FMS
Fluid Management Systems

Validation of the Analysis of PFAS/PFOS in Wastewater Samples Using EPA Method 1633 with Semi-Automated Solid Phase Extraction

Purpose

- Sample Preparation Workflows and Tools for EPA Method 1633
- Validation Study Data
- EPA Method 1633 Various Aqueous Matrices

Target Analytes

Method	533	537.1	1633	ISO21675
PFBA	x		x	x
PFPeA	x		x	x
PFHxA	x	x	x	x
PFHpA	x	x	x	x
PFOA	x	x	x	x
PFNA	x	x	x	x
PFDA	x	x	x	x
PFUnA	x	x	x	x
PFDoA	x	x	x	x
PFTrDA		x	x	x
PFTeDA		x	x	x
PFBS	x	x	x	x
PFPeS	x		x	
PFHxS	x	x	x	x

Target Analytes

Method	533	537.1	1633	ISO21675
PFHpS	x		x	x
PFOS	x	x	x	x
PFNS			x	
PFDS			x	x
PFDoS			x	
4:2FTS	x		x	
6:2FTS	x		x	x
8:2FTS	x		x	x
PFOSA			x	x
NMeFOSA			x	x
NEtFOSA			x	x
NMeFOSAA		x	x	x
NEtFOSAA		x	x	x
NMeFOSE			x	

Target Analytes

Method	533	537.1	1633	ISO21675
NEtFOSE			x	
HFPO-DA	x	x	x	x
ADONA	x	x	x	x
PFMPA	x		x	
PFMBA	x		x	
NFDHA	x		x	
9Cl-PF3ONS	x	x	x	x
11Cl-PF3OUdS	x	x	x	
PFEESA	x		x	
3:3 FTCA			x	
5:3 FTCA			x	
7:3 FTCA			x	
PFOcDA				x
PFHxDA				x
8:2 FTUCA				x
8:2 diPAP				x

Optimizing the PFAS Analysis Workflow

- **Automate the Sample Prep Workflow**
  - **Automate the Solid Phase Extraction Step**
  - **Automate the Concentration/Evaporation Step**

- **Automated, Semi-Automated SPE extractions and Concentration**
  - **Reduces Human Error**
  - **Reduces Outside contamination and background**
  - **Reduces Solvent Usage**
  - **Reduces Labor**

- **Use SPE solutions to deliver consistent, reproducible results**
- **Different configurations to handle Matrix type and Budget**
- **No Teflon Components**

Comparison of Manual SPE vs. Automated SPE Methods

Manual SPE	Automated/Semi-Auto SPE
Manually Separate Waste	Separates Aqueous and Organic Waste
<10 mls solvent evaporate	<10 mls solvent to evaporate
Run times are ~ 30 to 90 minutes	Run times are ~20 to 50 minutes or less
Technician Time 25 minutes	Technician time 5 minutes
Physical transfer and Concentration steps	Automatic and Direct to Concentration delivery and completion
Concentration step 70 to 200 minutes	Concentration step 70 minutes ready for injection

Attributes

- **Closed System**
- **Ability to load samples by vacuum or positive pressure consistently.**
- **Handle difficult Matrices**
- **Ability to dry cartridges by vacuum and positive Nitrogen gas pressure.**
- **Easily handle various cartridge designs and sizes without cumbersome modifications.**
- **Easy, Simple Sample delivery**
- **Bottle Rinse**

Automated Solid Phase Extraction front end for LC/MS

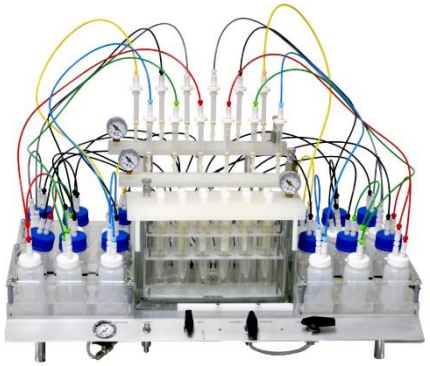
EconoTrace® PFC

TurboTrace® PFC

TurboTrace®
Parallel
Sequential

LC/MS

Semi-Automated Solid Phase Extraction front end LC/MS



EZPFC

LC/MS

Can this Handle Dirty Samples?

Typical Cartridge can have problems!

- **6ml cartridge**
  - **Doesn't do well**
  - **Frit Surface Area is to small**

Yes, A Cartridge will work

- **25ml cartridge**
  - **Does well**
  - **3X the Frit Surface Area**

FMS, Inc. Plastic Filtration Wool

Glass/Plastic Wool

- Irregular random stranding
- Slows Particles to the Uniform Frit
- Prevents Clogging

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Sample Bottle Filter

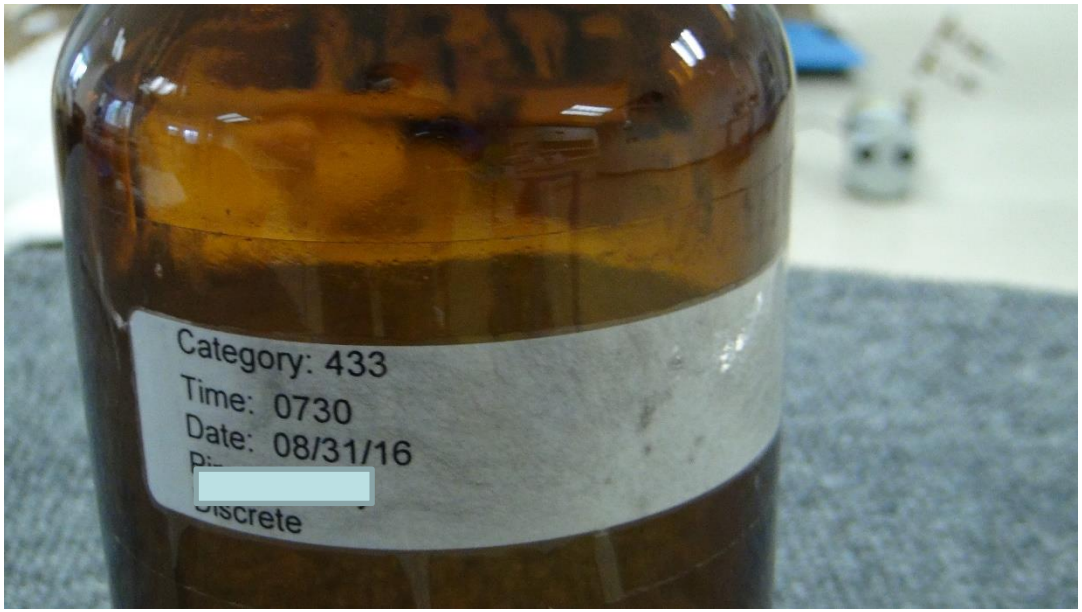
Prepping the 6ml Cartridge with Plastic Filtration Wool

6ml cartridge with Plastic wool

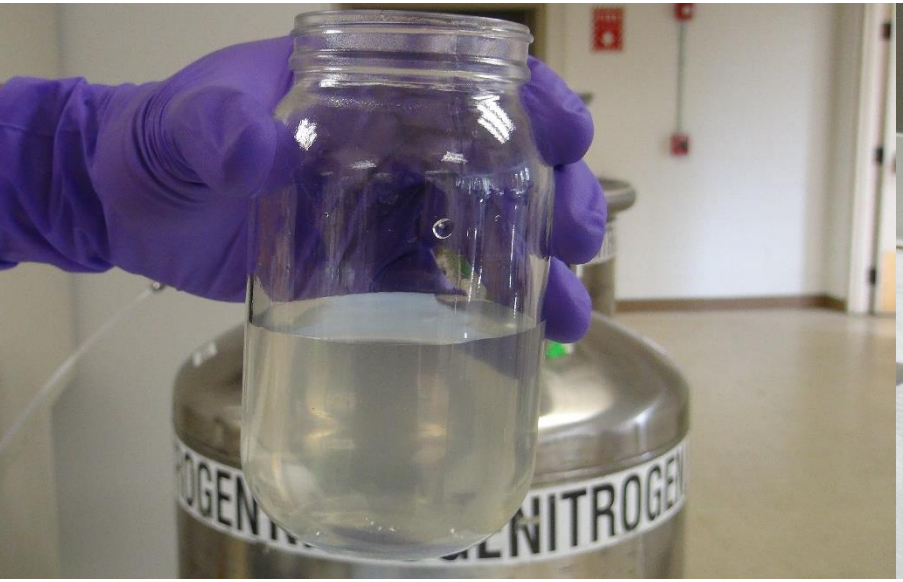
- Take a little and push it into the barrel of the syringe until it touches the cartridge Frit

- The Sample will not clog, it will take longer to process

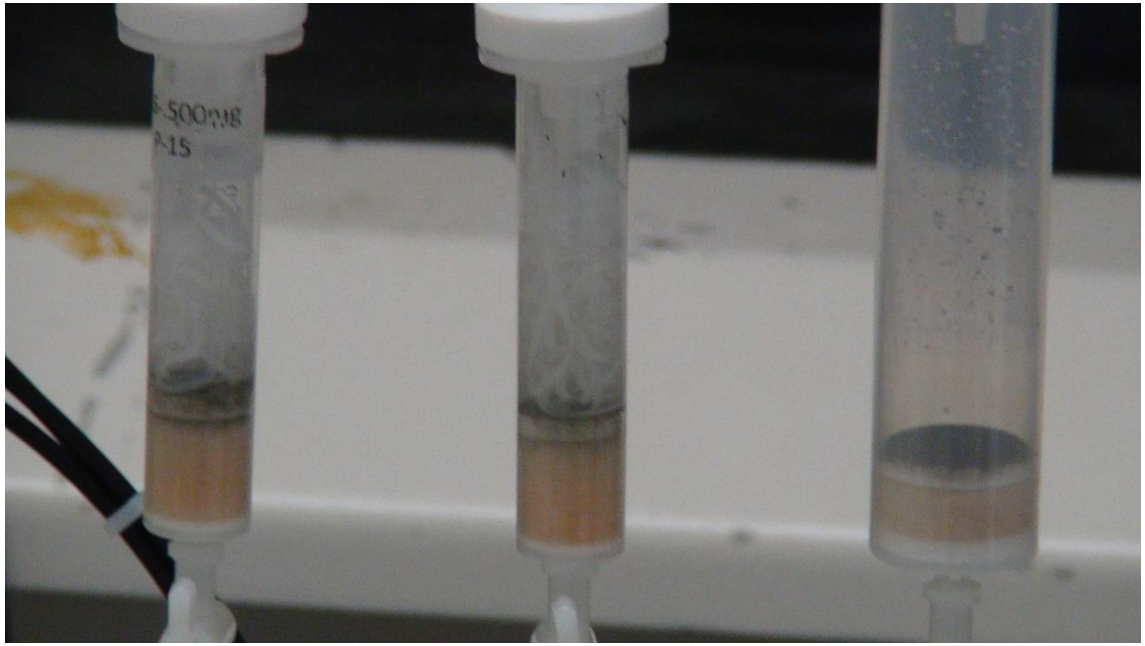
Dirty Sample from a Customer



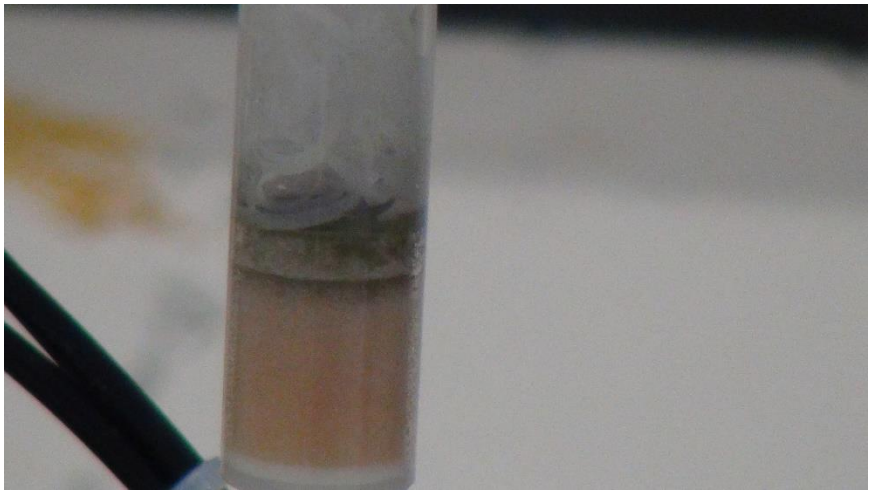
Industrial 433 Matrix 250ml

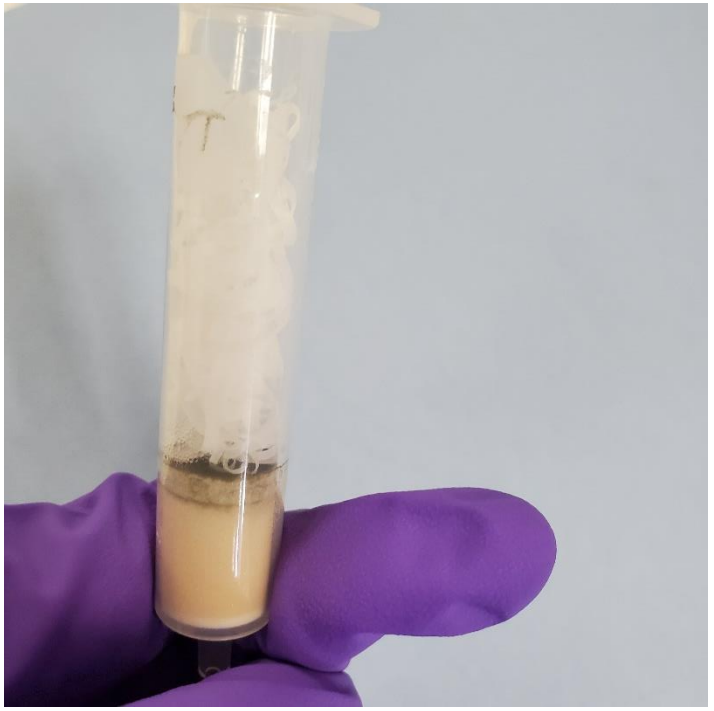


6ml and 25ml Cartridges

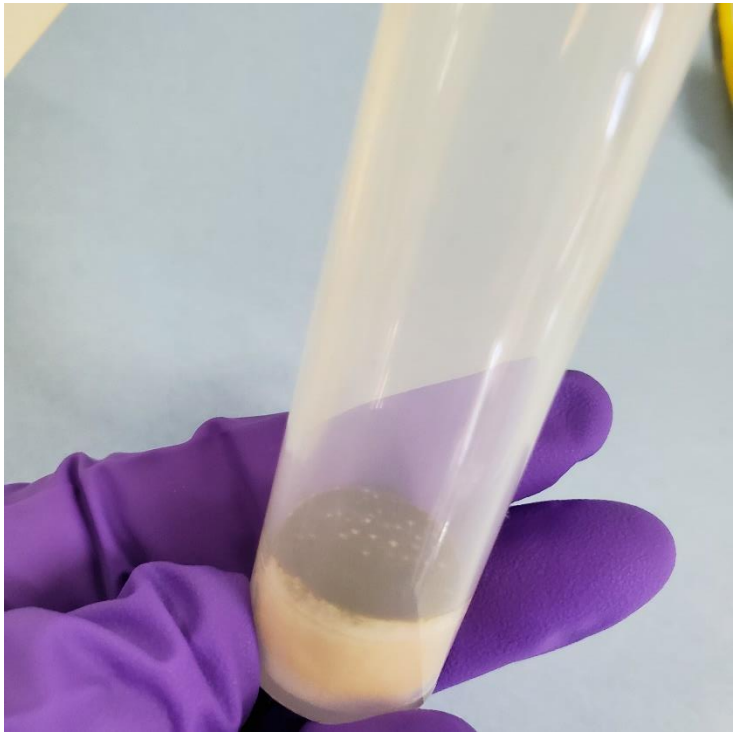


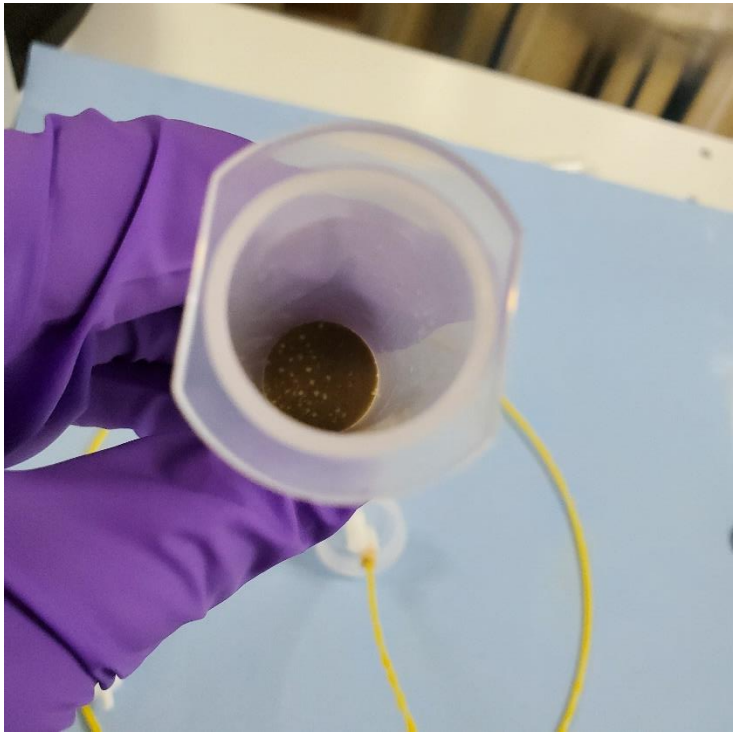
500 ml run to completion on 6 ml cartridge with Plastic Wool





500ml run to completion
25ml cartridge





Reasons for Semi-Automated SPE

- **Closed System**
- **12 samples in parallel**
- **Reduced Actions / Easy to Use**
- **Simplified procedures**
- **Semi-Automated versus Manual protocols = Reproducibility**
- **Increased Sample Throughput**
- **Low cost compared to Automated solutions**

Objective for Semi Automation

- **Incorporate automated system capabilities to the semi-automated platform.**
- **Our goal is to establish several Standard Operating Procedures (SOPs) for the testing lab through the utilization of a solitary extraction platform.**
- **In order to optimize time and minimize mistakes, it is crucial to decrease the amount of manual steps involved.**

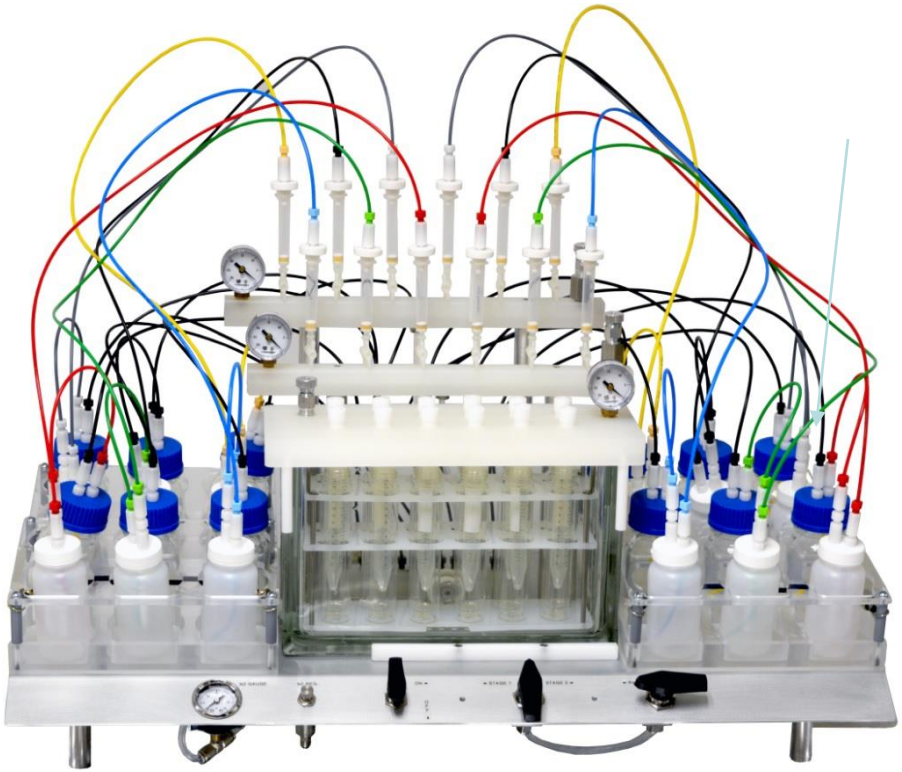
Goal

- **Efficient**
  - Uses all SPE cartridge sizes
  - Dedicated manifold for cartridge conditioning and sample loading
  - Dedicated manifold for extraction and extracts
  - Separates Organic from Aqueous waste
  - Vacuum cartridge drying, Nitrogen cartridge drying or combined
  - Automated Bottle Rinse and Elution
  - Inline Extract Drying
  - Small number of components to clean

- **Low Capital Expense**

EZPFC®

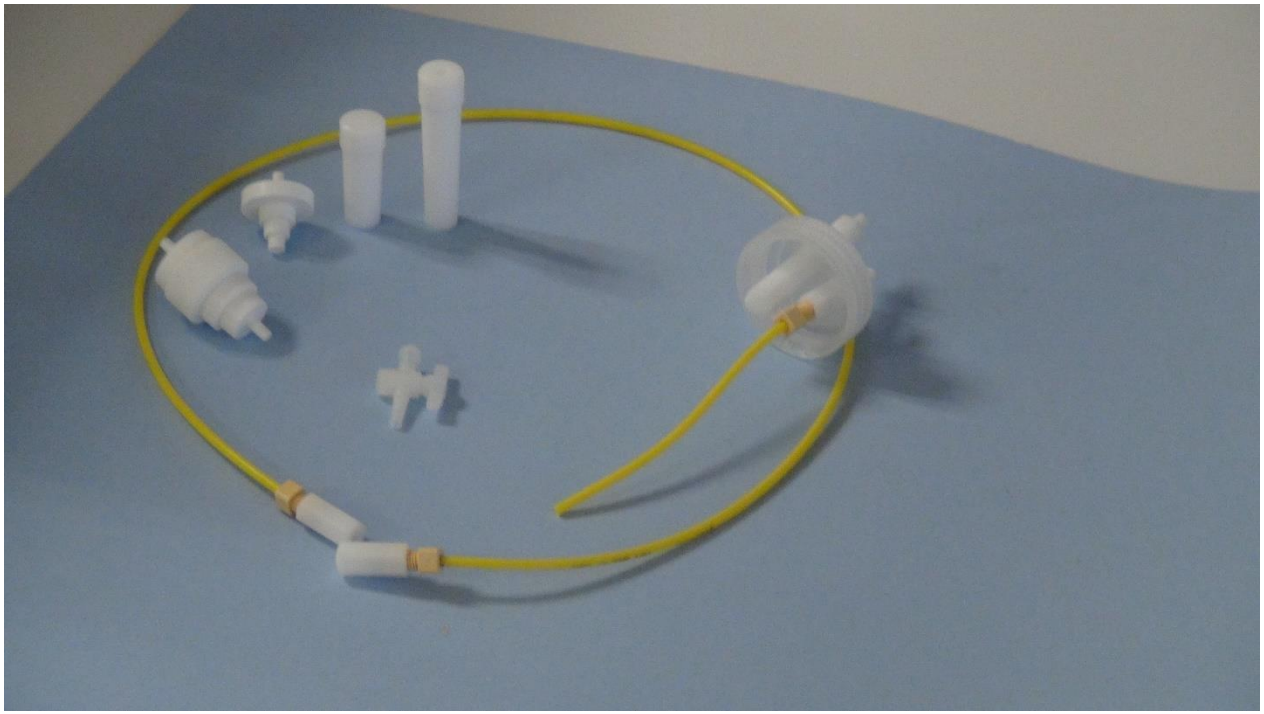
Drinking Water,
Wastewater,
Particulate laden samples



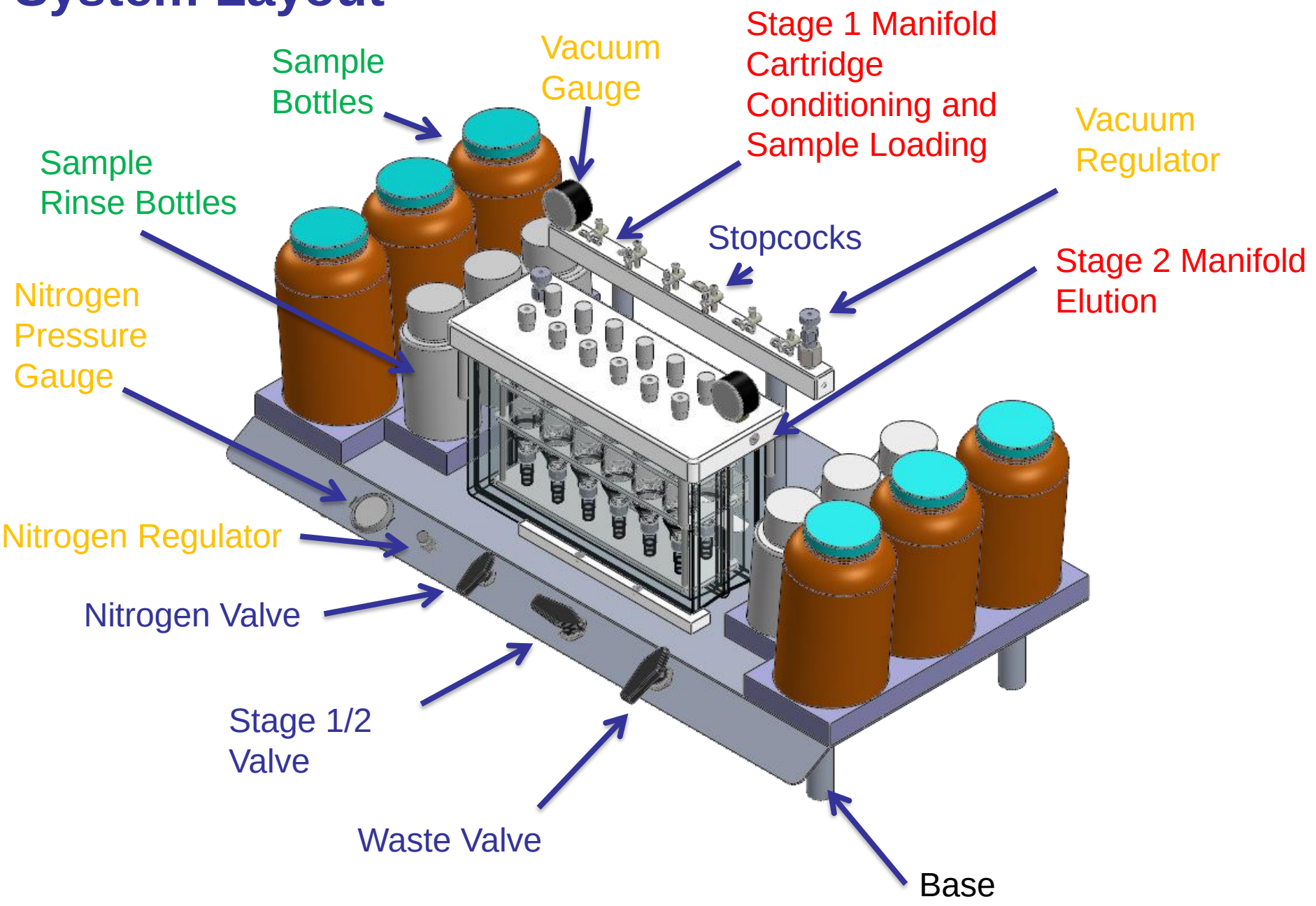
EZPFC 12 sample

System Components

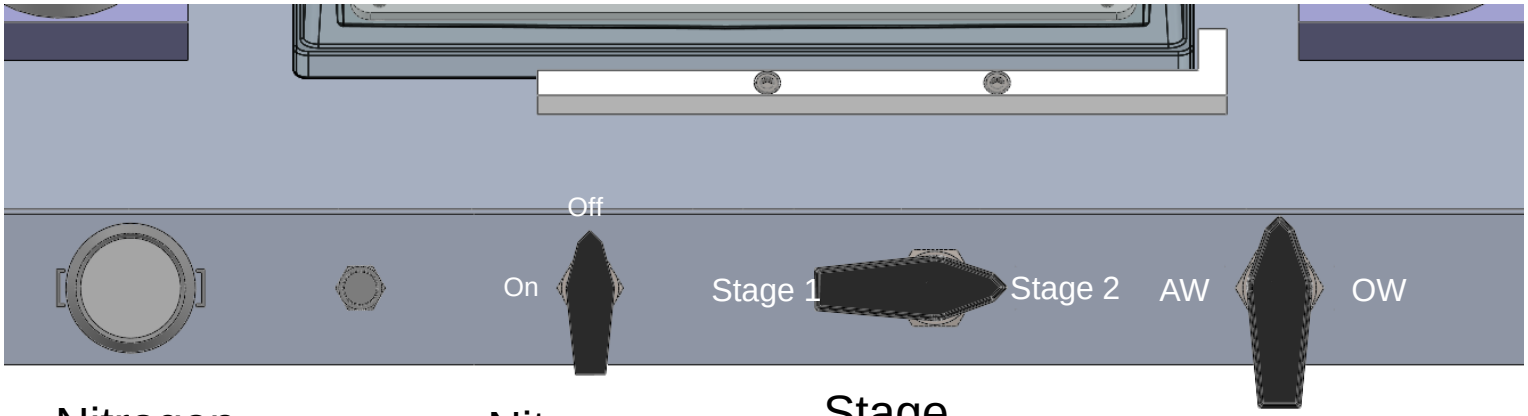
- No Teflon
- Tubing - High Density Polyethylene
- Fittings – Delrin
- Cartridge Adapters – Medical Grade Polypropylene



System Layout



Control Valve Layout



Nitrogen Gauge

Nitrogen Valve

Stage 1/2 Valve

Waste Valve

Automated Concentration for PFAs

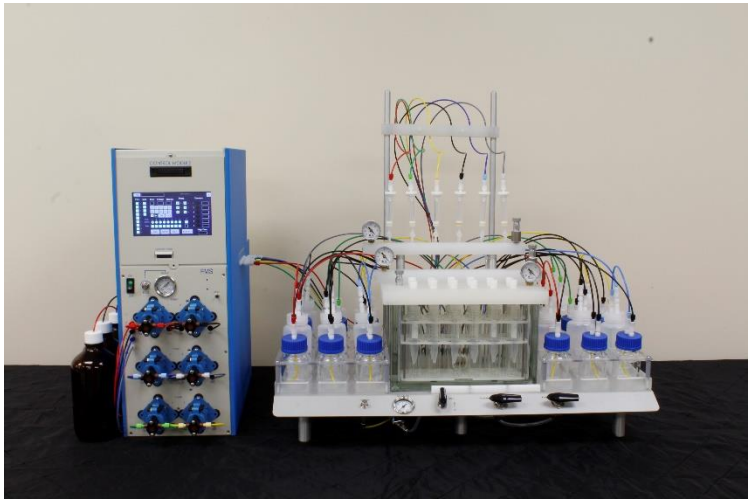
- SuperVap 24 PFC
  - 24 positions
  - 15ml Conical vials
  - Timed Endpoint
- SuperVap 12 PFC
  - 12 positions
  - 50ml Conical vials
  - Timed Endpoint

Clean up is easy with no cross contamination

- Back Flush the sample line into the original sample bottle with an IPA non-Teflon squirt bottle.
- Wash the inside of the bottle cap with IPA squirt bottle
- Wash Cartridge Adapters with IPA squirt bottle or sonicate in a beaker
- Ready for the next 12 samples

Multipump for EZPFC

- For delivery of Solvent to 6 cartridges in Parallel
- Used for Conditioning and Elution
- Up to Six solvents
- Nitrogen Drying
- No Teflon



We Learned about Sources of Contamination

- Make sure you test for Background Contamination before you start
  - LC/MS Check
  - Pipette Tips
  - Solvents
  - Water
  - Solvent Bottles

LC/MS Analysis EPA 1633

- **Analysis**
  - Take aliquot from final 5 mL extract (Method 1633 does not require volume reduction of final extract)
  - Agilent 1290 Infinity II LC System
  - Agilent 6475 Triple quad LC/MS
  - Agilent Zorbax Eclipse Plus C18 column 3.0 x 50 mm, 1.8 um
  - Column temperature 40 ^{o}C
  - Injection 5.0 uL

LC/MS Analysis EPA 1633

- **Analysis**
  - Mobile phase 5 mM ammonium acetate in 95% water, 5% acetonitrile (A) and methanol (B) Gradient
  - 0 min 98% A 2% B
  - 0.2 min 98% A 2% B10 min 5% a 95% B
  - Stop time 12.2 min
  - Dynamic MRM negative electrospray
  - T (gas) = 230 ^{o}C

Stage 1

- Condition cartridges with 15 mL 1% methanolic ammonium hydroxide, followed by 5 mL of 0.3M formic acid
- Load samples across the cartridges at 5-10 mL/min (~ 8-inch Hg)
- Sample bottles rinsed with 5 mL reagent water (twice), followed by 5 mL of 1:1 0.1M formic acid/methanol (using nitrogen)
- Rinses loaded across cartridges
- Dry 15 sec under vacuum

Stage 2

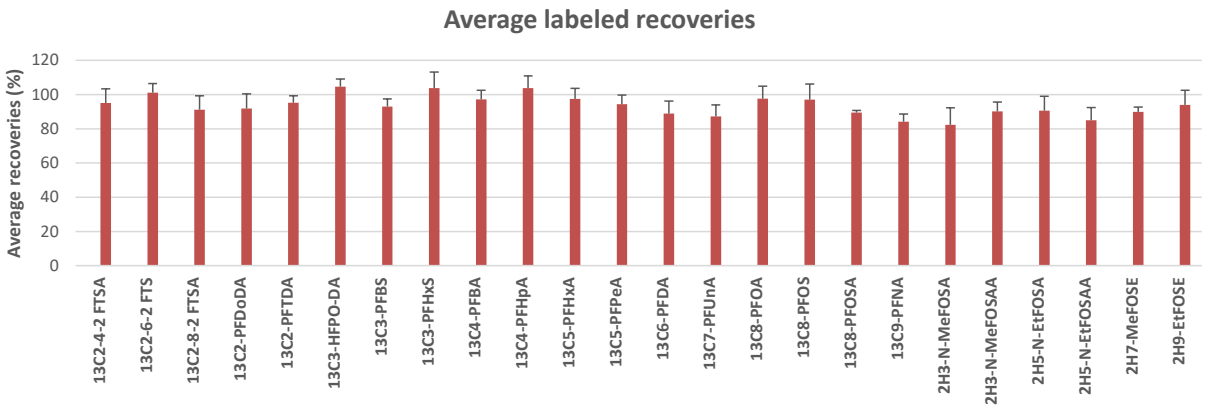
- Rinse sample bottles with 5 mL 1% methanolic ammonium hydroxide
- Load rinses across cartridges and collect in polypropylene tubes
- Cleanup carried out with 10 mg loose carbon
- As per the method no further concentration is carried out.

IDC Data for Labeled

Recoveries (%) and acceptance windows (%) for 24 surrogate PFAS in synthetic wastewater (1633) using EZPFC.

Compound Name	Percent		EZPFC-IDC-1	EZPFC-IDC-2	EZPFC-IDC-3	EZPFC-IDC-4	Window
13C2-4-2 FTSA			95.1	93.7	105.3	86.3	40-200
13C2-6-2 FTS			96.9	104.7	106.7	96.0	40-200
13C2-8-2 FTSA			91.1	98.3	94.4	80.8	40-300
13C2-PFDoDA			81.6	97.7	98.4	89.6	10-130
13C2-PFTDA			90.3	96.9	99.3	94.4	10-130
13C3-HFPO-DA			103.0	110.3	106.0	99.3	40-130
13C3-PFBS			89.0	96.9	96.3	90.0	40-135
13C3-PFHxS			95.9	108.0	115.7	95.9	40-130
13C4-PFBA			92.0	102.6	100.7	93.4	5-130
13C4-PFHpA			95.9	112.5	107.0	100.0	40-130
13C5-PFHxA			93.4	102.0	103.2	91.3	40-130
13C5-PFPeA			94.2	98.9	97.2	87.6	40-130
13C6-PFDA			81.8	93.0	95.7	85.3	40-130
13C7-PFUnA			83.9	86.4	95.9	83.0	30-130
13C8-PFOA			89.0	106.0	99.6	96.1	50-200
13C8-PFOS			93.9	110.4	91.3	92.5	50-200
13C8-PFOSA			90.4	90.0	88.1	89.7	40-130
13C9-PFNA			85.0	89.0	82.6	80.1	40-130
2H3-N-MeFOSA			87.6	91.0	76.8	74.2	10-130
2H3-N-MeFOSAA			95.5	93.0	87.7	84.5	40-170
2H5-N-EtFOSA			95.8	96.6	90.0	80.0	10-130
2H5-N-EtFOSAA			89.6	79.0	91.3	80.3	25-135
2H7-MeFOSE			93.3	89.0	90.1	87.3	10-130
2H9-EtFOSE			92.2	105.8	89.3	88.7	10-130

IDC Labeled



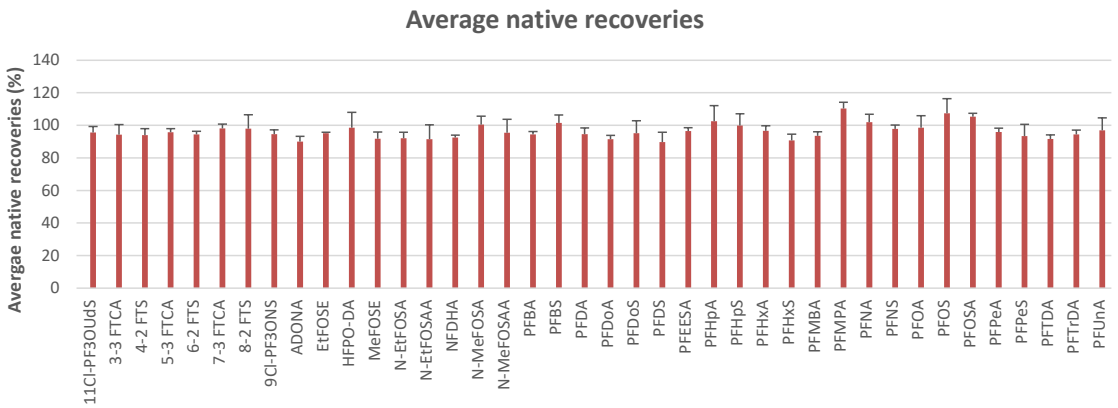
Average labeled recoveries (% , n=4)

IDC Data for Natives

Recoveries (%) and RSDs (%) for 40 native PFAS in synthetic wastewater (1633) using EZPFC (spiked with 1-38 ng/L).

Compound Name	Percent	EZPFC-IDC-1	EZPFC-IDC-2	EZPFC-IDC-3	EZPFC-IDC-4	Window	RSD (%)
11Cl-PF3OUdS		92	93	100	97	50-150	3.62
3-3 FTCA		87	96	93	101	70-130	6.18
4-2 FTS		89	98	94	96	70-135	3.90
5-3 FTCA		96	96	93	98	70-130	2.14
6-2 FTS		92	95	95	96	70-135	1.89
7-3 FTCA		98	97	95	102	55-130	2.79
8-2 FTS		92	91	100	109	70-140	8.52
9Cl-PF3ONS		93	92	97	97	70-145	2.72
ADONA		87	90	94	89	70-135	3.24
EtFOSE		95	95	95	96	70-130	0.57
HFPO-DA		92	111	100	91	70-135	9.42
MeFOSE		89	96	89	94	70-135	4.02
N-EtFOSA		89	93	91	96	70-135	3.57
N-EtFOSAA		93	90	81	101	70-135	8.81
NFDHA		93	92	94	91	65-140	1.57
N-MeFOSA		94	101	100	106	70-135	5.12
N-MeFOSAA		86	95	105	96	65-140	8.21
PFBA		93	96	93	95	70-135	1.68
PFBS		109	98	100	99	70-140	4.88
PFDA		98	94	90	96	65-140	3.83
PFDoA		93	92	88	93	70-130	2.34
PFDoS		93	105	87	96	45-135	7.64
PFDS		85	91	97	86	70-135	6.07
PFEESA		95	99	96	96	70-135	1.99
PFHpA		99	101	94	116	70-135	9.44
PFHpS		91	108	101	99	70-140	7.22
PFHxA		96	97	93	100	70-135	3.07
PFHxS		90	91	87	95	70-135	
PFMBA		91	92	96	95	65-145	2.55
PFMPA		106	107	115	113	60-140	3.83
PFNA		105	100	96	107	70-140	4.85
PFNS		96	100	95	99	70-135	2.44
PFOA		102	89	99	105	65-155	7.24
PFOS		97	109	120	104	70-140	8.89
PFOSA		107	102	105	107	70-135	2.16
PFPeA		93	98	96	96	70-135	2.36
PFPeS		93	91	87	103	70-135	7.17
PFTDA		91	93	94	89	70-145	2.50
PFTrDA		92	98	95	93	60-145	2.52
PFUnA		89	105	93	100	70-135	7.62

IDC Native Recoveries



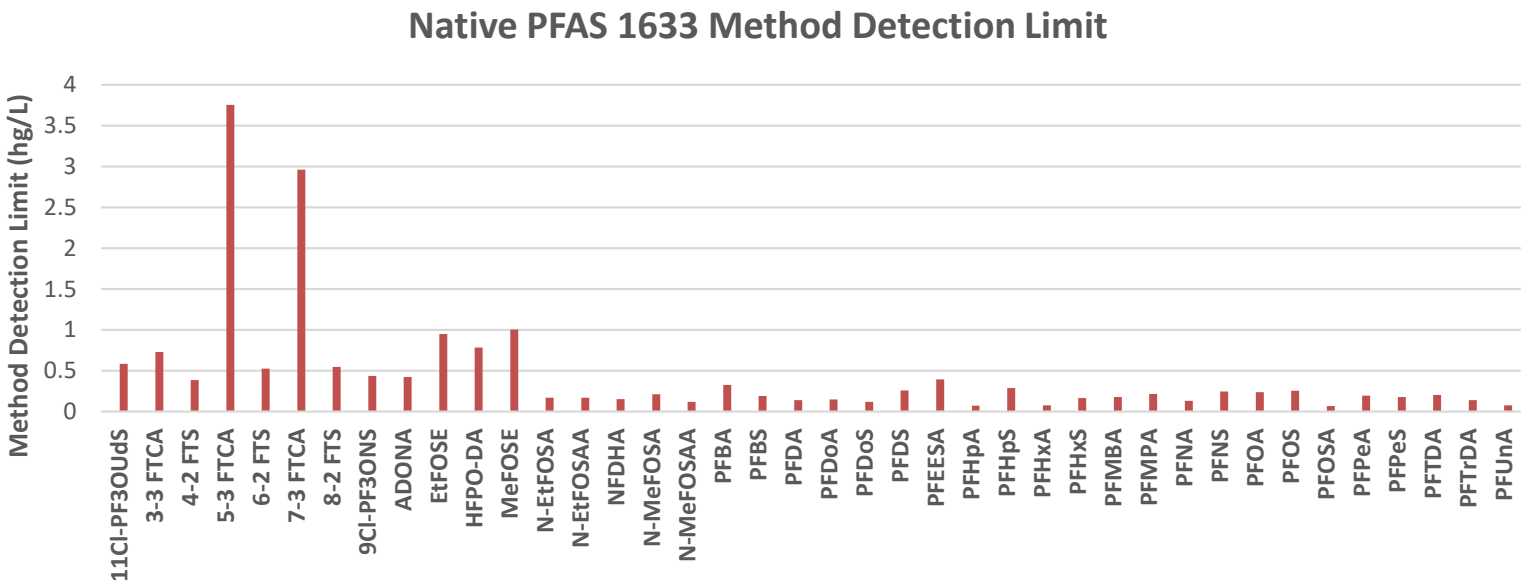
Initial Demonstration of Capability (1-38 ng/L, n=4)

MDL Data

Method Detection Limit values for 40 native PFAS in synthetic wastewater (1633) using EZPFC
(spiked with 0.2-9 ng/L).

Compound Name	In ng/L	EZPFC-MDL-1 Final Conc.	EZPFC-MDL-2 Final Conc.	EZPFC-MDL-3 Final Conc.	EZPFC-MDL-4 Final Conc.	EZPFC-MDL-5 Final Conc.	EZPFC-MDL-6 Final Conc.	EZPFC-MDL-7 Final Conc.	STDEV	MDL
11Cl-PF3OUdS		1.24	1.30	1.47	1.00	1.19	1.30	0.93	0.19	0.58
3-3 FTCA		1.08	1.53	1.71	1.07	1.39	1.29	1.26	0.23	0.73
4-2 FTS		1.46	1.43	1.48	1.44	1.21	1.62	1.50	0.12	0.39
5-3 FTCA		8.16	8.96	10.10	7.16	8.24	9.73	6.98	1.19	3.75
6-2 FTS		1.54	1.61	1.58	1.51	1.30	1.74	1.28	0.17	0.53
7-3 FTCA		8.73	9.36	9.52	8.02	8.94	9.47	6.94	0.94	2.96
8-2 FTS		1.26	1.32	1.51	1.76	1.32	1.56	1.43	0.17	0.55
9Cl-PF3ONS		1.02	1.31	1.26	0.98	1.13	1.17	0.95	0.14	0.44
ADONA		0.95	1.07	1.27	0.95	0.97	1.18	0.92	0.13	0.42
EtFOSE		3.21	3.20	3.79	3.46	3.04	3.80	3.24	0.30	0.95
HFPO-DA		0.98	1.22	1.75	1.43	1.34	1.46	1.16	0.25	0.79
MeFOSE		3.41	3.23	3.83	3.28	2.77	3.48	3.36	0.32	1.01
N-EtFOSA		0.24	0.23	0.25	0.28	0.34	0.34	0.37	0.05	0.17
N-EtFOSAA		0.30	0.34	0.35	0.33	0.38	0.21	0.32	0.05	0.17
NFDHA		0.60	0.64	0.63	0.55	0.55	0.64	0.52	0.05	0.16
N-MeFOSA		0.41	0.28	0.27	0.31	0.24	0.35	0.21	0.07	0.21
N-MeFOSAA		0.31	0.33	0.28	0.31	0.25	0.34	0.36	0.04	0.12
PFBA		1.12	1.19	1.35	1.21	1.05	1.30	1.16	0.10	0.33
PFBS		0.26	0.34	0.33	0.33	0.22	0.41	0.31	0.06	0.19
PFDA		0.27	0.31	0.29	0.32	0.22	0.36	0.28	0.04	0.14
PFDoA		0.33	0.31	0.43	0.29	0.30	0.31	0.30	0.05	0.15
PFDoS		0.36	0.25	0.35	0.29	0.28	0.33	0.32	0.04	0.12
PFDS		0.25	0.32	0.49	0.26	0.26	0.31	0.28	0.08	0.26
PFEESA		0.72	0.70	0.86	0.67	0.53	0.90	0.66	0.13	0.39
PFHpA		0.33	0.31	0.30	0.28	0.26	0.29	0.30	0.02	0.07
PFHpS		0.34	0.28	0.49	0.39	0.26	0.33	0.20	0.09	0.29
PFHxA		0.30	0.30	0.35	0.30	0.27	0.32	0.29	0.02	0.08
PFHxS		0.40	0.28	0.32	0.27	0.27	0.34	0.38	0.05	0.17
PFMBA		0.51	0.58	0.61	0.54	0.45	0.61	0.56	0.06	0.18
PFMPA		0.50	0.54	0.58	0.38	0.41	0.49	0.46	0.07	0.22
PFNA		0.29	0.25	0.33	0.31	0.29	0.35	0.23	0.04	0.13
PFNS		0.23	0.21	0.25	0.34	0.22	0.07	0.23	0.08	0.25
PFOA		0.46	0.32	0.28	0.23	0.26	0.30	0.32	0.08	0.24
PFOS		0.40	0.28	0.32	0.52	0.33	0.35	0.30	0.08	0.26
PFOSA		0.30	0.32	0.32	0.28	0.30	0.32	0.26	0.02	0.07
PFPeA		0.55	0.60	0.70	0.63	0.50	0.63	0.57	0.06	0.20
PFPeS		0.27	0.31	0.35	0.23	0.29	0.35	0.40	0.06	0.18
PFTDA		0.21	0.26	0.39	0.23	0.23	0.22	0.31	0.06	0.20
PFTrDA		0.29	0.24	0.39	0.29	0.28	0.30	0.30	0.04	0.14
PFUnA		0.29	0.28	0.29	0.32	0.30	0.31	0.25	0.02	0.08

MDL Study



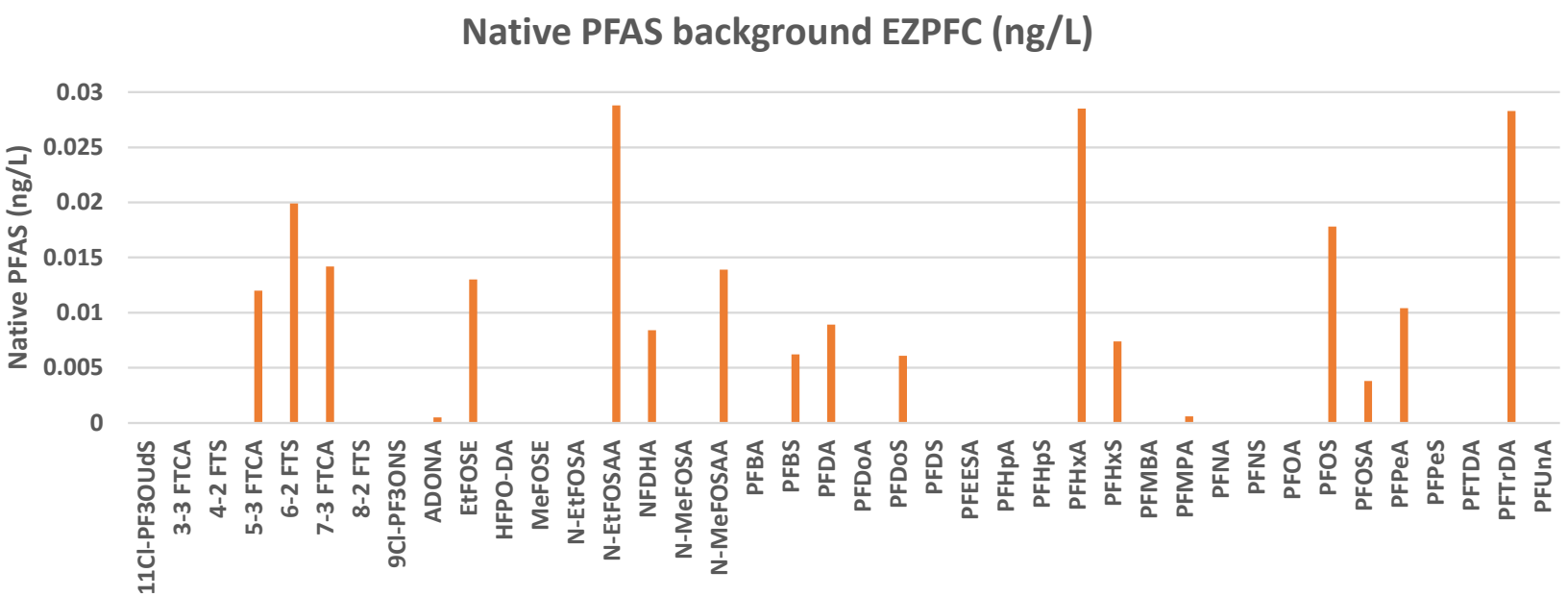
Method Detection Limit
(0.2-9 ng/L, n=7)

System Background

Native PFAS 1633 background for EZPFC (ng/L)

11Cl-PF3OUdS	0.0000
3-3 FTCA	0.0000
4-2 FTS	0.0000
5-3 FTCA	0.0120
6-2 FTS	0.0199
7-3 FTCA	0.0142
8-2 FTS	0.0000
9Cl-PF3ONS	0.0000
ADONA	0.0005
EtFOSE	0.0130
HFPO-DA	0.0000
MeFOSE	0.0000
N-EtFOSA	0.0000
N-EtFOSAA	0.0288
NFDHA	0.0084
N-MeFOSA	0.0000
N-MeFOSAA	0.0139
PFBA	0.0000
PFBS	0.0062
PFDA	0.0089
PFDoA	0.0000
PFDoS	0.0061
PFDS	0.0000
PFEESA	0.0000
PFHpA	0.0000
PFHpS	0.0000
PFHxA	0.0285
PFHxS	0.0074
PFMBA	0.0000
PFMPA	0.0006
PFNA	0.0000
PFNS	0.0000
PFOA	0.0000
PFOS	0.0178
PFOSA	0.0038
PFPeA	0.0104
PFPeS	0.0000
PFTDA	0.0000
PFTrDA	0.0283
PFUnA	0.0000

System Background

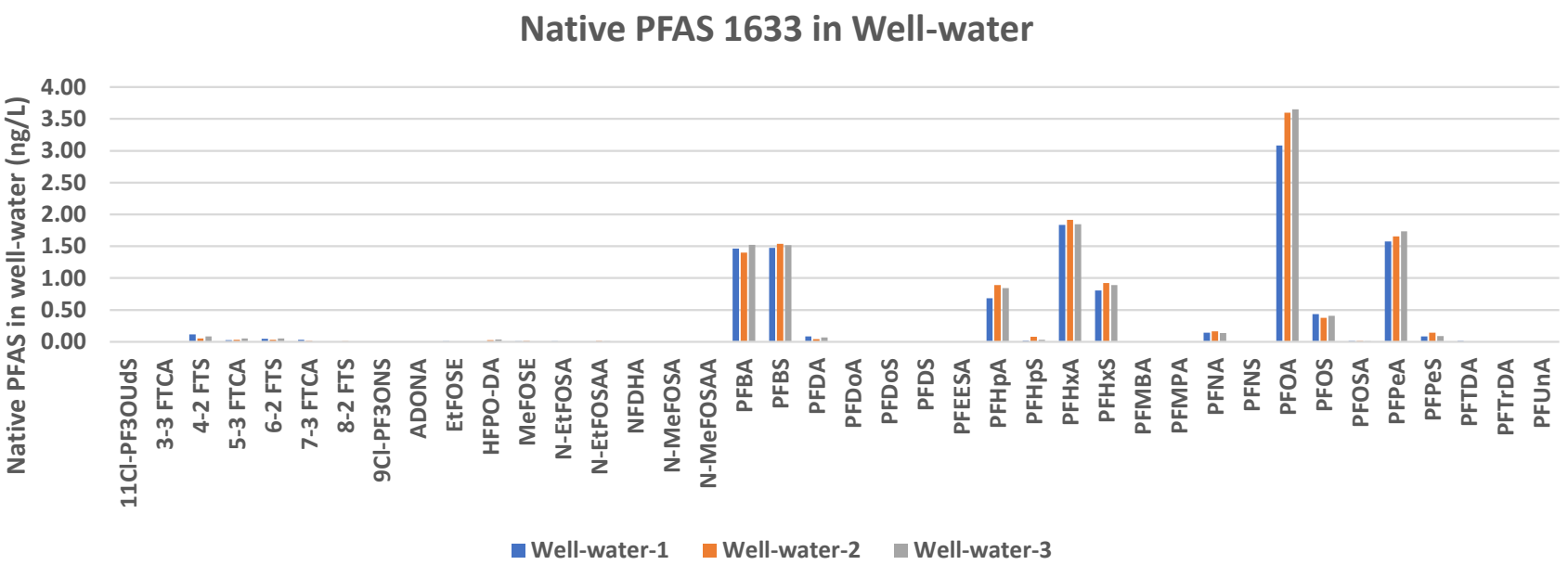


FMS
Fluid Management Systems

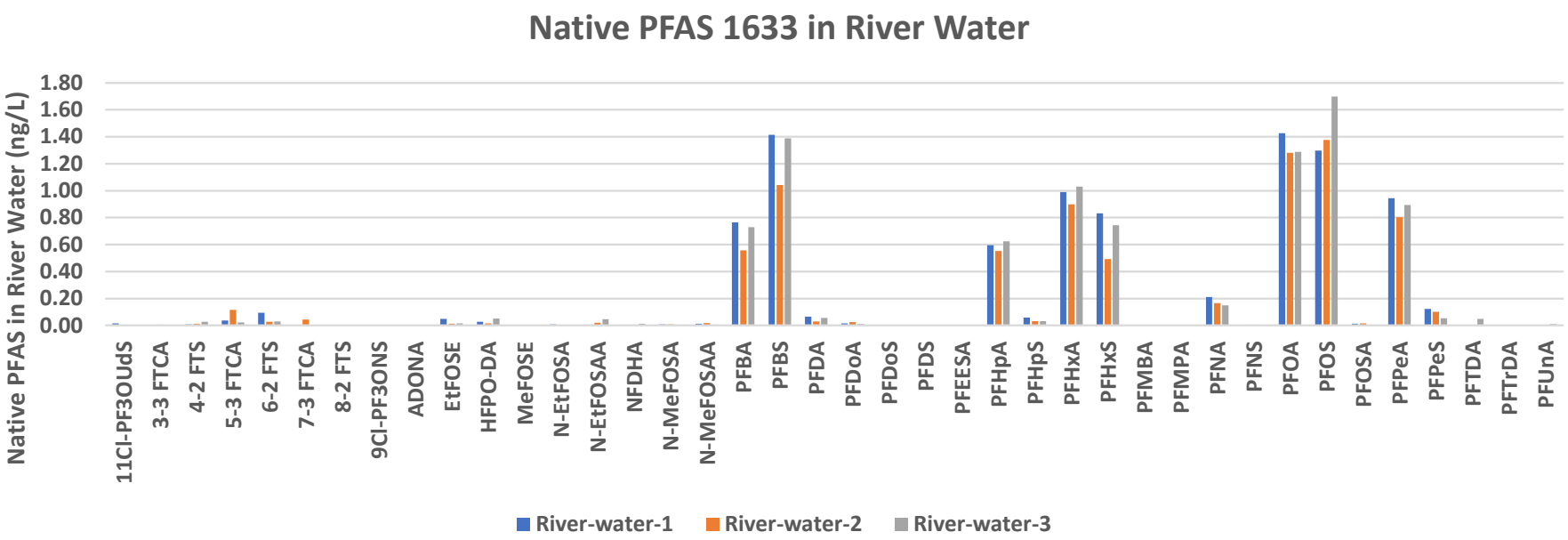
Matrices

Compound Name In ng/L	Well-water-1 Final Conc.	Well-water-2 Final Conc.	Well-water-3 Final Conc.	River-water-1 Final Conc.	River-water-2 Final Conc.	River-water-3 Final Conc.	TAP-WATER-1 Final Conc.	TAP-WATER-2 Final Conc.	TAP-WATER-3 Final Conc.
11Cl-PF3OUdS	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
3-3 FTCA	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
4-2 FTS	0.12	0.06	0.09	0.01	0.01	0.03	0.02	0.01	0.01
5-3 FTCA	0.02	0.03	0.05	0.04	0.12	0.02	0.03	0.02	0.02
6-2 FTS	0.05	0.03	0.05	0.09	0.03	0.03	0.04	0.05	0.04
7-3 FTCA	0.03	0.02	0.00	0.00	0.04	0.00	0.00	0.00	0.00
8-2 FTS	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9Cl-PF3ONS	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
ADONA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EtFOSE	0.01	0.00	0.01	0.05	0.01	0.02	0.00	0.01	0.02
HFPO-DA	0.00	0.03	0.04	0.03	0.02	0.05	0.02	0.00	0.05
MeFOSE	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.06
N-EtFOSA	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
N-EtFOSAA	0.00	0.01	0.01	0.01	0.02	0.05	0.01	0.01	0.03
NFDHA	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00
N-MeFOSA	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
N-MeFOSAA	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01
PFBA	1.46	1.40	1.52	0.77	0.56	0.73	0.60	0.57	0.65
PFBS	1.47	1.54	1.52	1.41	1.04	1.39	0.75	0.80	0.86
PFDA	0.09	0.04	0.07	0.06	0.03	0.06	0.02	0.01	0.00
PFDoA	0.00	0.00	0.00	0.01	0.03	0.01	0.02	0.02	0.02
PFDoS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFEESA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFHpA	0.68	0.89	0.84	0.59	0.55	0.62	0.36	0.39	0.42
PFHpS	0.02	0.08	0.03	0.06	0.03	0.03	0.04	0.00	0.07
PFHxA	1.84	1.92	1.85	0.99	0.90	1.03	0.54	0.57	0.61
PFHxS	0.81	0.93	0.89	0.83	0.49	0.74	0.66	0.55	0.59
PFMBA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFMPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFNA	0.14	0.17	0.14	0.21	0.17	0.15	0.03	0.06	0.07
PFNS	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
PFOA	3.08	3.60	3.65	1.43	1.28	1.29	1.06	0.82	1.02
PFOS	0.44	0.38	0.41	1.30	1.38	1.70	0.64	0.55	0.81
PFOSA	0.02	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.01
PFPeA	1.58	1.65	1.74	0.94	0.80	0.89	0.66	0.63	0.70
PFPeS	0.09	0.14	0.09	0.12	0.10	0.05	0.11	0.11	0.12
PFTDA	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.02
PFTrDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PFUnA	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00

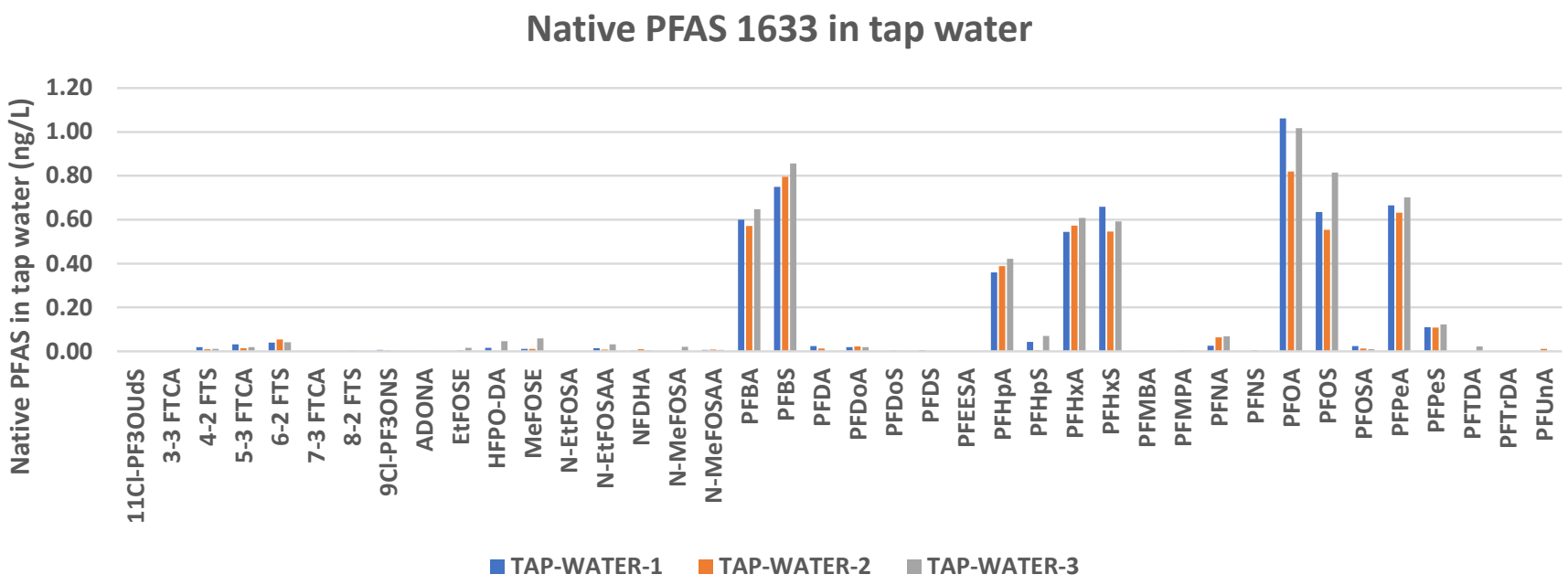
Well Water


Native PFAS 1633 in Well-water
Native PFAS in well-water (ng/L)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
11Cl-PF3OUdS
3-3 FTCA
4-2 FTS
5-3 FTCA
6-2 FTS
7-3 FTCA
8-2 FTS
9Cl-PF3ONS
ADONA
EtFOSE
HFPO-DA
MeFOSE
N-EtFOSA
N-EtFOSAA
NFDHA
N-MeFOSA
N-MeFOSAA
PFBA
PFBS
PFDA
PFDoA
PFDoS
PFDS
PFEESA
PFHpA
PFHpS
PFHxA
PFHxS
PFMBA
PFMPA
PFNA
PFNS
PFOA
PFOS
PFOSA
PFPeA
PFPeS
PFTDA
PFTrDA
PFUnA
Well-water-1
Well-water-2
Well-water-3

River Water


Native PFAS 1633 in River Water
Native PFAS in River Water (ng/L)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
11Cl-PF3OUdS
3-3 FTCA
4-2 FTS
5-3 FTCA
6-2 FTS
7-3 FTCA
8-2 FTS
9Cl-PF3ONS
ADONA
EtFOSE
HFPO-DA
MeFOSE
N-EtFOSA
N-EtFOSAA
NFDHA
N-MeFOSA
N-MeFOSAA
PFBA
PFBS
PFDA
PFDoA
PFDoS
PFDS
PFEESA
PFHpA
PFHpS
PFHxA
PFHxS
PFMBA
PFMPA
PFNA
PFNS
PFOA
PFOS
PFOSA
PFPeA
PFPeS
PFTDA
PFTrDA
PFUnA
River-water-1
River-water-2
River-water-3

Tap Water


Native PFAS 1633 in tap water
Native PFAS in tap water (ng/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
11Cl-PF3OUdS
3-3 FTCA
4-2 FTS
5-3 FTCA
6-2 FTS
7-3 FTCA
8-2 FTS
9Cl-PF3ONS
ADONA
EtFOSE
HFPO-DA
MeFOSE
N-EtFOSA
N-EtFOSAA
NFDHA
N-MeFOSA
N-MeFOSAA
PFBA
PFBS
PFDA
PFDoA
PFDoS
PFDS
PFEESA
PFHpA
PFHpS
PFHxA
PFHxS
PFMBA
PFMPA
PFNA
PFNS
PFOA
PFOS
PFOSA
PFPeA
PFPeS
PFTDA
PFTrDA
PFUnA
TAP-WATER-1
TAP-WATER-2
TAP-WATER-3

Semi-Automated SPE in Summary

- **EZPFC and SuperVap systems are easy to use and install**
  - **Complete Water Sample Prep Workflow**
- **Low cost, High throughput, Low maintenance solution**
- **EZPFC Extractions and Concentration**
  - **Closed System Reduces Contamination**
  - **Less user interactions**
  - **Reduces Human error**
  - **Bottle Rinse**

Summary

- **FMS semi-automated SPE and SuperVap systems deliver consistent, reproducible results**
- **Handles a wide range of Sample sizes and matrix types**
- **Uses all SPE Cartridge sizes**

Semi Automated SPE for PFAS

- **EZPFC**
  - **2 EZPFC 12 position systems runs 24 samples a batch in 90 Minutes**

Questions

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