PFAS: The CFPUA Experience

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Presentation Credits

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- **Ben Kearns**, Water Resources Manager
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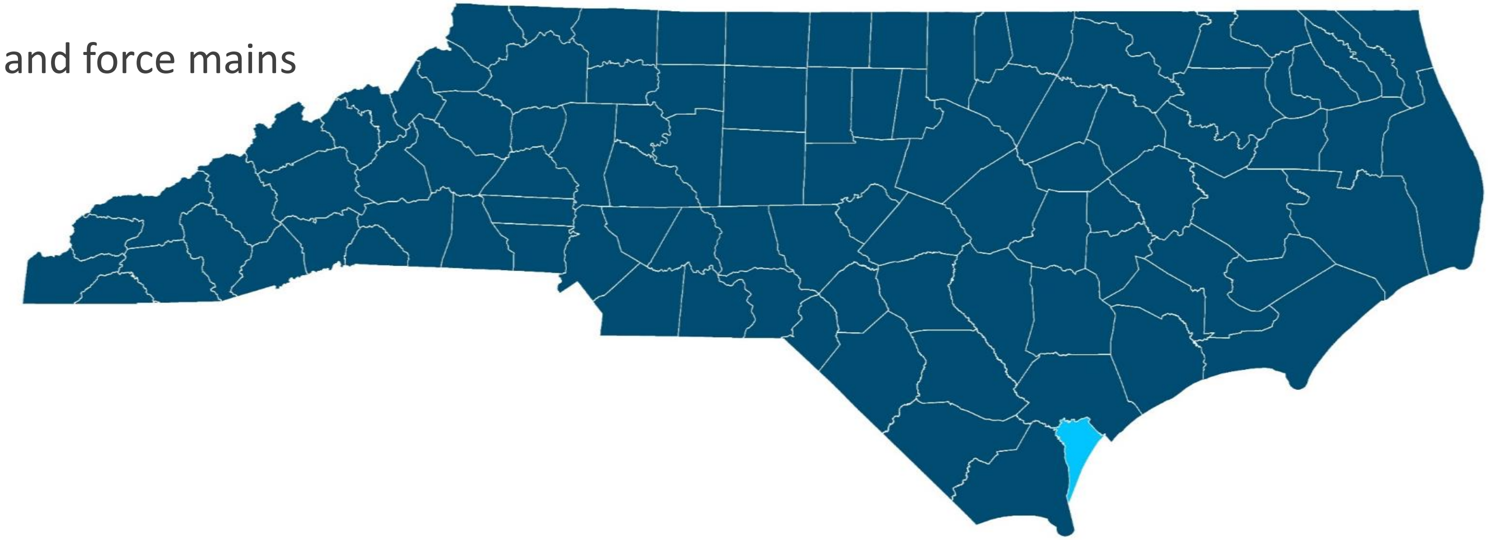
Cape Fear Public Utility Overview

Wastewater System

- 2 wastewater treatment plants
  - Northside: 16 MGD
  - Southside: 12 MGD
- 156 sewer pump stations
- 1,030+ miles of gravity sewer and force mains

Water System

- 2 water systems
  - 2 groundwater sources
  - 1 surface water source
- 2 water treatment plants
  - Sweeney: 35 MGD
  - Richardson: 7 MGD
- 1,100+ miles of water mains
- 10 storage tanks



Sweeney Water Treatment Plant

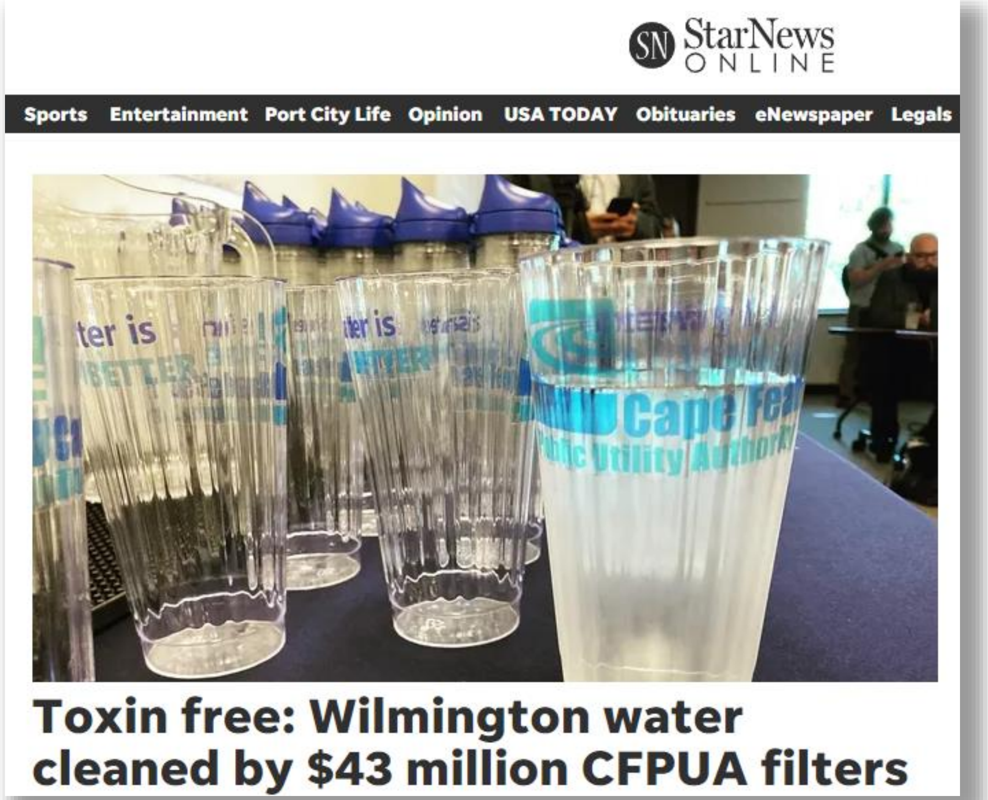
1. Raw Water Ozonation
2. Superpulsators
3. Intermediate Ozonation
4. Biofiltration with GAC
5. **Deep Bed GAC Contactors**
6. UV Disinfection
7. Finished Chemical Addition
8. Clearwells
9. High-Service Pump Station
10. Backwash and Residuals Handling

Sourcing Water from the Cape Fear

A Five-Year Odyssey…


Thursday, June 8, 2017
@starnewsonline
WILMINGTON, N.C.
StarNews
SPECIAL REPORT: TOXIC TAP WATER
Toxin taints CFPUA drinking water
From plant to pipes
Researchers have found chemicals made at the Fayetteville Works plant and used to make Teflon in the pipes of CFPUA's water system.

Wilmington StarNews front page, June 8, 2017


StarNews ONLINE
Sports Entertainment Port City Life Opinion USA TODAY Obituaries eNewspaper Legals
Toxin free: Wilmington water cleaned by $43 million CFPUA filters

StarNewsOnline Homepage, October 11, 2022

PFAS in the Cape Fear River: How we got here

June 2017 – Wilmington StarNews publishes article on GenX in the Cape Fear River.

November 2017 – State partially suspends Chemours' permit to discharge wastewater to the Cape Fear River, but levels of PFAS remain in raw water.

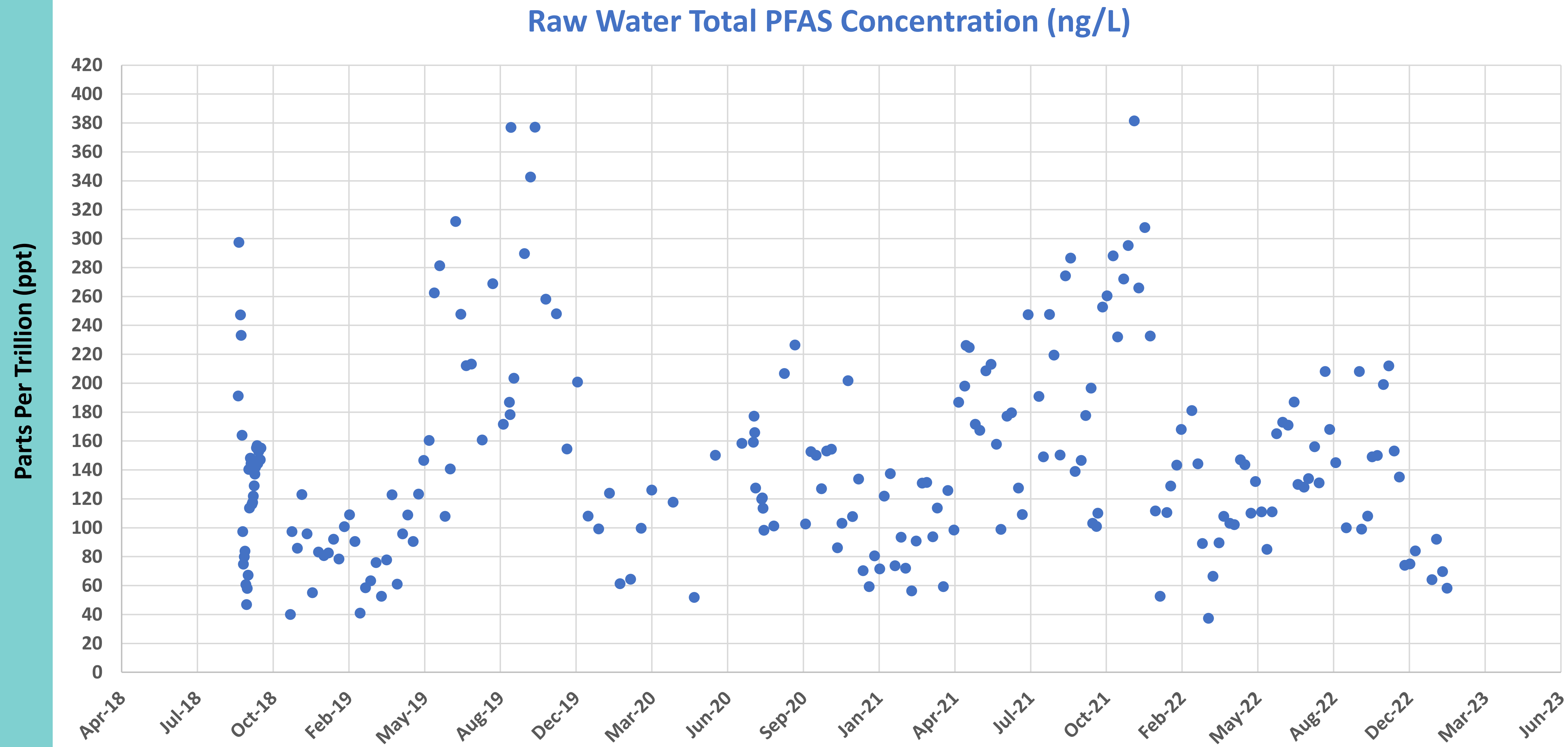
Sources of PFAS in the River:

- Groundwater at Chemours plant
- River sediment
- Air emissions

N.C. Department of Environmental Quality Consent Order

- Approved by judge February 25, 2019
- Requires additional controls at the Chemours facility
- Addresses only PFAS that NCDEQ and Chemours agree come from the plant

PFAS in the Cape Fear River



PFAS Solution Timeline

- News Story: PFAS — June 2017
- Study & Pilot Test — Aug 2017
- Design and Fund — Oct 2018
- Construct — Nov 2019
- Startup — Oct 2022

Dedication February 2023

Pilot Testing in 2017 and 2018

- Technologies Considered:
  - Granular activated carbon
  - Ion exchange
  - Reverse osmosis
- Operational Strategies
- Criteria for Full-Scale Design
- Considerations:
  - Removal rates
  - Environmental impacts
  - Cost and rate impacts

PFAS Treatment Non-Cost Considerations

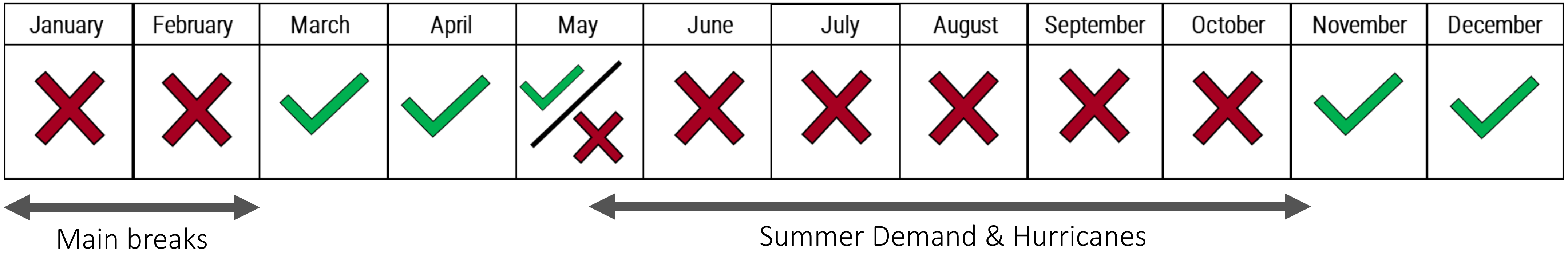
	Granular Activated Carbon	Ion Exchange	Reverse Osmosis
PFAS removal	Effective at PFAS reduction	Effective at PFAS reduction	Provides broad removal of all varieties of PFAS
Flexibility	Can be modified to adapt to changes in regulations	Limited flexibility	Limited flexibility because RO provides broad removal
Corrosion control	Consistent with existing corrosion-control program	Consistent with existing corrosion-control program	Requires additional treatment to prevent lead and copper corrosion
Environmental	Removes PFAS from the environment	Filter media must be disposed of; cannot be destroyed like carbon	Creates waste stream with concentrated PFAS levels to Cape Fear River (NPDES permit required)

PFAS Treatment Cost Considerations

	Granular Activated Carbon	Reverse Osmosis
2018 Capital Costs	$46 Million	$150 Million
Annual Operating Costs	$2.9 Million	$4.7 Million
Lifecycle NPV	$215 Million	$504 Million

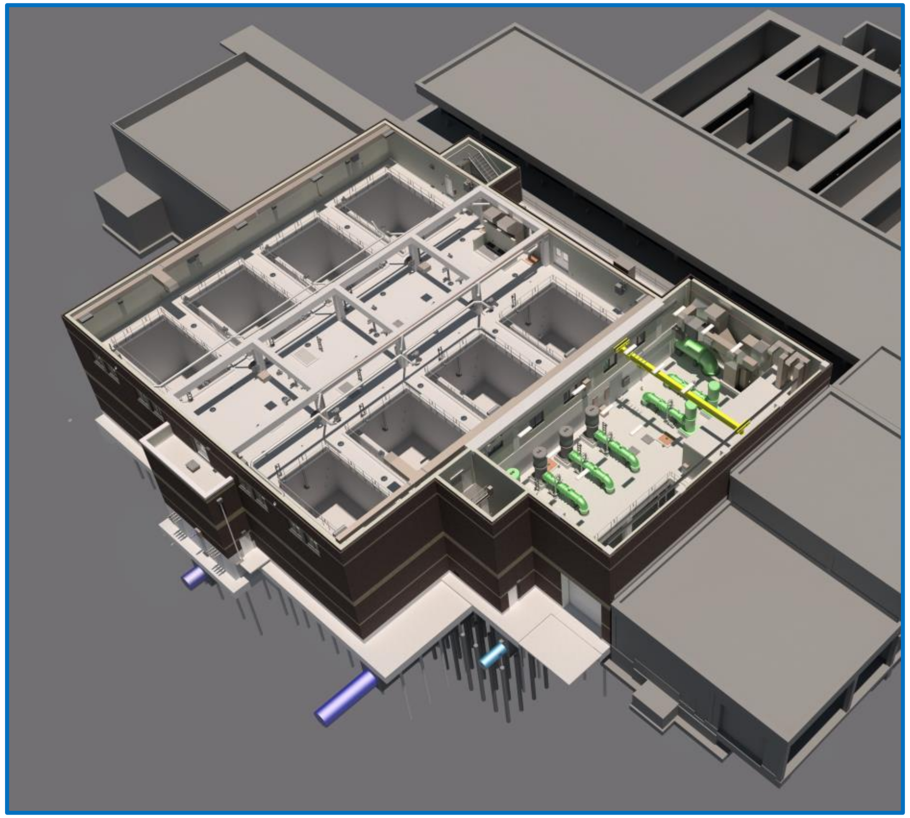
Interim PFAS Reduction Steps

- Utilize the 14 existing biological filters at Sweeney: periodically replace their biologically active GAC media with fresh GAC for short-term adsorption (2018-2022)
- Helped with temporary reductions (40% PFAS), but was not a long-term solution
- Existing biological filters were not designed to remove PFAS compounds
- Phased and staggered to ensure we retained the biological mode benefits
- It was not a permanent strategy because:
  - Narrow window for replacement, shown in green below
  - Impacted ability to remove other contaminants such as 1,4-Dioxane, a “likely carcinogen,” according to EPA

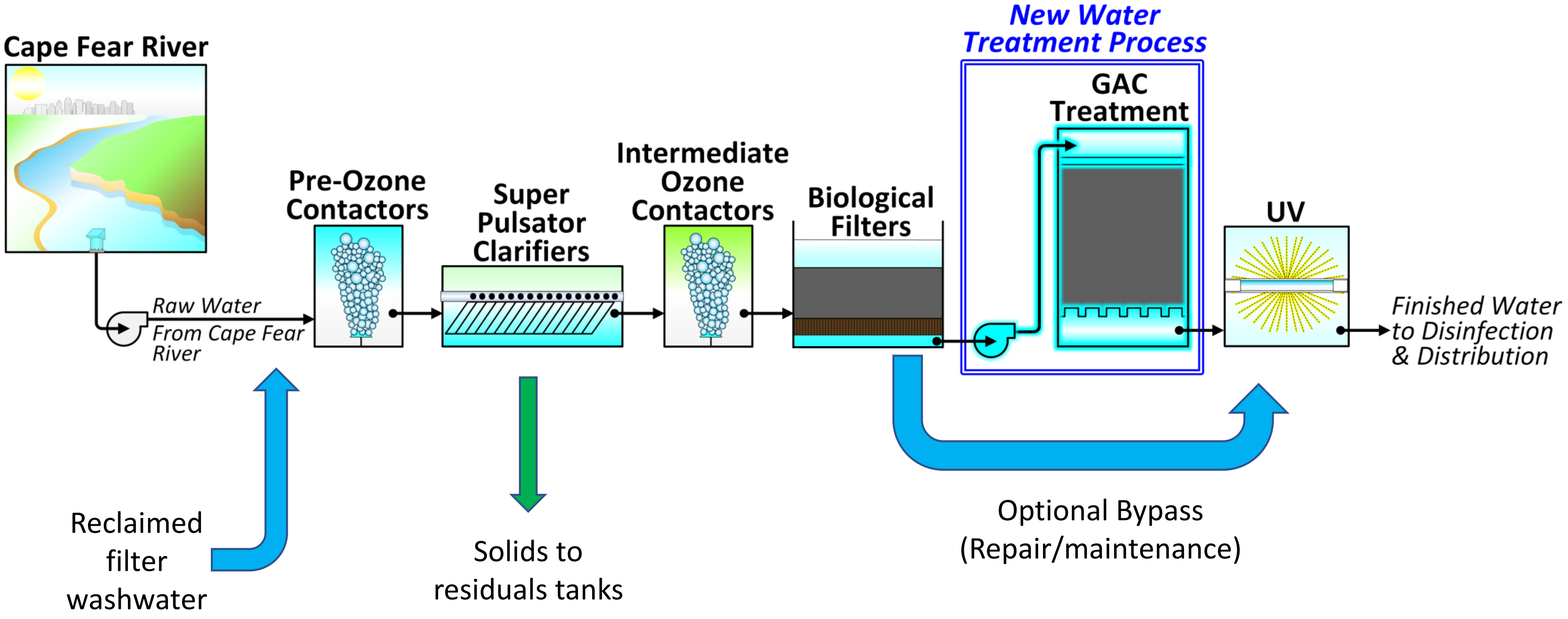


Design Summary

Granular Activated Carbon Contactor Design Summary	
Number of GAC Contactors	8
Design Flow Rate (each)	3,823 GPM
Type	Concrete Basin
Size (each)	22 x 38 feet
GAC Media Depth	12.5 feet
Contact Time at Design Flow	20 minutes

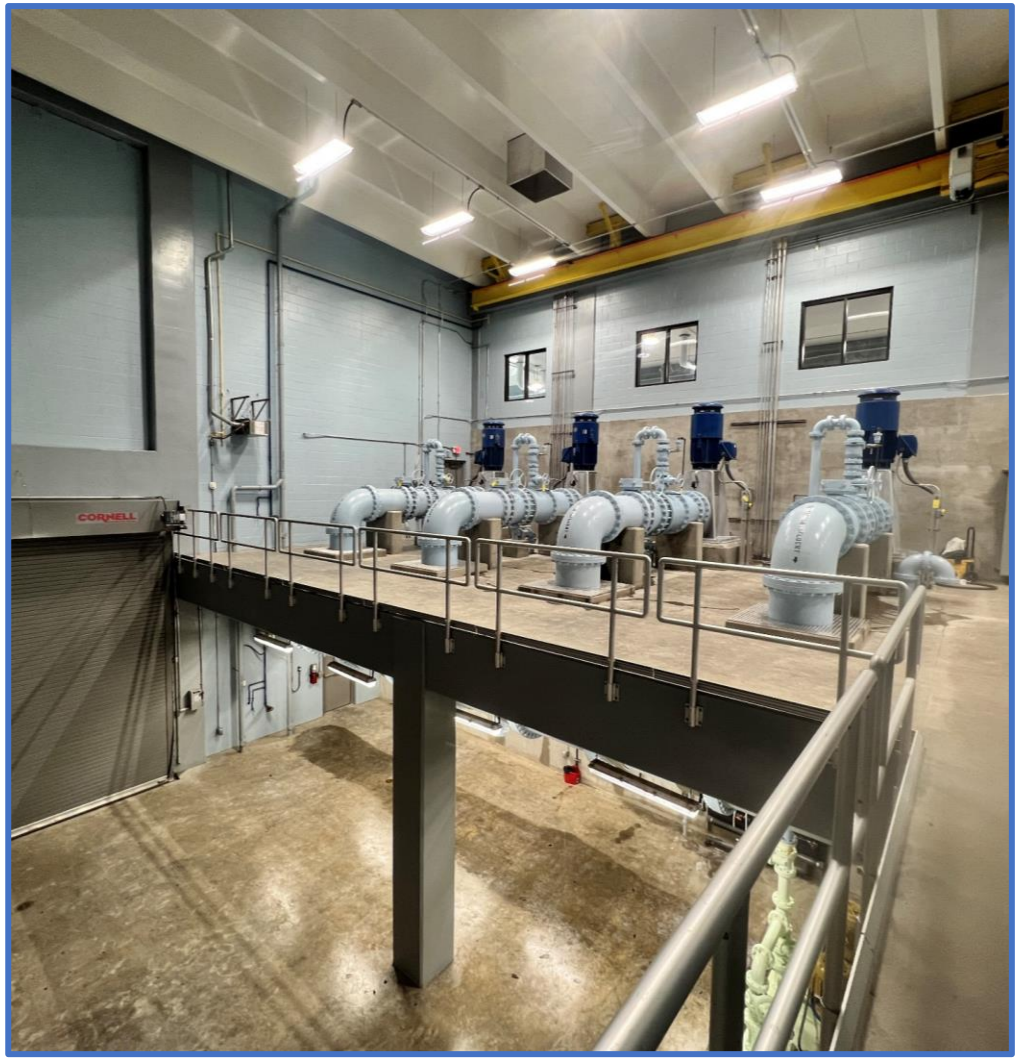


GAC Treatment Location



Pump and Electrical Room

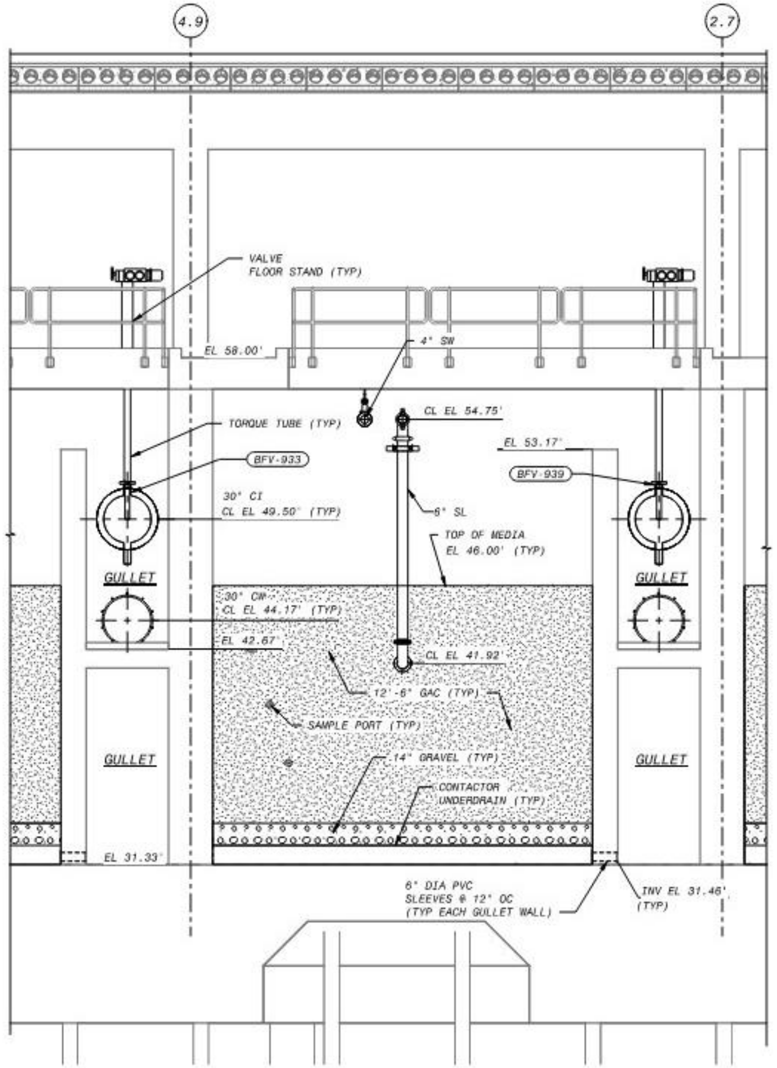
- Influent Pumps
  - Four (4) Vertical Turbine Pumps
  - 10,400 GPM – 125 HP
- Backwash Pumps
  - Two (2) Vertical Turbine Pumps
  - 11,100 GPM – 250 HP
- Electrical Room
- Loading Area
  - Bridge Crane
  - Slurry Water Pumps
  - Sample Panel

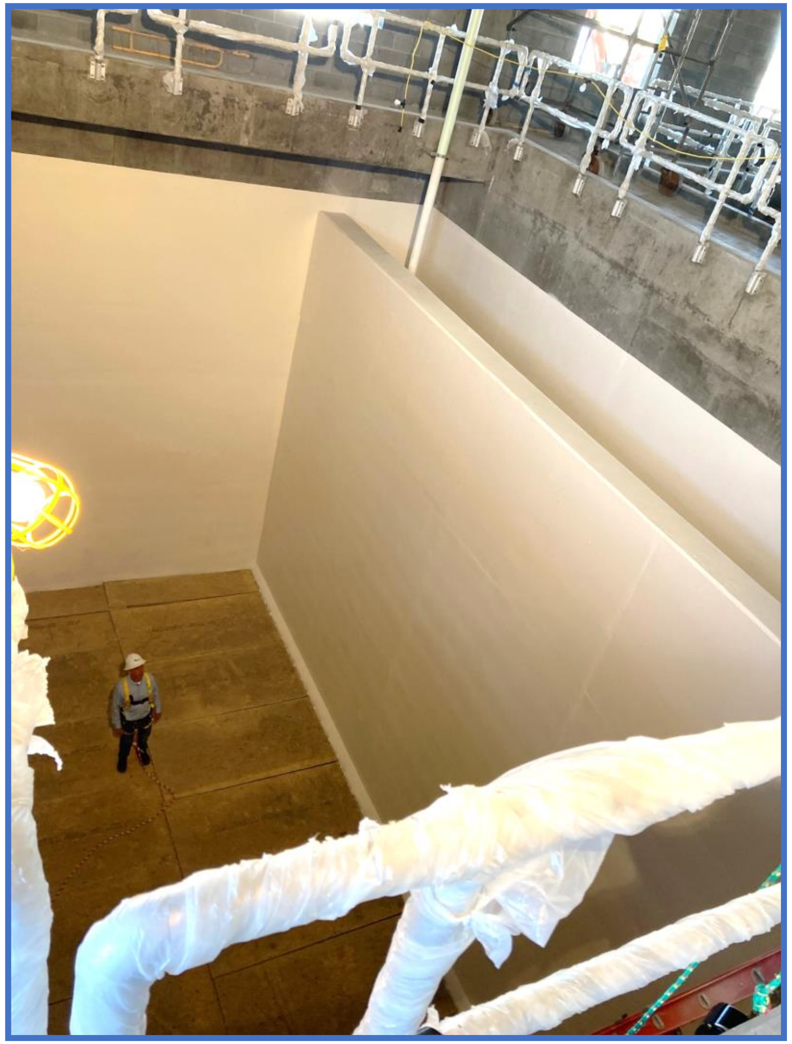


GAC Contactor Overview

- 44 MGD treatment capacity
- At peak capacity, takes 20 minutes for the water to flow through
- Almost 3,000,000 pounds of GAC media
- 8 GAC contactors
  - 14 inches of graded gravel
  - 12.5 feet of GAC media (Calgon F400)
  - Up to 375,000 pounds of GAC per contactor
  - GAC media cost per contactor is about $670,000

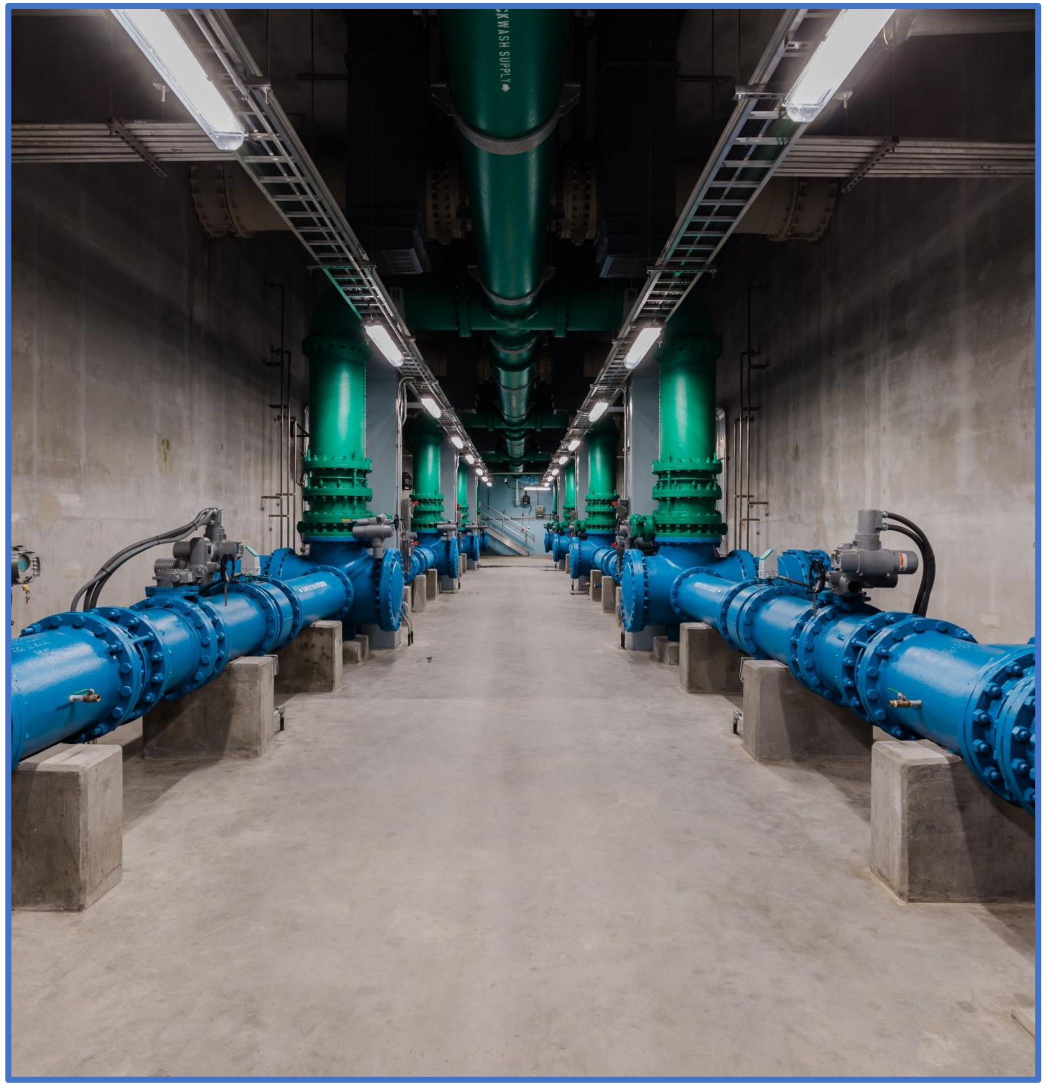
GAC Contactor Overview





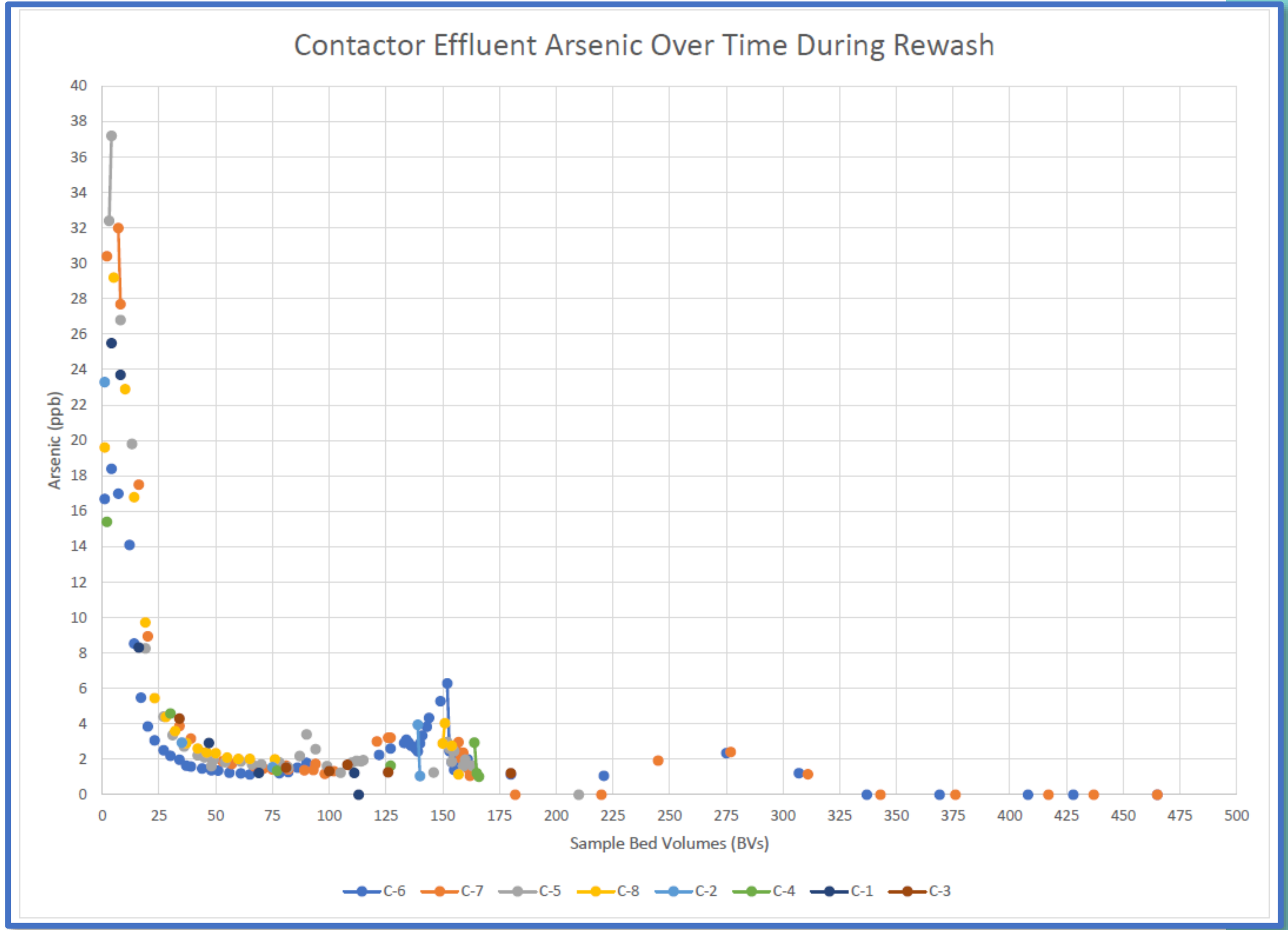
Contactor Pipe Gallery

- Piping & Valves
  - Contactor Influent
  - Contactor Backwash Supply
  - Contactor Effluent
  - Contactor-To-Waste
  - Contactor Backwash Waste
  - Slurry Water
  - Stainless Steel GAC Slurry Piping
- GAC Contactor Sampling
  - 75%, 50%, 25%
  - Effluent



GAC Facility Startup

- Each contactor required 8 tractor/trailer loads of GAC.
- Media installation took 2 to 3 days per contactor using the slurry pumping system designed with the facility.
- Each contactor required 6 to 10 days of backwashing and rinsing to waste to lower effluent pH and arsenic levels to acceptable levels.
- Managing the volume of water through the existing wash water handling facilities was a challenge.
- 2.5 months for media loading and preparation for 8 contactors.
- Integrated new GAC contactors gradually (1 to 2 at a time) into plant operations.



GAC Media Exchange

- GAC removes PFAS from water through adsorption.
  - Water flows over the GAC and PFAS compounds cling to the surface area of GAC particles.
- Over time as GAC adsorbs PFAS, there is less surface area to treat water.
- GAC media must be periodically replaced to achieve high level of PFAS removal (target 300-330 days).
- Three replacements so far in 2023:
  - Filters are drained, and GAC removed.
  - Carbon will be taken offsite by vendor for “regeneration” (PFAS removed by exposing GAC to extreme temperatures) and returned to Sweeney for reuse.
  - Replacement cycle is averaging 60 days
  - Estimated cost: $3 - $5 million per year

GAC Filters Optimization: Year One

- October 2022: Deep-bed GAC filters come online at the Sweeney Plant
- March 2023: EPA Proposes first time Nation Primary Drinking Water Regulations (NPDWR) for PFAS
- PFAS initially removed to at or near non-detectable levels in the finished water, but shortly afterwards we saw some breakthrough, especially from short-chain compounds.
- Using PFMOAA as the indicator compound for filter changeout
- Year One is focused on optimization and learning to use and manage the facility.

EPA's Proposed Action for the PFAS NPDWR

Compound	Proposed MCLG	Proposed MCL (enforceable levels)
PFOA	0 ppt*	4.0 ppt*
PFOS	0 ppt*	4.0 ppt*
PFNA	1.0 (unitless) Hazard Index	1.0 (unitless) Hazard Index
PFHxS		
PFBS		
HFPO-DA (commonly referred to as GenX Chemicals)		

The Hazard Index is a tool used to evaluate potential health risks from exposure to chemical mixtures.

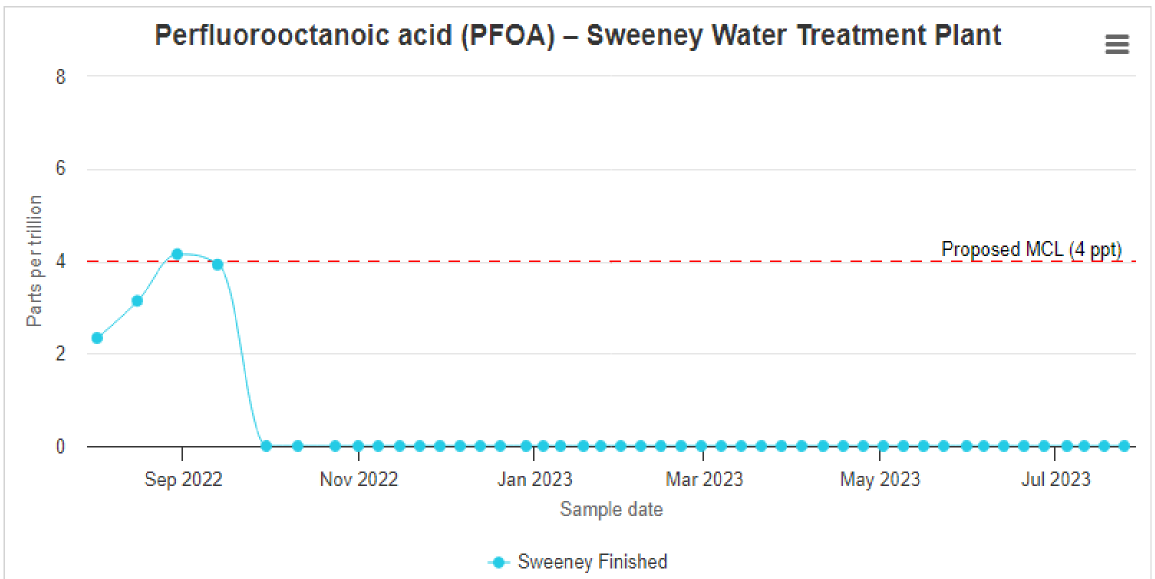
*ppt = parts per trillion (also expressed as ng/L)

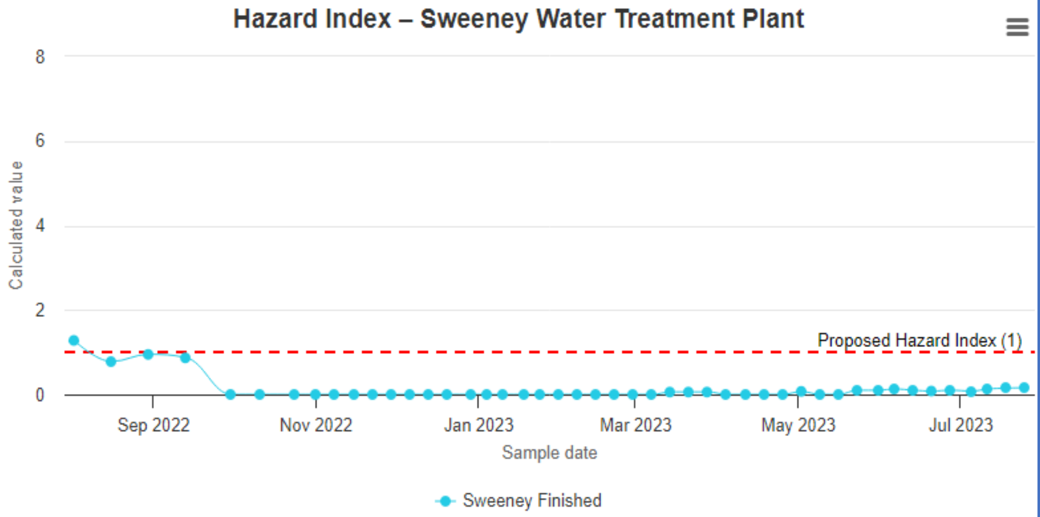
EPA United States Environmental Protection Agency

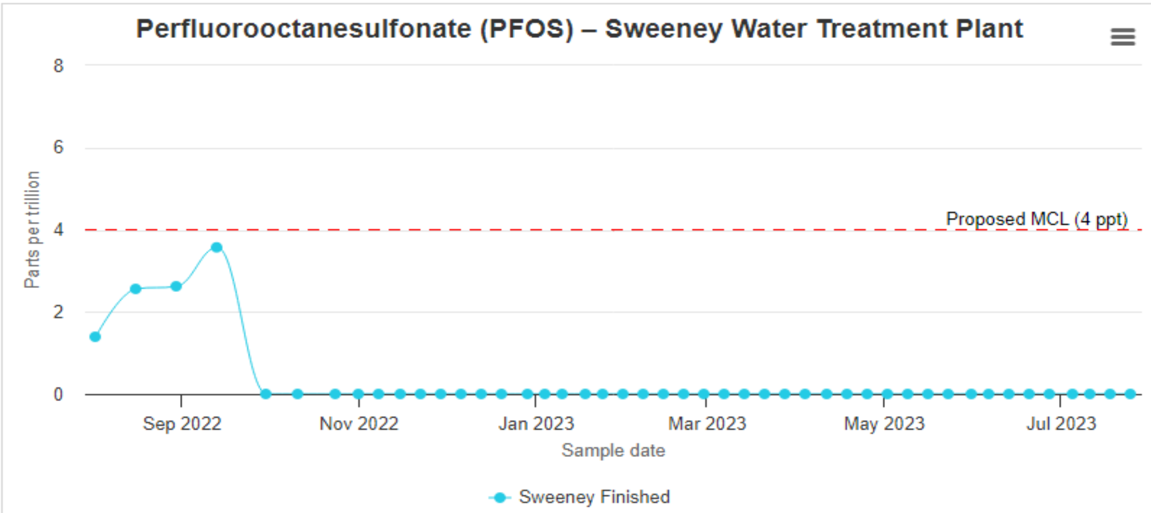
Office of Water

GAC Filters Optimization Successes

- GAC facility <u>easily meeting</u> the proposed NPDWR standard for PFOA, PFOS and the Hazard Index for PFHxS, PFNA, PFBS and HFPO-DA (GenX).
- <u>Optimization continues</u> for non-regulated compounds







Final Project Highlights

- **Schedule:**
  - Study/Pilot testing – 12 months
  - Design – 9 months
  - Construction – 36 months
  - Contractor – Adams Robinson
- **Construction Cost:**
  - Bid – $35,915,000
  - Final (Estimated) – $36,084,104
  - Change Orders – 0.5%
- **Total Project Cost:** $43 million
- **Impact to average customer's bill:** $5.39/month

Thank You!

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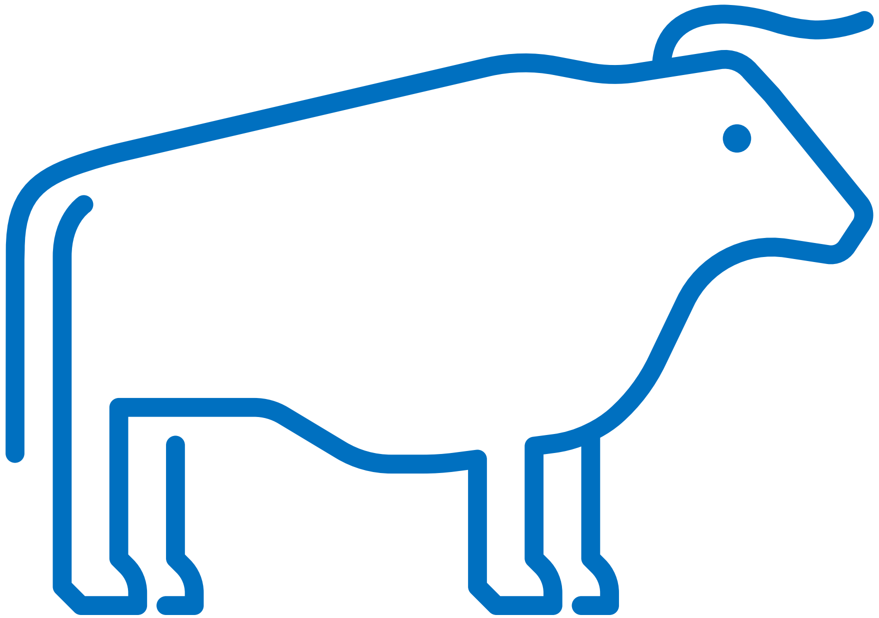


Experimental versus Standard Methods

- EPA Approved Standard Methods for 29 PFAS Compounds (M533, M537.1; M1633)
- Experimental methods now are identifying approximately 70 compounds (MM533 and MM537.1)
- The National Resource Defense Council (NRDC) conducted a pilot study across 16 states. This study used experimental methods from contract laboratory Eurofins.
- This study found that ultra-short-chain PFPrA was the most frequently occurring compound in drinking water systems, detected in 24 of 30 samples.
- PFPrA was also the PFAS compound reported at the highest concentrations in 15 of 30 samples.

Comparision of PFAS Analytes by Method 8-8-23

EPA APPROVED

METHOD 533 / METHOD 537.1 / METHOD 1633 / GEL

- 11Cl-PF3OUdS
- 9Cl-PF3ONS
- ADONA
- *HFPO-DA*
- *PFBS*
- PFDA
- PFDoA
- PFHpA
- *PFHxA*
- PFHxS
- PFNA
- PFOA
- PFOS
- PFUnA

METHOD 537.1 / METHOD 1633 / GEL

- NEtFOSAA
- NMeFOSAA
- PFTA
- PFTrDA

METHOD 533 / METHOD 1633 / GEL

- 4:2FTS
- 6:2FTS
- 8:2FTS
- NFDHA
- *PFBA*
- PFEESA
- PFHpS
- PFMBA
- PFMPA
- *PFPeA*
- PFPeS

EPA DRAFT

METHOD 1633 / GEL

- N-EtFOSE
- N-MeFOSE
- N-MeFOSA
- PFDS
- 3:3 FTCA
- N-EtFOSA
- PFNS
- PFOSA
- PFDoS
- 7:3 FTCA
- 5:3 FTCA

RESEARCH

GEL

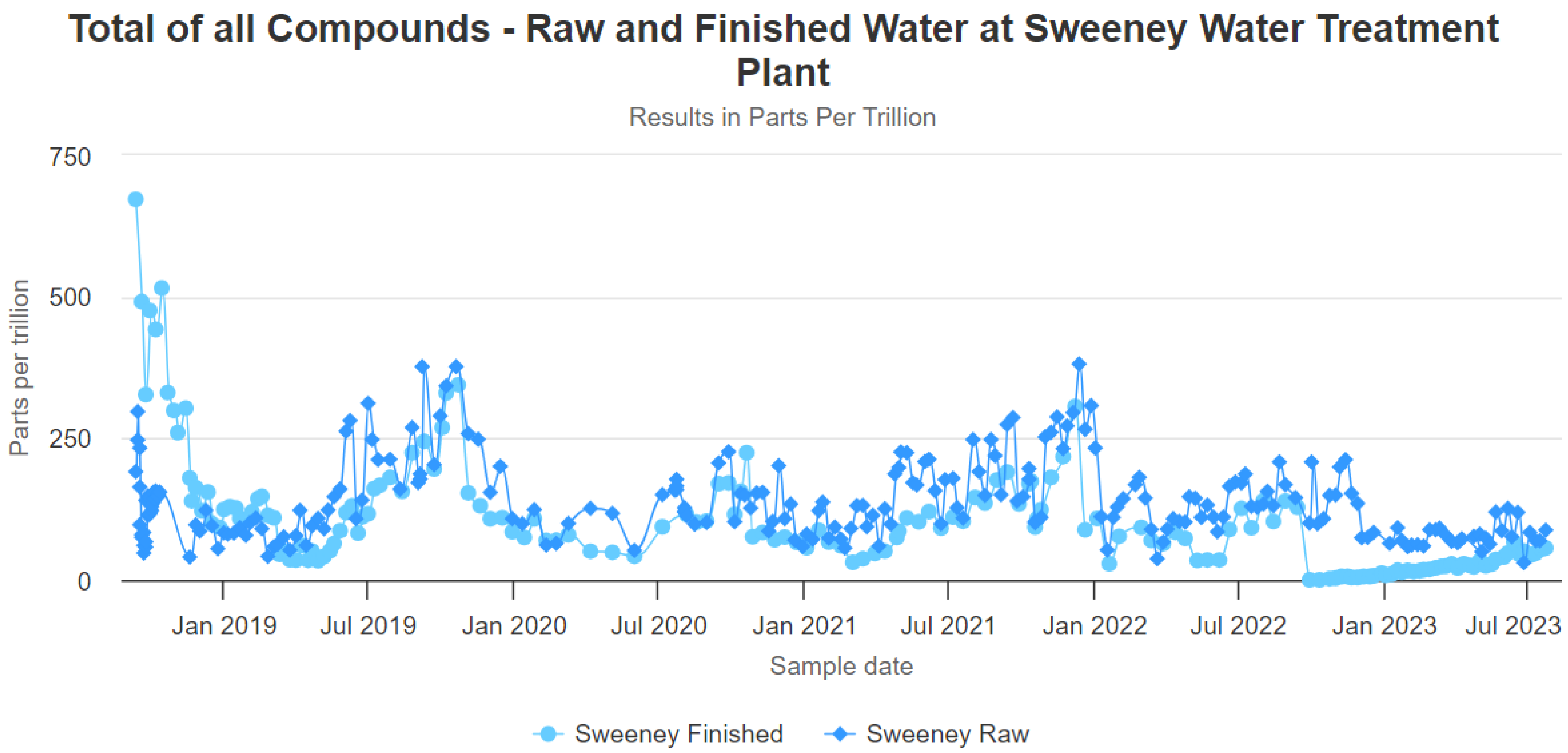
- 10:2 FTS
- *PMPA*
- PFODA
- R-PSDA
- PSDA
- R-PSDCA
- R-EVE
- PEPA
- FOEA
- PS Acid
- FBSA
- *PFO2HxA*
- PFO3OA
- PFO4DA
- PFO5DA
- *PFPrA*
- FHEA
- FDEA
- *PFMOAA*
- PFHxDA
- EVE Acid
- Hydro-PS Acid
- Hydro-EVE Acid
- NVHOS
- PFECA-G
- NVHOS
- 6:2 FOSA
- FHxSA
- N-AP-FHxSA

*Chemours Specific

TEST COMPARISON

Test	Approval	Used For	Type	# of Chemicals Detected
Method 533	EPA Approved	Drinking Water	Isotope Dilution	25
Method 537.1	EPA Approved	Drinking Water	Solid Phase Extraction with ICP/MS/MS	18
Method 1633	Draft	Groundwater, Surface water, Wastewater, Soil, Biosolids, and Sludge	Isotope Dilution	40
GEL	Research	Drinking water, Surface water, Wastewater, Soil, and Biosolids	Isotope Dilution combining 533, 537.1, and 1633	65

All Compounds using Experimental Testing Methods



Next Steps

- Moving to a dual trigger for media exchange (10,000 bed-volumes or 10 ppt for PFMOAA).
- Near future: testing of new combinations of GAC and new novel sorbents with our in-house pilot plant.
- Asking the North Carolina's Secretary's Scientific Advisory Board to add PFPrA and other ultra-short chain PFAS to their PFAS Action Plan.