



Practical Applications of Direct Aqueous Injection Methods for Quantitative PFAS Analysis by LC-MS/MS

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Sanja Risticovic, PhD, LC-MS Department Manager
Tammy Chartrand, National PFAS Program Lead

Outline



- Introduction to PFAS
- Sample preparation procedures
- Method overview: Drinking water, non-potable water, soils
- Performance of EPA 1633 method for aqueous and solid samples
- Direct Aqueous Injection approach for waters and soils
- Method comparison and studies



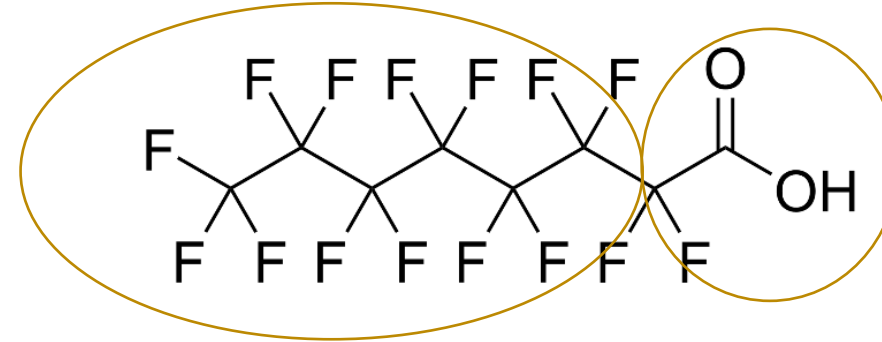


Properties and Uses PFAS

- C-F backbone = good stability under heat and chemical stress
- Dual hydrophobic, hydrophilic structure = Oil, grease, water and stain repellent
- Low surface tension = good surfactant and lubricant property
- Sources:
 - **Firefighting foams (AFF)**
 - Household and consumer products: cookware, clothing, paper, leather, textiles, cosmetics, food Packaging, cleaners and paints
 - Manufacturing and industrial processes
 - Indirect sources:
 - landfills (leachate)
 - Waste water treatment plants (effluent and biosolids)

Hydrophobic

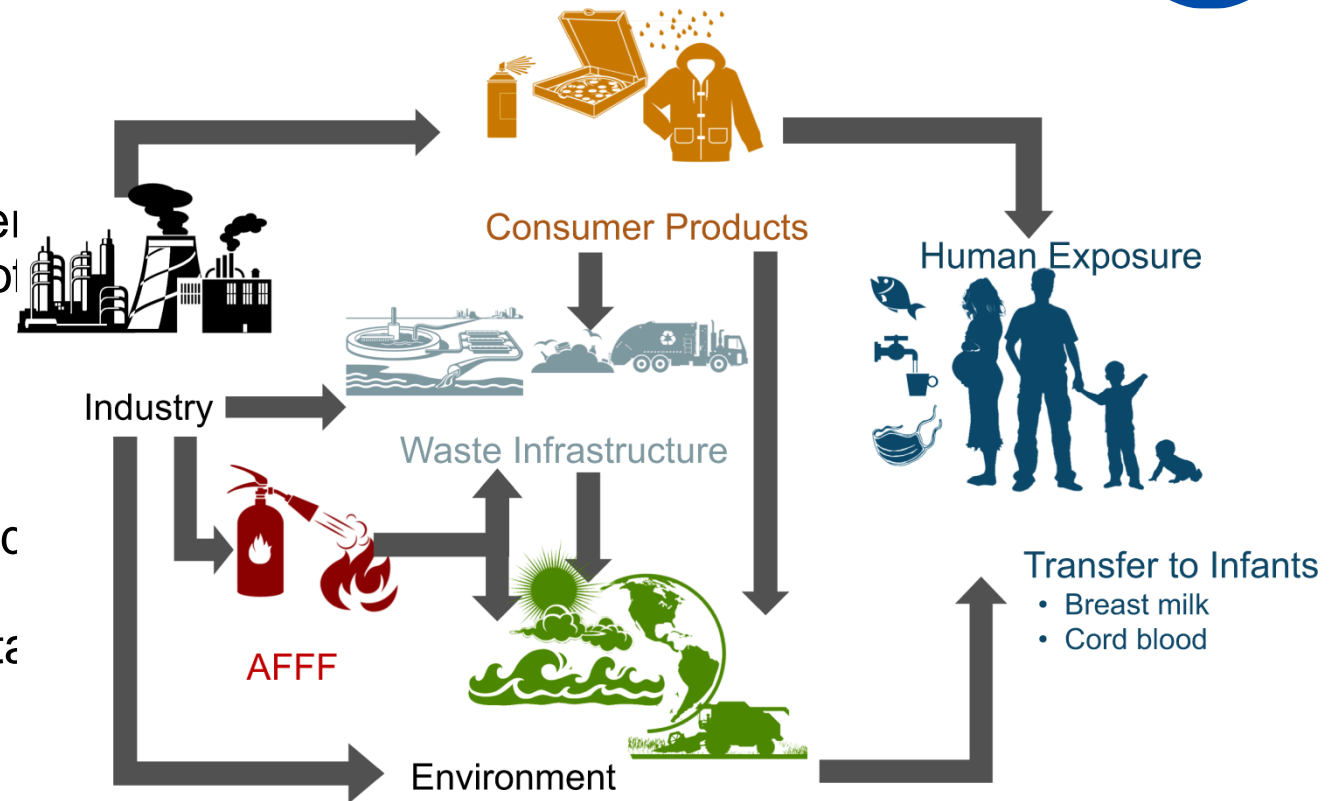
Hydrophilic



Human Health and Environmental Concerns



- Most human exposure to PFAS is from diet (food and water)
- Other exposure pathways: soil and groundwater contact, consumer product contact, inhalation of vapour or dust
- Not bio transformed or metabolized, but accumulate in serum, liver and kidneys
- Range of potential health risks have been linked to PFAS exposure including increased risk of certain cancers, reproductive and developmental effects, Thyroid and liver damage, immune system effects
- Extremely mobile – can travel long distances in the environment and up the food chain
- Accumulates in tissues of plants and animals
- Very limited toxicity data available

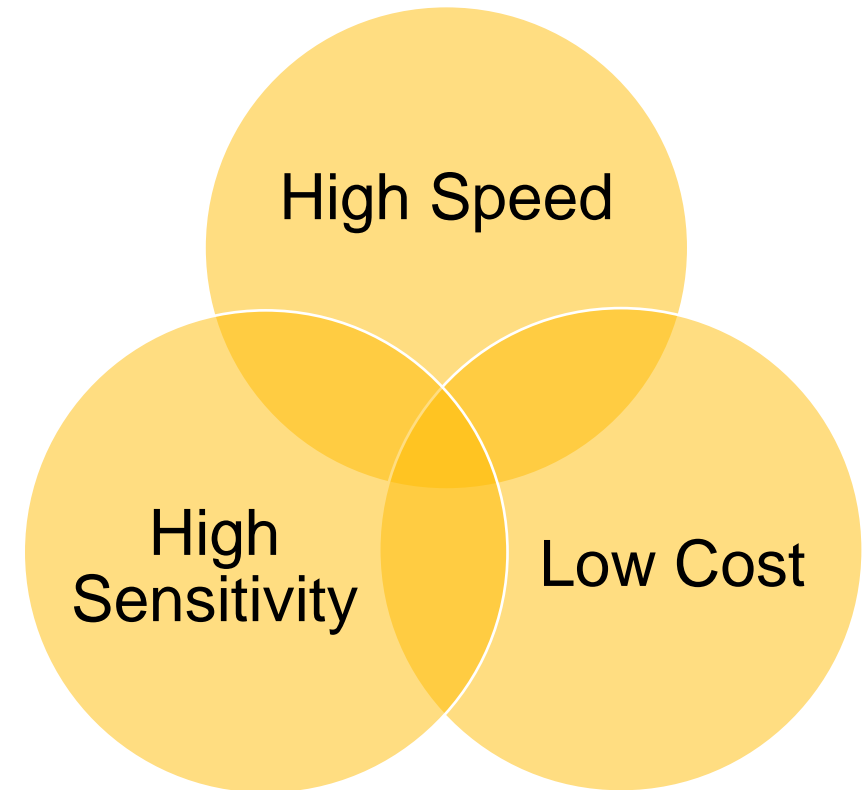


Source: Sunderland et al. 2019 A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects

Industry needs and Priorities



- Feedback from the industry: TAT is critical (and one of the biggest challenges for labs!)
- Methods are complex and sample preparation takes time
- Need for trace level analysis
- High percentage of samples needing to be re-extracted or run at multiple dilutions
- Multiple methods and expanding analyte lists

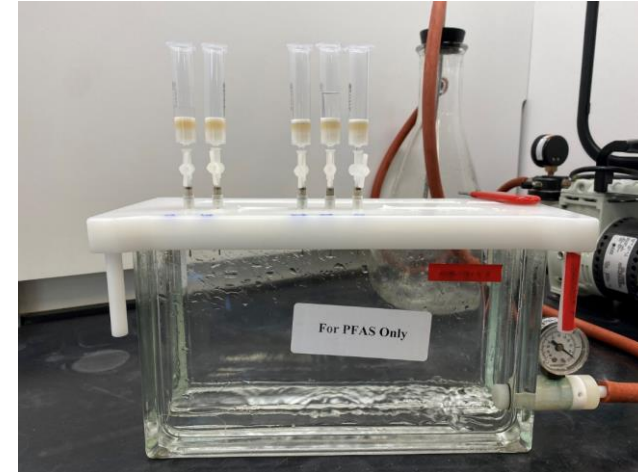


Sample Preparation



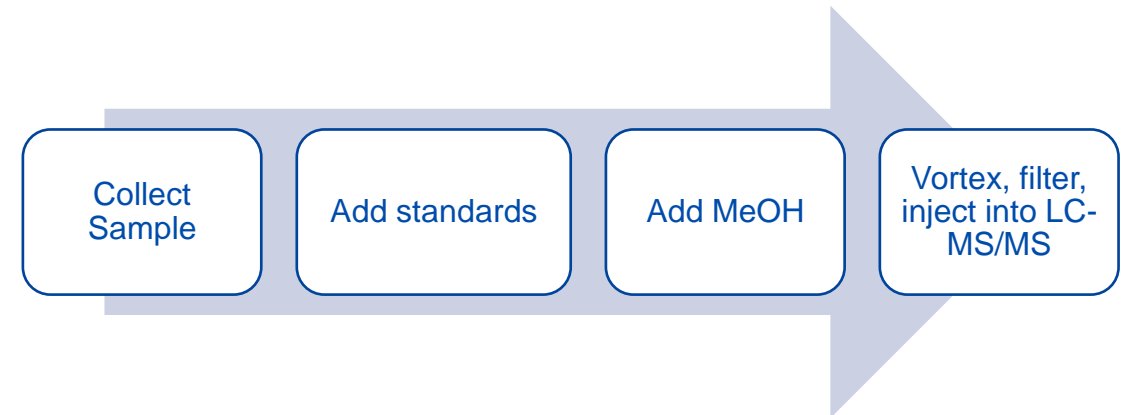
Solid Phase Extraction

- done prior to analysis using an SPE cartridge
- Required for drinking water methods
- Remove interfering components
- Cleanup and concentrate sample
- Needed to achieve low level RLs (2 ng/L)



Direct Injection

- Simple sample preparation
- Solvent dilution / Co-solvation (aqueous)
- Methanol-water extraction (solid)
- No clean up / concentration step = higher RLs (20 ng/L)



Method Overview – Drinking Water



	EPA 537.1	EPA 533	MoE E3457
Initial sample volume	250 mL	250 mL	60 mL
SPE cartridge	Styrenedivinylbenzene (SDVB), 500 mg, 75 µm	Strata-X-AW 500 mg, 33 µm	Strata-X-AW, 200 mg, 33 µm
Diluent	96:4% MeOH:water	20:80% MeOH:water	Mixture of water, MeOH, IPA and 10% formic acid solution
SPE extraction procedure	250 mL sample extracted, evaporated to dryness at temp NMT 65 °C and reconstituted in 1 mL	250 mL sample extracted, evaporated to dryness at 55-60 °C and reconstituted in 1 mL	60 mL sample extracted, evaporated to 2 mL, and 0.1 mL of extract mixed with 0.25 mL HPLC water, 0.1 mL MeOH, 0.05 mL of IPA and 5 uL of 10% formic acid
SPE extraction procedure – drying time	5 min	5 min	6 min
SPE elution procedure	8 mL MeOH	10 mL, 2% ammonium hydroxide in MeOH	2.5 mL MeOH, 4.5 mL 0.3% ammonium hydroxide in MeOH
Preservation	5.0 g/L Trizma	1 g/L ammonium acetate	Sodium thiosulfate
Date of release	2018	2019	2022
Total number of parameters	18 compounds	25 compounds	16 compounds

Method Overview - Non-Potable Waters and Solids



Non-potable waters

EPA 1633

ASTM 8421

ASTM 7979

SW-846 8327

Solids

EPA 1633

ASTM
8535

ASTM
7968



	EPA 1633
Initial sample volume	500 mL
SPE cartridge	Strata-X-AW 200 mg, 33 µm
Diluent	MeOH with 4% water, 1% ammonium hydroxide and 0.625% acetic acid
SPE extraction procedure	500 mL sample extracted, extracts submitted to carbon cleanup
SPE extraction procedure – drying time	15 sec
SPE elution procedure	5 mL, 1% ammonium hydroxide in MeOH
Preservation	none
Date of release	2024
Total number of parameters	40 compounds

Improvements with EPA 1633

↑ number of target analytes, 9 functional groups, 40 PFAS compounds, 24 EIS compounds, 7 NIS compounds

Improvement in sensitivity and selectivity: SPE extraction + carbon cleanup

Isotope dilution and extracted internal standard quantification

Sample prescreening

Total suspended solids

Extensive list of QC acceptance criteria

EPA1633 methodology for analysis of aqueous samples



Water samples

500 mL sample + EIS solution

pH adjustment

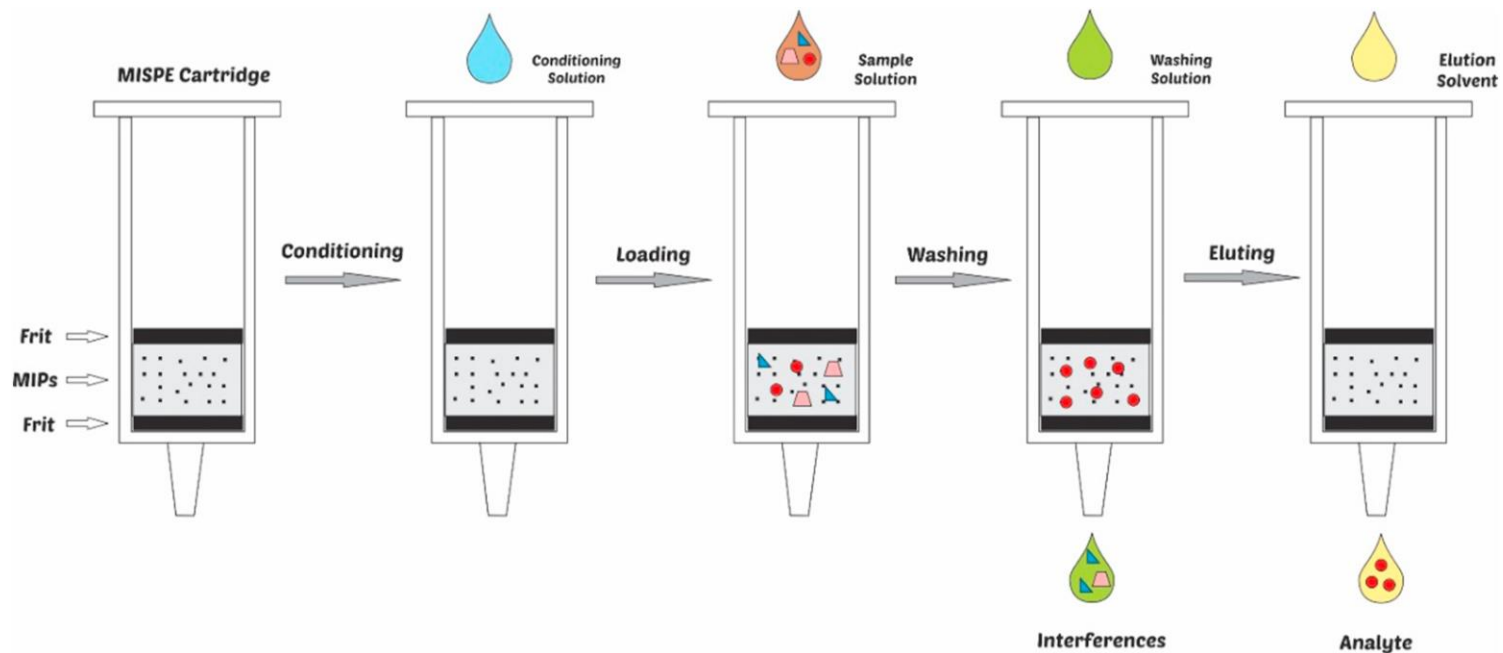
SPE with WAX SPE cartridge

Carbon cleanup, centrifuge, filter

Add NIS solution

LC-MS/MS analysis

7.5 hour preparation



EPA1633 methodology for analysis of solid samples



Soil samples

5 g sample + EIS solution

Extraction with 0.3% methanolic ammonium hydroxide.
Vortex, shake, centrifuge, repeat 3x.

Carbon cleanup, centrifuge

Concentrate at 55 °C

Dilution with H₂O, pH adjustment

SPE with WAX SPE cartridge

Add NIS solution

LC-MS/MS analysis



3-fold solvent extraction-
shake/centrifuge/decant,
carbon cleanup



Solvent
exchange/volume
reduction-methanol to
aqueous



Add water



Adjust pH



Follow SPE procedure
for aqueous samples



12-hour preparation



What Impacts 1633 Turn Around Time?

Total Suspended Solids screen for waters or moisture pre-screen for soils

- Method is not applicable to aqueous samples with > 50 mg solids – application of dilution, centrifugation and appropriate anticlogging methodologies
- Solid sample preparation procedure relies on moisture content in sample

Sample pre-screening for PFAS concentrations

Duration of sample preparation method

QA/QC requirements

Analysis time

Analytes in blank < MDL

Extensive cleaning procedures

PFAS EPA 1633 Analysis Summary



Run time: 12-15 min

Sample preparation: 20 samples/7.5 hours for Waters and 20 samples/12 hours for Solids

QA/QC samples and requirements

- 1 Method blank
- Laboratory fortified blanks – MRL check sample and mid-level LCS
- Matrix spike (MS) and Duplicate only if requested
- CCV run every 10 samples and at end of sequence
- CVS for validation of initial calibration
- Instrument sensitivity check standard
- Bile salt interference check standard
- Surrogate/EIS recovery failures - re-extraction required
- Dilutions - re-extraction required for isotopic dilution for dilution factors > 20

EPA1633 Sample Screening



Appendix A - Sample Pre-screening Instructions

Samples that are known or suspected to contain high levels of analytes may be pre-screened using the following procedure. These are example procedures using smaller sample aliquots spiked with EIS and NIS and no clean up procedures. Other pre-screening procedures may be used. The results of the pre-screening should be used by the analyst to assess the need for sample or extract dilutions necessary to keep the target analytes within the calibration range of the instrument. The results may also be used to reduce the risk of prevent gross contamination of the instrument when dealing with unfamiliar sources of samples.

Aqueous Samples

1. Weight out 10 (±0.1) g of sample into a 50-mL centrifuge tube.
2. Add 50 µL of EIS and NIS to the sample and vortex to mix.
3. Filter 1 mL of the sample through 0.2-µm membrane filter into a microvial. Sample is ready for instrumental analysis.

Solid and Tissue Samples

1. Weigh 1.0 (±0.1) g sample into 50-mL polypropylene centrifuge tubes.
2. Add 20 mL of 0.3% methanolic ammonium hydroxide (Section 7.1.7.1). Vortex and mix on a shaker table (or equivalent) for 10 min. Allow to settle and/or centrifuge to produce a clear extract.
3. Filter using a SINGLE StEP® filter vial:
 - a. Add 20 µL of EIS to a clean SINGLE StEP® filter vial (chamber).
 - b. Add 400 µL of clear extract from step 2 (e.g., by adding extract until it reaches the fill line), carefully vortex to mix.
 - c. Use filter/plunger part and filter.
4. Transfer 30 µL of filtrate to a ~300-µL polypropylene micro-vial and dilute to 300 µL with 0.3% methanolic ammonium hydroxide (Section 7.1.7.1). Add NIS to the filtrate.
5. The extract is now a 10x dilution.
6. Sample is ready for instrumental analysis.

Calculate results using the equivalent sample weight computed as follows:

$$\text{Equivalent Weight} = \text{Sample weight (g)} \times \frac{0.4 \text{ mL}}{20 \text{ mL}}$$

Note that the EIS concentration in the diluted portion is 0.5x the level in the regular analysis of solid samples.

Required by method prior to sample preparation

1633 screening procedure not standardized; recommendation is a dilution resulting in high “reporting limits”

No QA/QC requirements

Used to determine initial sample extraction mass/volume

Screening results are for internal lab use; not reportable to client

Direct Injection PFAS Methods



ASTM 8421

Optional isotopic dilution for non-potable water, landfill leachate and sludge



ASTM 7979

Non-isotopic dilution for non-potable waters and sludge



SW-846 8327/3512

Non-isotopic dilution for non-potable waters and solids



ASTM 7968

Non-isotopic dilution for soils



ASTM 8535

Optional isotopic dilution for soils and biosolids

Direct Inject Methods for Aqueous Samples



ASTM 8421, ASTM 7979 and SW-846 8327

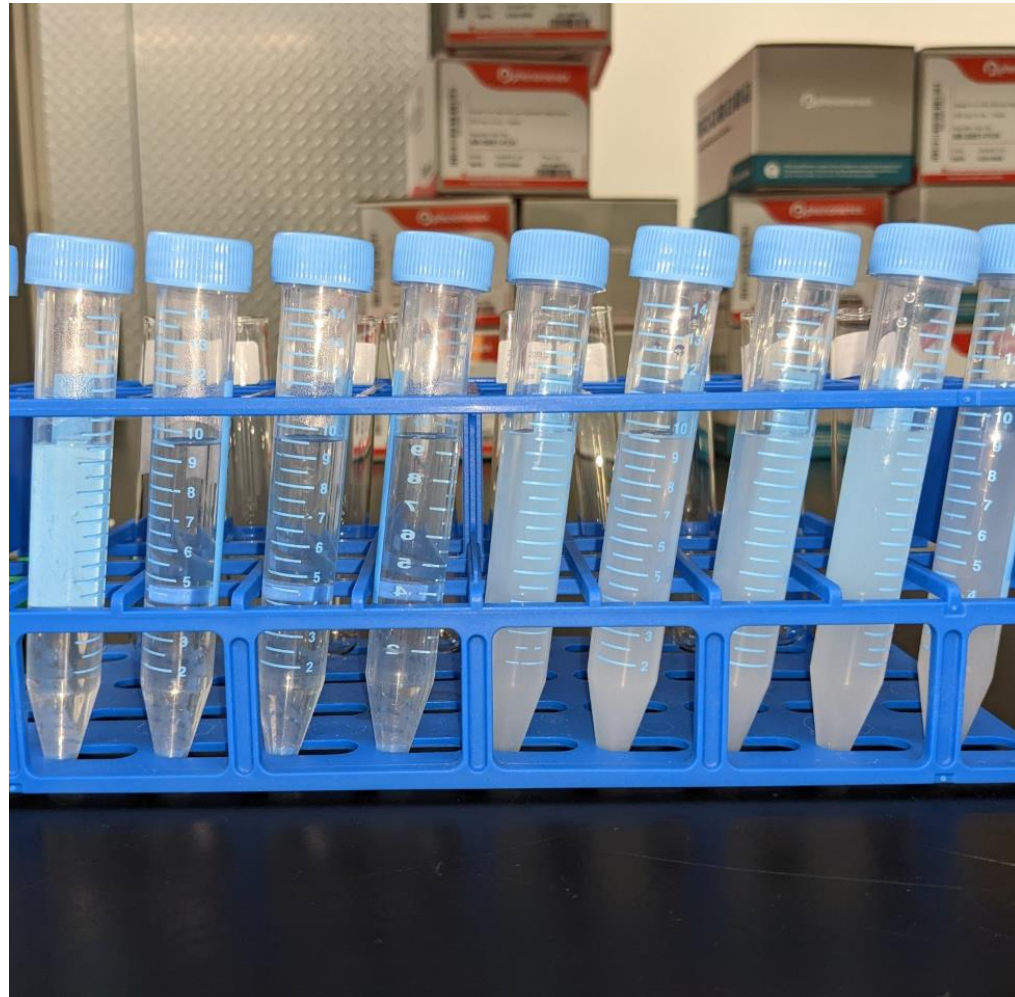
Add surrogate/EIS

Add methanol

Shake

Syringe filter

Add acetic acid



Direct Inject Method for Solid Samples



ASTM 7968, ASTM 8535

Add surrogate

Add 10 mL of 50:50 % water:methanol

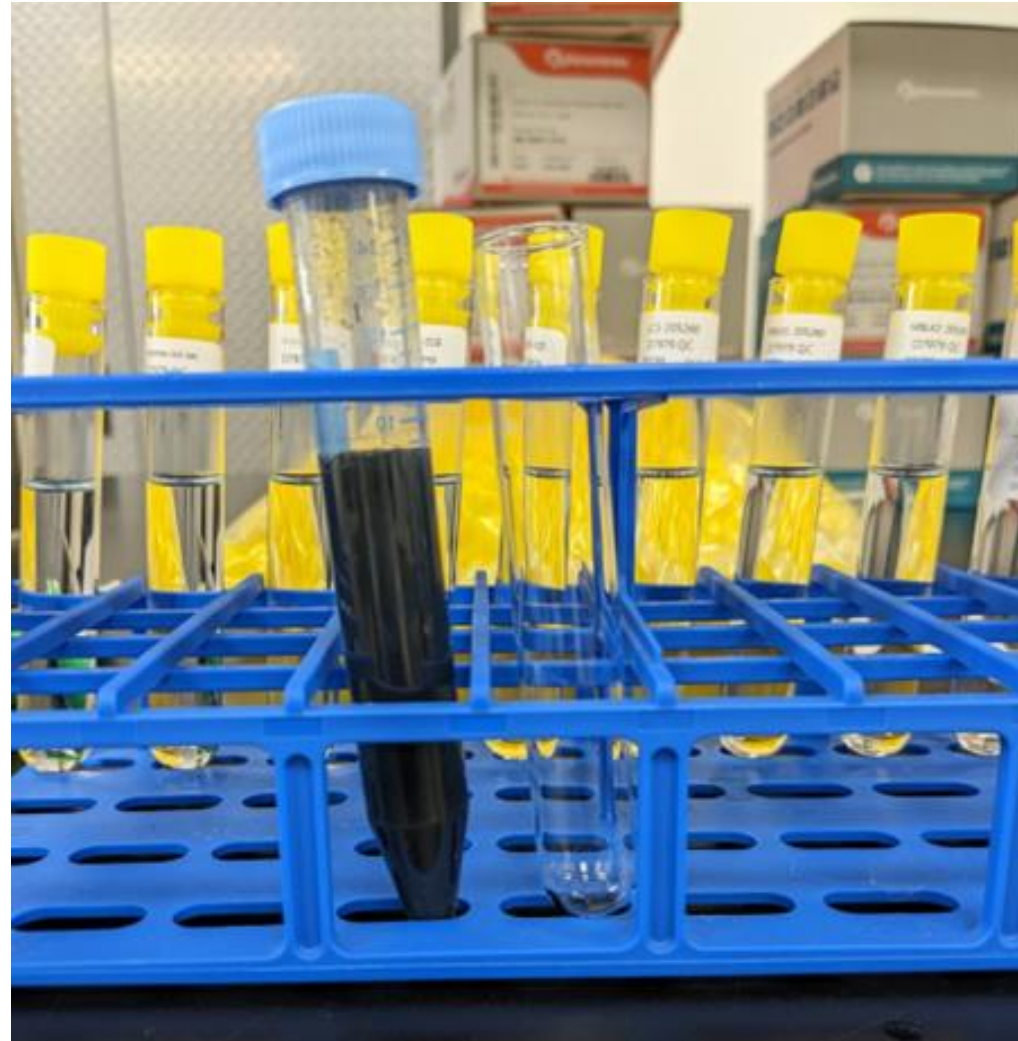
Add ammonium hydroxide

Tumble for 1 hour

Centrifuge

Syringe filter

Add acetic acid





Direct Aqueous Injection Analysis Summary

Run time: 15-21 min

Sample preparation: **100 samples/7.5 hours for Waters and 50 samples/7.5 hours for Solids**

QA/QC samples and requirements

- 2 method blanks
- Laboratory fortified blanks – MRL check sample and mid-level LCS
- Matrix spike (MS) and Duplicate
- CCV run every 20 samples and at end of sequence
- CVS for validation of initial calibration
- Surrogate recovery failures - no re-extraction required
- Dilutions - no re-extraction required for non-isotopic dilution

Method Comparison – Aqueous Samples



	1633 Waters	ASTM D8421	ASTM D7979	SW-846 8327
Matrix	Non-Potable Water	Non-Potable Water	Non-Potable Water	Non-Potable Water
Sample Size	250-500 mL	5 mL	5 mL	5 mL
Bottle Type	250-500 mL and 60-100 mL HDPE Bottle	15 mL Polypropylene Falcon Tube	15 mL Polypropylene Falcon Tube	15 mL Polypropylene Falcon Tube
Holding Time	At 0-6 °C: Preparation - 28 Days from collection date At ≤ -20 C°: Preparation - 90 days from collection date Analysis - 90 days from preparation date	At 0-6 °C: Preparation/Analysis - 28 days from collection date	At 0-6 °C: Preparation/Analysis - 28 days from collection date	At 0-6 °C: Preparation - 14 days from collection date Analysis - 30 days from extraction date
Extraction Method	Solid Phase Extraction	Cosolvation	Cosolvation	Cosolvation
Carbon Cleanup Requirement	Yes	No	No	No
Screening Requirement	Yes	No	No	No
Guidance for High Solids	< 50 mg solids	> 1.0 g/L, add ammonium hydroxide	> 0.2 %, add ammonium hydroxide	No
Guidance for Moisture	N/A	N/A	N/A	N/A
Dilutions	Dilutions with <5% EIS recovery and not meeting S/N requirement require re-extraction	Re-extraction not required	Re-extraction not required	Re-extraction not required
Sample preparation time	20 samples/7.5 hours	100 samples/7.5 hours	100 samples/7.5 hours	100 samples/7.5 hours

Method Comparison – *Aqueous Samples*



	1633 Waters	ASTM D8421	ASTM D7979	SW-846 8327
Calibration Type (Internal vs. External Standard)	Internal	Internal or External	External	External
Isotopic Dilution Method	Yes	Optional	No	No
Ion Ratio Requirements	± 50% Midpoint of Calibration	± 30% Average of Initial Calibration	± 35% Average of Initial Calibration	± 50% Average of Initial Calibration
Signal to Noise Requirement	3:1 with secondary ion transition 10:1 without secondary ion transition	None	None	10:1 with secondary ion transition 3:1 without secondary ion transition
Blank Requirements	< MDL	< ½ MRL	< ½ MRL	< ½ MRL
Instrument Sensitivity Check	Yes	No	No	No
Method Reporting Limits (MRL)	1-25	10-50 ppt	10-300 ppt	N/A
Number of Analytes	40	44	21	24

Method Comparison – Solid Samples



	1633 Soils	ASTM D7968	ASTM D8535
Matrix	Soil, Sediment, Biosolids	Soil, Sediment	Soil, Sediment, Biosolids
Sample Size	5 g, 0.5 g for Biosolids	2 g	2 g
Bottle Type	120 mL HDPE Bottle	120 mL HDPE Bottle	120 mL HDPE Bottle
Holding Time	Preparation - 90 Days from collection date Analysis - 90 days from preparation date	At 0-6 °C: Preparation/Analysis - 28 days from collection date	At 0-6 °C: Preparation/Analysis - 28 days from collection date
Extraction Method	Solid-Liquid Extraction followed by Solid Phase Extraction	Solid-Liquid extraction	Solid-Liquid extraction
Carbon Cleanup Requirement	Yes	No	No
Screening Requirement	Yes	No	No
Guidance for High Solids	N/A	N/A	N/A
Guidance for Moisture	Yes	No	No
Dilutions	Dilutions with <5% EIS recovery and not meeting S/N requirement require re-extraction	Re-extraction not required	Re-extraction not required
Sample preparation time	20 samples/12 hours	50 samples/7.5 hours	50 samples/7.5 hours

Method Comparison – Solid Samples



	1633 Soils	ASTM D7968	ASTM D8535
Calibration Type (Internal vs. External Standard)	Internal	External	Internal or External
Isotopic Dilution Method	Yes	No	Optional
Ion Ratio Requirements	± 50% Midpoint of Calibration	± 35% Average of Initial Calibration	± 30% Average of Initial Calibration
Signal to Noise Requirement	3:1 with secondary ion transition 10:1 without secondary ion transition	None	None
Blank Requirements	< MDL	< ½ MRL	< ½ MRL
Instrument Sensitivity Check	Yes	No	No
Method Reporting Limits (MRL)	160-4000 ng/kg	25-750 ng/kg	25-125 ng/kg
Number of Analytes	40	21	44



Direct injection analysis of per and polyfluoroalkyl substances in surface and drinking water by sample filtration and liquid chromatography-tandem mass spectrometry

Sample preparation protocol

Sample centrifugation (40 mL, 16 000 rpm for 45 min at 4 °C)

Filter 6.0 mL of sample

Add 13 C labelled surrogates
Add 1 mL MeOH (filter rinse)
Vortex

0.985 mL of filtered sample + IS 13C4 PFHpA

Vortex, inject into LC-MS/MS

Analysis protocol

LC-MS/MS parameter	
Mobile phase	20 mM ammonium acetate, MeOH
Columns	Delay: Waters Atlantis T3 3 µm (100 mm × 2.1 mm ID) Analytical: Waters Atlantis T3 3 µm (50 mm × 2.1 mm ID)
Instrument	Sciex QTRAP MS 6500
Column temperature and flow rate	35 °C, 0.2 mL/min
Injection volume	5.0 µL
Run time	13.5 min
Ionization	Negative ESI, MRM mode

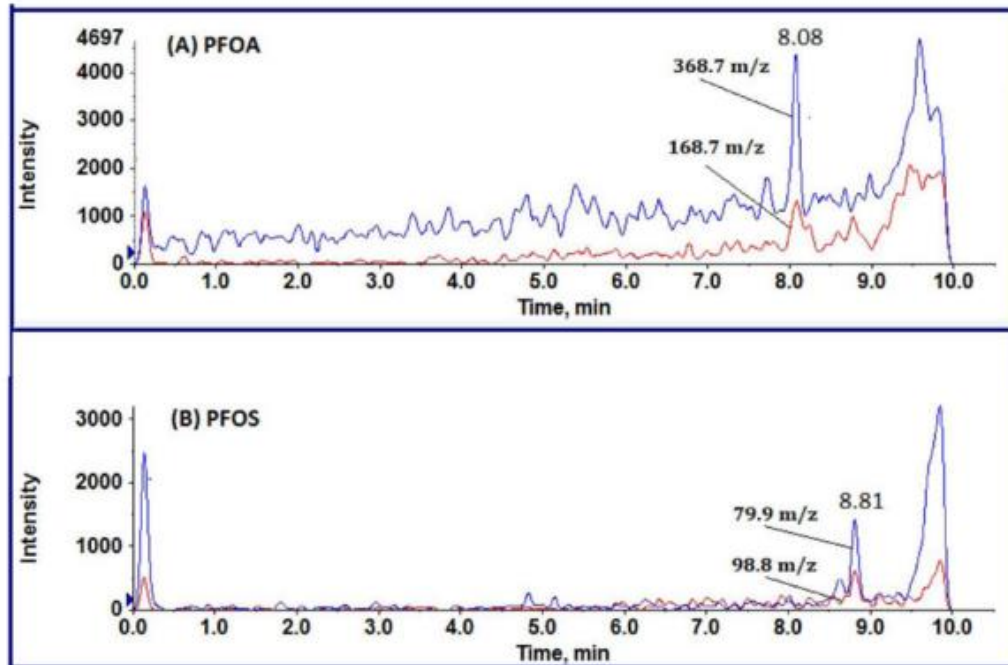
Direct injection analysis of per and polyfluoroalkyl substances in surface and drinking water by sample filtration and liquid chromatography-tandem mass spectrometry



Characterization of surface water and detection of PFOA and PFOS

PFAS concentration (ng/mL) in tap and suspected site surface water samples.

Sample ID	PFBS	GenX	4.2 FTS	PFOS	PFNA	PFOA	PFHxS	PFHpA
Site 1	0.012	ND	ND	0.037	0.007	0.043	ND	ND
Site 2	0.007	ND	ND	0.04	ND	0.032	ND	ND
Site 3	ND	ND	ND	0.038	ND	0.052	ND	ND
Site 4	ND	ND	ND	0.05	ND	0.042	ND	ND
Site 5	0.007	ND	ND	0.016	0.015	0.048	ND	ND
Site 6	ND	ND	ND	0.017	0.011	0.019	ND	ND
Tap water	ND	ND	ND	0.069	0.008	0.037	ND	ND



Method performance

Compounds	LOD, (ng/mL)	LDR, (ng/mL)	Spiking* (ng/mL)	Spike Rec [†] (n = 8) (%)	MX ± RSD (n = 6) (%)	MXD ± RSD (n = 6) (%)	FRB ± RSD (n = 6) (%)	CCV ± RSD (n = 8) (%)
Short-chain								
PFBS	0.007	0.02–0.56	0.42	85.8 ± 6.0	87.4 ± 5.7	89.5 ± 4.1	87.9 ± 4.9	94.8 ± 4.0
GenX	0.04	0.08–2.40	1.8	84.8 ± 8.9	88.1 ± 5.1	86.8 ± 4.2	88.9 ± 7.1	87.8 ± 5.6
4.2 FTS	0.007	0.02–0.56	0.42	99.8 ± 4.6	85.8 ± 7.6	85.6 ± 4.7	94.1 ± 5.8	105.3 ± 5.0
Long-chain								
PFHpA	0.021	0.05–1.60	1.2	94.6 ± 4.2	91.1 ± 5.6	87.1 ± 4.5	90.0 ± 3.4	103.1 ± 8.4
PFHxS	0.019	0.05–1.52	1.14	83.9 ± 5.7	91.7 ± 4.8	94.8 ± 2.4	93.4 ± 5.5	98.4 ± 3.9
PFOA	0.015	0.04–1.20	0.9	101.8 ± 4.3	88.6 ± 6.8	91.0 ± 2.5	95.7 ± 4.9	111.2 ± 4.4
PFOS	0.02	0.05–1.60	1.2	110.1 ± 7.8	84.5 ± 17.7	95.9 ± 25.9	104.3 ± 11.9	113.5 ± 10.6
PFNA	0.02	0.05–1.60	1.2	99.3 ± 6.9	97.2 ± 5.3	106.0 ± 9.9	107.8 ± 6.7	110.1 ± 9.1
Surrogates								
13C2–4:2 FTS	NM	0.04–1.80	0.96	94.3 ± 7.5	94.5 ± 20.0	83.9 ± 4.9	90.9 ± 4.1	104.3 ± 3.5
13C4–PFOA	NM	0.06–1.92	1.44	97.6 ± 3.0	90.7 ± 6.2	90.9 ± 2.2	100.4 ± 4.0	104.4 ± 5.2
13C4–PFOS	NM	0.10–3.20	2.4	106.0 ± 8.2	83.9 ± 17.6	97.1 ± 25.7	103.8 ± 9.7	111.6 ± 9.9
13C5–PFNA	NM	0.06–1.92	1.44	97.1 ± 8.3	97.7 ± 4.6	99.6 ± 11.5	112.7 ± 8.2	107.3 ± 6.0

Standard Test Method for Determination of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous Matrices by Co-solvation followed by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) ASTM D8421-24



Sample preparation protocol



Analysis protocol

LC-MS/MS parameter	
Mobile phase	400 mM ammonium acetate in water, ACN
Column	Analytical: UHPLC CSH Phenyl-Hexyl, 2.1 × 100 mm and 1.7 μm
Column temperature and flow rate	35 °C, 0.3-0.4 mL/min
Injection volume	10-30 μL
Run time	21 min
Ionization	Negative ESI, MRM mode

Standard Test Method for Determination of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous Matrices by Co-solvation followed by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) ASTM D8421-24



Method performance native PFAS

Analyte	RPD (%) Limit	Lower Limit (%)	Upper Limit (%)
PFTriA	9.26	74.8	111
PFDaA	8.11	75.5	107
PFUnA	7.82	76.3	107
PFDA	5.22	85.5	106
PFOS	18.7	50.7	124
PFNA	8.26	76.3	109
PFOA	4.45	86.5	104
PFHxS	9.53	79.3	117
PFHpA	6.14	81.9	106
PFHxA	6.73	85.4	112
PFBS	17.2	73.9	141
PFPeA	4.47	90.2	108
PFBA	8.17	93.4	125
PFTreA	16.0	50.8	113
PFDoS	14.6	59.8	117
4:2 FTS	14.9	71.1	129
NMeFOSA	11.0	72.1	115
NEtFOSA	7.90	73.8	105
PFPeS	4.79	91.3	110
6:2 FTS	9.67	78.7	117
NMeFOSE	4.35	87.0	104
NEtFOSE	16.5	69.0	134
PFHpS	5.68	89.5	112
HFPO-DA	5.30	71.6	92
PFOSA	11.5	68.5	114
8:2 FTS	18.1	64.2	135
ADONA	3.69	88.5	103
9Cl-PF3ONS	7.66	79.2	109
PFNS	11.9	73.7	120
11Cl-PF3OUdS	7.63	78.4	108
NMeFOSAA	11.0	72.3	115
NEtFOSAA	20.4	53.8	134
PFPeA	17.6	65.0	134
NFDHA	4.13	90.5	107
PFDS	10.9	76.0	119
PFEESA	4.35	90.1	107
PFMPA	6.76	96.5	123
PFMBA	1.81	96.5	104
3:3 FTCA	4.78	87.6	106
5:3 FTCA	3.82	88.3	103
7:3 FTCA	4.41	86.9	104
FHUEA	5.17	85.2	105
FOUEA	8.09	82.2	114
HQ-115	19.9	66.3	144

Method performance surrogates

Surrogate	RPD (%) Limit	Lower Limit (%)	Upper Limit (%)
MPFBA	11.7	85.1	1136
M5PFHxA	3.24	91.4	104
M3PFHxS	3.42	94.5	108
M8PFOA	2.90	91.3	102
M9PFNA	8.61	76.5	108
M8PFOS	5.86	87.1	110
M6PFDA	5.69	83.2	104
M7PFUnA	7.87	75.5	103
MPFDoA	8.63	76.2	107
M4:2 FTS	11.7	78.1	125
M6:2 FTS	8.12	81.6	112
M8:2 FTS	19.5	61.7	138
D5-N-EtFOSAA	20.2	56.2	130
D3-N-MeFOSAA	5.24	85.0	105
M3PFBS	3.68	94.3	109
M5PFPeA	5.11	90.4	111
M4PFHpA	3.57	89.4	103
M2PFTreA	13.5	60.7	104
M8PFOSA	9.86	73.5	109
D-N-EtFOSA	7.84	75.3	103
D-N-MEFOSA	11.1	72.6	113
D7-N-MeFOSE	4.33	86.1	102
D9-N-EtFOSE	17.0	66.6	133
MHFPO-DA	4.15	75.4	88.7

Simplified and Fast Analysis of Per and Polyfluoroalkyl Substances in Non-potable Waters



Sample preparation protocol – as per ASTM D8421

Analysis protocol

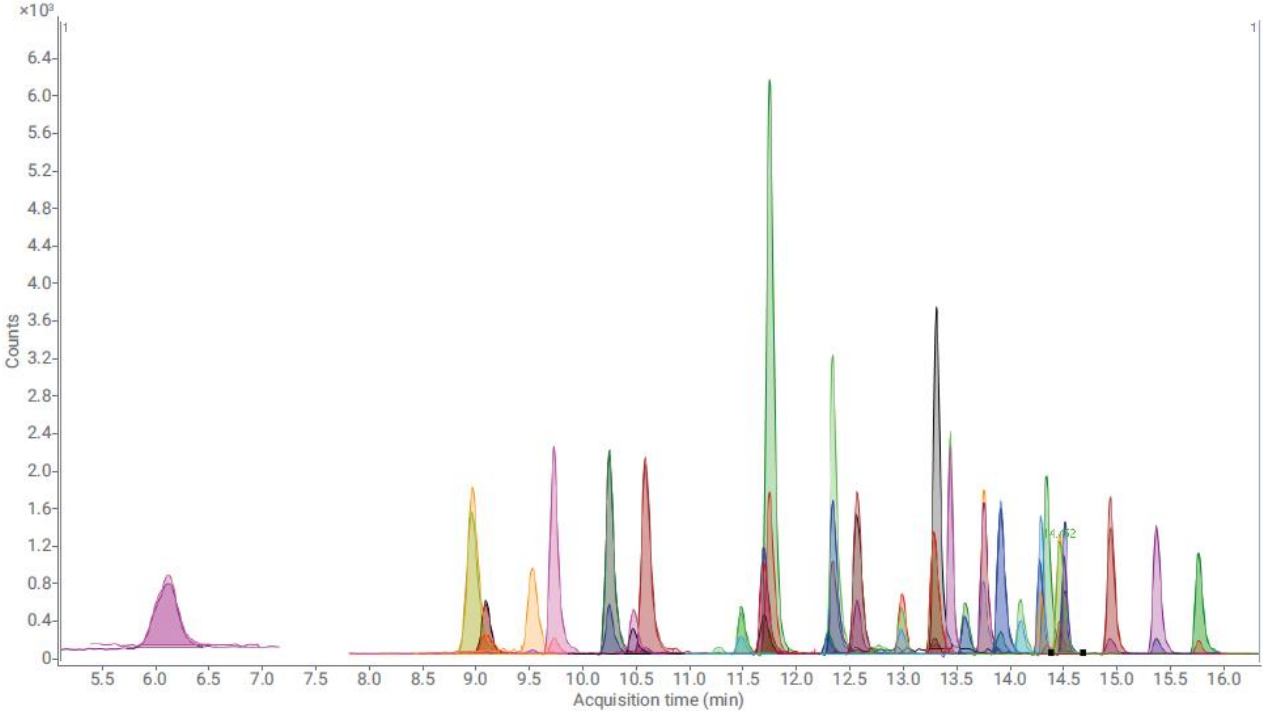
LC-MS/MS parameter	
Mobile phase	0.1 % acetic acid in water, 0.1 % acetic acid in MeOH
Column	Delay: Agilent ZORBAX RRHD Eclipse Plus C18, 50 × 3.0 mm, 1.8 μm Analytical: Agilent ZORBAX RRHD Stable Bond C18, 100 × 2.1 mm, 1.8 μm
Column temperature and flow rate	50 °C, 0.4 mL/min
Injection volume	30 μL
Run time	25 min
Ionization	Negative ESI, MRM mode

Simplified and Fast Analysis of Per and Polyfluoroalkyl Substances in Non-potable Waters

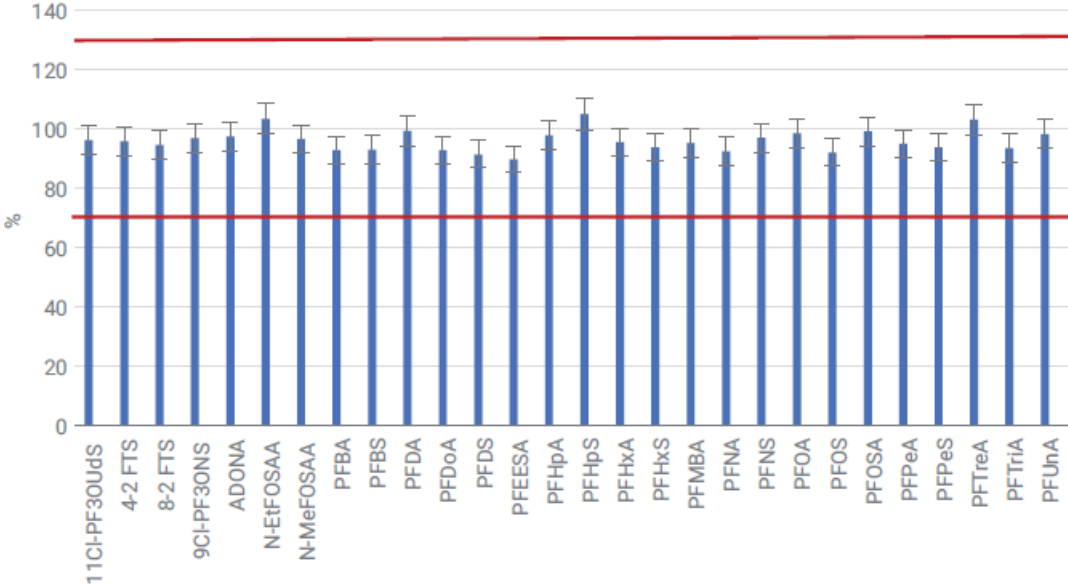


Method performance

80 ng/L in 0.1 % acetic acid in 1:1 (v:v) ultrapure water:methanol



Accuracy and precision –
Water samples fortified at 160 ng/L





Benefits and limitations

Method Type	SPE	Direct Injection
Benefits	<ul style="list-style-type: none">• Required by EPA and Department of Defense (DoD) for analysis of drinking waters• Improvement in method sensitivity• Efficient removal of matrix interferences, improved selectivity• Industry gold standard for low level PFAS analysis	<ul style="list-style-type: none">• Large volume injection for improvement of sensitivity on instrument• Designed for high-throughput applications, fast sample preparation• Reduced consumption of organic solvents, lower cost• Decreased risk of lab-based PFAS contamination• Screening level characterization of samples• Highly impacted samples• Samples having high TSS and settled solids less challenging• Complementary to methods based on SPE
Limitations	<ul style="list-style-type: none">• Extensive sample preparation procedure• Extensive cleaning procedure• Increased sample handling	<ul style="list-style-type: none">• Higher LOQ for water samples• Unsuitable for Drinking Waters

Regulation and Guidelines



PFAS Compound	Soil								Non-Potable Water							
	LOR (mg/kg)		Guideline or Standard (mg/kg)						LOR (ug/L)		Guideline or Standard (ug/L)					
	EPA 1633	ASTM 8535	CCME SQG	Heath Canada SSV	CFIA Biosolids	BC CSR	Alberta T1	Atlantic PIRI	EPA 1633	ASTM 8421	CCME GWQG	ECCC SWQG	BC CSR	Alberta T1	Quebec SW (lowest)	Atlantic PIRI GW
PFBA	0.0002	0.000125		114				114	0.004	0.05						30
PFPeA	0.0001	0.000125		0.8				0.8	0.002	0.05						0.2
PFHxA	0.0001	0.000025		0.8				0.8	0.0004	0.01						0.2
PFHpA	0.0001	0.000025		0.8				0.8	0.0008	0.01						0.2
PFOA	0.0001	0.000025		0.7				0.7	0.001	0.01			0	0.2	0.066	0.2
PFNA	0.0001	0.000025		0.08				0.08	0.002	0.01						0.02
PFBS	0.0001	0.000025		61		300		61	0.001	0.01			80			15
PFHxS	0.0001	0.000025		2.3				2.3	0.0025	0.01						0.6
PFOS	0.0001	0.000025	0.01	0.01	0.05	0.4	0.01	0.35	0.002	0.01	6	6.8	0	0.6	0.011	0.6
6:2 FTS	0.0005	0.000025		0.8					0.004	0.05						
8:2 FTS	0.00025	0.000025		0.8					0.004	0.05						
									0.011	0.09	Health Canada Drinking water Objective (30 ng/L or 0.03 ug/L)					

≥ 100x below guideline
≥ 10x below guideline
below guideline
above guideline

Conclusions and Takeaways



- Direct Injection methods are a lower cost option with potential for fast turnaround time
- Can be for screening level characterization, highly impacted samples, or when there is a need for rapid results
- Trace level SPE methods such as 1633 are still critical for understanding impacts on site, particularly near drinking water sources or sensitive receptors
- Another great option that can be used in combination with more robust methods
- Important to talk to your laboratory and discuss available options and suitability for the data quality objectives, timeline and budget of your project





Thank you!

Questions?



Sanja Risticcevic
PhD, LC-MS Department Manager
Sanja.Risticcevic@alsglobal.com



Tammy Chartrand
BSc, National PFAS Program Lead
Tammy.Chartrand@alsglobal.com