CSWEA WI 2022 GOVERNMENT AFFAIRS SEMINAR

PFAS IN WISCONSIN: DRINKING WATER

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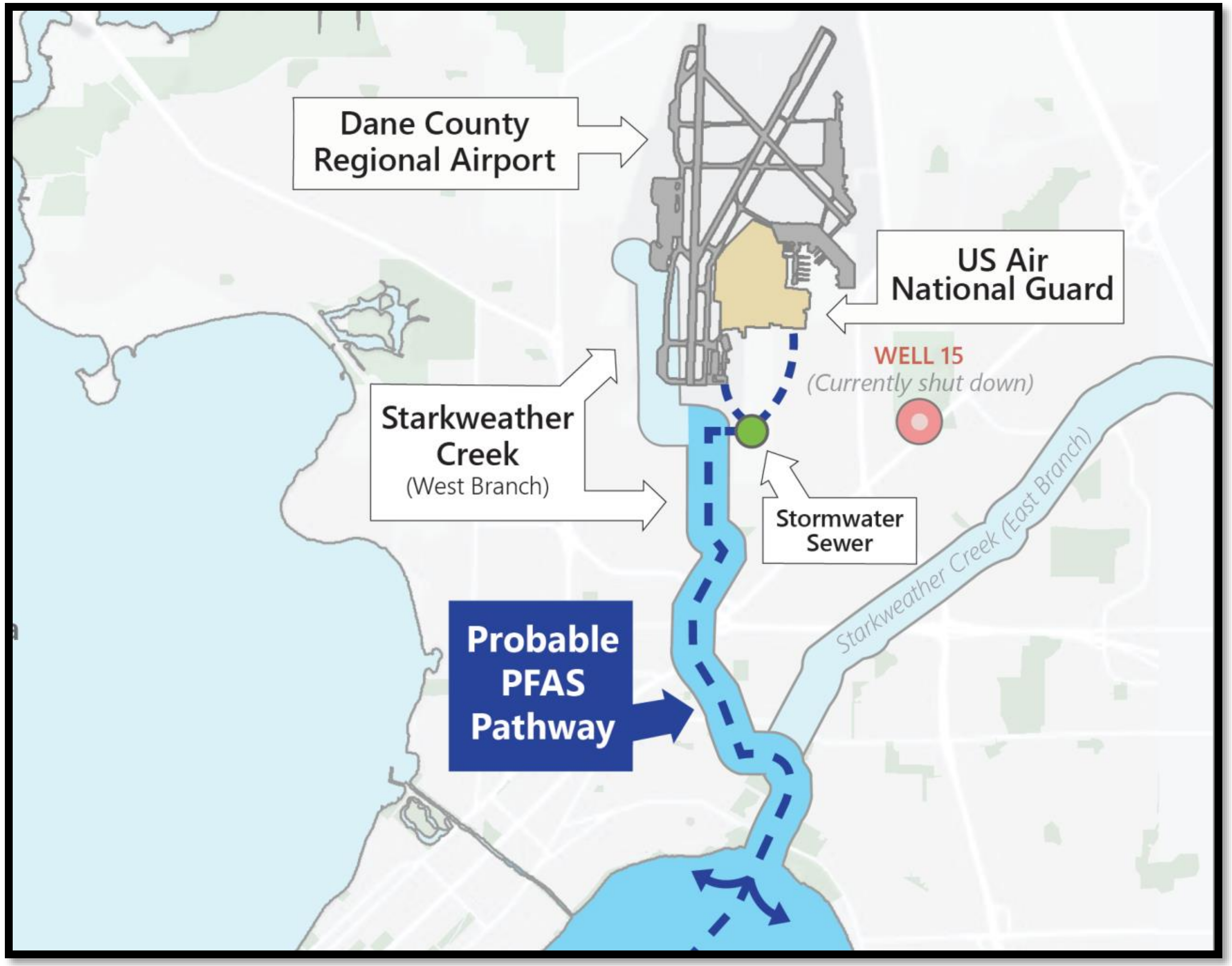
PFAS BACKGROUND

BACKGROUND: *PFAS OVERVIEW*

- Class of chemically similar human-made substances
- Present in consumer products
- Repel oil, water, and grease
- “Forever chemicals”

BACKGROUND: *PFAS OVERVIEW*

- Ubiquitous
- Persistent
- Mobile
- Bio-accumulative
- Toxic at low levels



BACKGROUND: *PFAS IMPACT ON HUMAN HEALTH*

Madison Water Utility

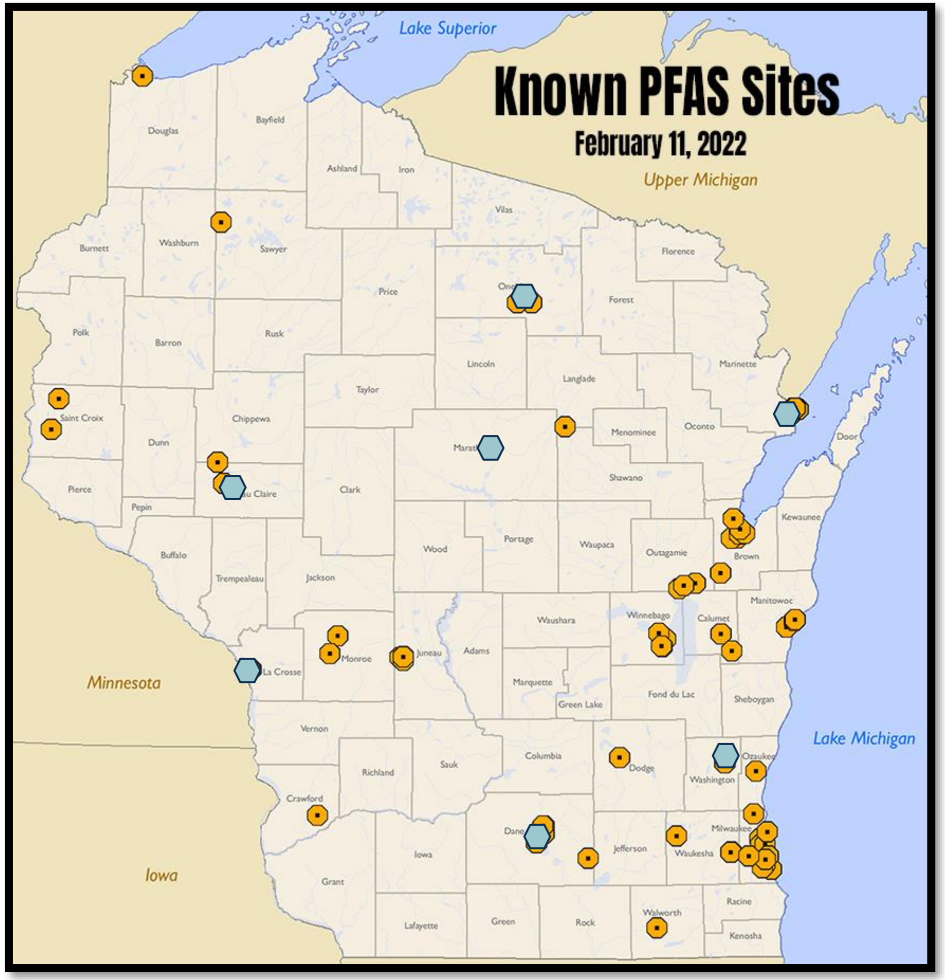
Research in People

- Increased risk of thyroid disease
- Decreased fertility in women
- Increased risk of high blood pressure in pregnant women
- Lower infant birth weight
- Decreased response to vaccines
- Increased cholesterol levels

Research in Lab Animals

- Damage to liver and immune system
- Developmental delays
- Birth defects

BACKGROUND: PFAS IMPACTED SITES (WI)



Source: dnr.wisconsin.gov

Locations of known Wisconsin drinking water systems impacted by PFAS:

- La Crosse (French Island)
- Rhinelander
- West Bend
- Marinette / Peshtigo (private wells)
- Madison
- Eau Claire
- Wausau

REGULATIONS & GUIDANCE: DRINKING WATER

REGULATIONS & GUIDANCE: *PFAS TESTING*

	UCMR3* (2013 – 2015)	UCMR5* (2023 – 2025)
Water Systems Required to Test	All LARGE utilities (>10,000 people); representative sample of smaller systems	All LARGE utilities; all systems serving 3,300 to 10,000 people, some smaller systems (subject to funding and lab capacity)
Test Method	EPA Method 537	**EPA Method 537.1** and 533
Number of PFAS Tested	**PFOS**, **PFOA**, PFNA, PFHxS, PFBS, PFHpA	Twenty-nine PFAS
Reporting Limits (RL)	10 – 90 ng/L (parts per trillion, ppt)	2 – 20 ng/L
Water Systems with Detections > RL	3 of 94	**???**
Impacted WI Communities	Rhinelander, La Crosse, West Bend	**???**

**UCMR = Unregulated Contaminants Monitoring Rule (Cycles 3 & 5)*

REGULATIONS & GUIDANCE: *PFOA & PFOS*

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US Environmental Protection Administration (EPA)

- Provisional Health Advisory (2009): 400 ppt for PFOA and 200 ppt for PFOS
- Revised Health Advisory (2016): **70 parts per trillion for PFOA + PFOS**
- Proposed Rule (MCL) expected Fall 2022 & Final Rule in Fall 2023 *(PFAS Strategic Roadmap)*

WI Department of Natural Resources (DNR)

- Proposed a Maximum Contaminant Level (MCL): **20 parts per trillion for PFOA + PFOS**
- Natural Resources Board to consider proposed rule on 2/23/22

REGULATIONS & GUIDANCE: *OTHER PFAS*

WI Department of Health Services (DHS)

- Recommended groundwater standards for 16 additional PFAS (18 total including PFOA & PFOS)
- Recognizing the potential cumulative risk associated with exposure to a mixture of PFAS; recommend a **Hazard Index (HI)** approach that takes into account relative toxicity of individual PFAS

Sample Calculations:

PFAS	Guidance (ppt)	Source #1	HI Contribution #1	Source #2	HI Contribution #2
PFOA + PFOS	20	12	0.60	18	0.90
PFBA	10,000	100	0.01	18	<0.01
PFHxS	40	6	0.15	18	0.45
		Total: **118**	**HI: 0.76**	Total: **54**	**HI: 1.35**

- When the HI value equals or exceeds 1.0, DHS recommends “*bottled water or another safe alternative water source*” for drinking, preparing food or infant formula, and watering fruit/vegetable gardens

MADISON WATER UTILITY

MADISON WATER UTILITY: OVERVIEW

Water System Infrastructure:

22 Production Wells / Entry Points

- 1800 – 2400 gpm capacity
- >65 MGD total capacity
- Average daily pumping (2020): 24 MG
- Maximum day (2021): 35 MG

32 Reservoirs/Water Tanks/Towers

- 42 million gallons of storage

30 Booster Pump Stations

904 Miles of Water Main

65,000 Service Connections

10 Pressure Zones

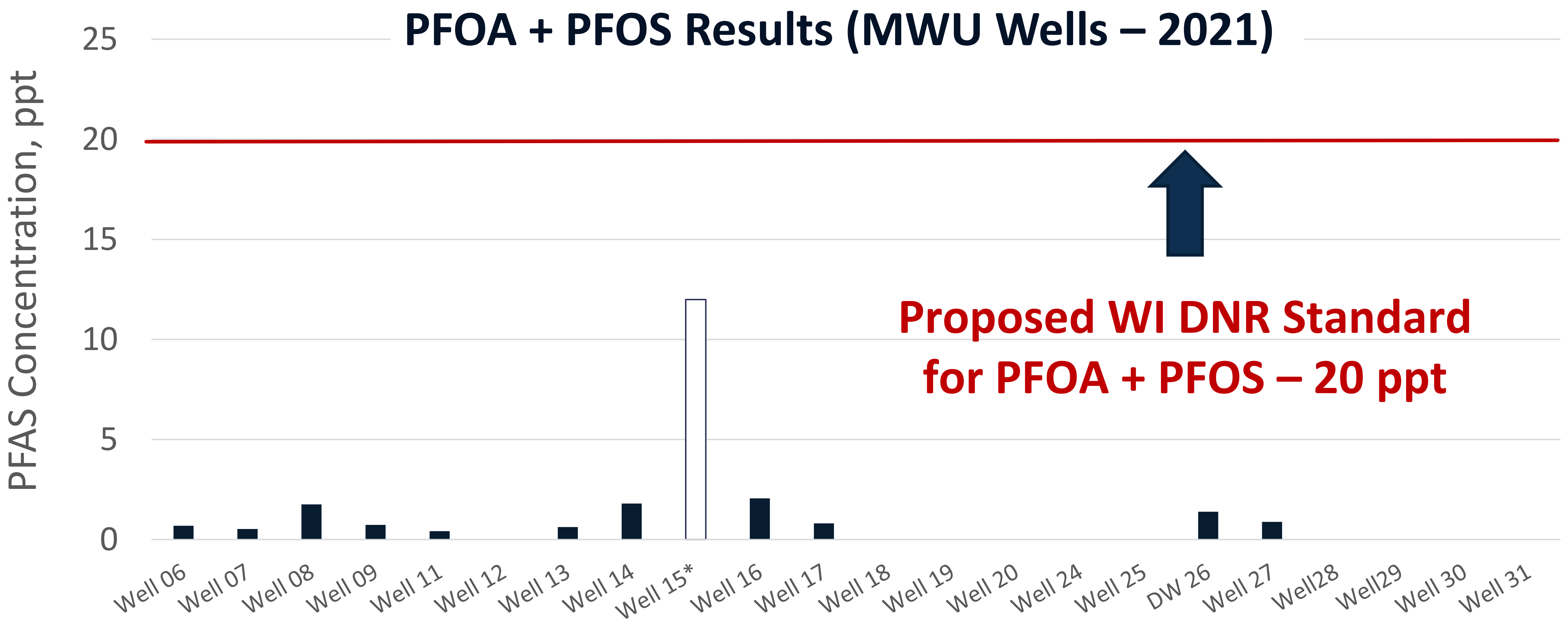
Employees, Customers & Budget:

Population Served:		270,000
Employees (FTE):		128
Annual Budget (2021):		
	Operating	$45.6 million
	Capital	$6.6 million

MADISON WATER UTILITY: RESULTS SUMMARY

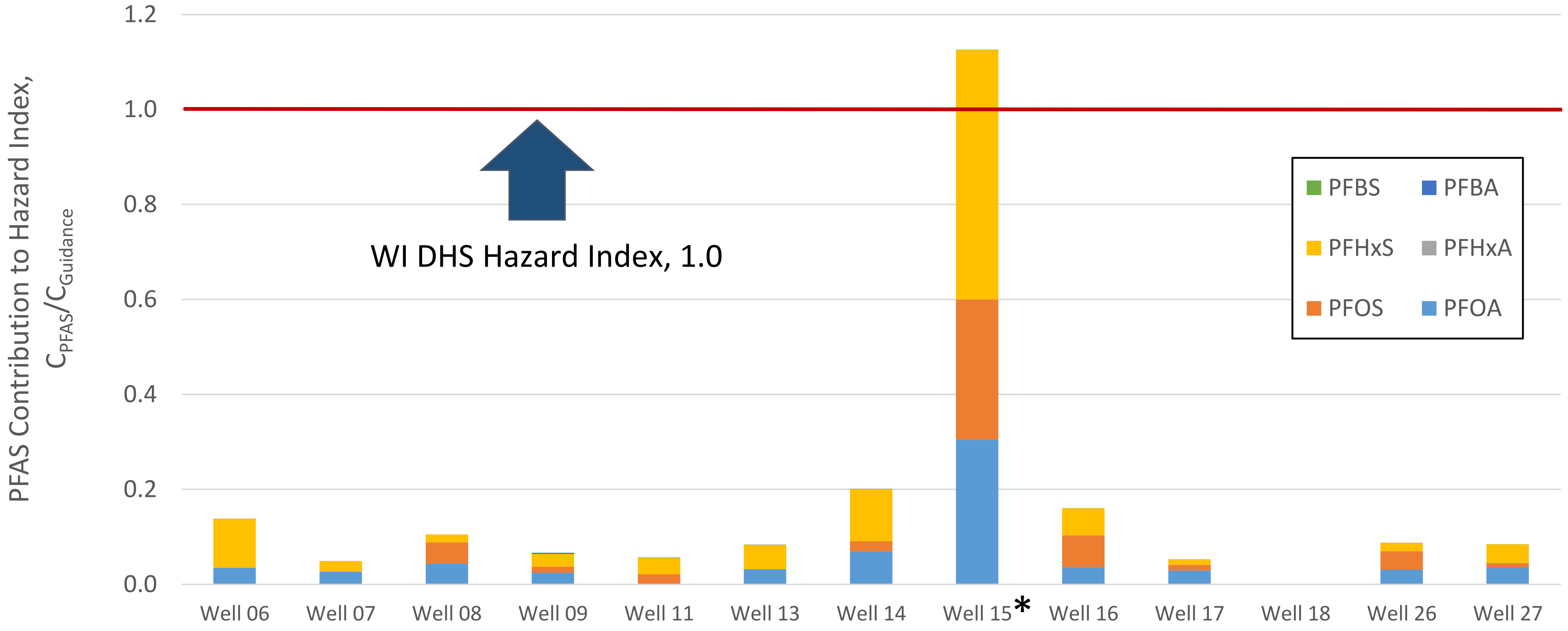
PFAS Tested	**33 PFAS**
2021 Detections	**10 PFAS**
MWU Wells With 1+ PFAS	**13 of 22 Wells**
MWU Wells PFAS – Non Detect	**9 of 22 Wells**

MADISON WATER UTILITY: 2021 PFAS RESULTS



* Currently shut down / out of service (data from 2019)

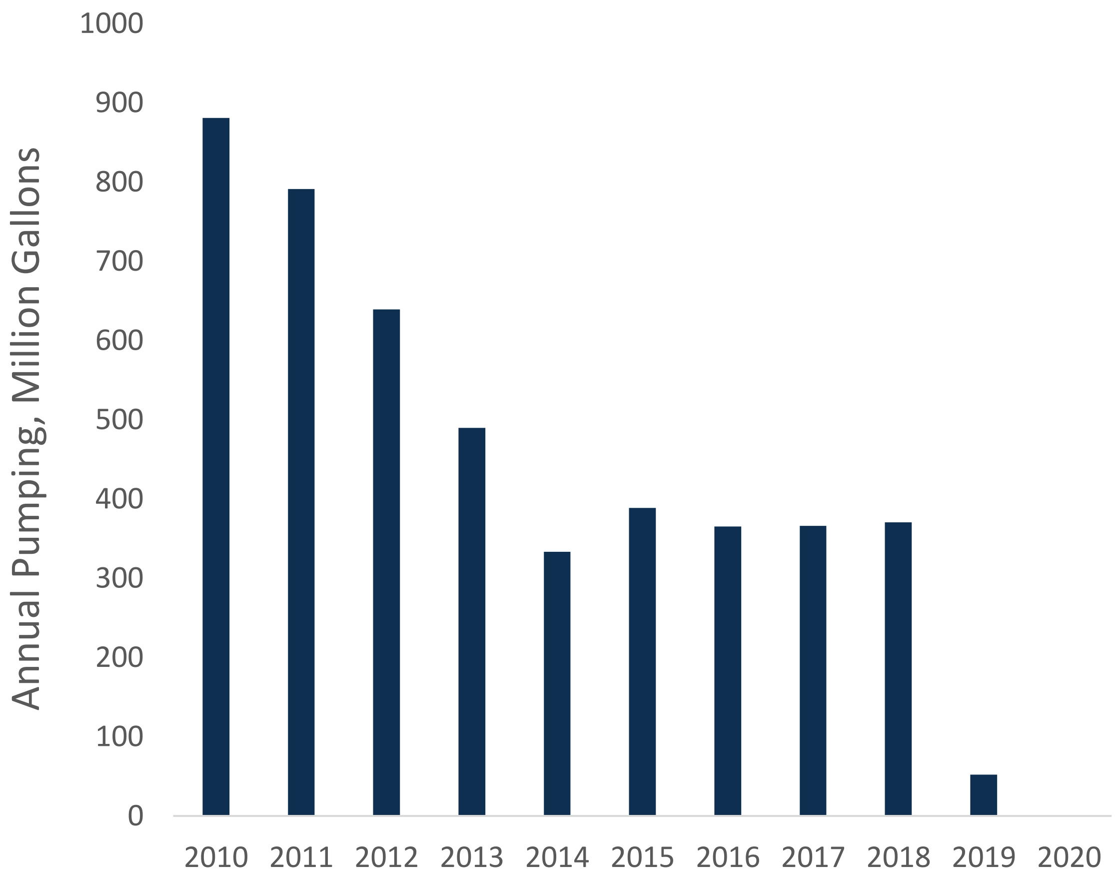
MADISON WATER UTILITY: HAZARD INDEX



Currently shut down / out of service

MADISON WATER UTILITY: MUNICIPAL WELL #15

- Constructed in 1965
- Workhorse on Madison's Eastside
  - Pumping capacity – 3 MGD
  - Up to 1 billion gallons per year
- History of organic contaminants
  - Volatile organics – PCE & TCE
  - 1,4-Dioxane (2013)
  - PFAS (2017)
- Air Stripper installed in 2013 ($2.3M)
- Well shut down in early 2019 (PFAS)



FEASIBILITY STUDY – WELL #15

FEASIBILITY STUDY: TREATMENT OPTIONS

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- Adsorptive Media
  - Granular Activated Carbon (GAC)
  - Ion Exchange (IX)
- Membrane Filtration (RO)
- Advanced Oxidative Processes

Treatment Method	Potential Removal[1]	Costs	Considerations	
			Pros	Cons
Activated Carbon	PFOA: 40-99% PFOS: 18-98% PFBA: 99% PFBS: 98% PFHxA: 95% PFHxS: 90% PFHpA: 90% PFHpS: 82% PFNA: 93%	$$	• Widely used for PFAS removal, high removal rates possible • Powder activated carbon is useful for responding to spills or as a potential low-capital cost solution.	• Lower removal rates for perfluoroalkyl acids and short-chain PFAS • Possibility of competitive adsorption with other compounds present, such as TOC • Low rate of adsorption in GAC may result in long mass transfer zones and adjustment of associated operating requirements • Requires thermal regeneration of GAC; regenerated GAC may not be as effective as virgin GAC • Creates waste residuals to dispose of exhausted carbon and potential opportunity for pollution
Anion Exchange	PFOA: 77-97% PFOS: 90-99% PFBA: 97% PFBS: 98% PFHxA: 97% PFHxS: 99% PFHpA: 94% PFHpS: 99% PFNA: 98%	$$	• Sorption rates depend on the resin and porosity • Can partially remove PFOA, PFNA, and PFOS • Resin can be specialized for specific PFAS and allows IX to have a higher capacity than activated carbon	• Costs are similar to activated carbon but depend greatly on resin and treatment system • Rate of exchange will depend on many factors, including influent PFAS concentration, design of the IX, solution ionic strength and bead material • Surface water supplies may need clarification/filtration before treatment • Range of efficacy for long and short-chain PFAS
Membrane Filtration	PFOA: 47-99% PFOS: 93-99% PFBA: 99.9% PFBS: 99.8% PFHxA: 99.2% PFHxS: 99% PFHpA: 99% PFHpS: 99% PFNA: 99%	$$$	• Excellent, broad spectrum removal of PFAS • Optimal for groundwater systems	• Brine management may be a challenge based on local and federal regulatory requirements. • High capital expense with high energy demands • Susceptible to fouling and may require pre-treatment • Reverse osmosis is more effective than nanofiltration for PFAS removal but generally requires higher operating costs

1. Potential removal rates are based on reported data from the EPA's Drinking Water Treatability Database for PFAS.

AWWA: Drinking Water Treatment for PFAS Selection Guide

FEASIBILITY STUDY: OBJECTIVES

Evaluate treatment alternatives & develop cost estimates to

- Restore production rate of 1000 gpm (50% capacity)
- Reduce total PFAS, PCE, & TCE each by >90%
- Eliminate the use of the air stripper

FEASIBILITY STUDY: APPROACH

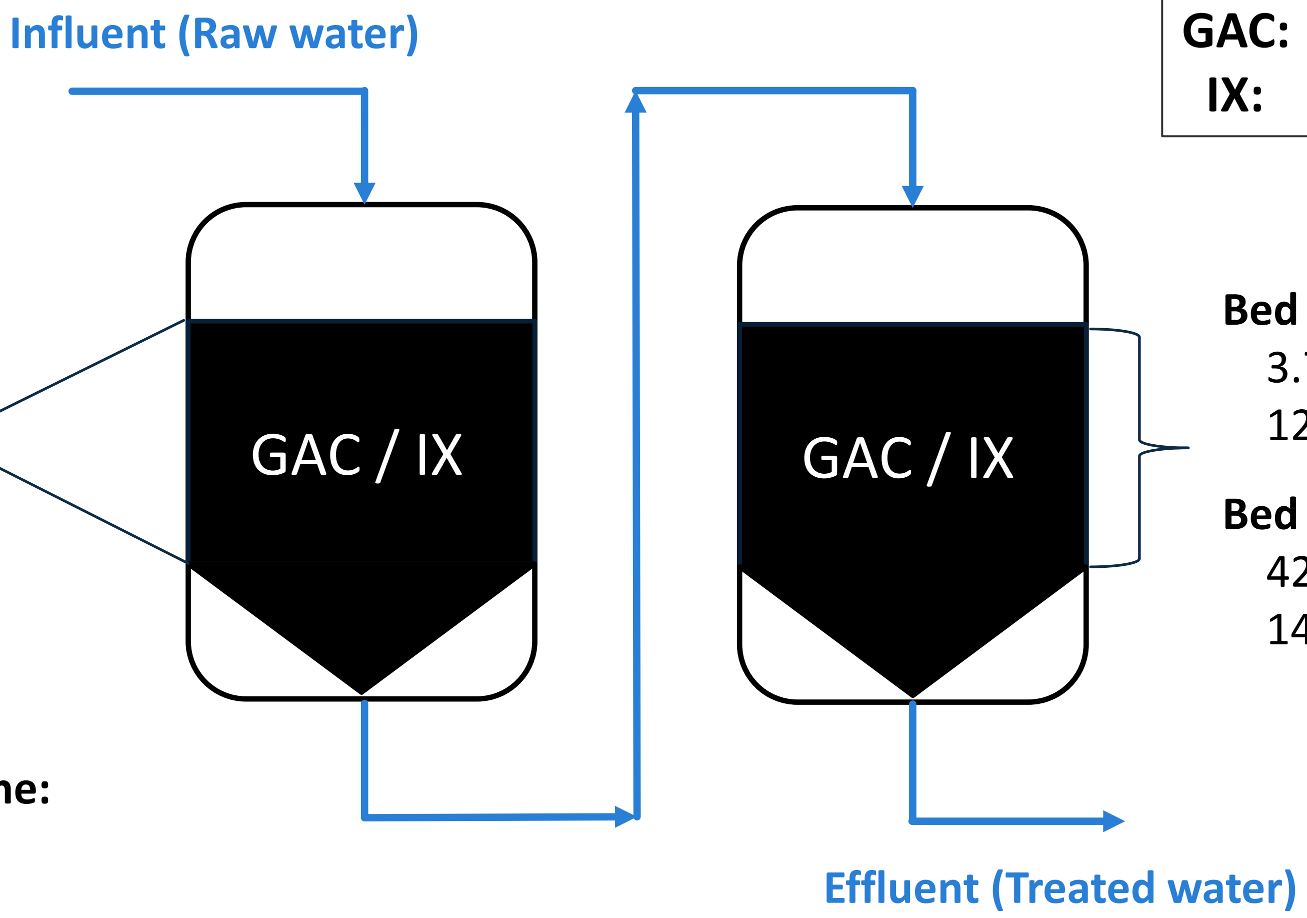
Perform Rapid Small-Scale Column Testing (RSSCT) on two **granular activated carbon (GAC)** media

Use computer modeling to assess predicted performance of **ion exchange (IX)** resin

FEASIBILITY STUDY: DESIGN PARAMETERS

GAC: granular activated carbon
IX: ion exchange resin

Media: GAC or IX



Bed Depth:
3.75 ft (IX) to
12.38 ft (GAC)

Bed Volume:
424 ft^3 (IX) to
1400 ft^3 (GAC)

Empty Bed Contact Time:
3.17 min (IX) to
10.47 min (GAC)

FEASIBILITY STUDY: GAC RESULTS

GAC removed **all PFAS** to below detectable levels for some time

- **>90% reduction** achieved for ~30,000 bed volumes (218 – 225 days; 315 MG)
- Fast breakthrough of short-chain carboxylic acid PFAS (PFBA & PFPeA)

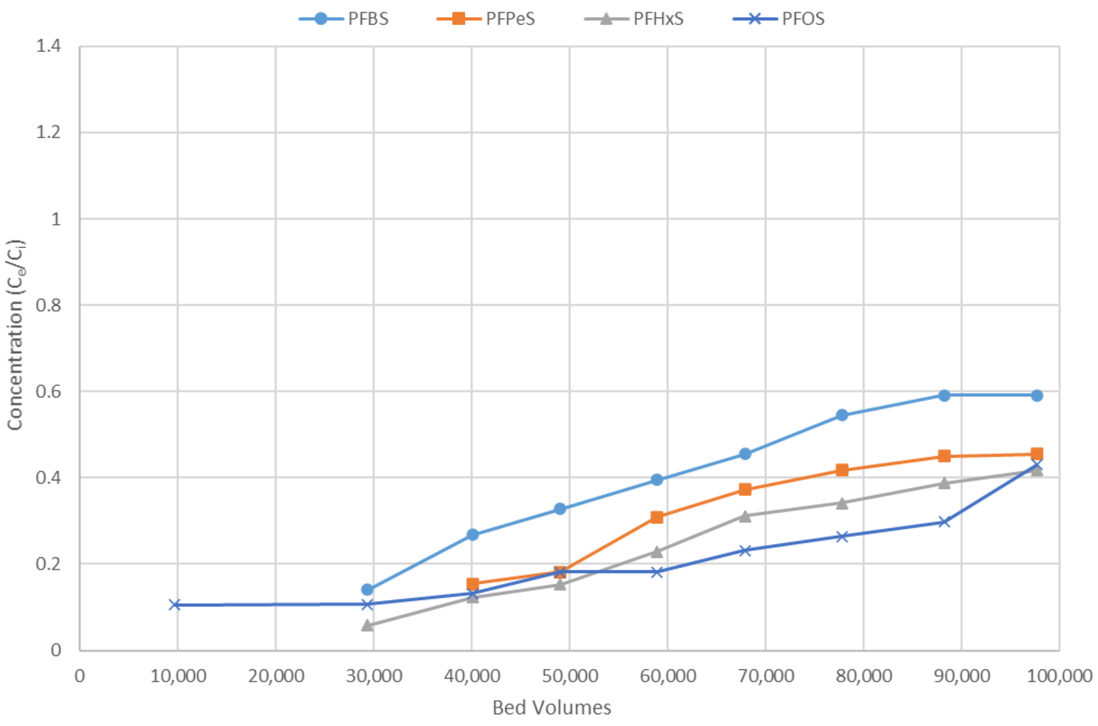
Removal of TCE & PCE to below detectable levels for duration of RSSCT

- 100,000 bed volumes = 1 billion gallons of treated water
- Equivalent to 2 years of treatment @ UW 15

FEASIBILITY STUDY: GAC RESULTS

Carboxylic Acids

Sulfonic Acids



Breakthrough Order: Carboxylic acids >> Sulfonic acids; Shorter chain >> Longer chain PFAS

FEASIBILITY STUDY: IX RESULTS

IX resin modeling predicts achievement of PFAS treatment objective:

- **>90% reduction** achieved for ~42,000 bed volumes (93 days; 133 MG)
- Overall performance limited by short-chain PFAS
- Unable to meet secondary objective (PCE & TCE removal)

FEASIBILITY STUDY: COST COMPARISON

Treatment Cost	GAC-1	GAC-2	IX
Equipment Capital Cost	$670,000	$875,000	$812,250
System Construction Cost	$155,000	$155,000	$115,000
Media Cost, $/cf	$53.93	$127.32	$434.79
Rebed Service Cost	$75,500	$178,250	$184,330
Annual O&M Cost	$136,000	$299,000	$733,000
Life Cycle Cost (50-year NPV)	**$4,664,000**	**$9,148,000**	**$20,169,000**

FEASIBILITY STUDY: COST COMPARISON

	Treatment Objective	Replacement Interval	Annual O&M	50-year Net Present Value
Primary	>90% reduction total PFAS	218 days	$136,000	$4,664,000
Alternative #1	Total PFAS < 20 ng/L	618 days	$54,000	$2,554,000
Alternative #2	PFOA & PFOS < 2 ng/L	720 days	$48,000	$2,400,000

NEXT STEPS FOR MADISON WELL #15

Madison Water Utility

Short-Term Practices

- Divert Water from an Adjacent Pressure Zone
- Public Education – Wise Use of Outdoor Water (Summer)

Long-Term Solutions

- Evaluate Alternative Options to Replace Lost Supply
  - Maintain Status Quo: Implement Water Restrictions During Dry Periods
  - Add Treatment (GAC) to Existing Well Site
  - Construct a Replacement Well Elsewhere
- Determine the Best and Most Cost-Effective Solution for Meeting Water Supply Needs on the Eastside

Questions/Comments?

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