



PFAS Study of Maine Wastewater Effluent

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MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

Protecting Maine's Air, Land and Water

Topics

- Maine WWTF Effluent Study
- Effluent sample data results
- Project set-up
- Comparison of Lab Isotope data vs 1633 data
- EPA Method 1621 – New!
 - Adsorbable Organic Fluorine



Maine Bill-LD1911

- Sampling for PFAS in wastewater discharges
- Purpose
 - Establish a baseline of effluents throughout state
 - Surface water dischargers for watershed modeling
- 105 public facilities, 19 private
- Surface water and subsurface
 - Quarterly groundwater sampling
 - EPA Method 537.1 M



Effluent Sampling Plan

- Operators collect samples – training, SOPs
- 10 samples per facility (one per month)
- Samples collected fall 2022 – summer 2023
- 4 rounds of field/ equipment blanks



Pre-planning

- Procured lab contractor for courier services and PFAS analysis
- Monthly status meetings throughout study
- Hands on training sessions
 - Operators throughout state
 - 1-page “cheat sheet”
- Customized CoC
- Data handling plan



Results - Effluent Sampling Data

Concentration, ppt

LD1911 PFAS Sum of 6 Study Statistics Summary-

Public Facility- Effluent Results			
Mean	Median	High	Low
48.61	20.23	836.10	6.60

Private Facility- Effluent Results			
Mean	Median	High	Low
53.53	15.90	217.31	3.73

Public Facility- Spray MW Results			
Mean	Median	High	Low
4.85	1.44	24.50	0.30

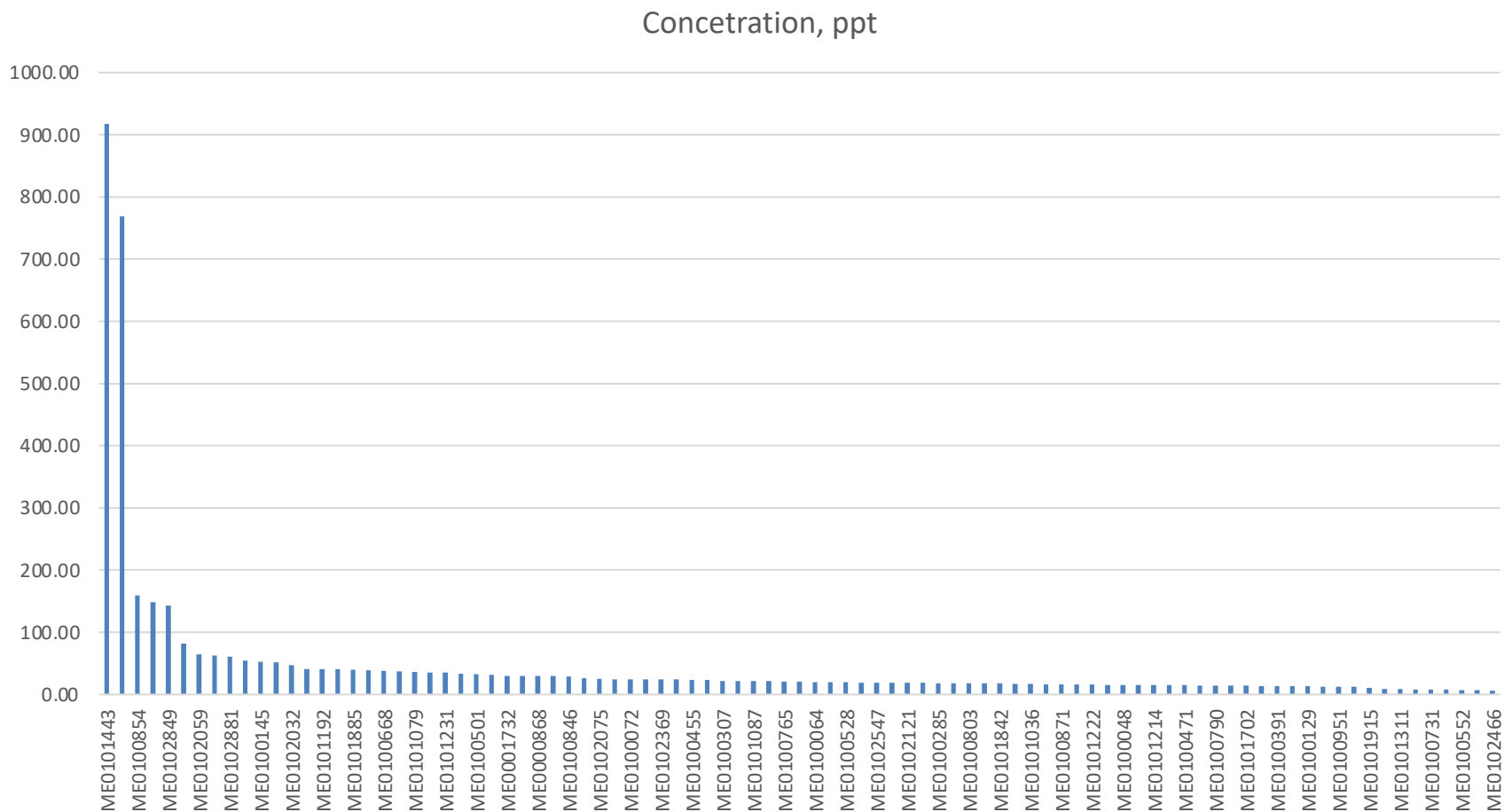
Private Facility- Spray MW Results			
Mean	Median	High	Low
25.11	13.90	55.40	6.02

Maine PFAS Sum of 6 - PFOA, PFOS, PFHpA, PFNA, PFDA and PFHxS

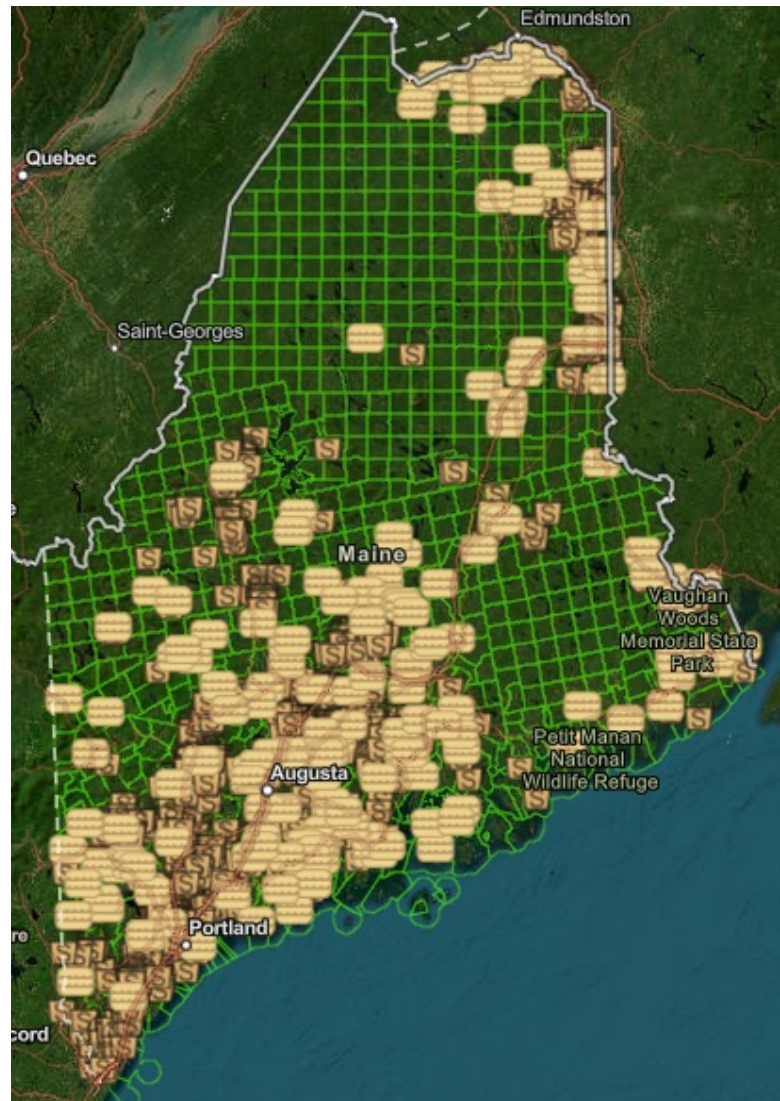


Average Concentration of PFAS

“Sum of 6” - POTWs



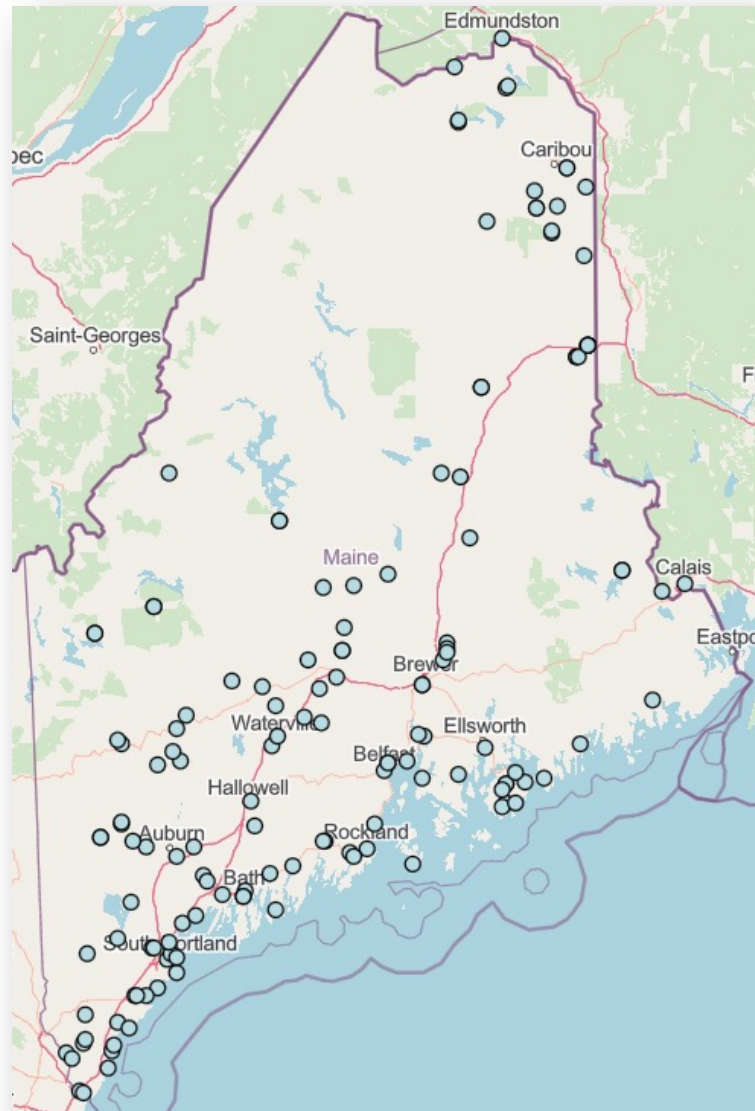
Maine PFAS Investigation Map



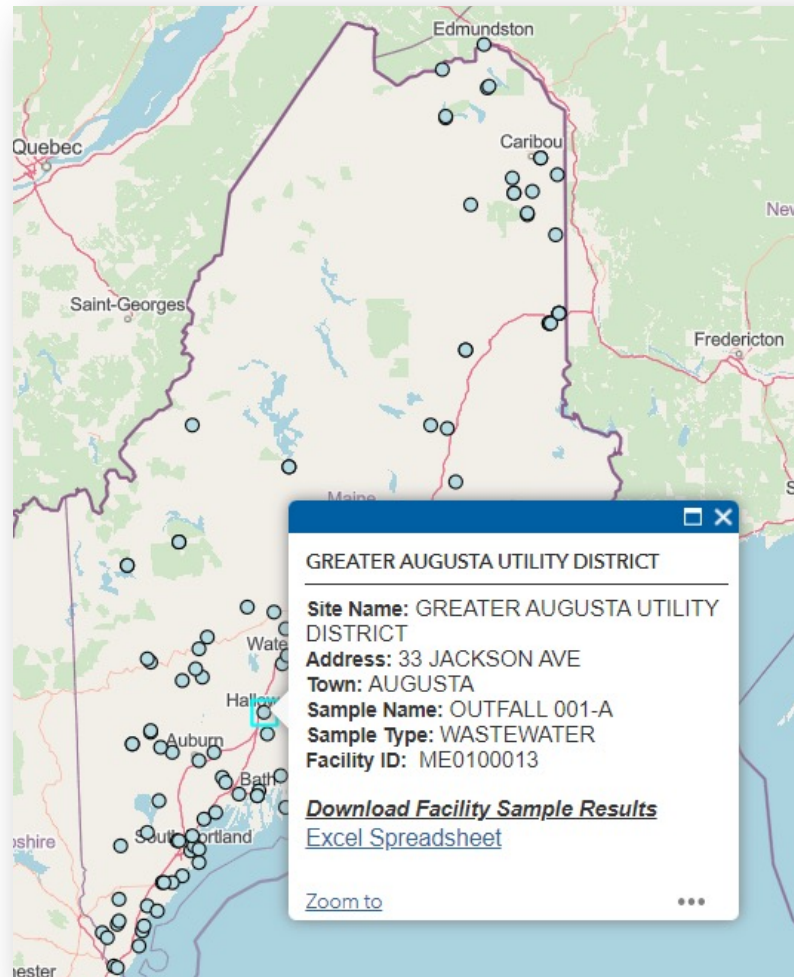
Groundwater
(residential well
drinking water),
Soil, Fish tissue,
Surface Water,
Wastewater



Participating Wastewater Plants



Viewing all Study Data



Report Run On:	#####										
Facility Name	GREATER AUGUSTA UTILITY DISTRICT										
MEPDES	ME0100013										
Discharges to	Kennebec River										
	All units are in Parts Per Trillion (PPT); equivalent units - nanograms per liter (ng/L)										
Parameter	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A	OUTFALL 001-A
	10/5/22	11/3/22	12/6/22	1/6/23	2/6/23	3/7/23	4/4/23	5/3/23	6/5/23	7/10/23	
SUM OF 6 PFAS	25.5 J	36.7 J	91.4	42.1 J	31.2 J	20 J	20.9 J	46.3 J	44.1 J	24 J	
HFPO-DA_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFBS_A	3.96	9.17	9.02	16.4	6.17	ND U	4.68 J	17.4	17.5	4.46 J	
PFHXS_A	2.45	2.99 J	4.59	4.89	2.88	2.34	2.86	4.09	8.12 J	1.5 J	
PFNA_A	1.13 J	1.59 J	5.34	1.8	1.68 J	1.34 J	0.647 J	2.41	2.91	1.7 J	
PFOS_A	6	10.9	50.3	8.19	11.9	4.39 J	6.16	9.59	8.26	6.77	
PFOA_A	10.3	14.4	20.8	18.2	9.13	7.91	7.77	19.8	16.7	9.33	
4:2 FTS_A	ND UJ	ND UJ	ND UJ	ND UJ	ND UJ	ND UJ	ND UJ	ND U	ND U	ND UJ	
6:2 FTS_A	2.6 J	4.25 J	4.84 J	6.2 J		2.07 J	ND UJ	3.35	5.13 J	4.28 J	
8:2 FTS_A	ND U	ND U	2.75 J	ND UJ	ND UJ	ND UJ	ND UJ	ND U	ND U	ND U	
ADONA_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
N-EtFOSAA_A	ND U	ND U	3.79	0.799 J	1.11 J	ND U	ND U	ND U	0.874 J	1.72 J	
N-MeFOSAA_A	ND U	ND U	7.89	1.29 J	1.84 J	ND U	ND U	1.68 J	1.42 J	0.893 J	
PFBA_A	13.4	28 J	22.2	26.3	10.3	22.1	20.6	38.6 J	29.7	14.7	
PFDA_A	0.48 J	0.676 J	4.34	0.81 J	1.03 J	ND U	0.427 J	1.14 J	0.655 J	1.22 J	
PFDOA_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFDS_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFHPA_A	5.15	6.13	6	8.2	4.62	4.04	3.08	9.31	7.46 J	3.44	
PFHPS_A	ND U	ND U	0.71 J	ND U	ND U	ND U	ND U	ND U	1.2 J	ND U	
PFHXA_A	27.2	38.4	37.2	61.9	20.9	21.1	10.2	77.4	75.6	24.4	
PFHXDA_A	ND U	ND U	ND U	ND U	1.64 J	ND U	ND U	ND U	ND U	ND U	
PFNS_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFODA_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFOSA	1.03 J	ND U	1.18 J	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFPEA_A	13	16	14.2	27	8.92	11	6.46	39.8	27.4	9.34	
PFPEA_A	0.348 J	0.559 J	0.565 J	0.749 J	ND U	0.368 J	ND U	0.619 J	0.692 J	0.577 J	
PFTEA_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFTRIA_A	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	
PFUNDA_A	ND U	ND U	0.58 J	ND U	ND U	ND U	ND U	ND U	ND U	ND U	

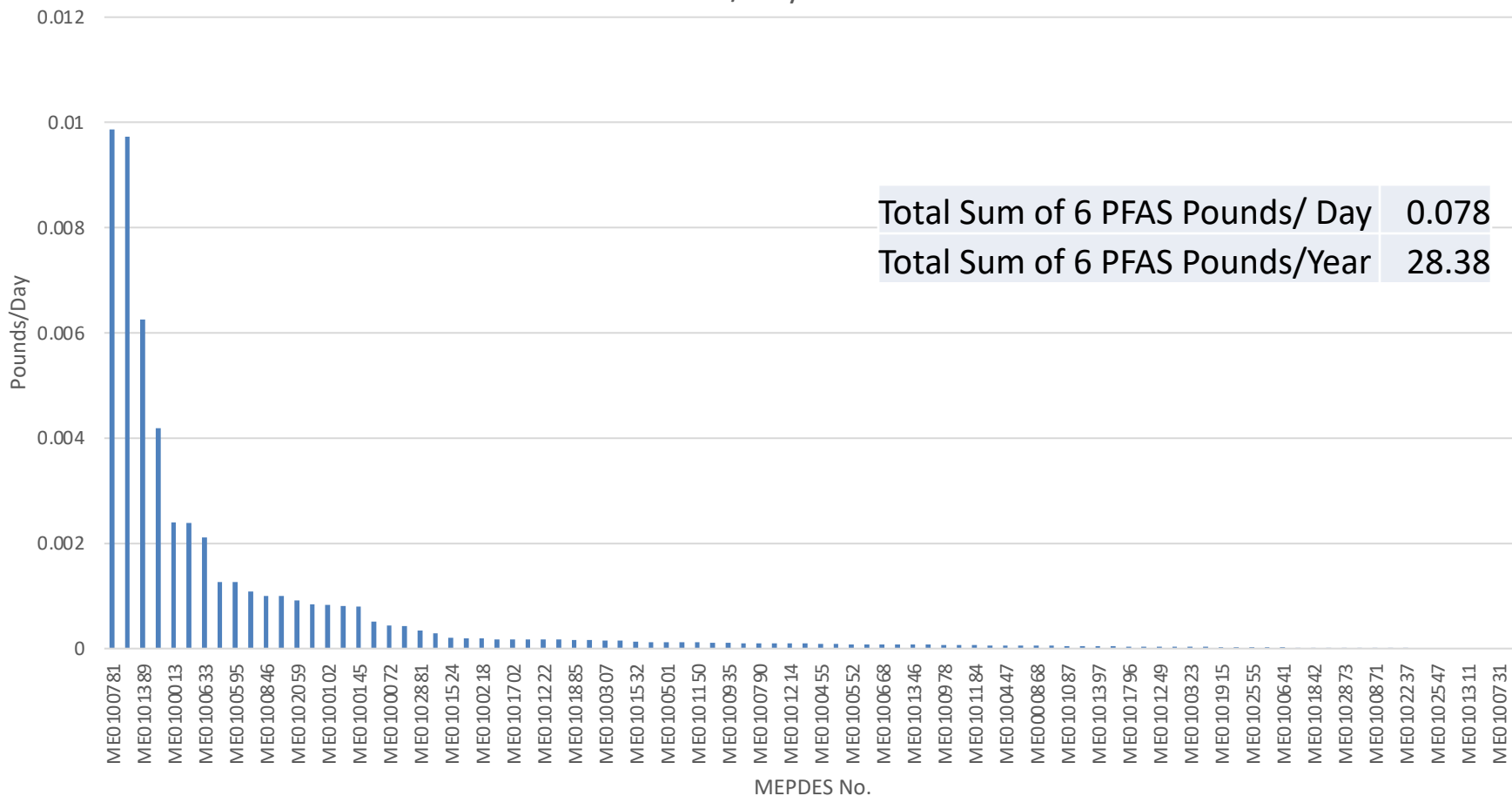
PFAS Wastewater Loading in Maine

- Collected daily flow each day PFAS sampling day
- Used average flow and average “Maine Sum of 6” PFAS concentration to calculate loading for each facility



Loading Summary- Maine POTWS

Pounds/ Day PFAS



POTW LIST

Pickup Zone	Courier Pickup Plan Month/yr	Pickup locations	Courier
ZONE 1	York County	14	ALPHA
ZONE 2	Cumberland County	12	ALPHA
ZONE 3	Orange/Franklin	9	ALPHA
ZONE 4	Kerns/Bedford/Scott	9	ALPHA
ZONE 5	Spartanburg/Lenoir/Union/York	13	ALPHA
ZONE 6	Franklin/Spencer/Net	5	ALPHA
ZONE 7	Pearlman/Net	4	ALPHA
ZONE 8	Pennsboro/Net	13	ALPHA
ZONE 9	Hamock	11	ALPHA
ZONE 10	Amherst/Net	14	ALPHA/Unishop
ZONE 11	Washington	4	ALPHA
MONTHLY TOTAL		305	

[illegible]

Location	Latitude	Country	Peak
Almaty	43° 45' N	Kazakhstan	1992
Amudarya	37° 15' N	Uzbekistan	1992
Bishkek	42° 55' N	Kyrgyzstan	1992
Kashgar	39° 30' N	China	1992
Kokchetav	53° 15' N	Kazakhstan	1992
Leningrad	59° 45' N	Russia	1992
Novosibirsk	55° 00' N	Russia	1992
Orsk	51° 45' N	Russia	1992
Qom	32° 15' N	Iran	1992
Shymkent	42° 45' N	Kazakhstan	1992
Tashkent	41° 45' N	Uzbekistan	1992
Urumqi	43° 45' N	China	1992
Yekaterinburg	56° 45' N	Russia	1992
Yuzhno-Sakhalinsk	46° 15' N	Russia	1992
Zhigansk	71° 45' N	Russia	1992
Almaty	43° 45' N	Kazakhstan	1993
Amudarya	37° 15' N	Uzbekistan	1993
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Urumqi	43° 45' N	China	1995
Yekaterinburg	56° 45' N	Russia	1995
Yuzhno-Sakhalinsk	46° 15' N	Russia	1995
Zhigansk	71° 45' N	Russia	1995

Lab-prepared Sample kits



Pre-printed Chain of Custody

CHAIN OF CUSTODY PAGE 1 OF 1								Date Rec'd in Lab:		ALPHA Job #:	
 Maine DEP- LD1911 PFAS Project Samples											
72 Center Street Brewer ME 04412 Tel: (207) 624-0713				320 Forbes Blvd Mansfield MA 02048 Tel: (508) 822-9300				Project Information: Facility Name: _____ Discharge Schedule: _____			
Client Information: _____ MEPDES # (Client Project #): _____								Contract and Billing Information: ALPHA Contract Number: 06A20220714*137			
Client: Maine Dept. of Environmental Protection				EGAD Site #: _____				Invoice to: Patricia.L.Korbet@maine.gov Brett.A.Goodrich@maine.gov			
Contact: Brett Goodrich Address: 17 SHS State: Maine Zip Code: 04901 Phone: 207-287-9034 Email: Brett.A.Goodrich@maine.gov				Project Manager: Brett Goodrich Facility Contact: _____ Facility Phone: _____ Facility Email: _____ Lab report copies to: dep.edd@maine.gov ; Kelly.Perkins@maine.gov ; Brett.A.Goodrich@maine.gov				To be completed by permittee before submitting samples			
Sampling Notes: _____				Turn-Around Time: ☐ Standard ☐ Rush (only confirmed if pre-approved) Date Due: _____				Daily Flow (MGD) for 24-hour period prior to sampling MGD _____			
								Check the box below for any events that occurred within 24 hours of sampling:			
								Wet weather event ☐ Yes ☒ No			
								Septage Received ☐ Yes ☒ No			
								Leachate or Other Transported Waste ☐ Yes ☒ No			
ALPHA Lab ID (Lab Use Only)	Sample Point Name (Ex. Outfall 001-A, Lagoon Effluent Before Spray)	Sample Date	Sample Time	Sample Matrix/Type	Sample Location	Collection Method	Treatment Status	Analysis: Maine 28 PFAS Compounds (Isotope Dilution)	Total # Bottles	Sample Comments:	
				WW	EF	GS	T	X	2		
	Field Blank (if applicable)			AQ	NA	NA	NA	X	1		
	Equipment Blank (if applicable)			AQ	NA	NA	NA	X	1		
Container Type: P=Plastic A=Amber Glass G=Glass B=Bacteria Cup BOD=BOB Bottle O=Other DEP Inspector: _____		Preservative: Tz= Trizma A=None O = Other _____		Sampled by: _____				Container Type: P Tz Preservative: _____		All samples subject to Alpha's terms and conditions.	
Relinquished by: _____				Date/ Time: _____		Received by: _____		Date/ Time: _____			
Relinquished by: _____				Date/ Time: _____		Received by: _____		Date/ Time: _____			
Relinquished by: _____				Date/ Time: _____		Received by: _____		Date/ Time: _____			
DEP Region: _____				Relinquished by: _____		Date/ Time: _____		Received by: _____		Date/ Time: _____	

Transition to EPA 1633

- Facilities collected duplicate samples during last round
- One analyzed using same method as other 9 sample (537.1M)
- One analyzed using draft version of EPA 1633
- Over 90 facilities collected duplicate samples
- Analyzed as “blind” duplicates in the lab



PFOS Comparison

PFAS	Average result		Median Result		Min Result		Max result		Average RPD	Number of Samples
	1633	537.1M	1633	537.1M	1633	537.1M	1633	537.1M		
PFOS	16.41	16.29	5.02	5.34	1.7	1.02	522	488	17.78%	94

EPA 1633 537.1M

Average: 16.41 PPT 16.29 PPT

Median: 5.02 PPT 5.34 PPT

Average RPD for PFOS: 17.78%

Max.: 522 PPT 488 PPT

STD Dev. 55.33 52.01

RPD <20% is “good” for most duplicate aqueous samples



PFOA Comparison

PFAS	Average result		Median Result		Min Result		Max result		Average RPD	Number of Samples
	1633	537.1M	1633	537.1M	1633	537.1M	1633	537.1M		
PFOA	25.23	22.05	9.68	7.81	1.93	1.52	451	424	19.05%	94

EPA 1633 537.1M

Average: 25.23 PPT 22.05 PPT

Average RPD for PFOA: 19.05%

Median: 9.68 PPT 7.81 PPT

Max.: 451 PPT 424 PPT

STD Dev. 69.26 62.32

RPD <20% is “good” for most duplicate aqueous samples



TEST METHODS



WATER



SOIL & OTHER
SOLIDS

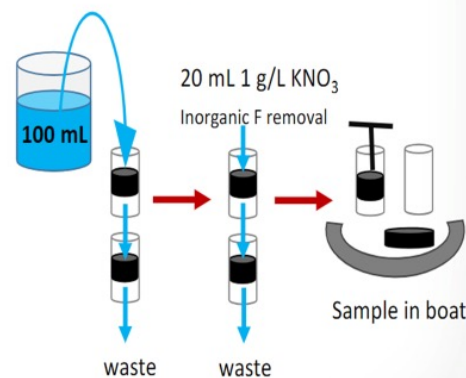
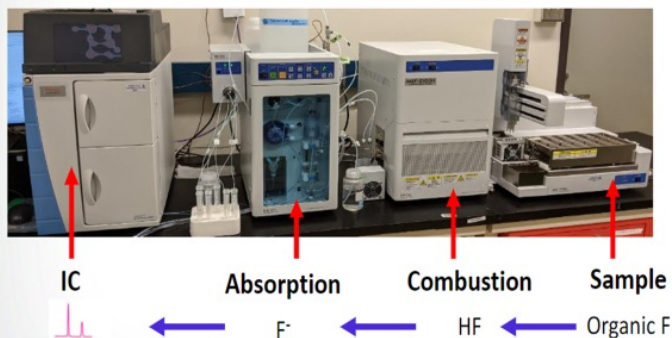
Adsorbable Organic Fluorine (AOF) EPA 1621



Approach – AOF/CIC

How:

- Screening method adsorbs contaminants onto granular activated carbon, removal of inorganic fluoride with nitrate solution, followed by combustion of the carbon
- Organofluorine compounds are converted to fluoride in the combustion process and measured by ion chromatography



Method Detection Limit: 1.4 - 2.2 µg/L

Ms. Jean Van Buren, USEPA ORD
“Targeted and Non-Targeted
Analytical Methods for PFAS
Detection and Quantification in
Environmental Matrices”

Northeast Conference on the
Science of PFAS, Marlborough,
MA 4/3/2023

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TEST METHODS



WATER



SOIL & OTHER
SOLIDS

Category	Total Organic Fluorine (TOF)			
	TOF	EPA 1621 (AOF)	1621M (EOF)	1621M (TF)
Matrices	Aqueous (only)	Aqueous (only)	Solids (only)	Solid and liquids
Sample Volume	1 x 125 mL PFAS (10 mL)	3 x 125 ml PFAS (100 mL)	1 x 90 mL SS PFAS (5 grams)	1 x 90 mL SS PFAS (1 gram)
Holding Time	90 Days	90 Days	90 Days	90 Days
LOQ	50 µg/L	2 µg/L	TBD	TBD
NOTES	- No extraction or adsorptions losses or concerns - Monitor INORGANIC and ORGANIC simultaneously - Low volume needed (<10 mL)	- Published method, “recommended” for use for WW monitoring - Not yet “required” until promulgated in 40CFR - Pace® single-lab validation study	- Same solids extraction procedure used for targeted PFAS methods. MeOH extract brought up to volume for TOF or AOF test - For some matrices, we might add a cryomill sample prep in advance of the extraction	- Does not differentiate between inorganic or organic fluorine, it is a “total” fluorine estimate - If inorganic fluoride is a significant concern, suggest also running EPA 300.0 for inorganic fluoride as a separate analysis

TOF - Total Organic Fluorine
AOF - Adsorbable Organic Fluorine
EOF - Extractable Organic Fluorine
TF - Total Fluorine

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