PFAS in Drinking Water

What it means for your community

Presented by:

MassDEP, Drinking Water Program and Office of Research and Standards

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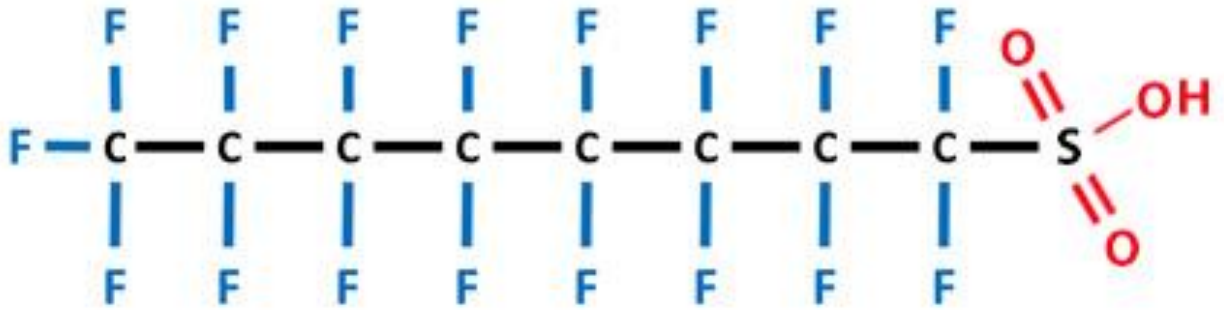
PFAS: A Unique Challenge

- **P**er- and poly**f**luoro**a**lkyl **S**ubstances
- Family of thousands of compounds
- **Extremely stable** – heat & stain resistant, water repellant
- **“Forever chemicals”** - persistent, do not biodegrade
- **Water Soluble**

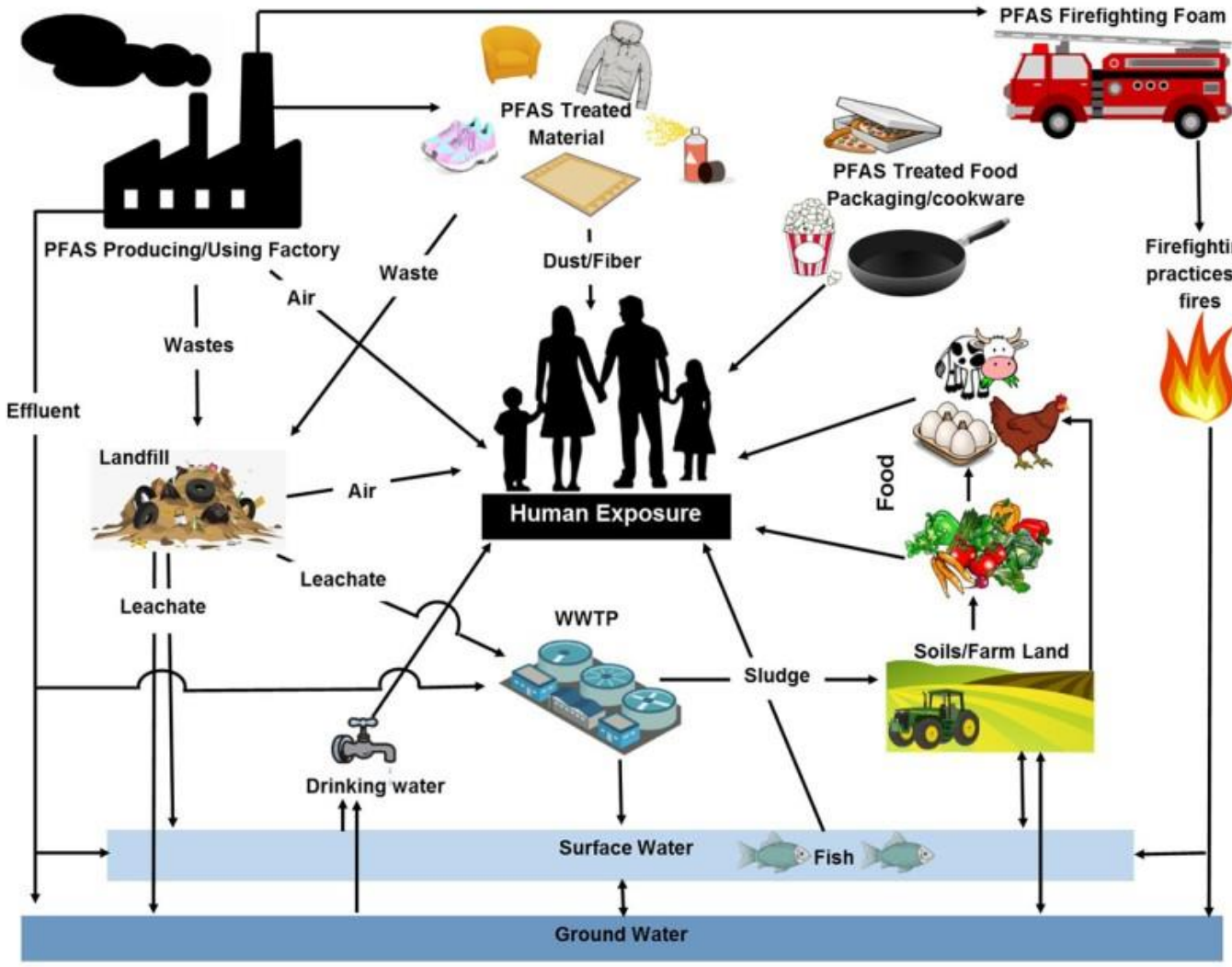


Common Uses of PFAS

- Aqueous film-forming foam (AFFF)
- Textile and leather treatments
  - stain resistance/water repellency
- “Waterproof” down fabrics
- Paper coatings - grease resistant
- “Waxes” - floor, car, ski
- Manufacturing

Exposure to PFAS through consumer products is common, but when drinking water is contaminated, it is the primary source of exposure.

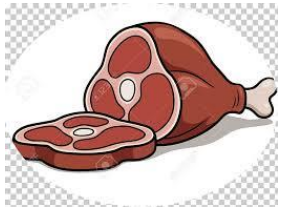
PFAS Pathways into the environment and human exposure



Human Exposure and sources of PFAS
Image: DWP, adapted from Oliaei et al. 2013.

Why Focus on Drinking Water and Not Food?

Diet is the largest source of PFAS exposure.

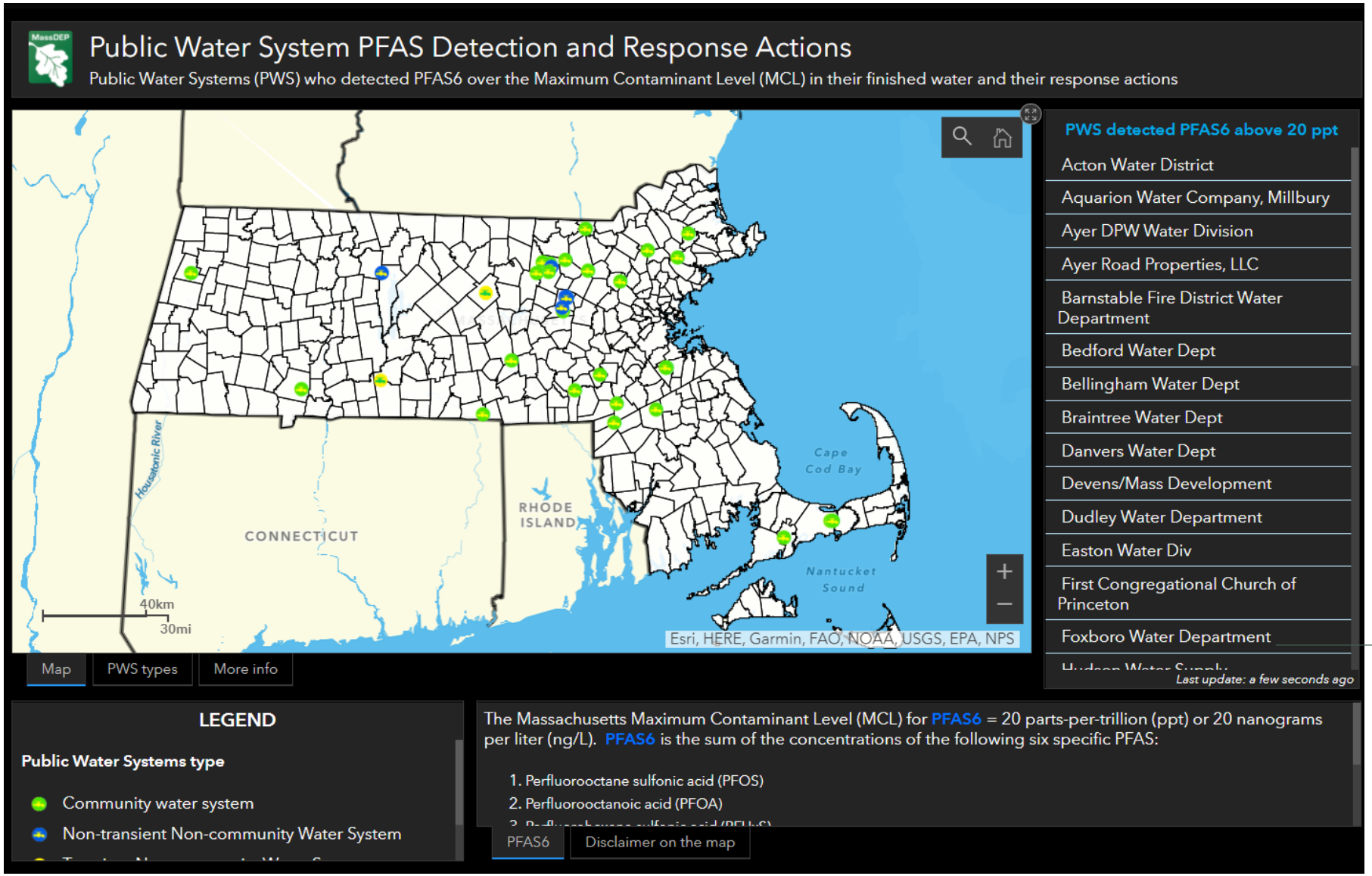





Largest sources in the diet:

- Adults: seafood, meat and meat products
- Toddlers: milk and milk products, eggs and egg products
- Infants: drinking water (up to 60%)

* *A Review of the Pathways of Human Exposure to Poly- and Perfluoroalkyl Substances (PFASs) and Present Understanding of Health Effects.* Journal of Exposure Science Environmental Epidemiology, November 2018, Sunderland et. al.



PFAS discovered at PWS sources

See this maps on our webpage:

Web address in handout or just Google: MassDEP PFAS

New PFAS6 Drinking Water Standard

Regulations establish a new **Maximum Contaminant Level (MCL)**: highest level of a contaminant allowed in drinking water.

MCLs are enforceable standards

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"PFAS6" MCL is **20 ppt** for the sum of six PFAS

- PFOS: perfluorooctane sulfonic acid
- PFOA: perfluorooctanoic acid
- PFHxS: perfluorohexane sulfonic acid
- PFNA:perfluorononanoic acid
- PFHpA: perfluoroheptanoic acid
- PFDA: perfluorodecanoic acid

PFAS Standards Comparisons

Massachusetts and other States

	PFOS	PFOA	PFNA	PFHxS	PFHpA	PFDA
U.S. EPA Health Advisory	**70 Sum of two**		**NA**	**NA**	**NA**	**NA**
MA MCL, GW standard	**20 Sum of six**					
VT MCL	**20 Sum of five**					**NA**
CT Action Levels	**70 Sum of five**					**NA**
WI Recommended GW standard	**20**					
ATSDR Based on draft ATSDR toxicity values and EPA exposure parameters	**7**	**11**	**10**	**70**	**NA**	**NA**
NY MCL	**10**	**10**	**NA**	**NA**	**NA**	**NA**
NJ MCL	**13**	**14**	**13**	**NA**	**NA**	**NA**
CA Notification levels (Response Levels)	**6.5 (40)**	**5.1 (10)**	**NA**	**NA**	**NA**	**NA**
MI MCL	**16**	**8**	**6**	**51**	**NA**	**PFNA value recommended**
MN guidelines	**15**	**35**	**NA**	**47**	**NA**	**NA**
NH MCL	**15**	**12**	**11**	**18**	**NA**	**NA**
Most other states (EPA value by default)	**70**		**NA**	**NA**	**NA**	**NA**

Applicability to Public Water Systems

MCL Applies to:

- **COM** - Community Water Systems (year-round residential customers)
- **NTNCs** - Non-transient, Non-Community Water Systems
  - Schools/Daycares, Businesses (25+ employees)

Applicability to Public Water Systems

MCL does not apply to:

- **TNCs** - Transient, Non-Community Water Systems
  - Recreational Areas, Campgrounds, Hotel/Motels
  - Must collect one sample, may have site-specific health assessment

Initial Monitoring Start

Sampling Start Dates for COM and NTNC:

- $>$ 50,000 population **January 1, 2021**
- $\leq$ 50,000 & $>$ 10,000 population **April 1, 2021**
- $\leq$ 10,000 population **October 1, 2021**

TNC PWS must collect <u>one</u> sample at each entry point (their finished water) by 9/30/2022

Seasonal PWS – Commence sampling at the start of operations

Regulatory Basics for NTNC and COM PWS

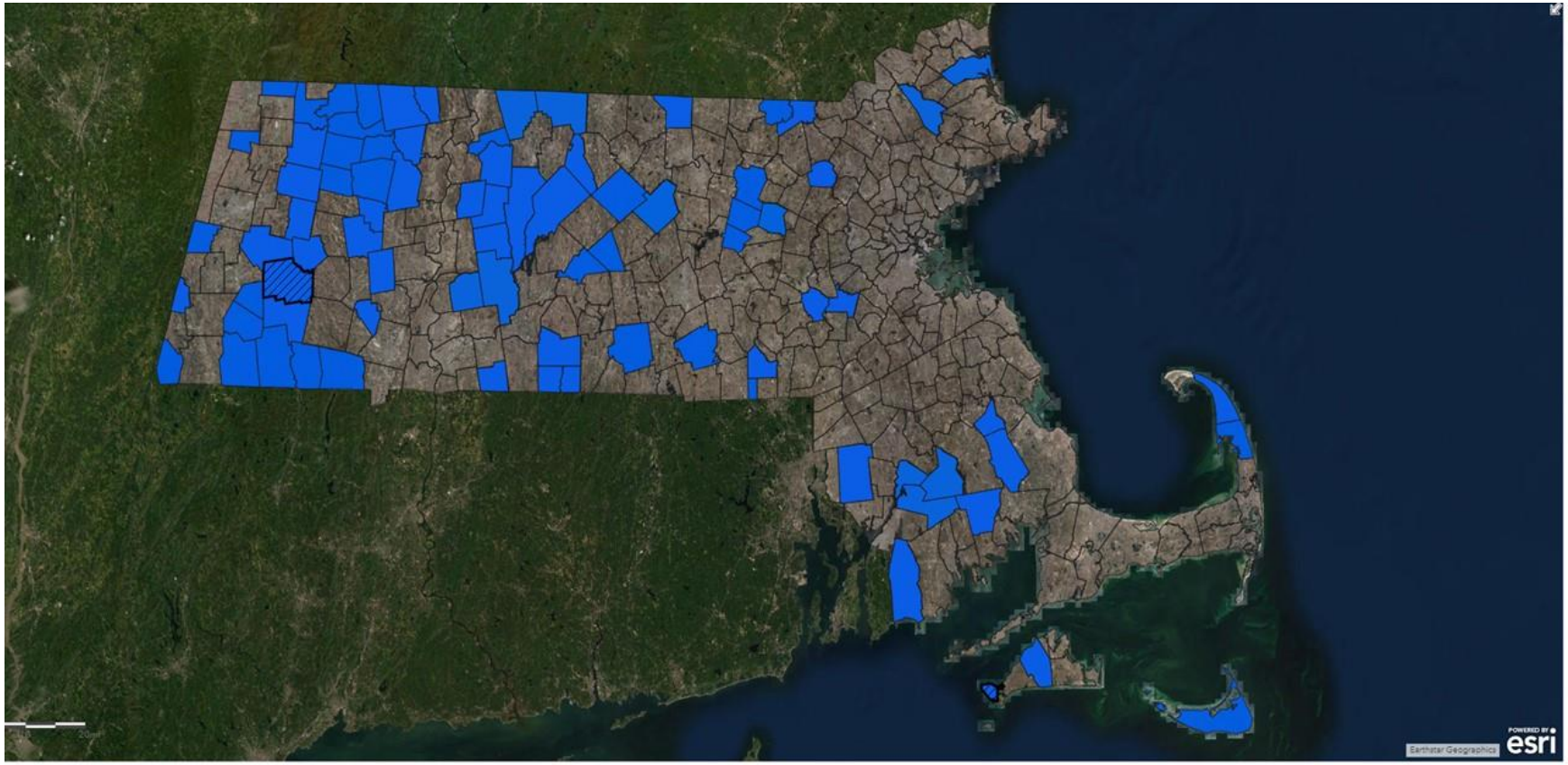
- ✓ Required actions include lowering PFAS levels, Public Education, and Public Notice.
- ✓ Many PWS in Massachusetts have already taken actions to lower PFAS6 level to below 20 ppt.
- ✓ PWS must publish detects in CCR. Health language must be included if MCL is exceeded.

PWS Free PFAS Analyses

- One free round of PFAS sampling for PWS (and confirmatory sampling if needed) available until June 30, 2021.
- PWS can sign up at: https://www.mass.gov/forms/pfas-free-sampling-initiative-notice-of-interest-form-for-public-water-systems
- PWS may need to begin increased monitoring before implementation date if PFAS6 > 10 ppt.

Private Well PFAS Samples

- MassDEP Private Well PFAS Sampling Program
  - 83 Priority Towns >60% served by private wells
  - Work with Town and Board of Health
  - Postcard invitations to select private well owners
    - Some near potential PFAS sources, some random
  - 20-40 private wells selected for free sampling



We will be contacting the Boards of Health in these Towns over the next 6 months.

Towns targeted for private well sampling

> 60% residents private wells

Basis of MA Drinking Water Standards for PFAS and Suggestions for Addressing Consumer Questions

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- Dr. Sandra Baird Ph.D., Chief, Toxicology Group, Office of Research and Standards
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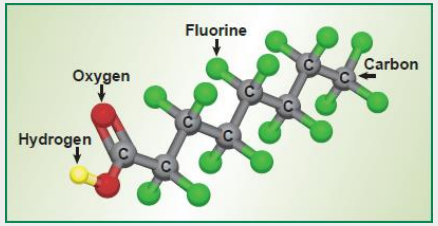
Outline

- Why are PFAS in drinking water a concern?
- Summary of MA PFAS6 standards
- Toxicological basis of MA PFAS6 standards
- Consumer questions

Why Are Long-Chain PFAS a Concern?

- **Infants/children at risk**
  - Crosses placenta
  - Expressed in breast milk
- **Toxicity at low exposure levels**
  - Developmental
  - Effects on the immune system
  - Endocrine disruption: thyroid hormone
  - Liver
- **Persistent**
  - Do not appreciably breakdown in the environment
  - Long (years) serum half lives
- **Water soluble and Widespread Impacts**



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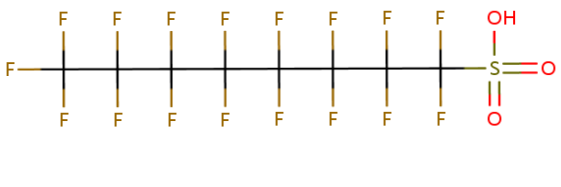
PFAS Challenges

- PFAS are a very large group of chemicals with wide range of properties
- Multiple PFAS are often found in drinking water
- People are exposed to different combinations of PFAS in water and other media
- EPA test methods identify multiple PFAS
- Limited information about toxicity, kinetics, exposure for PFAS addressed by EPA test methods - other than PFOA and PFOS

PFOA

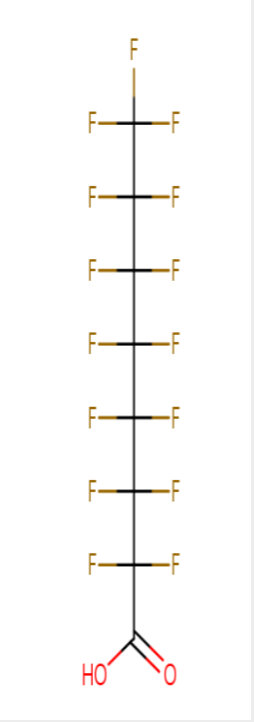
PFOS



EPA Drinking Water Method 537.1 Analytes

# Carbons	EPA Method 537 Analytes	
4	PFBS	Perfluorobutanesulfonic acid
6	PFHxA	Perfluorohexanoic acid
6	PFHxS	Perfluorohexanesulfonic acid
7	PFHpA	Perfluoroheptanoic acid
8	PFOA	Perfluorooctanoic acid
8	PFOS	Perfluorooctanesulfonic acid
9	PFNA	Perfluorononanoic acid
10	PFDA	Perfluorodecanoic acid
11	NMeFOSAA	2-(N-Methylperfluorooctanesulfonamido)acetic acid
11	PFUnA	Perfluoroundecanoic acid
12	NEtFOSAA	2-(N-Ethylperfluorooctanesulfonamido)acetic acid
12	PFDoA	Perfluorododecanoic acid
13	PFTrDA	Perfluorotridecanoic acid
14	PFTA	Perfluorotetradecanoic acid

PFOA



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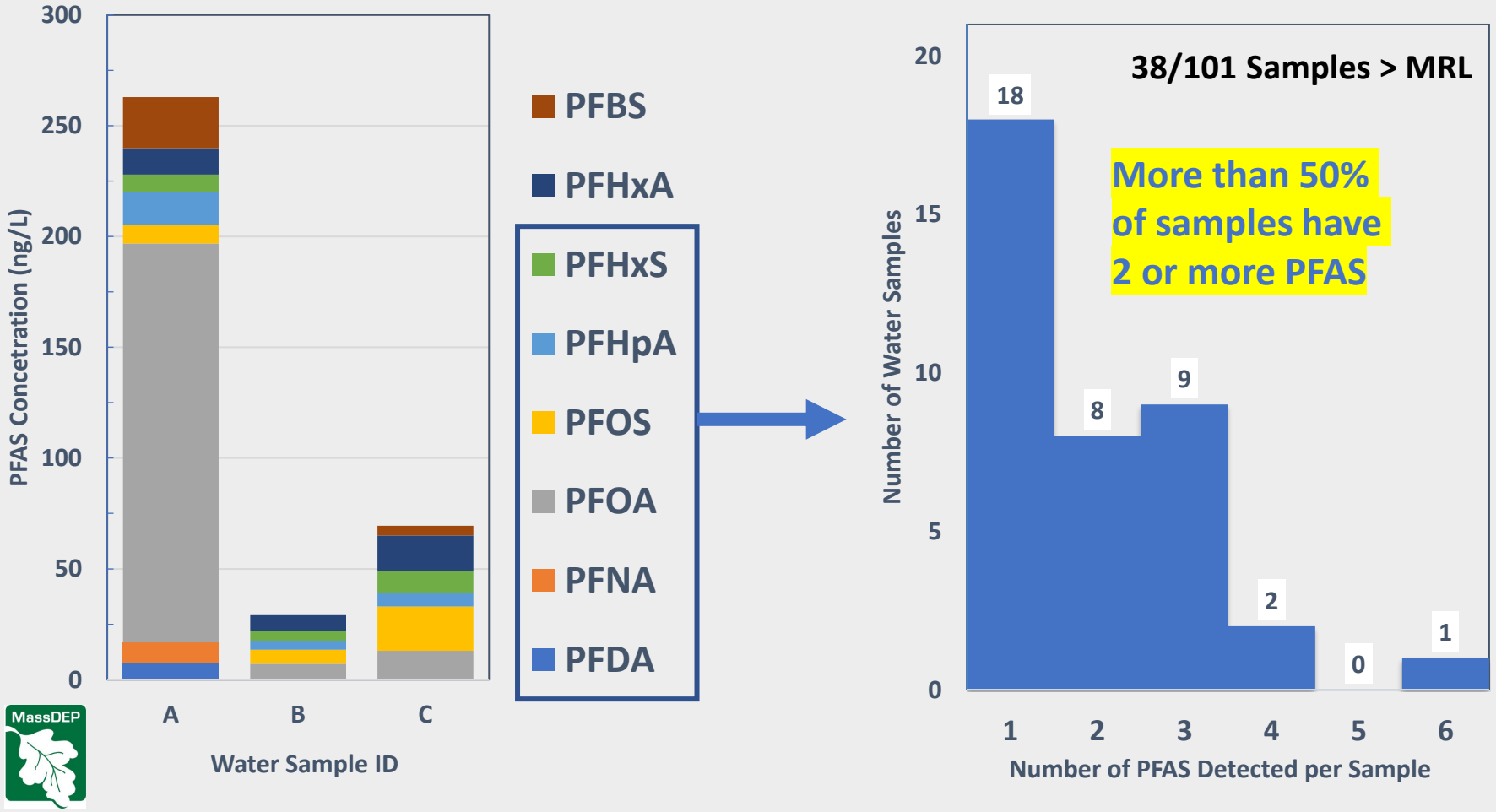
PFAS Co-occur in Drinking Water

Common PFAS detected in MA drinking water from early subset of samples



MassDEP Approach

- Subclass
- Which ones?
  - EPA **Method 537.1 analytes** – DW data
  - Focused on **longer chain PFAS**
    - **More toxic and persistent** in human body
  - **PFOA and PFOS as surrogates: best studied**
  - Subclass with very similar chemical structures
    - **+/- 2 carbons from PFOS/PFOA**
    - **Same functional groups**
  - 7 compounds: PFNA; PFHxS; PFHpA; PFHxA; PFDA; PFOS; PFOA
    - PFHxA (C6) much less toxic/shorter half life
  - Final subclass incudes 6 compounds

Final Subclass of Longer Chain PFAS Regulated by MassDEP

# Carbons	EPA Method 537 Analytes	
4	PFBS	Perfluorobutanesulfonic acid
6	PFHxA	Perfluorohexanoic acid
6	PFHxS	Perfluorohexanesulfonic acid
7	PFHpA	Perfluoroheptanoic acid
8	PFOA	Perfluorooctanoic acid
8	PFOS	Perfluorooctanesulfonic acid
9	PFNA	Perfluorononanoic acid
10	PFDA	Perfluorodecanoic acid
11	NMeFOSAA	2-(N-Methylperfluorooctanesulfonamido)acetic acid
11	PFUnA	Perfluoroundecanoic acid
12	NEtFOSAA	2-(N-Ethylperfluorooctanesulfonamido)acetic acid
12	PFDoA	Perfluorododecanoic acid
13	PFTrDA	Perfluorotridecanoic acid
14	PFTA	Perfluorotetradecanoic acid

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Basis of Drinking Water Values

Animal Toxicology Studies
Human Epidemiological Studies

TOXICITY INFORMATION

-> Review studies
-> Evaluate dose-response info
-> Identify study with relevant effect at lowest doses: Point of Departure (POD)
-> Extrapolate to human equivalent dose
-> Account for limitations with uncertainty factors
->-> Toxicity value – daily acceptable dose mg per kg body weight per day (mg/kg bw/day) **Reference Dose (RfD)**

TOXICITY VALUES

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Apply exposure parameters considering:
-> Sensitive populations
-> Potential for other sources of exposure
->-> DW conc. – ng per liter water (ng/L)

DW CONC.

PFAS Standards for Drinking Water Hazardous Waste Sites

- Most elements in derivation consistent with USEPA PFOA/PFOS Drinking Water Health Advisories
  - Exposure parameters; relative source contribution factor; summing concentrations
- Revised RfD for PFOA and PFOS: lower (more toxic) vs. EPA value
- Added four additional closely related PFAS
  - PFOA/PFOS used as surrogates based on similarities in chemical structures; half lives; and effects
  - Also informed by relative potency assessment
- Reviewed and endorsed by MassDEP Health Effects Advisory Committee

Why Did MassDEP Revise the Reference Dose?

- Multiple effects in multiple studies at lower exposure levels than used in EPA's assessment
    - Thyroid; Liver; Developmental (mammary gland, liver, skeletal); Immunotoxicity
- Taken together these raise compelling concerns
- However, because the individual studies have limitations alternative PODs not selected
    - Small numbers of experimental animals
    - Single dose experiments
    - Differing interpretations about significance and relevance of reported effects

Updated Reference Dose

- To account for more sensitive effects a database UF (UF_D) was applied
  - Established approach
  - Used by ATSDR and several other states in PFAS assessments
- UF_D per USEPA guidance either 10 or $10^{1/2}$
- UF_D of $10^{1/2}$ selected
  - comparisons of serum levels at alternative PODs: 2 to 5-fold lower
- Revised RfD = 5 X 10^{-6} mg/kg-day (vs. EPA PFOA and PFOS RfD of 2 X 10^{-5}

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What About the Other PFAS in the Subclass?

- Much less data
- Look to similar surrogate chemicals with more extensive toxicity data: in this case PFOA and PFOS
- “Similarity” based on
  - Chemical structures
  - Toxicity profiles
  - Half-lives
  - Comparative potency evaluation – where data allows

PFAS6 Subclass Characteristics

- Very long (years) and often overlapping half-live estimates in people

PFOA	PFOS	PFNA	PFHxS
840-1400	1241-2000	900-1540	1716-3100

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Subclass Characteristics

- Share similar toxicity profiles
  - Liver
  - Thyroid
  - Development
  - Immune system
- Cause adverse effects at similar doses
  - Overlapping serum concentration and human equivalent dose ranges at adverse effect levels
  - MassDEP comparative potency assessment of National Toxicology Program (NTP) study data

NTP PFAS Toxicity Study

- National Toxicology Program (NTP) (2018)
  - 28-day tox studies for 7 PFAS; data on multiple endpts
  - Best available comparative potency study

# Carbons	Sulfonates	Carboxylates
4	PFBS	
6	**PFHxS**	PFHxA
8	**PFOS**	**PFOA**
9		**PFNA**
10		**PFDA**

PFHpA was not included in NTP study

Potency Comparisons based on NTP 28-day study

- Relative potencies compared for sensitive benchmark responses
  - Free Thyroxine concentration
  - Relative Liver weight
- Doses associated with benchmarks calculated
  - For both responses using two measures of dose
  - Based on multiple dose response models averaged using Bayesian Benchmark Dose approach

Bayesian Benchmark Dose BBMD (Shao and Shapiro 2018)
https://benchmarkdose.org/

Potencies Relative to PFOA

NTP (2018) 28-day male rat bioassay data

End Point	Free T4	Relative Liver Wt	Free T4	Relative Liver Wt
Exposure Metric	Serum (mg/L)		HED (mg/kg-day)[a]	
BMR	20%	5%	20%	5%
PFOA	1	1	1	1
PFOS	3	1	4	1
PFNA	3	0.9	2	0.6
PFHxS	0.5	0.2	0.8	0.2
PFDA	1	2	2	2

- For all compounds relative potencies equal 1 (equipotent), for one or more endpoints
- Most within factor of two; maximum difference of 5.

[a] HED: Human Equivalent Dose, half-life adjusted.

Conclusions: RP Evaluation NTP Study

- All five of the longer-chain PFAS caused dose-dependent effects in the liver and thyroid
- Potencies similar across compounds and dose metrics
- Revised RfD for PFOS and PFOA applied to subclass
  - Consistent with dioxin-like PCB and PAH approaches
- Other elements of USEPA approach used to set Health Advisories applied
- MCL PFAS6 = 20 ppt

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Addressing Questions from the Public

- A few things to keep in mind
- Some “common” questions and suggested responses

Things to Keep in Mind When Addressing Consumer Questions

- Consuming water with PFAS6 above the drinking water standard does not mean that adverse effects will occur.
- The degree of risk depends on the level of the chemicals and the duration of exposure.
- The drinking water standard assumes that individuals drink only contaminated water, which typically overestimates exposure.
- Risks somewhat above the MCL are low but cannot be ruled out for sensitive subgroups.
- MassDEP staff may be able to assist in answering questions. As individual circumstances and concerns vary, consumers with specific health concerns may wish to consult their doctor or health professional.

Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Can I shower/bathe/brush my teeth using the water?
  - PFAS are not significantly absorbed through the skin.
  - Incidental ingestion, in particular by children who may swallow the water when bathing or brushing their teeth, may occur.
  - These uses are not a significant concern until levels in the water are far above the MCL (>210 ppt).
  - Steps can be taken to minimize incidental ingestion by supervising young children when bathing.

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Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Can PFAS get into my home's air from the water?
  - PFAS are not very volatile so levels in air from the water are typically not a concern.
  - Evidence indicates that house dust can contain PFAS from consumer items – ventilation when vacuuming and dusting and use of HEPA vacuums and air filters may help reduce exposures.

Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Is it safe to nurse my baby if I have been drinking PFAS containing water?
  - PFAS are expressed in breast milk BUT there are well documented benefits of breastfeeding.
  - The CDC and other Public Health organizations have concluded that PFAS in drinking water should not be a factor in maternal decisions regarding nursing.
  - Concerned individuals should consult with their health care professional.

Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Can I use the water for laundry?
  - Since PFAS are not significantly absorbed dermally or volatile, using the water for laundry does not present a significant exposure risk.
  - Some laundry items themselves may contain PFAS and these may get into dryer lint and dust. Steps to minimize inhaling these may reduce exposures.

- Can I use the water for washing foods, dishes and other items?
  - In most situations the water can be safely used for washing and rinsing foods and washing dishes.
  - For washing items that might go directly into your mouth, like dentures and pacifiers, only a small amount of water might be swallowed and the risk of experiencing adverse health effects is low.

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Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Is it OK to use the water for gardening?
  - Certain plants may take up some PFAS6 from irrigation water and soil.
  - Unfortunately, there is not enough scientific data to predict how much will end up in a specific crop.
  - Since people eat a variety of foods, the risk from the occasional consumption of produce grown in soil or irrigated with water contaminated with PFAS6 is likely to be low.
  - Families who grow a large fraction of their produce would experience higher potential exposures and should consider steps that can reduce PFAS6 exposures from gardening.

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Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Can my pets or companion animals drink the water?
  - It is reasonable to consider the MCL protective of mammalian species.
  - For mammalian species PFAS risks are likely to be similar to those for people. However, these animals differ in size and drink different amounts of water than people. There is less data on PFAS6 effects on other species like turtles, reptiles, birds, and fish.
  - As a precaution, if you have elevated levels of PFAS6 in your water, you may wish to consider using alternative water for your pets. If you have concerns, you may also want to consult with your veterinarian.

Examples of Consumer Questions About Water Containing PFAS Above the MCL

- Should I get a PFAS blood test?
  - A blood test can provide an indication of your overall exposure but is of limited clinical utility not routinely recommended.
  - Sometimes, researchers collect community-based data on serum PFAS levels as part of epidemiological studies on factors that may impact exposures, clearance rates and health effects.

Questions?