

Analysis of Per- and Polyfluorinated Substances (PFASs)

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Innovation that Provides Sustainable Solutions to Complex Local Challenges, Worldwide

Outline



- Why are emerging contaminants an analytical challenge?
- PFASs occurrence
- PFASs chemistry
- Analytical methods
- Field sampling considerations
- Field screening technologies



Why are Emerging Contaminants Such an Analytical Challenge?

- Many ECs have lower assessment criteria than typical:
 - Perfluorooctane sulfonate (PFOS): 0.2 µg/L (US EPA Provisional Health Advisory Level)
 - 1,4-Dioxane: 0.35 µg/L (US EPA Health Advisory Level)
 - N-Nitroso-dimethylamine: 0.42 ng/L (US EPA tap water screening level)
- Analytical challenges at low levels: extraction, detection, lab standards
- Possible sample interferences
 - PFASs in sampling or analytical materials and equipment
 - 1,4-Dioxane in decontamination detergent?
- Widespread, anthropogenic background (e.g., atmospheric PFASs)

PFASs Occurrence

- US EPA Safe Drinking Water Act requires public water supply (PWS) monitoring for regulated and Unregulated Contaminant Monitoring Rule (UCMR) lists
- UCMR3 (2012) added 1,4,-Dioxane and PFASs:

perfluorooctanesulfonate acid (PFOS)

perfluorooctanoic acid (PFOA)

perfluorononanoic acid (PFNA)

perfluorohexanesulfonic acid (PFHxS)

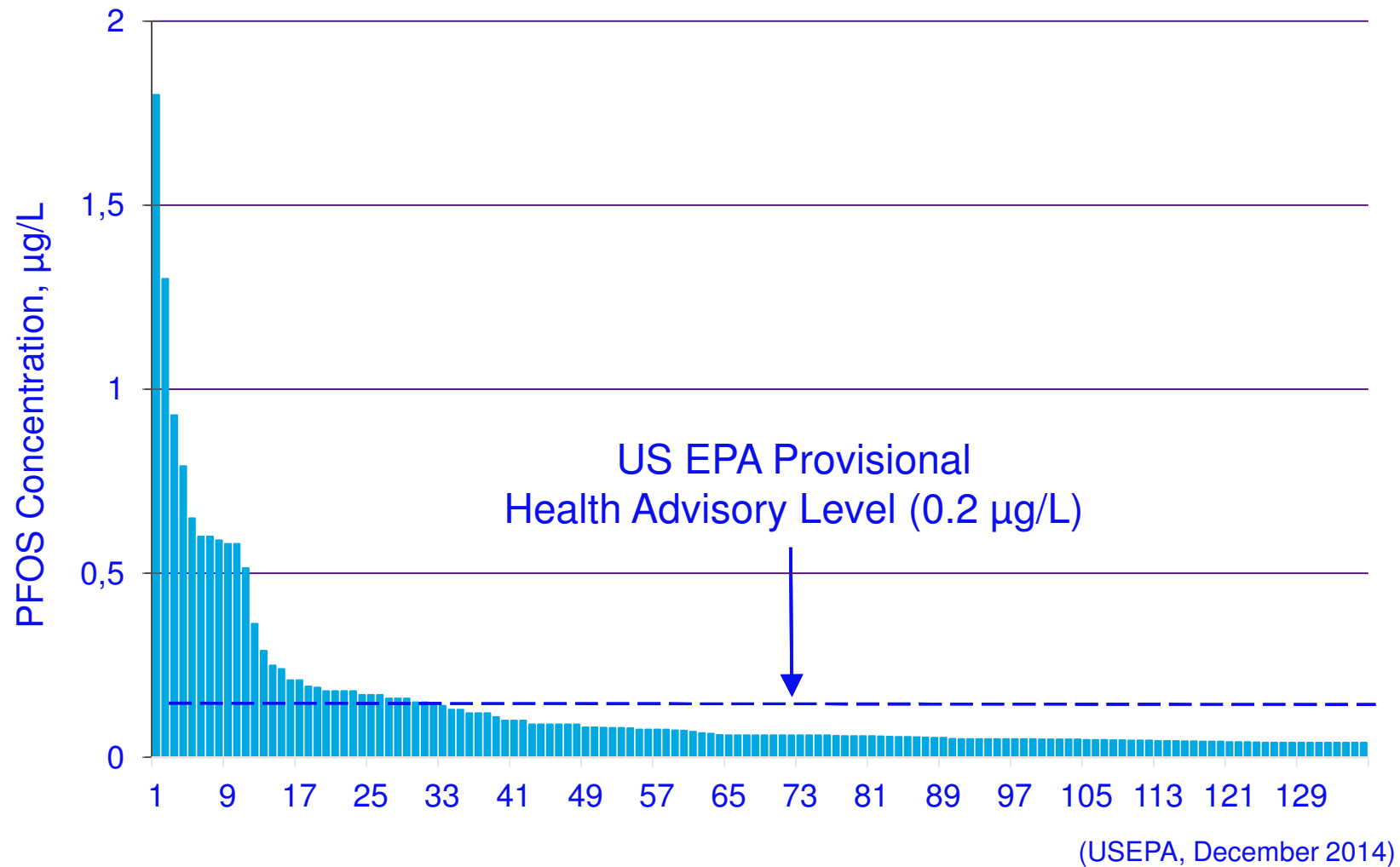
perfluoroheptanoic acid (PFHpA)

perfluorobutanesulfonic acid (PFBS)

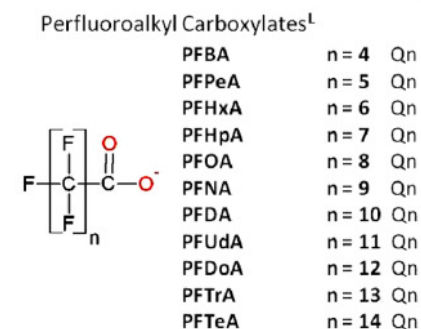
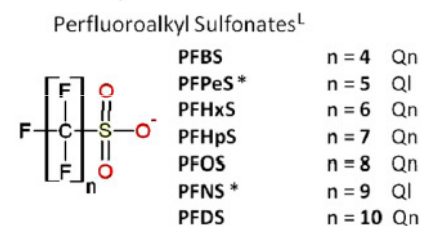
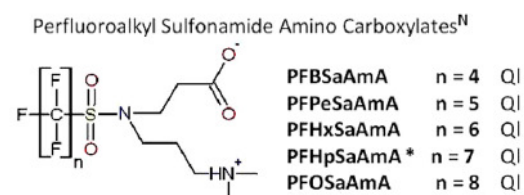
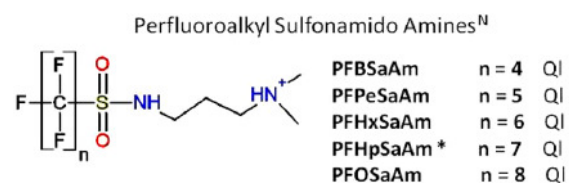
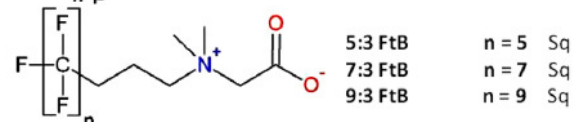
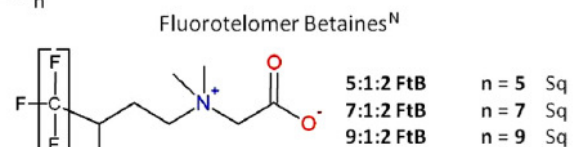
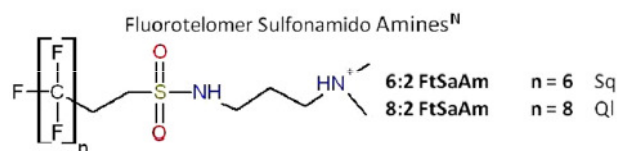
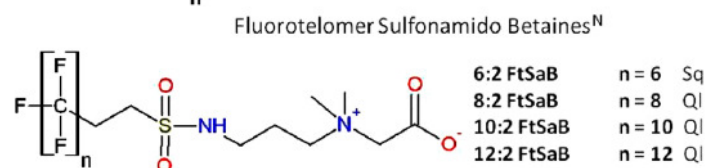
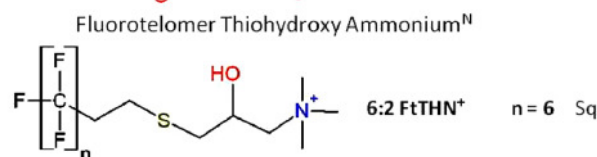
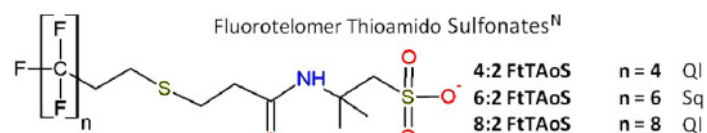


UCMR3 PFOS Results (December 2014)

136 Detections out of 16,909 Analyses = 0.8% Rate



PFASs Chemistry



From Backe, et al, 2013 and others

PFAS Analytical Methods

- Gas Chromatography (GC) and GC/Mass Spectrometry (GC/MS) – PFOS and fluorotelomer sulfonates generally not of sufficient volatility.
- High Performance Liquid Chromatography with Mass Spectrometry (HPLC/MS) – Possible interferences from co-elution within complex environmental matrices impact selectivity and sensitivity.
- Triple or Quadrupole Time of Flight mass spectrometry (TripleTOF/MS, QuadTOF/MS) – Measures the mass-to-charge ratio of an accelerated particle and uses modeling to define what possible chemistries exist.
- HPLC-MS/MS (EPA Method 537, CAM SOP-00894, ISO 25101) – State of the practice for drinking water, but extraction method may require modification for waters impacted by a full suite of AFFF-related co-contaminants

PFASs Analytical Method – EPA 537 List

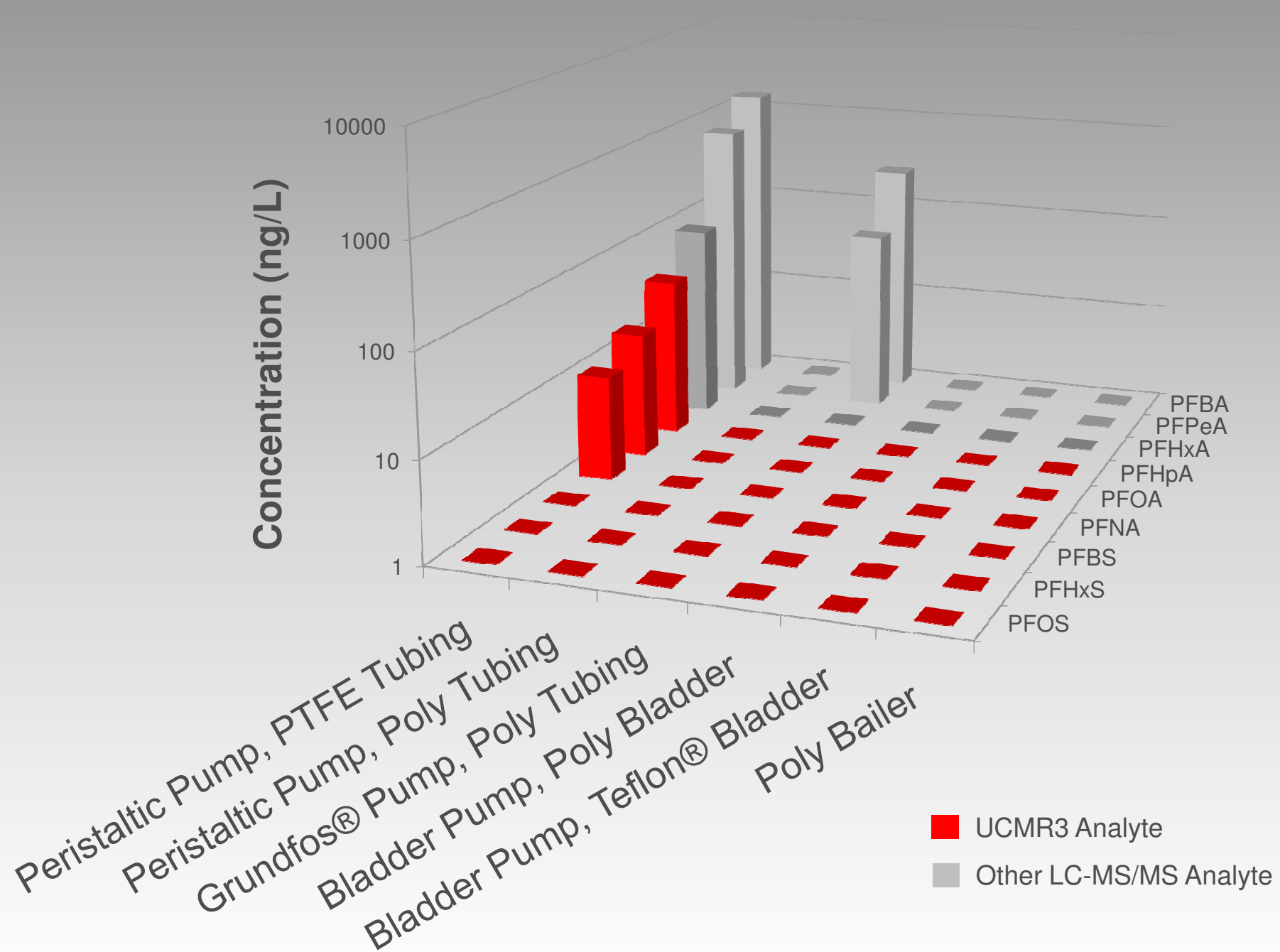
Analyte Description	RL	MDL	Units
Perfluorobutanoic acid (PFBA)	2.00	0.458	ng/L
Perfluoropentanoic acid (PFPeA)	2.00	0.989	ng/L
Perfluorohexanoic acid (PFHxA)	2.00	0.786	ng/L
Perfluoroheptanoic acid (PFHpA)	2.00	0.802	ng/L
Perfluorooctanoic acid (PFOA)	2.00	0.748	ng/L
Perfluorononanoic acid (PFNA)	2.00	0.654	ng/L
Perfluorodecanoic acid (PFDA)	2.00	0.440	ng/L
Perfluoroundecanoic acid (PFUnA)	2.00	0.748	ng/L
Perfluorododecanoic acid (PFDoA)	2.00	0.584	ng/L
Perfluorotridecanoic Acid (PFTriA)	2.00	0.551	ng/L
Perfluorotetradecanoic acid (PFTeA)	2.00	0.199	ng/L
Perfluoro-n-hexadecanoic acid (PFHxDA)	2.00	0.123	ng/L
Perfluoro-n-octadecanoic acid (PFODA)	2.00	0.672	ng/L
Perfluorobutane Sulfonate (PFBS)	2.00	0.918	ng/L
Perfluorohexane Sulfonate (PFHxS)	2.00	0.870	ng/L
Perfluoro-1-heptanesulfonate (PFHpS)	2.00	0.713	ng/L
Perfluorodecane sulfonate (PFDS)	2.00	1.21	ng/L
Perfluorooctane Sulfonate (PFOS)	2.00	1.28	ng/L
Perfluorooctane Sulfonamide (FOSA)	2.00	0.638	ng/L

(TestAmerica, 2015)

Field Sampling Considerations

- CH2M's lab tested common sampling configurations
- Pumps, bladders, tubing, bailers
- Used standard Equipment Blank QA/QC procedures
- Ran deionized water through each assembly
- Captured water in non-PTFE sample containers
- Oregon State University performed analytical work





Potential Field Screening or Low Cost Analytical Screening Technologies

- Foam height analysis (Welcker, 2006)
- astkCARE™ anionic surfactant detection kit (CRCCare)
- Methylene blue active substance (MBAS) (Commercially available)
- Fluorous membrane ion-selective electrode (United Science)
- Microfluidic paper-based analytical device (MPAD) (Colorado State University)
- Particle-induced gamma ray emissions (PIGE) spectroscopy (Hope College)
- Polar organic chemical integrative sampler (POCIS) (University of Queensland)

Thank You For Your Time

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