Estimated Greenhouse Gas Emissions and Risk Reduction from PFAS Treatment of Maine Drinking Water

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PFAS Regulation for Maine Drinking Water

- Maine SP 64 – LD 129 (2021)
  - Required testing for PFAS across the state, including drinking water sources
  - Established interim drinking water standard of 0.020 μg/L for the sum of six PFAS
  - Required that DHHS enact rulemaking to establish a drinking water maximum contaminant level (MCL) as a final rule on or before June 1, 2024
- On March 14, 2023, US EPA proposed a 0.004 μg/L MCL for PFOA and PFOS, plus a hazard quotient threshold for several additional PFAS. States can set drinking water standards that are equal to or more stringent than EPA standards.

TABLE 1: PFAS Currently Regulated in Maine Drinking Water

Full Name	Acronym
Perfluorooctanoic acid	PFOA
Perfluorooctane sulfonate	PFOS
Perfluorononanoic acid	PFNA
Perfluorohexane sulfonate	PFHxS
Perfluoroheptanoic acid	PFHpA
Perfluorodecanoic acid	PFDA

PFAS in Maine Drinking Water

- There is currently a wide range of users in the statewide database with sample type listed as "drinking water" that exceed the interim 0.020 μg/L standard.
- There are additionally neighborhoods in some locations where private wells exceed the interim standard. DEP is treating that water with activated carbon.

CURRENT SITE NAME	Town	SAMPLE DATE	CONCEN TRATION	UNITS
BONNY EAGLE MIDDLE SCHOOL	BUXTON	8/9/2022	864	ng/L
CUTLER RESIDENTIAL DEVELOPMENT	CUTLER	9/18/2020	768.28	ng/L
BONNY EAGLE JHS MSAD 6 ENG SWDS BUXTON	BUXTON	7/13/2022	164.71	ng/L
OLD WOODSTOCK RD-HOULTON	HOULTON	11/8/2017	132.6	ng/L
HOLLIS CONSOLIDATED ELEMENTARY SCHOOL	HOLLIS	7/26/2022	81.96	ng/L
CHARLESTON AFS	CHARLESTON	10/28/2020	62.999	ng/L
CHEBEAGUE ISLAND SCHOOL	CHEBEAGUE ISLAND	4/26/2022	49.14	ng/L
BONNY EAGLE HIGH SCHOOL	STANDISH	7/13/2022	34.2	ng/L
TRENTON ELEMENTARY SCHOOL	TRENTON	11/13/2017	33.81	ng/L
PFAS DATA - UNCONFIRMED SOURCE FAIRFIELD	FAIRFIELD	1/26/2022	28.2	ng/L
WASHINGTON COUNTY COMMUNITY COLLEGE	CALAIS	2/16/2022	24.44	ng/L
LISBON WATER DEPARTMENT	LISBON	7/29/2019	18.62	ng/L

PFAS Treatment

- Removing PFAS from water to a target value requires drinking water treatment. Possible methods include:
  - Sorption to activated carbon
  - Sorption to an ion exchange resin
  - Reverse osmosis
- Of the above, activated carbon is the most established method and likely to be used in the near future.
- Treatment by activated carbon is strongly affected by the target PFAS concentration. The lower the level, the (much) more activated carbon needed.

Activated Carbon and Greenhouse Gas Emissions

- Activated carbon provides sorption sites for many dissolved compounds in water, including PFAS.
- Activated carbon sources
  - Coal that is “activated” by steam to create a highly porous and absorptive structure.
  - Biomass that is first carbonized in high heat and low oxygen, followed by activation by steam.
- Generating activated carbon is energy intensive and emits significant greenhouse gas quantities (Gu et al. 2018)
  - 18 kg CO_2 eq / kg AC for coal source
  - 9 kg CO_2 eq / kg AC for biomass source

Image from https://buyactivatedcharcoal.com/

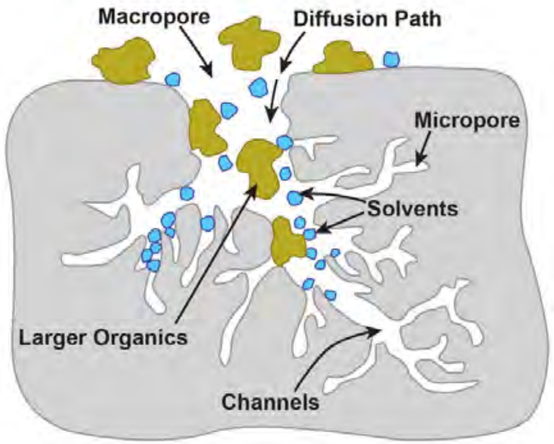

Image from Kemp (2017)

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PFAS Water Treatment Simulations

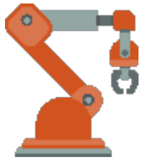
- Simulated activated carbon treatment of PFAS-contaminated drinking water
- Municipal water supply
  - 70,000 users
  - Raw water sum-of-six PFAS = 0.300 μg/L based roughly on 2014 Kennebunk River Well sample
- Residential water supply
  - 4 users (1 household)
  - Raw water sum-of-six PFAS = 0.365 μg/L based on 75th percentile for sites in ME DEP database (March 7, 2022) download
- Five target PFAS water concentrations: current ME standard, 0.1X, 0.5X, 2X, 10X

PFAS Water Treatment Simulations

- Activated carbon adsorption parameters from Burkhardt et al. (2022)
  - Coal-based activated carbon
  - Biomass-based activated carbon (coconut shells)

- Greenhouse gas emissions factors for:
  - Activated carbon production

  - Treatment vessel building and shipping

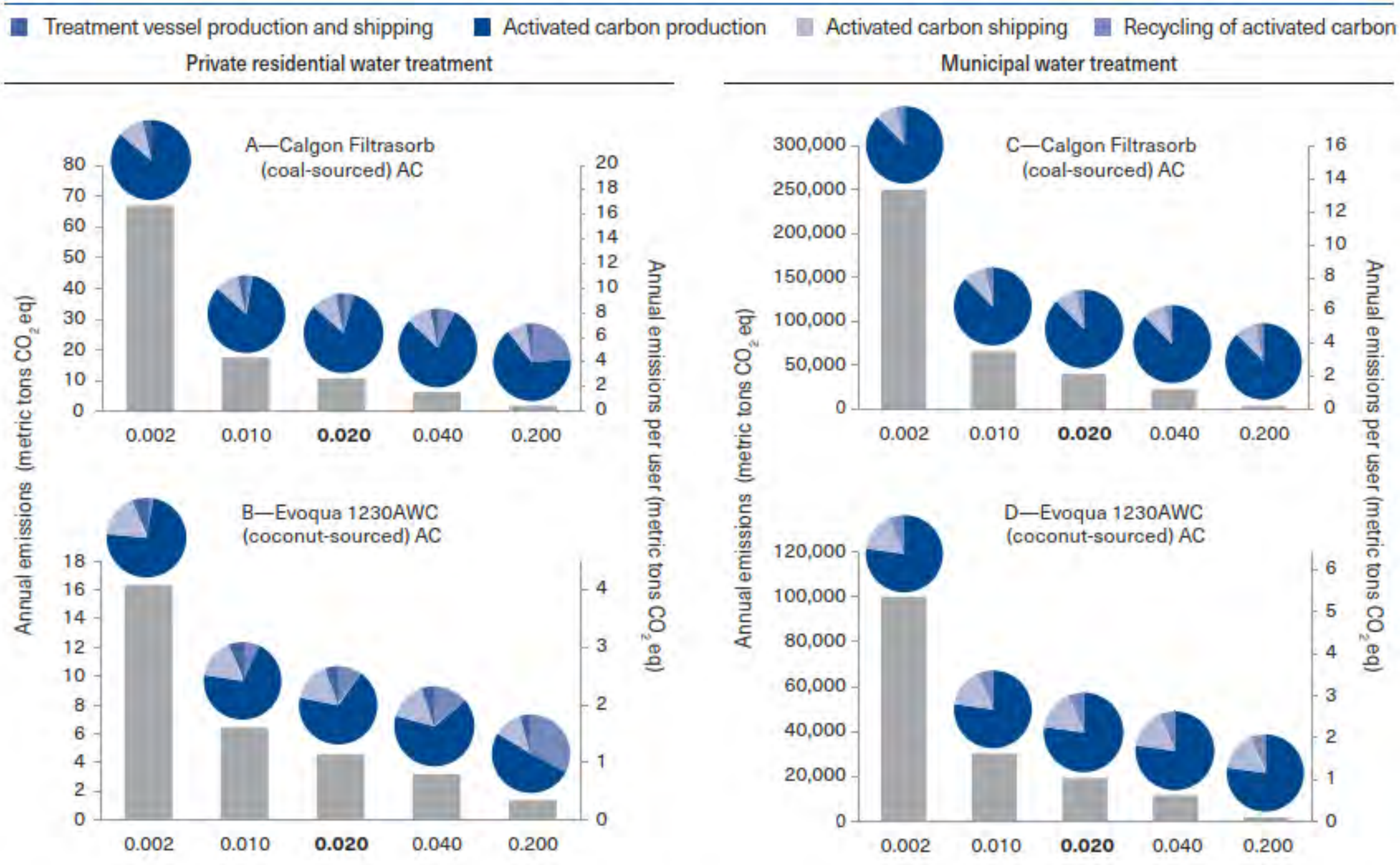


  - Activated carbon shipping Pennsylvania to/from Maine

  - Activated carbon disposal (thermal desorption)

  - Not included: PFAS destruction

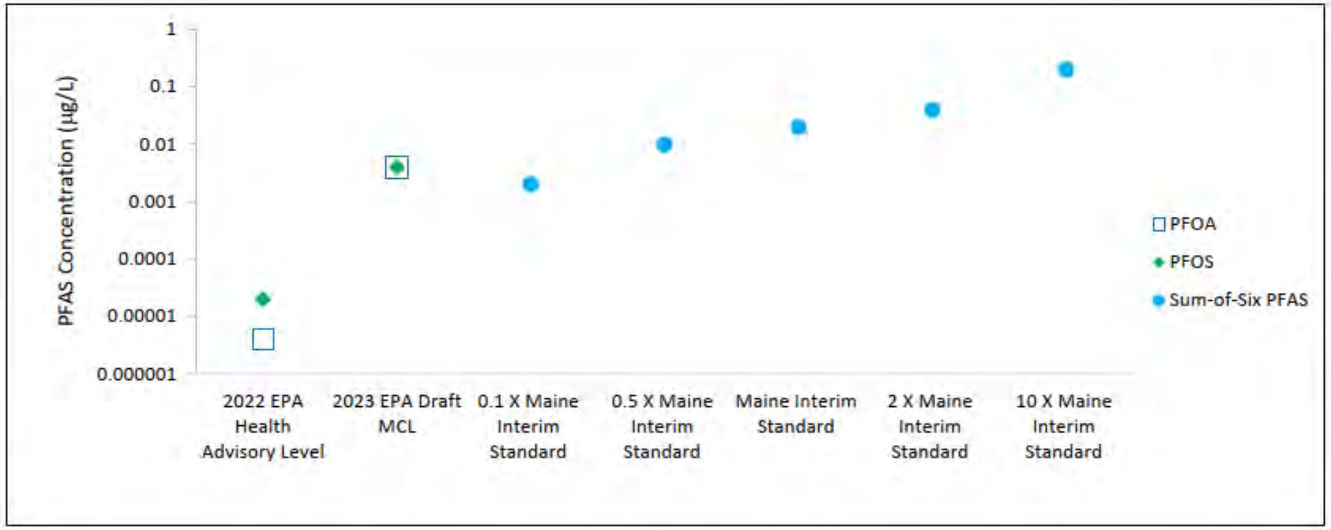
Greenhouse Gas Emissions Estimates



Graphs from McAlexander et al. (2022)

PFAS Treatment for Risk Reduction

- 2022 EPA Health Advisory Levels for PFOA and PFAS are based on 7-year-old's decreased vaccine response for tetanus and diphtheria, respectively.
- If the health advisory levels indeed indicate safe conditions only below those concentrations, any detectable concentration of PFOA or PFAS would indicate some health risk.
- The EPA toxicological model for the health advisory levels is linear. Doubling a concentration means doubling the risk.



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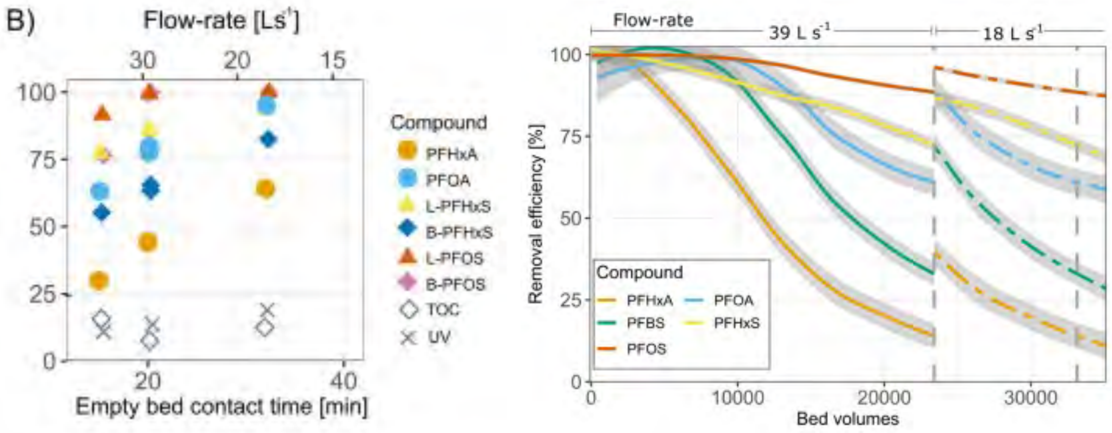
Potential Policy Considerations for Rulemakers

- Consider greenhouse gas emissions as one cost in the cost-benefit analysis for an MCL
  - MCL to be finalized in 2024
  - Future updates
- Use available toxicological information to implement standards for individual PFAS, rather than a sum-of-six approach (e.g., lower standards for PFOA and PFOS versus PFHxS)

"Climate change represents the greatest threat of our age"

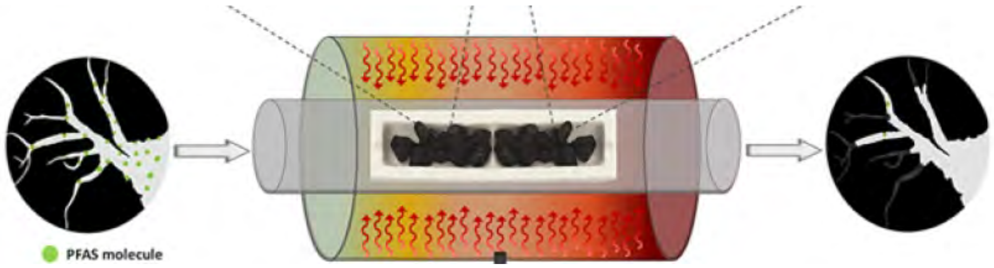
Potential Considerations for DEP or Similar

- Facilitate information sharing between facilities on PFAS treatment efficiency parameters.



Example PFAS treatment efficiency graphs from Belkouteb et al. (2020)

- Coordinate a common pool for recycled activated carbon, which has a lower greenhouse gas emissions footprint than virgin media.



Activated carbon thermal regeneration image from Baghirzade et al. (2021)

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Summary

- PFAS removal from drinking water will have a benefit of risk reduction, and a cost associated with increased greenhouse gas emissions.
- Low target PFAS concentrations (e.g., to 0.002 μg/L) could mean a near doubling of greenhouse gas emissions for drinking water users.
- Policy makers might consider this in a cost-benefit analysis, and the state might coordinate improved efficiencies among water supplies.

References

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