nebra
North East Biosolids & Residuals Association

Recycled organics: Tools for sustainability.

CECs: Implications for Compost, PFAS in Particular

Ned Beecher, Special Projects Mgr., NEBRA

August 4, 2020

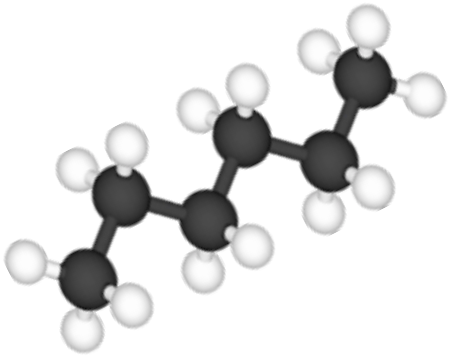
Vermont Organic Recycling Summit: 2020 &...

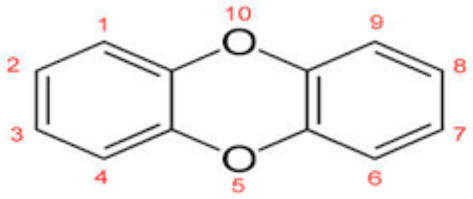
Recycling organic “wastes” benefits society & the environment.

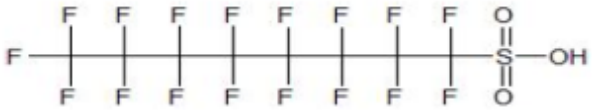
Organic residuals are treated, tested, regulated, and recycled routinely – and have been for decades. This does amazing things:

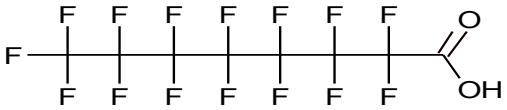
- enhances soil health
- recycles nutrients – macro & micro
- sequesters carbon (mitigating climate change)
- reduces fertilizer & pesticide use
- strengthens farm & landscape economies: thousands of landowners choose to use organic residuals, because they work!
- restores vitality to degraded lands
- puts to productive use residuals (biosolids, food scraps, yard & leaf waste, manures) that every community has to manage
- is part of the circular economy

PFAS & any emerging contaminant must be addressed in ways to continue to maximize these known benefits.









But what about *Contaminants of Emerging Concern* (CECs)?

…antibiotics to pharmaceuticals to dibenzo-p-dioxins to PFAS…

History of CECs in organics.

- Trace chemicals in composts are not new: 45+ years of research, especially focused on biosolids (e.g. PCBs, priority pollutants)
- Late 1990s, USGS research: CECs found in most U. S. streams
- Early 2000s: EPA robust dioxins/furans*-in-biosolids risk assessment
- NEBRA info: http://www.nebiosolids.org/resources/#/microconstituents/
- PPCPs
  - Medicines – hormones, drugs for disease & pain management, homeopathic drugs, vitamins & other health supplem
  - Hygiene – soaps, detergents, hand saniti
- Persistent herbicides (e.g. clopyralid)
- Microbeads,* microplastics
- Since 2016: PFAS… (e.g. PFOA*, PFOS*)

Best action to reduce potential risks?
Phase out use.
(*These are phased out.)

Concentrations of CECs in biosolids

Some of these show up in composts too...

Clark and Smith, 2010

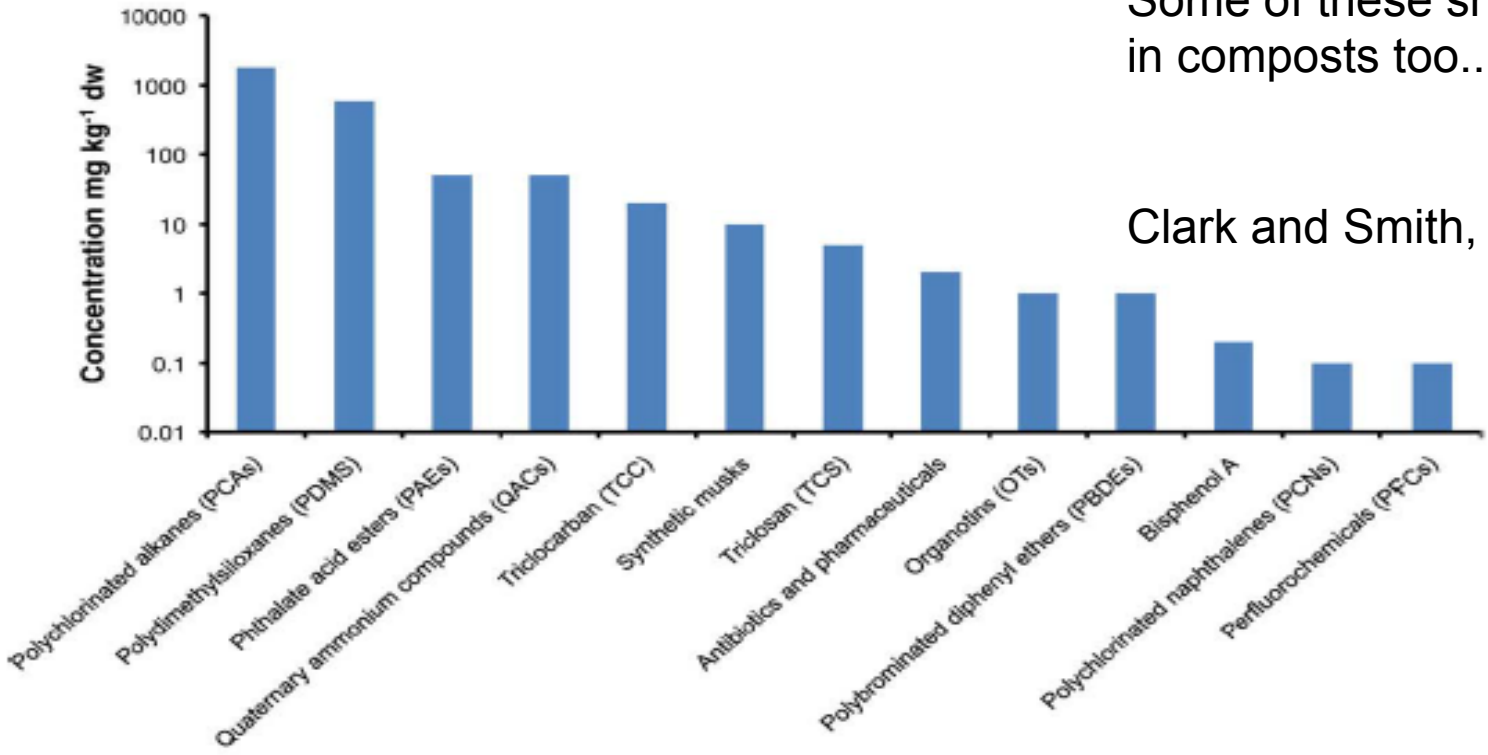


Fig. 1. Typical concentrations of selected 'emerging' organic contaminants in sewage sludge (mg kg^{-1} dw).

Much of the research on CECs is for biosolids.

- Composting certainly degrades many CECs (Buyuksonmez and Sekeroglu, 2005)
- Worst-case field application scenario with spiking of PPCPs led to measured PPCPs in tile drainage (Lappen et al., 2008)
- USGS study on fate: trace organics from biosolids & swine manure is found in worms (Kinney et al. 2008: http://toxics.usgs.gov/highlights/earthworms.html)
- No significant impact on tile drainage water quality from biosolids land application (Gottschall et al., 2012, 2013).... except when PFAS is regulated at 20 ppt....
- Low risk to human health from biosolids borne PPCPs, PBDEs, hormones and parabens, citing low rates of plant uptake and minimal impact on ground water quality (Gottschall et al. 2012, Hale et al. 2012, Sauborin et al. 2012)

CEC research: impacts

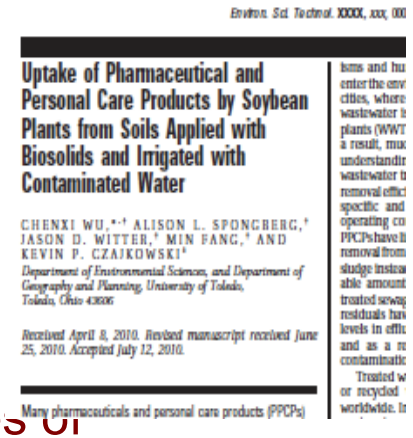
- "Maximum concentrations of PPCPs detected in effluents were generally far below toxic thresholds for a variety of endpoints drawn from the literature."
  – Topp et al., 2009 (changes when PFAS are regulated at 20 ppt)

- "Although the concentrations of, TCC, TCS, 4-NP, and total PBDEs in soil were greater in the biosolids-amended plots than in the control plots, the contaminants had no detrimental effects on the soil biota." –Hundal et al. 2009, Chicago

The details of research are important.

- Wu et al., 2010 − not representative of field conditions & actual biosolids use.
  - Showed some soybean plant uptake
  - Greenhouse study with spiked samples:

    Past research on trace metals and chemicals shows similar over-estimation of effect when spiked samples of the pollutant are used in microcosm studies
  - Context: TCS was used in toothpaste at 3,000 mg/kg
  - Wu et al. maximum measured concentration in plant (conservative scenario): 0.1 mg/kg (ppm)



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Uptake of Pharmaceutical and Personal Care Products by Soybean Plants from Soils Applied with Biosolids and Irrigated with Contaminated Water

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Many pharmaceuticals and personal care products (PPCPs)

Plant uptake: Sabourin et al. 2012

"Biosolids at application, and crop samples following harvest, were analyzed for 118 pharmaceuticals and transformation products, 17 hormones or hormone transformation products, and 6 parabens. Analyte concentrations in the biosolids were consistent with those detected in other surveys. Eight of the 141 analytes were detected in one or two crop replicates at concentrations ranging from 0.33 to 6.25 ng/g dry weight, but no analytes were consistently detected above the detection limit in all triplicate treated plots. Overall, this study suggests that the potential for micropollutant uptake into crops under normal farming conditions is low."

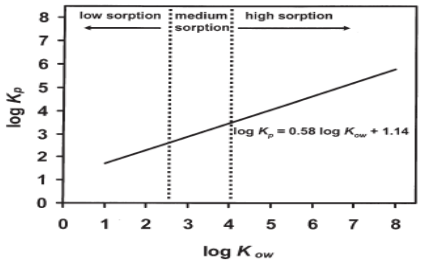
Summary of CEC concerns

The CECs that are in organics are there because they stick (e.g. to organic matter). Most remain stuck (in soil) or are broken down.

Chemicals of greatest concern in organics have…

- High log Kow - octanol-water partition coefficient
- High toxicity (to at least some species)
- Long half-lives (persistent)
- Bioaccumulative
- Dioxins/furans are example: thoroughly studied and not found to require regulation in biosolids (EPA, 2003)

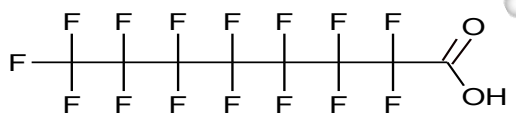
Xia et al. 2005

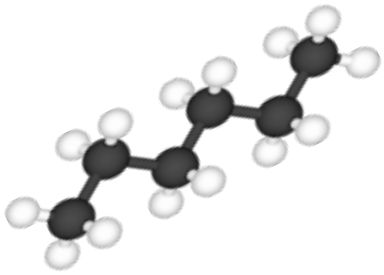


Ongoing CEC concerns being researched…

- PPCPs / Antibiotics
- Nanoparticles (both in biosolids and in other agriculture uses)
- PBDEs (flame retardants) – POPs, being phased out, are substitutes better?
- Synthetic musks – persistent, Europe limits them in biosolids/organics
- Microplastics (biosolids & composts likely not the major source on farms)

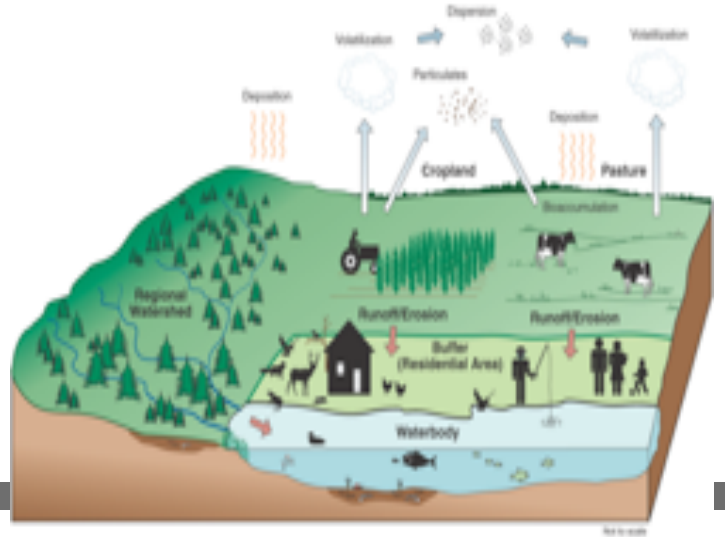
These all are relatively lower risk concerns compared to heavy metals (which have been addressed through source control) & pathogens. But PFAS?…





Risk assessment continues, but is a challenge.... and costly.

- Must prioritize (as has been done so far):
  - high production chemicals
  - most toxic
  - most persistent
- An alternative approach, is…



…Bioassays…

…a logical & efficient approach to assessing potential impacts

Addresses concern of impacts of mixtures.
Addresses concern of persistent exposure (of even short-lived compounds).
Improves understanding of the full system.

Biosolids bioassay research (McCarthy, et al., Ryerson Univ.)

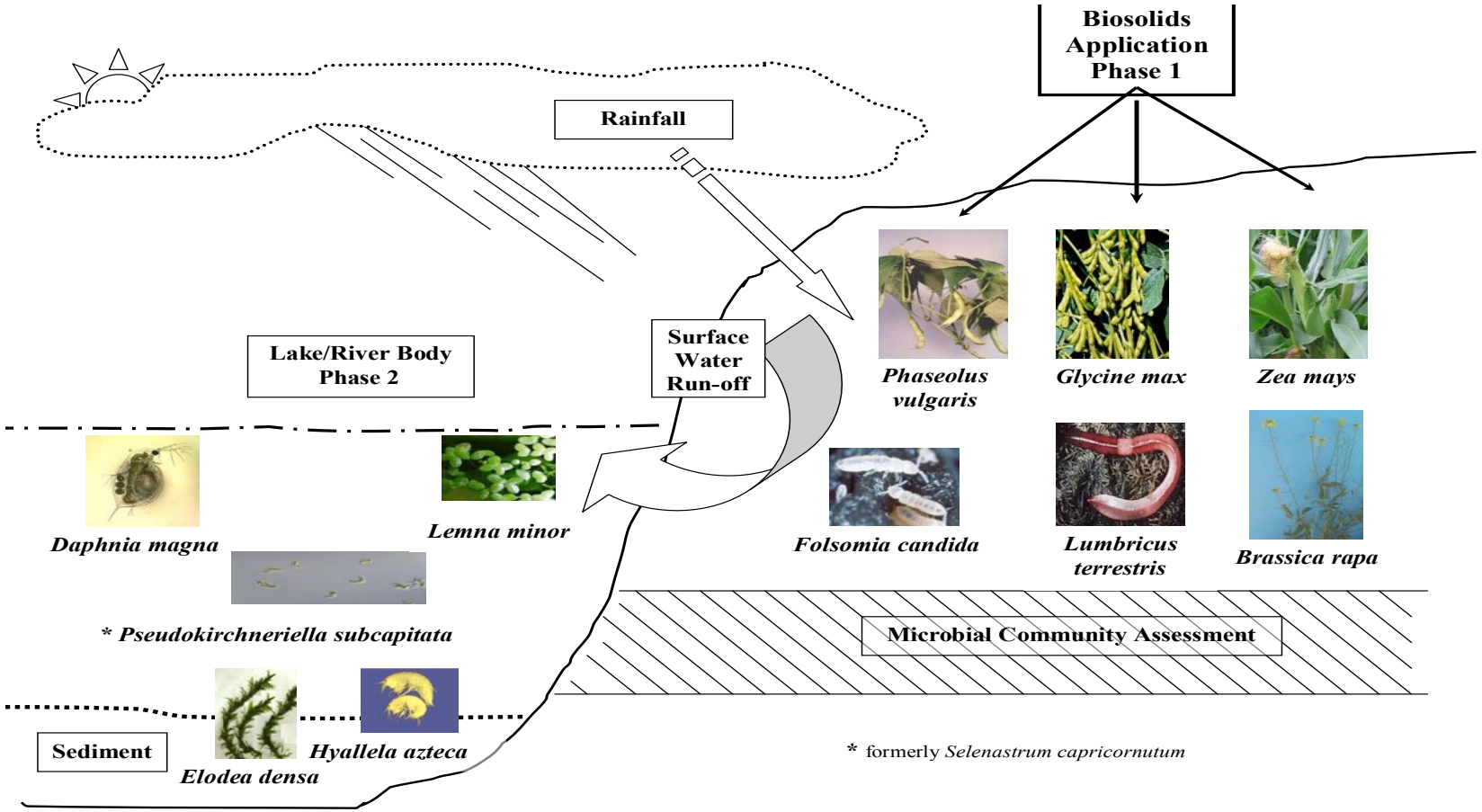


Figure 1. Possible contamination pathways and specific bioassays for the assessment of biosolids application impact.

Conclusions of Puddephat / McCarthy research:

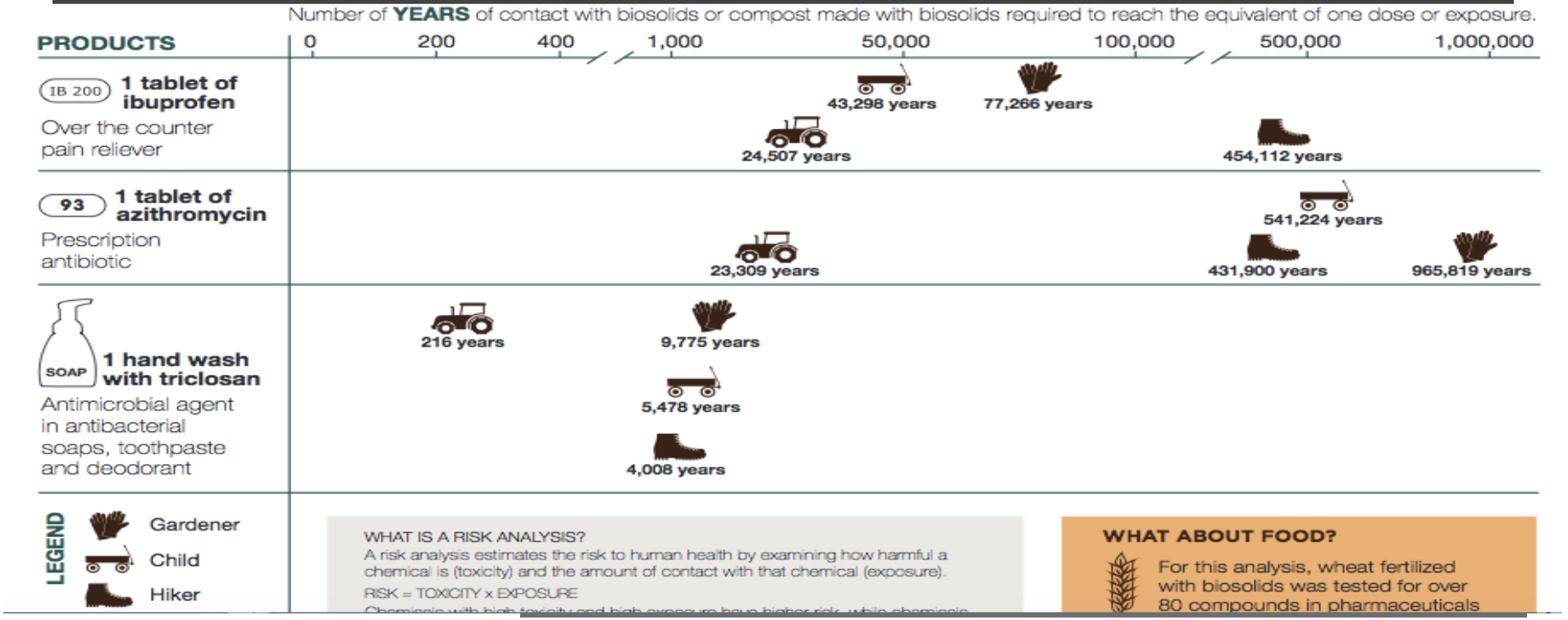
Puddephat, 2013:

"The findings showed that biosolids had little negative impact on the terrestrial biota examined and as a general rule, there was no impact observed. Where effects were observed, the majority of instances were positive. In the few instances where there was negative impact observed, for example in the initial growth stages of the plant bioassays, with further development of the organism, there was no longer a significant difference between the reference and treatment plants."

Remember: context is important.

nebiosolids.org

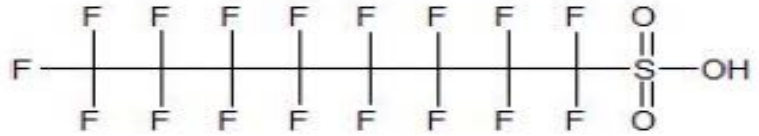
Number of years of contact to = 1 dose



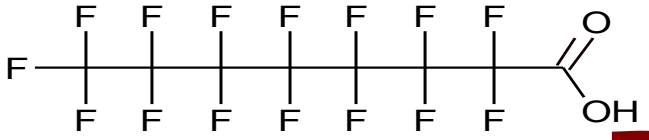
From NW Biosolids fact sheet

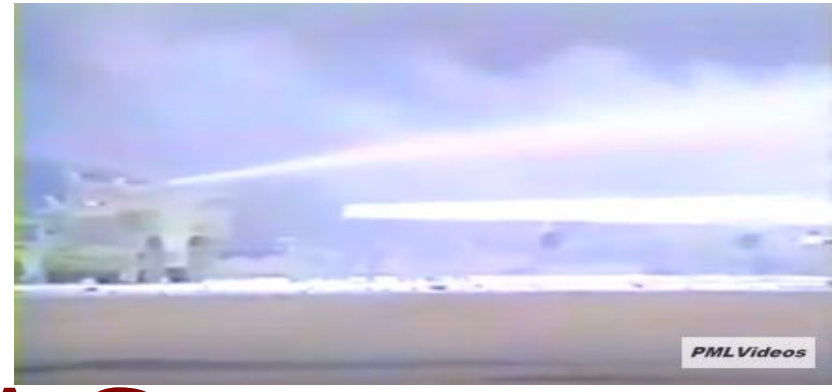
perfluorinated:

PFOS



PFOA



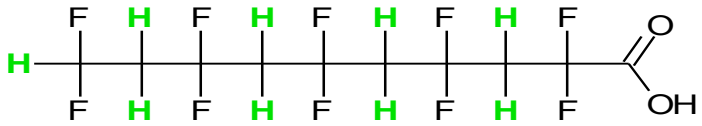


PFAS

an extreme, worst-case CEC

*the only *common* trace contaminant of drinking water regulated in low ppts*

polyfluorinated:

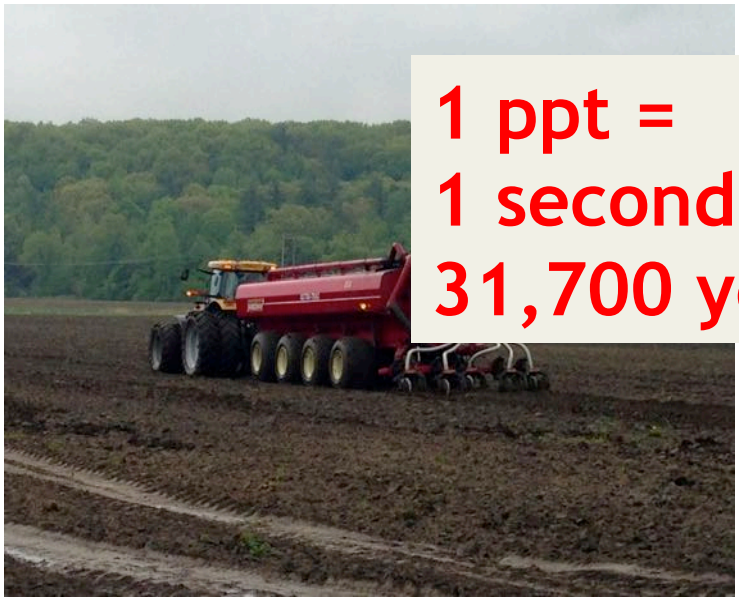


Widespread contamination + potential health concerns...

- There are hundreds of U. S. drinking water & groundwater PFAS contamination sites from industry & fire-fighting.
- Scary: “forever chemicals,” research links PFAS to to some negative health impacts
- Community groups, researchers calling for action; some states taking action. Voluntary phase-outs continue, e.g. ski waxes.
- VT is addressing PFAS aggressively, with some of the most strict water quality limits anywhere.
- See varying perspectives:
  - https://pfasproject.com/
  - https://www.ewg.org/key-issues/toxics/nonstick-chemicals
  - https://www.nebiosolids.org/pfas-biosolids
  - https://dec.vermont.gov/water/drinking-water/water-quality-monitoring/pfas
  - https://www1.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas-expert-panel.htm

PFAS are in wastewater, biosolids, & composts, because these mirror modern life.

- We are aware of them because of advances in analytical chemistry: measuring at ppt levels.



1 ppt =
1 second in
31,700 years.

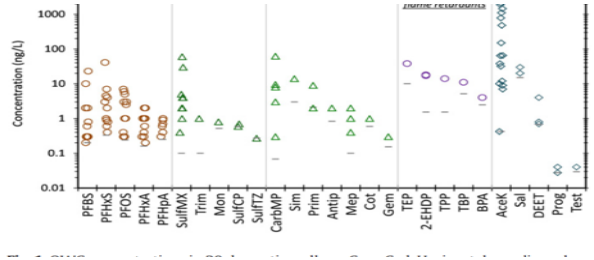
Why the concern about PFAS in organic residuals?

Regulations at background levels.

Leaching from biosolids and even food waste composts may not be able to meet these.

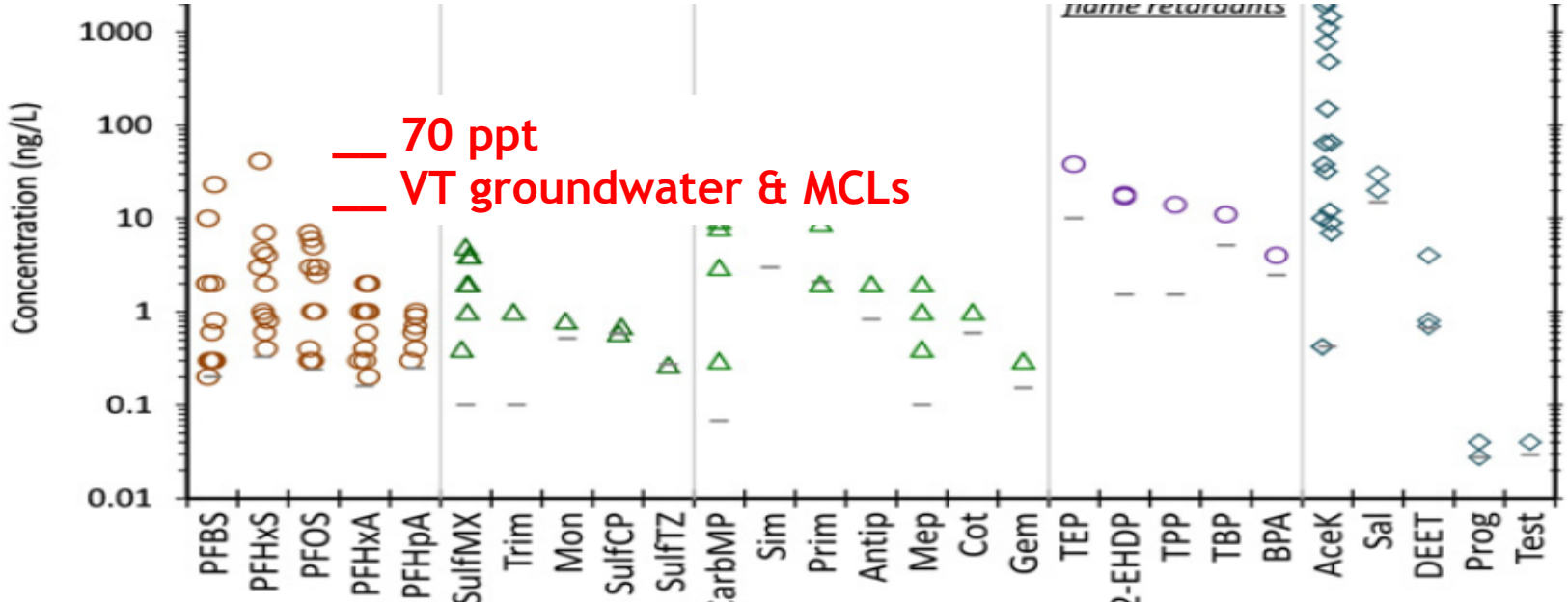
VT MCLs & groundwater quality standards:

- 20 ppt for the sum of:
  - PFNA
  - PFOA
  - PFOS
  - PFHpA
  - PFHxS



Septic systems may not be able to meet the VT MCLs:

Data showed that Cape Cod groundwater & drinking water was impacted only by septic systems; no industrial sources nearby.



* Schaider et al., 2016. Septic systems as sources of organic wastewater compounds in domestic drinking water wells in a shallow sand and gravel aquifer. *Sci. Total Environ.*

Uncertainties about PFAS

- Health implications debated
- Differences between different PFAS
- Precursors
- Analytical methods still in development
- Fate and transport in soils

Uncertainties lead to variability in regulations:

- Vermont drinking water standard (2020): 20 ppt (sum of 5 PFAS)
- Canada (Dec. 2018): PFOA = 200 ppt, PFOS = 600 ppt

More research needed. (In the meantime, address high contamination sites, and avoid impacting organics recycling programs!

There are 2 major sources of PFAS

in the environment:

- industrial discharges
- fire-fighting (including training, e.g. at military sites)

Data: PFAS contamination at industrial & firefighting sites

Examples:

1. Wolverine Worldwide Kent County tannery dump sites, Rockford, MI

   -Highest concentration is **76,000 PPT** (PFOA+PFOS)

   https://www.ewg.org/research/update-mapping-expanding-pfas-crisis

Suspected source: This area consists of a former licensed disposal facility owned and operated by Wolverine… and several unregulated dump sites across three townships in northern Kent County.

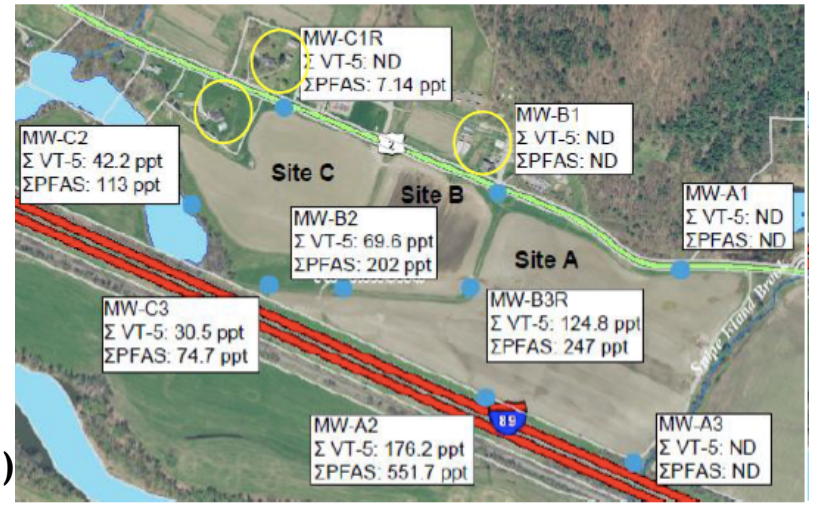
1. No. Bennington, VT

   -Highest concentration is **2,330 PPT** (PFOA only,private well, Asa Way)

Suspected source: Chemfab fabric-coating facility

Vermont: "Sewage sludge spreading leads to farm groundwater PFAS contamination:" (April 12, 2020)

https://vtdigger.org/2020/04/12/sewage-sludge-spreading-leads-to-farm-groundwater-pfas-contamination/



But...

- Only a few long-term biosolids use sites showed any potential issue.
- Levels far lower than industrial, firefighting, & military sites (e.g. 176 ppt max.)
- No significant impacts on farm products
- Biosolids are "worst-case"; food waste composts have lower PFAS.
- See NEBRA fact sheet: https://www.nebiosolids.org/pfas-biosolids

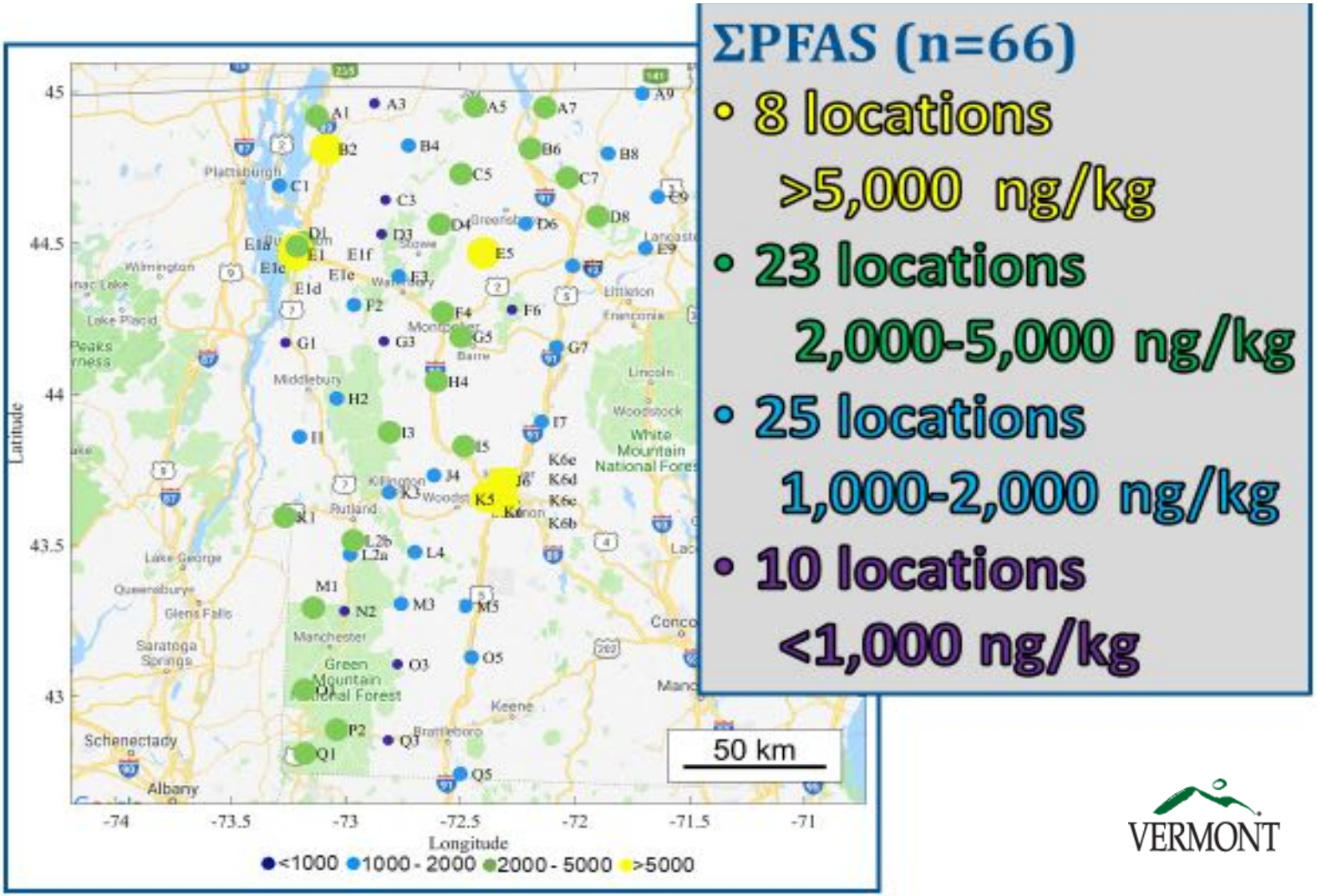
There is ambient background PFAS,...

including most wastewater & biosolids and other residuals (e.g. compost, paper mill residuals), septic (onsite) systems, solid waste management activities – receivers of PFAS, not original sources

Andrew will provide data....

PFAS in soils

Study for VT DEC 2018



VERMONT

Biosolids compost for my raspberries… I still use it, knowing it has PFAS in it. The benefits far outweigh the risks :)

Thank you.

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Acknowledgements & Sources of NEBRA PFAS slides

Inclusion on this list does not imply endorsement.

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***AND* many organizations across North America who funded NEBRA's PFAS work in 2018 - 2020.**

THANK YOU!

Start a conversation about PFAS!

- 5 Posters/Messages to engage legislators, customers, and the general public.
- 5 Bill Stuffers/1-Pagers (customizable)
- Suggested Donations for use:
  - $200 (Individual Utility)
  - $500 (Privately Held Company or State Association)
  - $1,000 (Regional Association)
  - $2,000 (National Association)
- For more information about the campaign or to access the materials, go to: https://www.newea.org/pfas-campaign-partner/