



**PFAS Talk**  
**Philip Myers, Director PEMY Consulting**  
**W-H4**  
**27 February 2024**

- **26th California Unified Program**
- **Annual Training Conference**
- **February 26-29, 2024**

# Environmental milestones

- Rachel Carson “Silent Spring”

- 1970 EPA Created
- 1971 Lead based paint restrictions
- 1971 Clean air act
- 1972 DDT banned
- 1972 Clean water act
- 1973 Ocean dumping act
- 1974 Leaded gasoline over
- 1974 Safe drinking water act
- 1976 Pesticides
- 1976 RCRA
- 1977 TSCA
- 1977 Love canal
- 1978 Lead air pollution
- 1978 CFCs
- 1978 PCBs
- 1980 Superfund
- 1981 Valley of the Drums

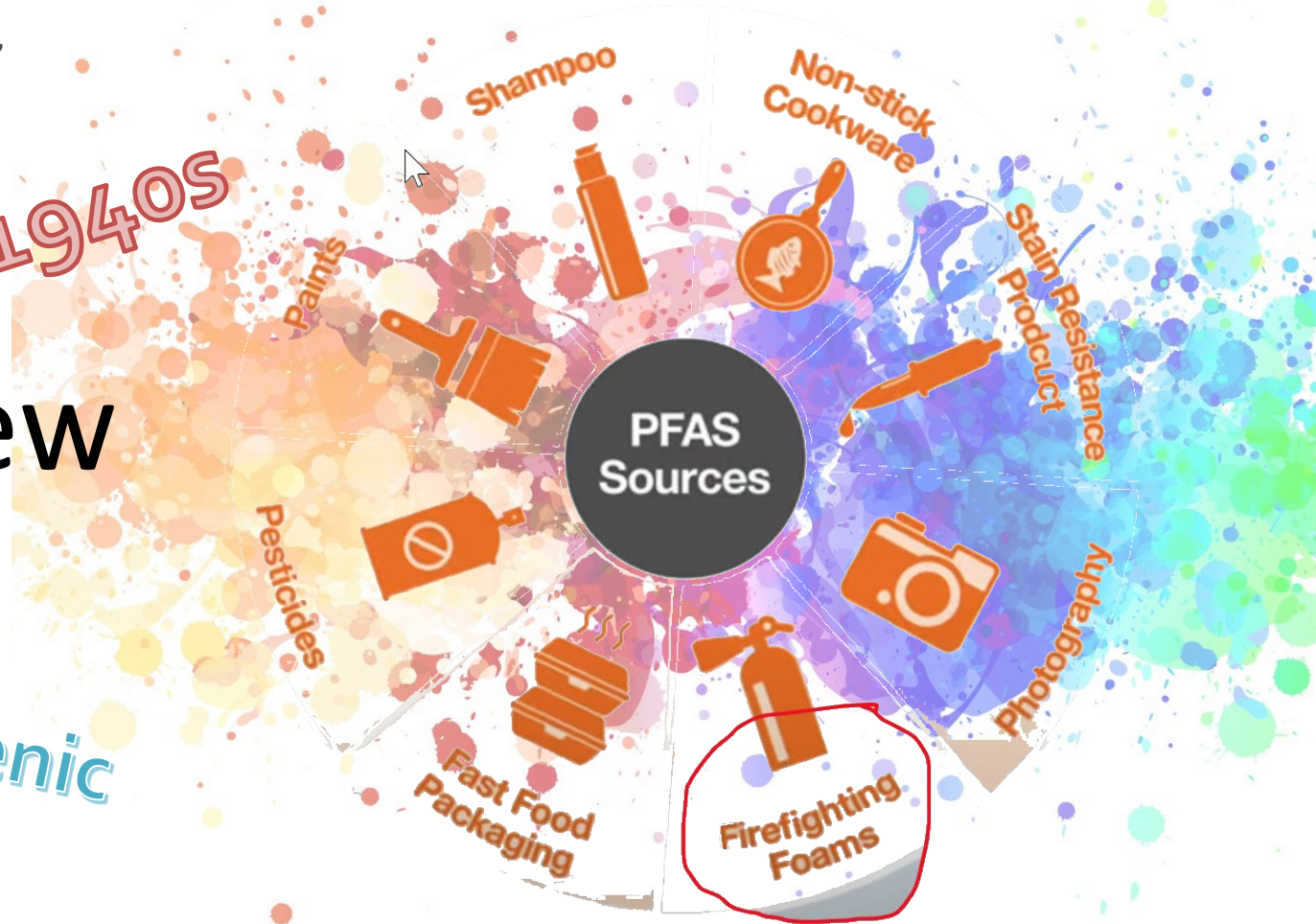
- 1982 Asbestos
- 1983 Dioxin
- 1983 EDB Pesticide
- 1985 Hole in ozone layer
- 1987 Right to Know EPCRA
- 1988 UST standards
- 1989 XON Valdez
- Acid Rain 1990
- 1995 First refinery regulation
- 1996 Food Quality Protection Act
- 1997 Protection for Children
- 2000 Emission standards cars
- 2001 Global POP treaty
- 2006 Clean diesel
- 2007 Ground water rule
- 2010 BP Gulf Oil Spill
- 2010 Greenhouse gas reporting
- 2012 Mercury from power generation
- **2017 EPA announces intent to address PFAS**

PFAS as “PEA-fass”

1940S

# Overview

Anthropogenic



# Forever chemicals



PRIMARY FACULTY

## Joseph G. Allen

Associate Professor of Exposure Assessment Science  
Environmental Health

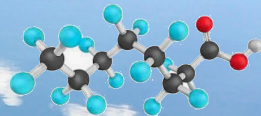
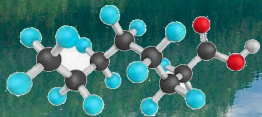
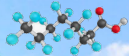
[jgallen@hsph.harvard.edu](mailto:jgallen@hsph.harvard.edu)

The “f” in “forever” comes from “fluorine” and the “c” in “chemicals” comes from “carbon.” The Harvard researcher Joe Allen coined the term “forever chemicals” in a 2018 op-ed in the Washington Post.

### **Organic Fluorine as an Indicator of Per- and Polyfluoroalkyl Substances in Dust from Buildings with Healthier versus Conventional Materials.**

Young AS, Pickard HM, Sunderland EM, Allen JG.

Environ Sci Technol. 2022 12 06. 56(23):17090-17099. PMID: [36331119](https://pubmed.ncbi.nlm.nih.gov/36331119/)



# PFAS side effects?

- Bioaccumulate in living systems including you
- Biomultiplication in food chain 5x – 50x
- Pervasive and persistence – hence “forever”
- In 2022 it was found that level of at least four perfluoroalkyl acids (PFAAs) in rainwater worldwide ubiquitously, and often greatly, exceeded the EPA’s lifetime drinking water health advisories



# Who are biggest users of AFFF

- The biggest users of AFFF are in the U.S. military, petrochemical, and aviation industries.
- Usage of PFAS and PFOS voluntarily discontinued in mid 2000s
- Replaced with other potentially harmful substances



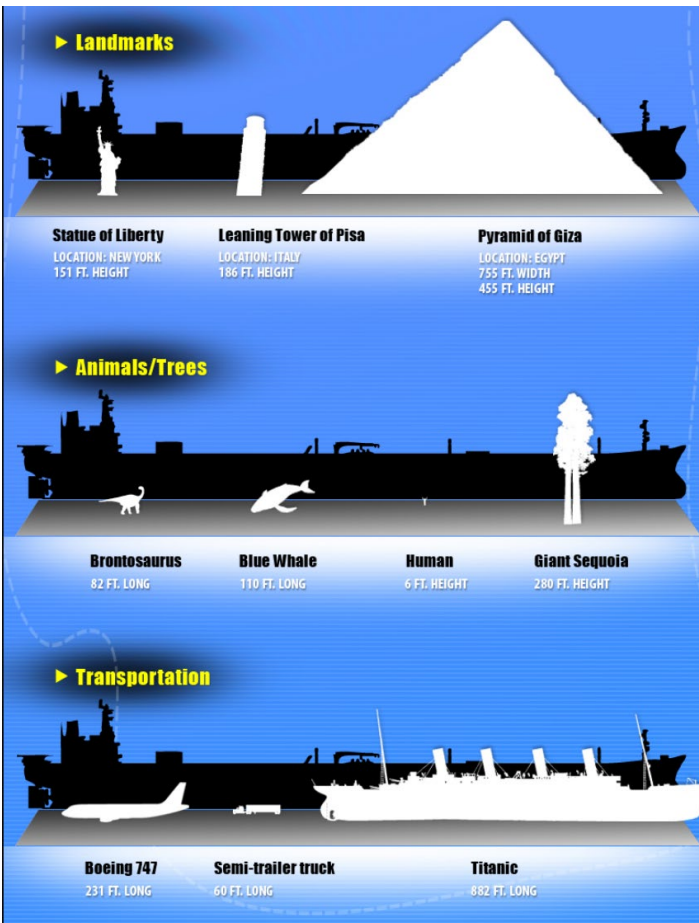
Scale



2500 cubes

1 ml per 400 pools





TT *Knock Nevis*, formerly *Seawise Giant*, leaving the Dubai Drydocks

History	
<b>Name</b>	<i>Seawise Giant</i> (1979–1991) <i>Happy Giant</i> (1991) <i>Jahre Viking</i> (1991–2004) <i>Knock Nevis</i> (2004–2009) <i>Mont</i> (2009–2010)
<b>Owner</b>	<b>Amber Development</b> (2009–2010)

<b>Length</b>	458.45 m (1,504.10 ft)
<b>Beam</b>	68.6 m (225.07 ft)
<b>Draft</b>	24.611 m (80.74 ft)
<b>Depth</b>	29.8 m (97.77 ft)
<b>Propulsion</b>	2 Mitsubishi V2M8 boilers (Designed by Combustion Engineering) Sumitomo <i>Stal-Laval AP</i> steam turbine, 50,000 hp

25M Cubes=  
160 large  
crude tanks  
Or  
10000  
Olympic  
pools  
U get 4 ppt  
by adding  
62 ml PFAS



# The Chemistry

# PFAS, PFOA, PFOS, GenX, PFBS?

- PFAS (Per and poly-fluoroalkyl substances)
- Around since invented in the 40s
- Concern when in 2000s Perflourooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in human blood detected
- Hundreds of different PFAS in water, soil and air.
- Most voluntarily phased out by US mfrs in the mid 2000s

# Carbon

atomic number

6

atomic weight

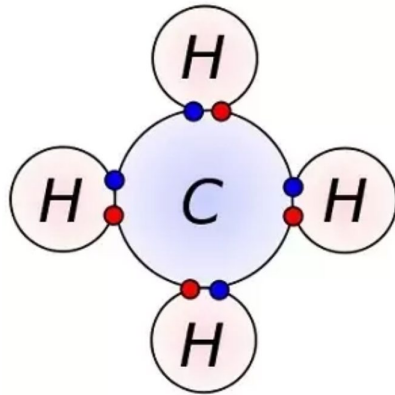
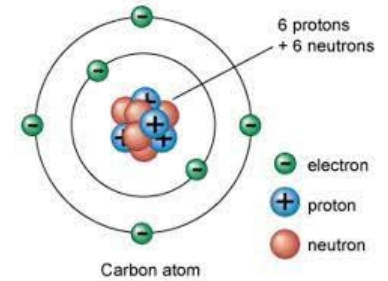
12.0096 to 12.0116

melting point

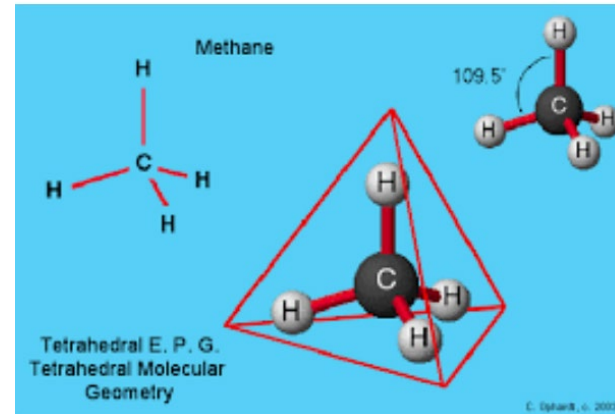
3,550 °C (6,420 °F)

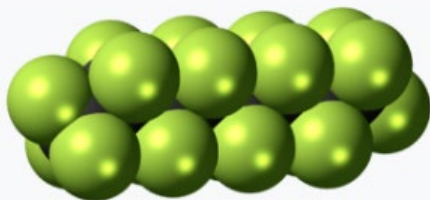
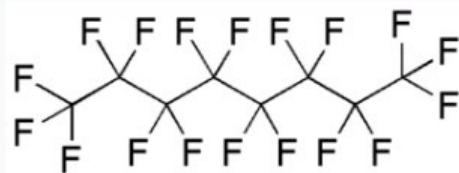
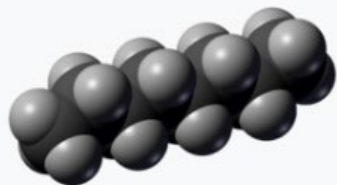
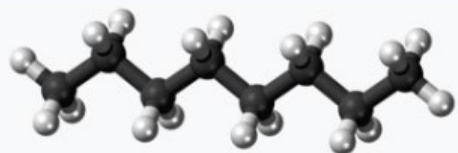
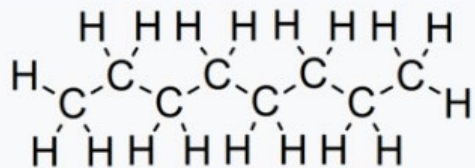
boiling point

4,827 °C (8,721 °F)

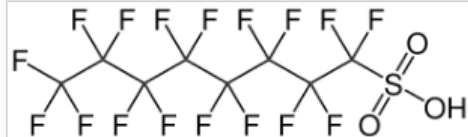
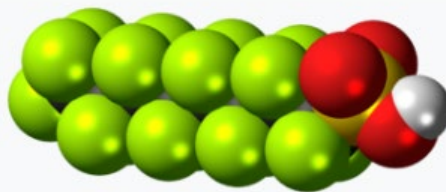


● Electron from hydrogen  
● Electron from carbon





### Perfluorooctanesulfonic acid



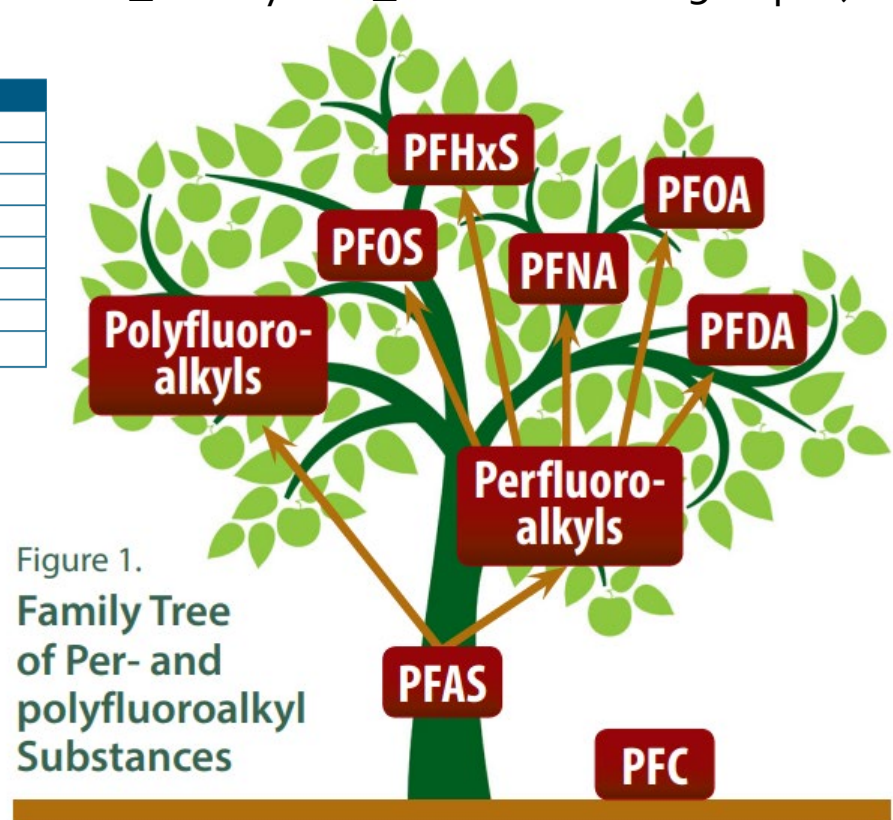
Skeletal structure of PFOS, an effective, persistent and bioaccumulative fluorosurfactant



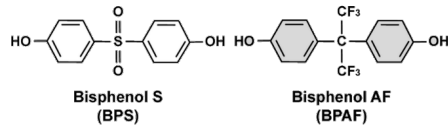
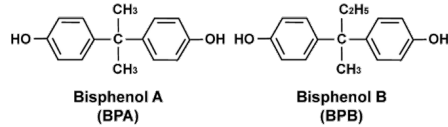
## The family tree of per- and polyfluoroalkyl substances (PFAS) for environmental health professionals

Abbreviation	Chemical name
PFOS	Perfluorooctane sulfonic acid
PFOA (aka C8)	Perfluorooctanoic acid
PFNA	Perfluorononanoic acid
PFDA	Perfluorodecanoic acid
PFOSA (aka FOSA)	Perfluorooctane sulfonamide
MeFOSAA (aka Me-PFOSA-AcOH)	2-(N-Methyl-perfluorooctane sulfonamido) acetic acid
Et-FOSAA (aka Et-PFOSA-AcOH)	2-(N-Ethyl-perfluorooctane sulfonamido) acetic acid
PFHxS	Perfluorohexane sulfonic acid

[ATSDR, NCEH Fact Sheet.]([https://www.atsdr.cdc.gov/pfas/docs/PFAS\\_FamilyTree\\_EnvHealthPro-508.pdf](https://www.atsdr.cdc.gov/pfas/docs/PFAS_FamilyTree_EnvHealthPro-508.pdf))



# “Chemical Wack a Mole”



Which would you choose?



# There are thousands of PFAS

- What if you regulate just PFOA – will it solve the problem?
- Which ones are toxic and what is the relative toxicity?
- If you are a manufacturer, can you stop making perfluorooctane that may be regulated and use perfluoroheptane? How toxic is the perfluoroheptane relative to the perfluorooctanes?
- What about adding other elements to the alkyl backbone?
- We just don't know about the others. Luckily, there is \$10B allocated to this by BIL

# PFAS cycle

INDUSTRIES THAT PRODUCE OR USE PFAS

PEOPLE/HOUSING

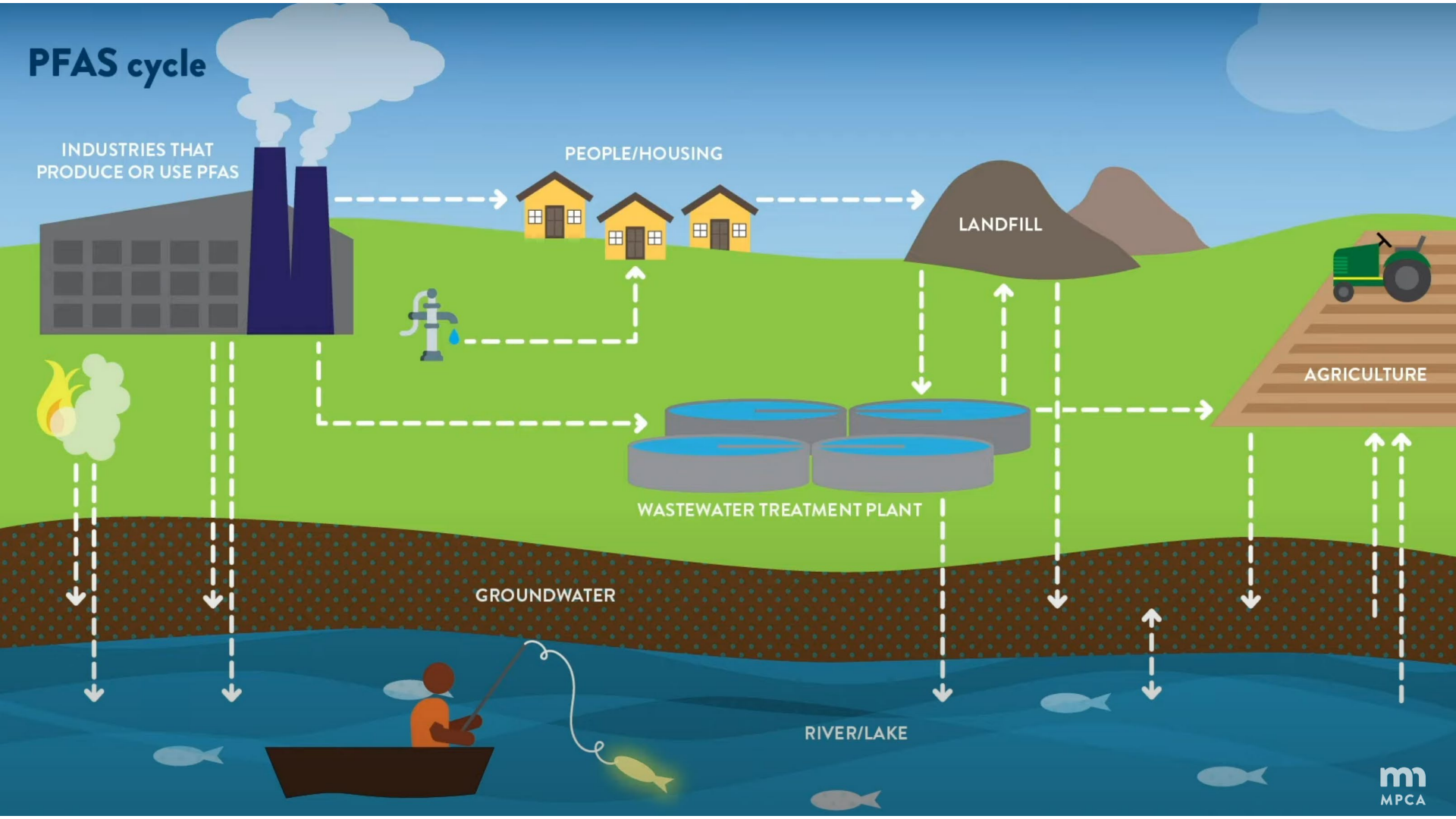
LANDFILL

AGRICULTURE

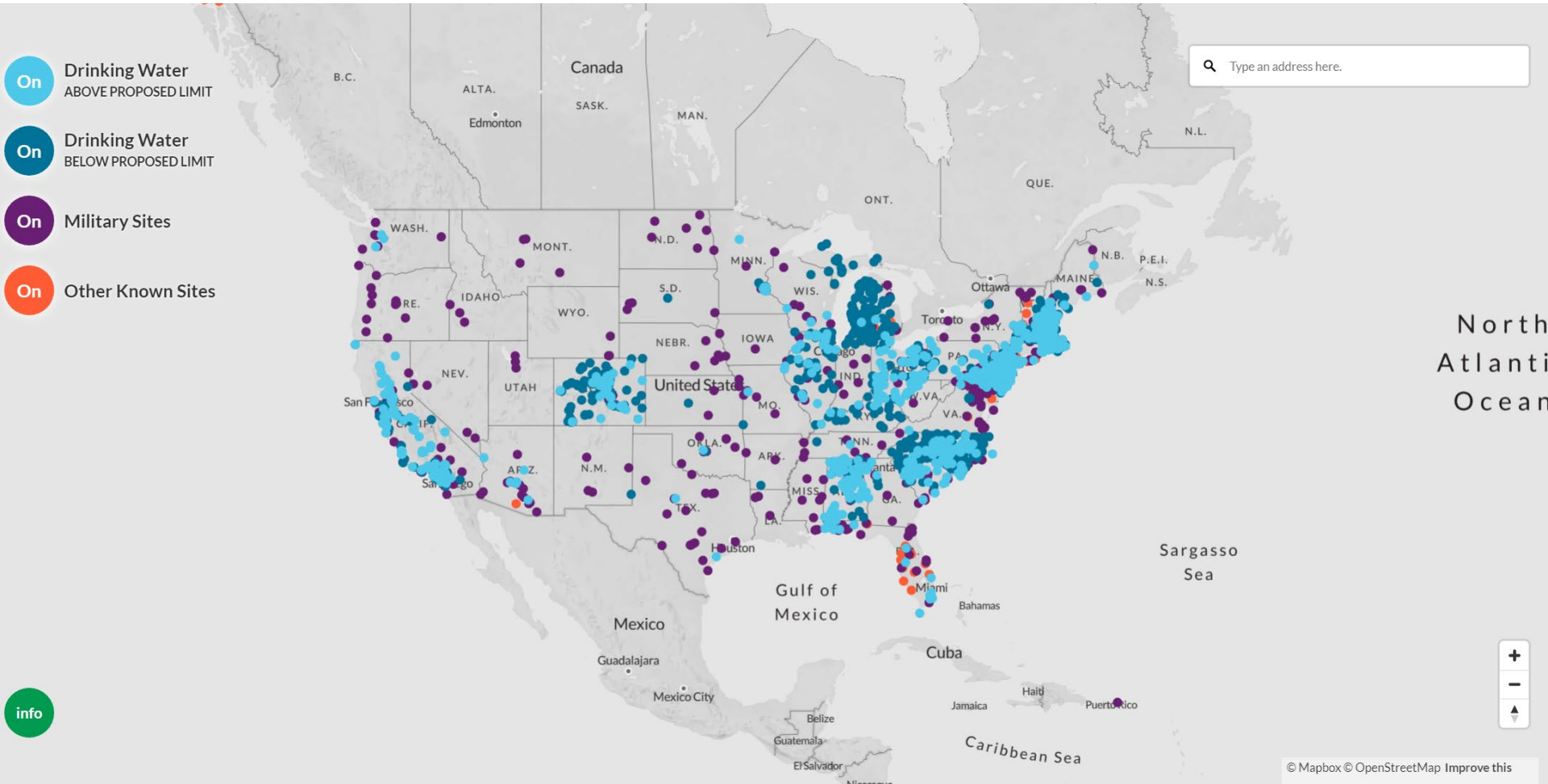
WASTEWATER TREATMENT PLANT

GROUNDWATER

RIVER/LAKE



# Where are they in the US water supplies



North  
Atlantic  
Ocean

Sargasso  
Sea

Gulf of  
Mexico

Caribbean  
Sea

# BREAK TIME!



26th California Unified Program  
Annual Training Conference  
February 26-29, 2024

# PFAS side effects?

- Bioaccumulate in living systems including you
- Biomultiplication in food chain 5x – 50x
- Pervasive and persistence – hence “forever”
- In 2022 it was found that level of at least four perfluoroalkyl acids (PFAAs) in rainwater worldwide ubiquitously, and often greatly, exceeded the EPA’s lifetime drinking water health advisories



# Who are biggest users of AFFF

- The biggest users of AFFF are in the U.S. military, petrochemical, and aviation industries.
- Usage of PFAS and PFOS voluntarily discontinued in mid 2000s
- Replaced with other potentially harmful substances



Scale

2500 cubes

1 ml per 400 pools





► Landmarks



**Statue of Liberty**

LOCATION: NEW YORK  
151 FT. HEIGHT

**Leaning Tower of Pisa**

LOCATION: ITALY  
186 FT. HEIGHT

**Pyramid of Giza**

LOCATION: EGYPT  
755 FT. WIDTH  
455 FT. HEIGHT

► Animals/Trees



**Brontosaurus**

82 FT. LONG

**Blue Whale**

110 FT. LONG

**Human**

6 FT. HEIGHT

**Giant Sequoia**

280 FT. HEIGHT

► Transportation



**Boeing 747**

231 FT. LONG

**Semi-trailer truck**

60 FT. LONG

**Titanic**

882 FT. LONG



TT *Knock Nevis*, formerly *Seawise Giant*, leaving the Dubai Drydocks

**History**

<b>Name</b>	<i>Seawise Giant</i> (1979–1991) <i>Happy Giant</i> (1991) <i>Jahre Viking</i> (1991–2004) <i>Knock Nevis</i> (2004–2009) <i>Mont</i> (2009–2010)
<b>Owner</b>	<b>Amber Development</b> (2009–2010)

<b>Length</b>	458.45 m (1,504.10 ft)
<b>Beam</b>	68.6 m (225.07 ft)
<b>Draft</b>	24.611 m (80.74 ft)
<b>Depth</b>	29.8 m (97.77 ft)
<b>Propulsion</b>	2 Mitsubishi V2M8 boilers (Designed by Combustion Engineering) Sumitomo <i>Stal-Laval AP steam turbine</i> , 50,000 hp

25M Cubes=  
160 large  
crude tanks  
Or  
10000  
Olympic  
pools  
U get 4 ppt  
by adding  
62 ml PFAS



# The Chemistry

# PFAS, PFOA, PFOS, GenX, PFBS?

- PFAS (Per and poly-fluoroalkyl substances)
- Around since invented in the 40s
- Concern when in 2000s Perflourooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in human blood detected
- Hundreds of different PFAS in water, soil and air.
- Most voluntarily phased out by US mfrs in the mid 2000s

# Carbon

atomic number

6

atomic weight

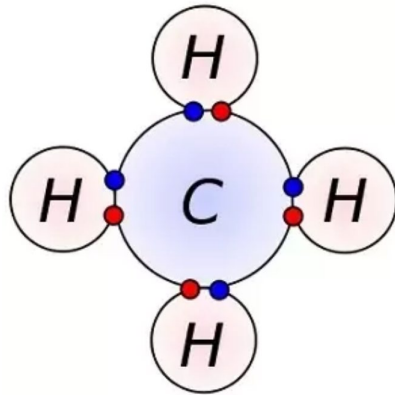
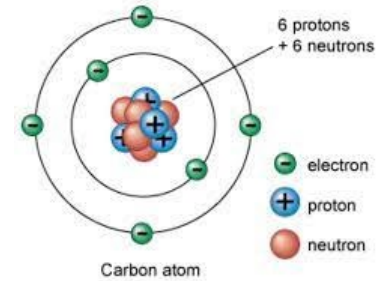
12.0096 to 12.0116

melting point

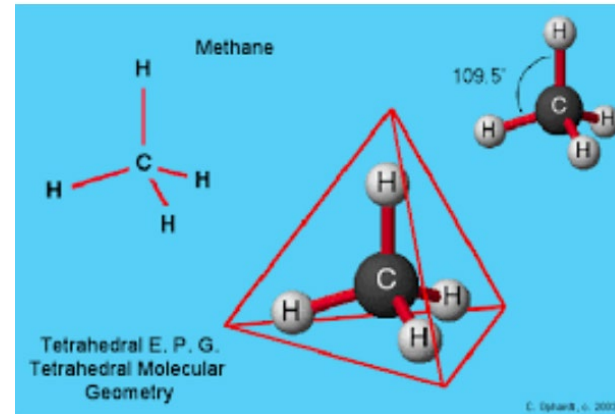
3,550 °C (6,420 °F)

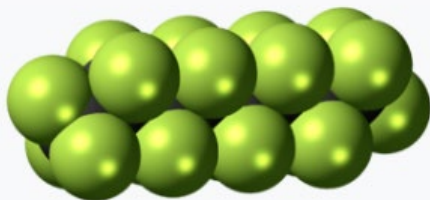
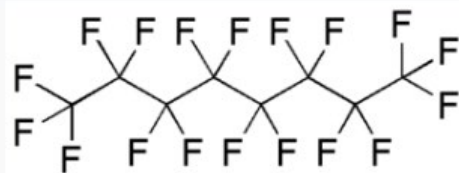
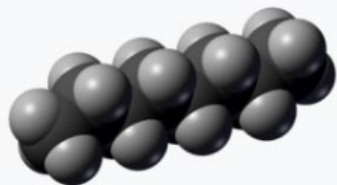
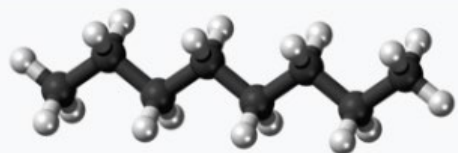
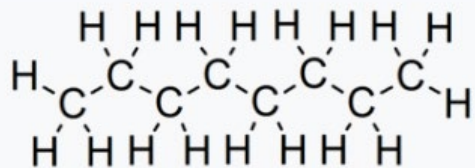
boiling point

4,827 °C (8,721 °F)

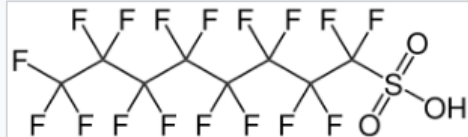


● Electron from hydrogen  
● Electron from carbon





### Perfluorooctanesulfonic acid



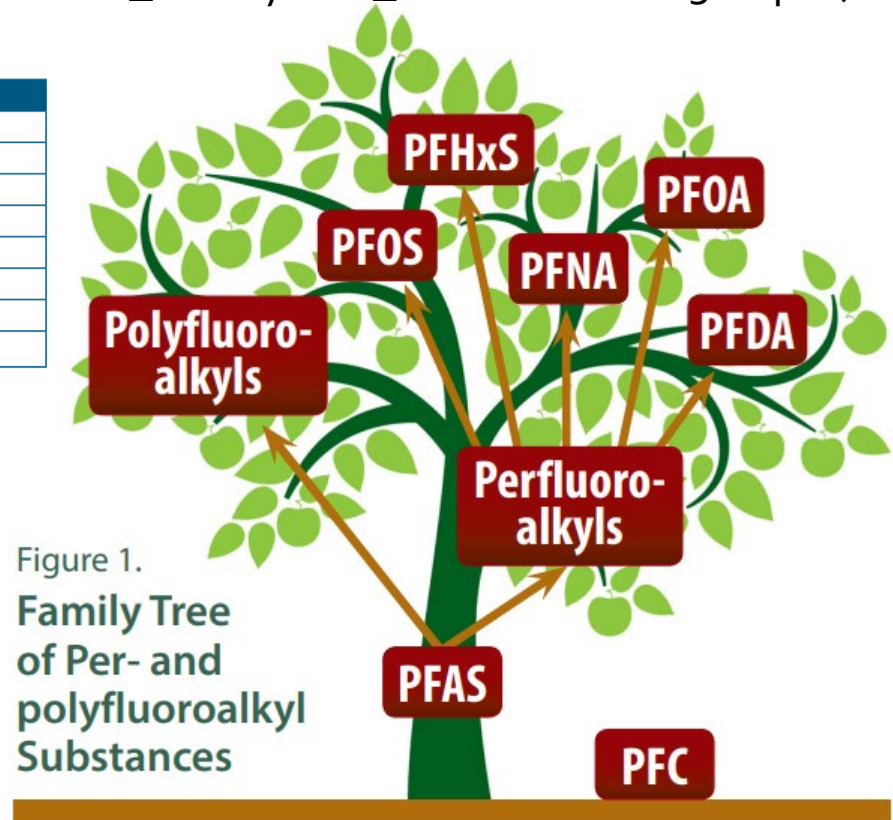
Skeletal structure of PFOS, an effective, persistent and bioaccumulative fluorosurfactant



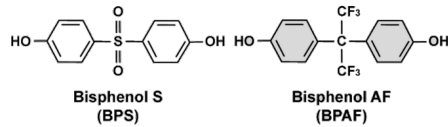
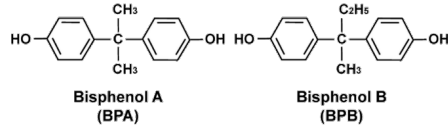
## The family tree of per- and polyfluoroalkyl substances (PFAS) for environmental health professionals

Abbreviation	Chemical name
PFOS	Perfluorooctane sulfonic acid
PFOA (aka C8)	Perfluorooctanoic acid
PFNA	Perfluorononanoic acid
PFDA	Perfluorodecanoic acid
PFOSA (aka FOSA)	Perfluorooctane sulfonamide
MeFOSAA (aka Me-PFOSA-AcOH)	2-(N-Methyl-perfluorooctane sulfonamido) acetic acid
Et-FOSAA (aka Et-PFOSA-AcOH)	2-(N-Ethyl-perfluorooctane sulfonamido) acetic acid
PFHxS	Perfluorohexane sulfonic acid

[ATSDR, NCEH Fact Sheet.]([https://www.atsdr.cdc.gov/pfas/docs/PFAS\\_FamilyTree\\_EnvHealthPro-508.pdf](https://www.atsdr.cdc.gov/pfas/docs/PFAS_FamilyTree_EnvHealthPro-508.pdf))



# “Chemical Wack a Mole”



*Which would you choose?*

# There are thousands of PFAS

- What if you regulate just PFOA – will it solve the problem?
- Which ones are toxic and what is the relative toxicity?
- If you are a manufacturer, can you stop making perfluorooctane that may be regulated and use perflouroheptane? How toxic is the perflourohepatane relative to the perfluorooctanes?
- What about adding other elements to the alkyl backbone?
- We just don't know about the others. Luckily, there is \$10B allocated to this by BIL



# PFAS cycle

INDUSTRIES THAT PRODUCE OR USE PFAS

PEOPLE/HOUSING

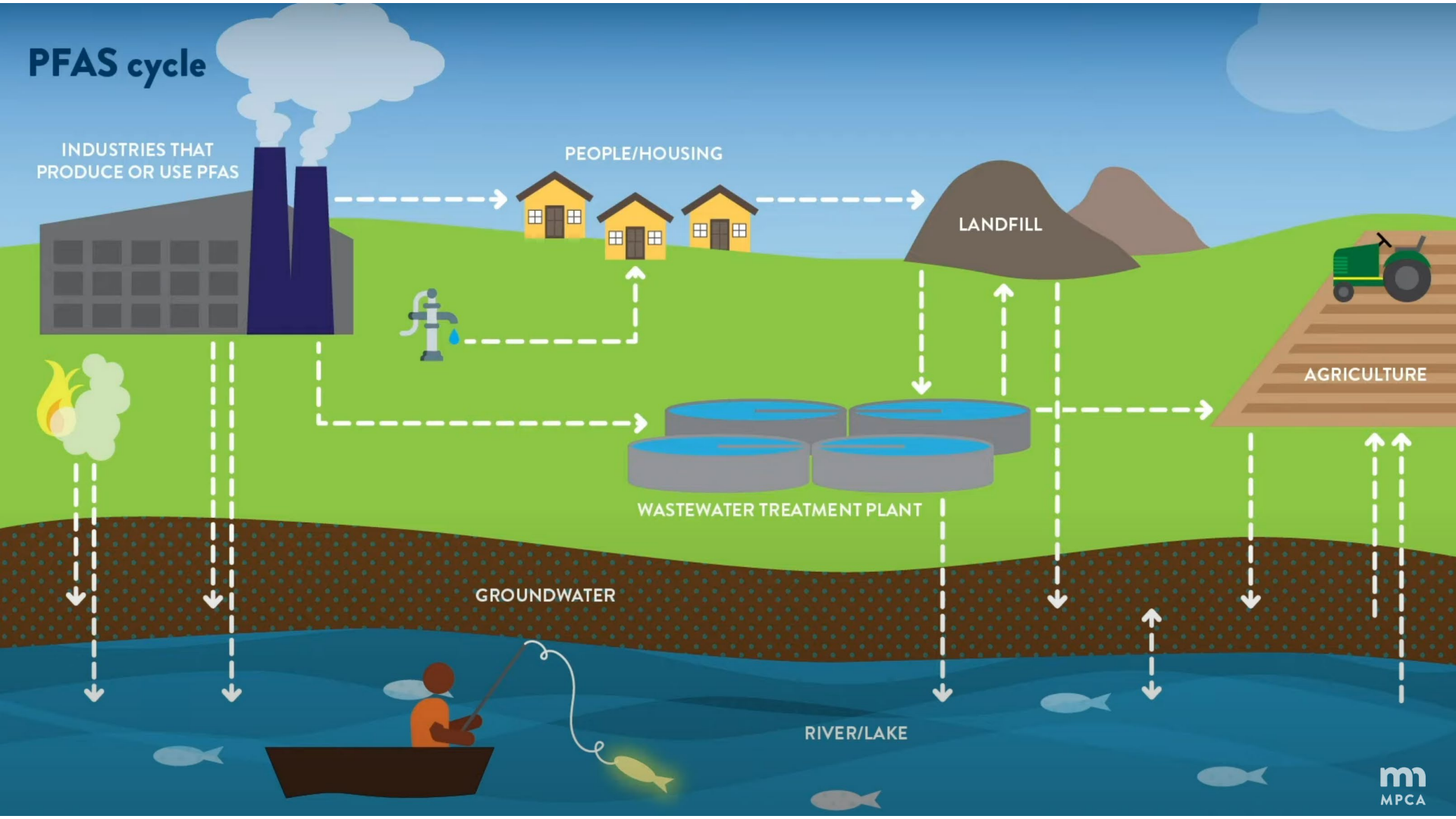
LANDFILL

AGRICULTURE

WASTEWATER TREATMENT PLANT

GROUNDWATER

RIVER/LAKE



# Where are they in the US water supplies

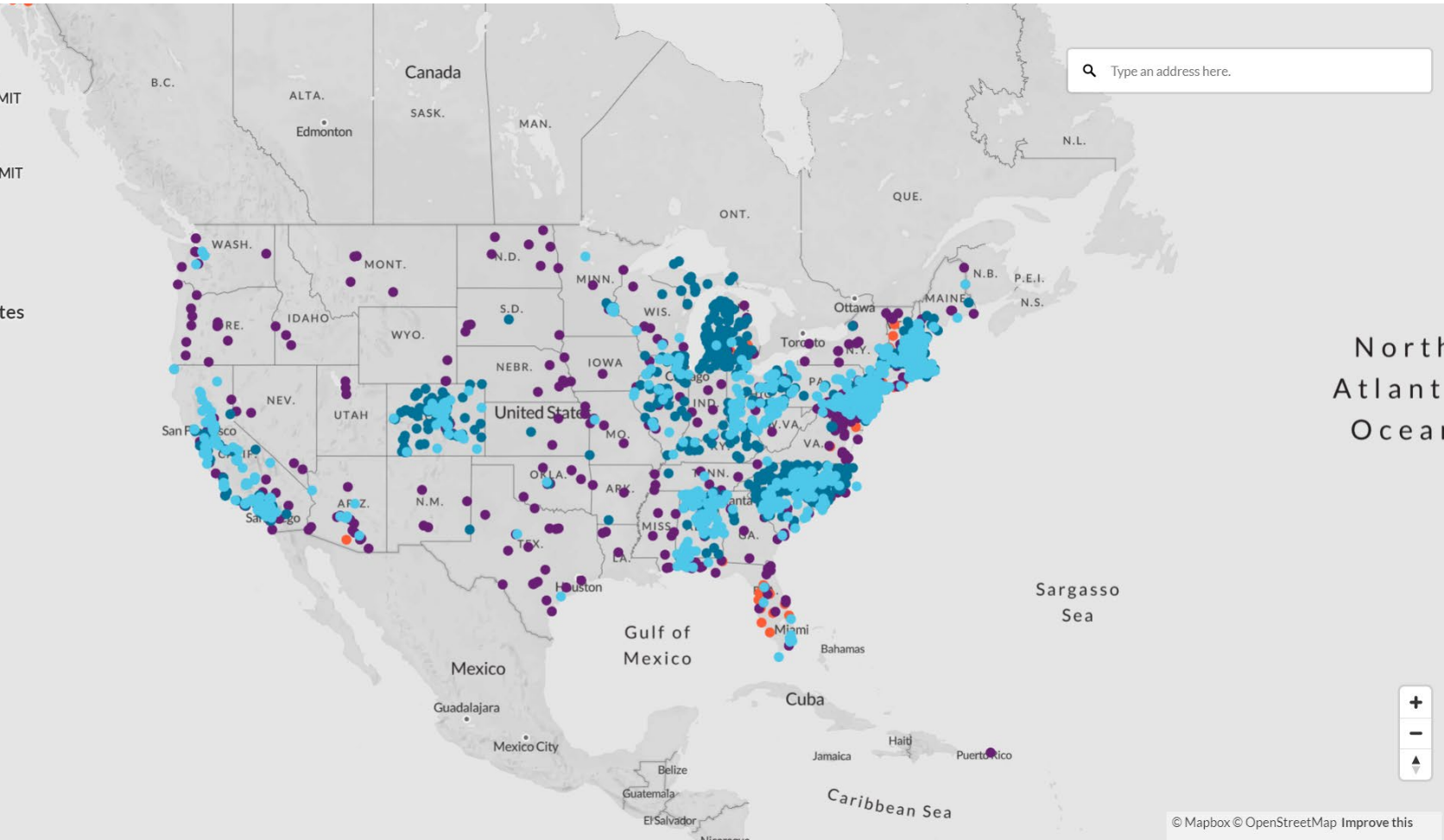
**On** Drinking Water  
ABOVE PROPOSED LIMIT

**On** Drinking Water  
BELOW PROPOSED LIMIT

**On** Military Sites

**On** Other Known Sites

info



🔍 Type an address here.

North  
Atlantic  
Ocean

Sargasso  
Sea

Gulf of  
Mexico

Caribbean  
Sea



# Any Questions?

Philip Myers, Director PEMY Consulting  
phil@pemyconsulting.com  
925-302-6707

26th California Unified Program  
Annual Training Conference  
February 26-29, 2024

