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We will begin our presentation in a few minutes…

Leadership and Excellence in Environmental Engineering and Science

What is a PechaKucha?

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

A PechaKucha celebrates people, passion and creative thoughts.

It's a popular Japanese-inspired presentation format where each speaker shows 20 slides for 20 seconds each.

- This event will consist of four speakers each showing 20 slides for 20 seconds each.
-
- Each presentation will be 6 minutes and 40 seconds.
- We will have a few minutes in between each presentation for some Q & A.

You will gain knowledge on four different topics in under an hour!

Let's get started!

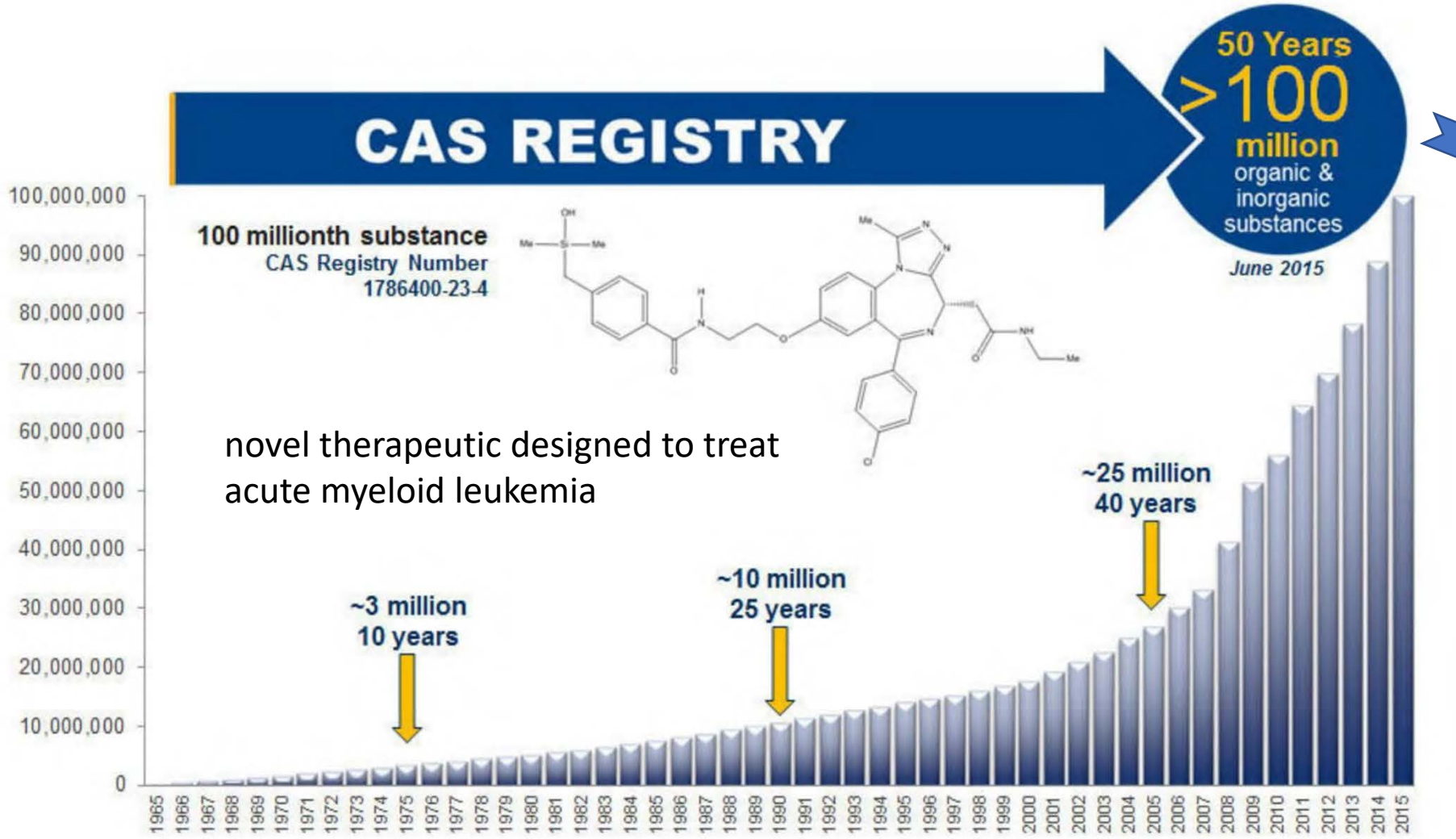
Contaminants of emerging concern in the environment: unintended consequences, new chemicals of concern, and understudied sources

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

Lee Blaney
Department of Chemical, Biochemical, and Environmental Engineering

University of Maryland Baltimore County

We use a lot of chemicals every day to improve our quality of life



Current:

<u>182 million unique</u>
organic & inorganic
substances

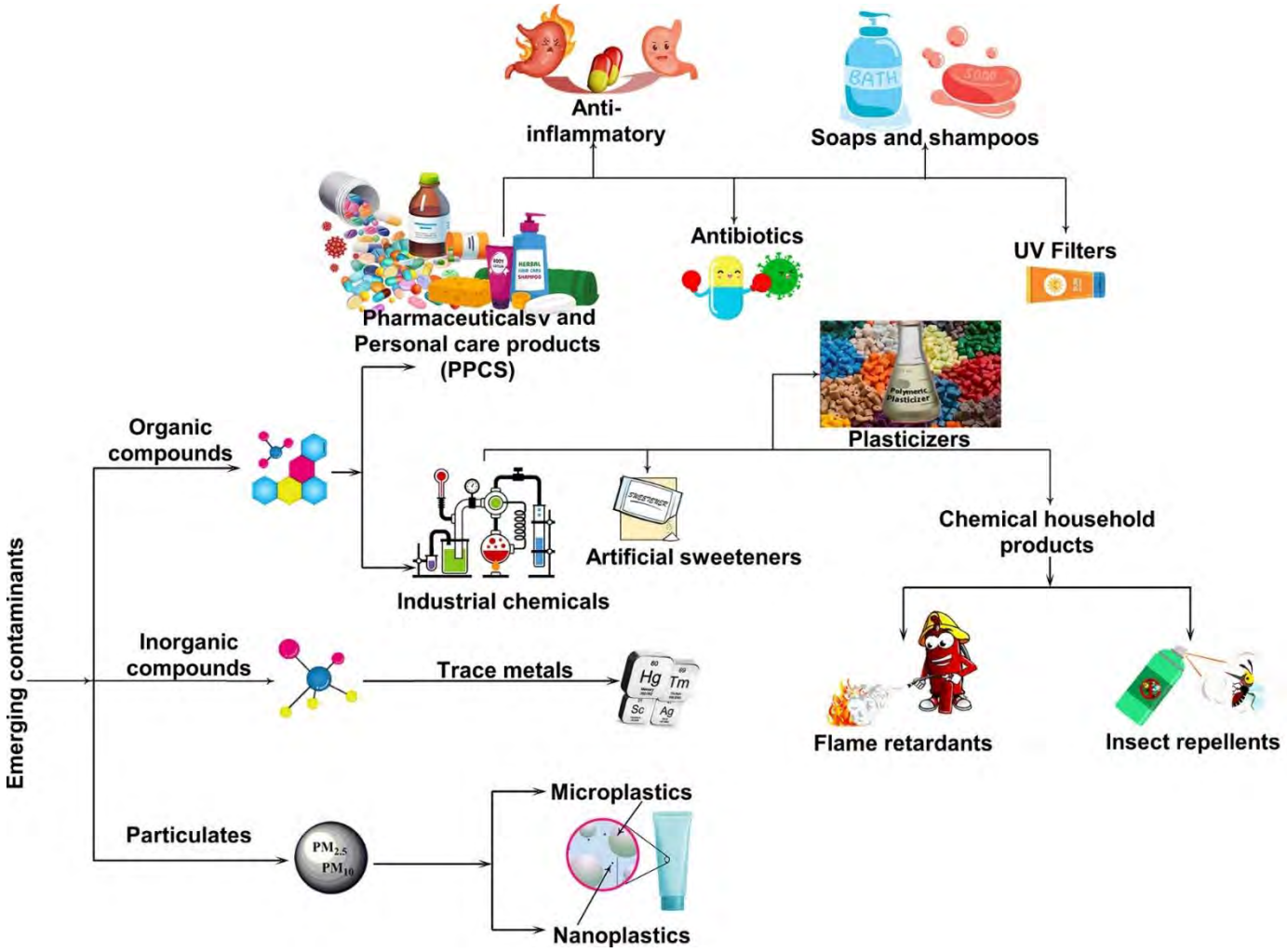
Rapid changes:

First 85 million
(past – 2014)

Second 85 million
(2014 – now)

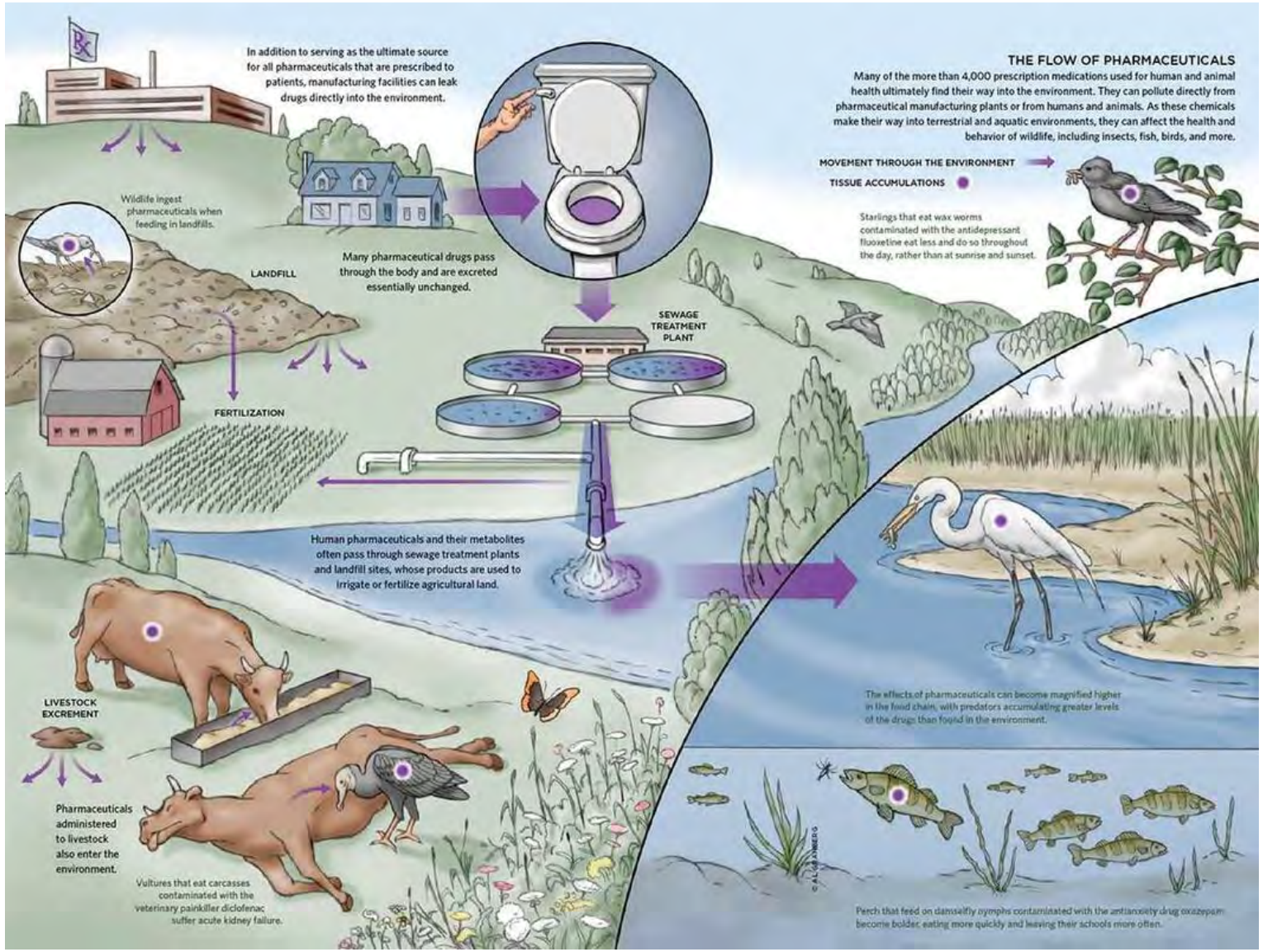
https://www.prnewswire.com/news-releases/cas-assigns-the-100-millionth-cas-registry-number-to-a-substance-designed-to-treat-acute-myeloid-leukemia-300106332.html

These substances include pharmaceuticals, personal care products, industrial chemicals, and others



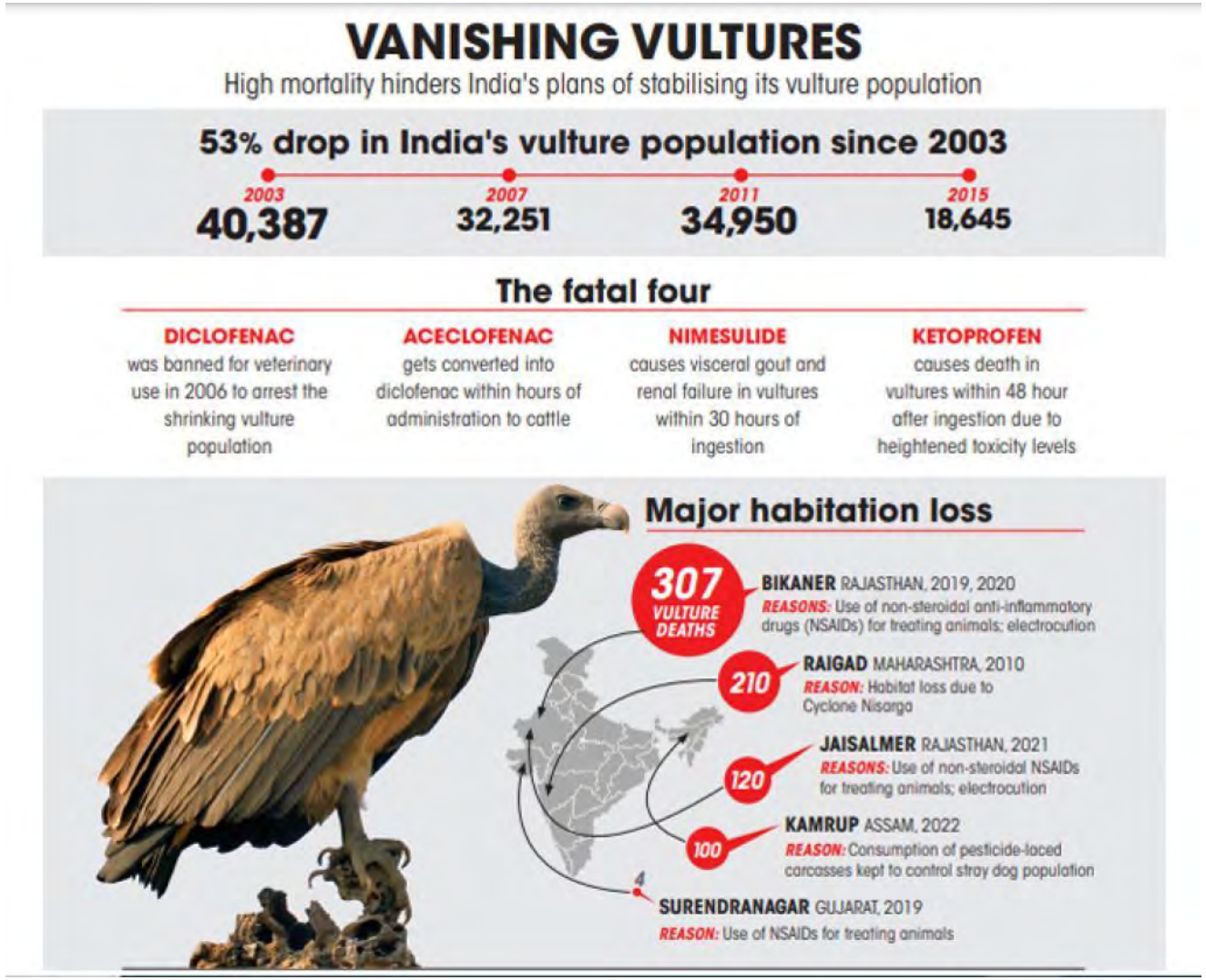
https://doi.org/10.1016/bs.apmp.2021.08.003

Those substances go down the drain and into the environment where they can have unintended consequences

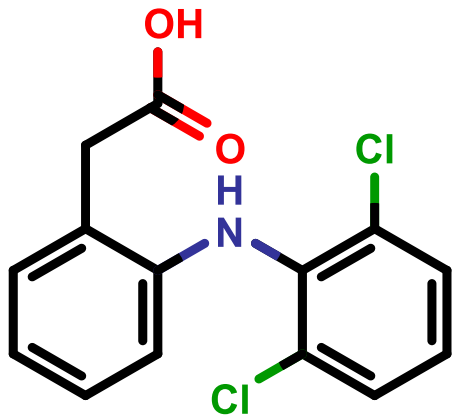


https://www.nwpa.us/learn/new-studies-on-contaminants-of-emerging-concern

The use of diclofenac to treat inflammation in cattle is an important lesson in unintended consequences



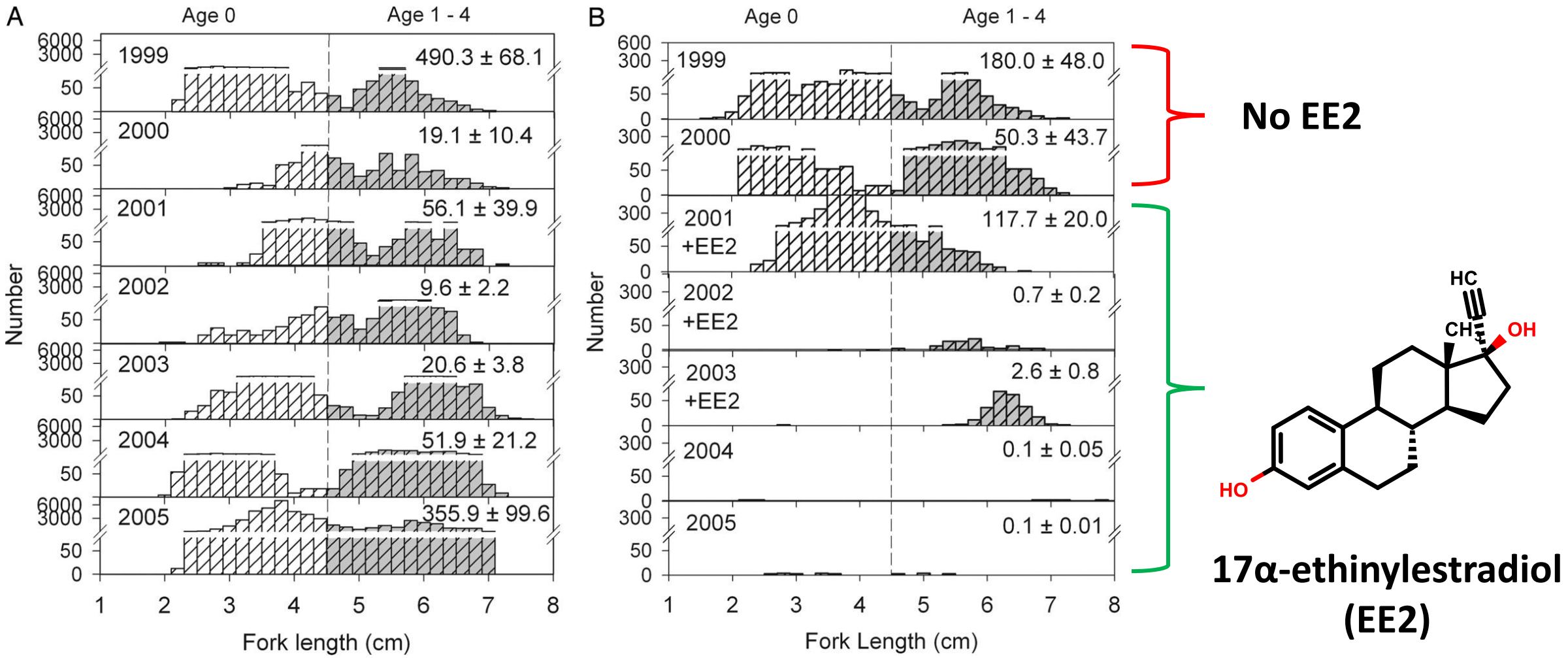
Diclofenac



In the span of just a few short years during the mid-1990s, vulture populations in India **fell by over 95% from a starting point of about fifty million birds** (Watson et al. 2004)

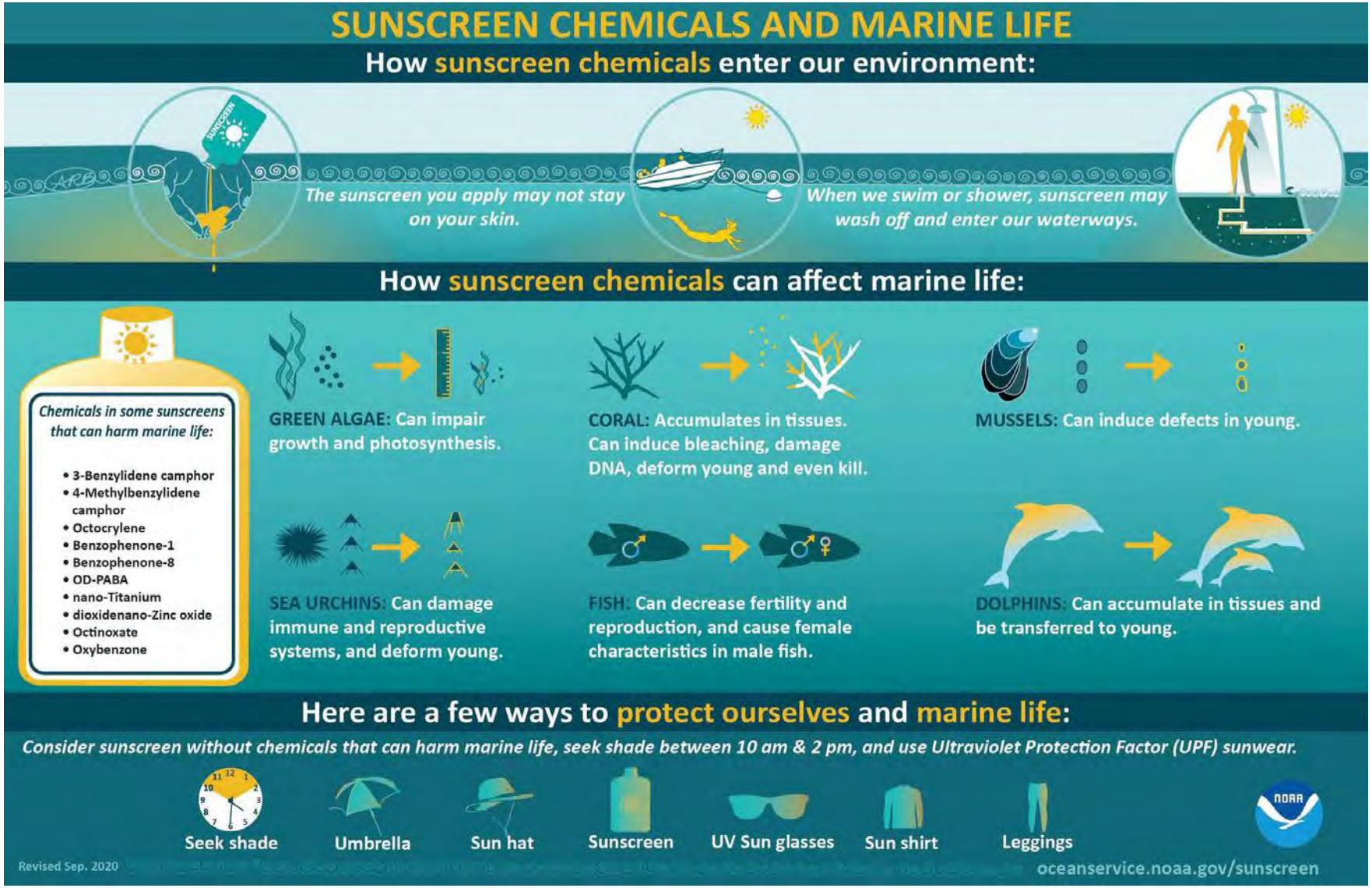
https://www.downtoearth.org.in/news/wildlife-biodiversity/drug-debacle-diclofenac-was-not-the-last-threat-for-india-s-vultures-82075

Endocrine disrupting chemicals, such as estrogenic hormones, can cause fish populations to crash



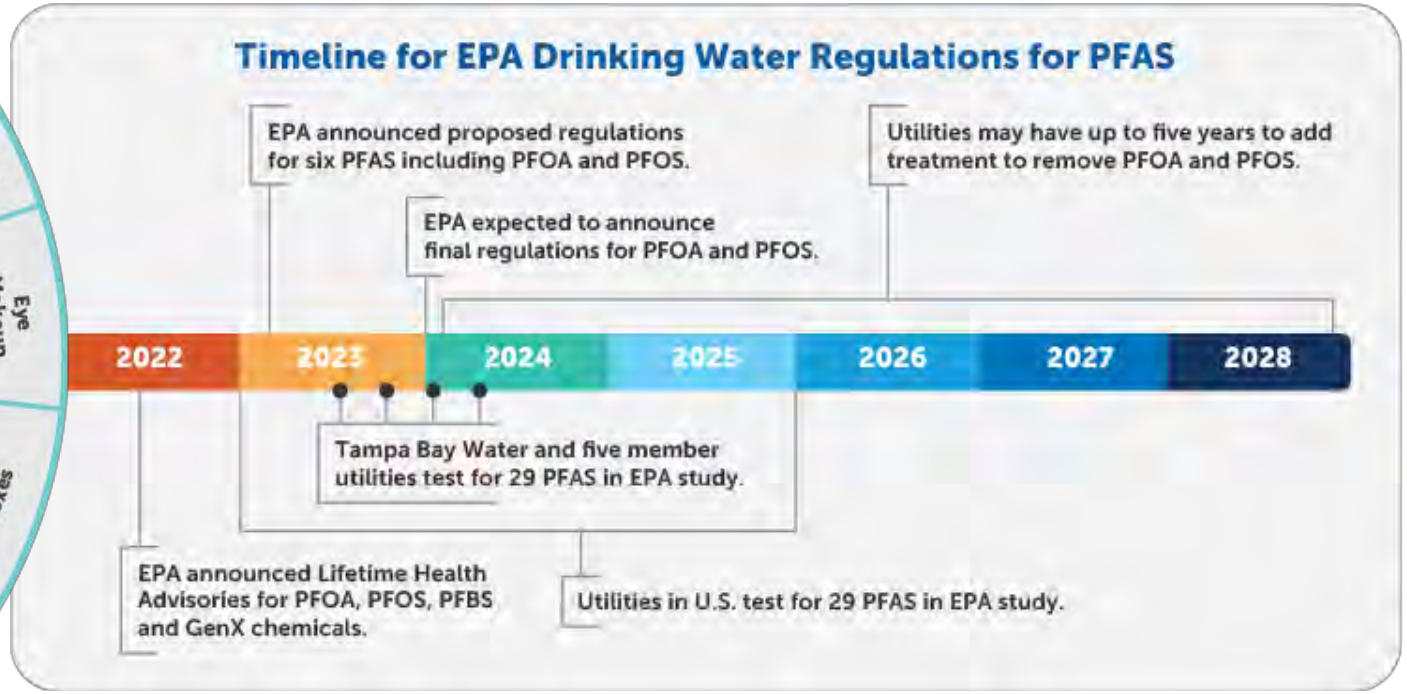
https://doi.org/10.1073/pnas.0609568104

Sunscreen agents, or UV filters, are being comprehensively evaluated due to coral toxicity concerns…



https://oceanservice.noaa.gov/news/sunscreen-corals.html

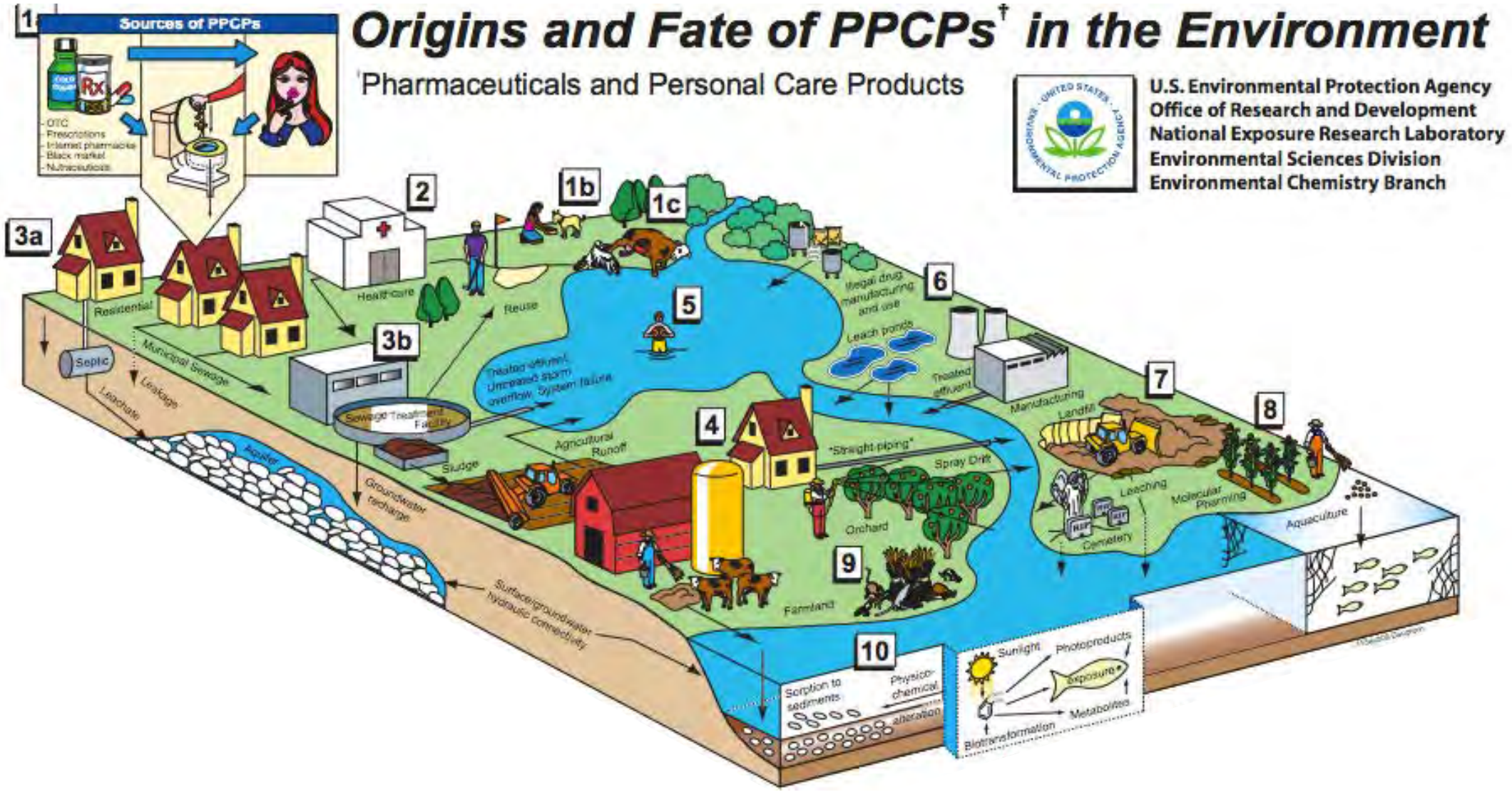
…and of course, per- and polyfluoroalkyl substances (PFAS), which are ubiquitously present in consumer and industrial products



https://tataandhoward.com/tag/pfas/

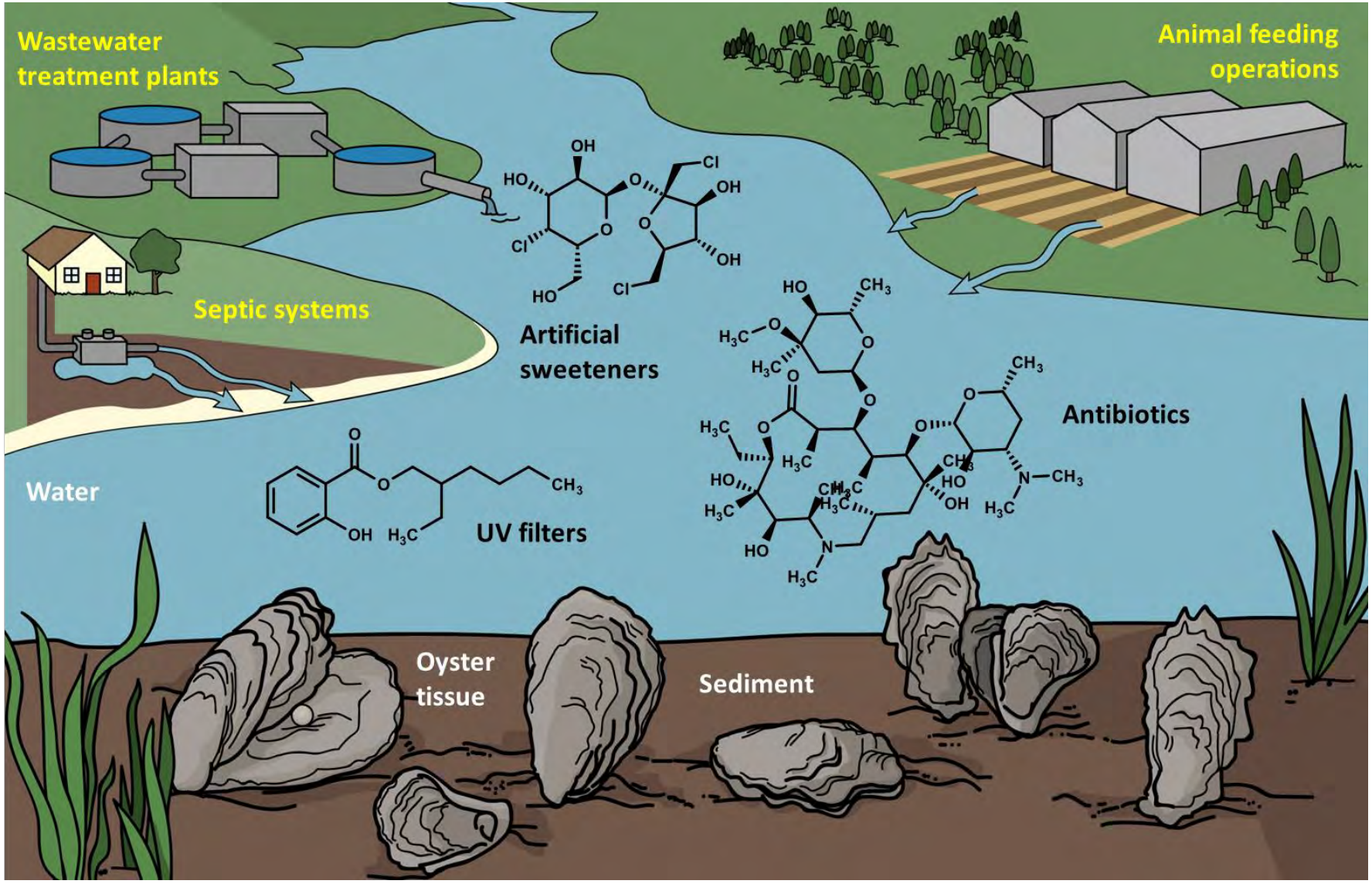
https://www.tampabaywater.org/qu

These contaminants of emerging concern (CECs) get into the environment through a number of different routes



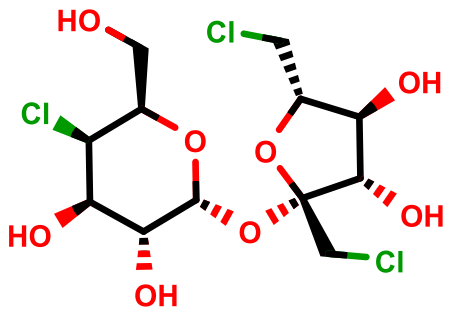
https://serc.carleton.edu/details/images/256859.html

Being in Baltimore, the Chesapeake Bay is an interesting test bed for us due to the unique makeup of CEC sources

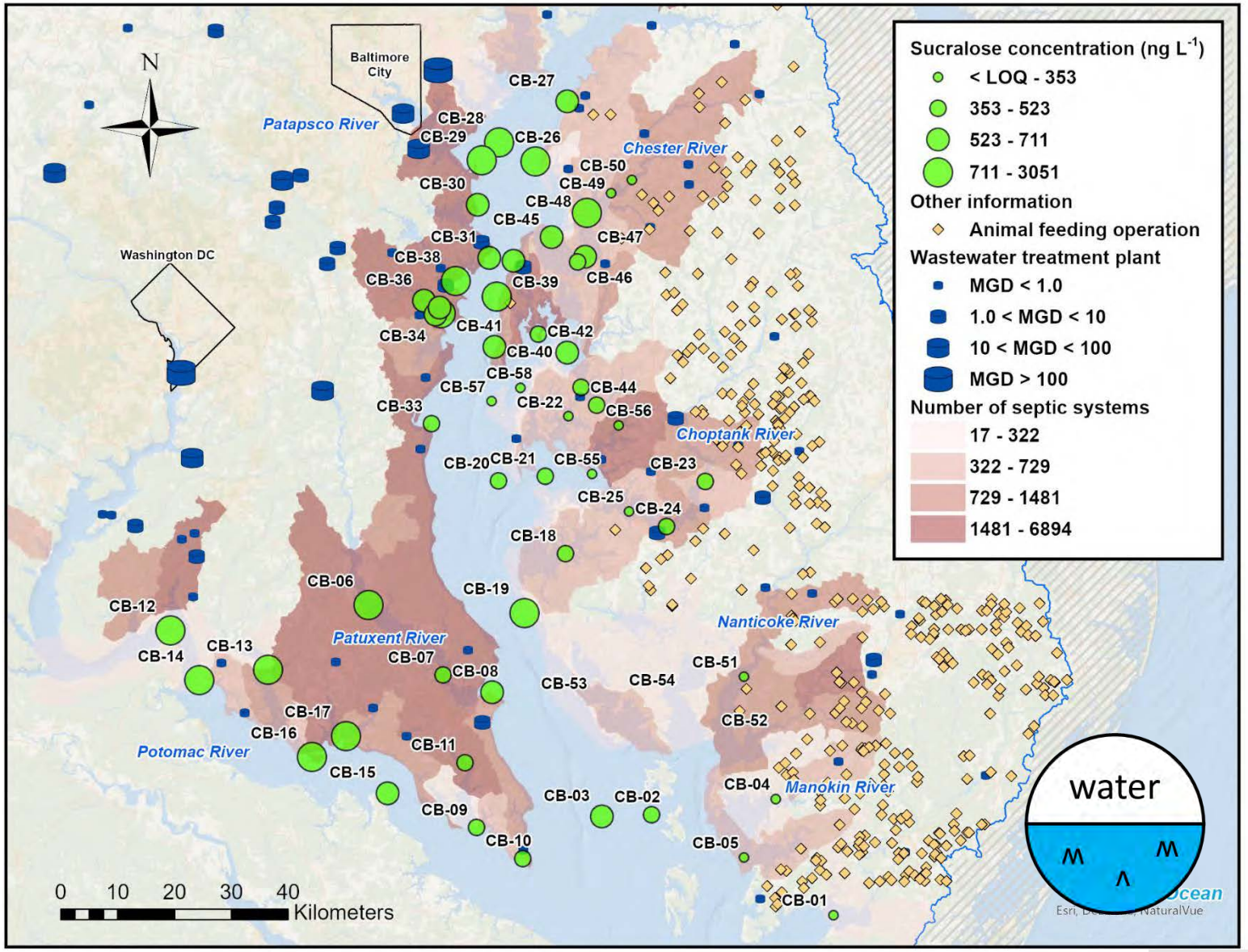


We use the artificial sweetener, sucralose, as a tracer of wastewater effluent to determine impacted areas in the Bay

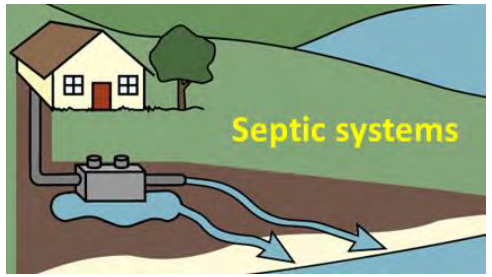
Sucralose

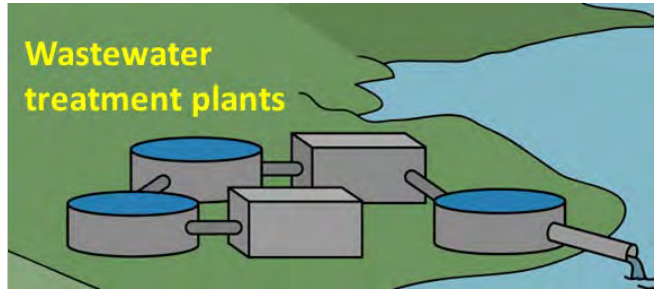


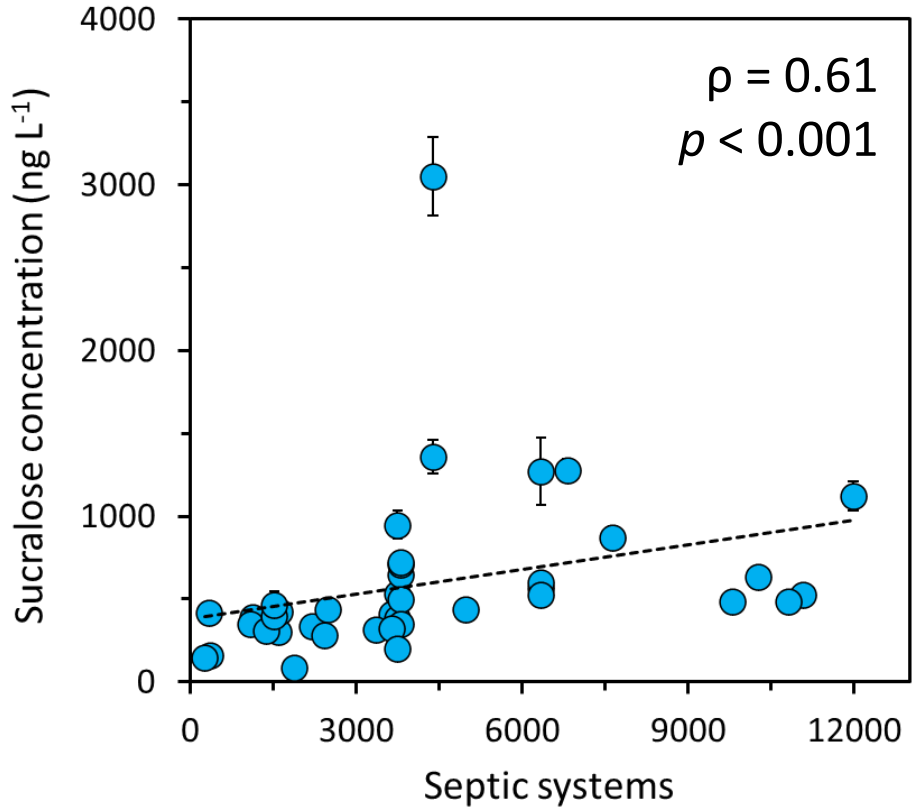
https://www.baristaunderground.com/products/splenda-sugar

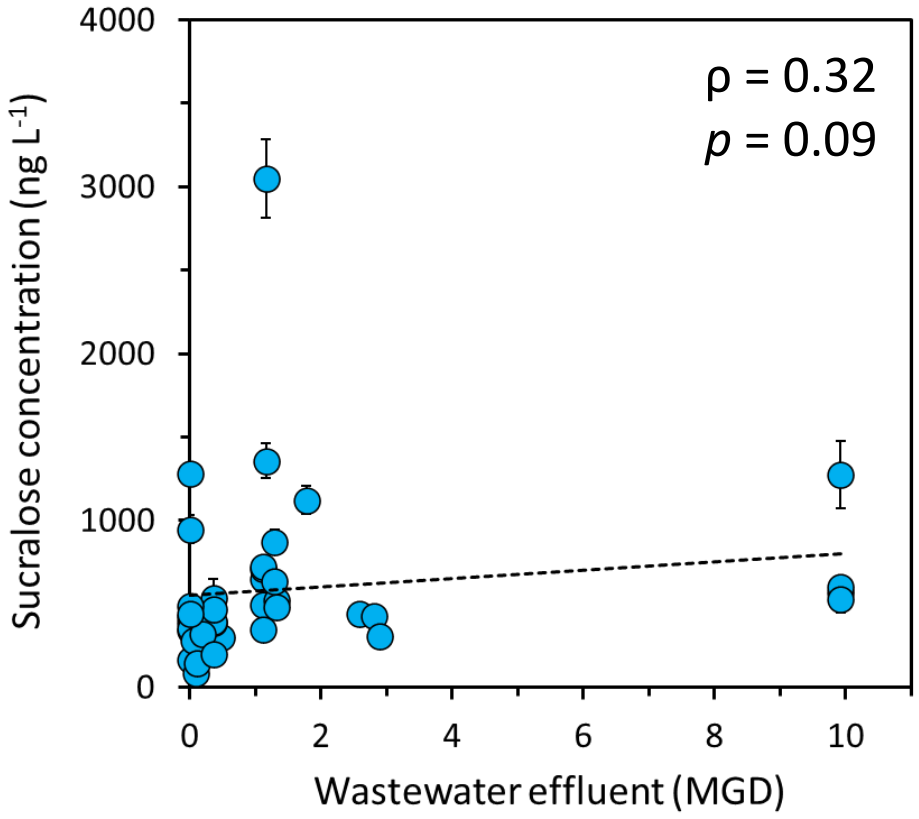


Interestingly, sucralose levels were more strongly correlated to upstream septic systems than (accumulated) wastewater effluent



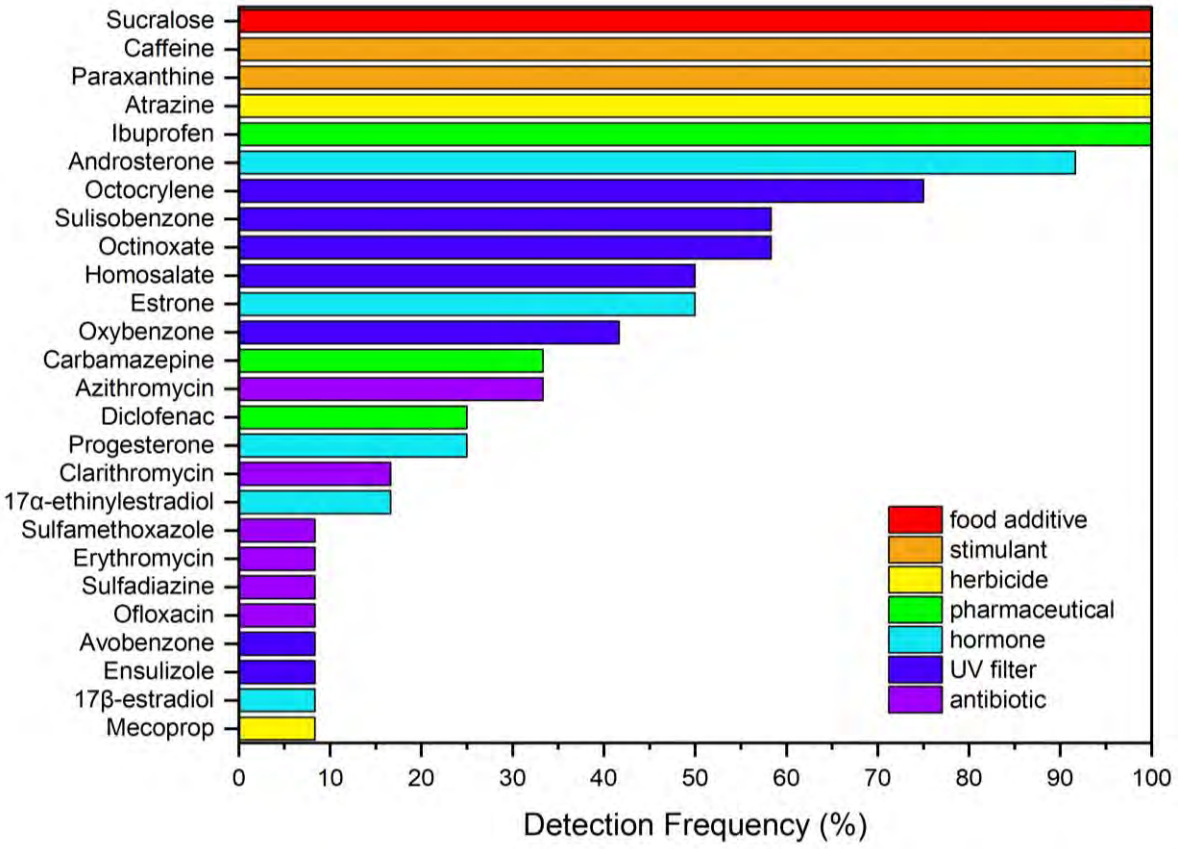






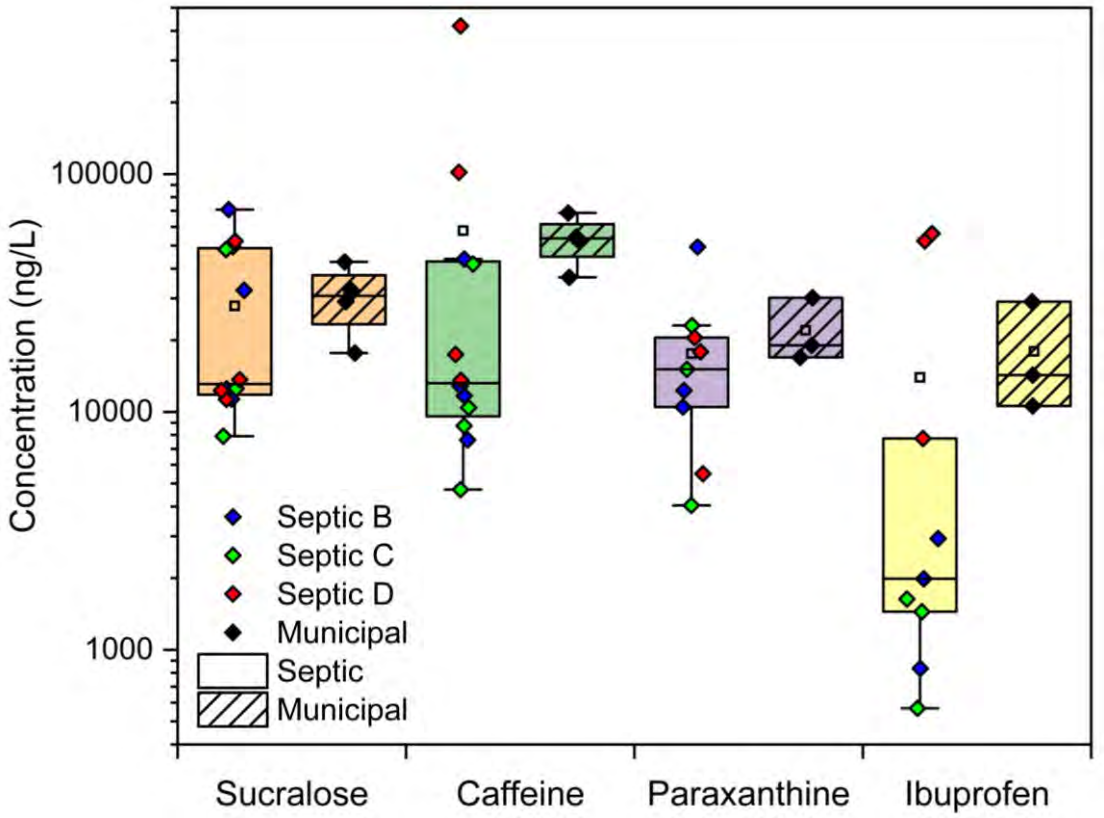
CEC detection frequencies and concentrations were high in selected septic systems from Baltimore County

CEC detection frequency



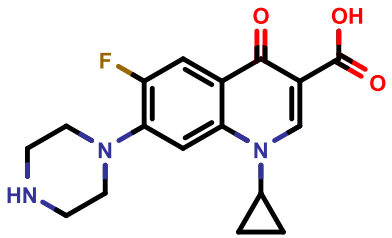
n = 12 (for most CECs)

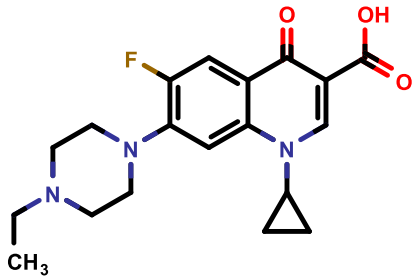
CEC concentrations



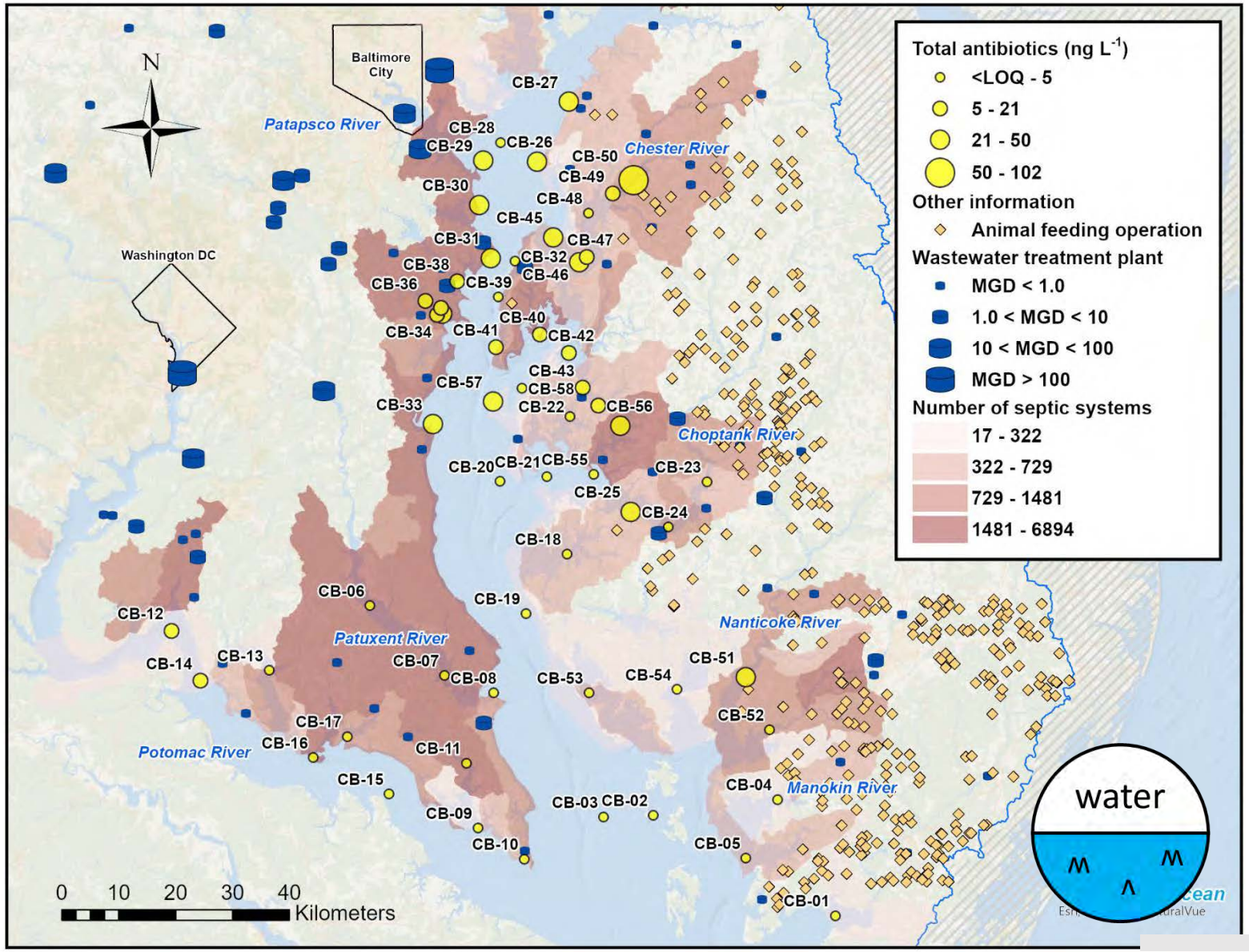
Except for the James River, antibiotic concentrations were generally low throughout the Chesapeake Bay

Ciprofloxacin



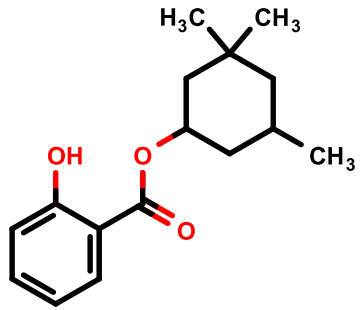


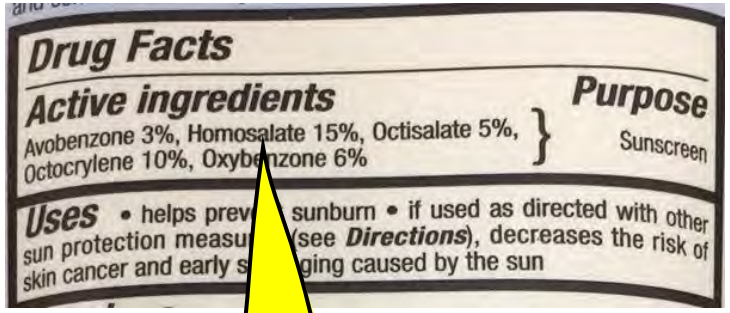
Enrofloxacin



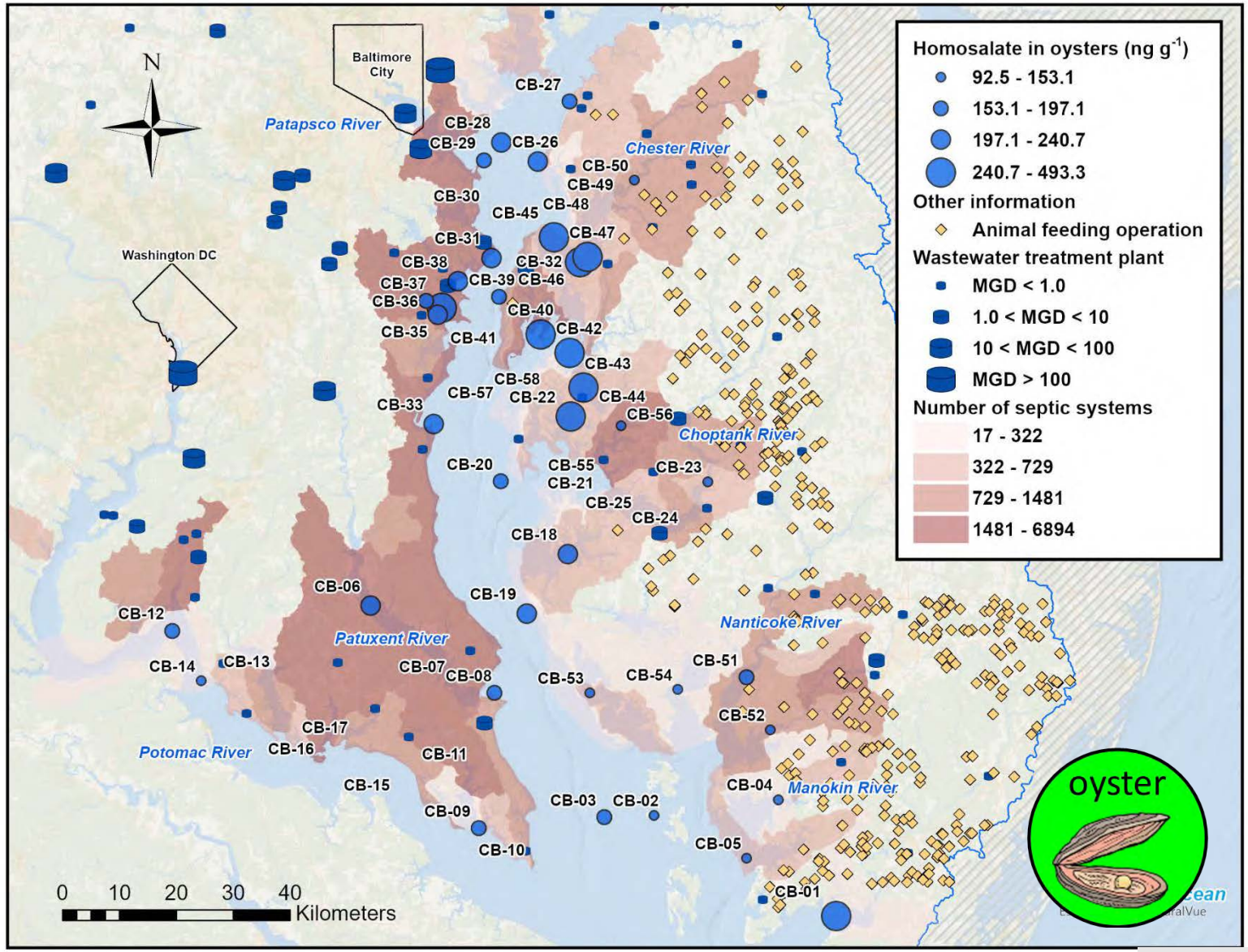
Compared to sucralose and antibiotics, UV filters tended to accumulate at higher concentrations in oysters

Homosalate

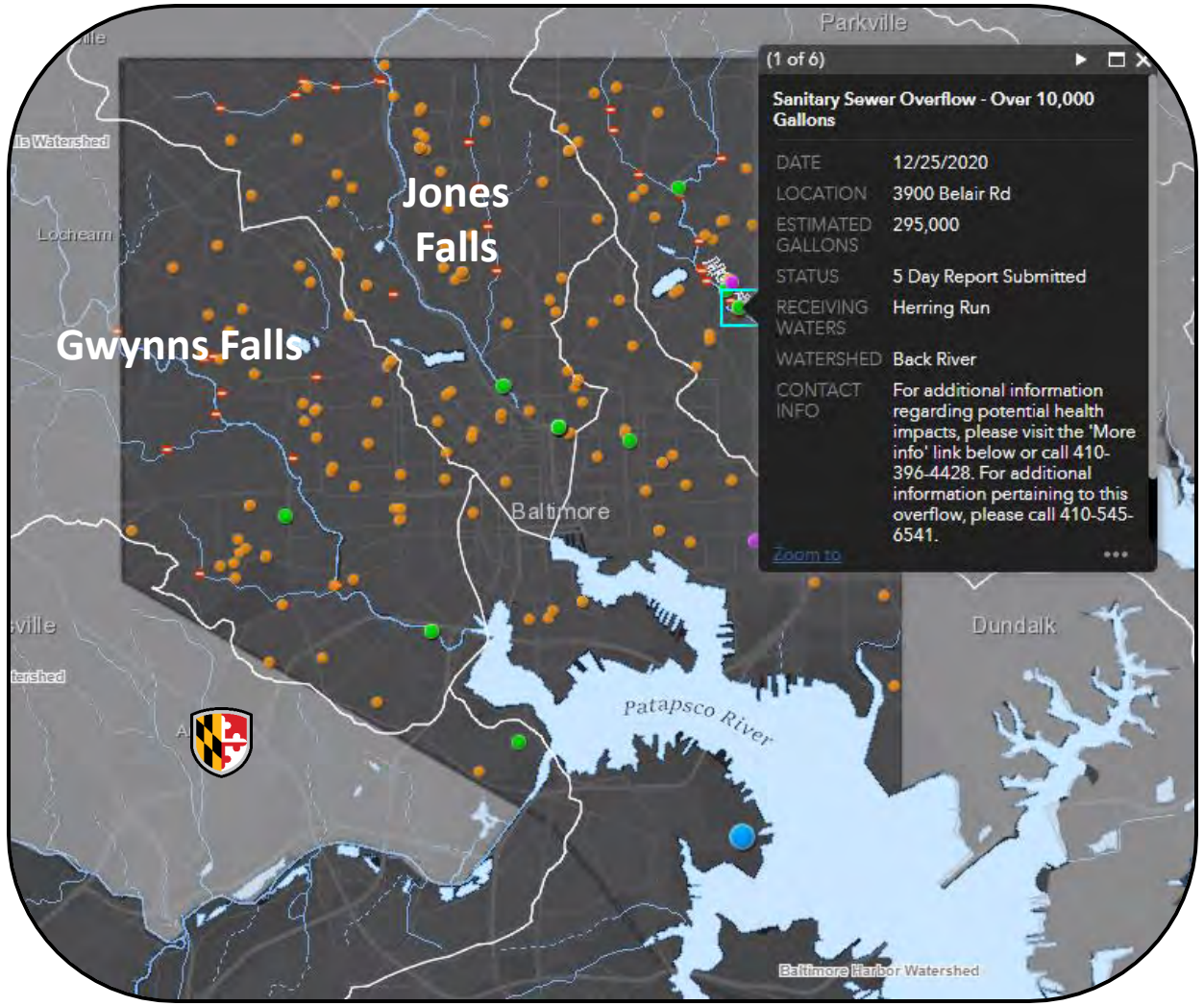




15% homosalate



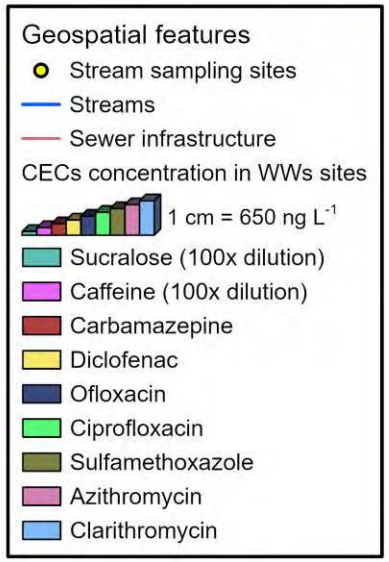
The importance of septic systems in the Bay, made us question CEC inputs from other (under-studied) sewer infrastructure

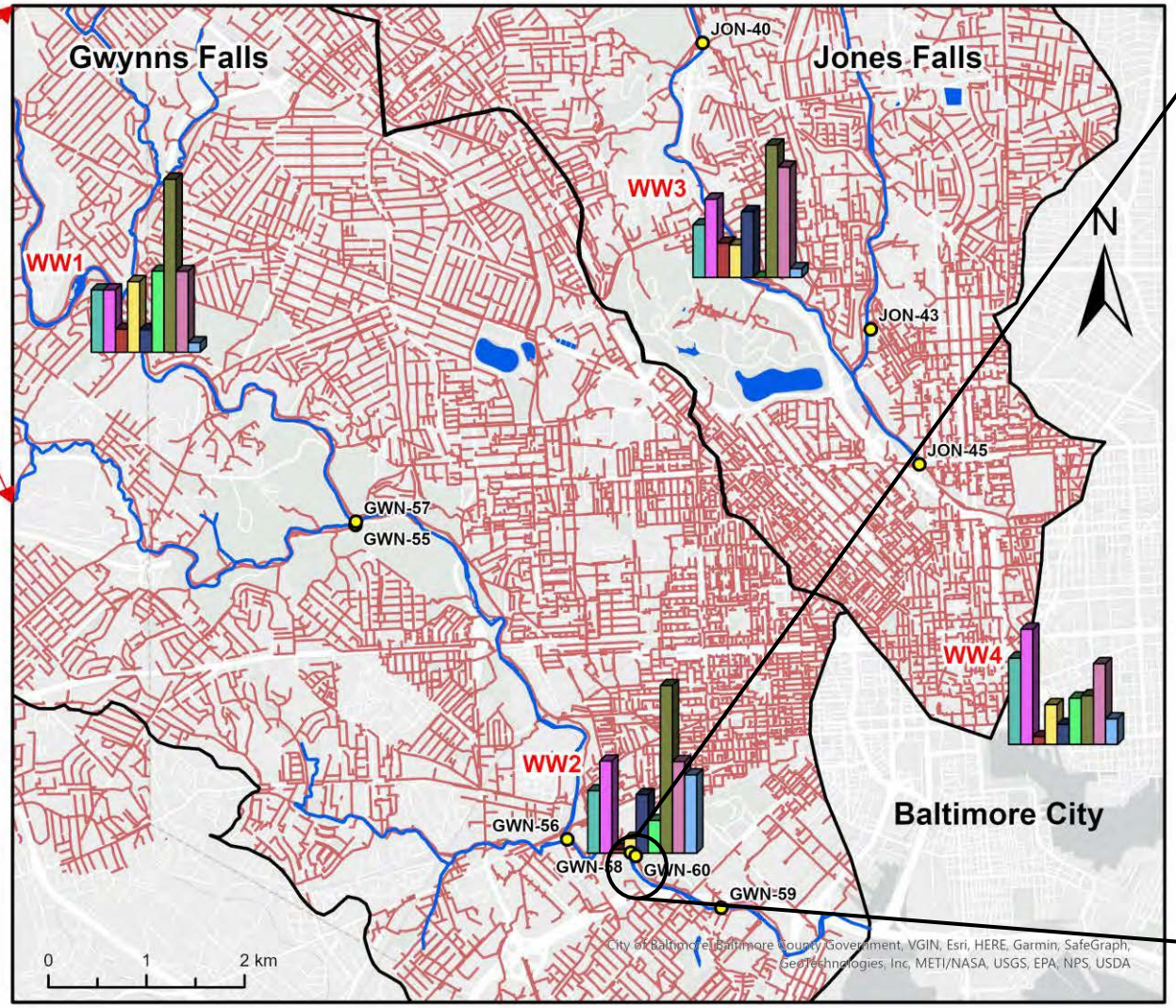


https://chesapeakebaymagazine.com/md-approves-74-million-in-bay-pollution-projects/

https://baltimoredpw.maps.arcgis.com/apps/webappviewer/index.html?id=a0

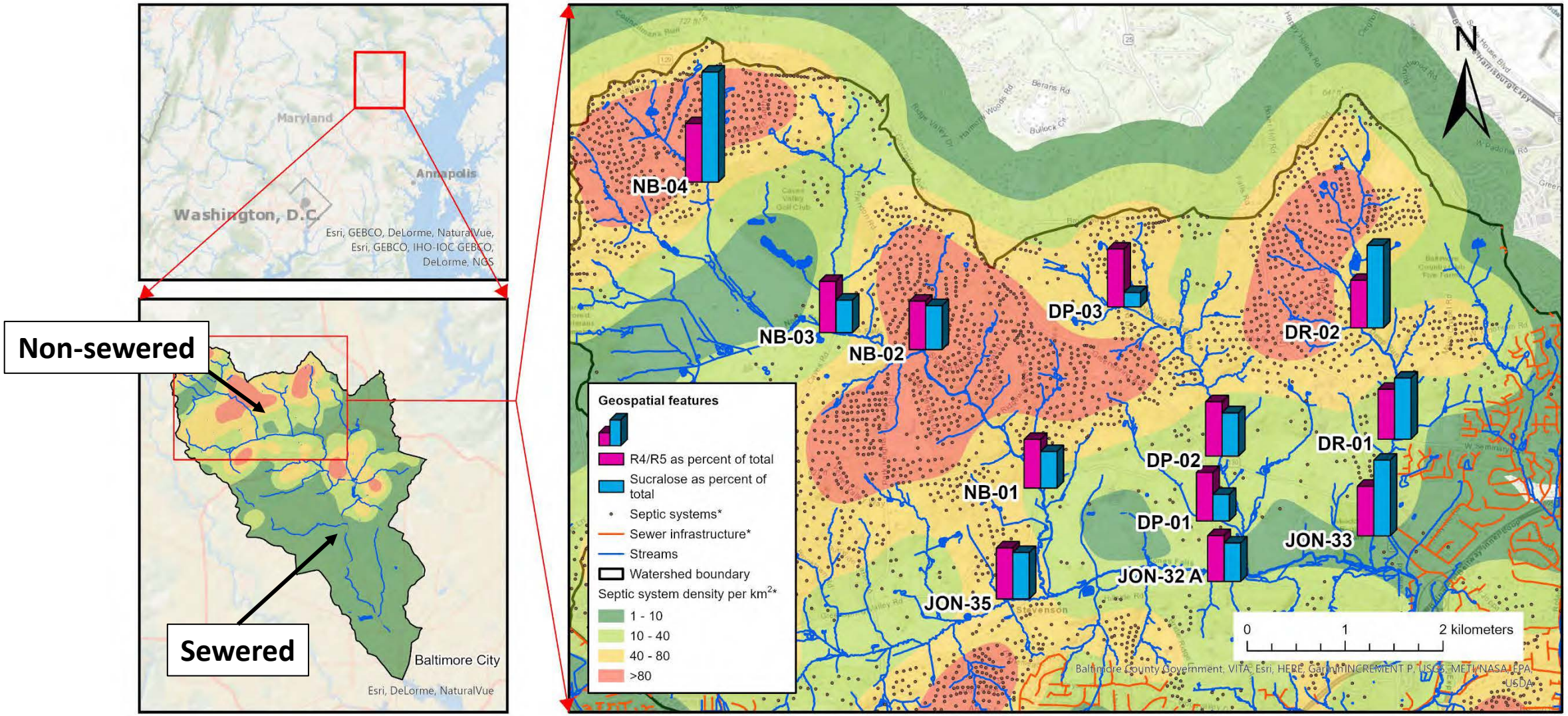
While sanitary sewer overflows are relatively infrequent, we found that chronic sewer leaks contributed CECs to the streams





leaking sanitary sewer infrastructure

In upstream locations, many households are on septic systems, and we found correlations between CECs and septic system density



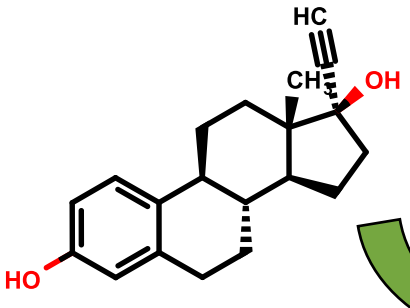
*Data obtained from the Baltimore County Department of Environmental Protection and Sustainability, 2022

To further inform bioaccumulation and ecotoxicity, we employed crayfish as biomonitors for estrogenic hormones and UV filters

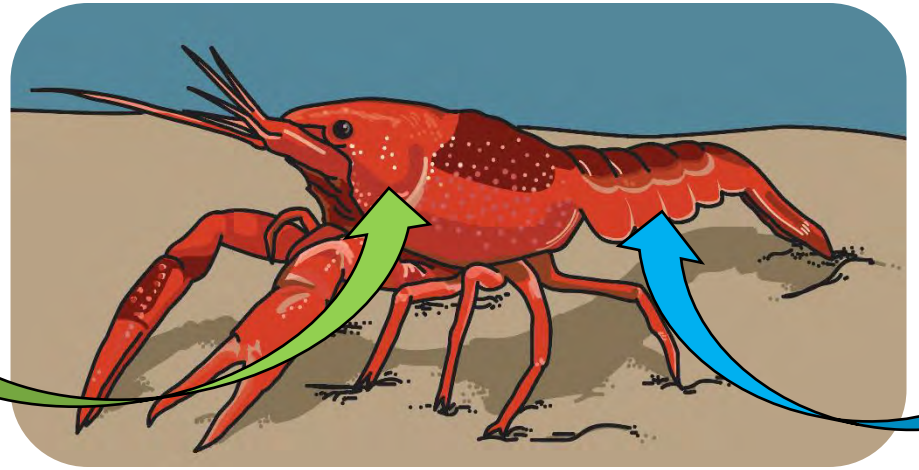
Table 2
Concentrations (ng/g lyophilized tissue) of analytes in the tissue of aquatic organisms. Error is standard deviation (n = 3).

Organism	Site[a]	EE2	E2	E1	BP-3	4-MBC	OC	EHMC	HMS
Eastern crayfish	BARN	n.d.[b]	n.d.	n.d.	n.d.	214 ± 23	60.6 ± 9.0	63.5 ± 7.2	399 ± 48
	DR1	n.d.	n.d.	n.d.	37.9 ± 4.4	352 ± 12	5.0 ± 0.1	n.d.	113 ± 7
	DR2	n.d.	n.d.	n.d.	n.d.	75.3 ± 11	37.1 ± 3.9	83.0 ± 5.1	263 ± 43
	DR3	n.d.	n.d.	n.d.	51.4 ± 2.2	97.8 ± 11	6.7 ± 0.3	n.d.	108 ± 3
	DR4	n.d.	n.d.	n.d.	n.d.	106 ± 17	113 ± 6	n.d.	260 ± 16
	DR5	17.1 ± 1.6	n.d.	n.d.	23.7 ± 0.3	112 ± 12	4.5 ± 0.4	n.d.	201 ± 20
	DRKR	n.d.	n.d.	n.d.	29.5 ± 0.3	190 ± 18	3.4 ± 0.2	n.d.	77.6 ± 7.5

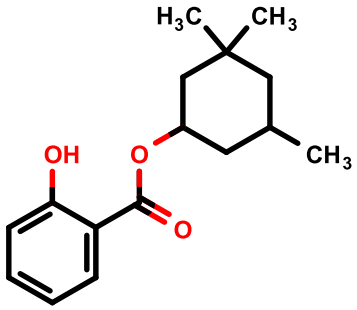
[a] BARN, Baisman Run; DR1-5, Dead Run Sites 1–5; DRKR, Dead Run at Franklintown; ARO, Aquatic Research Organisms; CBCR sites were located at the mouth of the Chester River, Chesapeake Bay.
[b] n.d. = not detected.



EE2: up to 17.1 ng/g (dw)



Homosalate: up to 399 ng/g (dw)



https://doi.org/

Thanks for your attention

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Q and A

If you have a question, just click on the Q and A icon on the bottom of the screen and type it in there.

A Subsea Oil Spill Response Solution for a Toppled Platform that has been Leaking into the Gulf of Mexico Since 2004

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

Dillon R. Hoffmann, PMP
Special Project Manager/Engineering Manager
Couvillion Group LLC

AAEES Member

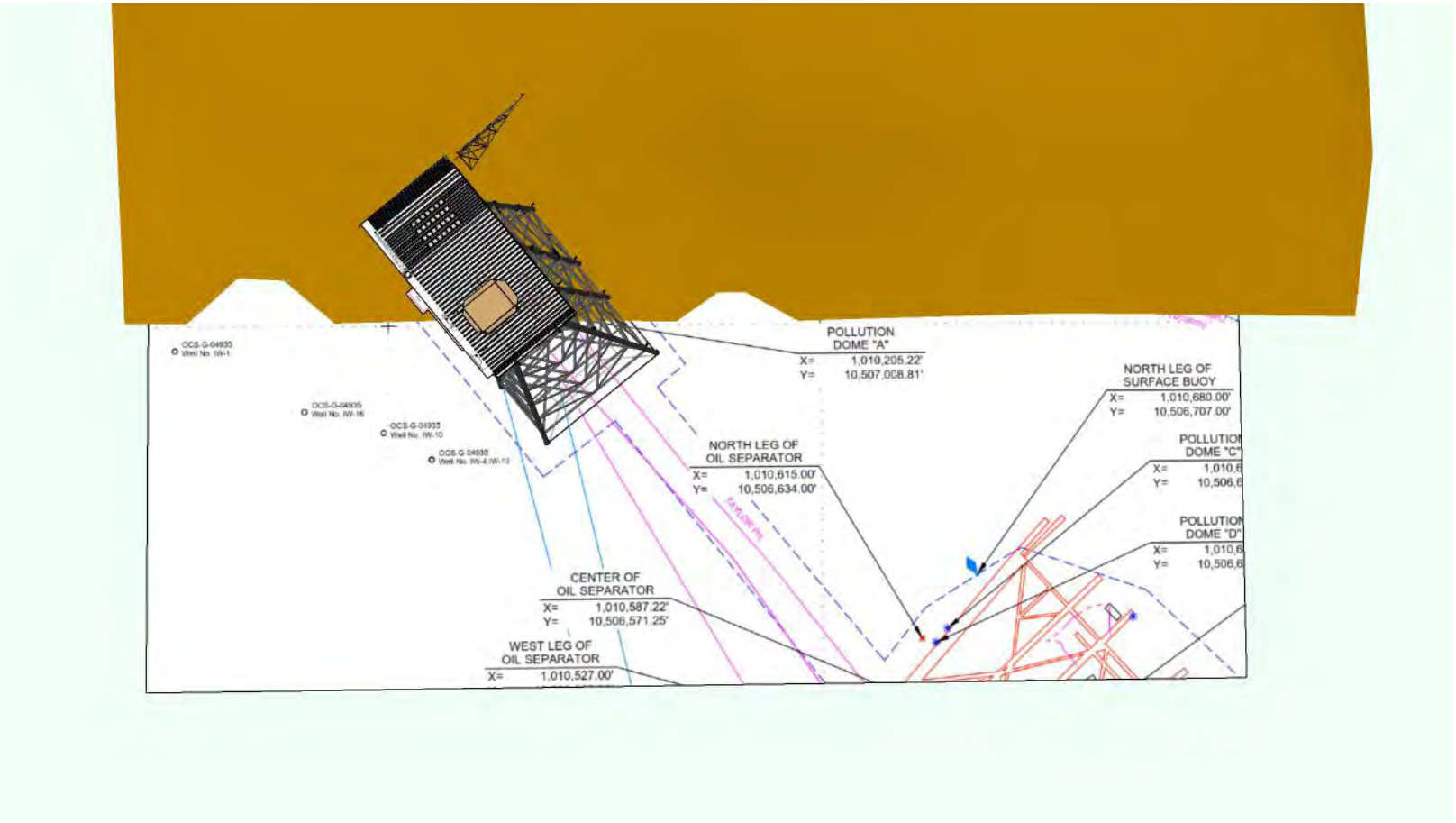
Oil and Gas Industry in the Gulf of Mexico

- According to the Bureau of Safety and Environmental Enforcement (BSEE) the Gulf of Mexico is currently home to:

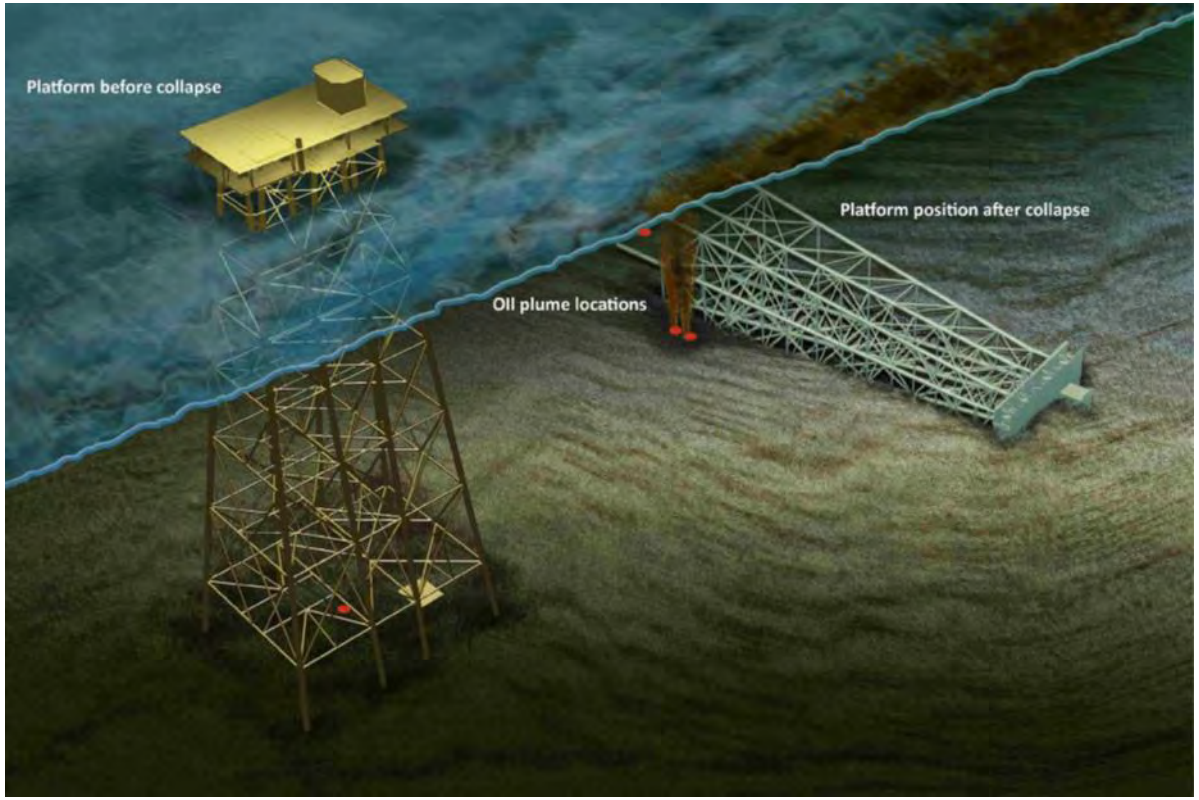
- Nearly 2,000 offshore structures
- 13,135 miles of active oil/gas pipelines
- An average of 1.7 million of barrels of oil per day are produced in the Gulf
- 15% of total US crude production
- 47% of the US crude refining takes place on the Gulf Coast

This presentation will outline the ramifications of a low probability high consequence event that can occur when oil companies are not held accountable for their actions.

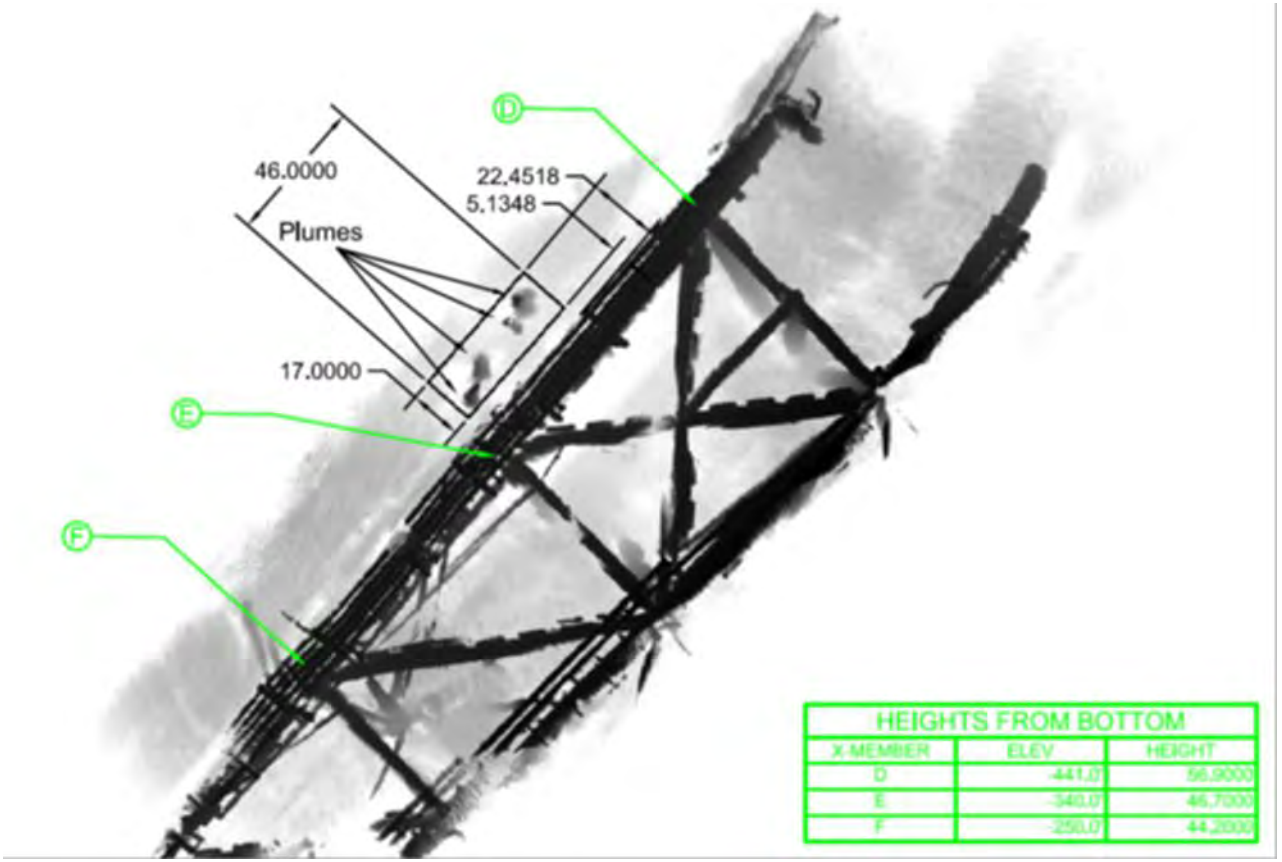
MC-20 Platform Toppling



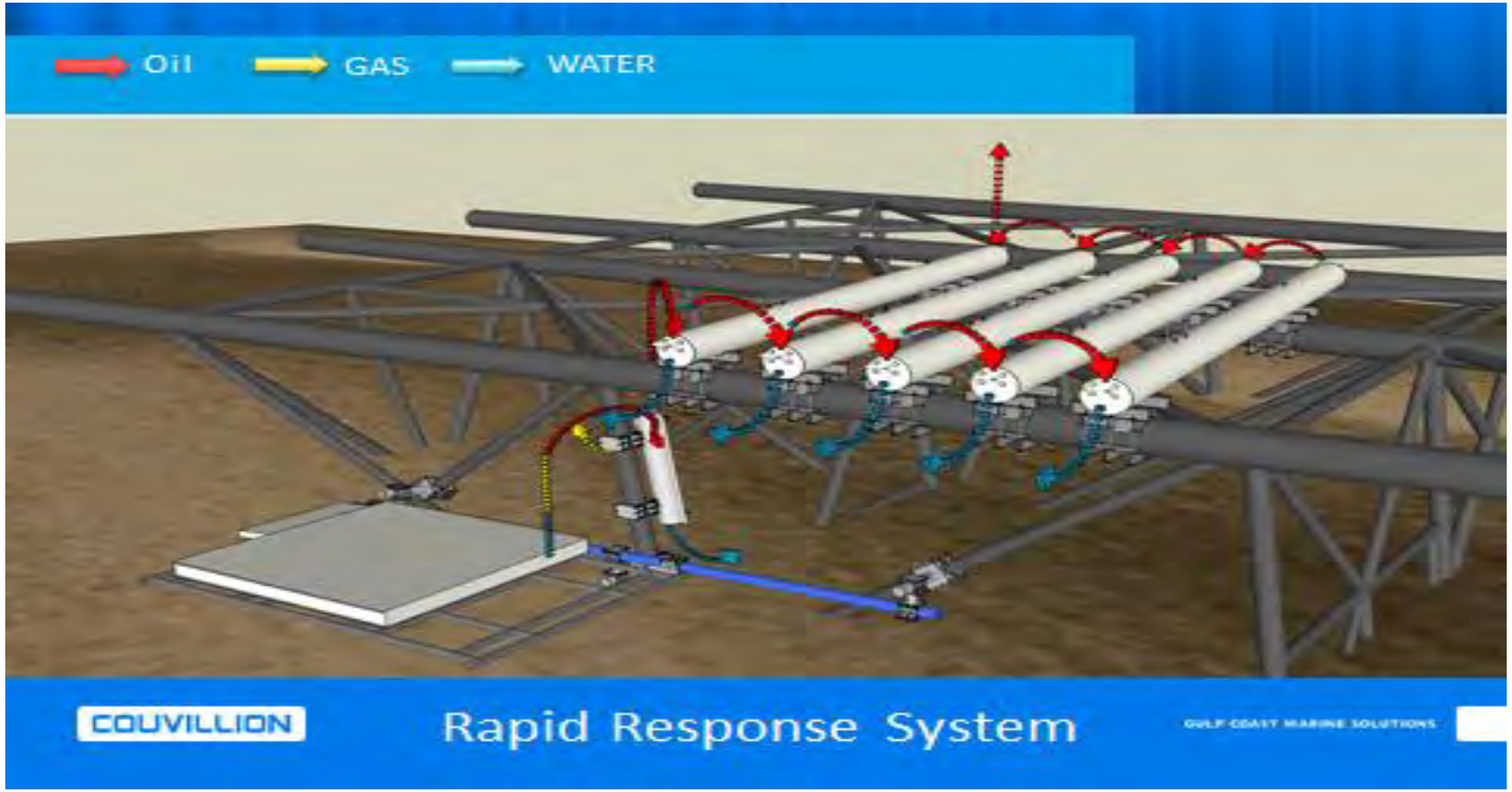
MC-20 A Platform Pre/Post Hurricane Ivan



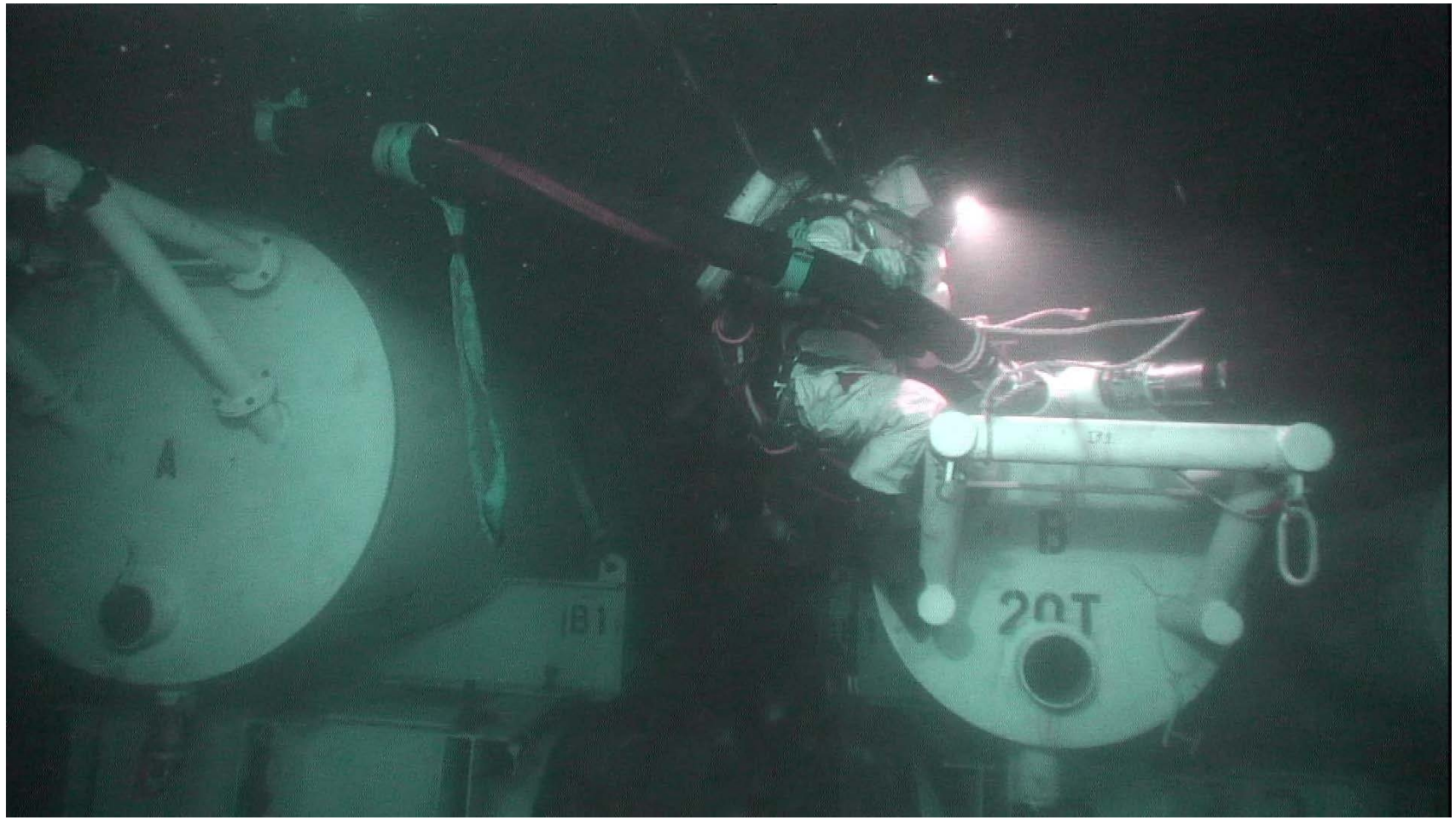
Plume Location in Relation to Downed Jacket



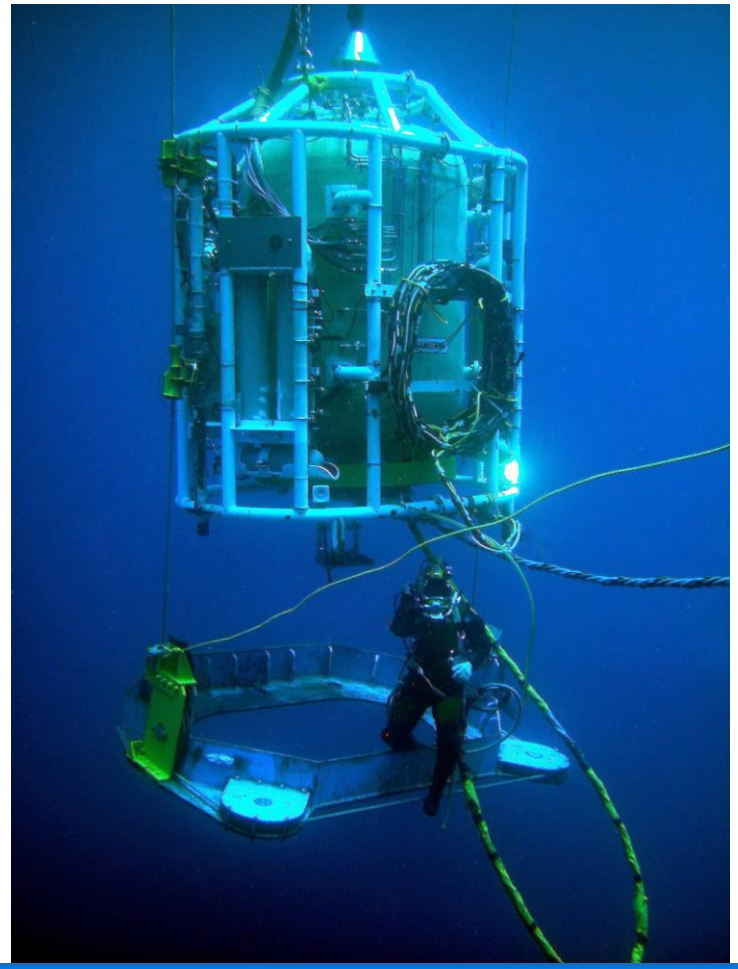
Rapid Response Solution System

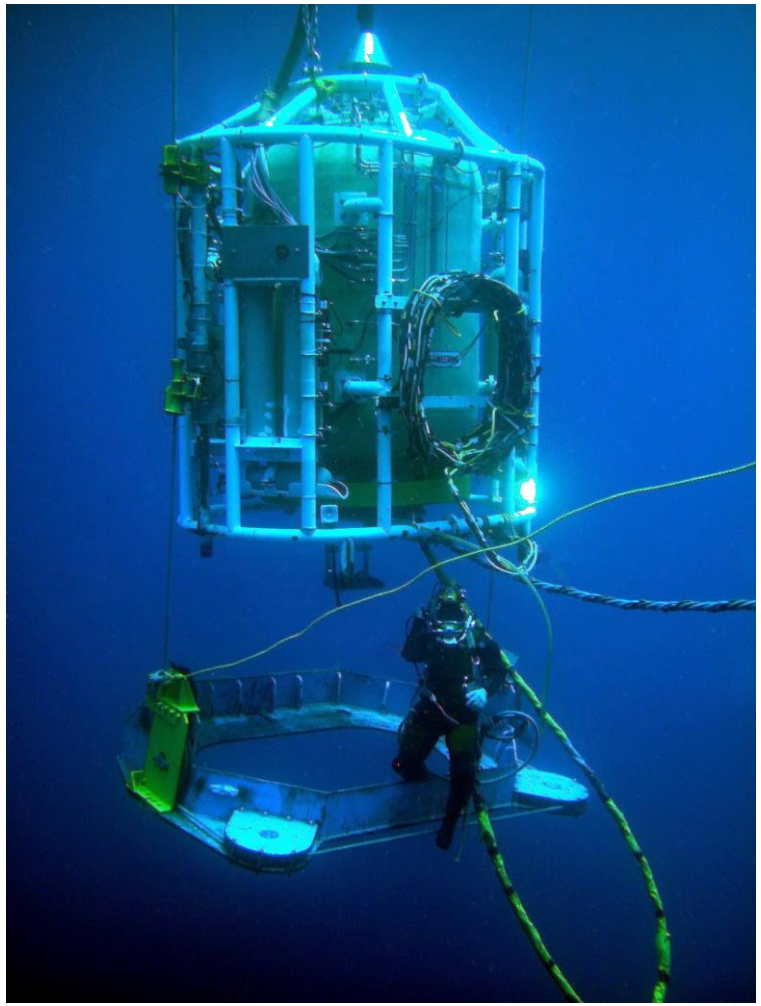


Diver Installing Hoses on Storage Container

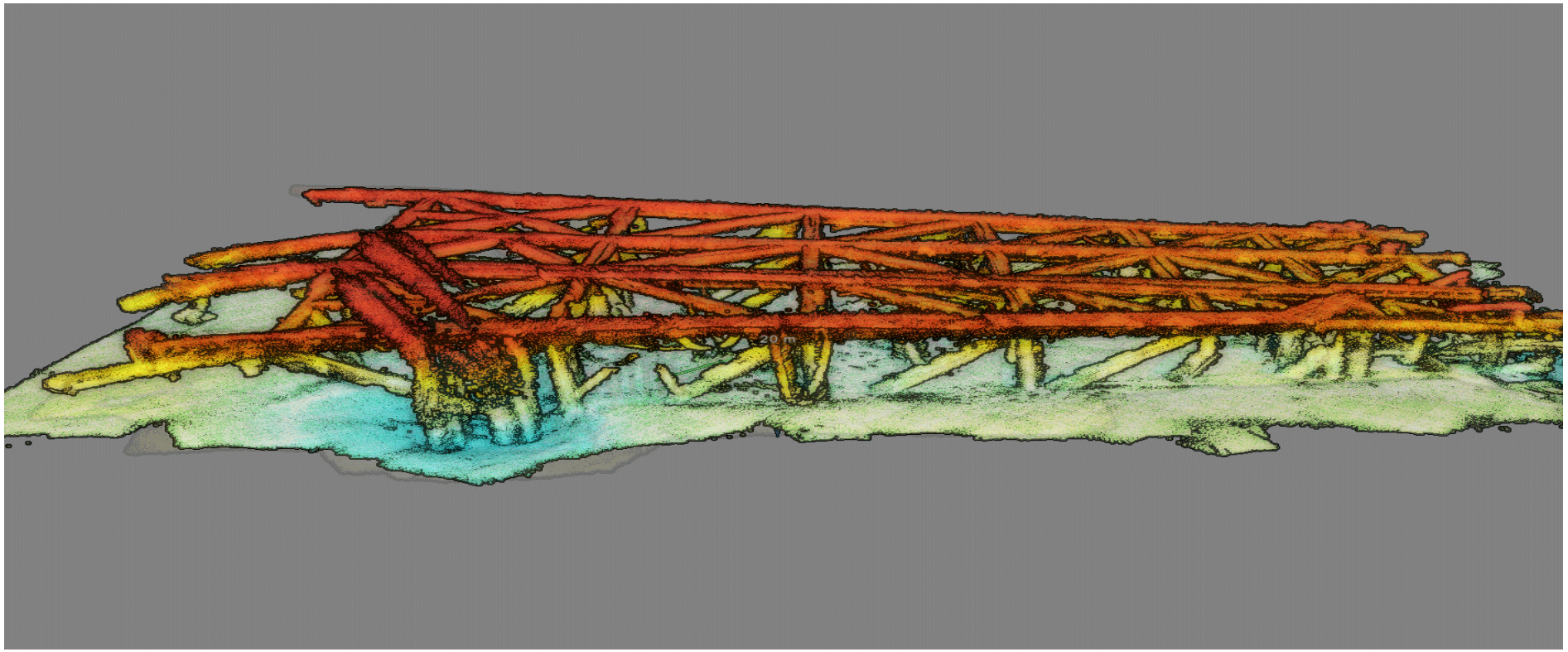


Diver Leaving the Bell to Work Onsite

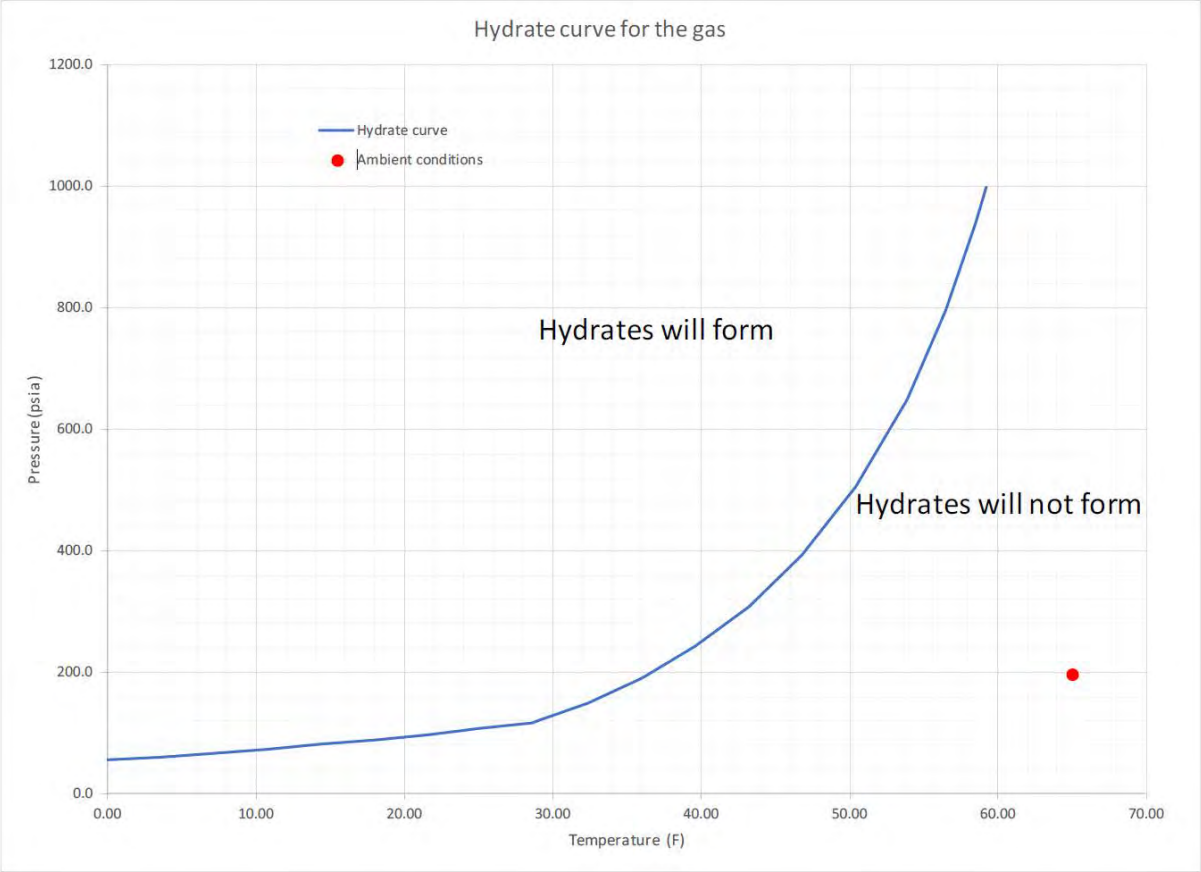




Echoscope Imagery from the MC-20 Site

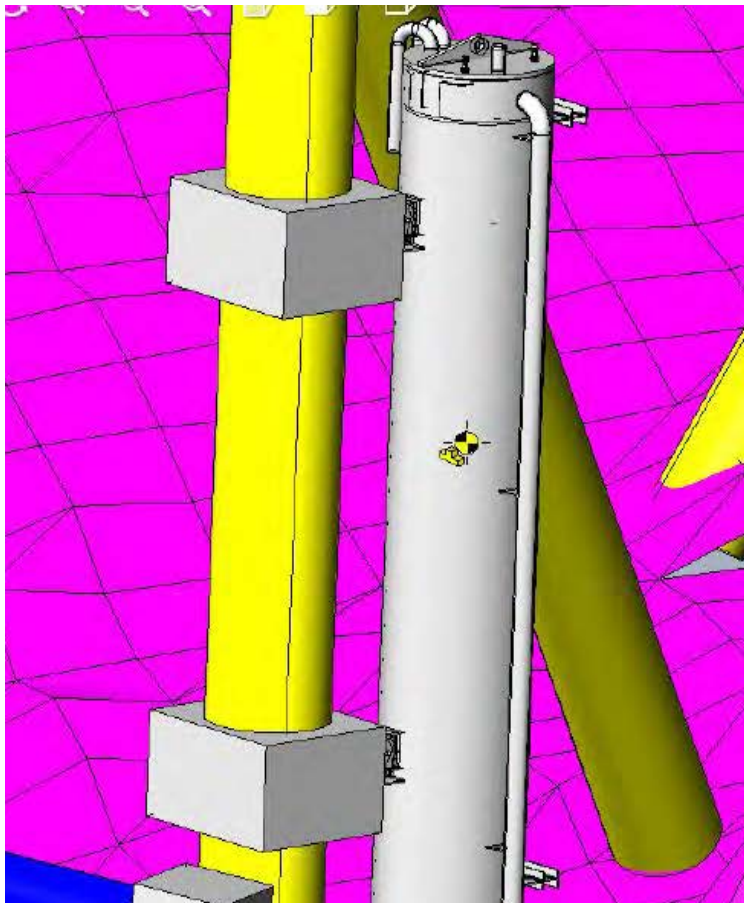


Flow Assurance Study



3-D Articulating Clamp Design

Separator Installation



System Components in Shipping to OII dock for Final Test fit-up using La Waterways

Small Scale Testing

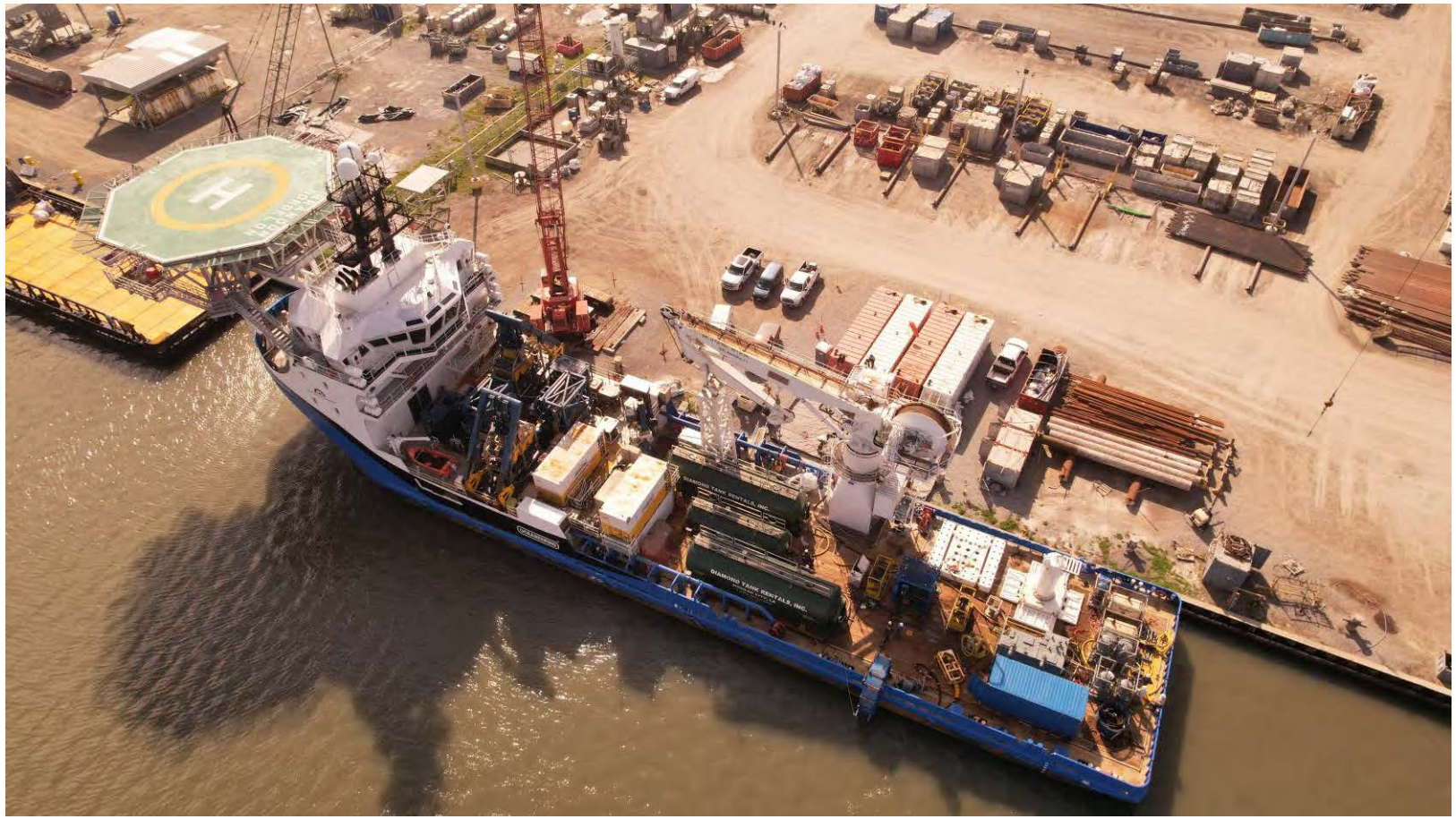
Test Fit Up

Test Fit Up

23 February 2019 First Day on Site to Install RRS

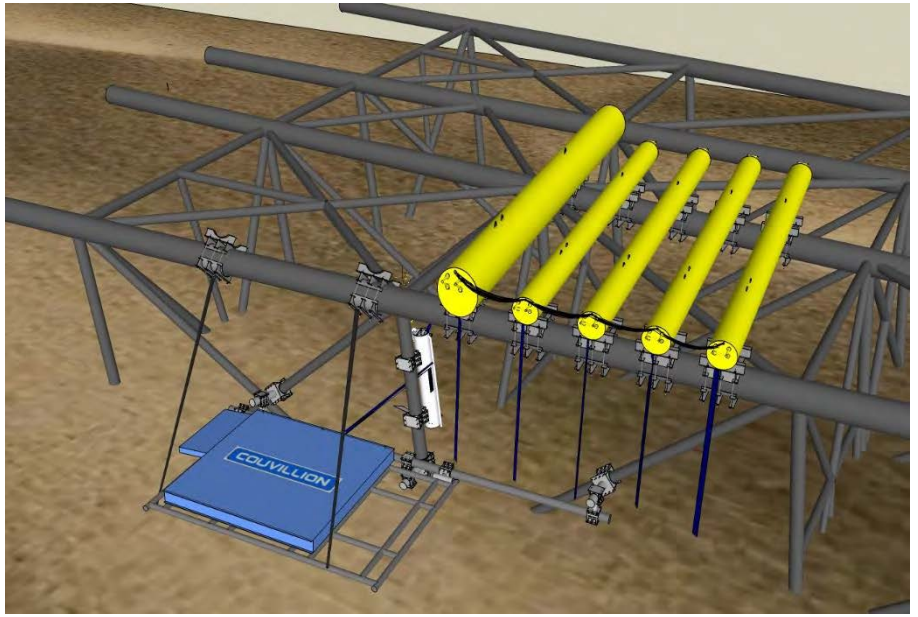
Leaving Site after RRS Installation

Port Fourchon LA Dockside Transfers



Salvaged Hydrocarbon Totals

	Bbl	Gal
Net Oil Collected	29170.1	1,225,144.2
Total Oily Fluids Collected	32,823.2	1,378,574.4



From April 12, 2019 through March 5, 2023 Couvillion Group has collected and recycled 1,225,144.2 gal of crude oil from the MC-20 site.

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Q and A

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Advancing PFAS Treatment Using Nanotechnology and 3D Printing

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

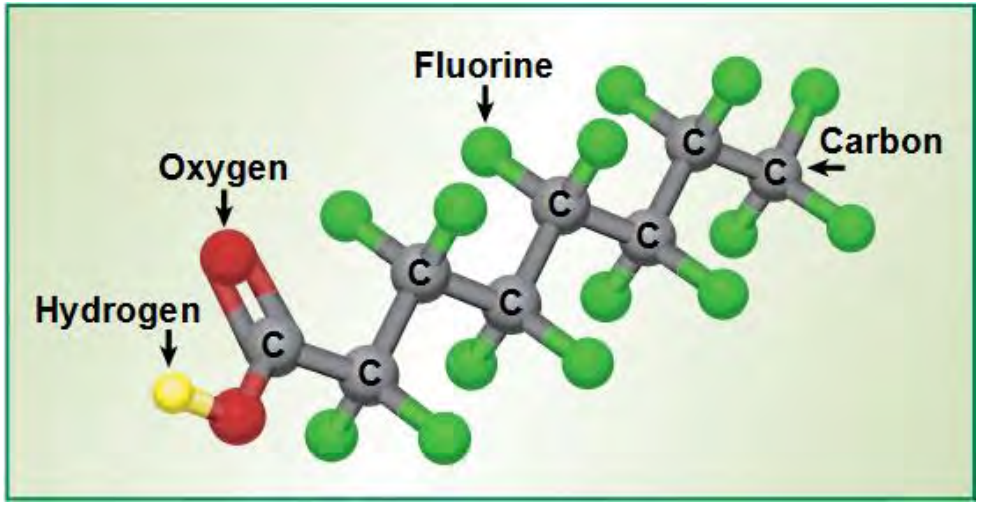
Dr. Nirupam Aich

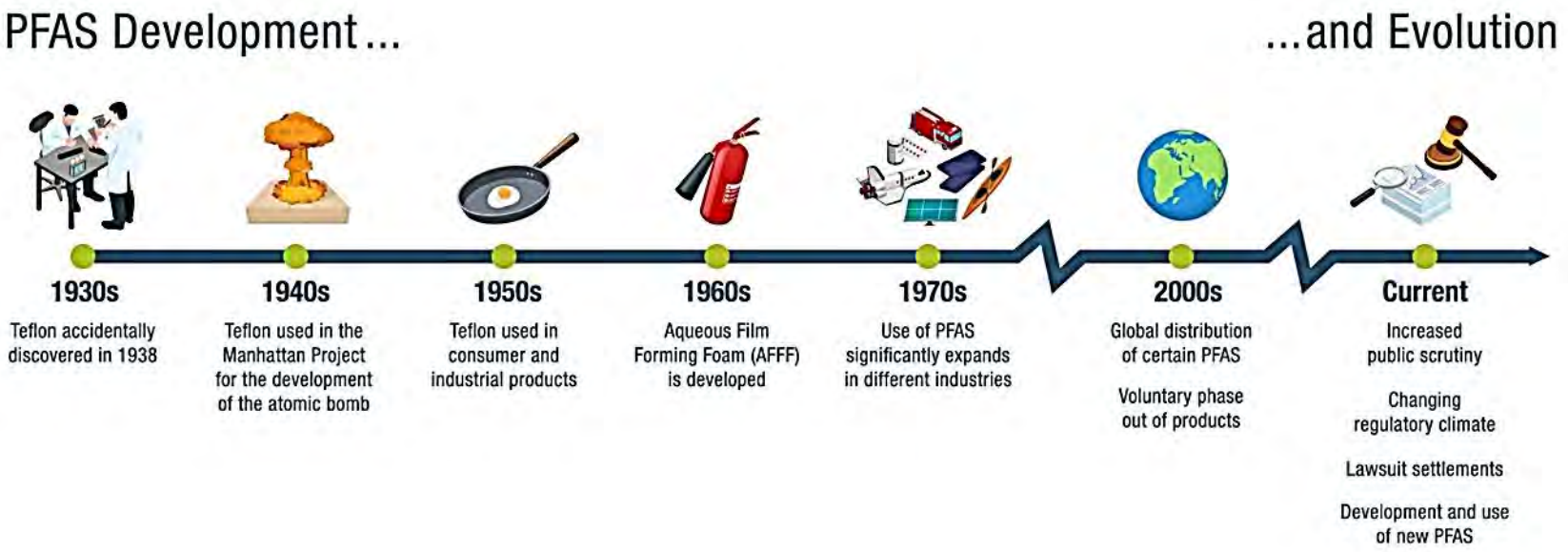
Associate Professor
University of Nebraska - Lincoln

Leadership and Excellence in Environmental Engineering and Science

Per- and Polyfluoroalkyl Substances (PFASs) in Water

- Anthropogenic *fluorinated organic compounds* commercially used in many industries since 1940's
- *Persistent*, *bio-accumulative* and *ubiquitous* in environment
- *Complex toxicity* profile
- Despite restriction for production in western countries, >*8000 PFASs* are prevalent in present global market
- ***C-F bond is very strong*** and difficult for breakdown





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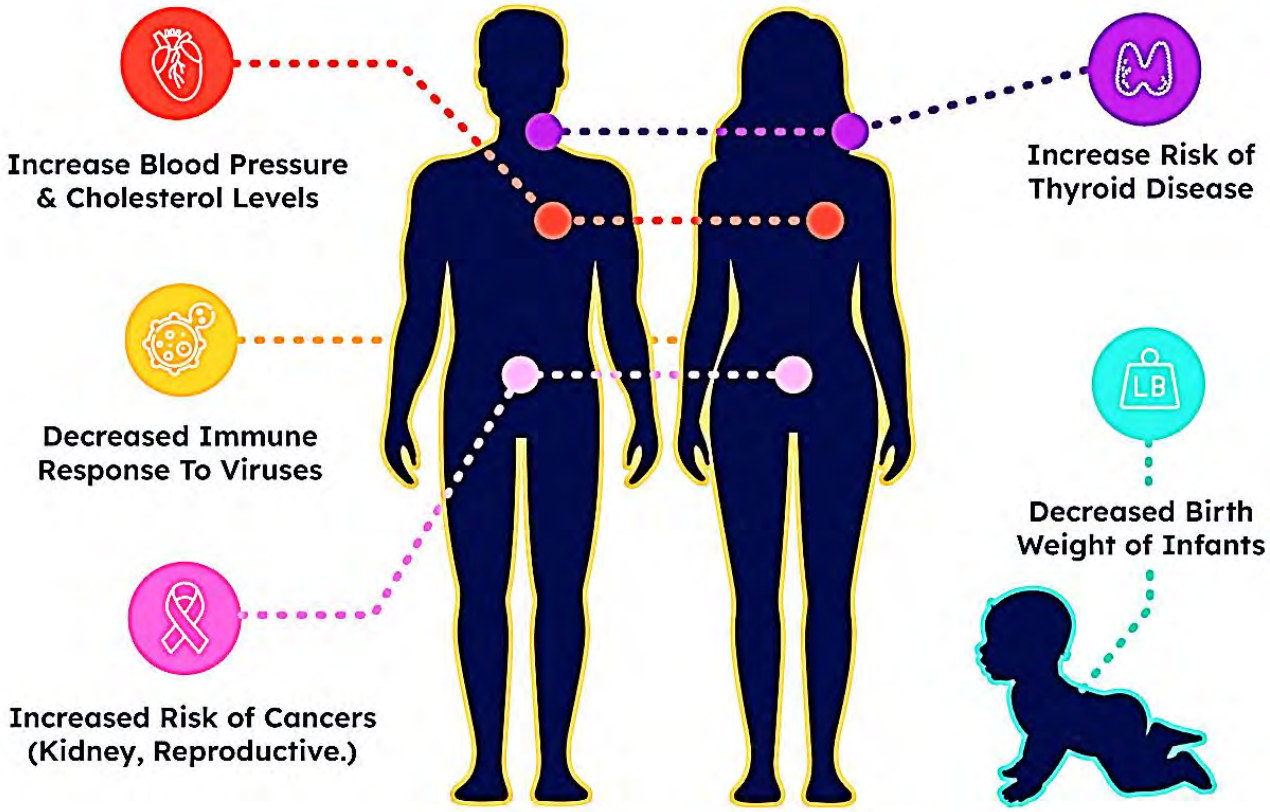
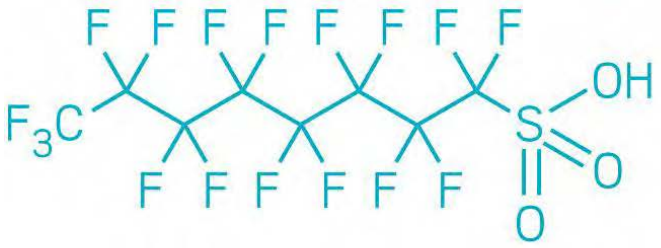
PFAS Toxicity and EPA Proposed Limit in Drinking Water

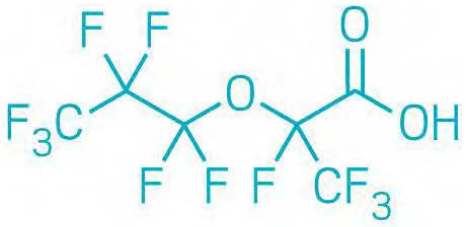
- Ubiquitous, persistent, and bio accumulative
- Increases cholesterol & risk of cancer, lowers immune response to viruses
- Increase the risk of thyroid disease
- Lowered birth weight of infant



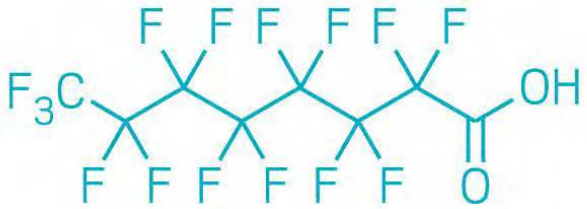
EPA Drinking Water Limit on PFAS



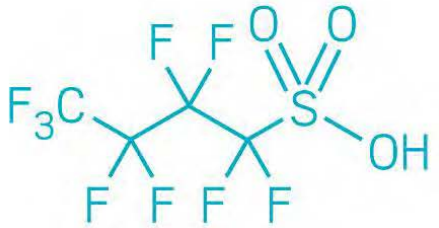
PFOS



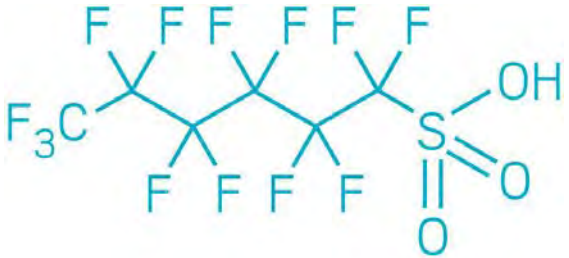
HFPO-DA



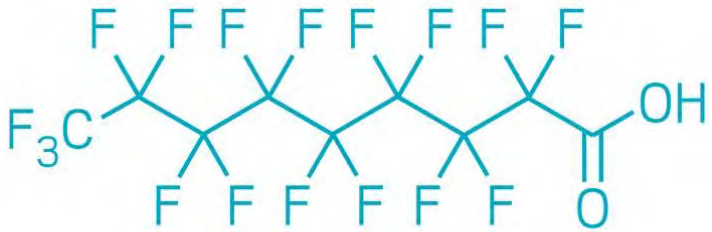
PFOA



PFBS



PFHxS



PFNA

U.S. ENVIRONMENTAL PROTECTION AGENCY

PFAS Compound	Proposed MCLG (non-enforceable)	Proposed MCL (enforceable)
PFOA	Zero	4.0 ng/L
PFOS	Zero	4.0 ng/L
PFNA	1.0 Hazard Index	1.0 Hazard Index
PFHxS		
PFBS		
GenX		

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PFAS Treatment Technologies

- Most focus is on adsorption/separation
- Degradation will be the key to remove
- Incineration is highly expensive
- Advanced oxidation/reduction processes are possibilities
- Several technologies are emerging

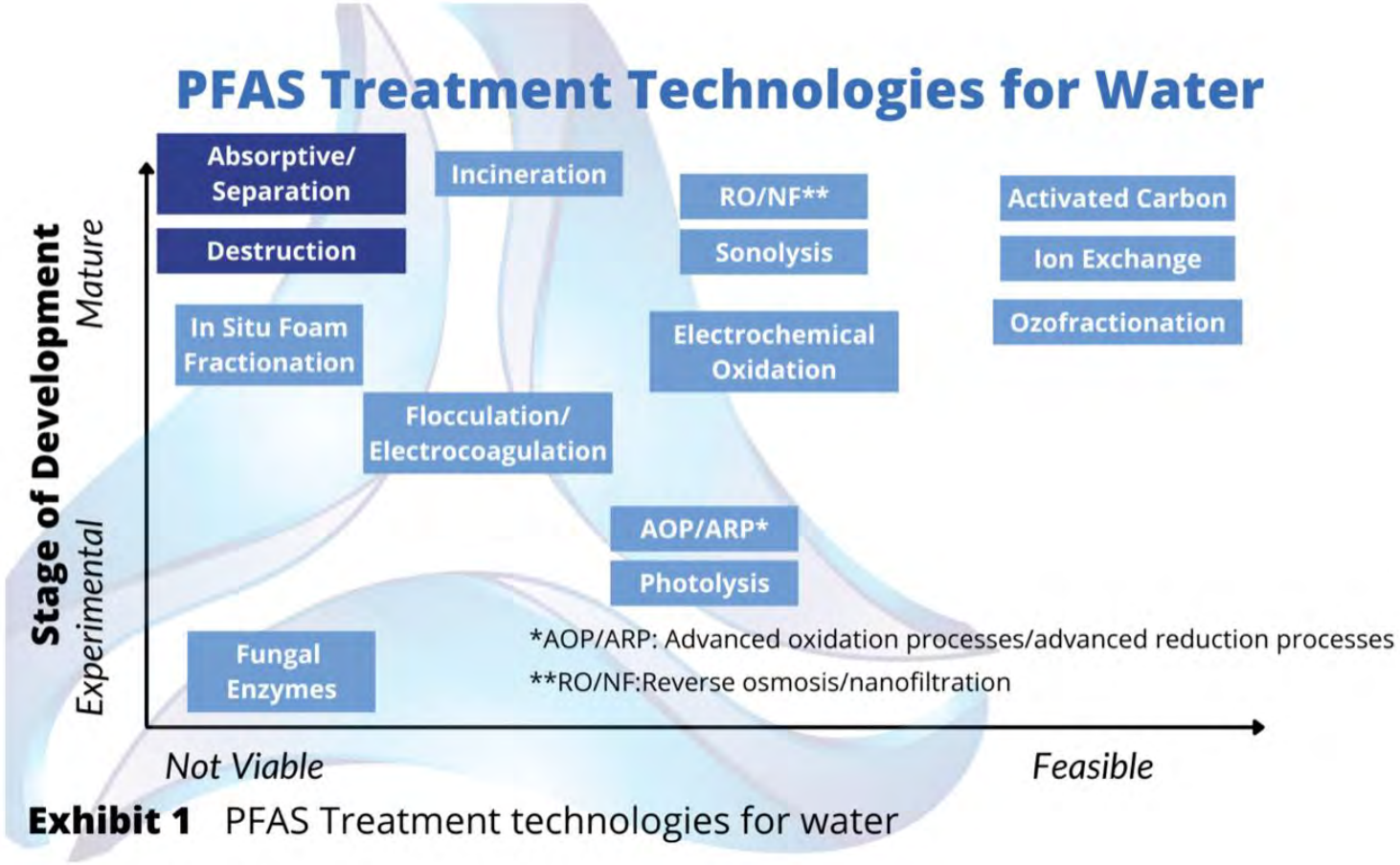

Exhibit 1 PFAS Treatment technologies for water

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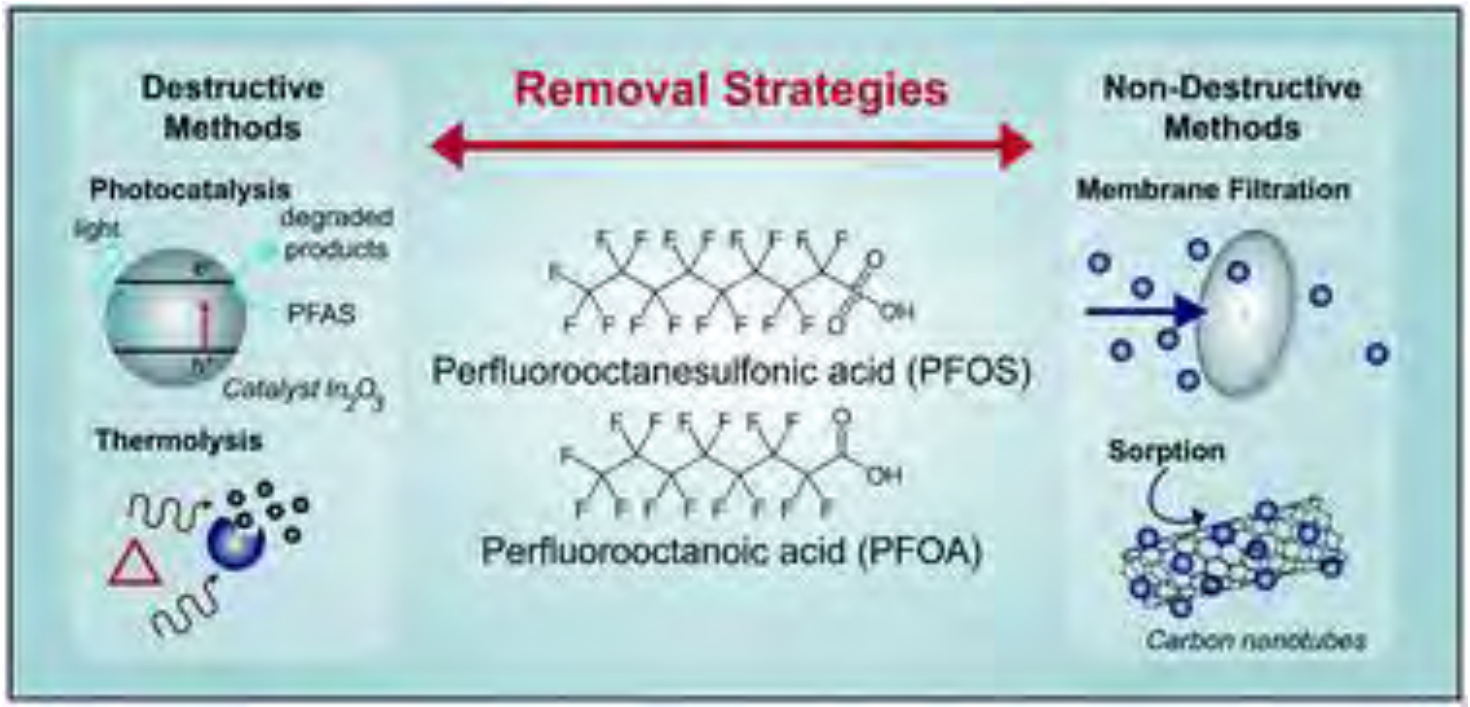
Nanomaterials for PFAS Treatment

- Nanomaterials can have high efficiency due to highly active surface area
- Surface modification is possible
- Potential for regeneration and reuse



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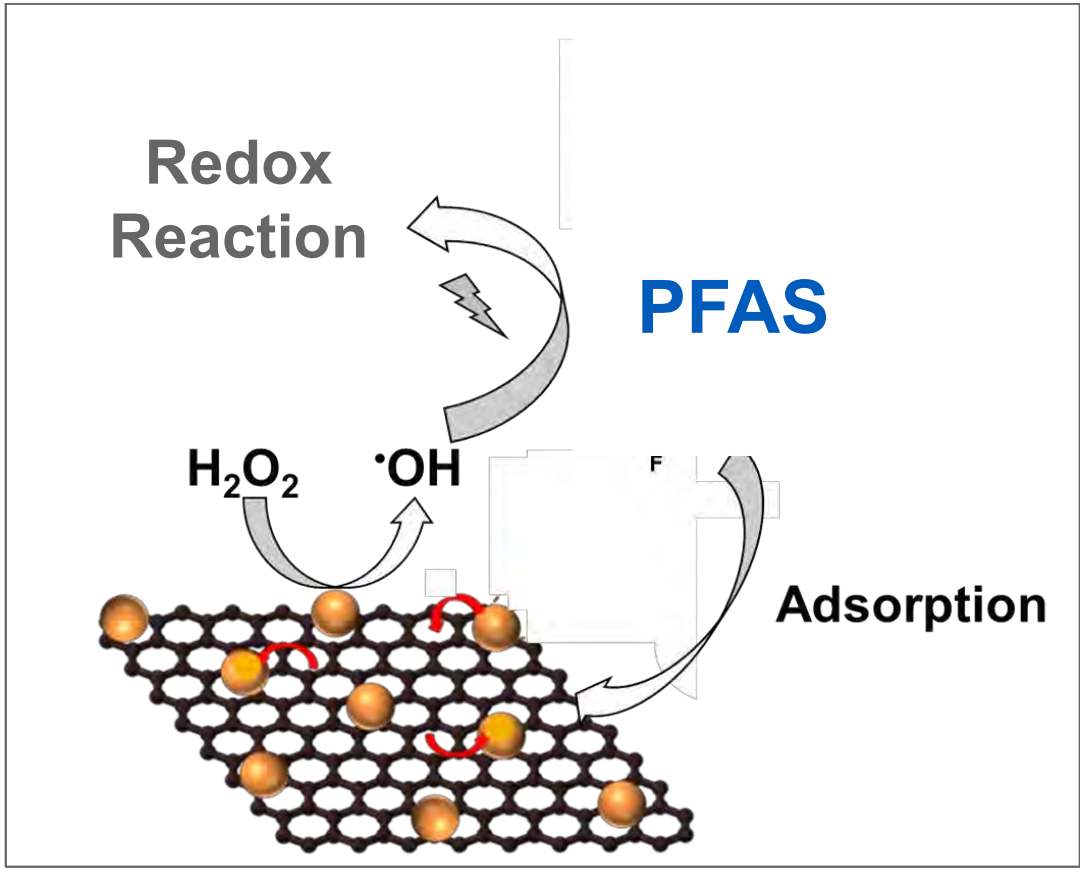
Graphene-Metal Nanohybrids for PFAS Treatment

Use **reduced graphene oxide-nanoscale zero-valent iron nanohybrid (rGO-nZVI NH)** to

- Treat PFASs with different head groups and chain-length
- At environmentally relevant concentration (sub-ppm)
- Exploiting both **adsorption** and **advanced oxidation process (AOP)**
- Determine if any **degradation** is happening



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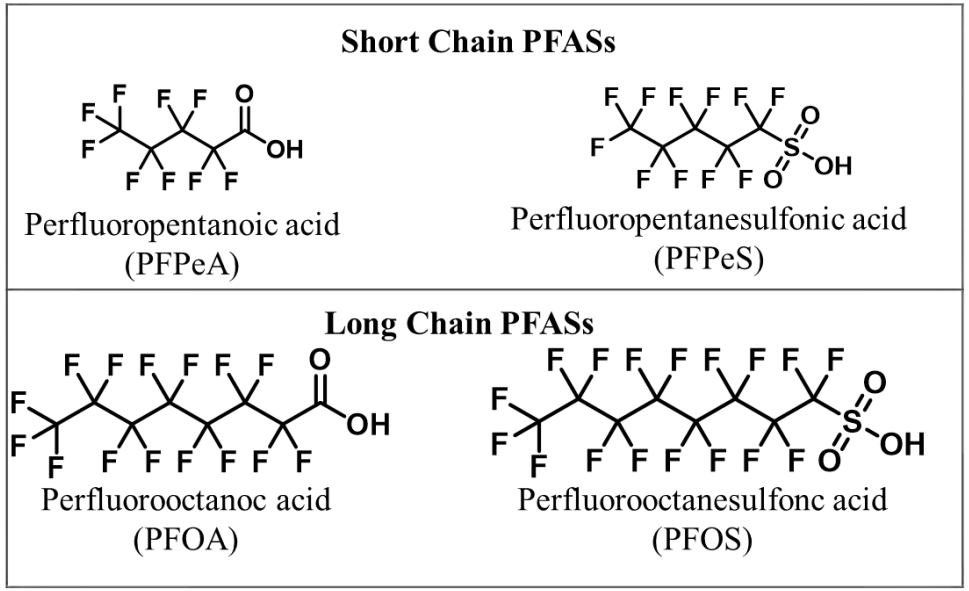
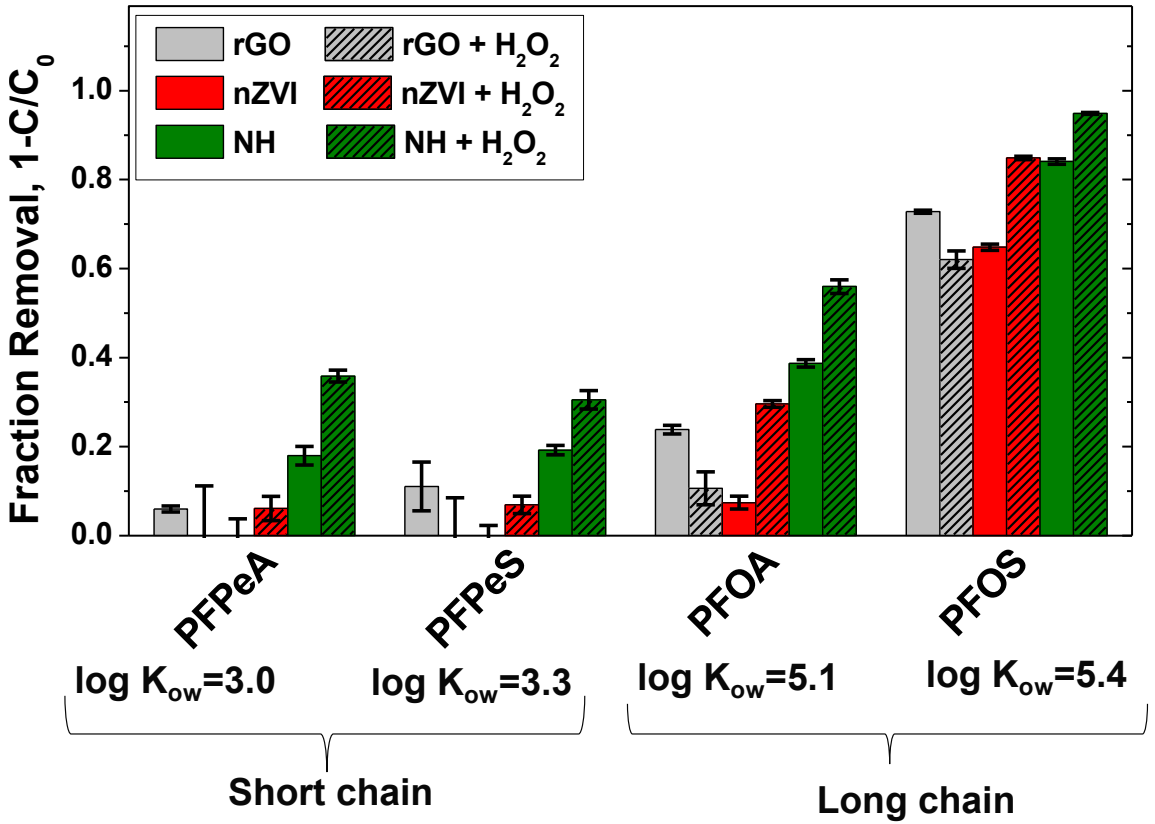
Graphene-Metal Nanohybrids for PFAS Treatment





- Long chain PFAS (PFOS and PFOA) are removed more than short chain ones (PFPeA and PFPeS): Hydrophobicity ($logk_{ow}$) dictated the removal efficiency
- rGO-nZVI NHs remove PFAS faster than rGO and nZVI
- AOP removes PFAS better and faster than adsorption

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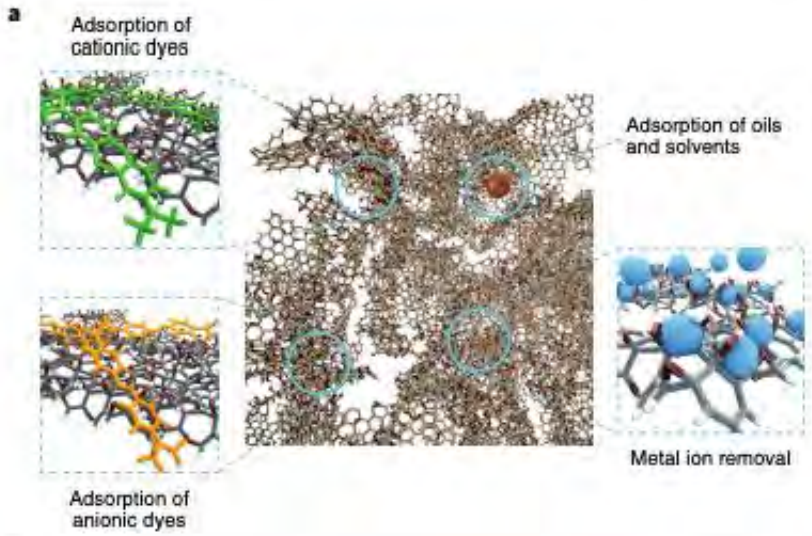
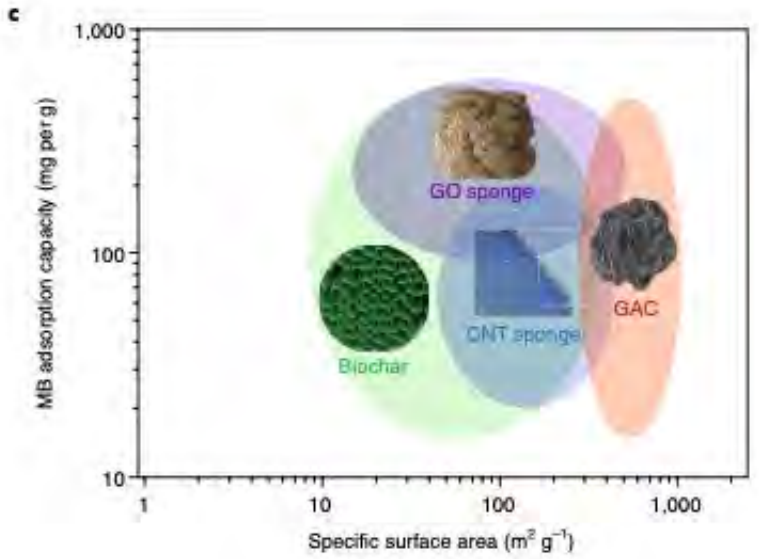
Graphene Aerogels for Water Treatment





nature nanotechnology
REVIEW ARTICLE
https://doi.org/10.1038/s41565-018-0325-6

Environmental performance of graphene-based 3D macrostructures

Nariman Yousefi[1], Xinglin Lu[2], Menachem Elimelech[2] and Nathalie Tufenkji[1*]

- ***Porous structure* and *mechanical stability*** and excellent candidates for pollutant adsorption
- Conventional <u>self-assembly synthesis routes</u> including hydrothermal and direct cross-linking are limited to provide scalability and architectural flexibility
- *Need <u>scalable</u> process* with *<u>controllable architecture</u>* to place into geometrically optimized water treatment devices

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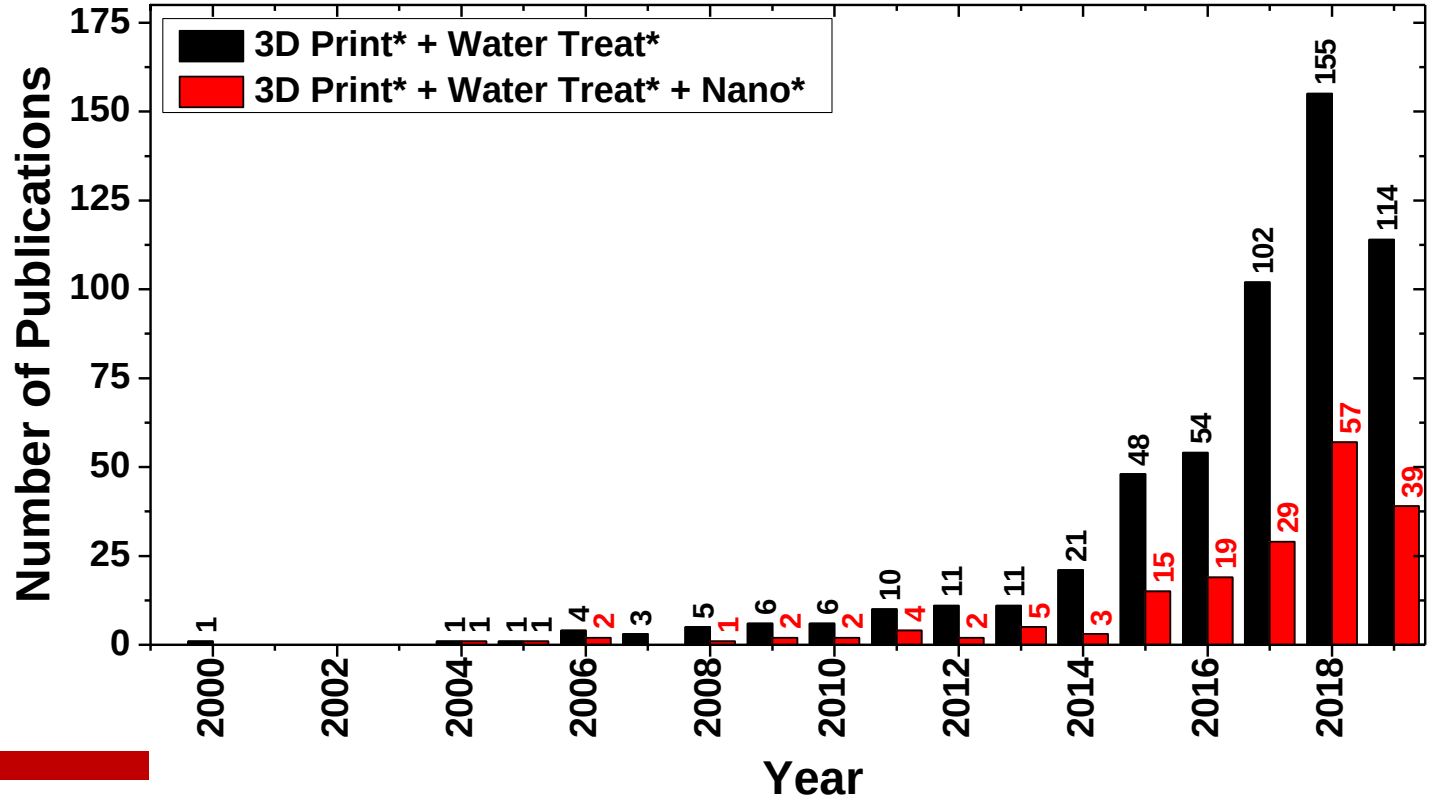
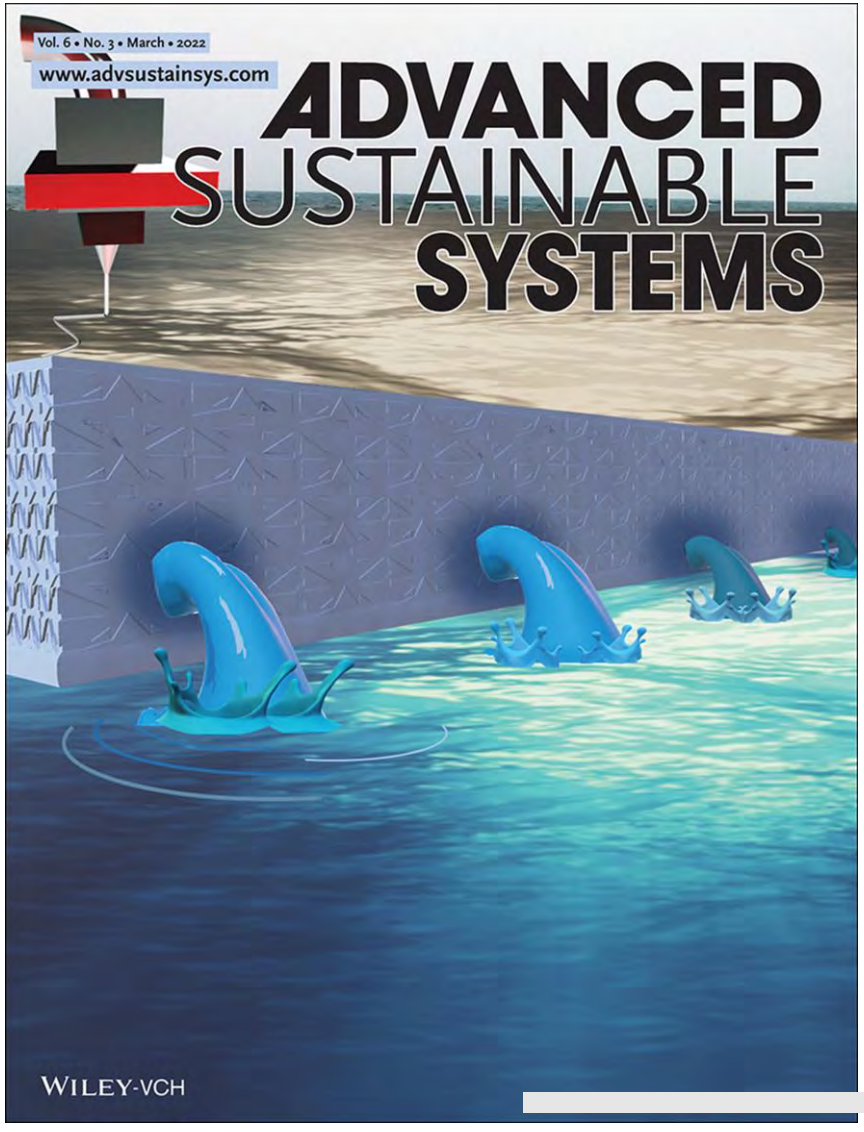
Additive Manufacturing or 3D Printing in Water Treatment: Trends

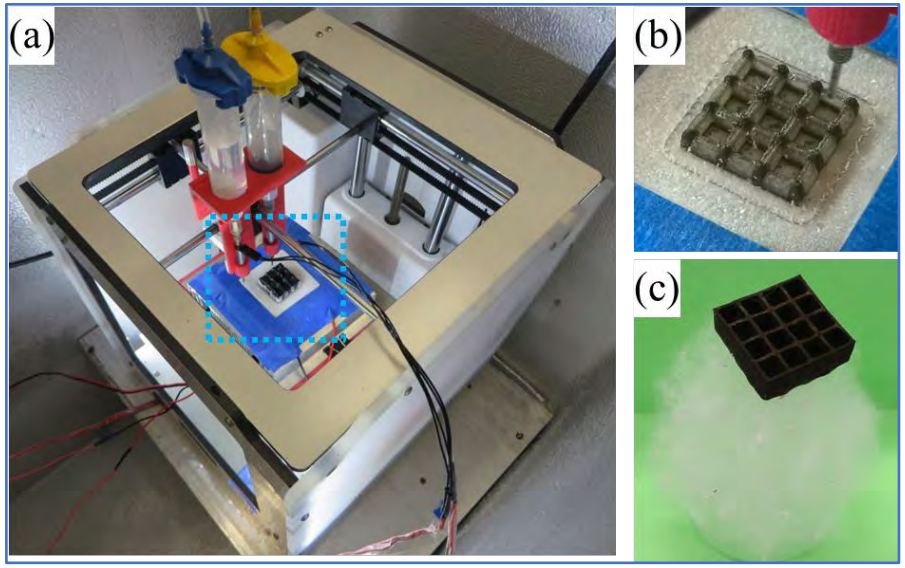
- Additive manufacturing offers unique advantages over top-down manufacturing
  a) Lowered material cost and waste
  b) Flexibility to design complex structures with high precision
  c) Combine material functionalities for improved applications

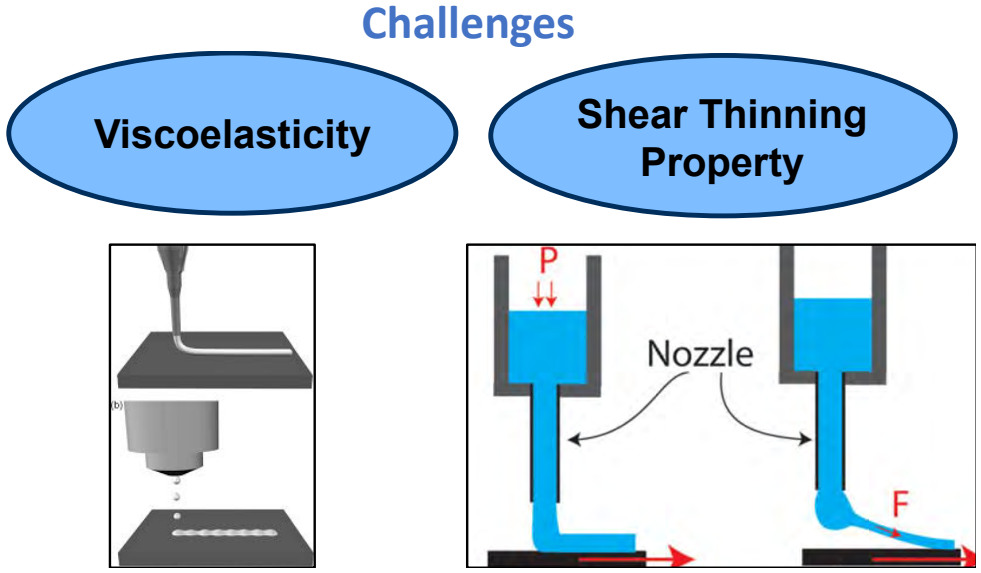




Direct Ink Writing (DIW) 3D Printing of Graphene Aerogels: Challenges

- *DIW printing refers to the continuous extrusion of ink materials in a layer-by-layer scheme to obtain a 3D structure*
- Challenge 1: Finding op*timum* *viscosity* *and* *printability*
- Challenge 2: *Stability of the printed aerogel in water*





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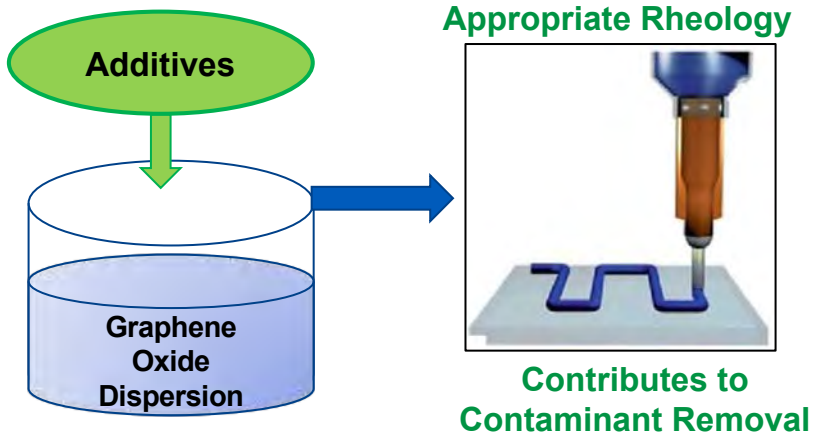
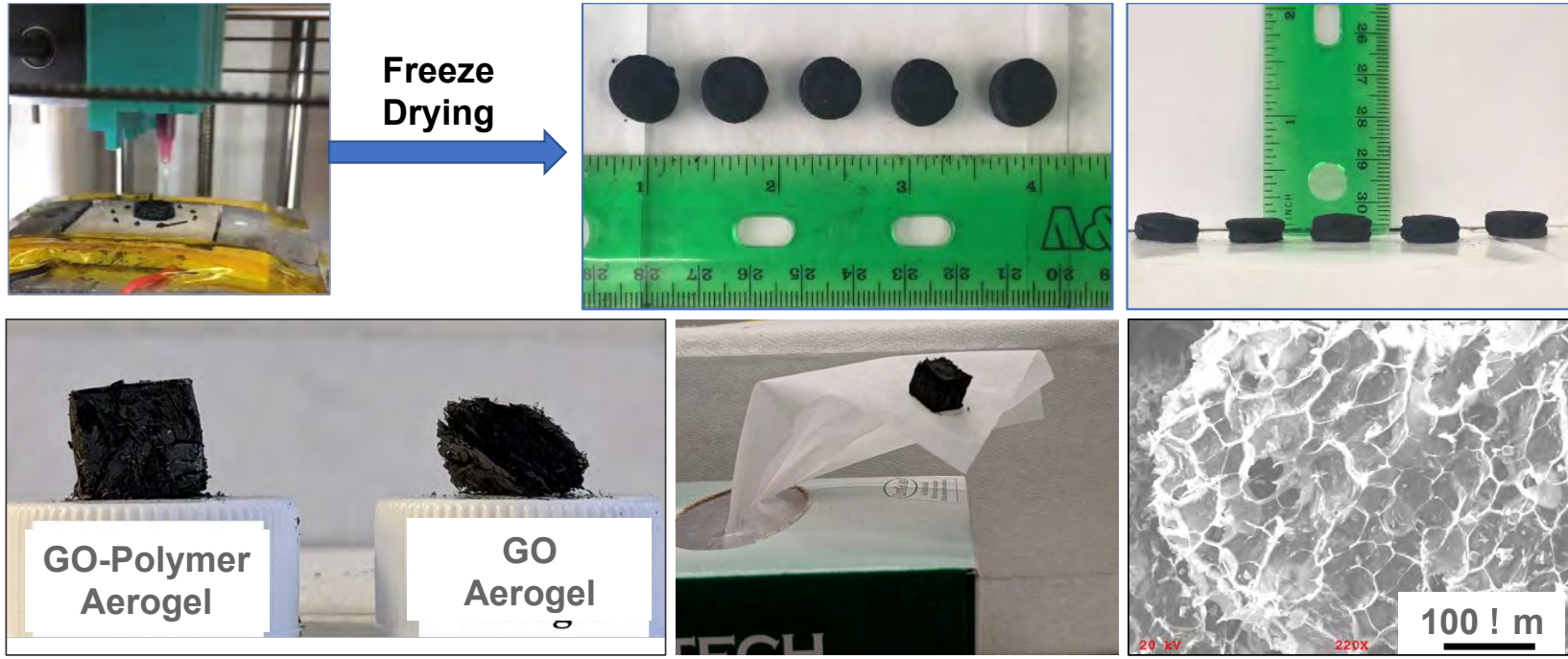
Direct Ink Writing (DIW) 3D Printing of Graphene Aerogels: Solution

- We added two different polymers to GO
- Changed the ratios to achieve optimum viscosity, printability, and water stability
- The added polymers are also known to contribute to the contaminant removal





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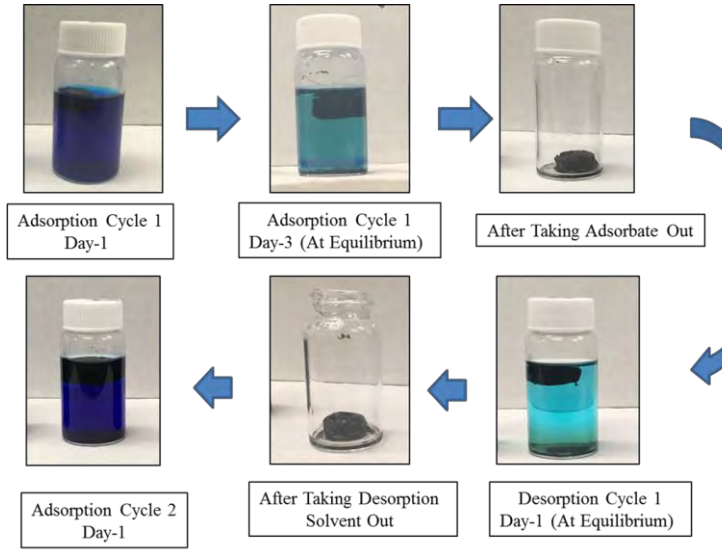
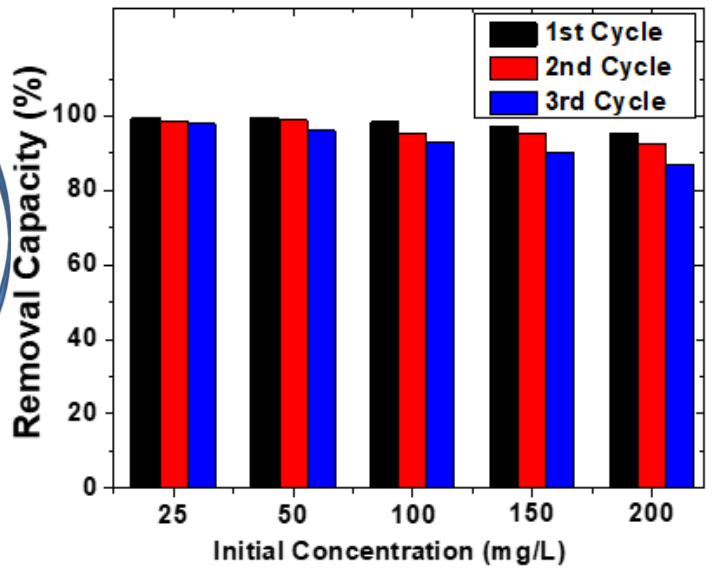
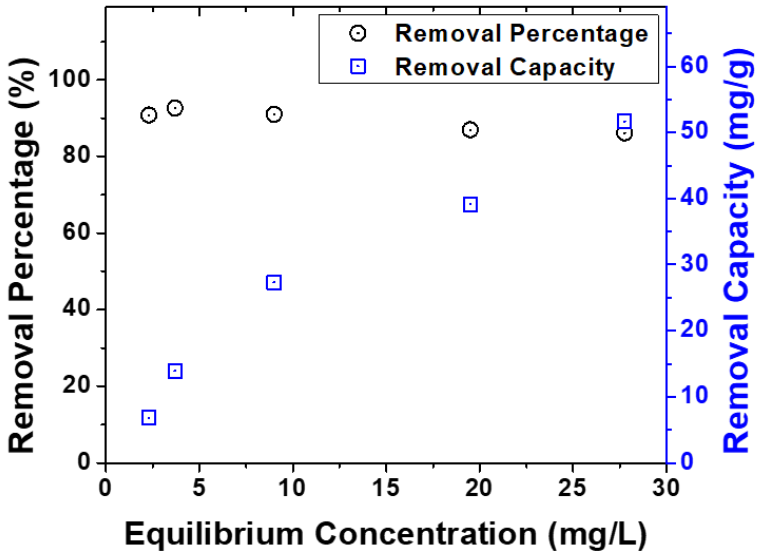
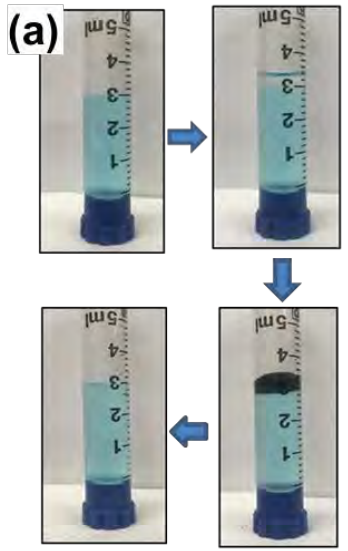
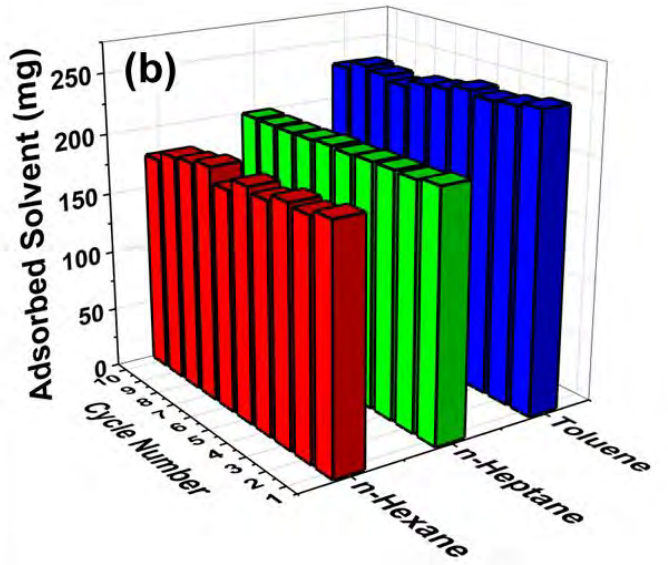
Contaminant Adsorption by 3D Printed Aerogels











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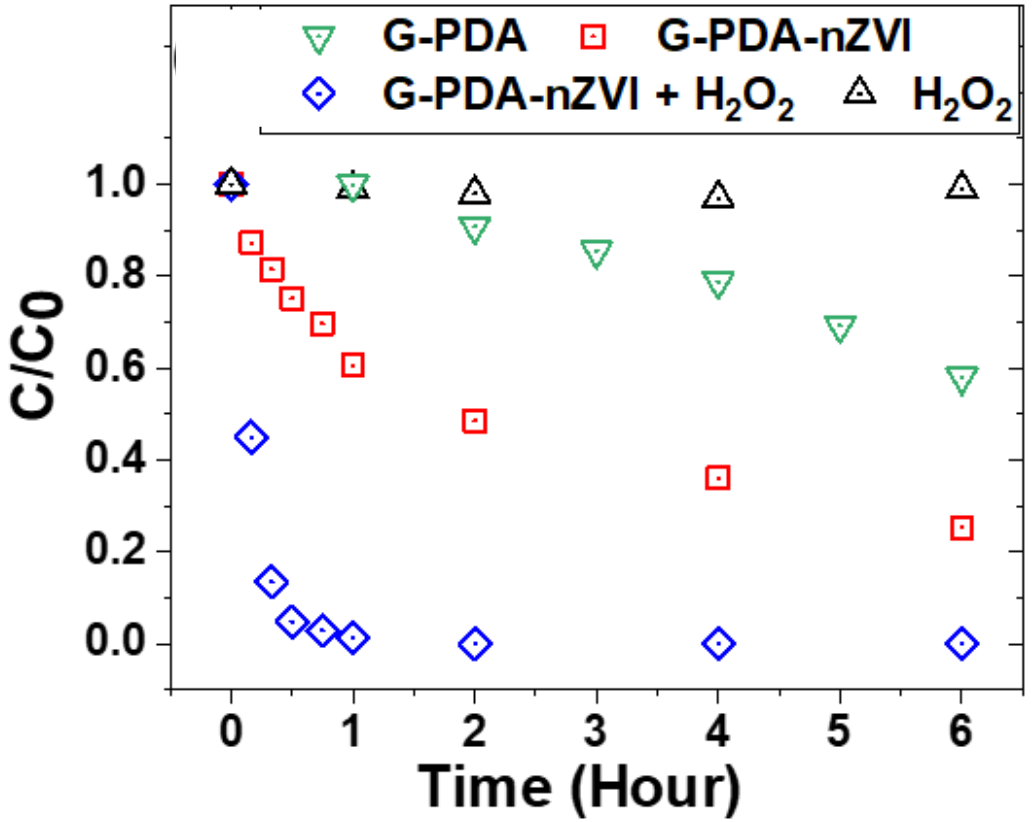
Contaminant Degradation by 3D Printed Graphene-Metal Aerogel

- Incorporated nano zero-valent iron (nZVI) to provide heterogeneous Fenton catalysis
- G-PDA-nZVI degrades 99% MB after 1 hour in the presence of H_2O_2



Masud et al in prep

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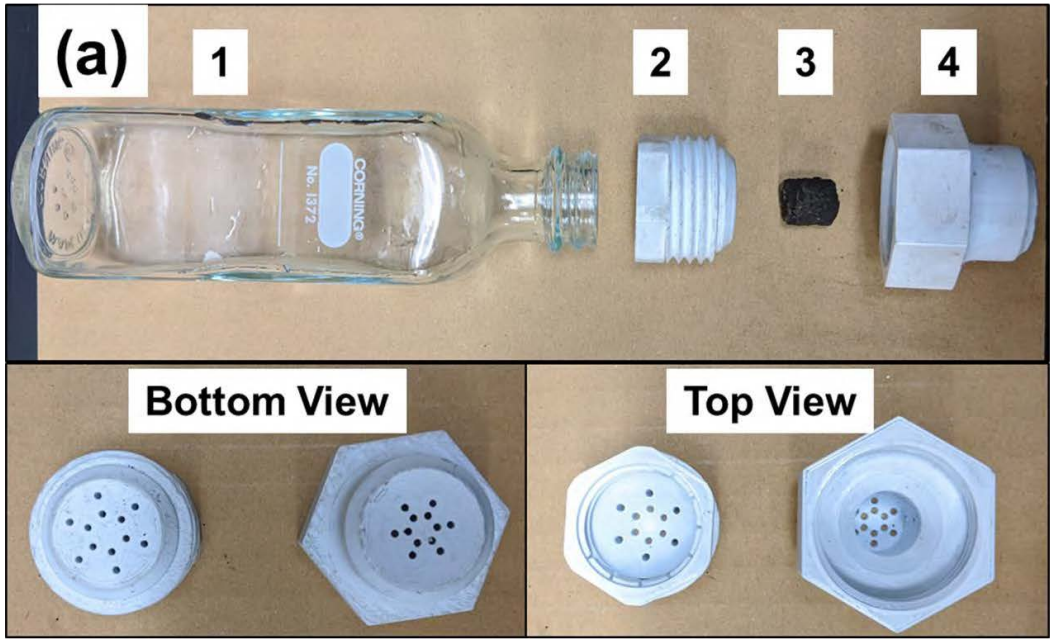
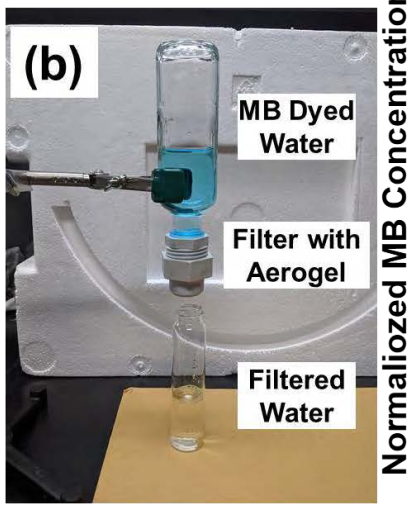
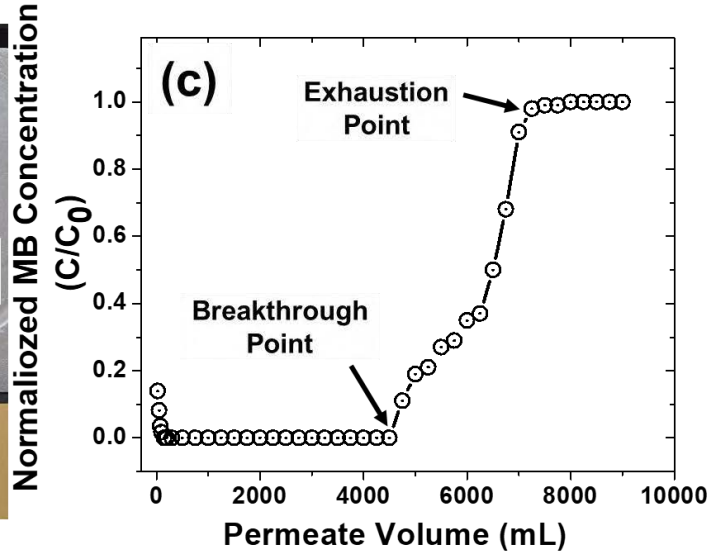
Contaminant Removal by 3D Printed POU Filter







Masud et al., Environmental Science: Nano, 2021

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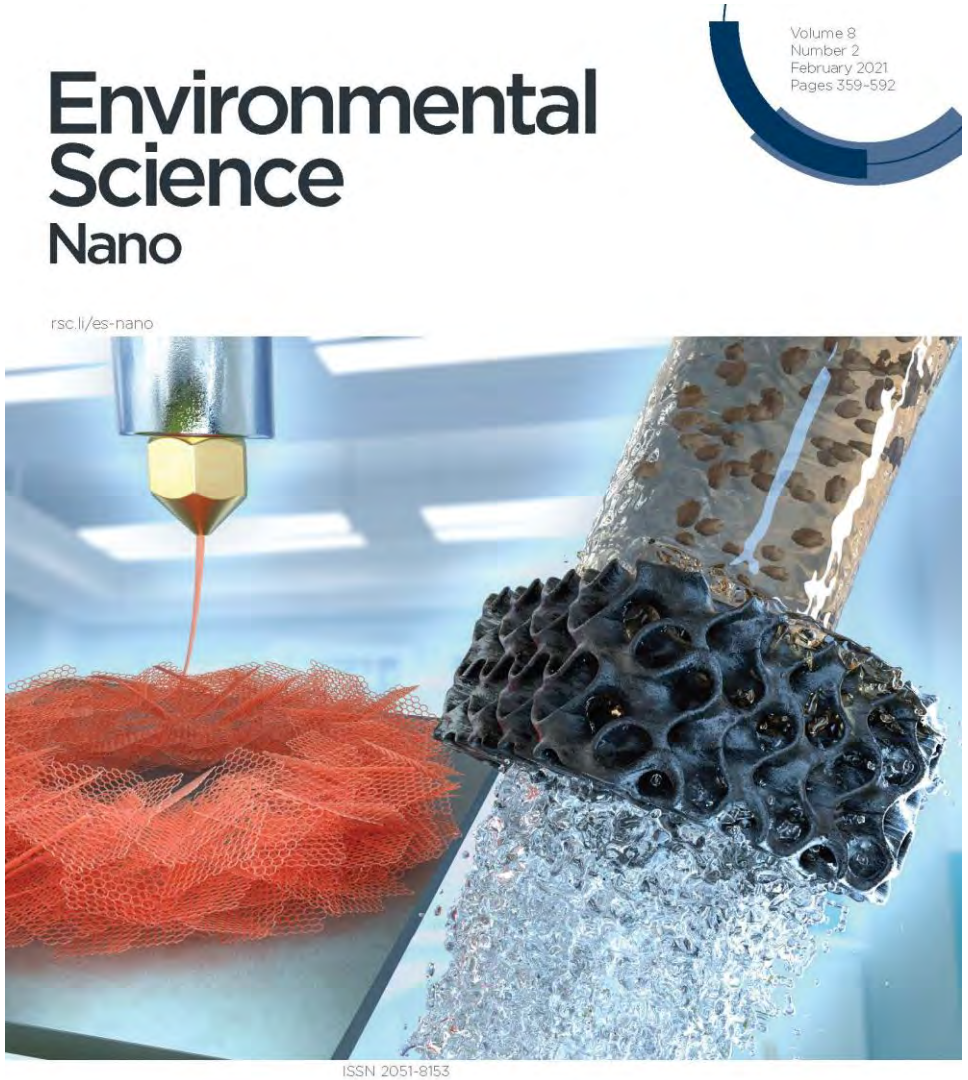
Combination of 3D Printed Aerogels for PFAS Treatment

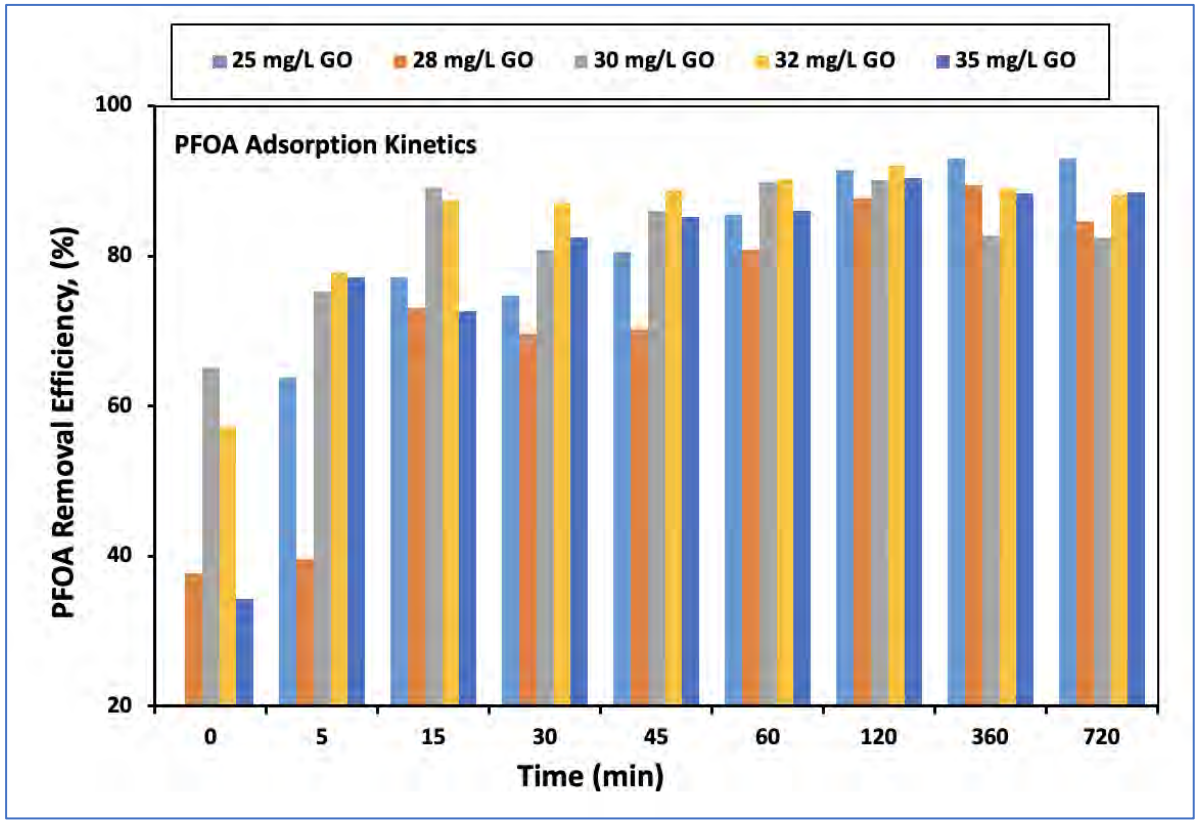
- Can we use 3D printed graphene-metal aerogels for PFAS treatment?
- What will be the mechanisms of interactions?
- How would the efficiencies change from powder based systems?
- Is tuning of aerogel structures possible to tune PFAS treatment?

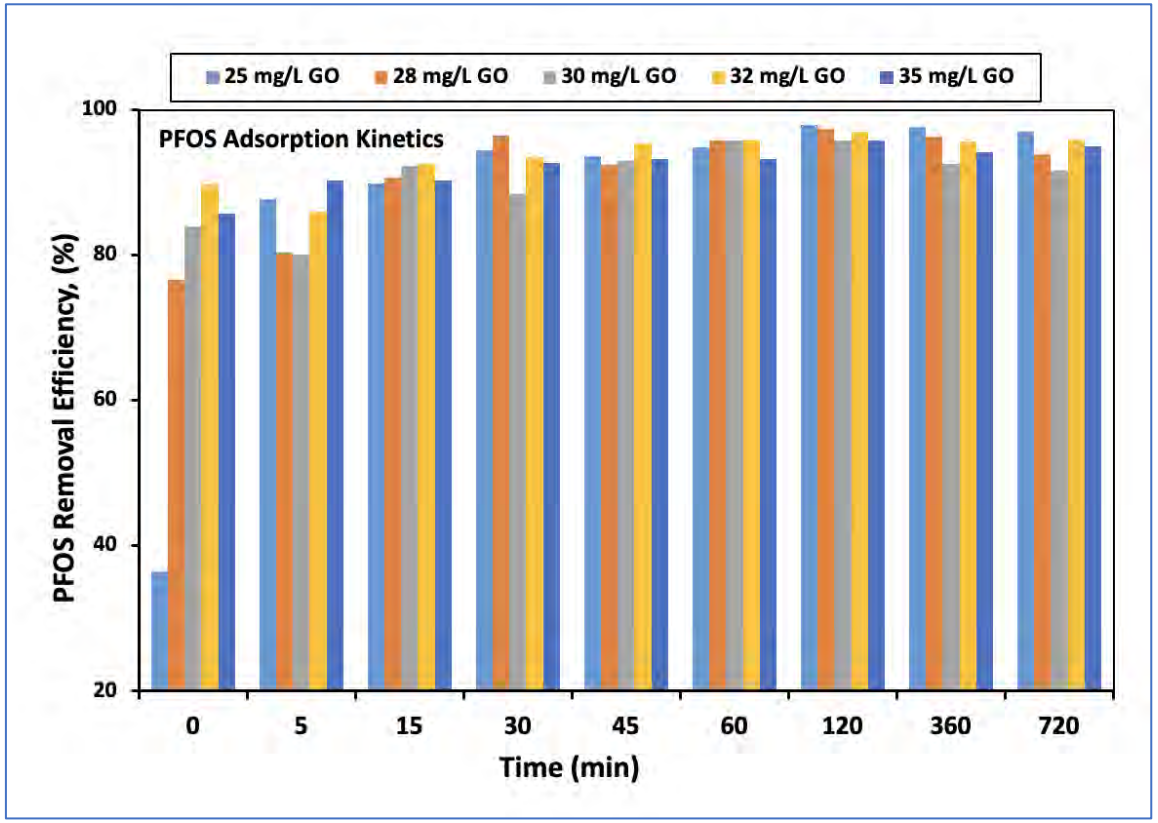
NSF CAREER AWARDS



Preliminary Results: PFAS Adsorption Using 3D Printed Graphene Aerogels

- Tested different compositions of Graphene-Polymer Aerogels
- Low GO aerogels have lower rates initially but highest adsorption capacity





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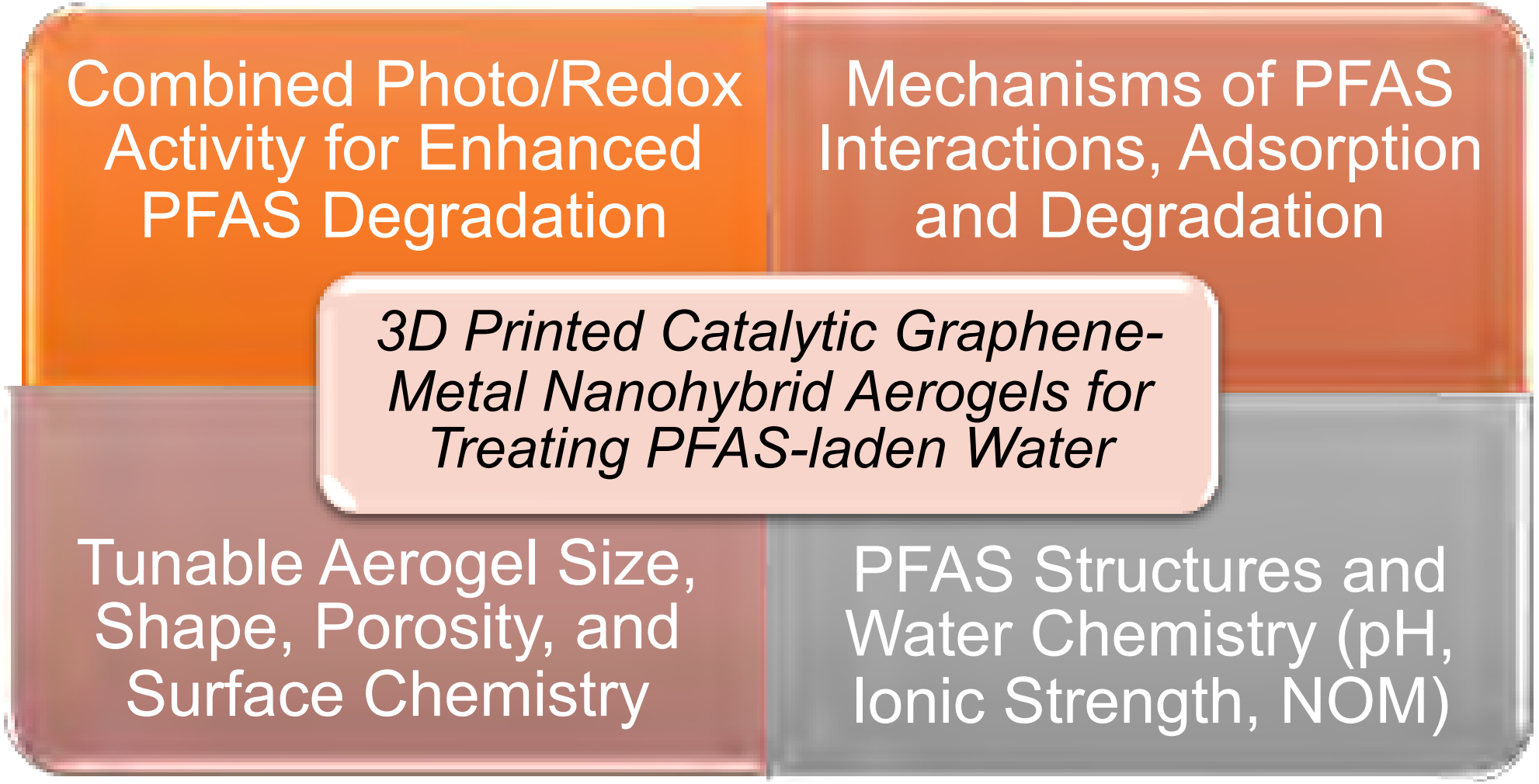
Long Road Ahead…….



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Nanotechnology Variations for PFAS Treatment

Nano-Bio Remediation

National Institute of Environmental Health Sciences
Superfund Research Program

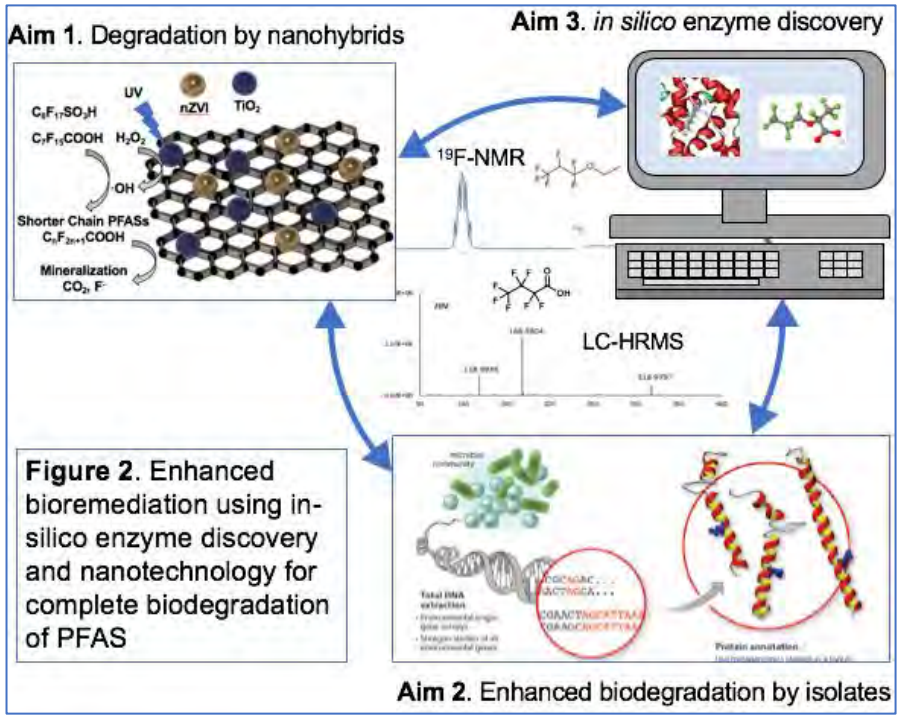
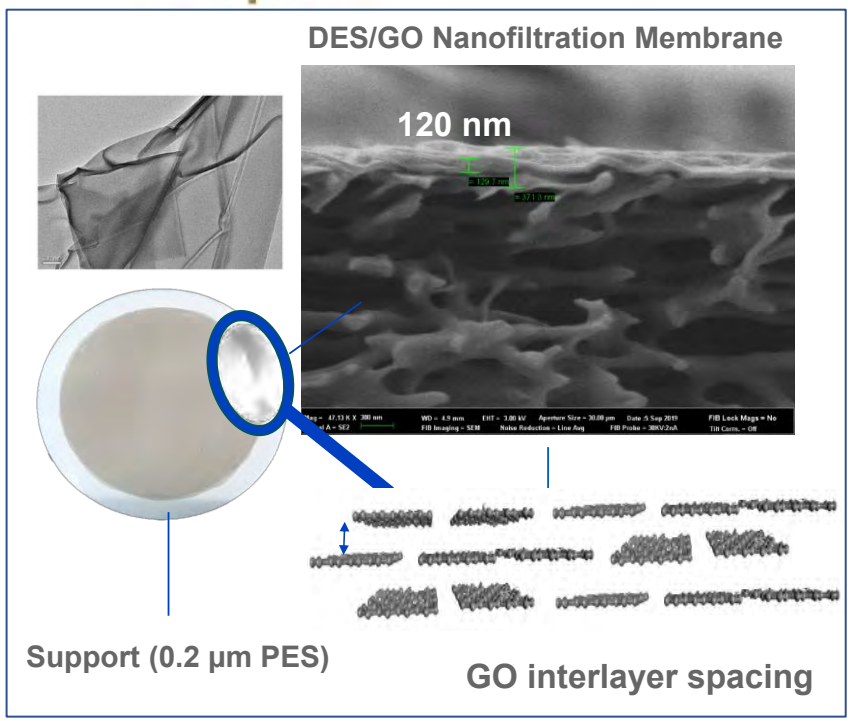


Figure 2. Enhanced bioremediation using in-silico enzyme discovery and nanotechnology for complete biodegradation of PFAS

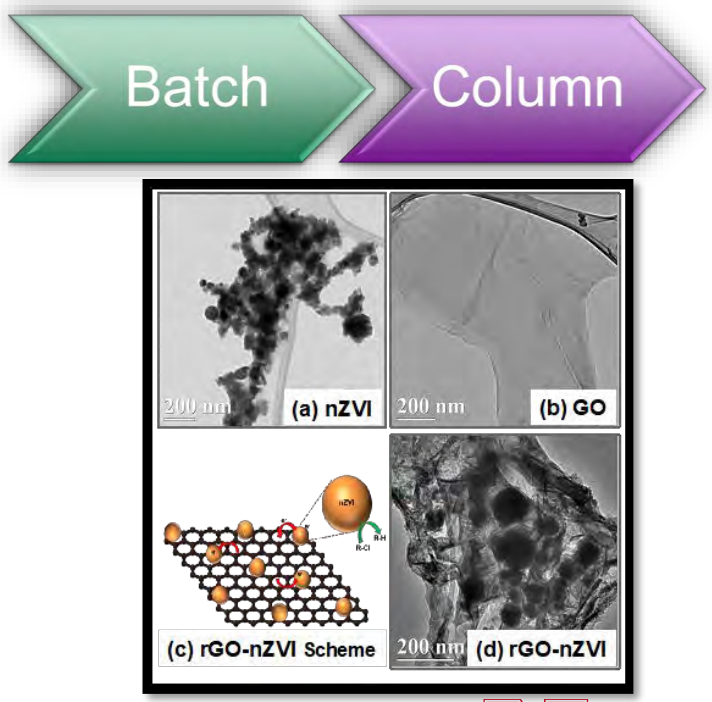
Nanocomposite Membrane

National Science Foundation



Nano-Modified Sorbents

SERDP
DOD • EPA • DOE



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Anika Azme

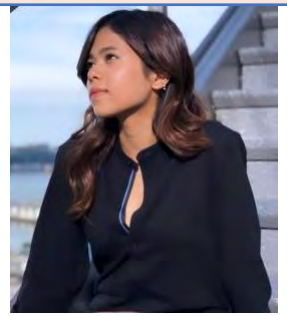
Ph.D. (Alumni)

Dr. Arvid Masud

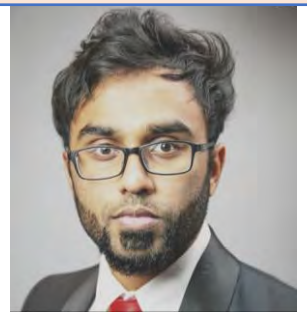
Dr. Novin Mehrabi

M.S.

Tashfia Mohona



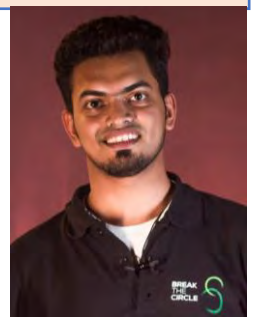
Anika Tabassum



Umar Faruq

Shruti Jagini

Laura Kowalski



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Zach Shepard

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Mollika Urmi

Dao Sysouvanh

Anusha Gupta

Lillian Baker

Shequana Courtney

Connor Bannochie

Sustainable Materials for Advanced wateR Treatment & Environmental Remediation (SMARTER)

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Q and A

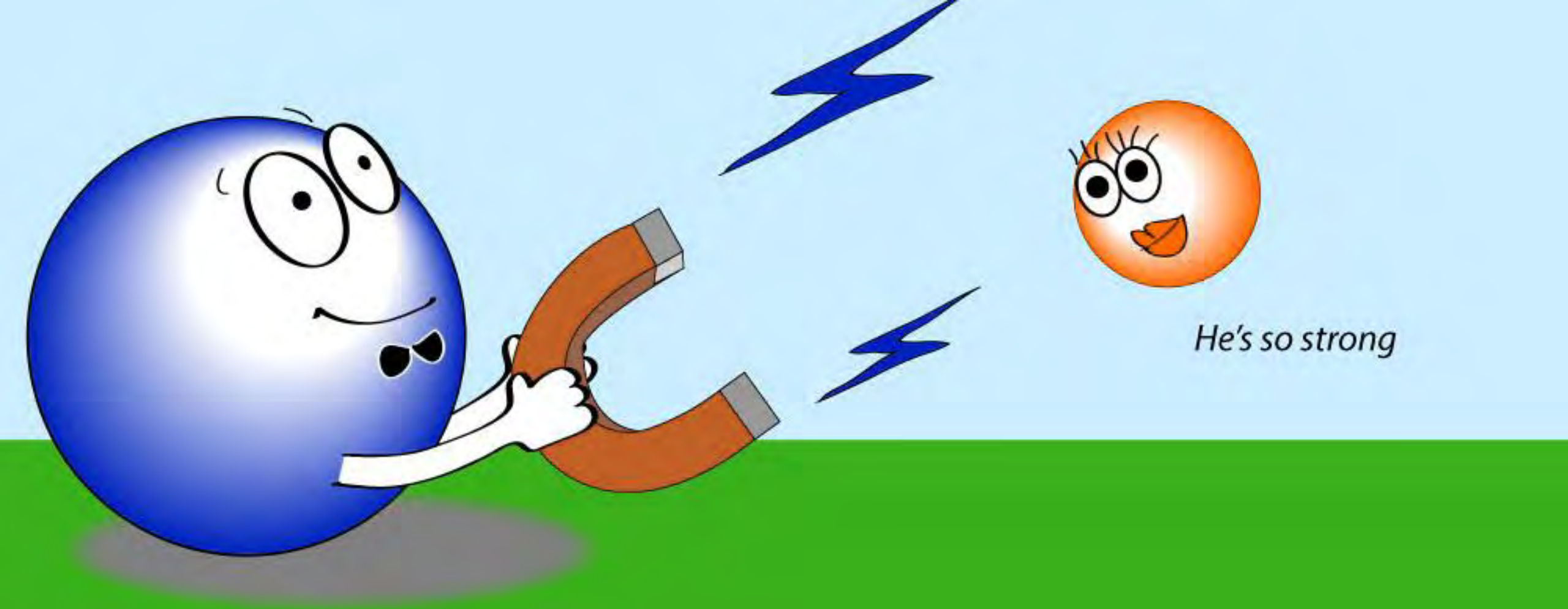
If you have a question, just click on the Q and A icon on the bottom of the screen and type it in there.

Breaking Down the Silos - Multimedia PFAS Workgroup

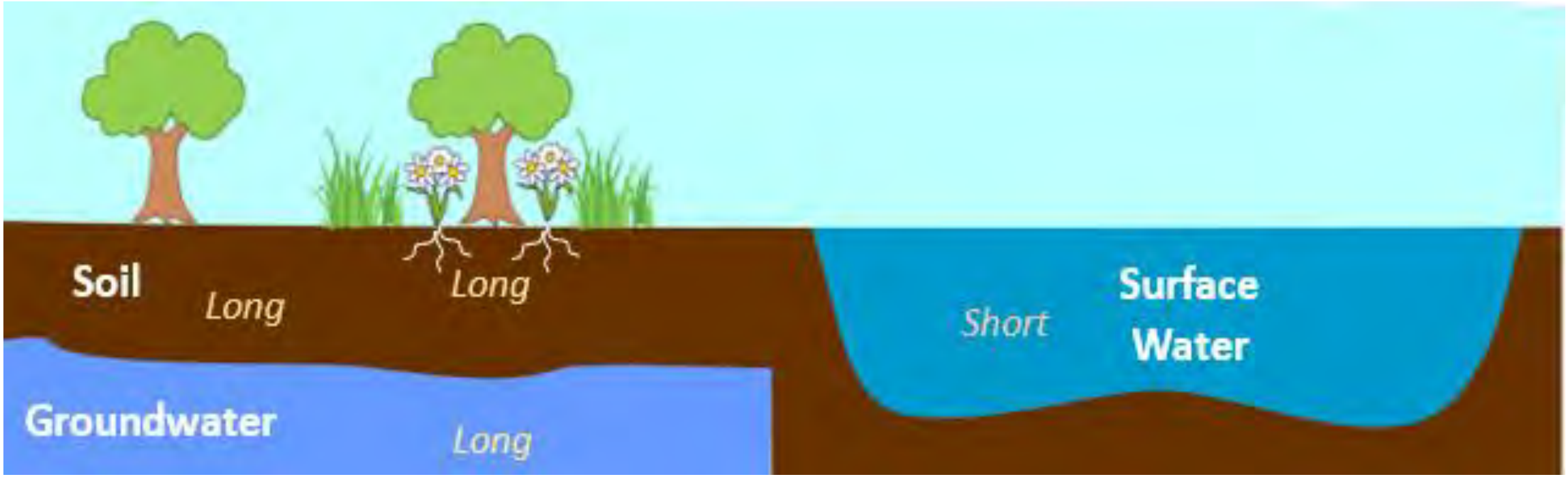
AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

Dr. Stephanie C. Bolyard

Senior Engineer to the Assistant Secretary
North Carolina Department of
Environmental Quality



ELECTRONEGATIVITY


Soil
Long
Long
Groundwater
Long
Short
Surface
Water


CARPETS


CARPET CLEANING
PRODUCTS


FOOD PACKAGING


FURNISHIN


COSMETICS


OUTDOOR GEAR


CLOTHING

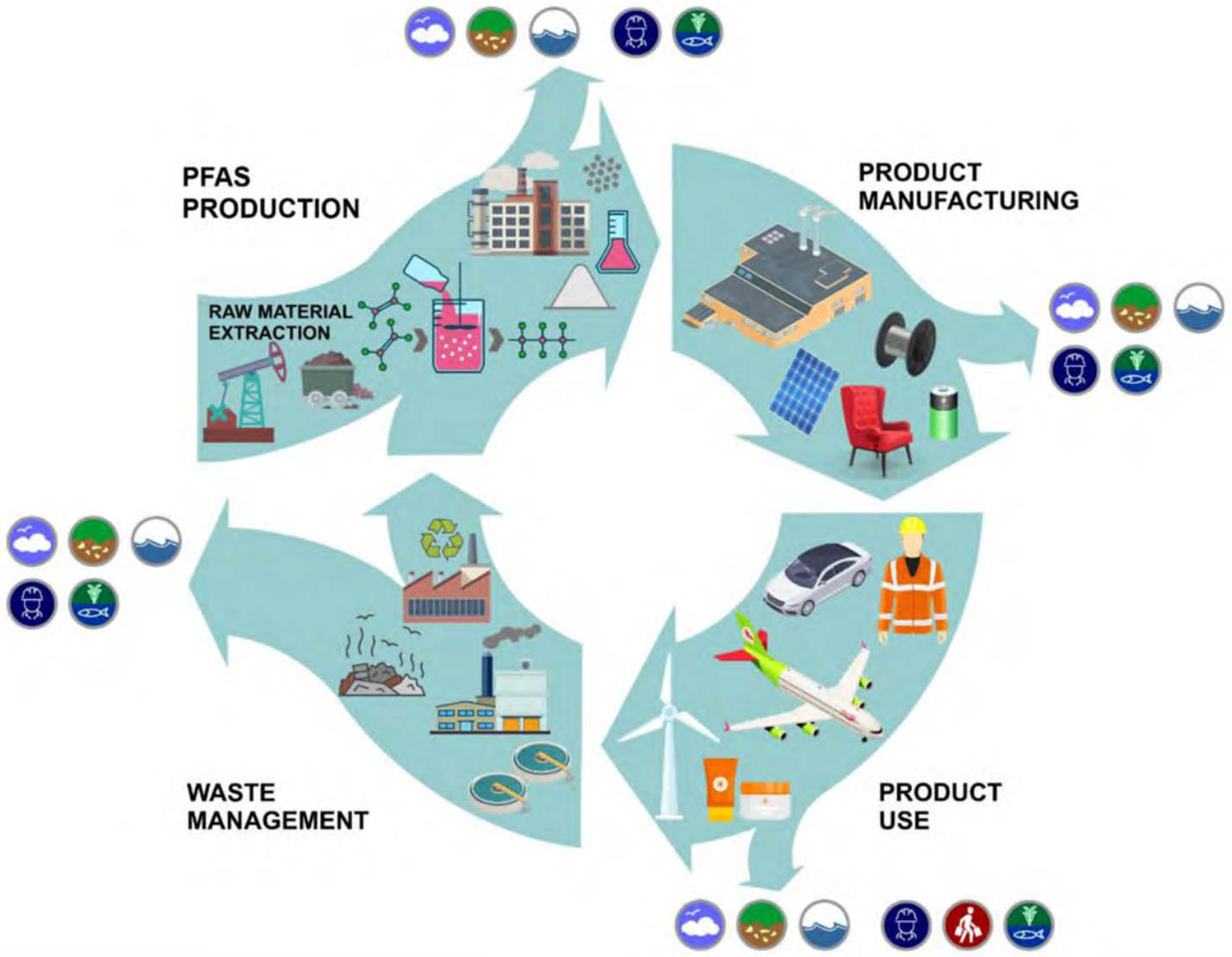

ADHESIVES AND SEALAN


PROTECTIVE COATINGS


NON-STICK COOKWARE


CARSEATS


FIREFIGHTING FO

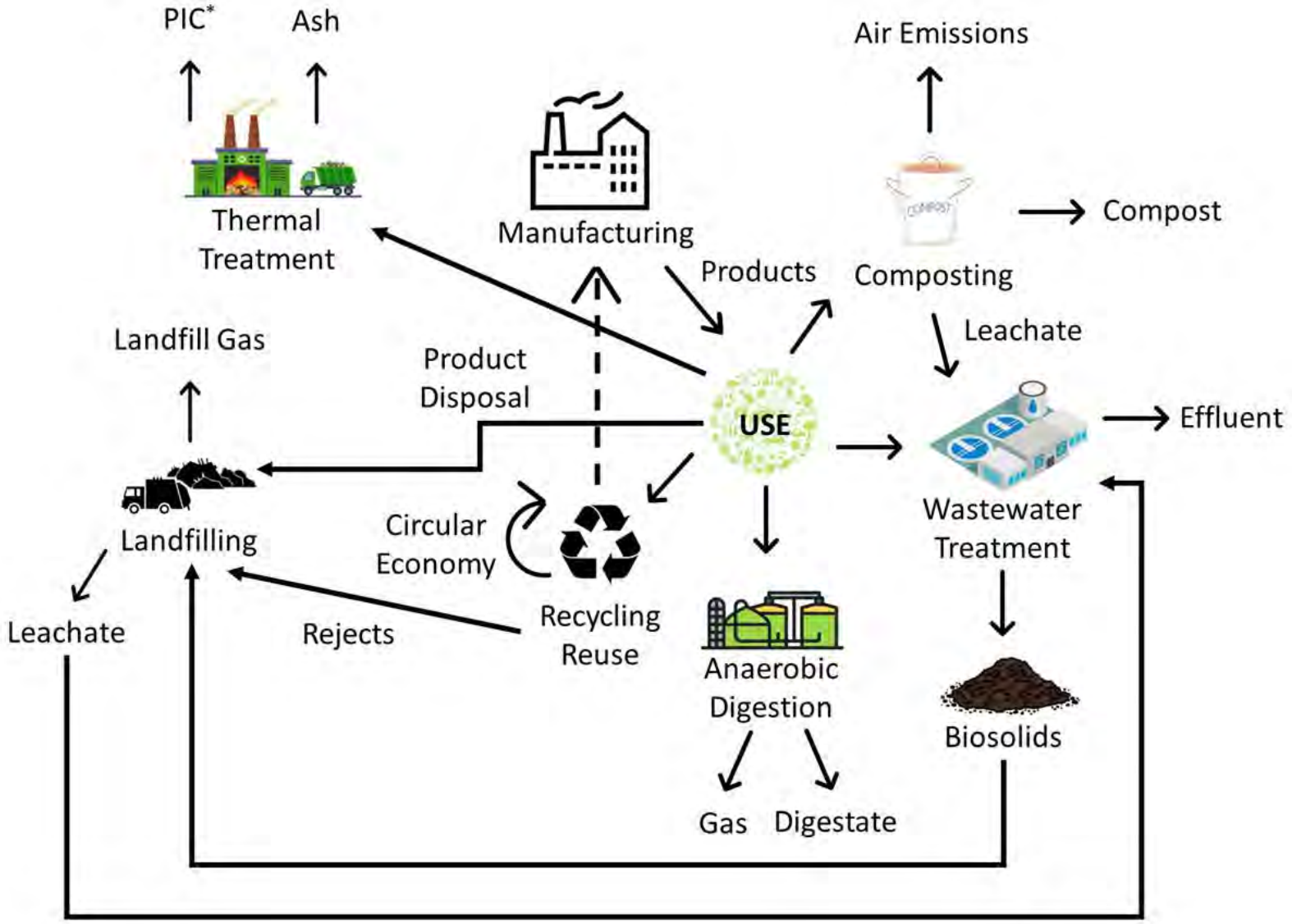


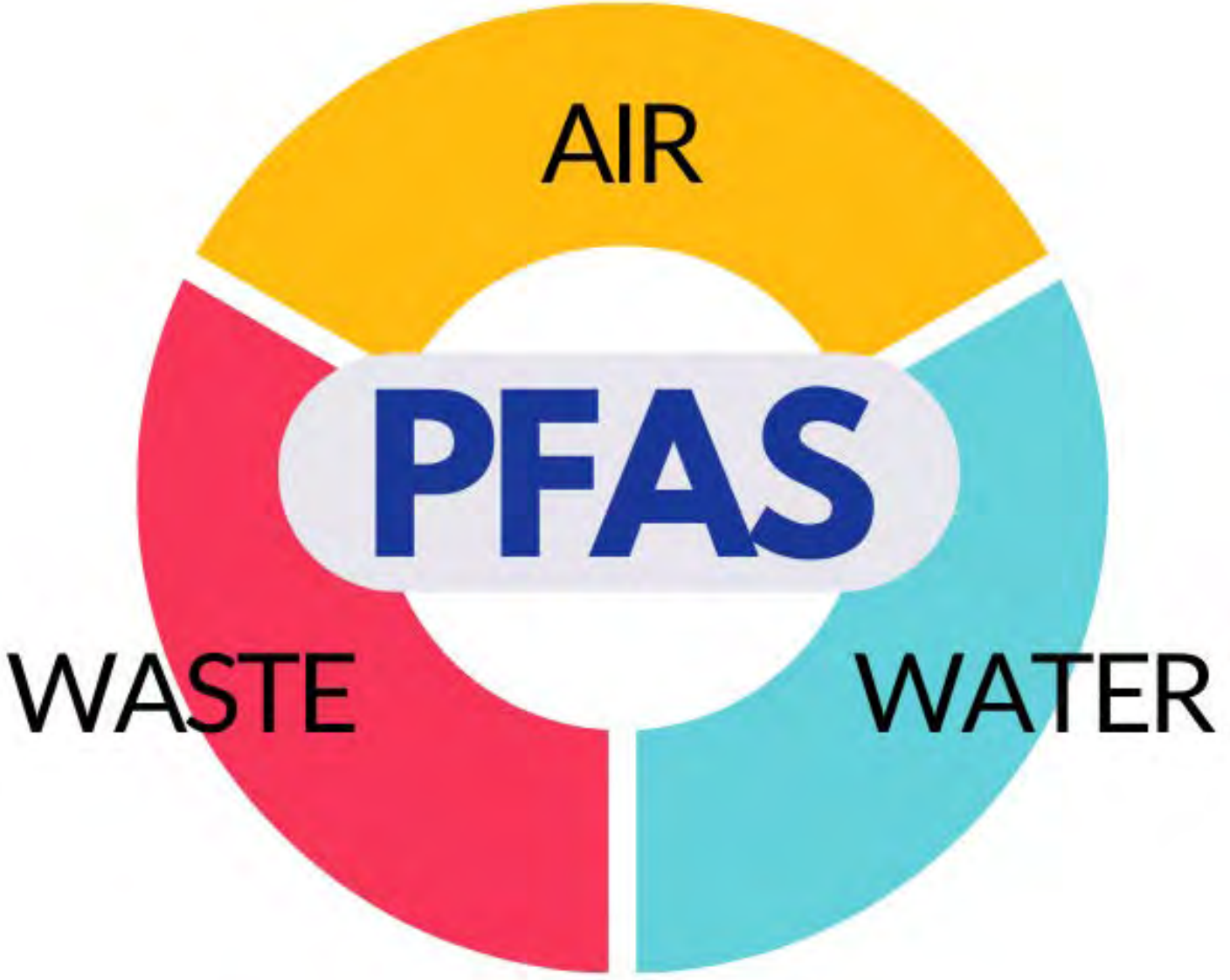
Emissions:

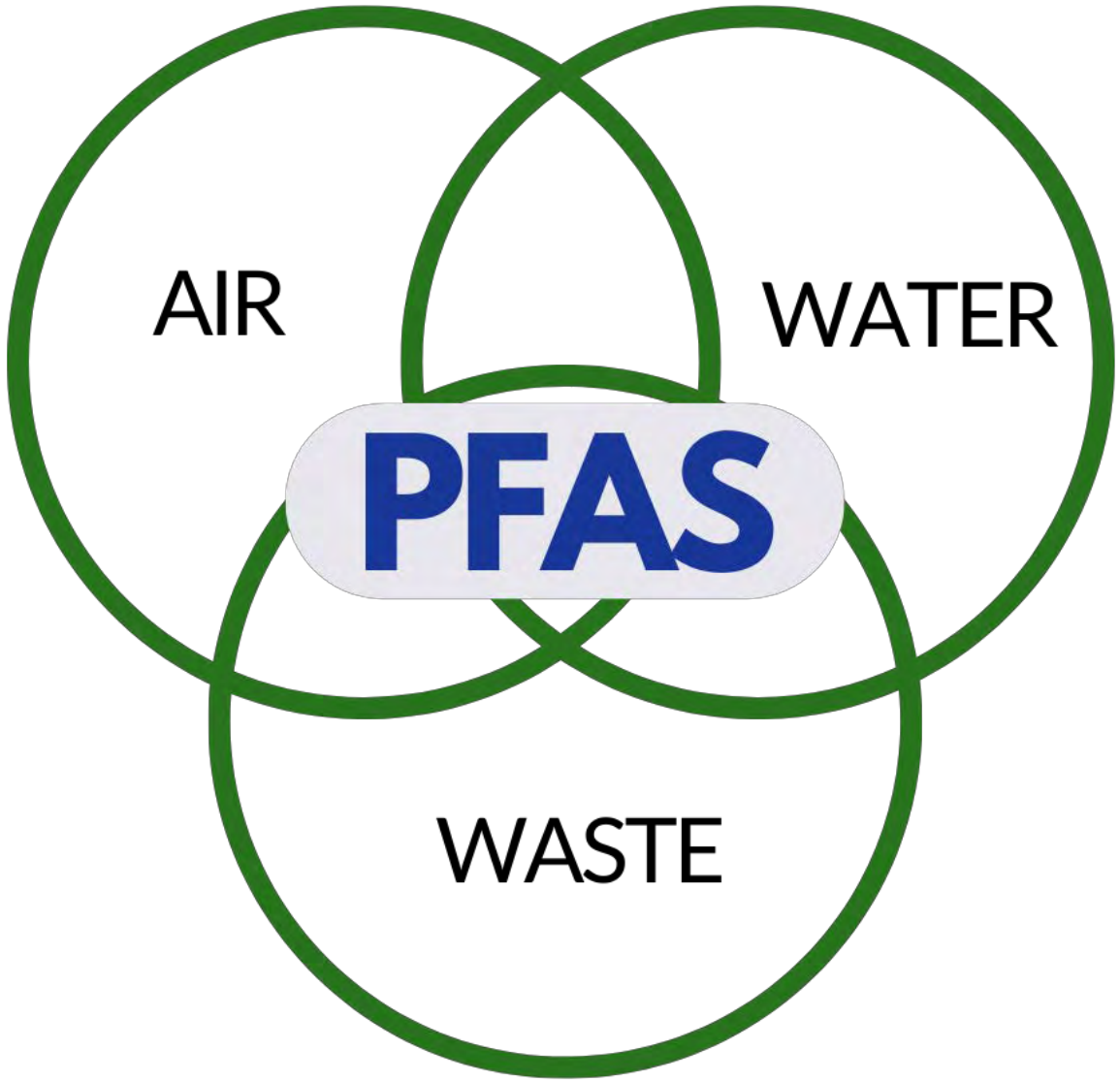
Air Soil Water

Exposure:

Worker Consumer Biota


PIC*
Ash
Air Emissions
Thermal Treatment
Manufacturing
Products
Composting
Compost
Landfill Gas
Leachate
Product Disposal
USE
Effluent
Landfilling
Circular Economy
Wastewater Treatment
Leachate
Rejects
Recycling Reuse
Anaerobic Digestion
Biosolids
Gas
Digestate


AIR
PFAS
WASTE
WATER


AIR
WATER
PFAS
WASTE

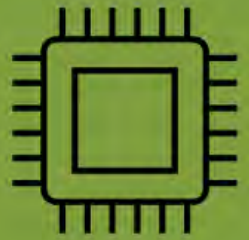
1 IN 22

Facilities Identified that Intersect Air, Water, and Waste

Solid Waste Landfills

Pharmaceutical and Medicine Manufacturing

Plastics Material and Resin Manufacturing



Semiconductor Industry

All Other Basic Organic Chemical Manufacturing


PRIORITIZE
SIMPLICITY
2012

Multimedia PFAS Working Groups


MEETING TODAY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Q and A

If you have a question, just click on the Q and A icon on the bottom of the screen and type it in there.

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