Chemical PFAS Health & Remediation Update

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Spring Environmental Inc.
March 9, 2021

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NEWS > SPOKANE

Airway Heights residents warned not to drink tap water amid chemical contamination findings from Fairchild AFB

UPDATED: Wed., May 17, 2017

NEWS > SPOKANE

Airway Heights tap water still contaminated

UPDATED: Fri., June 2, 2017

Water contamination area expanded in Airway Heights

Jan 19, 2018

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Airway Heights water safe to drink again after contamination

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By PHUONG LE and NICHOLAS K. GERANIOS - *Associated Press - Thursday, June 8, 2017*

Washington state to test drinking water for PFAS contamination linked to firefighting foam

Originally published May 21, 2018 at 6:00 am | *Updated May 21, 2018 at 5:05 pm*

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1946, DuPont introduced Teflon to the world, changing millions of people's lives

3

2001, attorney Robert Bilott filed a federal class-action suit against DuPont for polluting the drinking water of more than 70,000 people in and around Parkersburg, W.Va., with PFOA, a Teflon chemical known within the company as C8.

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Agenda

- Fundamentals
- Sources
- Health Effects
- Remediation Update
- Regulatory Update

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Fate of Indestrutible Polyfluroalkyl Substances (PFAS)

» Fundamentals

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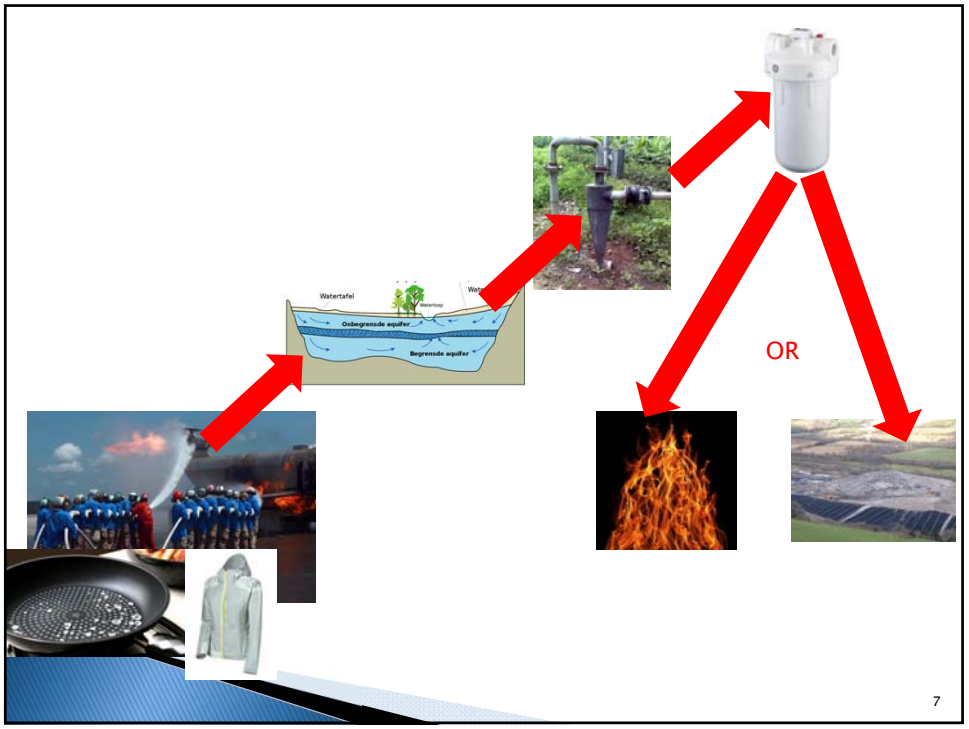

Fundamentals – PFAS

- Manmade chemicals that contain a carbon and fluorine atom backbone
- Came into common use in the 1950s and '60s
- Hundreds of known PFAS compounds with varying functional groups, which can include other elements such as oxygen, hydrogen, or sulfur.

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Fundamentals – PFAS

- An abbreviation for per- and poly-fluoroalkyl substances
- Also referred to as perfluorinated chemicals (PFCs)
- Long-chain PFASs comprise two sub-categories:
  - perfluoroalkyl carboxylic acids (PFCAs) with eight or more carbons, including PFOA, and
  - perfluoroalkane sulfonates (PFSAs) with six or more carbons, including
    - perfluorohexane sulfonic acid (PFHxS) and
    - perfluorooctane sulfonic acid (PFOS).
- Short-chain PFASs are generally less toxic and less bioaccumulative in wildlife and humans.
  - PFCA chemicals with fewer than eight carbons, such as perfluorohexanoic acid (PFHxA), and
  - PFSA chemicals with fewer than six carbons, such as perfluorobutane sulfonic acid (PFBS),

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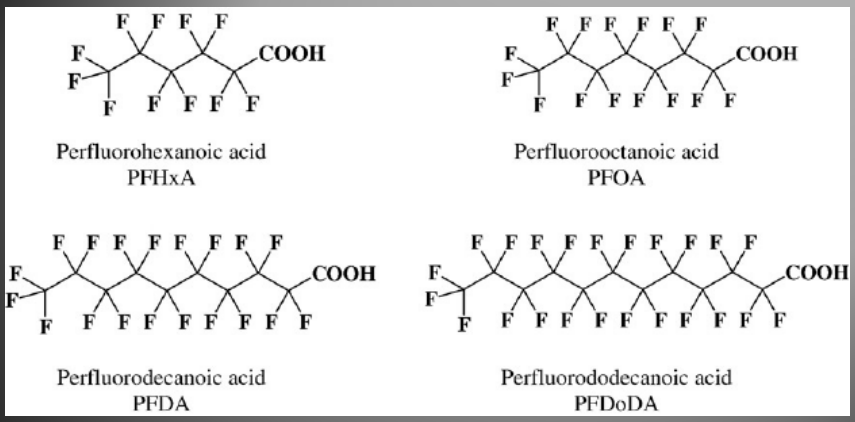

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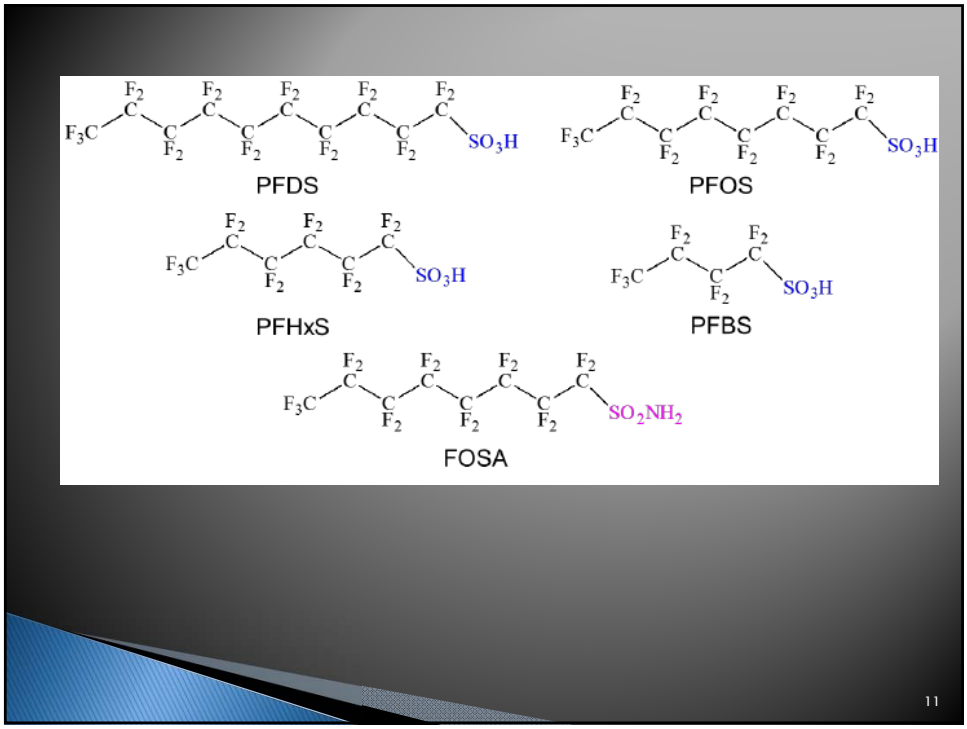
PFDS
PFOS
PFHxS
PFBS
FOSA
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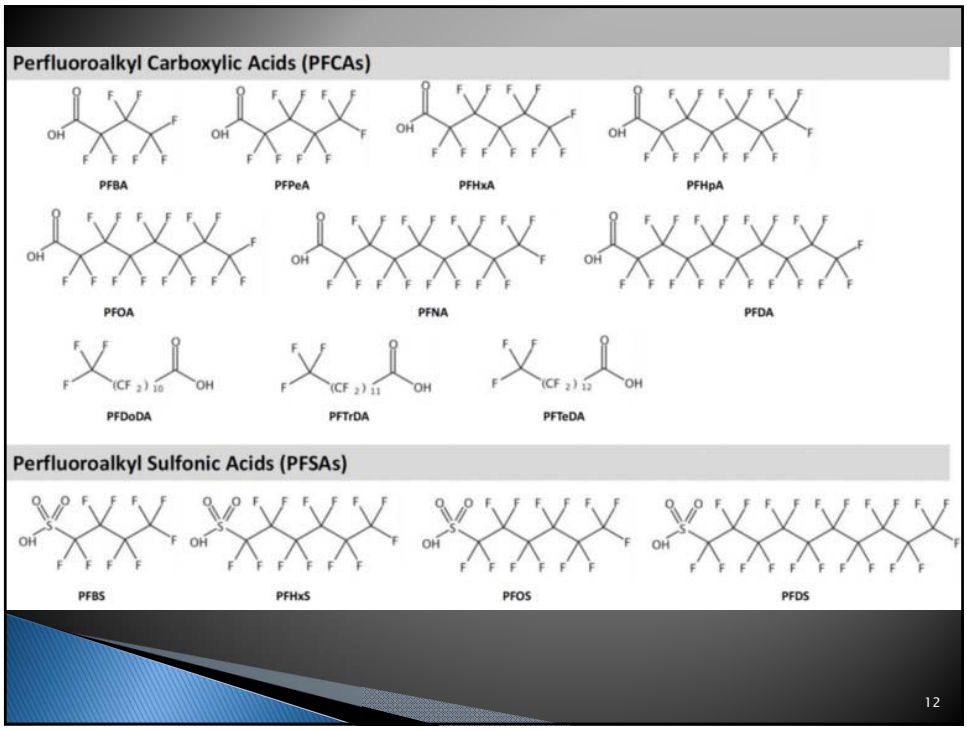
Perfluoroalkyl Carboxylic Acids (PFCAs)
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFNA
PFDA
PFDoDA
PFTrDA
PFTeDA
Perfluoroalkyl Sulfonic Acids (PFSAs)
PFBS
PFHxS
PFOS
PFDS
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Property	PFOS (Potassium Salt)	PFOA (Free Acid)
Chemical Abstracts Service Number	2795-39-3	335-67-1
Physical description (physical state at room temperature and atmospheric pressure)	White powder	White powder/ waxy white solid
Molecular weight (g/mol)	538	414
Water solubility at 25°C (mg/L)	550 to 570[2], 370[3], 25[4]	9,500[2]
Melting point (°C)	> 400	45 to 54
Boiling point (°C)	Not measurable	188 to 192
Vapor pressure at 20 °C (mm Hg)	0.00000248	0.017[5]
Octanol-water partition coefficient (log Kow)	Not measurable	Not measurable
Organic-carbon partition coefficient (log Koc)	2.57[6]	2.06
Henry's law constant (atm-m^3/mol)	3.05×10^{-9}	Not measurable
Half-life	Atmospheric: 114 days Water: > 41 years (at 25° C)	Atmospheric: 90 days[7] Water: > 92 years (at 25° C)

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Fundamentals

- **PFOA** (perfluorooctanoic acid)
- **PFOS** (perflurooctanoic sulfonate)
- **GenX** (replacement chemical for PFOA): trade name for a technology that is used to make high performance fluoropolymers (e.g., some nonstick coatings). Hexafluoropropylene oxide dimer acid (HFPO-DA) and its ammonium salt are the major chemicals associated with GenX.
- **PFBS** (replacement chemical for PFOA, Perfluorobutanesulfonic acid): chemical used to make consumer products including surface water, wastewater, drinking water, dust, carpeting and carpet cleaners, floor wax, and food packaging.

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Name	Abbreviation	Structural formula	Molecular weight (g/mol)	CAS No.
Perfluorobutane sulfonamide	H-FBSA	$C_4F_9SO_2NH_2$	299.12	30334-69-1
Perfluorobutane sulfonic acid	PFBS	$C_4F_9SO_3H$	300.10	375-73-5
Perfluorobutanoic acid	PFBA	C_3F_7COOH	214.04	375-22-4
Perfluorodecanesulfonic acid	PFDS	$C_{10}F_{21}SO_3H$	600.15	335-77-3
Perfluorodecanoic acid	PFDA	$C_9F_{19}COOH$	514.08	335-76-2
Perfluorododecanoic acid	PFDoDA	$C_{11}F_{23}COOH$	614.10	307-55-1
Perfluoroheptanesulfonamide	PFHpSA	$C_7F_{15}SO_2NH_2$	449.14	82765-77-3
Perfluoroheptanesulfonic acid	PFHpS	$C_7F_{15}SO_3H$	450.12	375-92-8
Perfluoroheptanoic acid	PFHpA	$C_6F_{13}COOH$	364.06	375-85-9
Perfluorohexane sulfonic acid	PFHxS	$C_6F_{13}SO_3H$	400.12	355-46-4
Perfluorohexanesulfonamide	PFHxSA	$C_6F_{13}SO_2NH_2$	399.13	41997-13-1
Perfluorohexanoic acid	PFHxA	$C_5F_{11}COOH$	314.05	307-24-4
perfluorononanesulfonic acid	PFNS	$C_9F_{19}SO_3H$	550.14	68259-12-1
Perfluorononanoic acid	PFNA	$C_8F_{17}COOH$	464.08	375-95-1
Perfluorooctane sulfonate	PFOS	$C_8F_{17}SO_3H$	500.13	1763-23-1
Perfluorooctanesulfonamide	PFOSA	$C_8F_{17}SO_2NH_2$	499.14	754-91-6
Perfluorooctanoic acid	PFOA	$C_7F_{15}COOH$	414.07	335-67-1
Perfluoropentanesulfonamide	PFPSA	$C_5F_{11}SO_2NH_2$	349.12	82765-76-2
Perfluoropentanesulfonic acid	PFPS	$C_5F_{11}SO_3H$	350.11	2706-91-4
Perfluoropentanoic acid	PFPA	C_4F_9COOH	264.05	2706-90-3
Perfluorotetradecanoic acid	PFTeDA	$C_{13}F_{27}COOH$	714.11	376-06-7
Perfluorotridecanoic acid	PFTrDA	$C_{12}F_{25}COOH$	664.10	72629-94-8
Perfluoroundecanoic acid	PFUDA	$C_{10}F_{21}COOH$	564.09	2058-94-8

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Fate of Indestrutible Polyfluroalkyl Substances (PFAS)

- Sources

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Sources – Purpose

- Non-stick
- Grease & oil resistant
- Water-resistant

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Sources

- Packaging
- Stain- and water-repellent fabrics (e.g. Scotchguard)
- nonstick products (e.g., Teflon)
- Polishes
- Waxes
- Paints
- Cleaning products
- Fire-fighting foams
- Production facilities or industries that use PFAS (e.g., chrome plating, electronics manufacturing, oil recovery).

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Sources

- US Chemical Data Reporting (CDR)
  - chemicals manufactured and imported in the US
  - Threshold 25,000 lbs at a single site
  - 2002 – last year PFOA was reported
  - 2006 & 2012 – PFOS was not reported

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Sources

- Process byproducts
- Unused products
- Wastewater effluent
- Solvent waste
- Spills
- Stack and fugitive emissions
- Sewage sludge
- Landfill leachate
- Treatment technologies residual streams:
  - activated carbon,
  - anion exchange resins, and
  - high-pressure membranes

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Fate of Indestrutible Polyfluroalkyl Substances (PFAS)

- Health Effects

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Routes of Exposure

- Ingestion

- Inhalation

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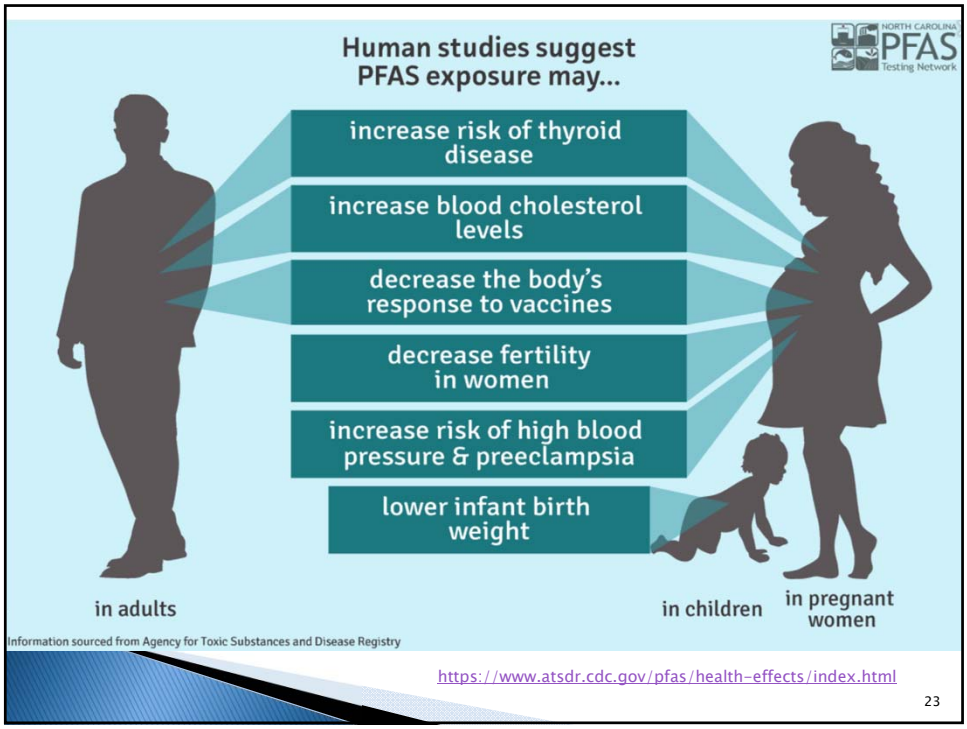

Health Effects

- Lifetime health advisories for only two PFAS chemicals: PFOA and PFOS, both found in firefighting foams.
- Monitored several additional "long-chain" PFAS compounds (compounds with six or more carbon atoms)
  - perfluoroalkyl carboxylic acids (PFCAs)
  - perfluoroalkane sulfonates (PFSAs).

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Current Unknowns

- Safe PFAS exposure for humans
- Differences in toxicity between different PFAS compounds
- Environmental breakdown mechanism
- Transportation (e.g. leaching)

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Fate of Indestrutible Polyfluroalkyl Substances (PFAS)

» Remediation Update

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Remediation Update

- In 2016, dozens of communities across the country were hit with unsettling news: PFASs had been found in their drinking water. A study of groundwater across the country found these chemicals in drinking water in 27 states, impacting 6 million Americans. Many of these communities are near military bases, airports, and industrial sites.

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Detection

- Takes specialized equipment and analytical methods.
- Commercial laboratories only have analytical methods to accurately detect 29 of the PFAS compounds.
- Low detection levels – parts per trillion

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EPA

EPA Analytical Methods for PFAS in Drinking Water

EPA's new validated Method 533 focuses on "short chain" per- and polyfluoroalkyl substances (PFAS) (i.e., those with carbon chain lengths of 4 to 12). Method 533 complements EPA Method 537.1 (published November 2018) and can be used to test for 11 additional PFAS. Using both methods, a total of 29 unique PFAS can be effectively measured in drinking water.

Analyte	Abbreviation	CASRN	Method 533	Method 537.1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	x	x
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acd	9Cl-PF3ONS	756426-58-1	x	x
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	x	x
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	x	x
Perfluorobutanesulfonic acid	PFBS	375-73-5	x	x
Perfluorodecanoic acid	PFDA	335-76-2	x	x
Perfluorododecanoic acid	PFDoA	307-55-1	x	x
Perfluoroheptanoic acid	PFHpA	375-85-9	x	x
Perfluorohexanoic acid	PFHxA	307-24-4	x	x
Perfluorohexanesulfonic acid	PFHxS	355-46-4	x	x
Perfluorononanoic acid	PFNA	375-95-1	x	x
Perfluorooctanoic acid	PFOA	335-67-1	x	x
Perfluorooctanesulfonic acid	PFOS	1763-23-1	x	x
Perfluoroundecanoic acid	PFUnA	2058-94-8	x	x
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	4:2FTS	757124-72-4	x	
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	6:2FTS	27619-97-2	x	
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	8:2FTS	39108-34-4	x	
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	x	
Perfluorobutanoic acid	PFBA	375-22-4	x	
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	x	
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	x	
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	x	
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	x	
Perfluoropentanoic acid	PFPeA	2706-90-3	x	
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	x	
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6		x
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9		x
Perfluorotetradecanoic acid	PFTA	376-06-7		x
Perfluorotridecanoic acid	PFTrDA	72629-94-8		x

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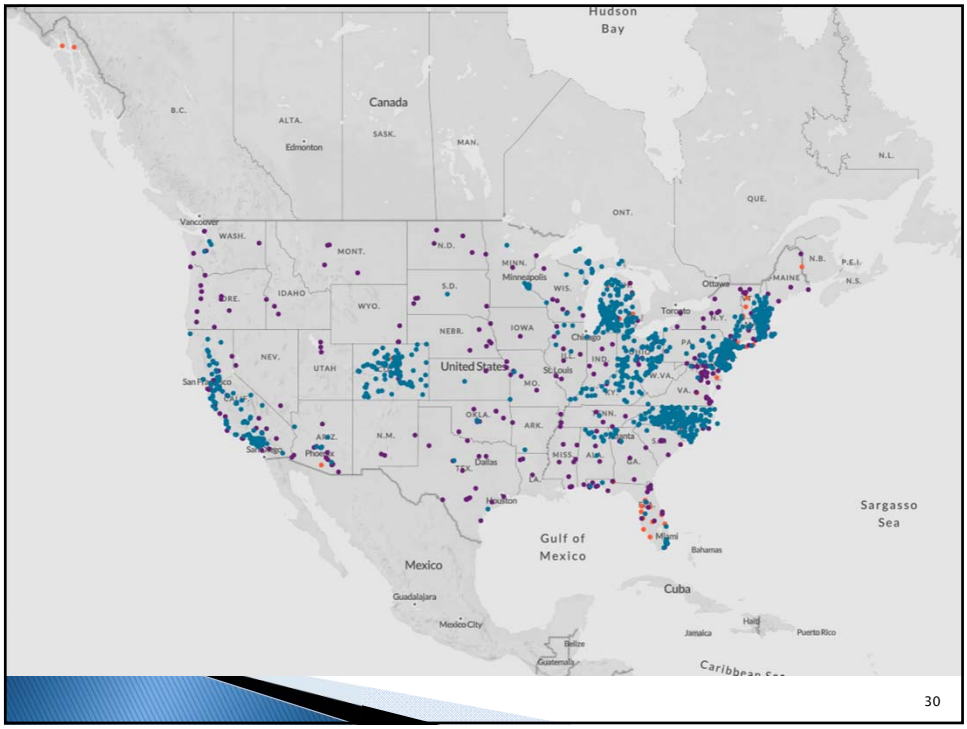

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Remediation Solutions

- Sorbtion
- Granular activated carbon
- Biochar
- Ion exchange
- Precipitation/flocculation/coagulation
- Redox manipulation
- Membrane filtration
- Reverse osmosis
- Nanofiltration

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Technological Solutions

- Technologies to destroy PFAS or manage the migration of PFAS in PFAS-containing materials:
  - Thermal treatment
  - Landfilling and
  - Underground injection control

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Thermal Treatment

- Hazardous waste combustors (HWCs)
  - hazardous waste incinerators (HWI)
  - cement kilns
  - boilers
  - lightweight aggregate kilns (LWAK)
  - hydrochloric acid production furnaces that burn hazardous waste
- Non-hazardous waste combustors
- Carbon reactivation units
- Thermal oxidizers.

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Current Uncertainties/Unknowns

- Standardized validated methodology for measuring PFAS gaseous emissions
- Detailed information on the amounts and concentrations of PFAS-containing materials that are generated and managed in thermal treatment devices
- Whether thermal treatment devices are adequately controlling fluorinated PICs
- Can surrogate DRE or TOF indicators be used as reliable indicators to ensure potential PICs are being controlled?
- Can catalysts be used to enhance PFAS destruction efficiency?

PICs = products of incomplete combustion

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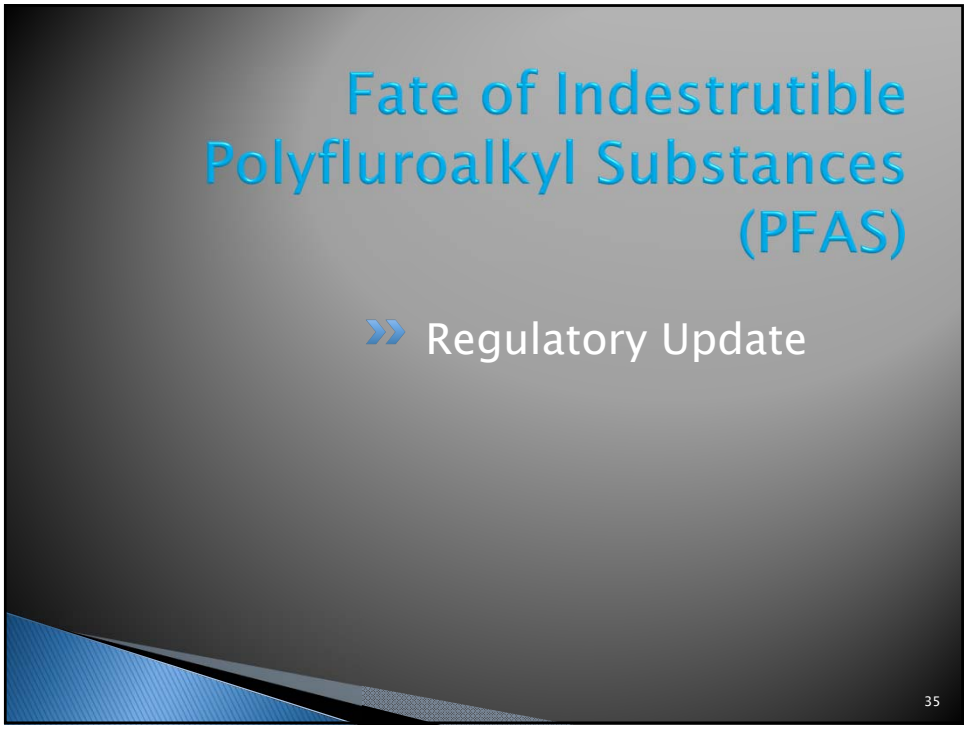

Regulatory Update

- 2002 EPA published two SNUR to require notification to EPA before any future manufacture (including import) of 88 PFAS chemicals specifically included in the voluntary phase out of PFOS by 3M that took place between 2000 and 2002.
  - March 11, 2002
  - December 9, 2002

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Regulatory Update

- 2006 PFOA Stewardship Program
  - To commit to achieve, no later than 2010, a 95 percent reduction, measured from a year 2000 baseline, in both facility emissions to all media of perfluorooctanoic acid (PFOA), precursor chemicals that can break down to PFOA, and related higher homologue chemicals, and product content levels of these chemicals.
  - To commit to working toward the elimination of these chemicals from emissions and products by 2015.

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Regulatory Update

- 2007 EPA finalized a SNUR on 183 PFAS chemicals believed to no longer be manufactured (including imported) or used in the United States.

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Regulatory Update

- 2011the FDA obtained voluntary agreements with the manufacturers of certain "long-chain" PFAS compounds authorized under food contact notifications to remove those substances from food contact applications.

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Regulatory Update

- 2012 Unregulated Contaminant Monitoring Rule (UCMR3) Program – EPA sampled drinking water in several communities between 2013 to 2015

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Regulatory Update

- 2013 EPA issued a rule requiring companies to report all new uses of certain PFOA-related chemicals as part of carpets

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Regulatory Update

- 2016, the FDA revoked the regulations that authorized the remaining uses of these long-chain PFAS in food packaging.

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Health Advisory Levels

- 2016 EPA set lifetime health advisory levels for PFOS and PFOA at just 70 parts per trillion

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Regulatory Update

- 12/19/2019 – EPA releases guidelines for PFAS in groundwater:
  - 40 ppt screening;
  - 70 ppt preliminary remediation goal
- 1/1/2020 – 160 PFAS added to list of chemicals subject to TRI reporting.
- 1/15/2020 – Courts dismiss claims for medical monitoring, health assessment and health effects study.
- 12/18/2020 – EPA published "Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances"

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Regulatory Update

- As required by the FY20 NDAA, the interim guidance addresses PFAS and PFAS-containing materials including:
  - Aqueous film-forming foam (for firefighting).
  - Soil and biosolids.
  - Textiles, other than consumer goods, treated with PFAS.
  - Spent filters, membranes, resins, granular carbon, and other waste from water treatment.
  - Landfill leachate containing PFAS.
  - Solid, liquid, or gas waste streams containing PFAS from facilities manufacturing or using PFAS.
- The interim guidance is not intended to address destruction and disposal of PFAS-containing consumer products, such as non-stick cookware and water-resistant clothing.
- The agency is also providing guidance on testing and monitoring air, effluent, and soil for releases near potential destruction or disposal sites. EPA's interim guidance captures the significant information gaps associated with PFAS testing and monitoring and identifies specific research needs to address the FY20 NDAA requirements.

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Commitments Made…		Results Delivered…
Expand toxicity information for PFAS	☑	Issued final PFBS assessment and revised GenX assessment in preparation for peer review. Conducted testing on another 120+ PFAS. Initiated assessments on five other PFAS.
Develop new tools to characterize PFAS in the environment	☑	Published new validated test methods to accurately test for and measure 29 PFAS chemicals.
Evaluate cleanup approaches	☑	• Issued Advance Notice of Proposed Rulemaking for consideration of additional authorities for addressing PFAS in the environment. • Issued interim guidance on disposal and destruction of PFAS and PFAS-containing materials. • Assessed viability of multiple thermal and non-thermal destruction technologies.
Develop guidance to facilitate cleanup of contaminated groundwater	☑	Developed interim guidance to facilitate cleanup of contaminated groundwater.
Use enforcement tools to address PFAS exposure in the environment and assist states in enforcement activities	☑	EPA has continued to address PFAS using a variety of enforcement tools, bringing PFAS actions to a total of 16. Enforcement work continues to ensure public health and environmental protections.
Use legal tools such as those in TSCA to prevent future PFAS contamination	☑	Finalized a Significant New Use Rule requiring anyone who wishes to manufacture, import or use such products in the United States to notify EPA before doing so.
Address PFAS in drinking water using regulatory and other tools	☑	Issued final determination to regulate PFOA and PFOS in drinking water and proposed to require monitoring for 29 PFAS in drinking water.
Develop new tools and materials to communicate about PFAS	☑	• Provided technical assistance and support to more than 30 states. • Conducted PFAS risk communication training, coordinated across the federal government, participated in conferences and meetings and worked to develop documents to explain key aspects about PFAS chemicals.

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Health Advisory Levels

- 2019 EPA proposed draft oral referenced for GenX chemicals and PFBS.

Chemical	Chronic RfD (mg/kg-day)
PFBS	0.01*
GENX chemicals	0.00008*
PFOA	0.00002
PFOS	0.00002
	*indicates draft value

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Regulatory Update

- 2/10/2021 – Minnesota calling for increased reuglation

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Washington State

- City of Issaquah
- City of Dupont
- Joint Base Lewis-McChord.
- Montesano Armory, Grays Harbor
- Naval Air Station Whidbey Island and outlying field near Coupeville.
- Fairchild Air Force Base and City of Airway Heights.

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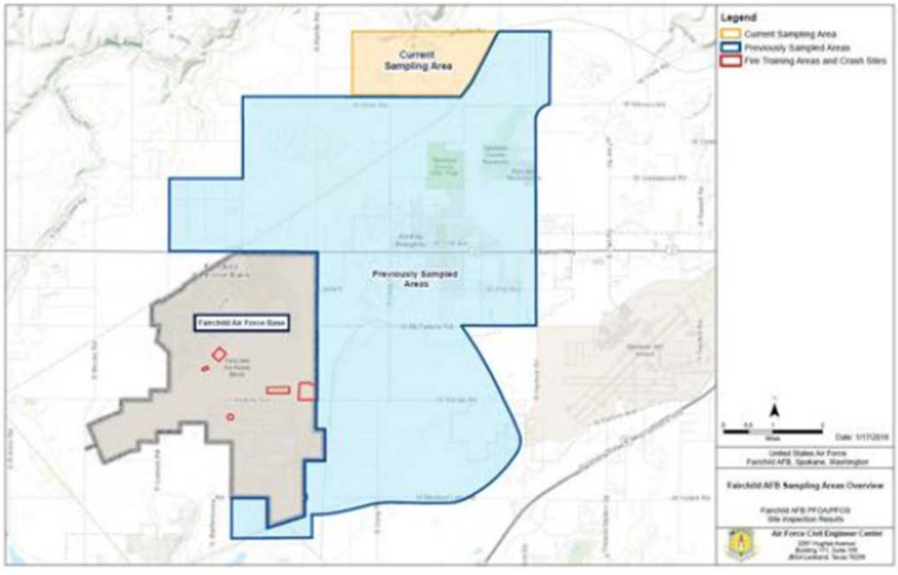

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Regulatory Update – WA

- 2018 – restrict some uses of PFAS in paper food wrappers if safer alternatives are available (ESHB 2658); prohibits use of PFAS foams in firefighter training exercises and bans new sales and distribution of PFAS-based firefighting foams, with some exceptions (ESSB 6413)
- 2020 – standards for PFAS in Group A public drinking water systems; DOH reviewed the most current science and is recommending state action levels on five PFAS compounds to protect public health (comments through 1/31/2020)
- 2020 – Safety products for Washington, Phase 2 (comments through 3/2/2020; then on 10/1/2020 adopted an emergency rule for the 2020 Drinking Water State Revolving Fund Construction Loan application cycle under chapter 246-296 WAC.
  - The rule will allow a water system to submit a water system plan that includes the proposed project to the department for review prior to the close of the application cycle (November 30, 2020) instead of at the time of application. It will also allow the department to review and approve applications within one-hundred-twenty days after the close of the application cycle (March 30, 2021). This amendment will provide greater flexibility for applicants and the department to complete necessary paperwork. The rule will remain effective until January 28, 2021.
- 2020 – DOH PFAS Chemical Action Plan; draft published 10/7/2020 and comments closed on 1/22/2021.

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Resources

- https://www.atsdr.cdc.gov/pfas/
- https://www.epa.gov/pfas/basic-information-pfas
- https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-and-polyfluoroalkyl-substances-pfass
- https://www.fda.gov/food/chemicals/and-polyfluoroalkyl-substances-pfas
- https://ntp.niehs.nih.gov/whatwestudy/assessments/noncancer/completed/pfoa/index.html
- https://www.ewg.org/news-and-analysis/2019/07/ewg-and-toxic-fluorinated-chemicals-20-years-fight-against-pfas
- https://www.doh.wa.gov/CommunityandEnvironment/Contaminants/PFAS

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Please respond to Course Evaluation on Whova App

Questions »

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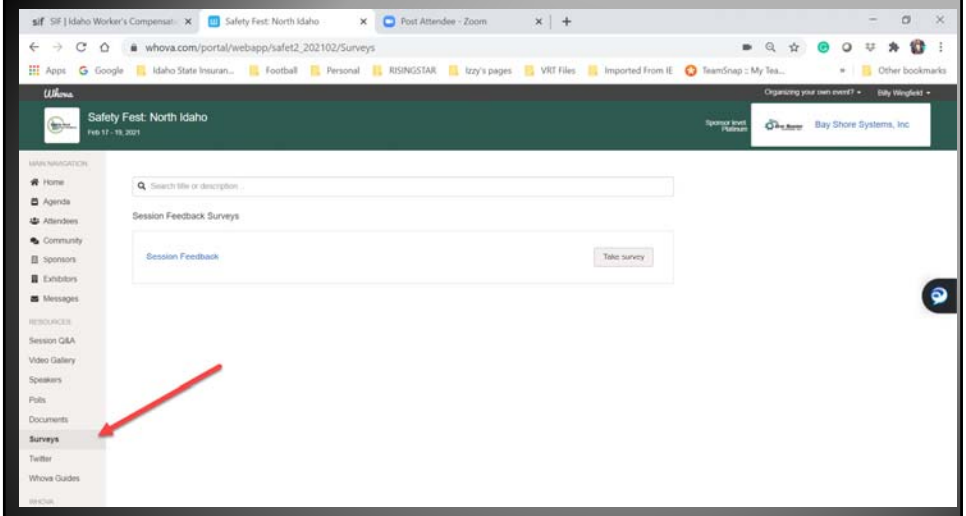

Course Evaluations – Web App

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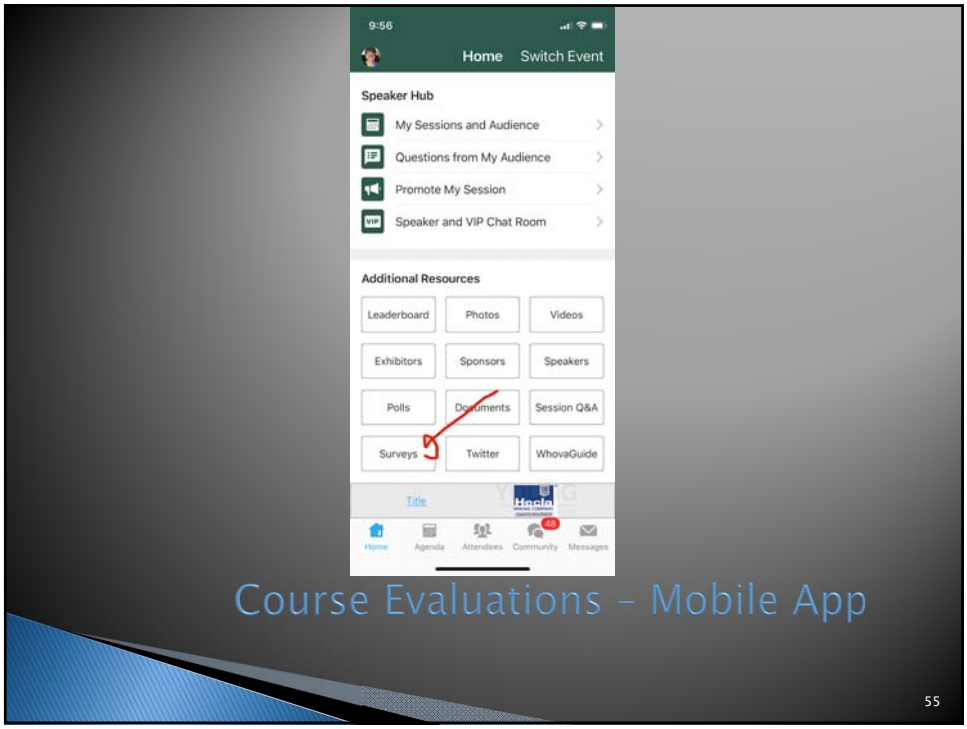
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My Sessions and Audience
Questions from My Audience
Promote My Session
Speaker and VIP Chat Room
Additional Resources
Leaderboard
Photos
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