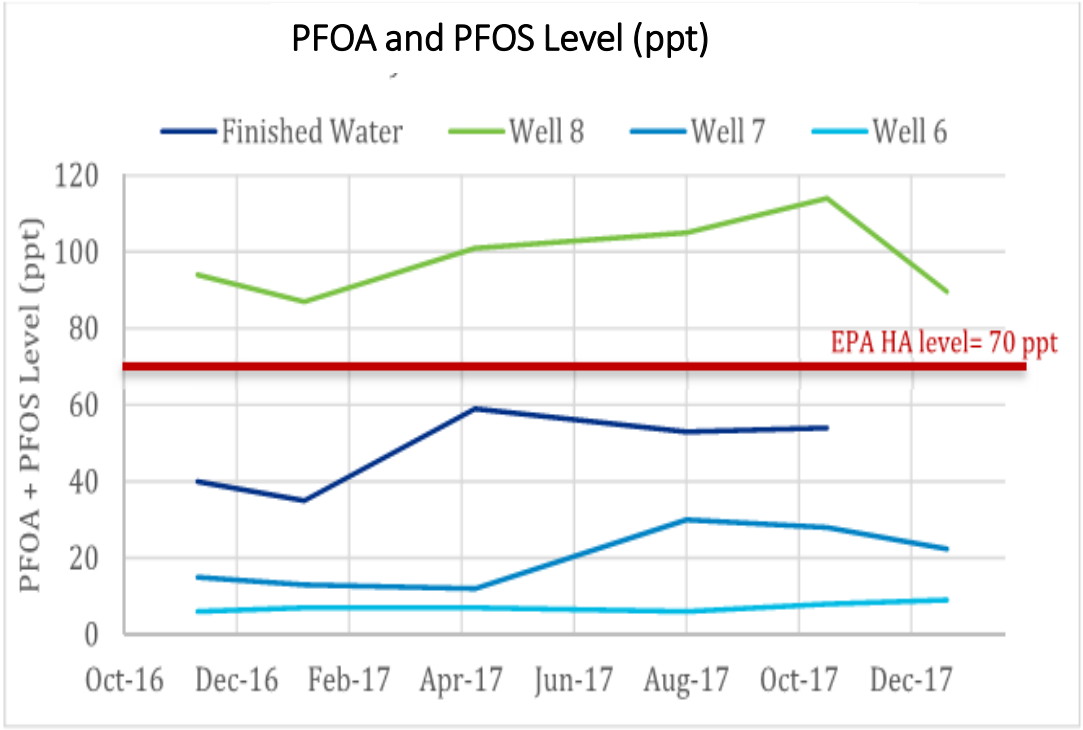
- 5 wells – 3 at Grove Pond, 2 at Spectacle Pond
- Two Greensand WTPs
- Two distribution storage tanks
- Demand: 1.4 MGD (average) & 2.7 MGD (maximum)
- 60 % of water use is commercial / industrial
- Total supply yield – 3.7 MGD

Ayer's Water Supply Challenges

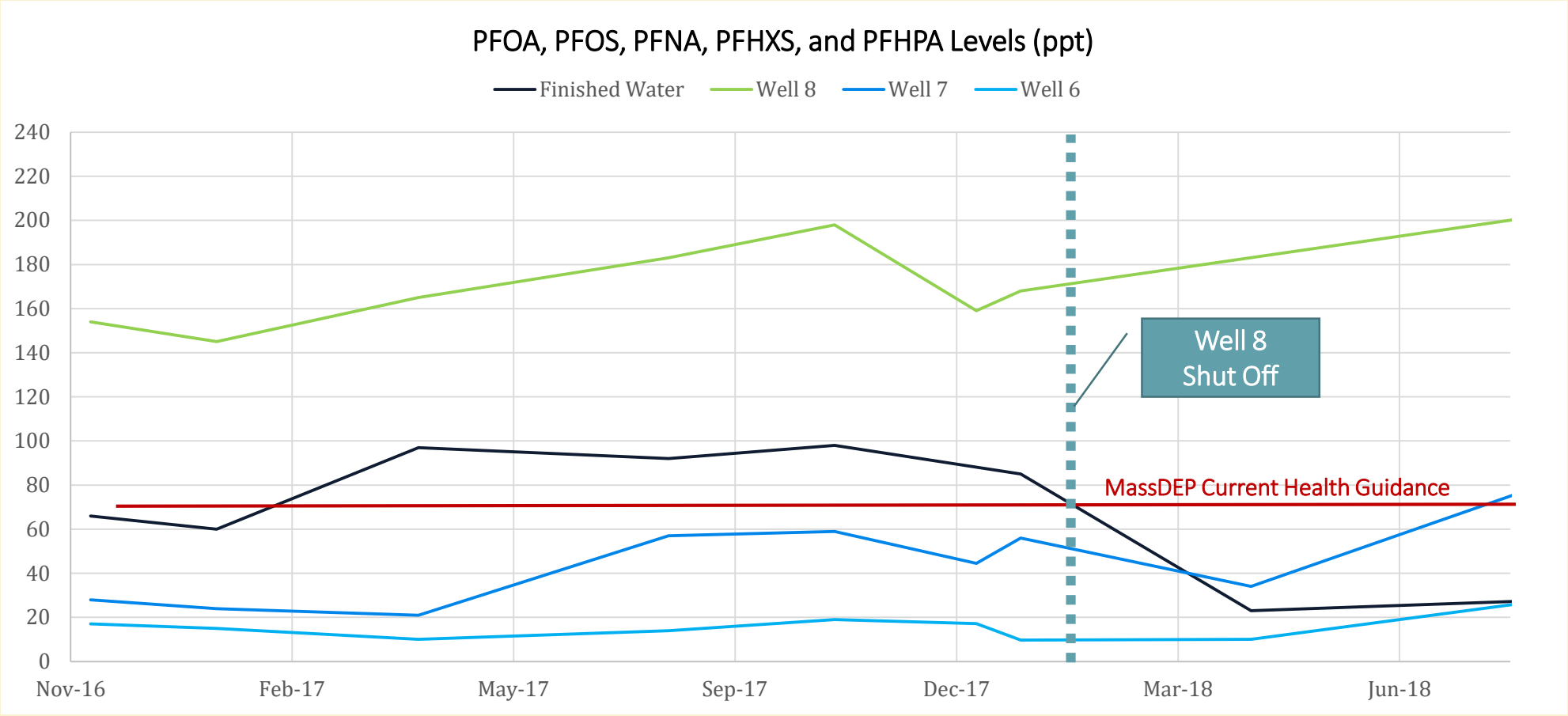
- Very high iron (2.5 to 3.4 ppm)
  - *Secondary MCL 0.3 ppm*
- Very high manganese (0.85 to 5.66 ppm)
  - *Secondary MCL – 0.05 ppm*
- Arsenic – 0.007 to 0.069 ppm
  - *MCL – 0.01 ppm*
- Lead and Copper Rule
- Total Coliform Rule
- Aging infrastructure

PFAS Discovery & Response

- Not required to sample for PFAS under UCMR3
- Sept. 2016: due to proximity to Fort Devens, MassDEP required Ayer to test Grove Pond Wells for PFOA and PFOS
- All wells had PFAS - GP Well 8 was over the 70 ppt EPA Health Advisory Level
- Contamination from past Ft. Devens activities
- Army Corps of Engineers is investigating extent of groundwater contamination



Discovery of PFAS vs. MassDEP Guidance Level



PFAS Discovery & Response

- Sampled Spectacle Pond Wells 1A and 2A - both had PFAS levels in 20s and 30s
- Since HA was 70 ppt, we did not start to address this supply at the time
- Also sampled levels in distribution storage tanks to evaluate system levels

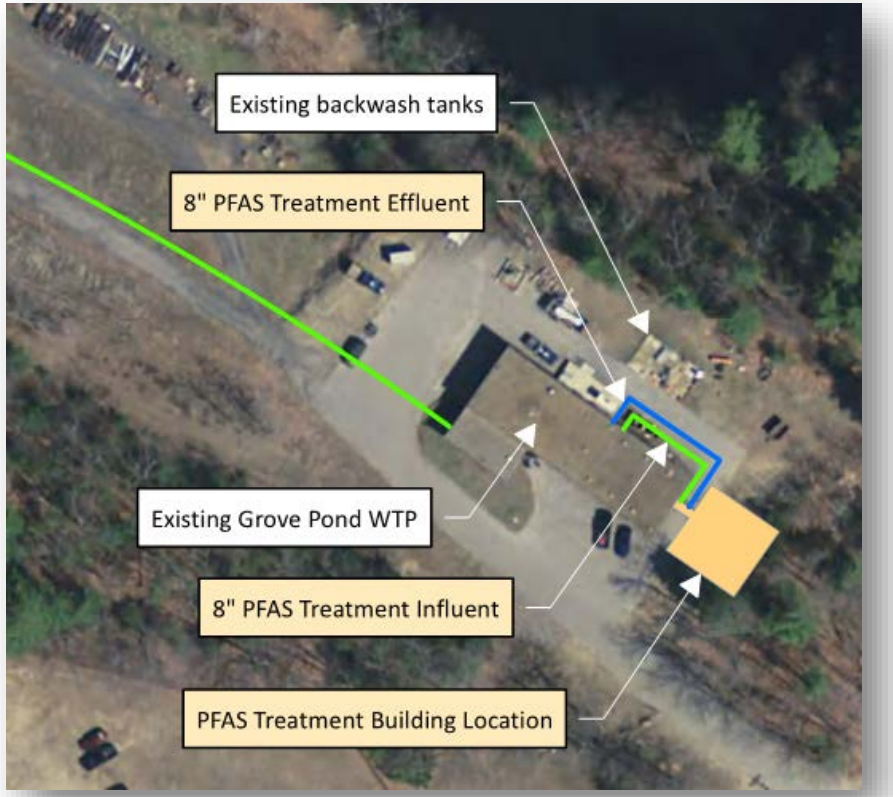
Working with MassDEP through 2018 Issues

- Worked closely with MassDEP (and still do)
- Changed SCADA controls so GP Well 8 would only run with Wells 6 & 7 to blend to below 70 ppt
- Dirty water complaints due to water chemistry changes (and stress on WTP)
- Positive Total Coliform in August
- GP Well 6 “plugging” – required redevelopment
- Constructed interconnection with Devens – but they have PFAS also!

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

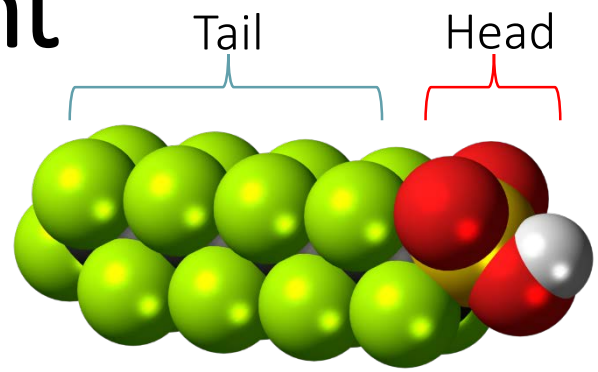
DPW Actions 2018

- Stopped using Well 8 in late February
- DPW issued public notification on March 29
- Evaluated supply alternatives
  - Interconnections, temporary treatment, use of emergency wells
- Completed preliminary treatment study
- Began bench scale testing & final design
- Re-activated Grove Pond Well 1
  - Fe 2.6mg/l, Mn 4.9mg/l
- Constructed Spec Pond Well 2 replacement
  - Tested at 900 gpm
- Cleaned and redeveloped Spec Pond Well 1A



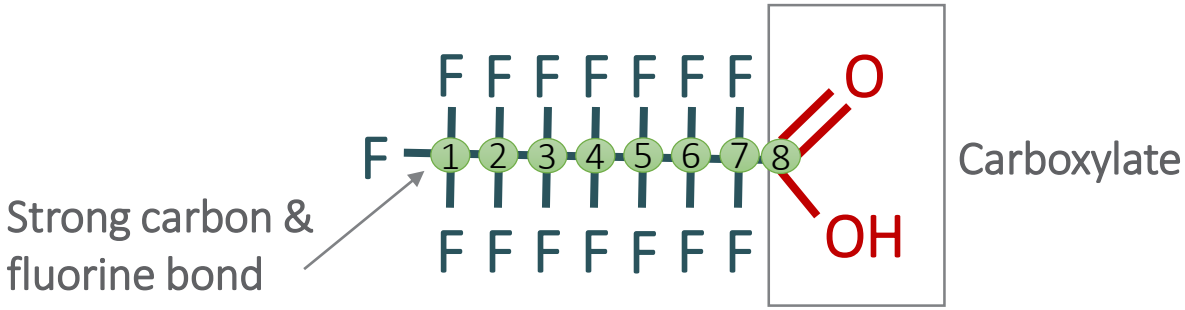
Ji Im, P.E.

PFAS - Emerging Contaminant

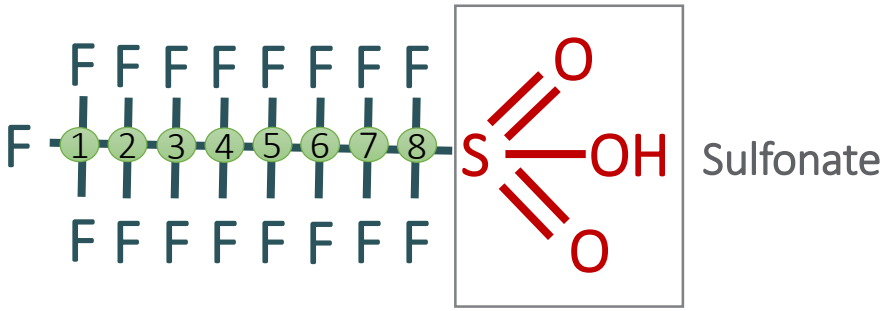


- *Per-* and *Poly-Fluoro Alkyl Substances* (PFAS)

- *Per Fluoro Octanoic Acid* (PFOA)



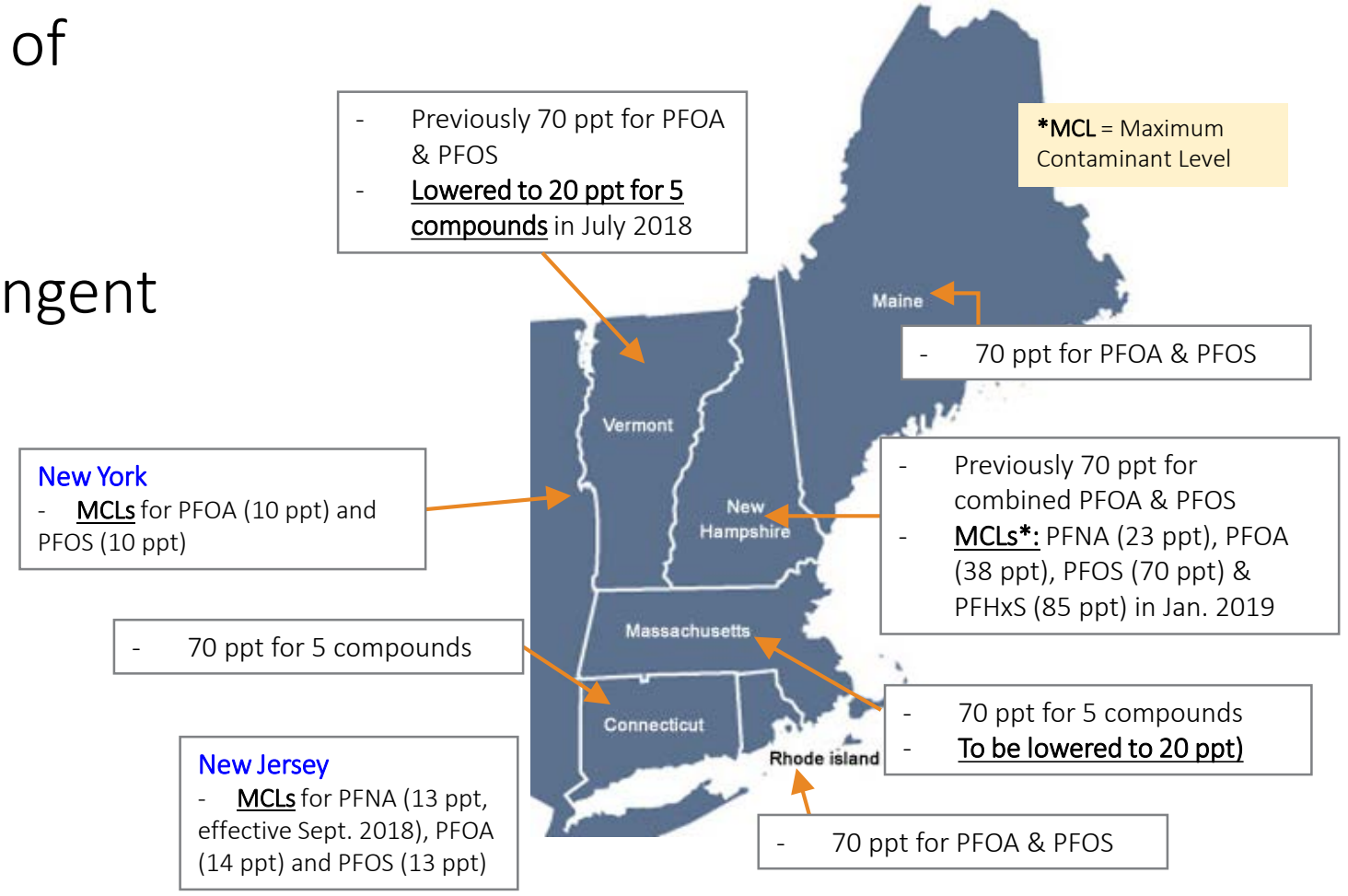
- *Per Fluoro Octane Sulfonic Acid* (PFOS)



State Regulatory Environment

- Overall downward trend of health advisory levels & standards nationally
- Public push for more stringent levels in drinking water

Source: National Telegraph



MassDEP Health Advisory Levels

- Massachusetts Department of Environmental Protection (MassDEP) health advisory level issued in June 2018
- 70 ppt in drinking water for: PFOA, PFOS, PFHxS, PFNA, and PFHpA, individually or combined– *TO BE LOWERED TO **20 PPT***
- MassDEP has begun the process of developing a PFAS MCL- Process may be completed by next spring

PFAAs	C4	C5	C6	C7	C8	C9	C10	C11	C12
Carboxylates	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA
Sulfonates	PFBS	PFPeS	PFHxS	PFHpS	PFOS	PFNS	PFDS	PFUnS	PFDoS

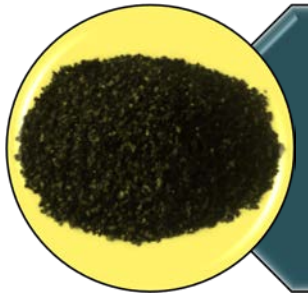
Short-Chain PFAS

Long Chain PFAS

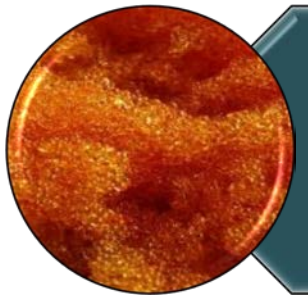
Grove Pond Water Treatment Plant (WTP)

- Grove Pond WTP
  - 2 million gallons per day (mgd) facility
- Three groundwater wells
- Existing treatment plant:
  - Greensand filtration for iron and manganese removal
  - Chemical treatment (e.g. pre-oxidation, disinfection, pH adjustment)

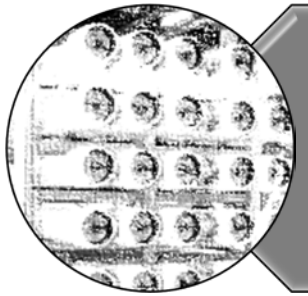
PFAS Treatment



Granular Activated Carbon (GAC)



Anion Exchange (AIX)

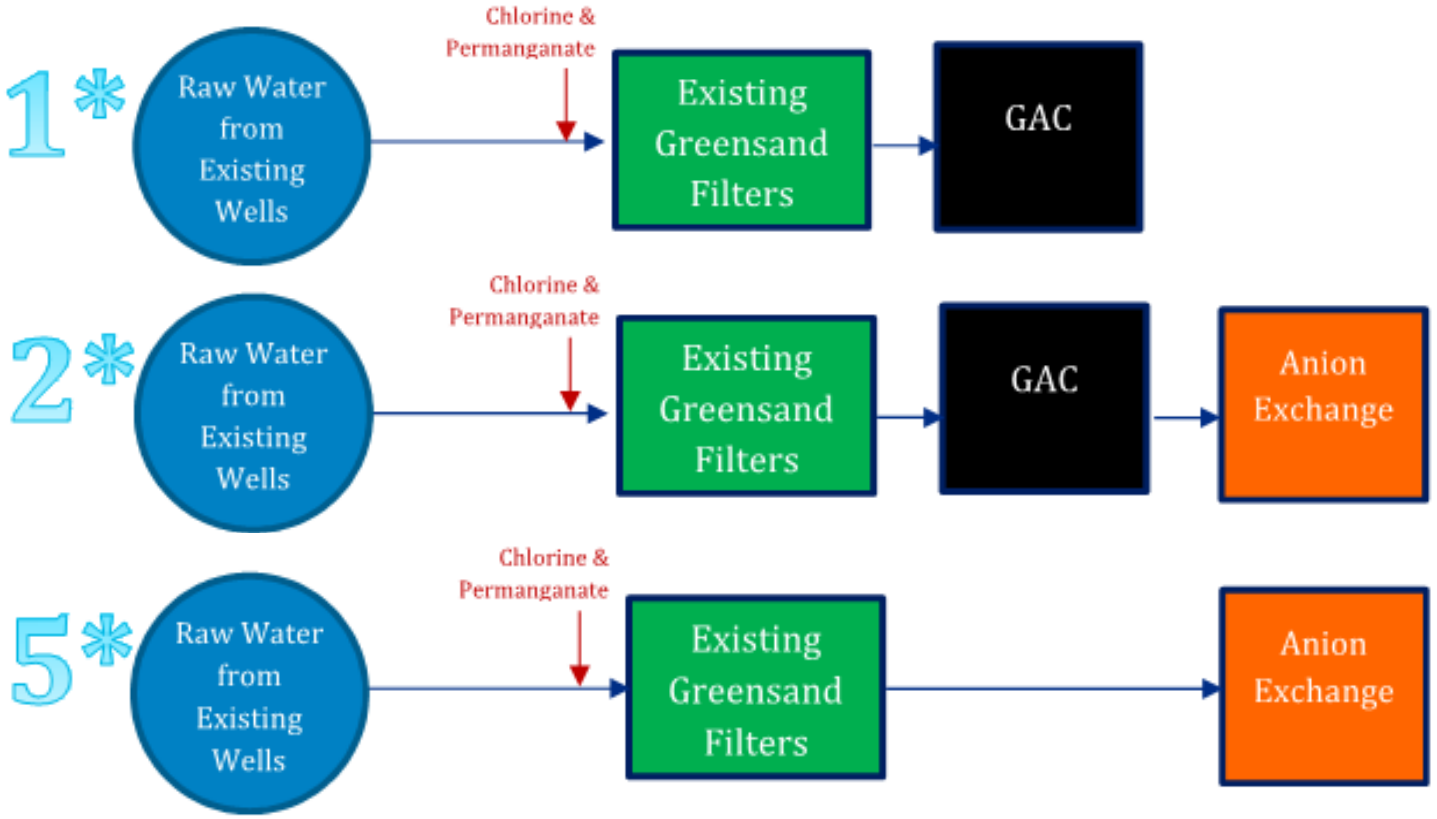


Membrane

- ✓ Water quality (e.g., low organic)
- ✓ Town's familiarity with pressure vessels
- ✓ No liquid waste stream of concern
- ✓ Comparatively lower cost (vs. membrane)

Bench Scale Testing: GAC Versus AIX

- PFAS treatment process to be placed downstream of the existing greensand filters (post iron & manganese removal)



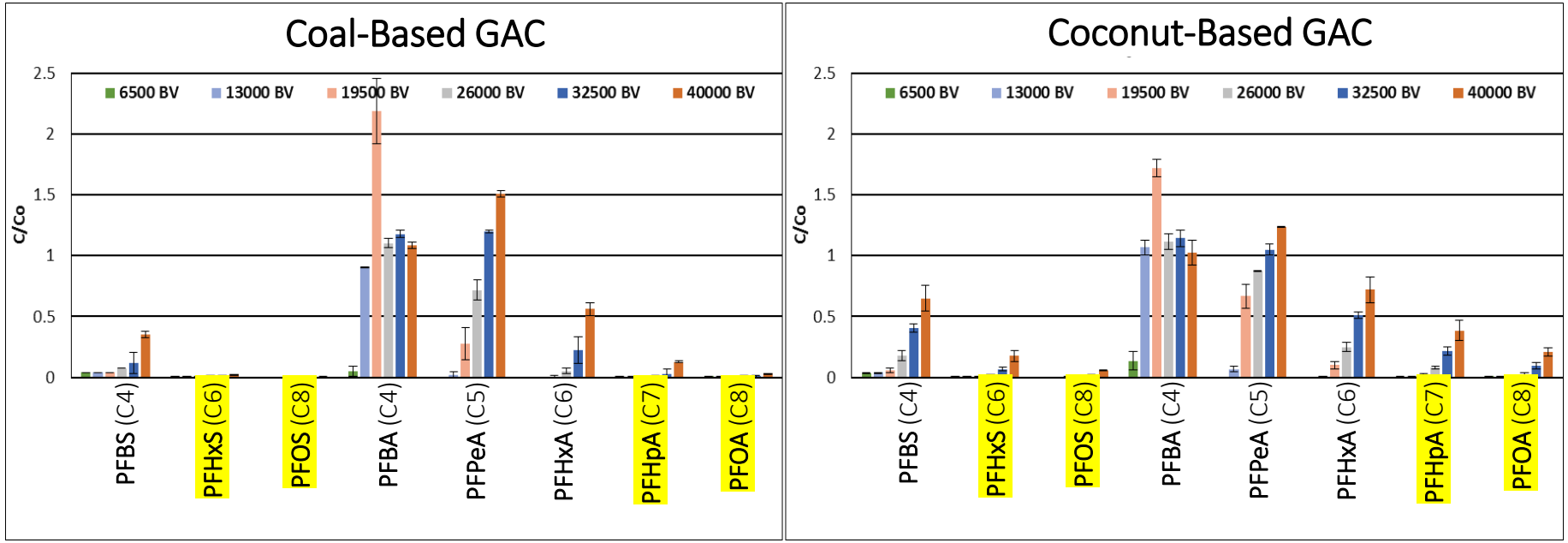
Bench Scale Testing: GAC versus AIX

Bench-scale testing to investigate:

- Two (2) GAC media
  - coal-based vs. coconut-based
- Two (2) AIX resin media
  - gel vs. macroporous
- GAC followed by AIX
- Impact of chlorine residual on AIX removal of PFAS

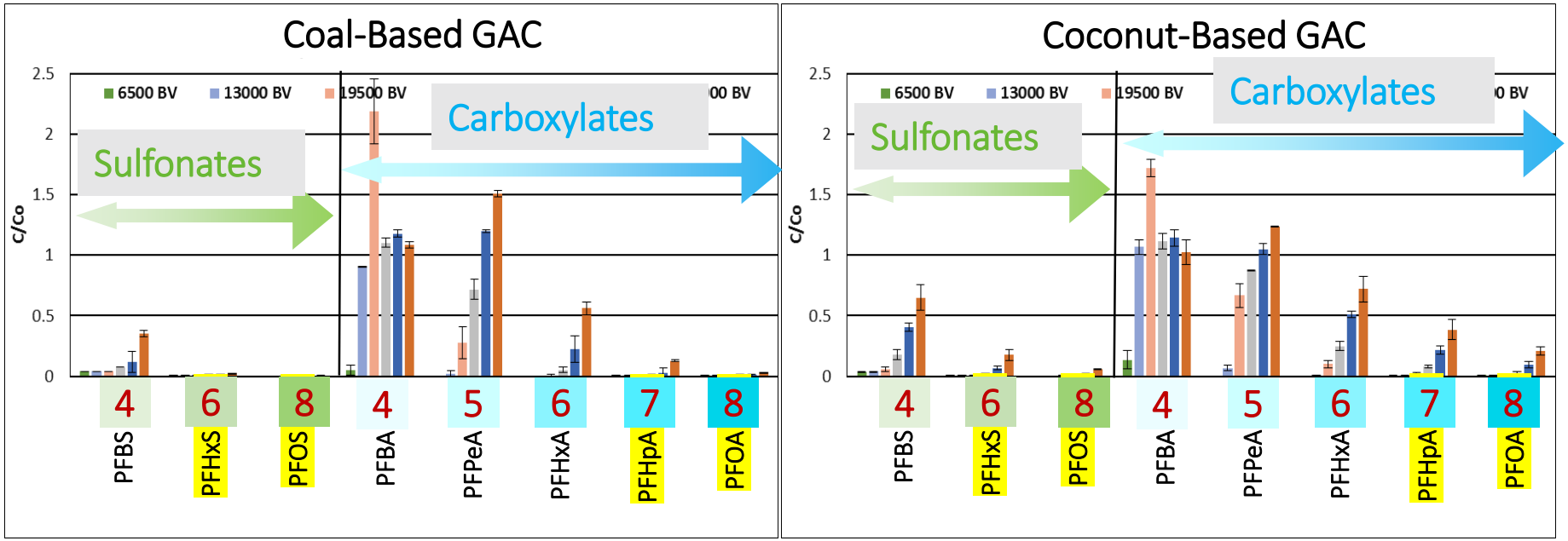
CDM Smith's Bellevue Laboratory, Washington

GAC



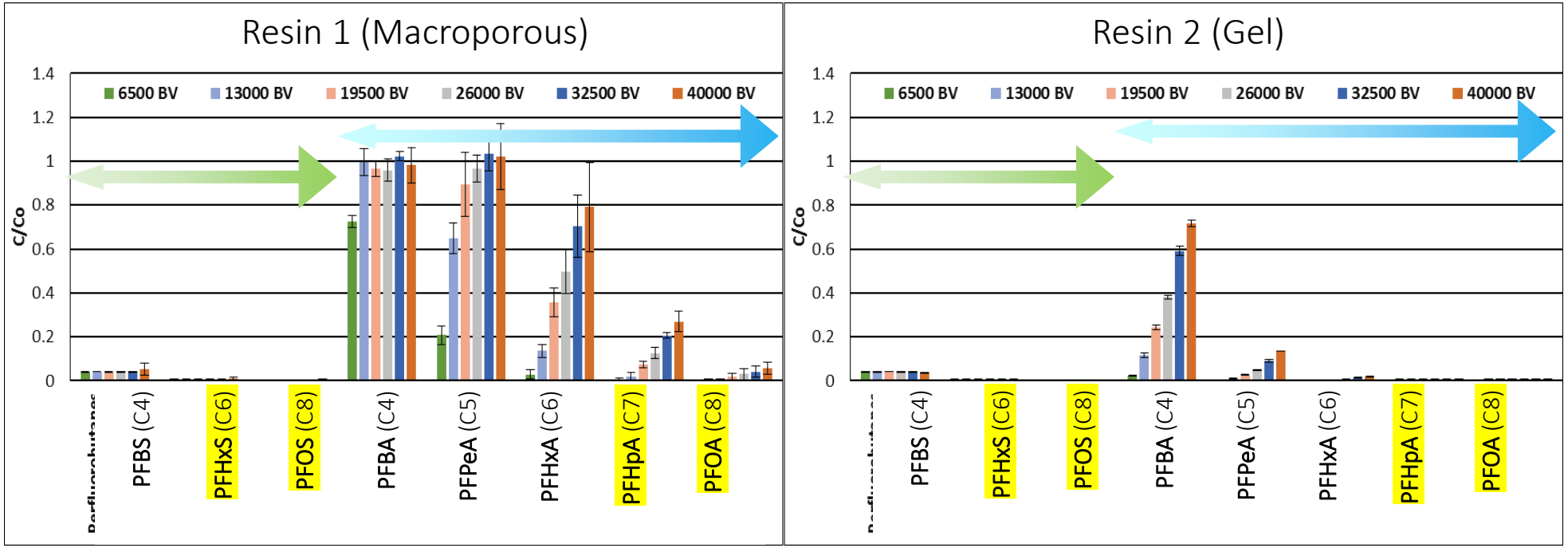
- Data in C/Co = final conc. / initial conc. = removal efficiency (lower C/Co = better removal)
- The two GAC products behaved similarly
- Better removal efficiency with sulfonates than carboxylates
- Better removal efficiency with longer chain compounds

GAC



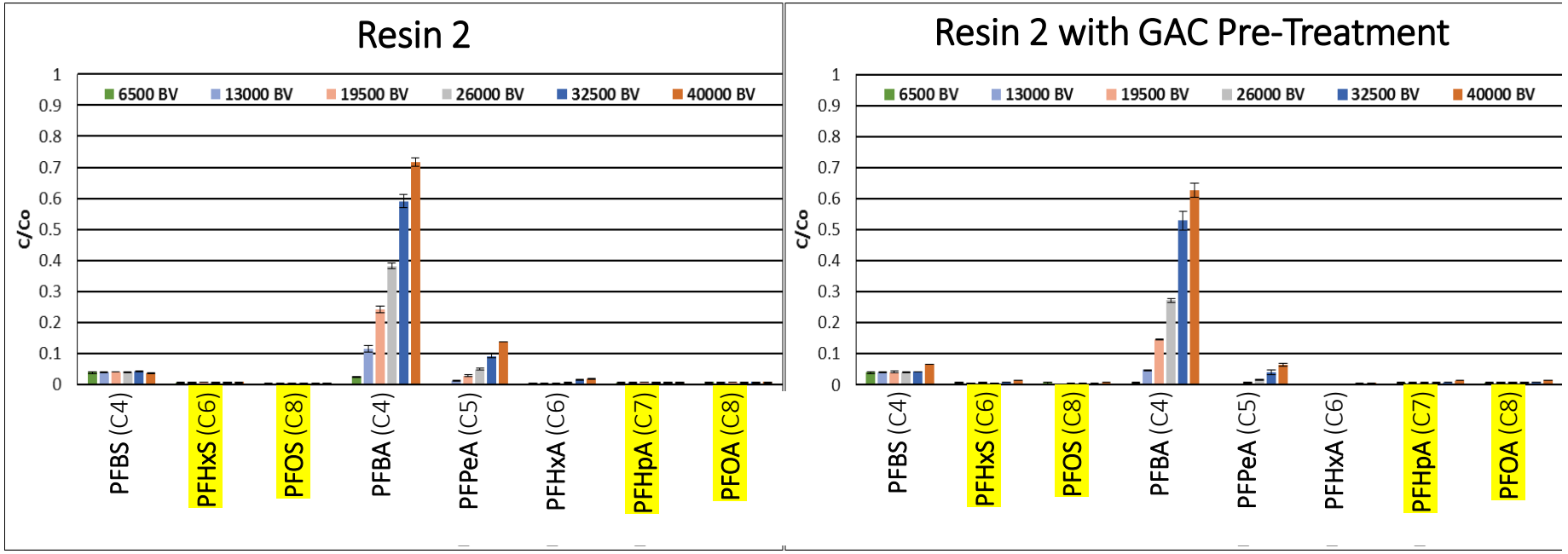
- Data in C/Co = final conc. / initial conc. = removal efficiency (lower C/Co = better removal)
- The two GAC products behaved similarly
- Better removal efficiency with sulfonates than carboxylates
- Better removal efficiency with longer chain compounds

AIX



- Resin 2 is specific for PFAS removal
- Significant differences in PFAS removal efficiency between the two resins tested
- **Harder to remove shorter chain carboxylates**

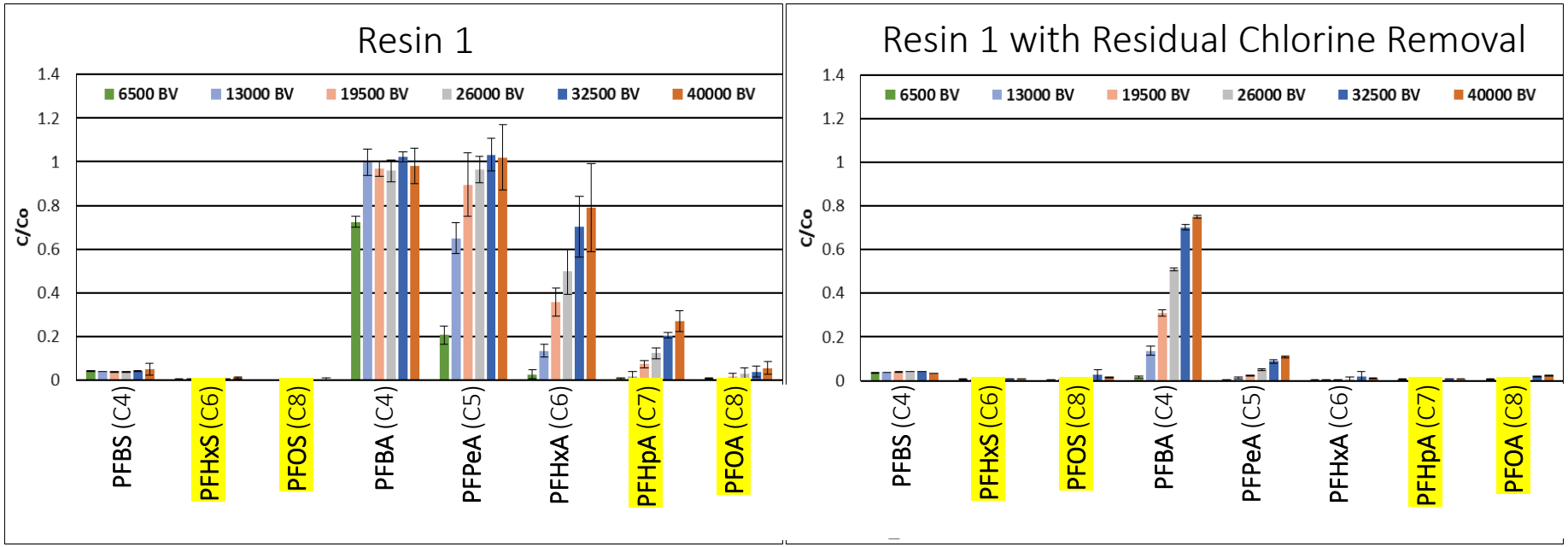
Effects of Pre-GAC Treatment



- Marginal improvement in AIX effectiveness by GAC pre-treatment upstream.

TOC = ~0.5 mg/L

Effects of Residual Chlorine Removal on AIX



- Chlorine residual in influent (0.2-0.5 mg/L) from the existing greensand filters
- Dechlorination with calcium thiosulfate resulted in enhanced PFAS removal efficiency

Chloride to Sulfate Mass Ratio (CSMR)

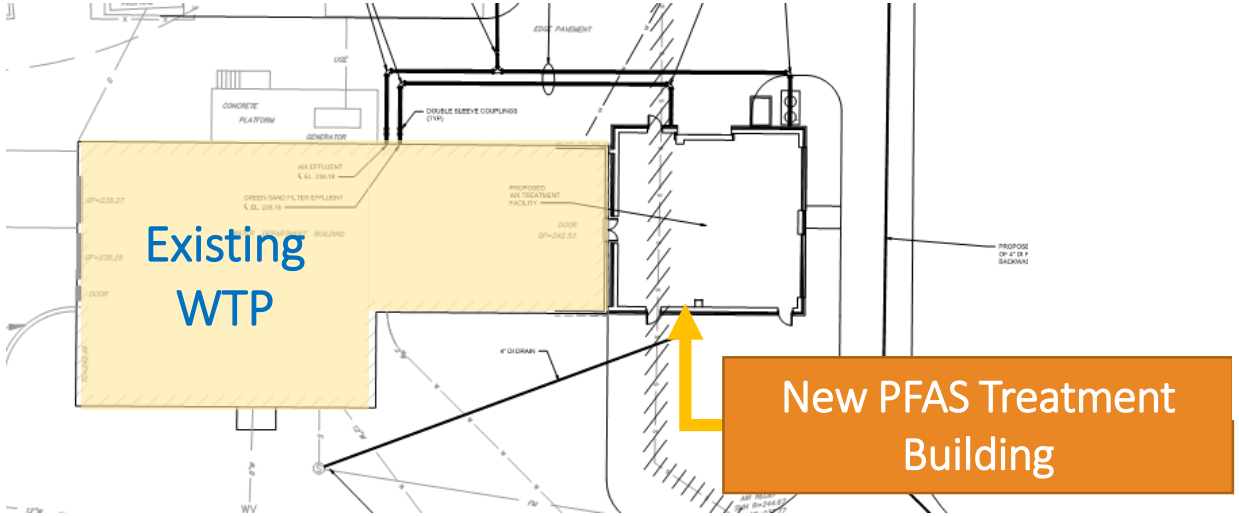
- Increased CSMR is associated with galvanic corrosion of lead solder connected to copper pipes
  - Raw water: **Average sulfate = 16.6 mg/L**
  - After 1,000 BVs:
    - Resin 1: sulfate = **6.4 mg/L**
    - Resin 2: sulfate = **16.6 mg/L**
  - After ~30,000 BVs:
    - Both Resin 1 and Resin 2 at the raw water sulfate level

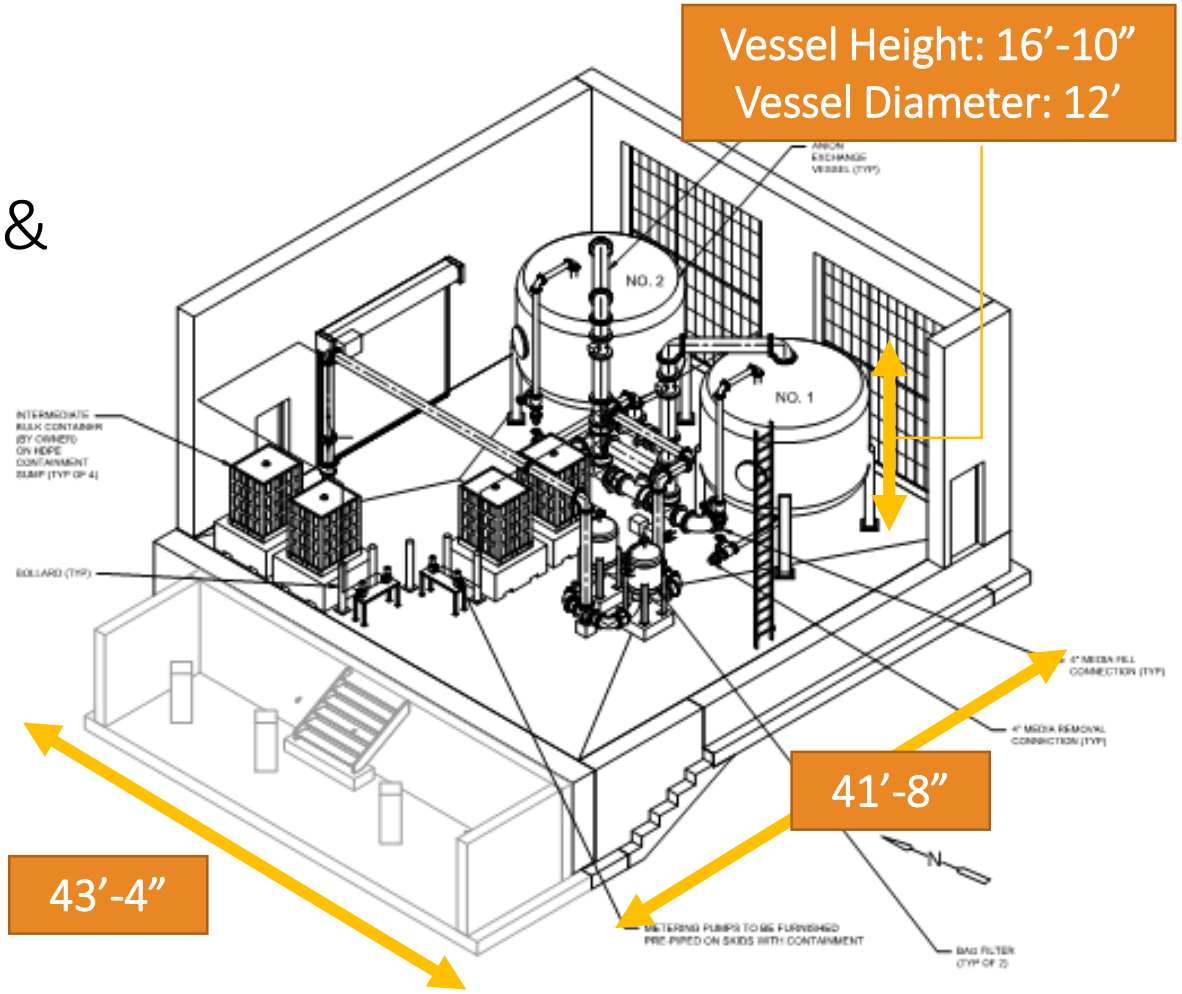
$$CSMR = \frac{Chloride}{Sulfate}$$

Scenario	CSMR
Current	7.7
After 1000 BVs – Resin 1	20
After 1000 BVs – Resin 2	7.7

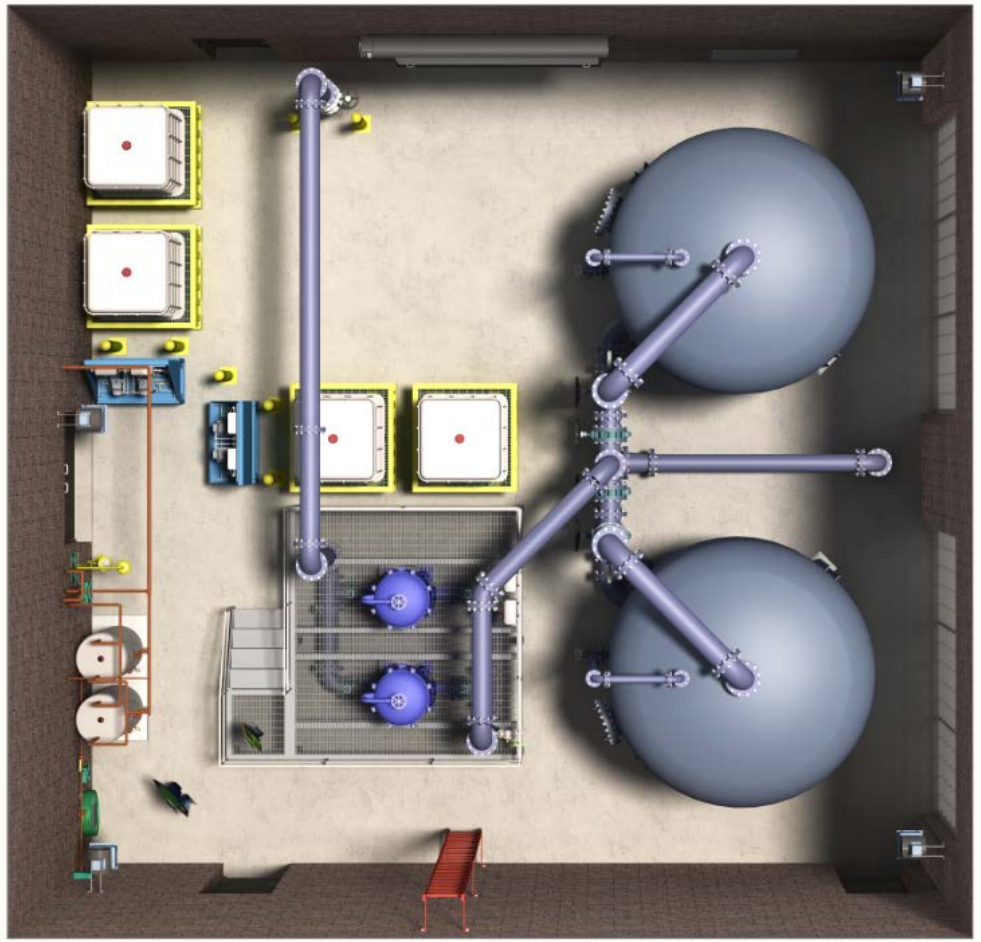
New PFAS Treatment Facilities

- AIX for PFAS Removal
- Calcium thiosulfate for dechlorination & bag filters prior to IX
- Zinc orthophosphate for improved corrosion control





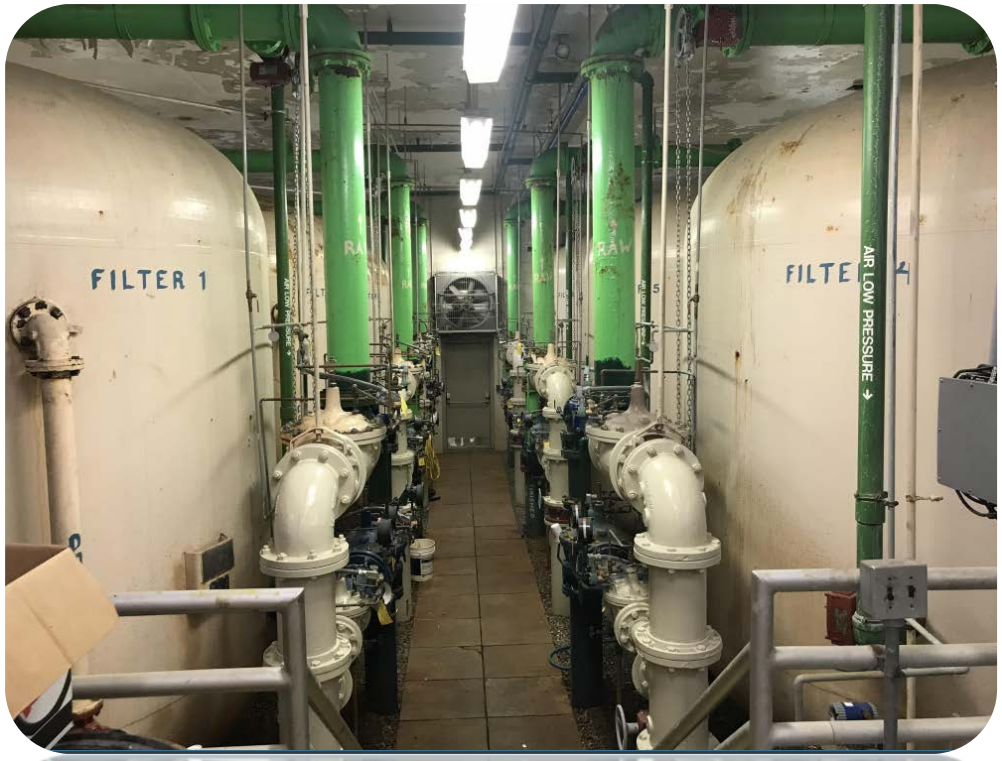
Approximately 1,800 ft^2



Construction Cost: $3.1M

Spectacle Pond WTP

- MassDEP's health advisory of 20 ppt anticipated
- Testing and design of AIX facility
- Beginning preliminary design process to evaluate process, costs, schedules
- Need to vote funding at Fall Town Meeting
- Working with MassDEP Waste Site Clean-up to identify responsible party (not Ft. Devens)



Point of Use (POU) Filter Testing

- POU home faucet filter system testing
  - At WTP vs. in distribution system
  - Cold water vs. hot water
  - Continuous use vs. normal residential use
- Monitoring PFAS, volume, and various water quality parameters
- Preliminary cold water testing results showed significant impact on capacity with chlorine residual

Mark Wetzel, P.E.

Where We Are Now

- April 2019 – sent out second public notice
- Installing temporary GAC treatment for GP Well 8
- Working with US Army to fund treatment and O&M (thank you EPA Region 1 and Senator Warren)
- Outdoor water ban (not popular)
- Continue to provide regular updates to the town officials, website and Facebook posts
- Personal response to residents questions
- Ayer cannot meet 20 ppt without treatment at Spec Pond Wellfield

Takeaways & Summary

- Water suppliers need to be provided with public talking points
- Need a better understanding of short- and long-term health effects
- State PFAS Response Team needed instead of case-by-case response, and regulatory “moving target” provides challenges to implementing solutions.
- PFAS actions may create other water quality issues
- Many considerations factor into PFAS treatment selection & placement
- Pre-design study is critical in determining treatment selection and compatibility with the existing treatment

Acknowledgement

- Town of Ayer DPW
  - Dan Van Schalkwyk, P.E.
- MassDEP Central Region
- CDM Smith team
  - Lisa Gove, P.E., BCEE
  - Alan LeBlanc, P.E., BCEE
  - Charles Schaefer, Ph.D.

Contact us!

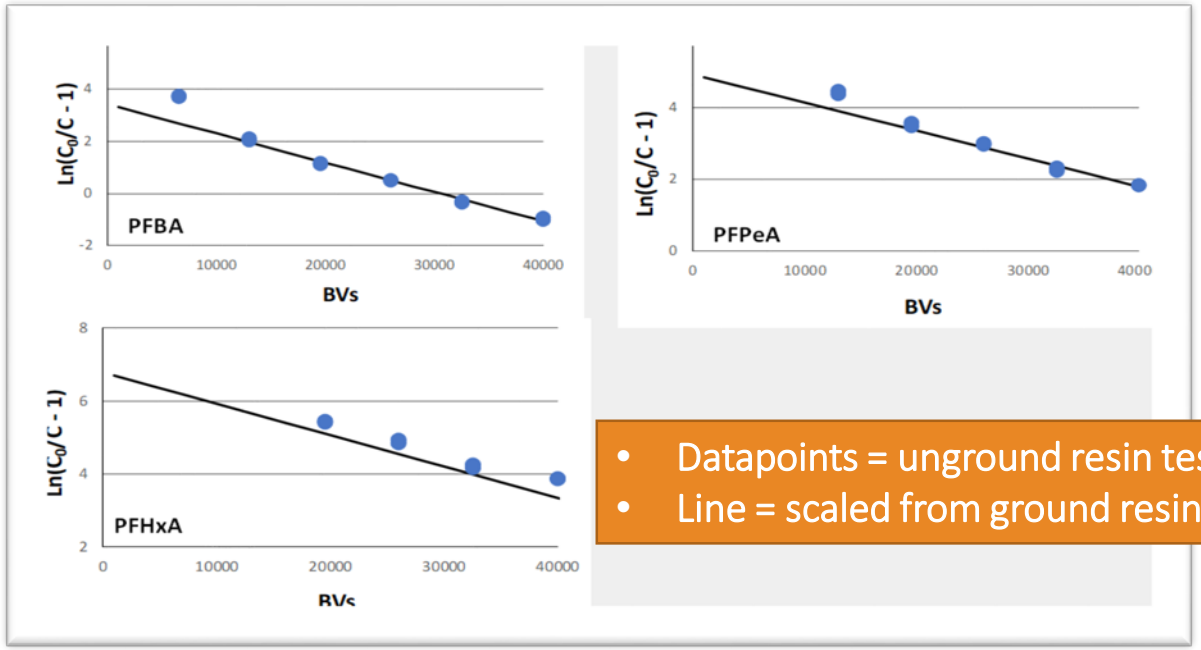
Ji Im, P.E.
603-222-8356
imj@cdmsmith.com
@Jihyon_Im

Mark Wetzel, P.E.
978-772-8240
mwetzel@ayer.ma.us
@dpwsupt

Water Partnership with CDM Smith

Learn more about the water partnership at cdmsmith.com/water and @CDMSmith

Validating Use of RSSCTs for PFAAs on AIX



- Datapoints = unground resin testing
- Line = scaled from ground resin data

Rapid Small Scale Column Testing (RSSCT)

$$\frac{EBCT_G}{EBCT_U} = \left(\frac{d_G}{d_U}\right)^2$$

constant diffusivity for scaling

Transport Eqn. (Thomas Model):

$$ln\left[\frac{C_0}{C} - 1\right] = \left(\frac{kmq_0}{Q}\right) - [EBCT]kC_0BV$$

where q0 scales with r-0.5 to account for surface sorption

- RSSCT, assuming constant diffusivity and coupled with the Thomas model, were effective for scaling PFAS removal with ground AIX resin.
- Demonstrated that RSSCT can be used to effectively evaluate PFAA uptake on AIX in low TOC water