Whidbey Island Water Systems Association
September 15, 2022

PFAS: Moving Forward under an Umbrella of Uncertainty

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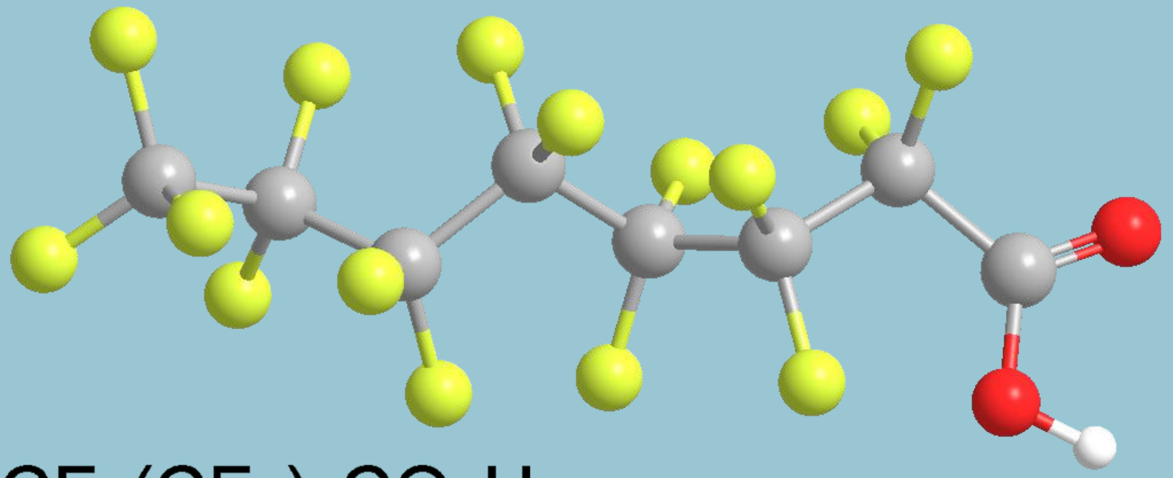
Perfluorooctanoic acid (PFOA)



$CF_3(CF_2)_6CO_2H$

Treatment

Drinking Water Treatment Options

PFAS treatment drinking water – currently three primary technologies:

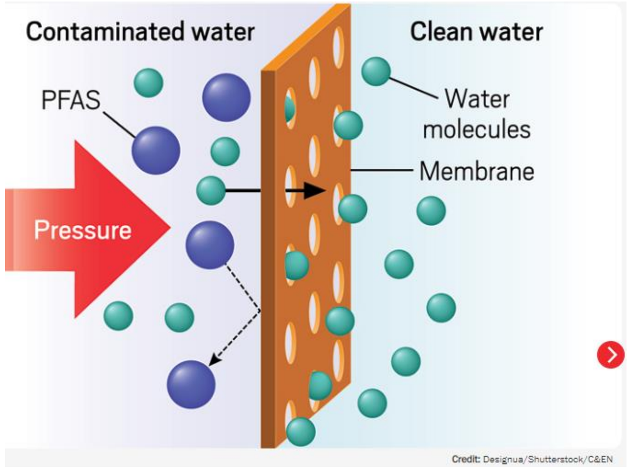
- **Granular Activated Carbon (GAC)**

Source: Calgon Carbon

- **Ion Exchange (IX) Resins**

Source: ECT2

- **Nanofiltration (NF) & Reverse Osmosis (RO) filtration**

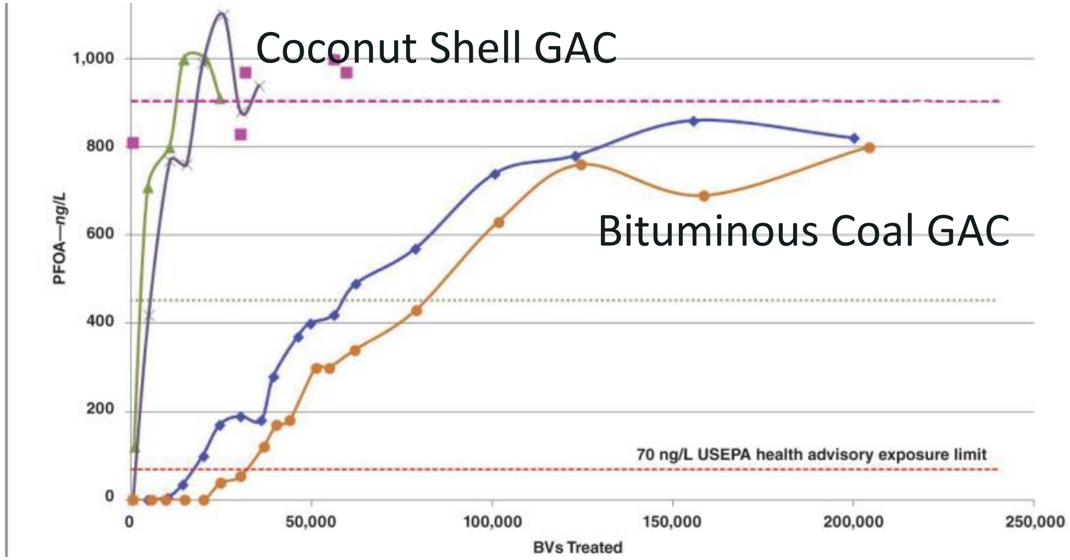


Granular Activated Carbon

Granular Activated Carbon (GAC)

- Very effective for adsorbing PFOA and PFOS, and other PFAS compounds in the fine pores of the carbon
- Short chain PFAS (like PFBS and GenX) can move saturate the media more quickly
- Pretreatment may be required to protect GAC media (extend life)

Lakewood Water District – 2.9 MGD



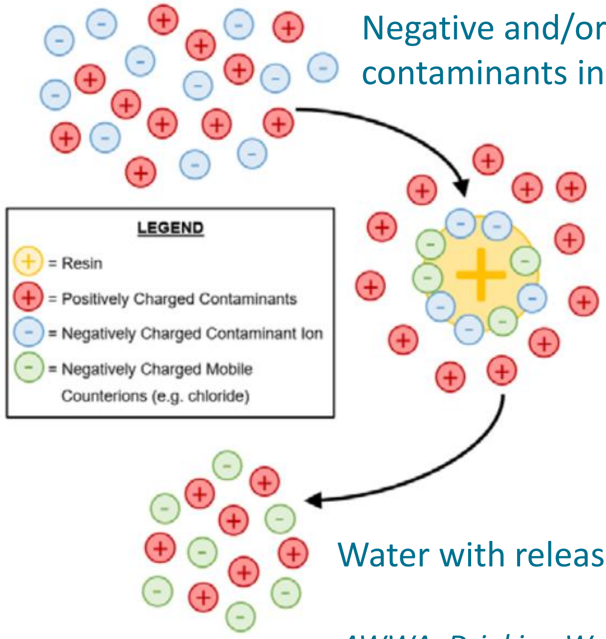
McNamara, J. et al (2018) Comparison of Activated Carbons for Removal of Perfluorinated Compounds From Drinking Water. J. AWWA 110:1

- Not all activated carbon is the same (Coal based vs Coconut shell – effectiveness is media, contaminant and water dependent)
- Deep track record of successful use
- Periodic backwashing may be needed
- Questions about regeneration of spent media

Ion Exchange Resins (IX)

Ion Exchange (IX) Resins

- Very effective for removal of several PFAS
- Smaller footprint when compared to GAC
  - Combination of ion exchange and adsorption
  - Typically use 20 – 50% of the media volume compared to GAC
- Pretreatment may be required to protect IX media (extend life)
- Media cost typically higher than GAC; whole system costs are comparable to GAC
- Single use resin (then dispose) or regenerable with NaCl or other solutions – regenerant stream a disposal challenge.



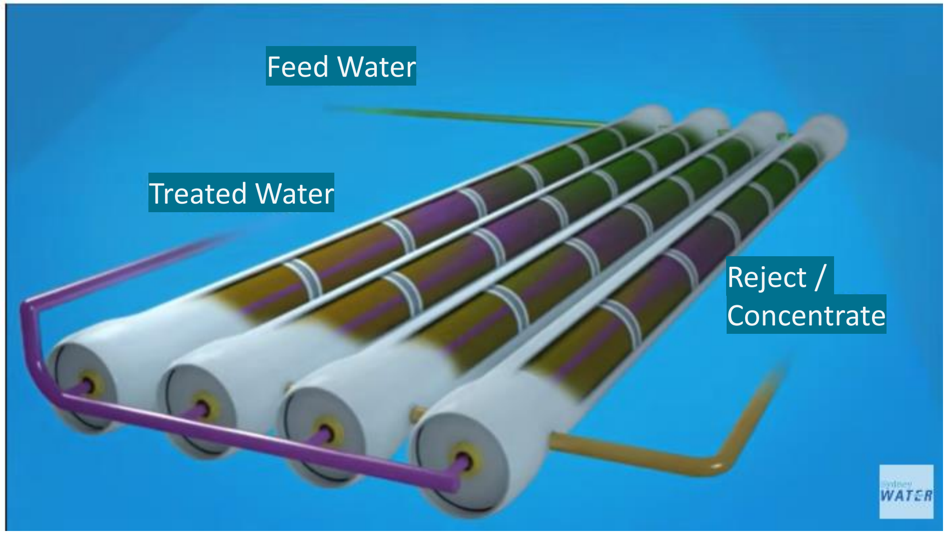
AWWA: Drinking Water Treatment for PFAS Selection Guide, 2019

Yorba Linda PFAS Removals Facility (IX – 25 MGD - $27 million)

Drinking Water Treatment Options

Nanofiltration (NF) & Reverse Osmosis (RO) filtration

- Very effective (RO tighter membrane than NF) at removing PFAS (as well as other constituents in water)
- Membranes require protection with pretreatment
- Operationally complex and expensive (Capital costs 2-3x GAC and IX options; Operating costs 2x higher)
- A significant fraction of water is "rejected" with contaminants (20% or more)
- Energy intensive pumping required for pressure
- Product water from RO treatment is corrosive to household plumbing
- Best application may be under counter – point-of use
- Complex issues with waste stream (need treatment for your treatment)



Sydney Water

Large Scale Plant Costs

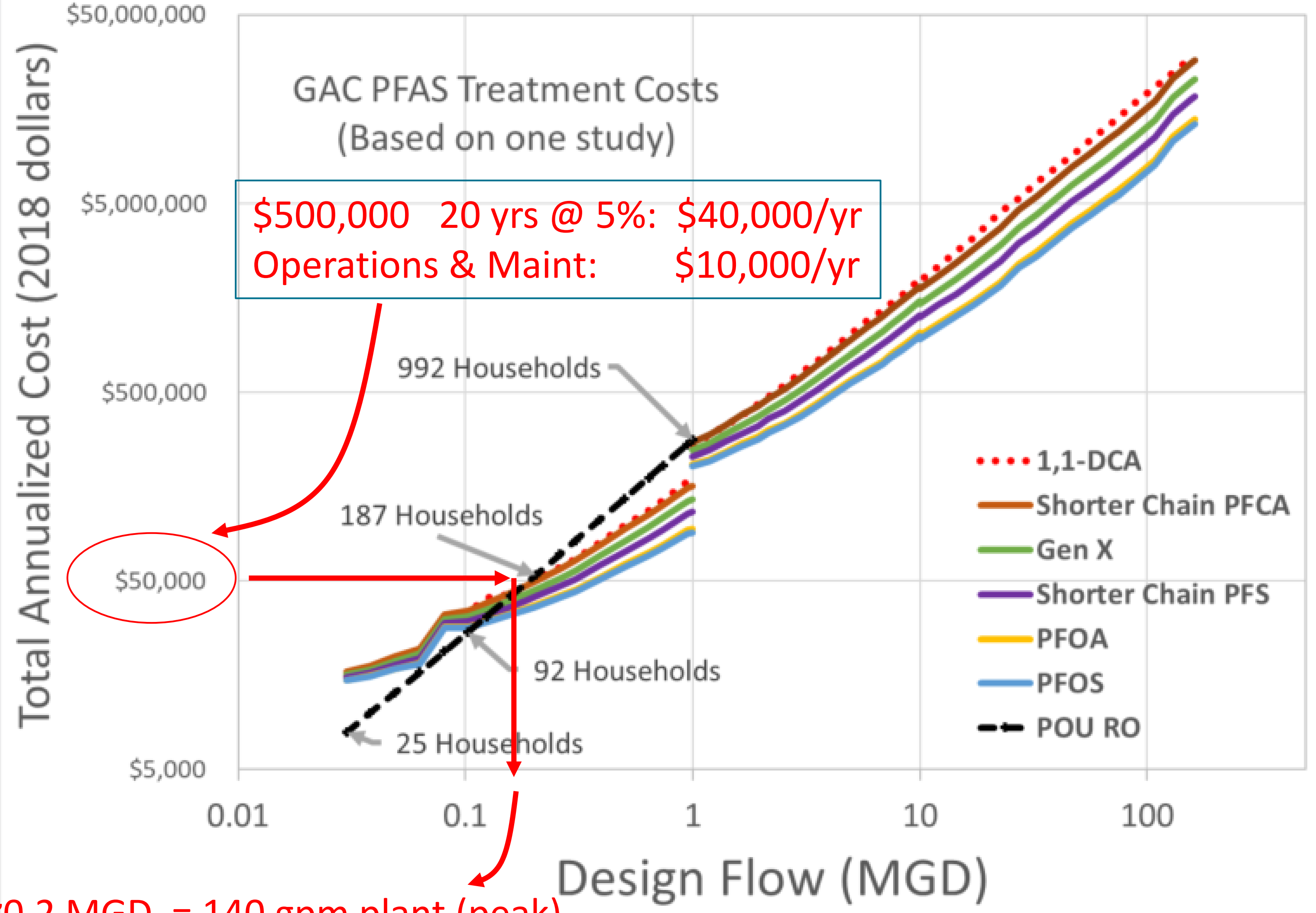
Table 5-1 Cost Summary for 44 MGD Treatment Plant

	POST-FILTER GAC CONTACTORS	POST-FILTER IX VESSELS	POST-FILTER REVERSE OSMOSIS
Capital Cost (+50%/-30%)	$46M	$46M	$150M
Annual O&M Cost	$2.7M	$2.1M	$4.7M
34 Year Present Value	$196M	$176M	$504M

Notes:
RO costs do not include NPDES discharge or additional raw water supply costs
Additional Staff = 2 x $70,000/yr (RO option only)
Based on current PFC concentrations in river
Contingency = 30%

Black & Veatch, 2018 – Cape Fear Water Authority, Emerging Contaminants Alternatives Analysis – Final Report.

Costs for PFAS Treatment: One GAC Example



~0.2 MGD = 140 gpm plant (peak)
70 gpm (avg) ~ 250-300 cnxs

Primary Assumptions:

- Two vessels in series
- 20 min EBCT Total
- Bed Volumes Fed
  - 1,1-DCA = 5,560 (7.5 min EBCT)
  - Shorter Chain PFCA = 4,700
  - Gen-X = 7,100
  - Shorter Chain PFS = 11,400
  - PFOA = 31,000
  - PFOS = 45,000
- 7 % Discount rate
- Mid Level Cost

Source: Speth, Thomas, et al., Cost of POU Vs. Centralized Treatment 2020 WQA Annual (Virtual) Conference

Treatment Solutions @ Scale

At the tap (~0.5 - 1 gpm)

Filter replacement $10 / 100 gallons
Source: PUR Manufacturer material

Small (~0.5 gpm – 1 CF media) to large (~5 gpm – 8 CF media) whole house system - $1,500 - $4,000

Media replacement $150/CF every 6 months - 3 years (Highly WQ dependent) – Assume biannually & Avg water use of 350 gallons per day
$.53/ 100 gallons

Source: Speth, Thomas, et al., 2020 WQA Annual (Virtual) Conference

300 - 500 gpm system
Capital: $2 - $7 million
Annual O&M: $40,000 - $150,000
Community of 1,200 connections using 350 gal/conn/day (153.3 MG/yr)
$0.03 - $0.10 / 100 gallons

Photo: Chang & Maring, Removing PFAS: Startup and Performance of the Coupeville GAC Treatment System, AWWA, May 20, 2021

Cost Information: PFAS in the Commonwealth of Massachusetts; Final Report of the PFAS Interagency Task Force, April 2022

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Evolving Issues in Treatment

Current Focus on PFOA and PFOS – What about others in the PFAS family?

- Occurrence: Wider testing both in drinking water (EPA Methods 537.1 and 533) and in other environmental matrices, like wastewater, stormwater, soils, etc. (EPA Method 1633)

- Human Health effects: Research, advisory levels, risk assessments and ultimately regulatory levels will be set – that will drive treatment.

PFAS Concentration and destruction remains important processes in development

- Incineration
- Advanced Oxidation
- Plasma-based treatments

Big issue: byproducts are we creating when we attempt to destroy PFAS?

***See**: Tow, et al. (2021) Managing and treating per- and polyfluoroalkyl substances (PFAS) in membrane concentrates, AWWA Water Science*

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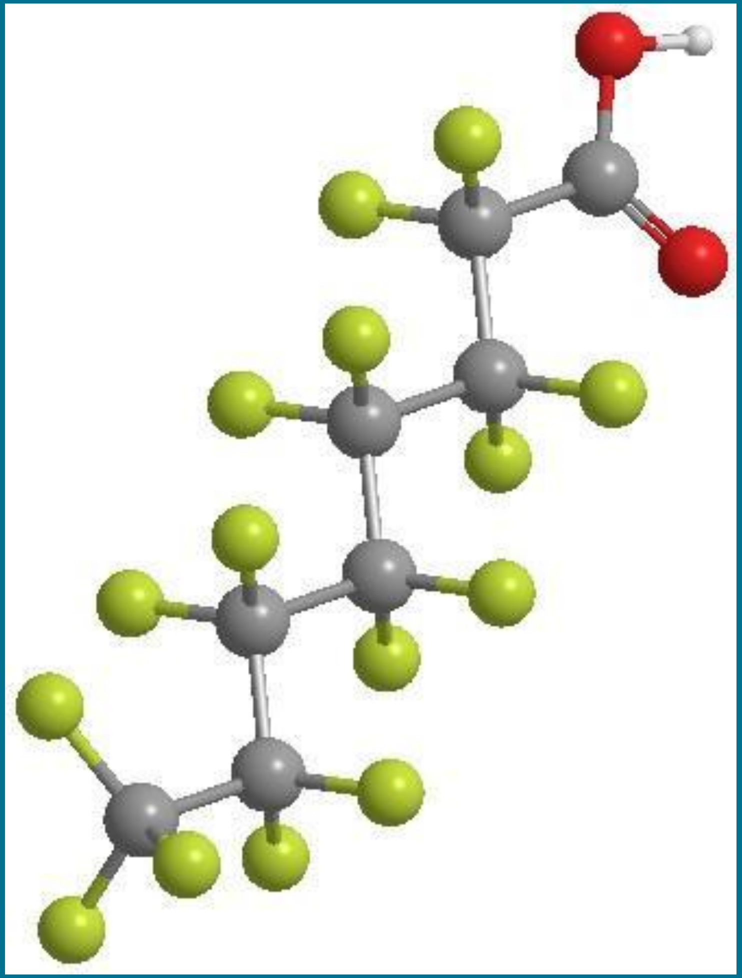
Thank You



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