

PFAS SAMPLING IN BIOSOLIDS AND SOILS IN MAINE



PRESENTED AT THE NORTHEAST RESIDUALS & BIOSOLIDS CONFERENCE OCTOBER 18, 2019:

BY

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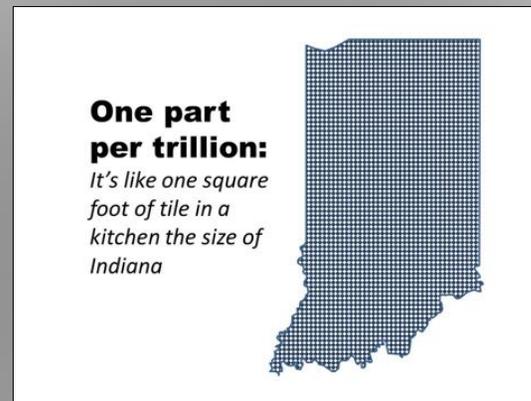
OF NORTHERN TILTH

OVERVIEW

- NORTHERN TILTH'S PFAS SAMPLING PROTOCOLS
- SUMMARY OF RESULTS
- RESUMPTION OF USE OF BIOSOLIDS IN MAINE IN 2019
- CONTEXT IN TERMS OF OTHER MATERIALS/BIG PICTURES

CHALLENGES OF SAMPLING FOR PFAS

- IT'S EVERYWHERE, AND...
- ANALYTICAL RESULTS ARE IN THE **PARTS PER TRILLION & BILLION**
 - EPA STANDARD FOR DRINKING WATER = 70 PARTS PER TRILLION (COMBINED PFOA & PFOS)
 - EXAMPLE - SCREENING CONCENTRATIONS FOR MAINE RESIDUALS:
 - 2.5 PPB – PFOA
 - 5.2 PPB – PFOS
 - 1.9 PPM – PFBS



MORE CHALLENGES OF SAMPLING FOR PFAS

- ON THE DAY OF SAMPLING YOU CAN'T:
 - SHOWER WITH SOAP
 - APPLY LOTION
 - FLOSS YOUR TEETH
 - WEAR HALF OF YOUR REGULAR OUTDOOR CLOTHING
 - EAT OR DRINK ANYTHING!

(JUST KIDDING ABOUT THE EATING PART....SORT OF)



ANOTHER PFAS SAMPLING
CHALLENGE...LOSING YOUR NON-
GORETEX BOOT IN THE MUCK

SOME PFAS SAMPLING NO-NO'S

(NOT AN EXHAUSTIVE LIST)

- GORE-TEX & OTHER WATERPROOF FABRICS
- MOST SUNSCREENS & INSECT REPELLANTS
- CLOTHES THAT HAVE BEEN WASHED FEWER THAN 6 TIMES SINCE PURCHASE
- CLOTHING LAUNDERED WITH FABRIC SOFTENER
- POST-IT NOTES
- PLASTIC CLIPBOARDS
- CHEMICAL (BLUE) ICE PACKS
- ALUMINUM FOIL



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PFAS SAMPLING REQUIRES SOME PLANNING AHEAD



- IDEALLY, NEED AT LEAST 1 WEEK OF LEAD TIME TO:
 - IDENTIFY AN **APPROVED LAB** & ORDER SAMPLING SUPPLIES FROM THEM
 - DETERMINE FIELDS TO BE SAMPLED, OBTAIN **MAPS & LANDOWNER PERMISSION**
 - PICK A SAMPLING DAY WITH **GOOD WEATHER** AND COORDINATE A COURIER PICK-UP
 - **GATHER** SAMPLING SUPPLIES / **DECONTAMINATE** EQUIPMENT

SUPPLIES & EQUIPMENT



- STAINLESS STEEL BOWLS
- STAINLESS STEEL SPOONS
- TILE SHOVEL
- SAMPLE CONTAINERS & COC FROM LAB
- NITRILE GLOVES
- FIELD DECON KIT: TAP WATER, DISTILLED WATER, PFAS-FREE WATER, ALCANOX SOLUTION, BRUSH, SPONGE, ZIPLOC BAGS
- COOLERS WITH ICE
- A VEHICLE LARGE ENOUGH TO FIT ALL OF THIS CRAP

SAMPLING PROCEDURES FOR SOIL

- DIG A HOLE 10" DEEP
- USE THE "DIRTY" SPOON TO SCRAPE AWAY THE SOIL THAT CAME INTO CONTACT WITH SHOVEL
- USE THE "CLEAN" SPOON TO SCOOP A COLUMN OF SOIL FROM THE SIDE OF THE HOLE FROM 8" DEEP TO THE SURFACE
- REPEAT THIS 10-20 TIMES PER FIELD, DEPENDING ON FIELD SIZE! YAY!!



EQUIPMENT DECON



- REMOVE PHYSICAL CONTAMINATION (IE, SOIL)
- RINSE WITH TAP WATER, SCRUB WITH ALCANOX
- THEN BEGINS THE ENDLESS RINSING WITH THE 3 TYPES OF WATER! WOO HOO!!
 - 3 RINSES WITH TAP WATER
 - 3 RINSES WITH DISTILLED WATER
 - 3 RINSES WITH PFAS-FREE WATER

QUALITY CONTROL MEASURES



- FIELD BLANKS AND EQUIPMENT BLANKS – THE BEST PART OF SAMPLING!
- MAINE DEP REQUIRES 1 FIELD BLANK & 1 EQUIPMENT BLANK PER SAMPLING EVENT

COST CONSIDERATIONS

- AN EXPERIENCED 2-PERSON TEAM CAN AVERAGE 30 – 45 MINUTES PER FIELD **IF** FIELDS ARE 10 ACRES OR LESS & CLOSE TOGETHER
- COST OF ANALYSIS FOR SOIL IS \$235-\$300 PER SAMPLE
- QUALITY CONTROL MEASURES SUCH AS FIELD & EQUIPMENT BLANKS ARE ~ \$175 PER SAMPLE. “EXTRACT & HOLD” IS AN OPTION FOR REDUCING COSTS IF ACCEPTABLE TO STATE REGULATORS.

MAINE BIOSOLIDS/COMPOST RESULTS

		PFOA	PFOS
Maine Data – Biosolids and Biosolids-Based Soil Amendments - Sample number = 49			
		<i>ug/kg (ppb) dry wt. basis</i>	
Median		2.8	15
Maximum		35	120
Minimum		0.6*	2.1
Maine Screening Std.		2.5	5.2
NEBRA data compilation	Avg.	5	14
2001 US biosolids **	Avg.	34	403

No clear trends in types of processing/size of plant v. PFAS concentrations

Voluntary phase out of PFOA and PFOS use in US → lower levels in the environment

* six samples were below the LOD for PFOA

** Venkatesan, A.K., R.U. Halden. 2013. J. Hazard Mater. Based on analysis of archived samples from the 2001 national sewage sludge survey

SOIL RESULTS FROM FIELDS AMENDED WITH CLASS B BIOSOLIDS

	PFOA	PFOS
Maine Data – Soil Concentrations from Agricultural Fields, n=29		
	<i>ug/kg (ppb) dry wt. basis</i>	
Median	1.9	6.1
Maximum	12.9	20.9
Minimum	1.1*	2.13
Maine Screening Std.	2.5	5.2

* six samples were below the LOD for PFOA

Current soil concentrations are reflective of higher concentrations from past applications

RESUMPTION OF DISTRIBUTION/LAND APPLICATION

- **COMPOST BLENDING FOR TOPSOIL MANUFACTURING**

	Compost	Loam	Manufactured Topsoil
% solids	79.3%	85.0%	84.2%
Density (pounds per cubic yard)	809	2400	1870
ratio by volume	1	2	NA
wet weight in mix	14.4%	85.6%	
dry weight in mix	13.6%	86.4%	
PFOA (ug/kg dry wt.)	7.0	0.52	
PFOS (ug/kg dry wt.)	10.1	1.10	2.3

Using soil background PFAS concentrations from VT DEC study (Zhu et al 2019. *PFAS background in Vermont shallow soils*) as level in loam in the loam/compost blend.

- **COMPOST LAND APPLICATION (APPLICABLE TO OTHER TYPES OF CLASS A BIOSOLIDS)**

PFAS Compound	Result	Screening Std.	Years to reach std.	Increase from background (VT data)
	<i>ug/kg dry wt.</i>		<i>@ 20 tons/acre</i>	<i>% after 1-year application</i>
PFBS	1.74	1900	NA	NA
PFOA	7.04	2.5	27.8	17.3%
PFOS	10.1	5.2	40.3	11.7%

RESUMPTION OF DISTRIBUTION/LAND APPLICATION

- CUMULATIVE LOADING CALCULATION FOR LAND-APPLICATION ON AGRICULTURAL FIELDS

PFOS Concentration In Soil Using Site-Specific Background	
Current Soil Concentration (ug/kg)	2.13
PFOS concentration in biosolids (ug/kg)	17.8
PFOS soil increase per year (ug/kg)	0.04
% background increase from 1 application	1.84
Number of Years Residual Applied	PFOS Conc in Soil After Application (ug/kg)
1	2.17
2	2.21
3	2.25
4	2.29
5	2.33

MILK AND FORAGE

In the spring and summer of 2019 the Maine Dept. of Ag and NEBRA analyzed milk and forage from a combined four farms that have used biosolids on a regular basis as a soil amendment. All PFAS compounds analyzed (PFBS, PFOA and PFOS) were below analytical reporting limits in all samples. This in contrast to detections in milk and forage results for one farm in southern Maine with significant levels of PFAS in milk and forage that which the Maine DEP believes is likely from an industrial material applied at the farm.



RESULTS FROM OTHER MEDIA

There has been a significant decrease in the concentration of PFOA and PFOS in the US population over the last 2 decades

		PFOA	PFOS
		<i>ug/kg (ppb) dry wt. basis</i>	
Human Blood - US population 1999 (CDC NHANES)		5	30
Human Blood - US population 2012 (CDC NHANES)		2	6
Dust in US Daycare Centers (Strynar and Lindstrom, 2008)		142	201
Household compost (Europe, Brandli et al 2007. J. Env. Monitoring)	median	6 (sum of PFAS)	
Vermont Background Soil conc. (Zhu et al 2019, by UVM for VT DEC)	Avg.	0.52	1.1
Concealer/Foundation cosmetic (Danish EPA 2018)	Up to	2370	

RESULTS FROM OTHER MEDIA

From Choi et al. 2019. *Perfluoroalkyl acid characterization in U.S. municipal organic solid waste composts.*

Environmental Science & Technology Letters

Letter

Note that the PFOA level in several of these non-biosolids composts would be higher than the Maine screening standard of 2.5 ppb)

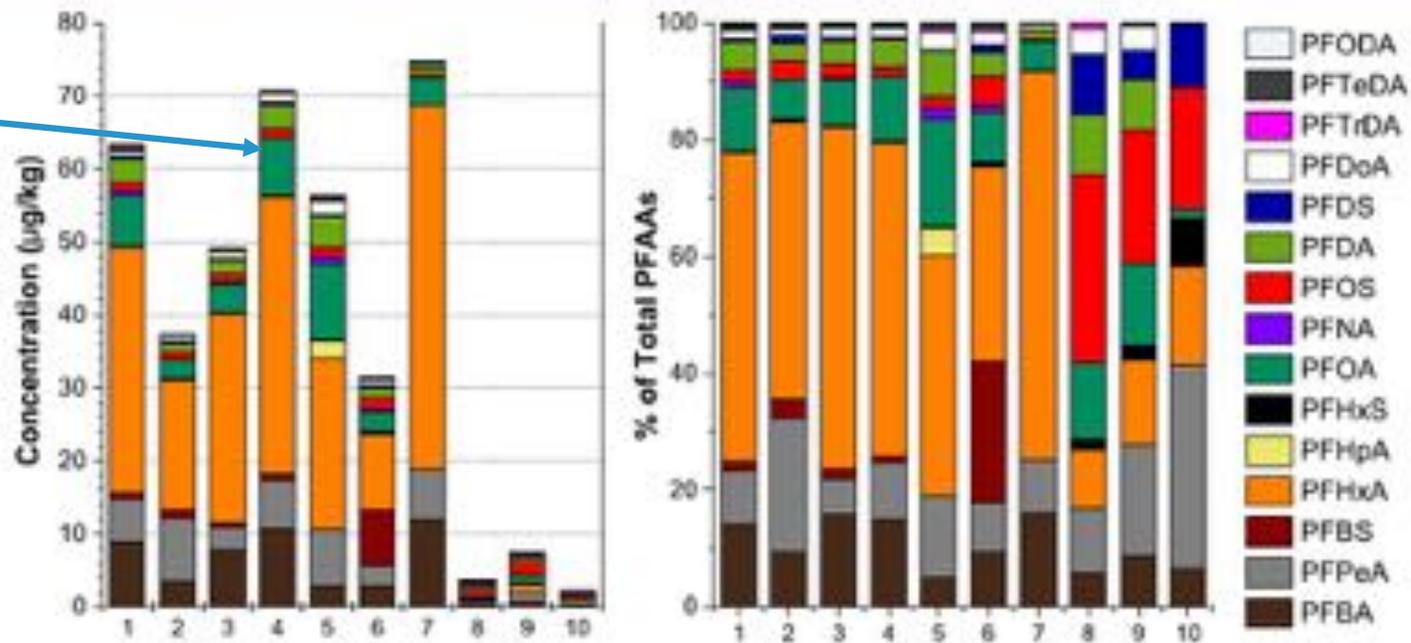


Figure 1. PFAA concentrations quantified (micrograms per kilogram oven-dried, <2 mm) in the compost (left) and the relative contribution (percent) of each PFAA to the total PFAAs quantified for composts 1–10 (right).



PFAS IN THE LARGER CONTEXT OF USING ORGANIC WASTES TO BUILD SOIL HEALTH AND FERTILITY

WHY PFAS IS DIFFERENT THAN SOME OF THE OTHER PAST CHALLENGES

- ANTIBIOTICS
- RESIDUALS PESTICIDES
- TRACE METALS
 - CADMIUM IN PHOSPHORUS SOURCES
 - ARSENIC IN CHICKEN MANURE
 - ZINC IN WOOD ASH

DIFFERENCES BETWEEN FARM WITH IMPACTS AND GENERAL PRACTICES AND SOIL LEVELS

WHAT WE'VE LEARNED

- ROBUST SAMPLING PLAN IS NECESSARY TO SAMPLE FOR PFAS IN ALL ENVIRONMENTAL MEDIA, DUE TO BOTH THE UBIQUITY OF THE COMPOUND IN CONSUMER PRODUCTS AND THE HIGH STAKES RELATED TO THE RESULTS
- BIOSOLIDS PFAS LEVELS APPEAR TO BE DECREASING OVER TIME, HOWEVER WITH CURRENT MAINE STANDARDS, LEVELS FOUND IN CONTEMPORARY BIOSOLIDS AND BIOSOLIDS PRODUCTS CONSTRAIN PROGRAMS IN WHICH THE MATERIALS ARE RECYCLED AS SOIL AMENDMENTS
- IN THE LARGER CONTEXT OF THE GLOBAL CARBON CYCLE AND SOIL HEALTH, IT IS IMPORTANT TO APPROACH THE ISSUE OF PFAS OCCURRENCE IN ORGANIC WASTES IN A REGIMENTED, DELIBERATE MANNER