

An Overview of Biosolids Science and Research

Virginia Biosolids Council Info Session
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Greg Evanylo

School of Plant and Environmental
Sciences, Virginia Tech

Introduction

- Restoration of degraded soils may be accomplished with locally-generated EQ biosolids.
- Objective: Evaluate EQ biosolids in field studies



Urban Garden Field Study

Odiney Alvarez-Campos; SPES, VT

- Objectives: To compare the effects of various EQ biosolids products and inorganic fertilizer on:
 - Vegetable crop yield
 - Soil chemical properties
 - Leachate nitrate concentrations

Urban Garden Field Research

Clay soil texture
pH = 7.73
3 ppm P (very low)
56 ppm K (medium)



Treatments: Soil Amendments

- **Fertilizer** – N, P, K (soil test recommendations)
- **Bloom** – dewatered, air-dried, cured – **1x & 5x** ag N rate
- **Bloom + Mulch blend** – **1x & 5x** ag N rate
- **Biosolids compost** – **1x & 5x** ag N rate
- **Heat-dried, pelletized biosolids** – **1x** ag N rate



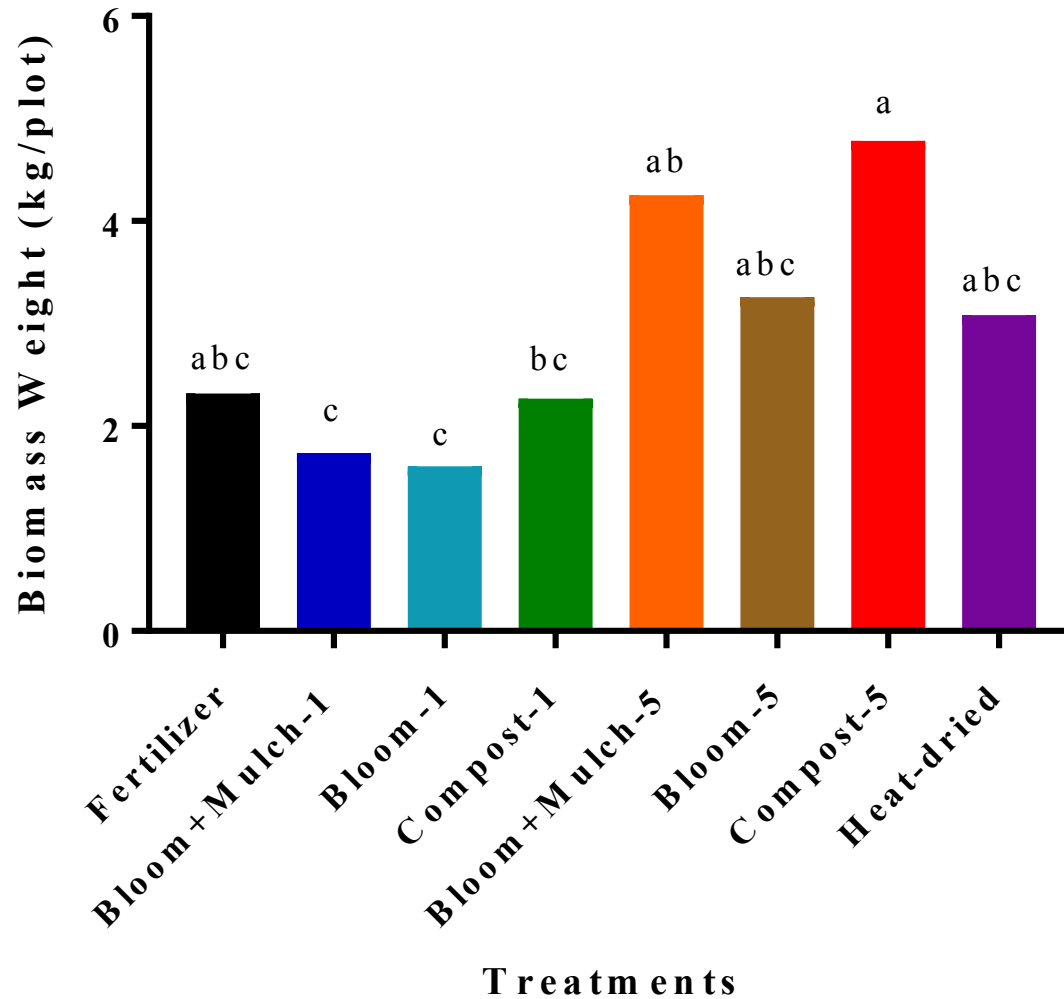
EQ Biosolids Composition

Parameter	Heat-dried	Bloom	Bloom + Mulch	Compost
Organic N (%)	4.34	2.89	2.34	2.46
Inorganic N (%)	0.57	0.31	0.53	0.43
P (%)	2.66	3.09	1.89	1.33
Fe (%)	3.28	8.26	5.44	2.67

Fall 2016 Vegetable Production



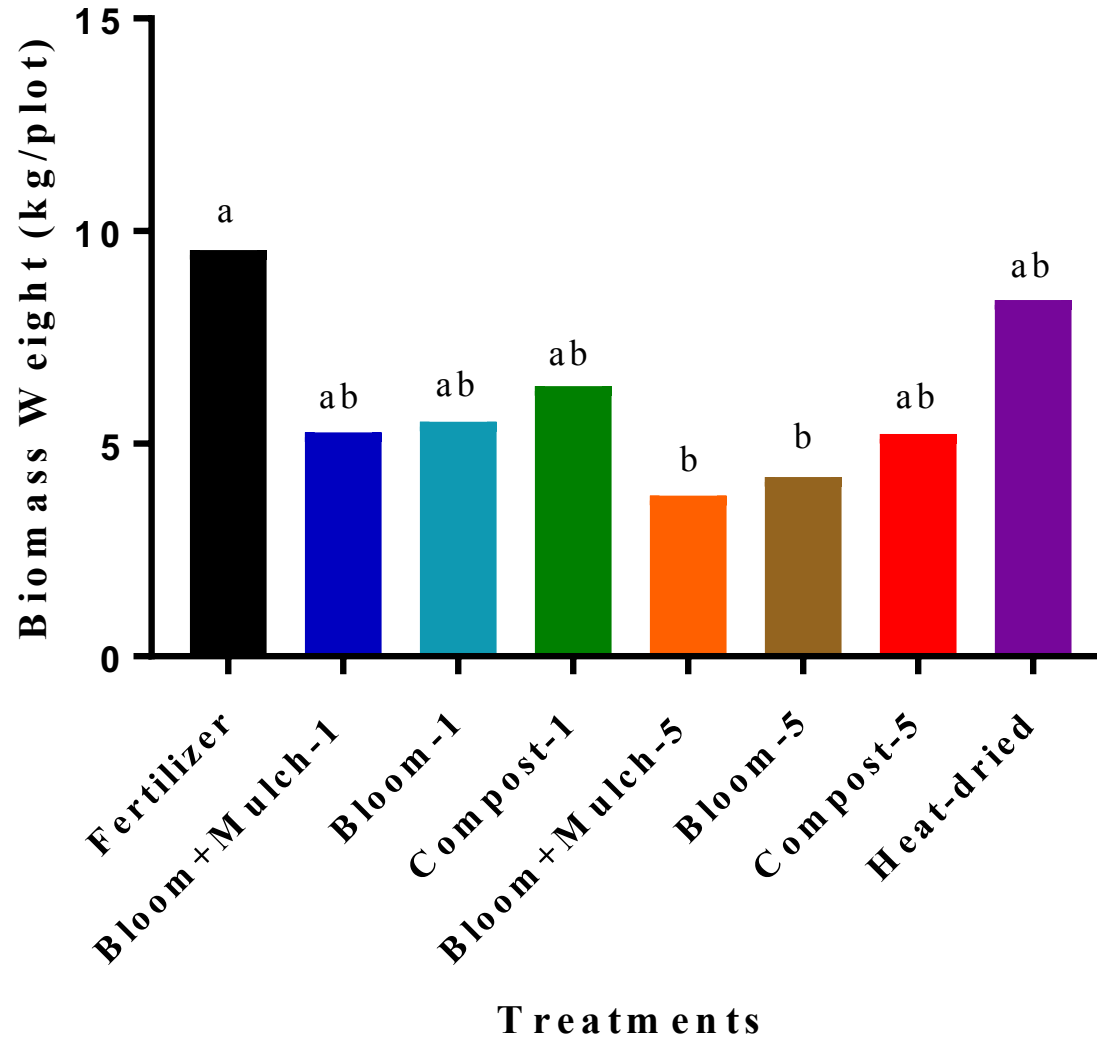
Results: Cabbage yield





Summer 2017 Vegetable Production

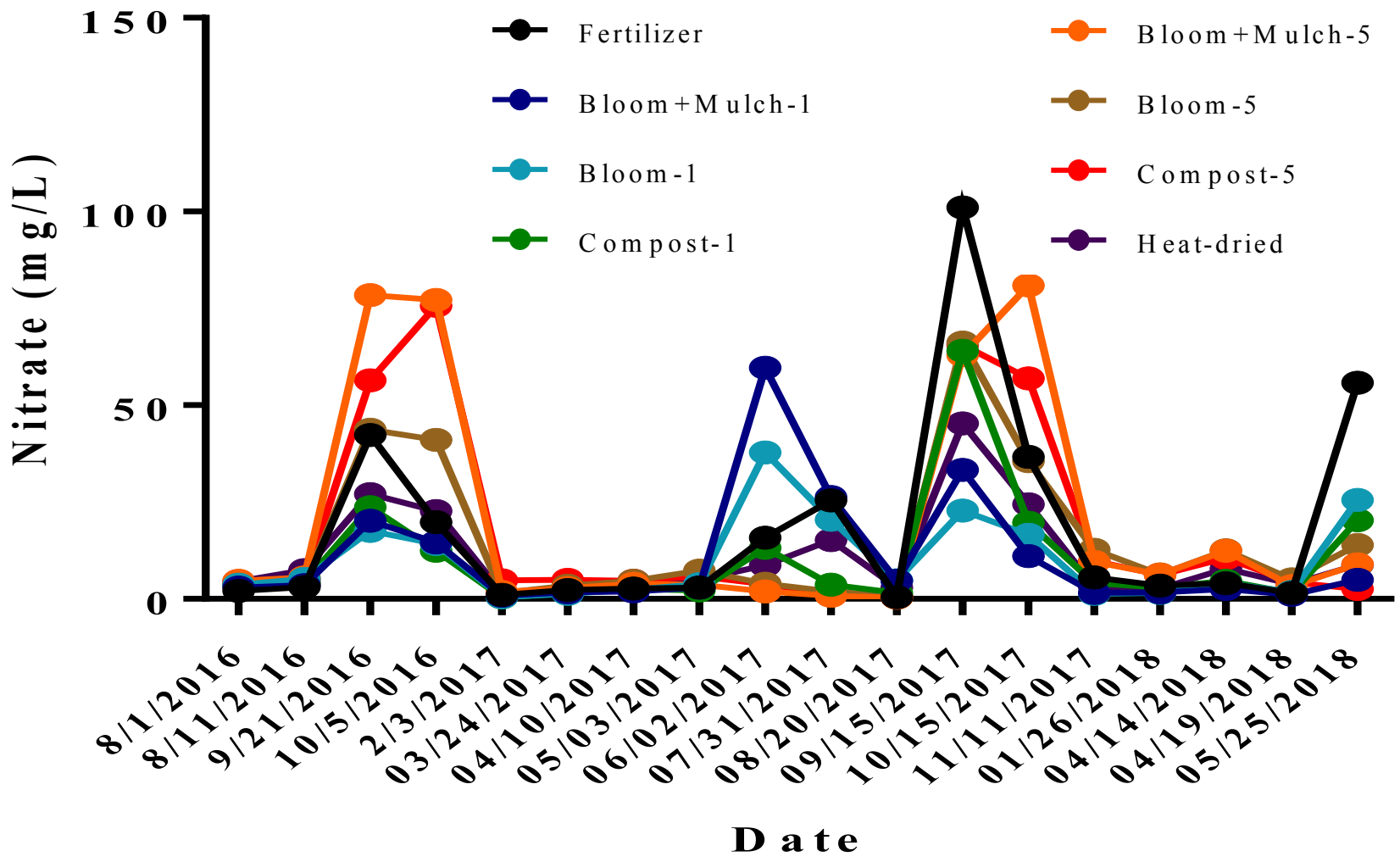
Results: Zucchini yield



Soil P (Jul 2017) and C (Oct 2017)

Trts	P added	Olsen P	SOC
	lbs P/ac	ppm	%
Fert	165	39 ab	0.72 b
BM-1x	556	20 c	1.1 b
Bloom-1x	1035	38 ab	1.2 b
Compost-1x	396	25 c	1.1 b
BM-5x	1450	29 bc	2.2 a
Bloom-5x	1964	43 a	1.9 a
Compost-5x	953	37 ab	2.0 a
Heat-dried	271	24 c	0.78 b

Treatment effects on Nitrate-N Loss

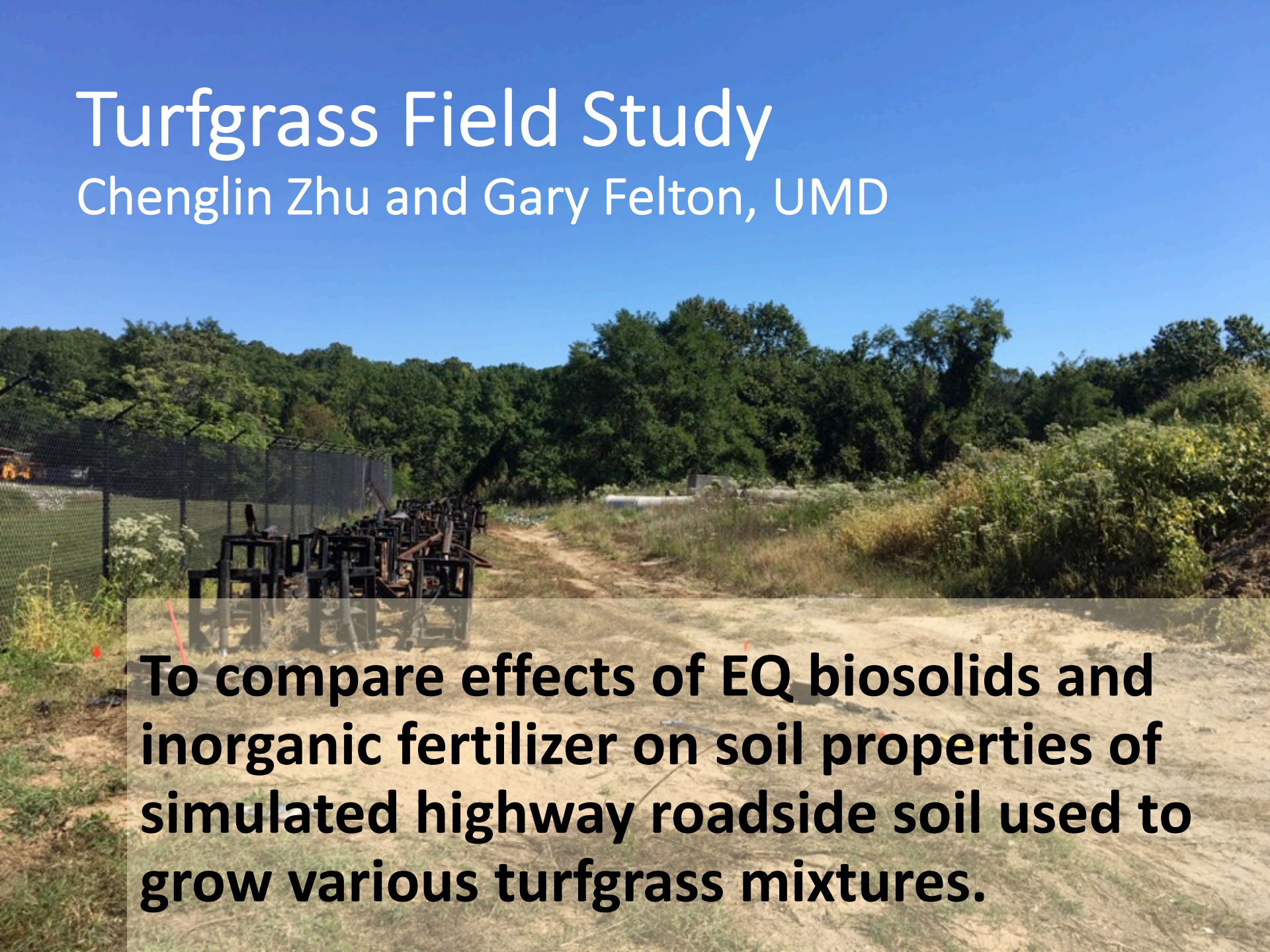


Treatment Effects on Nitrate-N Mass Loss

Treatment	N (lbs/ac)
Fertilizer	109 ab
Bloom+Mulch-1	58 b
Bloom-1	60 b
Compost-1	61 ab
Bloom+Mulch-5	122 a
Bloom-5	93 ab
Compost-5	105 ab
Heat-dried	64 ab

Turfgrass Field Study

Chenglin Zhu and Gary Felton, UMD



To compare effects of EQ biosolids and inorganic fertilizer on soil properties of simulated highway roadside soil used to grow various turfgrass mixtures.

Amendments (5)

Bloom

BSS

BM

Compost (deer)

Fertilizer

Turfgrass mixes (2)

MD SHA & residential blends

Amendments- 5x agron N rate

Study established fall 2016

4 replications

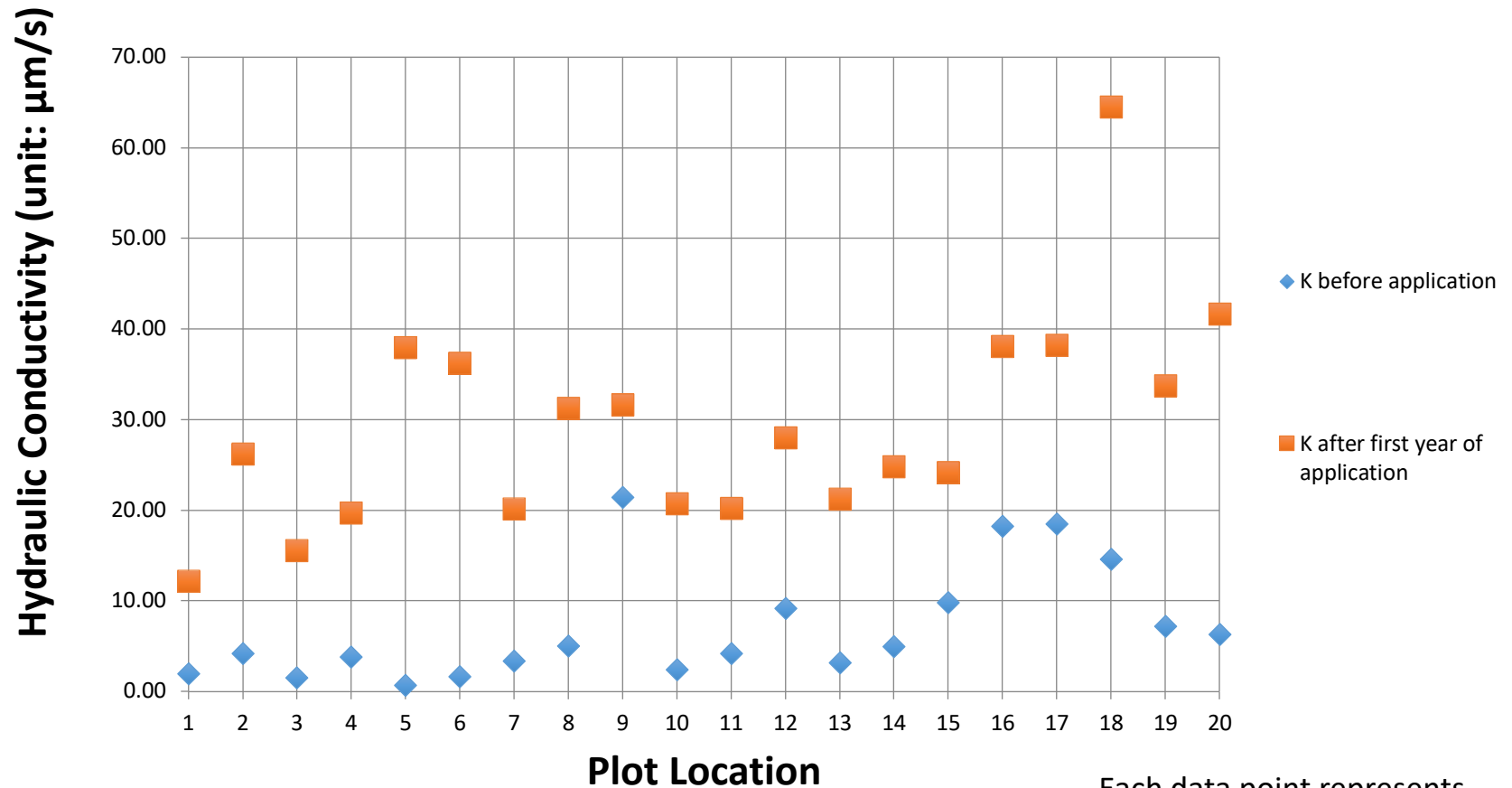


Grass and Soil Samples Collected in July 2017

Soil organic carbon increased
from 1.22 to 2.58 % with amendments.

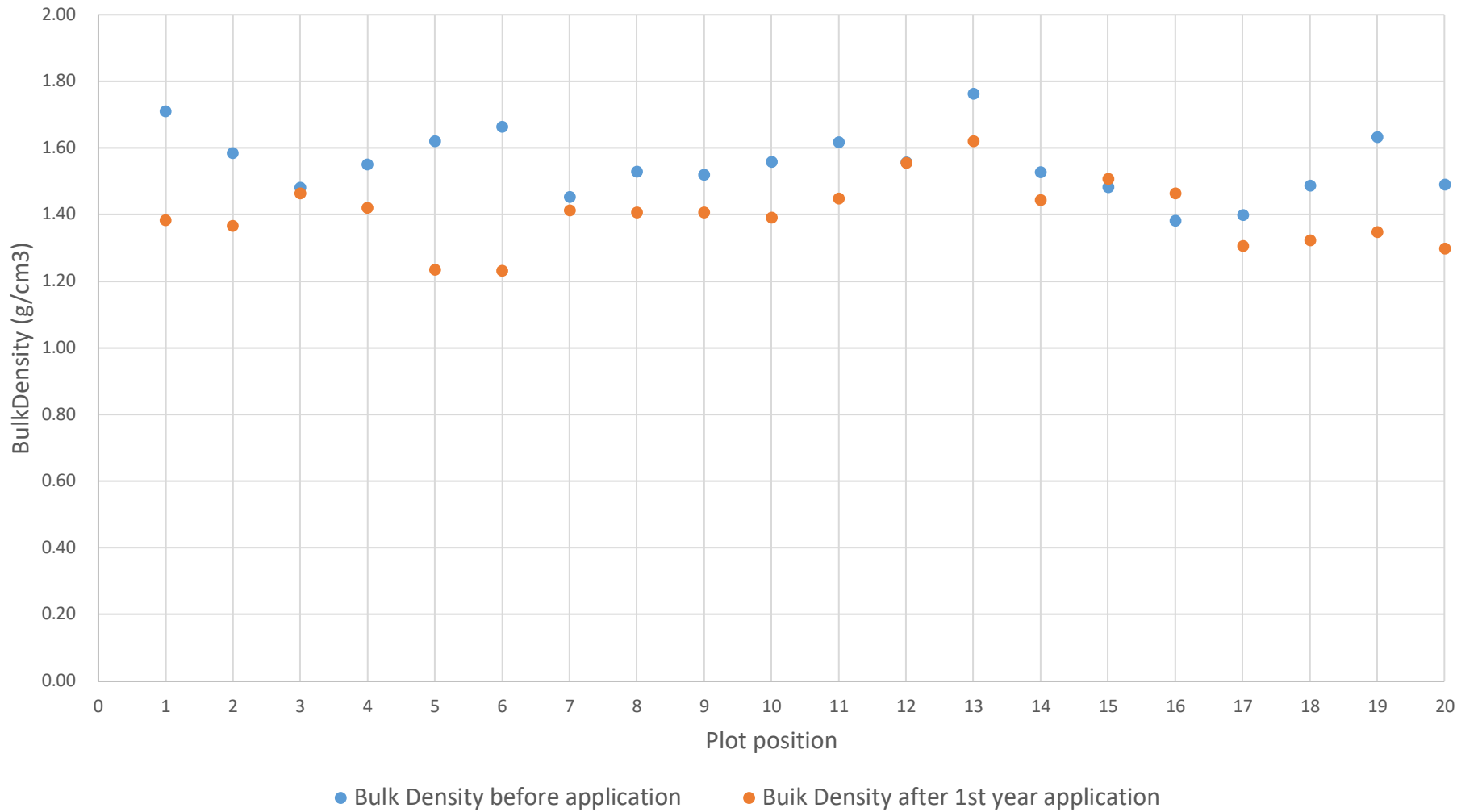
Saturated Hydraulic Conductivity Effects

Ksat before and after Year 1 applications

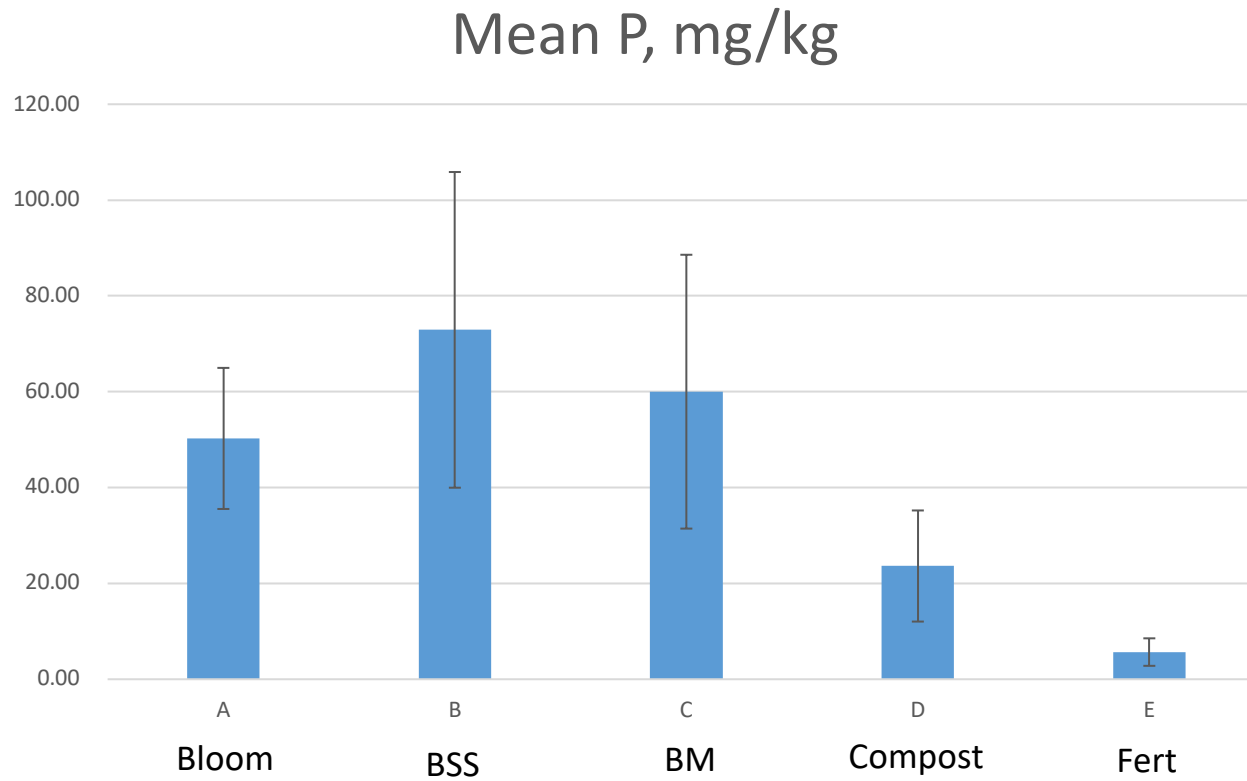


Each data point represents average of four plots.

Temporal Soil Bulk Density



Treatment Effects on Mehlich 3 Soil P



Field Study Conclusions

- EQ biosolids products may be applied to disturbed urban soils at mineland reclamation rates with relatively low nitrate N leaching and P runoff risks.
- Higher EQ biosolids application rates may support better plant growth in urban, low fertility soils.

THANKS TO



Water Environment Research Foundation
Collaboration. Innovation. Results.



Metropolitan Washington
Council of Governments

W3170 Research Updates

- Revisited Time Bomb Effect in honor of retirement of Tom Granato, MWRDGC
 - Granato, Tian, Cox, Evanylo, Ippolito, Chaney
- USEPA screening tool – Liz Resek
 - 250 additional pollutants in biosolids to be considered for risk modeling/screening; tool should be ready to use shortly
- PFAAs – Purdue University

Per- and Polyfluoroalkyl Acids (PFAAs) in Waste-derived Fertilizers

Rooney Kim Lazcano *et al*

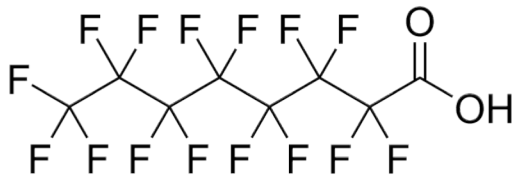
Ph.D. Candidate

Ecological Sciences and Engineering Interdisciplinary Program

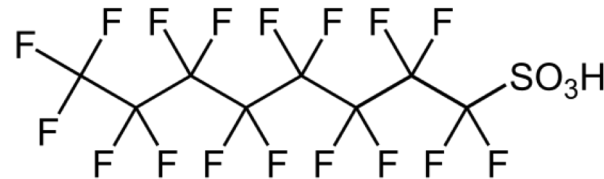


Poly- & perfluoroalkyl substances (PFASs) today's 'elephant in the room'

- PFASs with chain lengths from 4 to 16 C



PFOA C8: Perfluorooctanoic acid

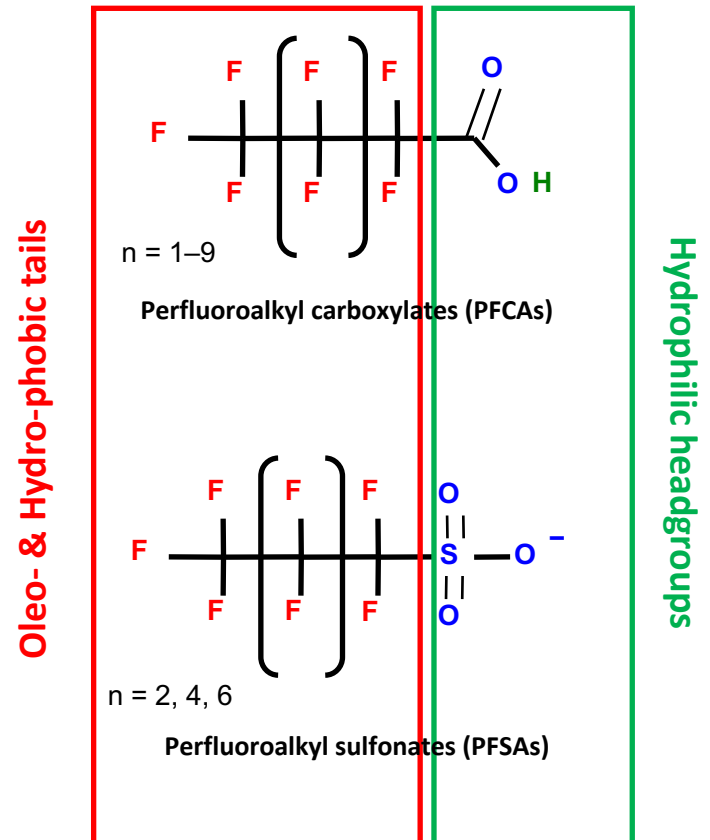


PFOS C8: Perfluorooctane sulfonic acid

- Ubiquitous (5-60 ng/mL avg in blood in 2012)
- Terminal microbial metabolites
- Persistent like PCBs BUT much more mobile
- Level of concern are at the ppt level

Per- and polyfluoroalkyl acids (PFAAs)

- Anthropogenic chemicals
 - Hydrophilic and lipophobic
 - High chemical and thermal stability
 - Lower surface tension
- Usage:
 - Stain-resistant carpets and fabrics
 - Non-stick cookware
 - Flame retardants
 - Aqueous film forming foams

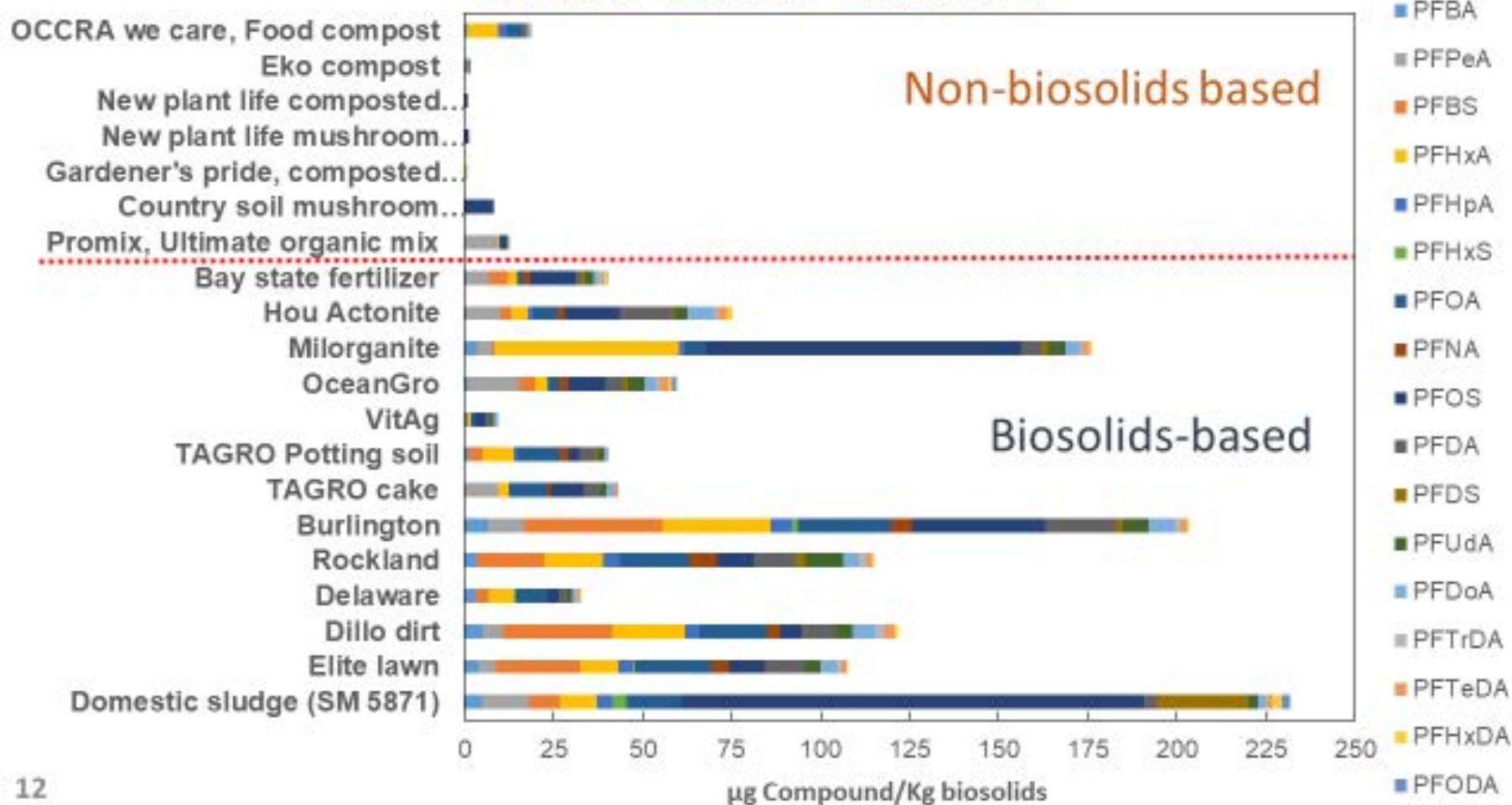


Type of the fertilizers

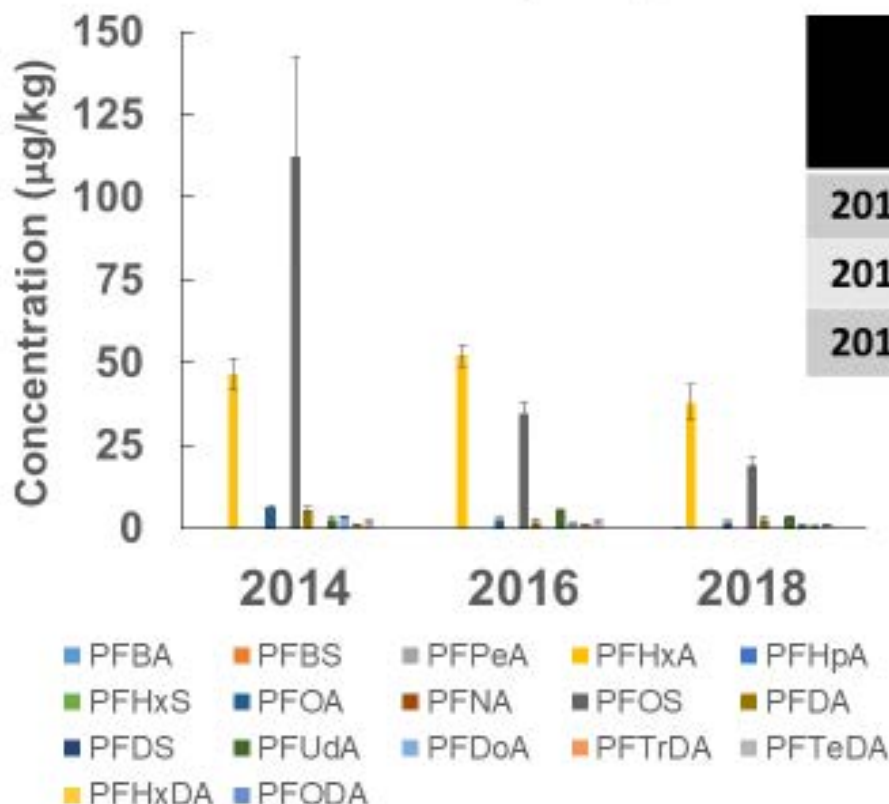


Brand name	Description
Bay State Fertilizer	Tumble-dried granular biosolids
Hou-Actinite	Granular biosolids
Milorganite	Heat-dried granular biosolids
OceanGro	Granular biosolids
VitAg	Granular biosolids
Elite Lawn	Biosolids with plant material (composted)
Dillo Dirt	Biosolids with residential yard trimmings
Delaware biosolids	Biosolids
Rockland biosolids	Biosolids with woodchips
Burlington biosolids	Biosolids with wood, yard and food waste
TAGRO potting soil	Biosolids with maple sawdust and aged bark
Promix	Peat/compost based growing mix
Country soil	Mushroom compost
New plant life mushroom	Mushroom compost
New plant life manure	Manure and peat
Gardener's pride	Manure
EKO compost	Compost with untreated wood products
OCRRA, WeCare	Food compost

Result: Fertilizer Extraction



The short-term temporal trends of PFAAs concentrations in Milorganite (sampled 2014, 2016 & 2018)



	Total Conc. Short chain ($\mu\text{g}/\text{kg}$)	Total Conc. Long Chain ($\mu\text{g}/\text{kg}$)	Total Conc. of PFAAs ($\mu\text{g}/\text{kg}$)
2014	46.6	132.8	179.4
2016	52.2	48.6	100.8
2018	38.6	29.2	67.8

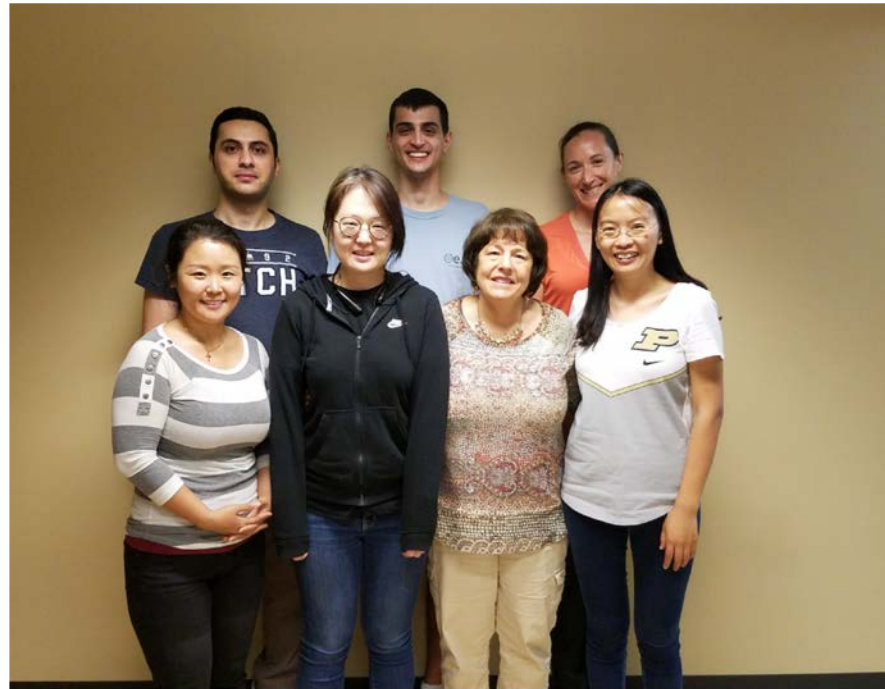
- **~44% reduction** in the **total PFAAs concentration** between 2014 and 2016
- **~33% reduction** between 2016 and 2018
- Substantial decrease in PFOS conc. as well as the total conc. of the long chain PFAAs

Summary

- Commercial biosolids-based fertilizers contain higher concentrations of total PFAAs than nonbiosolid-based fertilizers.
- Compost-based fertilizers with food have higher PFAAs concentrations than w/o food due to potential contamination during food processing.
- The total concentrations of PFAAs, especially long chain PFAAs, has decreased from 2014 (Milorganite).

Acknowledgement

- Dr. Linda Lee
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- Heather Trim on behalf of Zero Waste Washington
- Purdue Lynn Fellowship
- USDA – Agriculture and Food Research Initiative Competitive Grant
- DuPont



W3170 Research Updates

- Trace organics – George O'Connor, UF
 - Thermal drying, composting reduce antibiotic conc's
 - Possible 15th risk pathway – ARGs
 - Predators at greatest risk for bioavailable tr orgs

WWTP nutrient recovery
by micro-algae for
bio-plastic production
– Kuldip Kumar, MWRDGC



W3170 research Updates

- WERF project odor – Chip Elliott, PSU
- Remediation of Pb-contaminated urban soils with biosolids and other P-containing residuals – Nick Basta, OSU
- EQ product development from SF Biosolids - Manon Fisher, SFPUC & Sally Brown, UW
- Soil health – Jim Ippolito, CSU
- Regional and state association reports
 - Fisher, Kester (CASA), Maile Lono-Batura (NW Biosolids), Andrew Carpenter (NEBRA), Bill Toffey (MABA)