EBC Connecticut Emerging Contaminants Webinar:
Understanding the Toxicity, Analytical Issues & Regulatory Implications of PFAS
Welcome

Jackson Bailey

Marketing & Program Manager
Environmental Business Council
Introduction & Overview

Elizabeth Denly

Program Co-Chair

Program Director, PFAS Group

TRC
PFAS Guidance Values and Exposure Considerations

Jiayang Chien

Senior Environmental Scientist
Gradient
PFAS Guidance Values and Exposure Considerations

Jiayang Chien, M.P.H.

EBC Connecticut Emerging Contaminants Webinar
May 6, 2020
General Risk Assessment Process

- Hazard Identification
- Dose-response Assessment
- Exposure Assessment
- Risk Characterization

Characteristics and Uses of Per- and Polyfluoroalkyl Substances

**PFAS Characteristics**
- Some or all carbons fluorinated
- C-F bonds very strong
- Oil and water repellant
- Can bioaccumulate

**Uses**
- Aqueous Film-forming Foam
- All-weather clothing
- Non-stick coatings
- Stain-resistant carpet and upholstery
- Food packaging
## What Are the Agency Guidance Values?

### Guidance Values for Drinking Water and Acceptable Daily Intake

<table>
<thead>
<tr>
<th>Chemical</th>
<th>US EPA Health Advisory for Drinking Water (ng/L or ppt)</th>
<th>US EPA Reference Dose (mg/kg-day)</th>
<th>ATSDR Draft Minimum Risk Level (mg/kg-day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOA</td>
<td>70</td>
<td>$2 \times 10^{-5}$</td>
<td>$3 \times 10^{-6}$</td>
</tr>
<tr>
<td>PFOS</td>
<td>70</td>
<td>$2 \times 10^{-5}$</td>
<td>$2 \times 10^{-6}$</td>
</tr>
</tbody>
</table>
Human Equivalent Dose (HED)

- HED is the dose to humans that results in the serum concentration that is associated with health effects in animals.

$$\text{HED} = \text{Animal Serum Concentration} \times \text{Clearance}$$
## Half-lives of PFOA and PFOS in Humans and Animals

<table>
<thead>
<tr>
<th>Species</th>
<th>Sex</th>
<th>PFOA</th>
<th>PFOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>Female</td>
<td>18 days</td>
<td>38 days</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>17 days</td>
<td>43 days</td>
</tr>
<tr>
<td>Rat</td>
<td>Female</td>
<td>3.4 hours</td>
<td>18 days</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>6.5 days</td>
<td>54 days</td>
</tr>
<tr>
<td>Monkey</td>
<td>Female</td>
<td>33 days</td>
<td>155 days</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>20 days</td>
<td>166 days</td>
</tr>
<tr>
<td>Human</td>
<td>Both</td>
<td>2.3 years</td>
<td>3.3 years</td>
</tr>
</tbody>
</table>

Notes: (a) All values are approximations based on reported ranges. (b) A half-life is the time it takes for half of a chemical to leave the body.
## Basis of US EPA's Reference Doses

<table>
<thead>
<tr>
<th>Key study</th>
<th>Study type</th>
<th>Species</th>
<th>Critical effect</th>
<th>Effect level [Serum]</th>
<th>HED</th>
<th>UF</th>
<th>RfD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lau <em>et al.</em> (2006)</td>
<td>One-generation</td>
<td>Mouse</td>
<td>Delayed skeletal ossification; accelerated male puberty</td>
<td>LOAEL: 1 mg/kg-day [38,000 ng/mL]</td>
<td>0.0053 mg/kg-day</td>
<td>300</td>
<td>$2 \times 10^{-5}$ mg/kg-day</td>
</tr>
<tr>
<td>Luebker <em>et al.</em> (2005)</td>
<td>Two-generation</td>
<td>Rat</td>
<td>Reduced weight gain in F2 pups</td>
<td>NOAEL: 0.1 mg/kg-day [6,260 ng/mL]</td>
<td>0.00051 mg/kg-day</td>
<td>30</td>
<td>$2 \times 10^{-5}$ mg/kg-day</td>
</tr>
</tbody>
</table>

### Source
Derivation of US EPA Drinking Water Health Advisories for PFOA and PFOS

• Target population is lactating women
• Drinking water intake for lactating women = 54 mL/kg-day (90th percentile)
• Assumes 20% of total daily exposure comes from drinking water
• Lifetime Health Advisory = 0.07 µg/L = 70 ng/L
## State Screening Values for Drinking Water in the Northeast

<table>
<thead>
<tr>
<th>State</th>
<th>PFOA (ng/L)</th>
<th>PFOS (ng/L)</th>
<th>PFNA (ng/L)</th>
<th>PFHxS (ng/L)</th>
<th>PFHpA (ng/L)</th>
<th>PFDA (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut&lt;sup&gt;a&lt;/sup&gt;</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>Massachusetts&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Rhode Island&lt;sup&gt;c&lt;/sup&gt;</td>
<td>70</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Maine&lt;sup&gt;a&lt;/sup&gt;</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>New Hampshire&lt;sup&gt;d&lt;/sup&gt;</td>
<td>70</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Vermont</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>NA</td>
</tr>
<tr>
<td>New Jersey</td>
<td>14</td>
<td>13</td>
<td>13</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>New York</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes:
- Italicized text indicates proposed value.
- NA = Not Available;
- PFNA = Perfluorononanoic acid; PFHxS = Perfluorohexane sulfonic acid;
- PFHpA = Perfluoroheptanoic acid; PFDA = Perfluorodecanoic acid.

(a) Sum of the 5 PFAS compounds should not exceed 0.07 µg/L.
(b) Proposed January, 2020: Sum of the 6 PFAS compounds should not exceed 0.02 µg/L.
(c) PFOA and PFOS should not exceed 0.07 µg/L.
(d) New Hampshire proposed drinking water Maximum Contaminant Levels for 2019, but these values are currently under injunction.
General Risk Assessment Process

Hazard Identification → Dose-response Assessment → Risk Characterization

Exposure Assessment

How Might People be Exposed in a Community?
## Margins of Exposure

\[
\text{Margin of Exposure (MOE)} = \frac{\text{Agency POD}}{\text{NHANES Serum Concentration}}
\]

### Margins of Exposure Based on Serum Levels from NHANES 2015-2016

<table>
<thead>
<tr>
<th></th>
<th>PFOA</th>
<th>PFOS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Point of Departure (POD) Dose</strong></td>
<td>1 mg/kg-day</td>
<td>0.1 mg/kg-day</td>
</tr>
<tr>
<td><strong>Animal Serum Concentration at POD</strong></td>
<td>38,000 ng/mL</td>
<td>6,260 ng/mL</td>
</tr>
<tr>
<td><strong>General Population Geometric Mean Serum Concentration</strong></td>
<td>1.56 ng/mL</td>
<td>4.72 ng/mL</td>
</tr>
<tr>
<td><strong>Margin of Exposure for the Geometric Mean</strong></td>
<td>24,400</td>
<td>1,320</td>
</tr>
<tr>
<td><strong>General Population 95th Percentile Serum Concentration</strong></td>
<td>4.17 ng/mL</td>
<td>18.3 ng/mL</td>
</tr>
<tr>
<td><strong>Margin of Exposure for the 95th Percentile</strong></td>
<td>9,110</td>
<td>342</td>
</tr>
</tbody>
</table>

Source: Boomhower et al., 2020
Sites that Commonly Contain PFAS Compounds

Aqueous Film-forming Foam (AFFF) Sites
- Fire Training Academies
- Airports
- Gas Stations
- Military Bases

Industrial Production of PFAS or PFAS-coated Products
- Coated textiles
- Carpet

Paper Mills
- Production of coated paper and cardboard

Biosolids
How Might People be Exposed to PFAS Compounds at Sites?

- Soil/Sediment
- Fish
- Surface Water
- Drinking Water
### Applicable US EPA Residential Screening Level Values

<table>
<thead>
<tr>
<th>Environmental Medium</th>
<th>PFOA</th>
<th>PFOS</th>
<th>PFBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil (mg/kg)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.26</td>
<td>1.26</td>
<td>1,260</td>
</tr>
<tr>
<td>Tap Water (µg/L)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.4 (400 ng/L)</td>
<td>0.4 (400 ng/L)</td>
<td>400 (400,000 ng/L)</td>
</tr>
<tr>
<td>Fish (mg/kg)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.056</td>
<td>0.056</td>
<td>56</td>
</tr>
<tr>
<td>Air (µg/m&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>Not Volatile</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: PFBS = Perfluorobutane sulfonate. (a) Calculated with US EPA default assumptions in RSL Calculator with target cancer risk of 10⁻⁶ and target HQ = 1. (b) Additional values available in the calculator for workers. (c) Tap water – only includes ingestion. (d) Fish Ingestion requires site-specific input – the above value uses 30 g/day.
General Risk Assessment Process

Hazard Identification → Dose-response Assessment → Risk Characterization → Exposure Assessment

## Toxicity Values for Risk Assessments

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Oral Cancer Slope Factor (mg/kg-day)^{-1}</th>
<th>US EPA Reference Dose (mg/kg-day)</th>
<th>ATSDR Draft Minimum Risk Level (mg/kg-day)</th>
<th>In EPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOA</td>
<td>$7 \times 10^{-2}$</td>
<td>$2 \times 10^{-5}$</td>
<td>$3 \times 10^{-6}$</td>
<td>No</td>
</tr>
<tr>
<td>PFOS</td>
<td>NA</td>
<td>$2 \times 10^{-5}$</td>
<td>$2 \times 10^{-6}$</td>
<td>No</td>
</tr>
<tr>
<td>PFBS</td>
<td>NA</td>
<td>$2 \times 10^{-2}$</td>
<td>NA</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: NA = Not Available; PFBS = Perfluorobutane Sulfonate.
Summary

• Long human half-lives result in low toxicity values
• Primary pathway: ingestion
• Serum levels in general US population are below points of departure from toxicity studies
• Regulatory agency guidelines meant to protect even sensitive populations
• Exceedance of guidance values ≠ adverse health outcome
Questions?

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Evaluation of PFAS Data without an Approved Methodology

Elizabeth Denly

Program Director, PFAS Group

TRC
PFAS Analysis: What to Expect and How to Evaluate the Data

May 6, 2020
Methods and Analyte Lists
<table>
<thead>
<tr>
<th>Method</th>
<th>Year</th>
<th>Applicable Matrices</th>
<th># PFAS Analytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA 537 v 1.1</td>
<td>2009</td>
<td>Drinking Water</td>
<td>14 analytes</td>
</tr>
<tr>
<td>EPA 537.1</td>
<td>2018</td>
<td>Drinking Water</td>
<td>18 analytes</td>
</tr>
<tr>
<td>EPA 533</td>
<td>2019</td>
<td>Drinking Water</td>
<td>25 analytes</td>
</tr>
<tr>
<td>ASTM D7979-17</td>
<td>2017</td>
<td>Water, Wastewater</td>
<td>21 analytes</td>
</tr>
<tr>
<td>ASTM D7968-17</td>
<td>2017</td>
<td>Soil</td>
<td>21 analytes</td>
</tr>
<tr>
<td>ISO 25101</td>
<td>2009</td>
<td>Aqueous</td>
<td>PFOA/PFOS</td>
</tr>
<tr>
<td>DoD QSM 5.1</td>
<td>2017</td>
<td>Solid &amp; Aqueous</td>
<td>24+ analytes</td>
</tr>
<tr>
<td>DoD QSM 5.2</td>
<td>2018</td>
<td>Solid &amp; Aqueous</td>
<td>24+ analytes</td>
</tr>
<tr>
<td>DoD QSM 5.3</td>
<td>2019</td>
<td>Solid &amp; Aqueous</td>
<td>24+ analytes</td>
</tr>
<tr>
<td>EPA 537 “Modified”</td>
<td>Current</td>
<td>All</td>
<td>24+ analytes</td>
</tr>
<tr>
<td>Analyte</td>
<td>CAS No.</td>
<td>UCMR3 (6)</td>
<td>537 (18)</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>---------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>Perfluorobutanoic acid (PFBA)</td>
<td>375-22-4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Perfluoropentanoic acid (PFPeA)</td>
<td>2706-90-3</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Perfluorohexanoic acid (PFHxA)</td>
<td>307-24-4</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Perfluoroheptanoic acid (PFHpA)</td>
<td>375-85-9</td>
<td>X</td>
<td>X</td>
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<td>Perfluorooctanoic acid (PFOA)</td>
<td>335-67-1</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Perfluorononanoic acid (PFNA)</td>
<td>375-95-1</td>
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<td>X</td>
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<td>Perfluorodecanoic acid (PFDA)</td>
<td>335-76-2</td>
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<td>X</td>
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<td>Perfluoroundecanoic acid (PFUnA)</td>
<td>2058-94-8</td>
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<td>X</td>
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<td>Perfluorododecanoic acid (PFDoA)</td>
<td>307-55-1</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Perfluorotridecanoic Acid (PFTrA)</td>
<td>72629-94-8</td>
<td>X</td>
<td>X</td>
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<td>Perfluorotetradecanoic acid (PFTeA)</td>
<td>376-06-7</td>
<td>X</td>
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<td>Perfluorohexadecanoic acid (PFHxDA)</td>
<td>67905-19-5</td>
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<td>Perfluorooctadecanoic acid (PFODA)</td>
<td>16517-11-6</td>
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<td>Perfluoropentanesulfonic acid (PFPeS)</td>
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<td>Perfluorohexanesulfonic acid (PFHxS)</td>
<td>355-46-4</td>
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<td>Perfluoroctanesulfonic acid (PFOS)</td>
<td>1763-23-1</td>
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<td>X</td>
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<tr>
<td>Perfluorononanesulfonic acid (PFNS)</td>
<td>474511-07-4</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Perfluorodecanesulfonic acid (PFDS)</td>
<td>335-77-3</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Perfluorooctane Sulfonamide (FOSA)</td>
<td>754-91-6</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>N-methyl perfluoroctane sulfonamidoacetic acid (NMeFOSAA)</td>
<td>2355-31-9</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>N-ethyl perfluoroctane sulfonamidoacetic acid (NeFOSAA)</td>
<td>2991-50-6</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6:2 Fluorotelomer sulfonic acid (6:2 FTSA)</td>
<td>27619-97-2</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8:2 Fluorotelomer sulfonic acid (8:2 FTSA)</td>
<td>39108-34-4</td>
<td>X</td>
<td>X</td>
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<tr>
<td>4:2 Fluorotelomer sulfonic acid (4:2 FTSA)</td>
<td>757124-72-4</td>
<td>X</td>
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<tr>
<td>10:2 Fluorotelomer sulfonic acid (10:2 FTSA)</td>
<td>120226-60-0</td>
<td>X</td>
<td>X</td>
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<tr>
<td>N-Methyl perfluoroctane sulfonamidoethanol (N-MeFOSE)</td>
<td>24448-09-7</td>
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<td>X</td>
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<tr>
<td>N-Ethyl perfluoroctane sulfonamidoethanol (N-EtFOSE)</td>
<td>1691-99-2</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>N-Methyl perfluoroctane sulfonamide (MeFOSA)</td>
<td>31506-32-8</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>N-Ethyl perfluoroctane sulfonamide (EtFOSA)</td>
<td>4151-50-2</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>HFPO-DA (Gen-X)</td>
<td>62037-80-3</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>ADONA</td>
<td></td>
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<td>X</td>
</tr>
<tr>
<td>F-53B-9CI</td>
<td></td>
<td>X</td>
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</tr>
<tr>
<td>F-53B-11Cl</td>
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<td>X</td>
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</tr>
</tbody>
</table>

Analyte lists vary by method, laboratory, and regulatory agency

Determine what list you really need!
“Modified” EPA 537
Evaluate Holding Times

14 days to extraction; 28 days from extraction to analysis

Typical sample result summary form

- Number of PFAS reported
- Results, RLs, units
- Dilution results
- Collection date, prepared date, analysis date
- Percent solids (dry weight)
- Isotope Dilution

---

**Client Sample ID:** xxxx-08
**Date Collected:** 05/18/17 11:20
**Date Received:** 05/20/17 11:50

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Result</th>
<th>Qualifier</th>
<th>Dil Fac</th>
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<tbody>
<tr>
<td>Perfluorobutanoic acid (PFBA)</td>
<td>ND</td>
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<tr>
<td>Perfluoropentanoic acid (PFPeA)</td>
<td>ND</td>
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</table>

**Method:** 537 (modified) - Fluorinated Alkyl Substances

---

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**Date Collected:** 05/18/17 11:20
**Date Received:** 05/20/17 11:50

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Result</th>
<th>Qualifier</th>
<th>Dil Fac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfluorobutanoic acid (PFBA)</td>
<td>ND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfluoropentanoic acid (PFPeA)</td>
<td>ND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Client Sample ID:** xxxx-08
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<td></td>
<td></td>
</tr>
<tr>
<td>Perfluoropentanoic acid (PFPeA)</td>
<td>ND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

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<td>ND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfluoropentanoic acid (PFPeA)</td>
<td>ND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Solid Phase Extraction

- Is the lab extracting the **entire** sample and **rinsing** the sample bottle?
- What cartridge is the lab using?
  - *Styredivinylbenzene (SDVB) sorbent phase*
  - *Reverse phase copolymer characterized by a weak anion exchange (WAX) sorbent phase*
- Is the lab doing washes to remove interferences on the SPE cartridge?

![Diagram of SPE process]

- **250 mL sample**
- **1 mL final extract**

*PFBA, PFPeA poor recoveries*
How Do Labs Deal With Solids in Aqueous Samples?

- The following samples contain non-settleable particulate matter which plugged the solid-phase extraction column.
- The following samples were observed to have orange sediment at the bottom of the sample containers prior to extraction.
- The following samples were decanted prior to preparation due to excessive sediment in bottle.
- Due to excessive amount of sediment in the sample bottles, the aqueous portion of the following samples were decanted to new bottles prior to spiking and extraction.
- The MS/MSD precision for the batch was outside control limits. Due to the sample matrix containing excessive particulate matter, the entire sample containers were not able to be extracted; volumes extracted are noted in the preparation batch notes. Therefore the final concentrations are considerably different.
- The following sample was decanted prior to preparation due to having floating sediment particles and also some wood material.
- The following sample was centrifuged prior to spiking and the extraction due to the color being a dark yellow with floating material instead, which we cannot decant.
- Samples have fine sediment at the bottom of the bottle and mixed in with the sample water.
- Due to residual amounts of sediment in the sample, the sample container was placed in the oven and dried after extraction, and the weight was then recorded. The container was then extracted per the SOP.
- Samples contained significant amounts of solids that were expected to hinder loading of the full sample volume (including rinsing of the sample bottle) on the solid phase extraction cartridge and subsequent elution. These samples were centrifuged and the aqueous phase of each received sample was decanted to a new sample bottle. The decanted sample volumes were spiked with surrogate compounds and were extracted in the new bottles per the laboratory’s SOP. The results for these samples may be subject to a low bias due to potential losses of target analytes from adsorption to the original sample bottles. No further corrective action was feasible.
Separates compound mixtures on column. Column has high affinity for PFAS. The affinity of each compound to the column is different based on its solubility.

- Characteristic retention times
- Step 1 in compound identification: time the compound comes off the column

Sample Analysis: HPLC Separation (Part 1)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Retention Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFBA</td>
<td>1.527</td>
</tr>
<tr>
<td>$^{13}$C$_4$PFBA</td>
<td>1.525</td>
</tr>
<tr>
<td>PFOS</td>
<td>3.028</td>
</tr>
<tr>
<td>$^{13}$C$_4$PFOS</td>
<td>3.026</td>
</tr>
</tbody>
</table>

Retention time increases with carbon number
Unique fragmentation patterns (Step 2 of compound identification)
Parent/daughter combinations = definitive ID, more sensitive analysis

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Retention Time (min)</th>
<th>Parent/Daughter Ions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFBS</td>
<td>1.754</td>
<td>299/80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>299/99</td>
</tr>
<tr>
<td>$^{13}$C$_3$PFBS</td>
<td>1.752</td>
<td>302/83</td>
</tr>
<tr>
<td>PFOS</td>
<td>3.028</td>
<td>499/80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>499/99</td>
</tr>
<tr>
<td>$^{13}$C$_4$PFOS</td>
<td>3.026</td>
<td>503/80</td>
</tr>
</tbody>
</table>
Transition Ions (Parent/Daughter Ions)

- **Definitive Identification of Compounds**
  - Retention time from HPLC separation
  - Transition to characteristic daughter ions
  - Ion ratios

- **What happens when the ion ratios are outside limits?**
  - What are the limits?

- **What if there is no daughter/confirmation ion?**
  - PFBA
  - PFPeA
  - NMeFOSAA
  - NEtFOSAA

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Retention Time (min)</th>
<th>Parent/Daughter Ions</th>
<th>Ion Ratio</th>
<th>Ion Ratio Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFBS</td>
<td>1.754</td>
<td>299/80 299/99</td>
<td>2.91</td>
<td>1.35-4.05</td>
</tr>
<tr>
<td>(^{13}C_3)PFBS</td>
<td>1.752</td>
<td>302/83</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>(^{13}C_4)PFOS</td>
<td>3.026</td>
<td>503/80</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
Linear & Branched Isomers

- Before September 2016, some inconsistency in how this performed
- PFHxS, PFOS, PFOA, NMeFOSAA, NEtFOSAA
- If branched isomers not included, result is biased low.

Correct integration of PFOA

Incorrect integration of PFOA
Isotope Dilution: What is It?

- Sample spiked with KNOWN amount of isotopes (labeled surrogates or extracted internal standards)
- Isotopes match target analytes
  - $^{13}\text{C}_4\text{PFBA}$ is isotope associated with PFBA
  - $^{13}\text{C}_4\text{PFOS}$ is isotope associated with PFOS
  - etc. for each PFAS analyte
- Target PFAS result corrected by proportional amount based on isotope
- **BENEFITS:**
  - Corrects for analytical error associated with matrix
  - Corrects for matrix interferences

**Concentration Target PFAS** = $\frac{\text{Target PFAS Area} \times \text{True Concentration Isotope Area Isotope} \times \text{Calibration Factor}}{\text{Isotope Area}}$
How Can Isotope Dilution Vary Between Labs?

- **When** is the lab spiking the isotopic standards?
- **How** is the lab evaluating the recoveries of the isotopic standards?

<table>
<thead>
<tr>
<th>Surrogate</th>
<th>Lab 1 (%)</th>
<th>Lab 2 (%)</th>
<th>Lab 3 (%)</th>
<th>Lab 4 (%)</th>
<th>DoD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13C3-PFBS</td>
<td>25-150</td>
<td>50-150</td>
<td>26-148</td>
<td>31-159</td>
<td>50-150</td>
</tr>
<tr>
<td>13C3-PFHxS</td>
<td>25-150</td>
<td>50-150</td>
<td>34-126</td>
<td>47-153</td>
<td>50-150</td>
</tr>
<tr>
<td>13C4-PFHxA</td>
<td>25-150</td>
<td>50-150</td>
<td>35-126</td>
<td>30-139</td>
<td>50-150</td>
</tr>
<tr>
<td>13C8-PFOA</td>
<td>25-150</td>
<td>50-150</td>
<td>43-112</td>
<td>36-149</td>
<td>50-150</td>
</tr>
<tr>
<td>13C8-PFOS</td>
<td>25-150</td>
<td>50-150</td>
<td>43-115</td>
<td>42-146</td>
<td>50-150</td>
</tr>
<tr>
<td>13C9-PFNA</td>
<td>25-150</td>
<td>50-150</td>
<td>32-134</td>
<td>34-146</td>
<td>50-150</td>
</tr>
</tbody>
</table>

- If >10% recovery, results most likely not significantly affected.
- If <10% recovery, higher probability that results may be affected.
  - Some data validation guidelines recommend rejecting nondetect results if <10%.
  - Detected results: potential low bias
  - Only associated target PFAS affected

Example:
If 13C3-PFBS exhibits low %R, only affects PFBS.
PFAS Analytical Reports

Typical sample result summary form

- Number of PFAS reported
- Results, RLs, units
- Dilution results
- Collection date, prepared date, analysis date
- Percent solids (dry weight)
- Isotope Dilution recoveries
Blank Evaluation
Method Blanks, Field Blanks, & Equipment Blanks

- Is anything detected in the blank?
- Are there any potential false positives?
- **General Rule of Thumb:** If concentration in sample <10x the blank concentration, the result is potentially a false positive

**Example:**

- **10x Blank = 20 ng/L**
  - Sample conc = **120 ng/L**
  - **Real Hit**

- **10x Blank = 20 ng/L**
  - Sample conc = **3 ng/L**
  - **False Positive**

**PFOS in Blank = 2 ng/L**
Were all target analytes reported?

Were all recoveries within the acceptance limits?

If LCS recoveries are outside limits:
- POTENTIAL LOW BIAS or
- POTENTIAL HIGH BIAS

Affects the whole batch of samples prepared with the LCS.
Potentially unusable results:
- if recoveries are <10%
Matrix Spikes/Matrix Spike Duplicates (MS/MSDs)

- Were all target analytes reported?
- Were all recoveries within the acceptance limits?
- Were all RPDs within the acceptance limits?

If MS recoveries are outside limits:
- POTENTIAL LOW BIAS or
- POTENTIAL HIGH BIAS

Affects the sample that was spiked.

Potentially unusable results:
- if recoveries are <10%
Let’s Summarize Potential Biases

- **Blanks**
  - Detected results

- **Holding Times**
  - Missed holding times

- **LCS**
  - Low recoveries
  - High recoveries

- **Labeled Surrogates, Matrix Spikes**
  - Low recoveries
  - High recoveries

- **Subsampling Water Sample**

- **No Methanol Rinse on Bottle**

**HIGH BIAS**
- All Associated Samples in Batch

**LOW BIAS**
- Sample-Specific

**LOW BIAS**
- Sample-Specific Compound-Specific

**LOW BIAS**
- Sample-Specific

**HIGH BIAS**
- All Associated Samples in Batch

**LOW BIAS**
- Sample-Specific

**LOW BIAS**
- Sample-Specific

Long chain PFAAs

> C8 PFSAs & >C10 PFCAs:
Detection Limits
## Different Detection Limits

<table>
<thead>
<tr>
<th>Detection Limit</th>
<th>Accurate?</th>
<th>Precise?</th>
<th>Use to Demonstrate Below Cleanup Standards?</th>
<th>Use Values in Risk Assessment?</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDL</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>EDL&lt;sup&gt;1&lt;/sup&gt;</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MDL / DL</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LOD&lt;sup&gt;2&lt;/sup&gt;</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PQL</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>RL / QL / SQL / LOQ</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<sup>1</sup> Specific to dioxins/furans
<sup>2</sup> Specific to DoD projects
What To Use for PFAS?

- RLs most reliable value (aka LOQ, QL, SQL, ML, CRQL)
- Most labs RLs 2-10 ng/L or 1-5 ug/kg, depending on PFAS
- Do not use MDLs as nondetect values
- No J values

![Graphs of PFBA concentrations]

- **PFBA:** 0.35 J ng/L
- **PFBA:** <2.0 ng/L
- **PFBA:** 2.5 ng/L
###CAS Numbers and PFAS State

<table>
<thead>
<tr>
<th>PFAS State</th>
<th>Structure</th>
<th>CAS No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PFOA</strong></td>
<td>Anion</td>
<td>Perfluorooctanoate</td>
</tr>
<tr>
<td></td>
<td>Acid</td>
<td>Perfluorooctanoic acid</td>
</tr>
<tr>
<td><strong>PFOS</strong></td>
<td>Anion</td>
<td>Perfluorooctane sulfonate</td>
</tr>
<tr>
<td></td>
<td>Acid</td>
<td>Perfluorooctane sulfonic acid</td>
</tr>
</tbody>
</table>

*Labs should report acid form and CAS No. for acid*
# Standardized Methods in the Future?

<table>
<thead>
<tr>
<th>Future Method</th>
<th>Matrix</th>
<th>Calibration</th>
<th>Analytes/RLs</th>
<th>When?</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW-846 8327</td>
<td>Aqueous (non-DW)</td>
<td>Direct injection; External standard</td>
<td>24 PFAS; RL 10 ng/L</td>
<td>Draft version out</td>
</tr>
<tr>
<td>SW-846 8328</td>
<td>Aqueous and solids</td>
<td>Isotope dilution</td>
<td>24 PFAS in 8327 plus Gen-X; RL 10 ng/L</td>
<td>EPA collaborating with DoD (multi-year process)</td>
</tr>
<tr>
<td>SW-846 8329</td>
<td>Solid prep method</td>
<td>NA</td>
<td>NA</td>
<td>Not definite</td>
</tr>
</tbody>
</table>
Factors Affecting Data Comparability - PFAS

- Field Collection Techniques
- Sample Handling in the Laboratory (e.g., SPE, solids)
- Field / Method Blank issues
- Not using Isotope Dilution for Recovery Correction
- Degradation of Precursors
- Not including Branched Isomers
- Calibration differences (e.g., isotope dilution vs internal standard)
- Sensitivity differences (RLs not the same)
- Compound name differences
Summary – Take Away Points

- No standard PFAS Analytical Method for non-DW matrix
- SOPs are inconsistent across laboratories
- Evaluate the reported QC results
- Understand what your lab’s procedures are
Questions?

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www.TRCCompanies.com
PFAS Challenges for LEPs, Case Studies, and Trends

Robert Bowden

Associate

Fuss & O’Neill, Inc.
PFAS Challenges for LEPs, Case Studies and Data Trends

Bob Bowden, LEP
Fuss & O’Neill, Inc.

EBC Connecticut Emerging Contaminants Webinar
May 6, 2020
Agenda

- Challenges for LEPs
  - Cross Contamination
  - Background
  - Clean-up Criteria
- General Data Trends in CT
  - Car Wash
  - General Industrial Operations
  - Plating Operations
  - Fire Training Areas
PFAS Challenges for Environmental Professionals

- Determining when PFAS should be investigated as a COC – new/evolving info on uses/settings
- Lack of EPA-approved, validated analytical methods for media other than drinking water
- Evolving PFAS analyte lists - did we analyze for enough/the right compounds?
- Variability between laboratory procedures, analyte lists and reporting limits
- Lengthy laboratory turnaround times
- Evolving regulatory limits
PFAS Cross-Contamination

- Low action levels require extremely sensitive analysis using modified drinking water analysis, reporting limits down to single-digit ppt (ng/L)
- Field or laboratory cross-contamination can invalidate data sets - $$
- PFAS are present in many items used in everyday life, as well as in some sampling equipment – high potential for cross-contamination
- Special care needs to be taken during sampling to address this challenge:
  - SOPs prescribe materials that should and shouldn’t be worn/used
  - Be sure to also check with the driller!
PFAS Cross-Contamination

• Blanks are essential to verify that sampling procedures did not introduce PFAS contamination, and that the data obtained are valid and defensible

• Our experience:
  o 38 equipment, field and trip blanks
  o 6 different samplers
  o 9 different labs
  o Majority of analyses included 24 or more compounds
  o Results:
    - 33 of 38 blanks ND (87%)
    - Reporting limits of 2-9 ng/L
PFAS Cross-Contamination

• Blank outliers:
  o Perfluorobutanoic acid (PFBA) detected in 4 blanks:
    − 3-10 ng/L, all from same site, same event
    − Connecticut 5 PFAS not detected
  o Groundwater sampling event, one of many blanks:
    − Concentrations in ppb range, far greater than concentrations detected in site groundwater
    − Follow-up sampling confirmed initial site results, with no detections in blanks

• Conclusions:
  o It is possible to prevent cross-contamination
  o Blanks, although costly, are essential to verify sampling procedures and defend data
PFAS Background

• PFAS found to be ubiquitous in many areas, especially in groundwater:
  o Septic systems
  o Stormwater runoff
  o Aerial deposition, infiltration
• Published background soil study in VT:
  o PFOS – state-wide average 0.7 ug/kg
  o PFOA – state-wide average 0.3 ug/kg
• Our experience in CT:
  o 12 background groundwater samples from three sites
  o Hydrogeology well understood
  o PFAS detected in all background groundwater samples
  o Primary constituents: PFOS, PFOA and Perfluorohexane sulfonate (PFHxS)
## PFAS Background

<table>
<thead>
<tr>
<th>Location</th>
<th>Possible Sources</th>
<th># Samples</th>
<th># Detects</th>
<th>CT5 Range (ng/L)</th>
<th>Maximum Total PFAS (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban – Industrial</td>
<td>Manufacturing: • Plastics • Coating • Plating • Fire suppression • Fire training • WWTP • Landfills</td>
<td>5</td>
<td>5</td>
<td>1 sample @ 8 4 samples @ 19.3-55</td>
<td>59</td>
</tr>
<tr>
<td>Urban – Commercial</td>
<td>Fire houses • Wastewater treatment • Car wash • Dry cleaner • Salvage yard</td>
<td>7</td>
<td>7</td>
<td>6 samples @ 3-15 1 sample @ 59</td>
<td>95</td>
</tr>
</tbody>
</table>
Uncertainty Regarding Criteria

- CT Additional Polluting Substance Criteria – 5 PFAS:
  - We are currently looking for 24 or more PFAS
  - How do we address those other than the CT 5
- Soil: PMC for both GA- and GB-designated areas
- Groundwater:
  - GWPC – For GA areas
  - For GB sites, GWPC typically do not apply
- Surface water guidance levels (based on human fish consumption) are in the 5 to 15 ppt range – same order of magnitude as background
- Hopefully DEEP can develop a policy to address these issues
General Data Trends

- Car Wash
- General Industrial
- Plating
- Fire Training
Car Wash

- Car Wash
  - Closed for 10 years
  - 6 wastewater samples from underground wash water recycling tanks – all with PFAS detections:
    - Sum of 5 CT PFAS ranged from 32 to 98 ng/L
    - Total PFAS ranged up to 4,220 ng/L
    - 3 samples exceeded 70 ng/L action level
    - PFOA primary PFAS detected
  - 3 groundwater samples - 2 with PFAS detections:
    - Sum of 5 CT PFAS were 624 and 1,287 ng/L
    - Total PFAS concentrations 859 and 1,603 ng/L
    - 2 samples exceeded action level
    - PFOA and PFHxS primary detections
## General Industrial

<table>
<thead>
<tr>
<th>Business Type</th>
<th>Media Sampled</th>
<th># Samples</th>
<th># Detects</th>
<th>Sum of CT5</th>
<th>Primary PFAS</th>
<th>Max Total PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard Manufacturer (Inactive)</td>
<td>Groundwater</td>
<td>6</td>
<td>6</td>
<td>27-57 ng/L</td>
<td>PFOS</td>
<td>57 ng/L</td>
</tr>
<tr>
<td>Coating &amp; Adhesive Manufacturer (Active)</td>
<td>Soil</td>
<td>57</td>
<td>12</td>
<td>0.3-9.7 ug/kg</td>
<td>PFOS</td>
<td>37.3 ug/kg</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>23</td>
<td>22</td>
<td>4-35 ng/L</td>
<td>PFOS &amp; PFOA</td>
<td>1,011 ng/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 @ 904 ng/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 @ 322-1,660 ng/L</td>
<td>PFOS &amp; PFOA</td>
<td>1,743 ng/L</td>
</tr>
<tr>
<td>Aerospace Testing Facility (Active)</td>
<td>Groundwater</td>
<td>4</td>
<td>4</td>
<td>1 @ 28 ng/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 @ 322-1,660 ng/L</td>
<td>PFOS &amp; PFOA</td>
<td></td>
</tr>
</tbody>
</table>
General Industry Trends

• Groundwater
  o Detected at two locations above upper end of range of background:
    - Aerospace testing facility – likely historic from the fire suppression system
    - Coating and adhesives manufacturer – historic product landfills
  o GB sites, no current groundwater criteria

• Soil
  o Limited data from one site, many NDs
  o GB site, no exceedances of APS criteria
<table>
<thead>
<tr>
<th>Business Type</th>
<th>Media Sampled</th>
<th># Samples</th>
<th># Detects</th>
<th>Sum of CT5</th>
<th>Primary PFAS</th>
<th>Max Total PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Manufacturer (Active)</td>
<td>Groundwater</td>
<td>1</td>
<td>1</td>
<td>138 ng/L</td>
<td>PFOS &amp; PFOA</td>
<td>152 ng/L</td>
</tr>
<tr>
<td>Hardware Manufacturer (Historic)</td>
<td>Soil</td>
<td>1</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>1</td>
<td>1</td>
<td>276 ng/L</td>
<td>PFOS &amp; PFHxS</td>
<td>307 ng/L</td>
</tr>
<tr>
<td>Aerospace Manufacturer (Historic)</td>
<td>Groundwater</td>
<td>2</td>
<td>2</td>
<td>587-641 ng/L</td>
<td>PFOS &amp; PFHxS</td>
<td>710 ng/L</td>
</tr>
</tbody>
</table>
Plating Trends

• Groundwater – 3 sites:
  o Present in all samples
  o Concentrations 10 times or more higher than background
  o All GB groundwater sites
  o No current APS criteria for surface water
## General Fire Training

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Media Sampled</th>
<th># Samples</th>
<th># Detects</th>
<th>Sum of CT5</th>
<th>Primary PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Municipal Fire Training (No known use of AFFF)</td>
<td>Soil</td>
<td>6</td>
<td>1</td>
<td>134 ug/kg</td>
<td>PFOS</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>3</td>
<td>3</td>
<td>2-116.6 ng/L</td>
<td>PFOS &amp; PFHpA</td>
</tr>
<tr>
<td>Aerospace Manufacturer (Historic Fire Training Area)</td>
<td>Groundwater</td>
<td>6</td>
<td>2</td>
<td>78-606 ng/L</td>
<td>PFOS &amp; PFHxS</td>
</tr>
<tr>
<td>Defense Contractor (Historic Fire Training Area)</td>
<td>Soil</td>
<td>9</td>
<td>9</td>
<td>0.91-1.34 ug/kg</td>
<td>PFOA</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>3</td>
<td>3</td>
<td>512-1,390 ng/L</td>
<td>PFOS &amp; PFHxS</td>
</tr>
</tbody>
</table>
## Active Regional Fire Training School

<table>
<thead>
<tr>
<th>Media Sampled</th>
<th># Samples</th>
<th># Detects</th>
<th>Sum of CT5</th>
<th>Primary PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>29</td>
<td>26</td>
<td>8-424 ug/kg</td>
<td>PFOS &amp; PFHxS</td>
</tr>
<tr>
<td>Groundwater</td>
<td>6</td>
<td>2</td>
<td>424-48,903 ng/L</td>
<td>PFOS &amp; PFHxS</td>
</tr>
<tr>
<td>Potable Water</td>
<td>7</td>
<td>4</td>
<td>168-208 ng/L (same property)</td>
<td>PFOA</td>
</tr>
</tbody>
</table>
Fire Training Trends

- Sites with highest impact:
  - Consistent with trends across U.S.
  - Present at sites not used for decades
  - Present at sites with no existing knowledge of use
- Groundwater - All yielded exceedances of 70 ng/L standard
- Soil - no exceedances of APS Res DEC
- Three sites in GA areas
• In general, if you look for PFAS you have a good chance of finding them
• Cross-contamination is preventable by good planning and blanks
• Have to consider background – PFAS may be ubiquitous in the area
• Have not seen an exceedance of the APS Res DEC
• Site closure – DEEP needs to develop a policy to address SWPC and all PFAS constituents evaluated
Contact

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PFAS: A Legal and Risk Management Perspective

Andrew N. Davis

Partner
Shipman & Goodwin LLP
PFAS: What’s all the PFUSS?
A Legal and Risk Management Perspective

Environmental Business Council of New England
Webinar – May 6, 2020
Andrew N. Davis, Ph.D., Esq.
Outline

- Why Are The Agencies Regulating?
- Coordinating the Team: AND is Better
- Federal Regulatory Landscape
- State Regulatory Landscape
- Risk Management Plan
- Recommendations
Comprehensive List of PFAS

- Dimethyl hexafluoropropionate
- Perfluorooctanesulfonate
- Perfluoro(oxacyclopentane)
- Perfluorooctane sulfonate
- 6:2 Fluorotelomer thiolates
- 5:1 Fluorotelomer alcohols
- Perfluorooctanoic acid
- Monopotassium monoperfluoroalkyl ethylphosphate
- Perfluorodecanoic acid
- Perfluorodecanoic acid
- Perfluoropentadecanoic acid
- Perfluorodecyl iodide
- Perfluorooctane sulfonate
- Perfluorodecanoate
Impacts – Why Are Agencies Regulating?

• PFAS are hot “emerged” contaminants
  ◆ Regulators are moving “PFAST and PFURIOUS”

• Environmental Impacts
  ◆ Soil/groundwater contamination; degraded surface water bodies; natural resources

• Human Consumption Impacts
  ◆ Accumulate in the human body
  ◆ Resulting potential health effects
Coordinated Technical AND Legal Approach

- PFAS have technical AND legal issues
- Innovative solutions require technical AND legal expertise
- Lawyers AND consultants need to advise clients with one coordinated message
- Clients like certainty
Be Cognizant of Potential Litigation/Enforcement

- Attorney-Client Privilege
  - Engage and communicate through counsel
  - Understand limits of ACP with consultants
- Beware of written communications
  - Oral before written
  - Anything in writing may be discoverable (e.g. internal emails, texts, draft reports, notes, social media)
- Freedom of Information Act
  - Applicable to public entities (e.g. municipalities, schools)
EPA’s PFAS Action Plan (Feb. 2019)

- MCL & Enforceability
- Hazardous Substance Designation
- Monitoring Plan
- Research
- Enforcement Assistance
- Communication Toolbox

Update issued in Feb. 2020
Federal Regulatory Landscape

- **Water Actions**
  - Under SDWA, EPA issued a health advisory level for PFAS at 70 ppt
    - Not an MCL and not enforceable
    - Seeking information, data, and public comment for further SDWA regulation
  - Considering developing Clean Water Act water quality criteria

- **Cleanup Actions**
  - Considering CERCLA Hazardous Substance designation for PFOA & PFOS
    - Jan. 10, 2020 -- House passed PFAS Action Act to do just that
  - Interim Recommendations for Addressing Groundwater Contaminated with PFOA & PFOS in federal cleanup programs (w/ a 40 ppt screening standard)

- **Latest Actions**
  - Added 172 PFAS to EPCRA’s Toxic Release Inventory list
  - Proposed rule to ban manufacture and import of long-chain PFAS absent EPA review and approval (TSCA/SNUR)
State Actions

- Trends Point to Several Categories of Legislation and/or Regulation:
  - Manufacturing/Use Prohibitions
  - Ecological Protection/Restoration
  - Environmental Cleanup Levels
  - Drinking Water Safety

- We are seeing states conflict with federal authority at several sites, including at government facilities and military bases nationwide
  - E.g., some states have already banned fire-fighting foam (AFFF) while the Dept. of Defense ban on AFFF is not effective until Oct. 2024
PFAS Action in New England

• Connecticut (Current)
  - If PFAS are Contaminants of Concern (COCs) based on a review of site history and/or site operations, must consider in Site Characterization
  - Additional Polluting Substances (APS) under the RSRs
    - APS standards are in ppm and ppb while PFAS screening levels are in ppt
      - Res. DEC and I/C DEC at ppm; GA PMC and GB PMC at ppb
    - Groundwater Protection Criterion: 70 ppt total for 5 PFAS
  - Significant Environmental Hazard (SEH)
    - There are no RSR criterion for PFAS . . . yet
    - In the meantime . . . PFAS captured by C.G.S. § 22a-6u(c):
      - If any substance for which there is no RSR criterion has affected a public/private drinking water supply well, TEP must notify property owner, who must then notify DEEP and submit an action plan
PFAS Action in New England

• Connecticut (Future)
  ❖ Task Force released Action Plan (Nov. 2019) with dozens of proposals:
    ➢ Minimizing future uses of AFFF (fire-fighting foam);
    ➢ Sample public drinking water, private wells, and bottled water;
    ➢ Develop database of known potential sources; and
    ➢ Establish cleanup standards for soil, groundwater, surface water, etc.
  ❖ Ambitious first step --- but many unanswered questions remain:
    ➢ Risk of cross contamination in the field and in the laboratory (ppt!)
    ➢ How to remediate substances that are resistant to degradation?
  ❖ Three PFAS bills in the “present” legislative session:
    ➢ (1) to test public water supplies; (2) to limit use in food packaging; and
    (3) to prohibit fire-fighting foam (AFF)
PFAS Action in New England

• Massachusetts
  ◆ Considered “hazardous material” subject to Waste Site Cleanup Program
  ◆ MA Contingency Plan – PFAS notification requirements and cleanup standards for soil and groundwater are now final and effective 12/2019
  ◆ Groundwater cleanup standard - 70 ppt (Proposed - 20 ppt)
  ◆ Drinking Water MCL “Guideline” – 70 ppt total for 5 PFAS
    ➢ Proposed MCL – 20 ppt total for 6 PFAS (December 27, 2019)

• Rhode Island
  ◆ Proposed legislation to initiate process to set MCLs for groundwater and surface water, and require testing of public water supplies
  ◆ Proposed legislation prohibiting use in food packaging
  ◆ Groundwater standard is 70 ppt total for PFOA and PFOS
PFAS Action in New England

• New Hampshire
  ◆ Requires sampling of public water, landfills, and wastewater plants
  ◆ Among the strictest drinking water standards in the country
    ➢ PFOA – 12 ppt; PFOS – 15 ppt; PFHxS – 18 ppt; PFNA – 11 ppt

• Maine
  ◆ Task Force issued final report in December 2019 with recommendations:
    ➢ Require sampling of public water supplies and private wells; restrict uses in the food supply chain; and manage wastewater plant sludge.
  ◆ Required sampling of sludge/biosolids with 50 ppt screening standard

• Vermont
  ◆ New Water Supply Rule for 2020: all public water supplies must be sampled and...
    ➢ If < 20 ppt, future monitoring at varied intervals (triennial, annual, quarter)
    ➢ If >20 ppt, immediate Do Not Drink order
The Exotics...

• New York
  - Drinking Water Quality Council proposed MCL for PFOA/PFOS: 10 ppt
  - All sites in state cleanup programs must sample for 21 PFAS in soil, groundwater, surface water, sediment, and imported soils
    ➢ Further assessment required if detected in water/soil above certain trigger levels
  - DEC is building a database of 1800 potential public water supply sites

• New Jersey
  - Proposed PFOS and PFOA standards: groundwater (13 and 14 ppt) and drinking water standards (10 ppt)
    ➢ Approved by NJ DEP on March 30, 2020; sent to Governor for approval/publication
  - All remediation sites required to:
    ➢ (1) evaluate site history and operations;
    ➢ (2) if warranted, conduct site investigations; and
    ➢ (3) if required, remediate groundwater
Current Litigation

• Against chemical companies, manufacturers, U.S. military
• Brought by classes, utilities, municipalities, states
• Federal Action: EPA has “multiple criminal investigations underway” (details undisclosed)
• State Action
  ◆ New Hampshire
  ◆ Vermont
  ◆ Also, New Jersey, Minnesota, etc.
What Will Happen Now?

• Two Potential Paths
  ◆ Looking Backward
  ◆ Looking Forward
Looking Backward

- Will EPA/States Re-Open Closed Sites?
  - Remediate Further
  - Implications → massive new cleanup obligations
  - Huge Corporate Costs
  - Insurance Impacts
  - Closed Consent Orders/Decrees

- Prior Business Transaction Impacts
  - Sellers may have much more retained liability under prior transaction documents
Looking Forward

- Move forward with new laws, regulations, agency guidance and industry standards
- Future incremental cleanup obligations and costs
- In the PFAS era, what diligence is due in an asset, stock or real estate deal?
- What will buyers/developers/lenders/investors require... and then what do they do when they find what they did not want to find?
- How will testing/discovery impact sellers?
Risk Management

• Other Sources of Legal Liability
  
  ◆ Workforce Risk
  
  ➢ Contaminated soil, drinking water or materials on site
  
  ➢ Regulatory requirement to fix?
  
  ➢ Resulting lawsuits – workers compensation, OSHA, negligence, property damage, bodily injury, product liability
  
  ◆ PFAS Manufacturers/Users – Impacts to Business Operations
  
  ➢ Firefighting foam; food packaging
  
  ➢ Forced restructuring/reengineering
  
  ➢ “Forum” Shopping for Business Operations
Risk Management

• Should a company sample?
• If not, what should we be doing?
The Devil You Know

You don’t get to pick whether or not you get poisoned, you only get to pick your poison.

History of the “Wonder Chemicals”

- Ammonia
- Asbestos
- PCBs
- Lead
- BPA
- PFAS
Recommendation: Create a Risk Management Plan

- Conduct a Paper Audit
- Plan a Thought-Out Sampling (or Non-Sampling) Strategy
- Create a Communication Plan
- Evaluate Environmental Insurance Opportunities
Risk Management Plan

- Conduct a Paper Audit (Under A-C Privilege)
  - Identify Onsite & Up-gradient Sources
  - Identify Onsite & Down-gradient Liabilities (+ Non-owned Disposal Sites)
  - Cost Prediction (especially for publicly-traded companies)
  - Conduct Insurance Archaeology
    - If settled, examine scope and reopener provisions, if any
  - Examine Closed Consent Orders and Decrees
    - Reopener provisions?
Risk Management Plan

• Do you sample?
  ◆ Phase I assessment vs. Phase II investigation
  ◆ Because PFAS are not (yet) hazardous substances, they are not (yet) covered by ASTM Phase I standards

• Create Communication Plan
  ◆ Proactive, not reactionary
  ◆ Control/frame the message
  ◆ Define your objectives
  ◆ Understand targeted audiences

• Evaluate New Environmental Insurance Opportunities
Questions?

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PFAS: A Regulatory Update

Raymond Frigon
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CT DEEP

Lori Mathieu
Public Health Section Chief Drinking Water Section
CT DPH
PFAS: A Regulatory Update

Environmental Business Council
EBC Connecticut Emerging Contaminants Webinar: Understanding the Toxicity, Analytical Issues & Regulatory Implications of PFAS
May 6, 2020
8:45-12:00

DEPARTMENT of PUBLIC HEALTH
DEPARTMENT of ENERGY AND ENVIRONMENTAL PROTECTION
OVERVIEW OF CONNECTICUT PFAS ACTION PLAN
Connecticut Interagency PFAS Task Force

- July 8, 2019 Governor Ned Lamont established the Connecticut Interagency PFAS Task Force
  - Identify impacts to health and environment
  - Listen to stakeholders’ concerns
  - Identify actions to address impacts
- November 1, 2019 – Connecticut PFAS Action Plan
  - Recommended actions related to health, environment, and communication
CT PFAS Action Plan Recommendations

• Human Health
• Pollution Prevention
• Remediation
• Outreach
• Legislative Opportunities
Human Health Impacts

- Test drinking water for PFAS
- Monitor new research; modify health-based guidelines as appropriate
- Identify, prioritize, and evaluate other potential sources of PFAS exposure
- Procure testing equipment for the State Laboratory
Pollution Prevention

• Minimize future AFFF releases
  • Best practices for handling, storage, and disposal
  • AFFF take-back program
  • Evaluation, selection, and procurement of fluorine-free foams

• Identify other potential PFAS sources
  • Operations, processes, and consumer products

• Evaluate the levels of PFAS that reach wastewater treatment plants, biosolids, and compost

• Establish discharge limits for PFAS in air and water
Remediation

• Map potential PFAS sources to identify areas of greatest concern
• Identify impacted areas and ambient PFAS levels through large-scale environmental sampling
  • Sites and areas where AFFF has been stored or released
  • Landfills and surrounding areas
• Establish PFAS cleanup standards for soil, groundwater, surface water, and aquatic biota
• Continue using statutory authority to compel investigation and cleanup of PFAS releases
Public Outreach and Communication

- Enhanced public outreach by state agencies
  - Risk communication services (e.g., public meetings, informational materials)
- Up-to-date webpage content
- Collaboration with local health officials and emergency response personnel
- Enhanced notification procedures for emergency release incidents
Legislative Opportunities

• Safe Drinking Water Advisory Council
  • Make recommendations to the Commissioner of Public Health.
  • Maximum Contaminant Level, treatment technique, or Action Levels.
  • Timeframes and frequencies for sampling.
  • Form and content of public notification.
  • Development of educational materials and guidance.
Legislative Opportunities

- Minimize future releases of AFFF to the environment
  - AFFF take-back program
  - Other measures, such as a ban on use of AFFF for training purposes
- Evaluate whether the State can require the disclosure of products containing PFAS in Safety Data Sheets and product labeling
Governor’s Proposed FY 2021 Budget

Recommended Bond Authorization
- Establish AFFF take-back program
- Test private wells, provide resources to residents with PFAS-contaminated wells

Capital Equipment Purchase Fund
- Purchase PFAS analysis equipment for the State Public Health Laboratory
Governor’s Proposed FY 2021 Budget

General Fund Appropriations

For consulting services to assist the Safe Drinking Water Advisory Council

To initiate statewide surface water and sediment sampling

To enhance toxicology expertise, certify labs, and enable the DPH Laboratory to analyze PFAS in drinking water

To replace AFFF and nozzles in eight State-managed regional foam trailers
## Additional Polluting Substances

<table>
<thead>
<tr>
<th>Remediation Standard</th>
<th>APS Criterion*</th>
</tr>
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<tbody>
<tr>
<td>Residential Direct Exposure Criterion</td>
<td>1.35 mg/kg</td>
</tr>
<tr>
<td>Industrial/Commercial Direct Exposure Criterion</td>
<td>41 mg/kg</td>
</tr>
<tr>
<td>GA Pollutant Mobility Criterion</td>
<td>1.4 µg/kg</td>
</tr>
<tr>
<td>GB Pollutant Mobility Criterion</td>
<td>14 µg/kg</td>
</tr>
<tr>
<td>Groundwater Protection Criterion (Adopts DPH’s Drinking Water Action Level for ∑ PFOA, PFOS, PFHxS, PFNA, and PFHpA)</td>
<td>70 ng/L</td>
</tr>
<tr>
<td>Surface Water Protection Criterion</td>
<td>In Development</td>
</tr>
</tbody>
</table>

*Applies to ∑ PFOA, PFOS, PFHxS, PFNA, & PFHpA
After July 1, 2015, if a TEP in the course of investigating and remediating pollution on or emanating from a parcel determines pollution has affected a public or private drinking water supply well...with any substance from the release for which there is no RSR criterion,

* TEP shall notify client and owner of property within 7 days
* Owner of parcel that the source of pollution to a drinking water well shall:
  1) Notify Commissioner in writing within 30 days, and
  2) Perform confirmatory sampling of well and submit report to Commissioner with a plan for further action within 30 days
PFAS Bills Raised in the General Assembly

SB 297 – An Act Concerning the Use of PFAS in Class B Firefighting Foam

- Ban on training with AFFF – July 1, 2021
- Ban on firefighting with AFFF – July 1, 2022 (if alternative foam is identified by April 1, 2021)
- Take-back program for municipal AFFF – Development by October 1, 2021
PFAS Bills Raised in the General Assembly

HB 5288 – An Act Concerning PFAS

- Ban on training with AFFF – January 1, 2021
- Development and implementation, by January 2, 2021, of a plan for:
  - Statewide testing of water supply sources, water supplies, and bottled water for PFAS
  - Public education on the potential risks of drinking PFAS-contaminated water
PFAS Bills Raised in the General Assembly

HB 5291 – An Act Limiting the Use of PFAS & Expanded Polystyrene in Food Packaging

• Study on reasonable alternatives to food packaging containing intentionally added PFAS or expanded polystyrene – January 1, 2021

• Ban on the manufacture, sale, or distribution of any such food packaging with an identified alternative
For More Information

- Drinking from public supplies: DPH Drinking Water Section (860) 509-7333
- Drinking from private wells: DPH Private Well Program (860) 509-8401
- PFAS health effects: DPH Environmental & Occupational Health Assessment Program (860) 509-7740
- PFAS in the environment: DEEP Remediation Division (860) 424-3705

www.ct.gov/ctpfastaskforce
Questions?
Moderated Discussion

Moderator: Robert May

Program Co-Chair

Senior Vice President, Fuss & O’Neill, Inc.