



GREEN SCIENCE  
POLICY INSTITUTE

# A PFAS Primer

Clean Water Summit Partners  
State Water Board PFAS Order Compliance Webinar

Tom Bruton, PhD  
Green Science Policy Institute  
September 16, 2020



BR1 Building Research & Innovation (2017) 49(6), 738-755

**ENVIRONMENTAL Science & Technology**

**Fluorinated building insulation: a new paradigm**

**Novel and High Volume Use Flame Retardants in US Couches**

**Fluorinated PentabDE Phase Out**

**Fluorinated in U.S. Fast Food Packaging**

**Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants**

**ENVIRONMENTAL Science & Technology LETTERS**

**Fluorinated in U.S. Fast Food Packaging**

**Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants**

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<sup>8</sup>Green Science Policy Institute, Berkeley, California 94705, United States  
<sup>9</sup>California Department of Toxic Substances Control, 1001 I Street, Sacramento, California 95814, United States (Formerly at the Green Science Policy Institute, Berkeley, California 94705, United States)  
<sup>10</sup>Colorado School of Mines, 1500 Illinois Street, Golden, Colorado 80401, United States

**Supporting Information**

**ABSTRACT:** Drinking water contamination with poly- and perfluoroalkyl substances (PFASs) poses risks to the developmental, immune, metabolic, and endocrine health of consumers. We present a spatial analysis of 2013–2015 national drinking water PFAS concentrations from the U.S. Environmental Protection Agency's (US EPA) third Unregulated Contaminant Monitoring Rule (UCMR3) program. The number of industrial sites that manufacture or use these compounds, the number of military fire training areas, and the number of wastewater treatment plants are all significant

Hydrological units with detectable PFASs



Education

Research

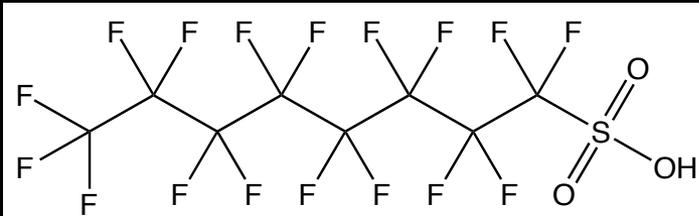
Retreats

**Policy & Purchasing Change**

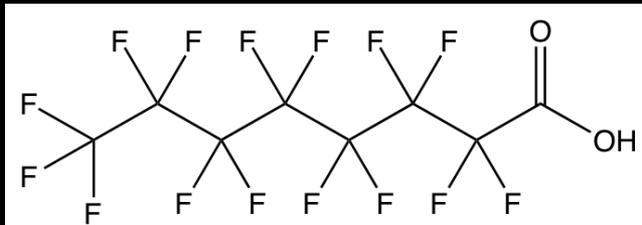
# PFAS

## (Per and Polyfluoroalkyl Substances)

PFOS



PFOA



Carbon-Fluorine bond strength:

- Leads to oil and water repellency
- “Forever chemicals” -- last for geologic time!

# Common Uses



CARPETS



CARPET CLEANING PRODUCTS



FOOD PACKAGING



FURNISHINGS



COSMETICS



OUTDOOR GEAR



CLOTHING



ADHESIVES AND SEALANTS



PROTECTIVE COATINGS



NON-STICK COOKWARE



CARSEATS



FIREFIGHTING FOAM

# May 2000

## 3M Employee Bulletin

Date: 05/16/2000

### 3M Phasing Out Some of its Specialty Materials

3M will phase out of the perfluorooctanyl chemistry in certain repellents and surfactant products by the end of this year. We thank the people in these business units for their hard work. They have consistently given the company and our customers their best efforts. For more information, below is a news release issued this morning:

-----  
**ST. PAUL, Minn -- May 16, 2000 --** 3M today announced it is phasing out of the perfluorooctanyl chemistry used to produce certain repellents and surfactant products.



# Ohio River Valley: West Virginia Manufacturing Plant

- PFOA used to manufacture Teflon
- Releases to water & air
- 70,000 + residents with contaminated drinking water
- C8 Health Study

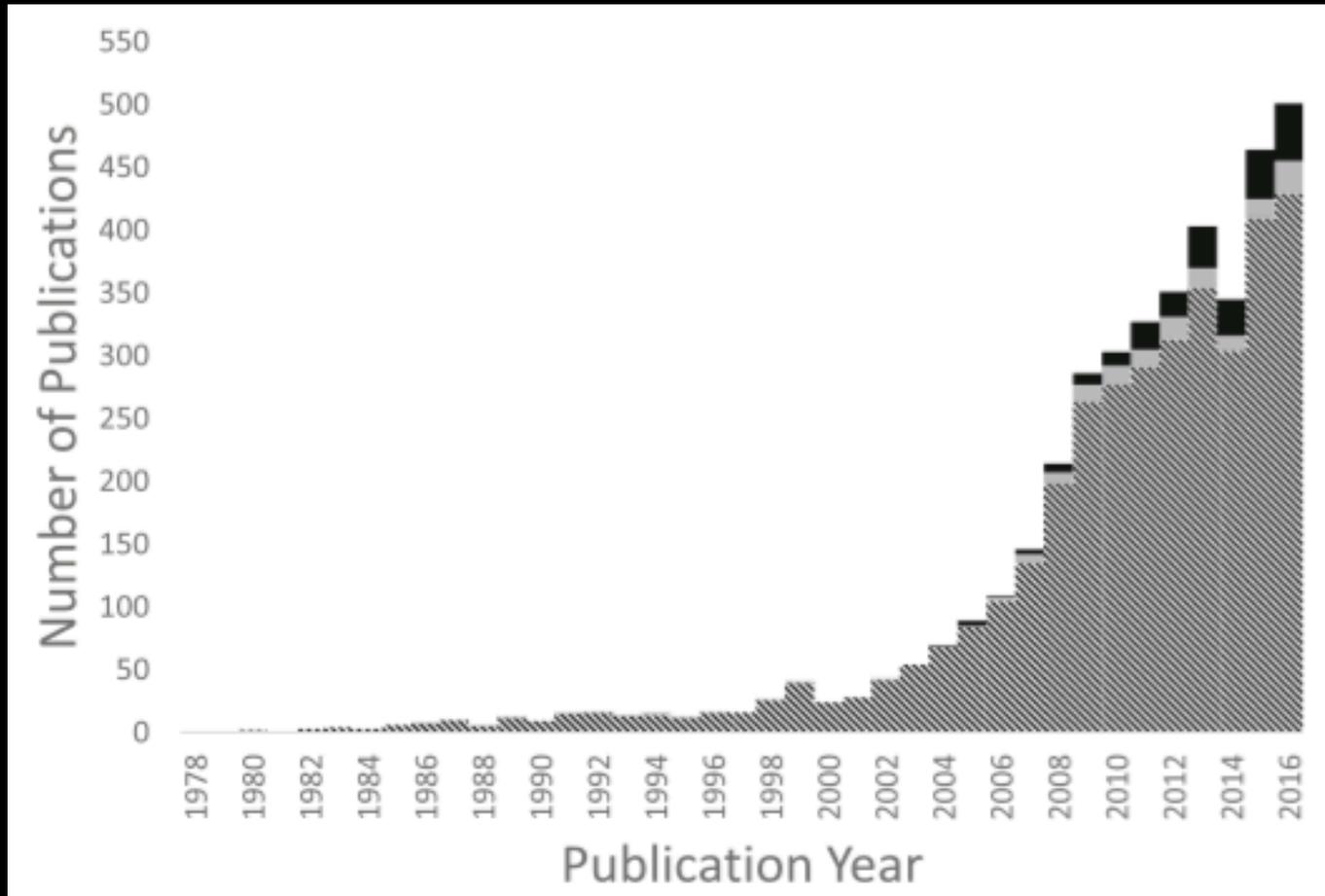


# Movie: Dark Waters

- The story of attorney Rob Bilott, who uncovered massive PFOA contamination from a DuPont factory in WV



# Scientific publications on PFAS



# *Perfluorochemical Surfactants* in the **Environment**

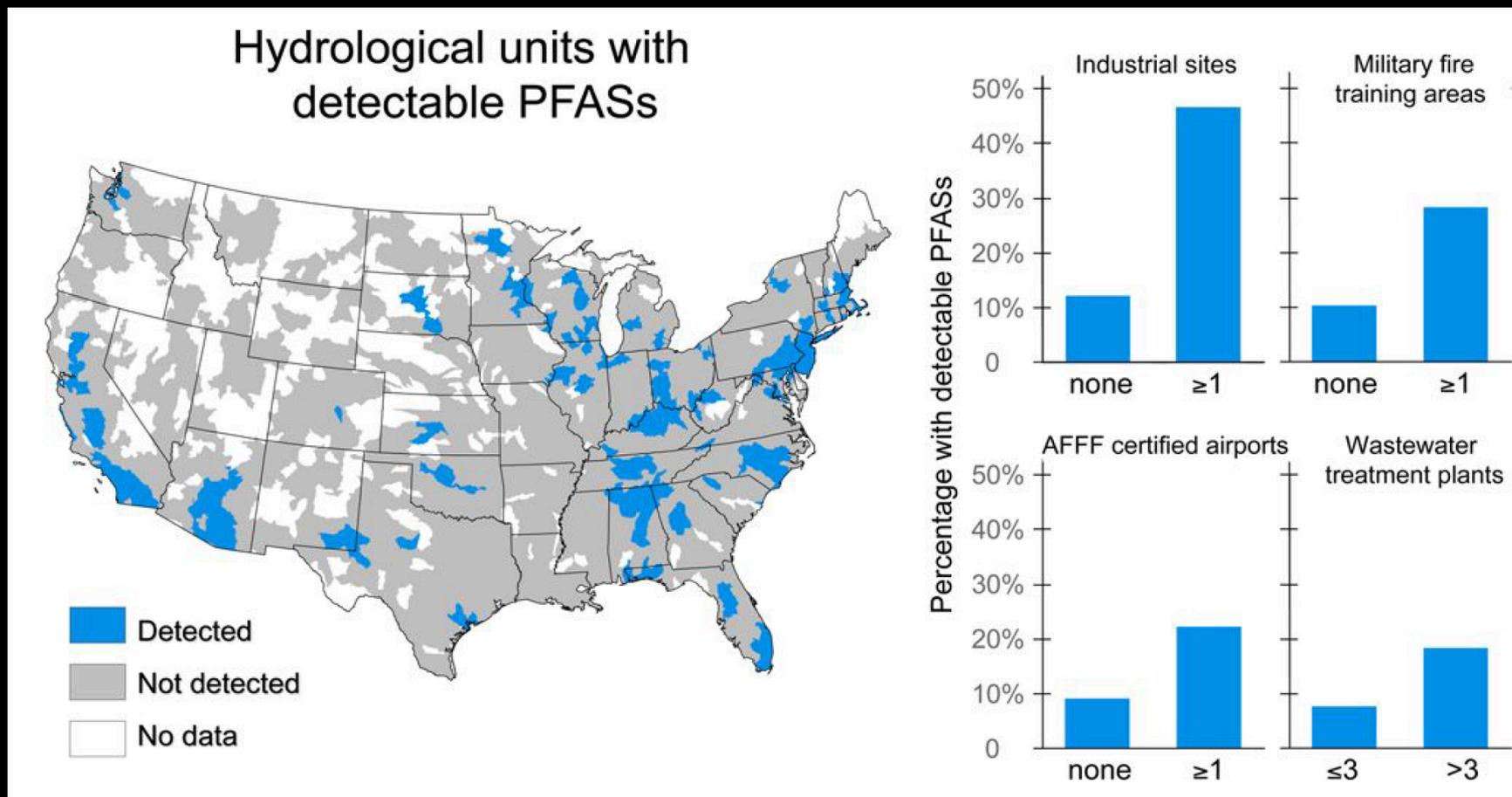
**These bioaccumulative compounds  
occur globally,  
warranting further study.**

JOHN P. GIESY AND KURUNTHACHALAM KANNAN

- Ubiquitous
- Long-range transport



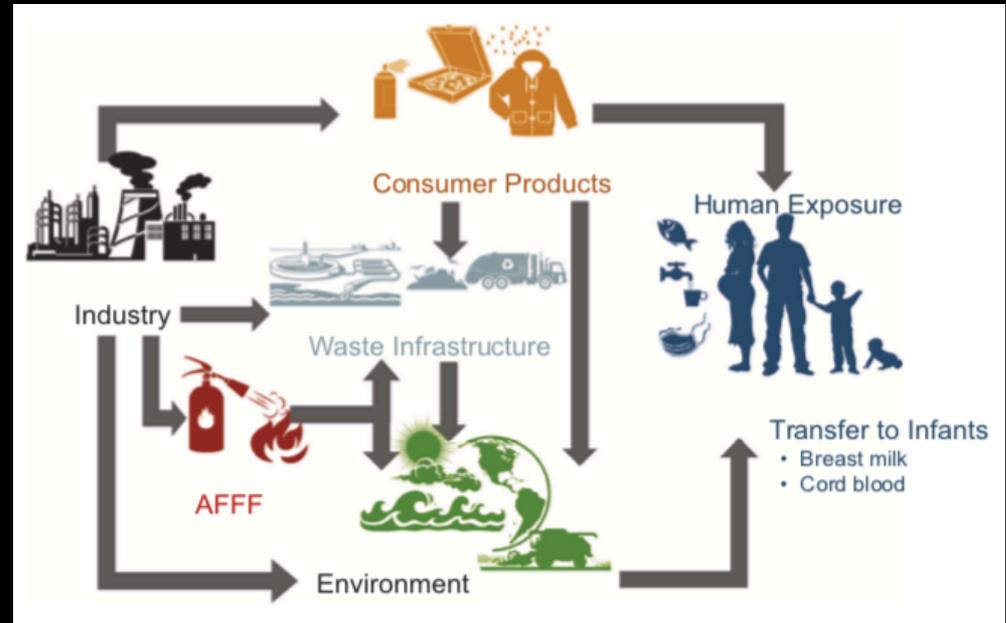
# UCMR<sub>3</sub> Data



EPA Lifetime Health Advisory Level of 70 ng/L PFOA + PFOS

# Exposure Sources & Pathways

- Drinking water
- Diet (foodstuffs & food packaging)
- Dust
- Air
- Consumer Products

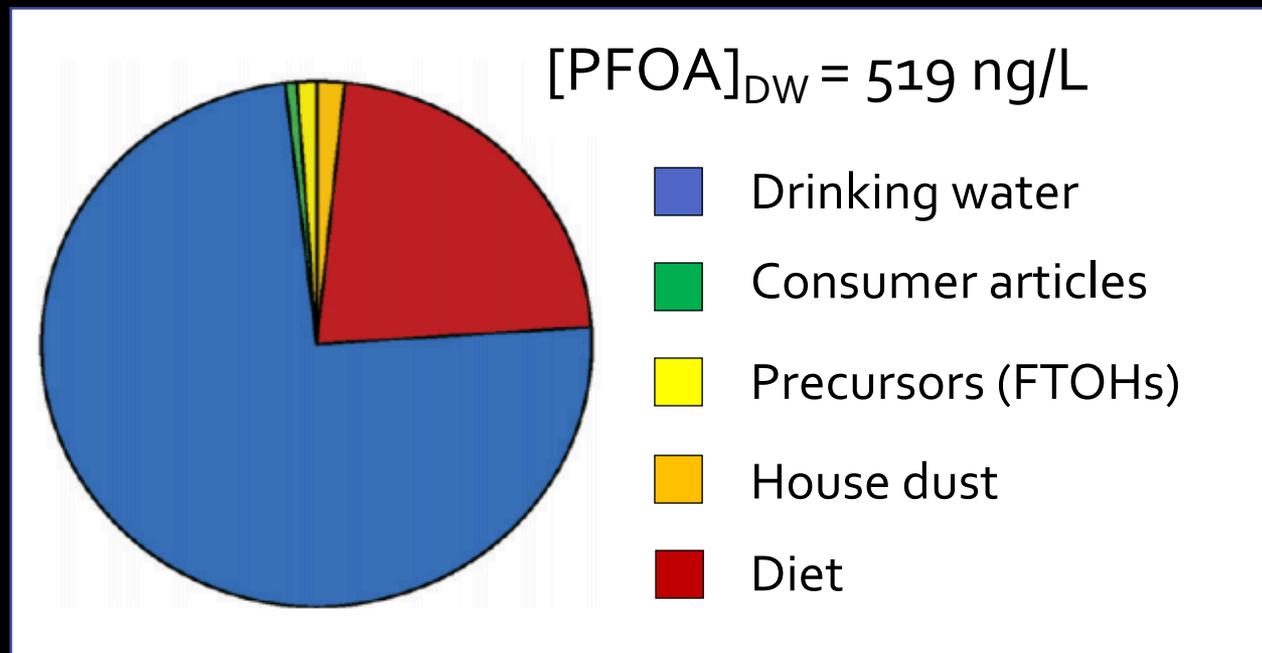


Sunderland et al., JESEE, 2018.  
DOI: 10.1038/s41370-018-0094-1

# Exposure Sources & Pathways

Scenario:

Contaminated drinking water

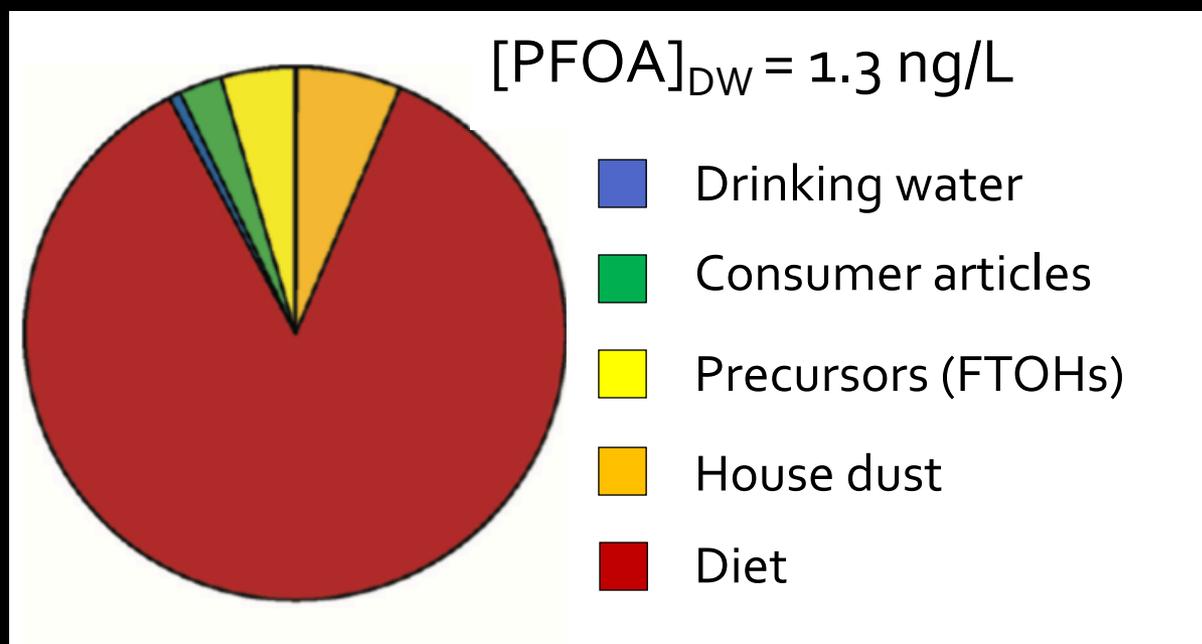


Vestergren & Cousins, ES&T, 2009. DOI: 10.1021/es900228k

# Exposure Sources & Pathways

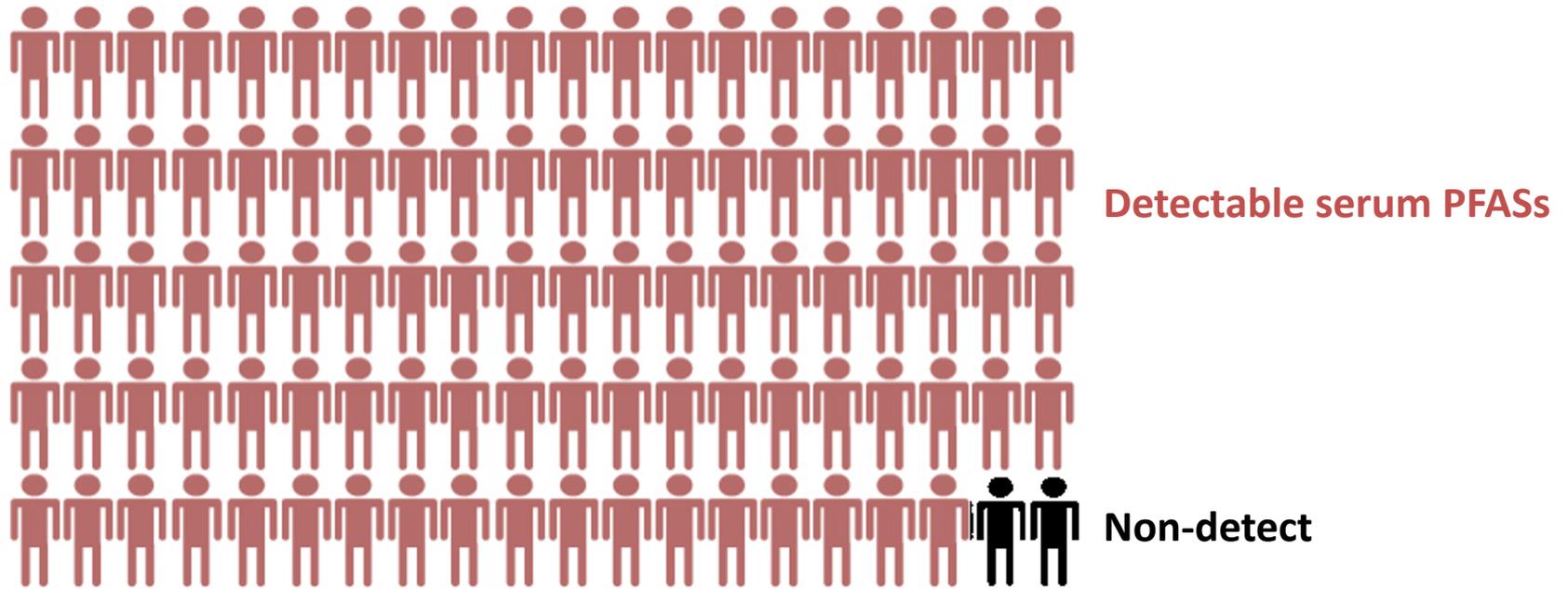
Scenario:

Background level in drinking water



Vestergren & Cousins, ES&T, 2009. DOI: 10.1021/es900228k

# PFASs exposure is a health concern



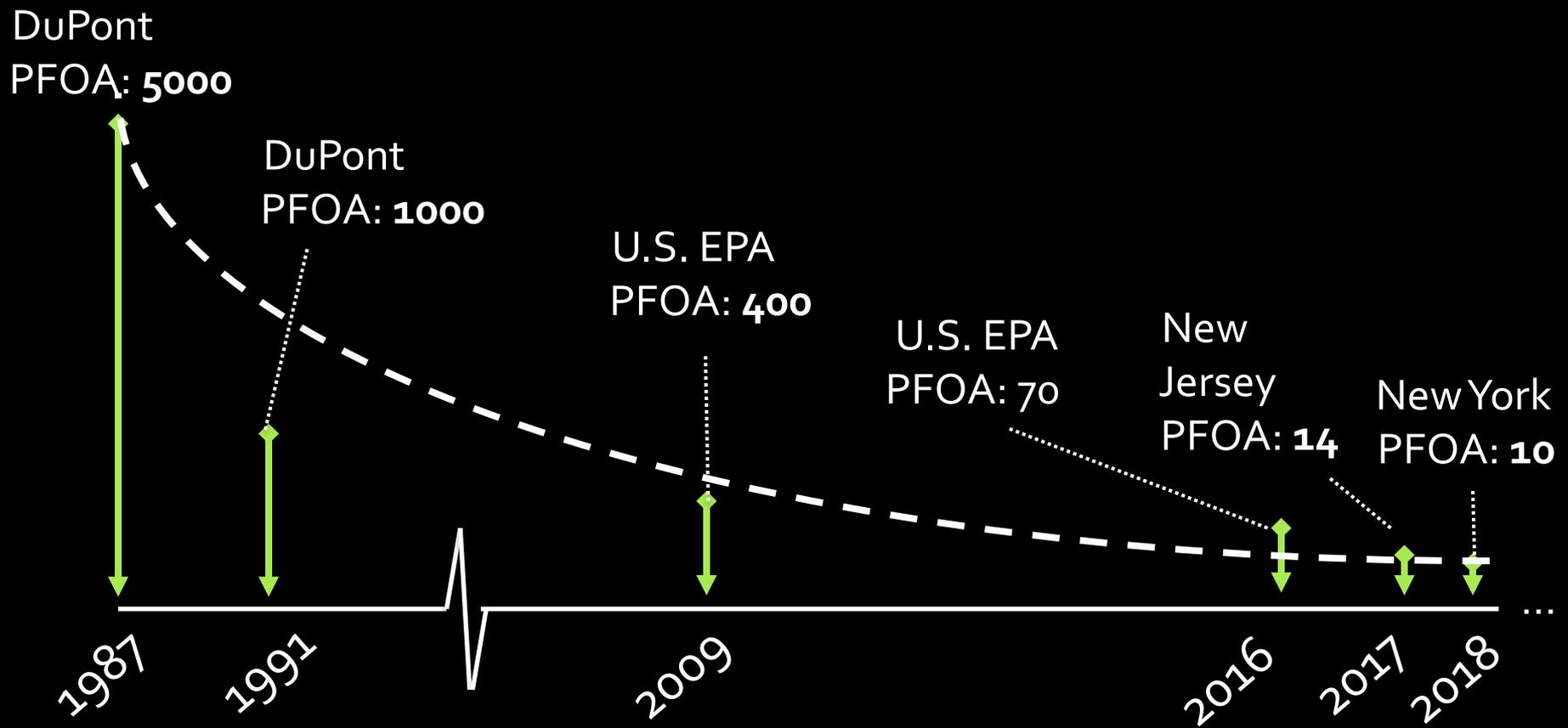
Exposure linked to health risks:

Cancer, elevated cholesterol, obesity, immune suppression, and endocrine disruption

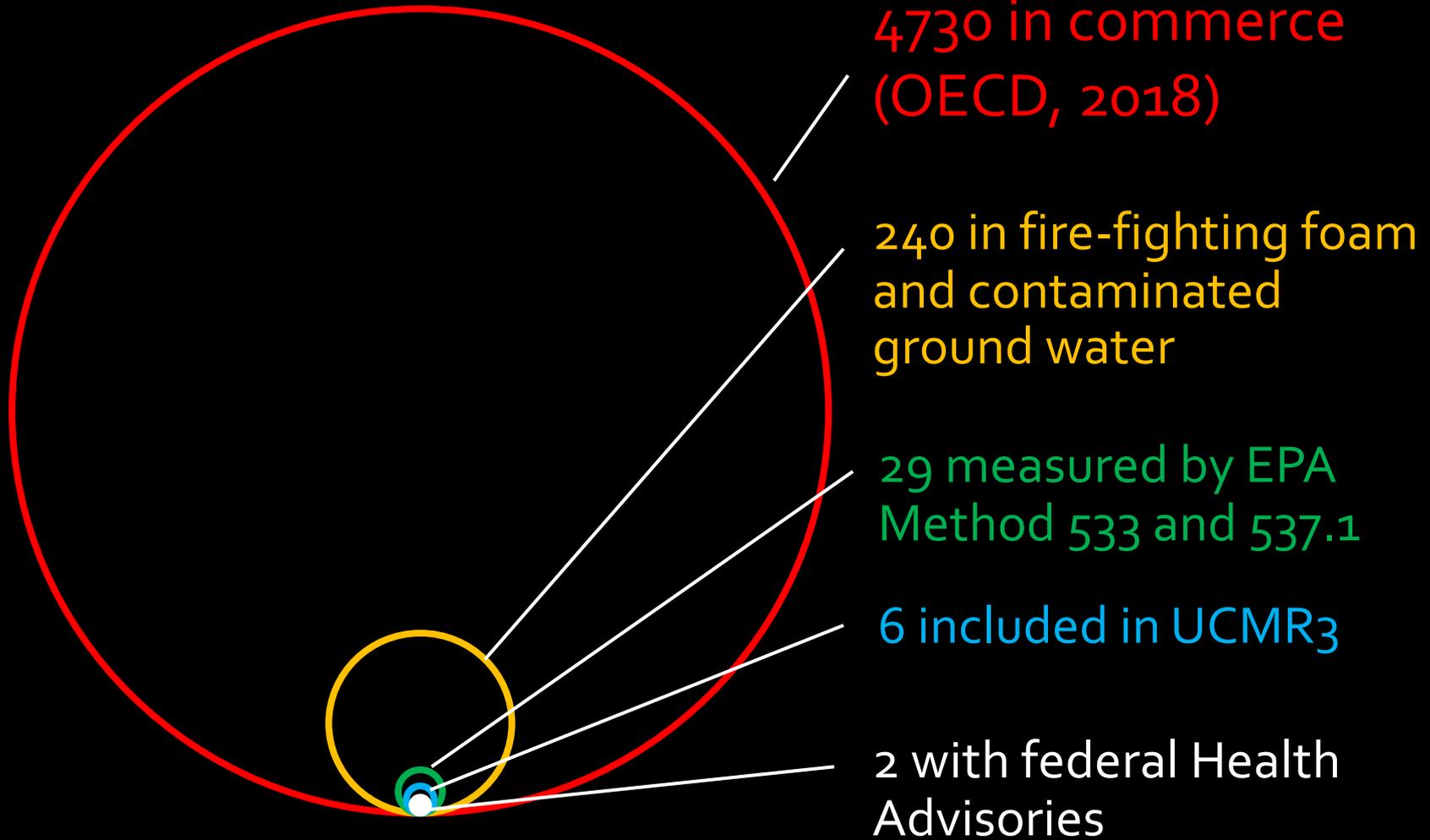
Courtesy, Cindy Hu, Harvard University

(Ref: Lewis et al., 2015; Grandjean et al., 2012; Braun et al., 2016; Barry et al., 2013)

# Drinking Water Health Guidelines (ng/L)



# PFAS



## Scientific Basis for Managing PFAS as a Chemical Class

Carol F. Kwiatkowski,\* David Q. Andrews, Linda S. Birnbaum, Thomas A. Bruton, Jamie C. DeWitt, Detlef R. U. Knappe, Maricel V. Maffini, Mark F. Miller, Katherine E. Pelch, Anna Reade, Anna Soehl, Xenia Trier, Marta Venier, Charlotte C. Wagner, Zhanyun Wang, and Arlene Blum

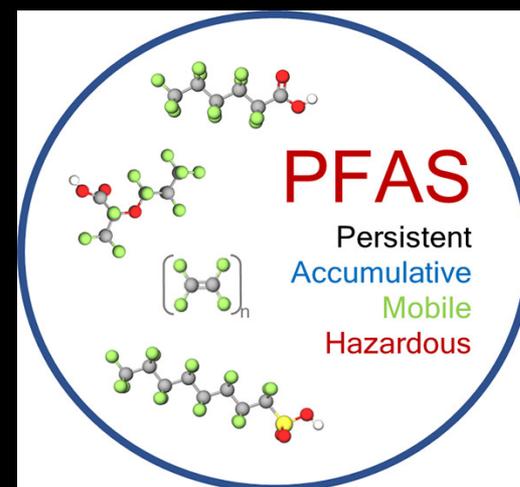


Cite This: <https://dx.doi.org/10.1021/acs.estlett.0c00255>



Read Online

- Extreme persistence and potential toxicity make all PFAS suspect
- Not enough time to study them all
- Avoid their use when possible

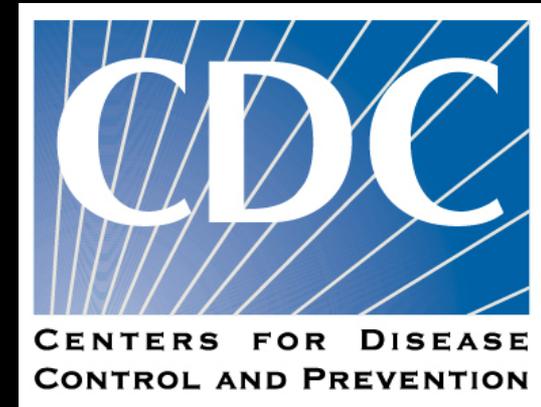


# Recent comments from CDC

Patrick Breysse, Director of the CDC's National Center for Environmental Health:

The presence of perfluorinated chemicals in U.S. drinking water is "one of the most seminal public health challenges for the next decades."

"...it won't be too long before we think hundreds of millions of Americans will be drinking water with levels of these chemicals above levels of concern."



- BNA News, Oct. 17, 2017

# PFAS & Wastewater Treatment

- Are WWTPs sources of PFAS?



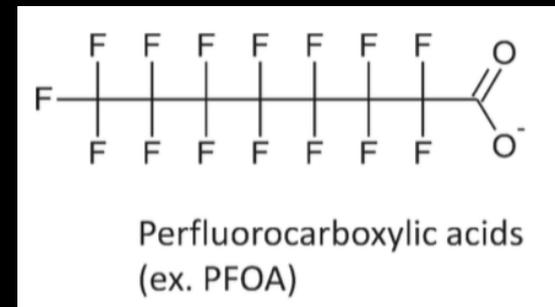
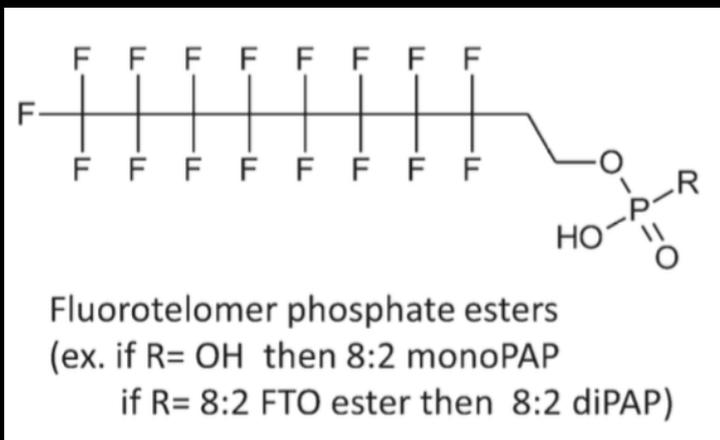
# Sources of PFAS Emissions

- Industrial
  - Plants that produce PFAS
  - Plants that use PFAS
- Firefighting foam
  - Military bases, airports, etc.
- Landfills
- Consumer products\* – carpets, apparel, food packaging, cosmetics, other

High input = high output.  
Industrial sources &  
firefighting foam are  
important.

# Conventional treatment trains not effective

- Perfluoroalkyl acids (PFOA, PFOS, etc.) resistant to biodegradation
- Aerobic treatment oxidizes precursor compounds, generating more perfluoroalkyl acids
- Effluent > Influent



# From WWTPs to the Environment: Biosolids

- Partitioning to biosolids
  - Long-chains > short-chains
- 2013 study: 10 out of 13 PFAS analyzed consistently detected in US municipal biosolids samples
- Potential for accumulation in agricultural soils & uptake to food crops

# Maine

- Paper mill sludge led to contamination of
  - Local municipal supply well
  - Milk at dairy
- Maine DEP:
  - All biosolids must now be tested for PFAS prior to use
  - Initial testing: nearly all biosolids exceed state screening levels for PFOS and/or PFOA (5.2 and 2.5 ng/g)



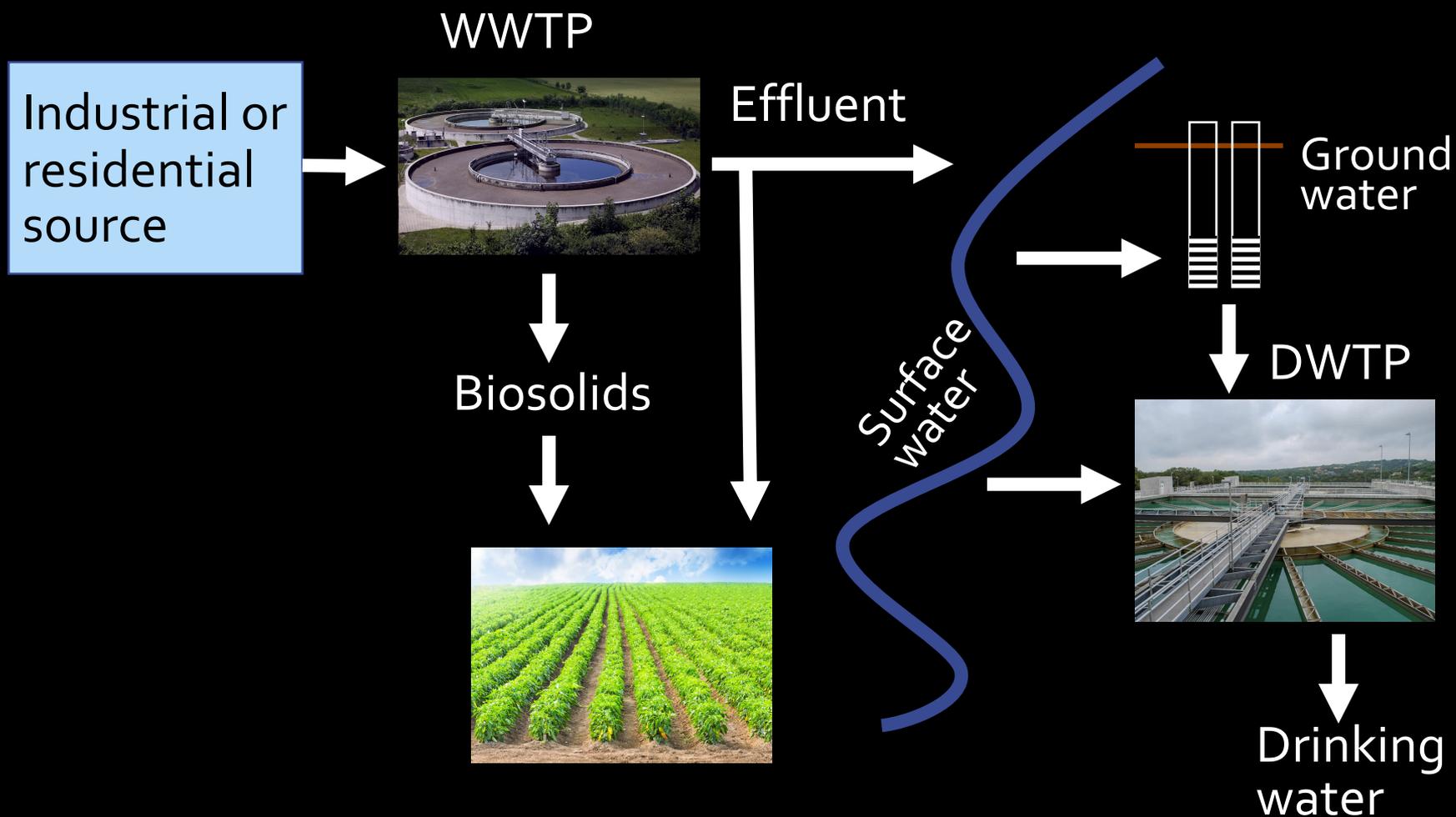
[theintercept.com/2019/06/07/pfas-chemicals-maine-sludge/](https://theintercept.com/2019/06/07/pfas-chemicals-maine-sludge/)

# From WWTPs to the Environment: Effluent

- Problematic for downstream users, example:  
Orange County
  - OC has more wells with reportable PFAS than LA, Riverside, and San Bernardino counties combined
  - Suspected source: treated wastewater from Inland Empire entering groundwater through Santa Ana River
  - OCWD expects to shut down 1/3 of its 200 wells this year due to PFOA & PFOS

See Orange County Register, Jan. 17, 2020

# PFAS Fate



# PFAS Treatment



## Drinking Water:

- Granular activated carbon
- Ion exchange
- Reverse osmosis

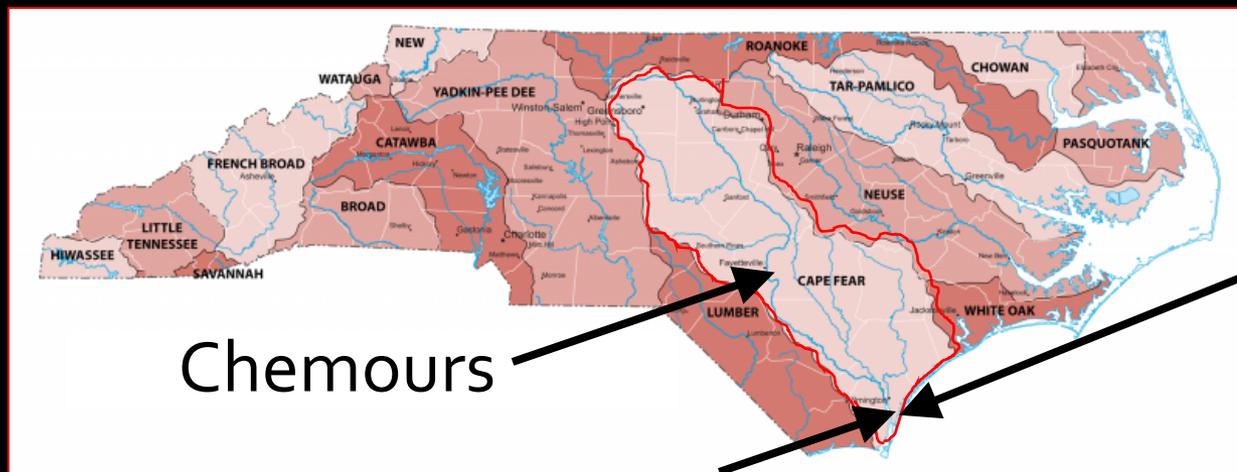
## Wastewater:

- Advanced treatment

## Biosolids:

- Industrial pretreatment

# Water Treatment Costs: North Carolina



Chemours

Brunswick County:  
reverse osmosis  
filtration:

- \$99M to build
- \$2.9M to operate

Cape Fear Public Utility Authority  
activated carbon filtration:

- \$46M to build
- \$2.7M to operate each year

Wilmington Star News, May 9<sup>th</sup> & 10<sup>th</sup>, 2018

# Congressional PFAS Task Force

- Launched 1/24/19

- Goals

- Educate
- Elevate
- Legislate
- Appropriate

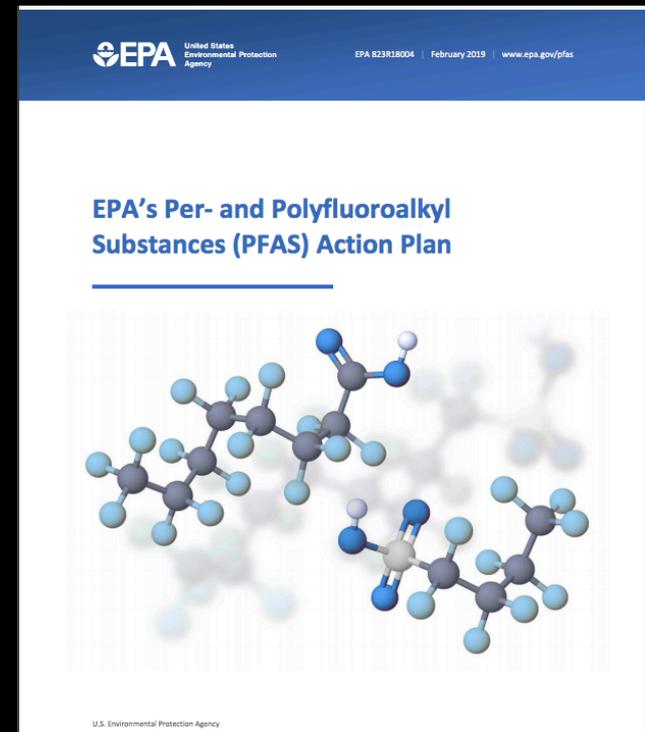


- Accomplishments

- CDC Health Studies
- USGS monitoring
- Stop DoD and FAA use of PFAS firefighting foam

# U.S. EPA

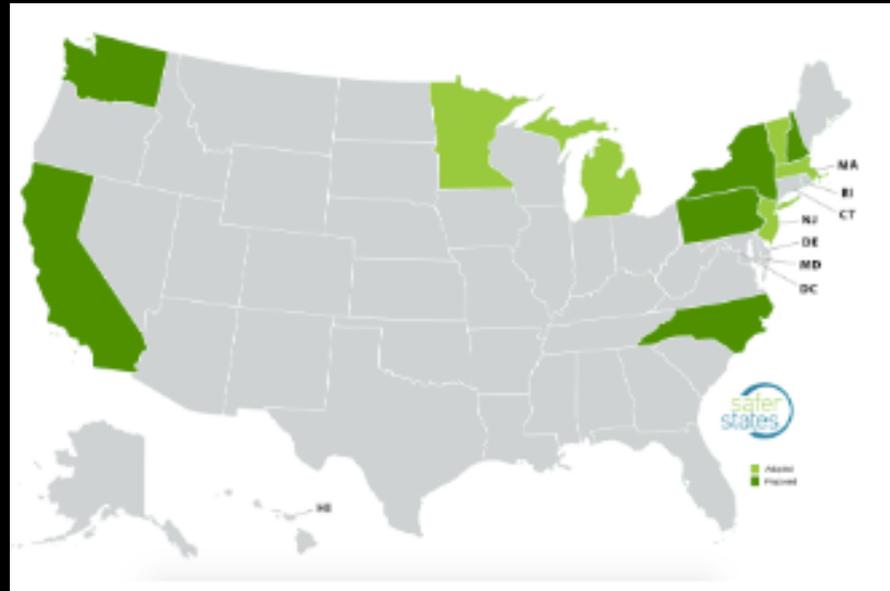
- May 2018: PFAS Summit
- Feb. 2019: PFAS Action Plan
  - Drinking water
  - Cleanup
  - Toxics
  - Monitoring
  - Research
  - Enforcement
  - Risk Communication



# Drinking water: US states

## Adopted or proposed standards & guidelines

- MN
- MI
- NJ
- VT
- CA
- NC
- NH
- NY
- PA
- WA



# Drinking water: California



August 2019: Notification levels dropped

- PFOS: 13 ppt → 6.5 ppt
- PFOA: 14 ppt → 5.1 ppt

Feb. 2020: Response levels dropped

- Formerly: (PFOA + PFOS) 70 ppt
- Now: PFOA 10 ppt, PFOS 40 ppt

OEHHA developing Public Health Goals

# CA Water Board PFAS Investigation

Announced March 2019

- Phase 1: airports, landfills, and nearby drinking water wells
- Phase 2: Refineries, fuel terminals, fire training locations, urban wildfire areas
- Phase 3: Wastewater treatment plants

July 9, 2020:

- Investigative order to ~250 POTWs (> 1 mgd)
- 31 PFAS compounds
- Beginning Q4 2020, to last 1 year

PFAS are Problematic  
& Difficult to Clean Up

Prevention is preferable!

Only use when necessary

# Moving away from PFAS



CARPETS



CARPET CLEANING PRODUCTS



FOOD PACKAGING



FURNISHINGS



COSMETICS



OUTDOOR GEAR



CLOTHING



ADHESIVES AND SEALANTS



PROTECTIVE COATINGS



NON-STICK COOKWARE



CARSEATS



FIREFIGHTING FOAM

# Thank you!

**PFAS Central: sharing notable news, scientific papers & events**

**NEWS**  
**PFAS Chemicals to be Banned in Firefighting Foam Used on Military Bases**  
U.S. Senator Kirsten Gillibrand today announced that a provision she cosponsored to prohibit the Department of Defense from procuring firefighting foam that contains per- and polyfluoroalkyl substances (PFAS) passed the Senate Armed Services Committee as part of the annual National Defense Authorization Act (NDAA).  
[LEARN MORE](#)

**SCIENCE**  
**Larval amphibians rapidly bioaccumulate poly- and perfluoroalkyl substances.**  
Toxic frogs lead to bioaccumulation in predator species.  
[LEARN MORE](#)

**POLICY**  
**The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS**  
A recent Nordic Council study, The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS, estimates the very high cost of harm to human health and the environment from PFAS exposure in Europe.  
[LEARN MORE](#)

To learn more:  
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