



How do fluorochemicals get into our drinking water, and how can we get them out?

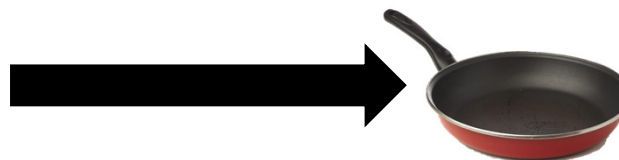
Detlef Knappe
(knappe@ncsu.edu)

PFAS: per- and polyfluoroalkyl substances

PFAS are released into the environment by:

 fluorochemical manufacturing processes, and
 production and use of products containing PFASs

- Non-stick coatings



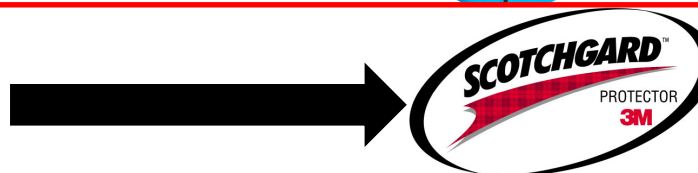
- Grease- and oil-resistant coatings for paper products



- Water repellent fabrics



- Stain-resistant coatings for fabrics, carpets, and leather

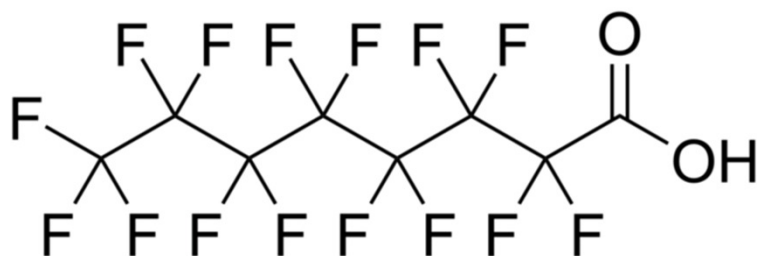


- Firefighting foams



Two types of PFAS have been widely studied → “Long-chain PFAS”

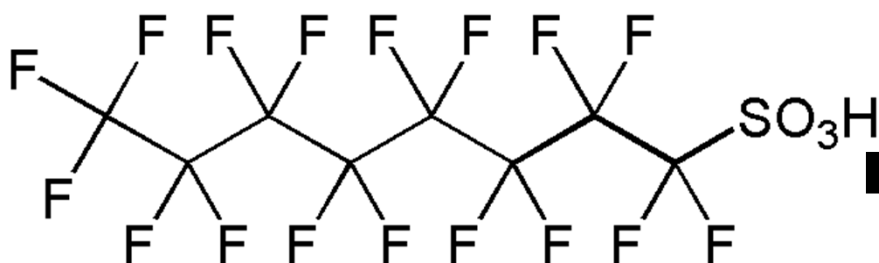
Perfluorooctanoic acid (PFOA / C8)



Common uses:
Goretex, Teflon



Perfluorooctane sulfonate (PFOS)

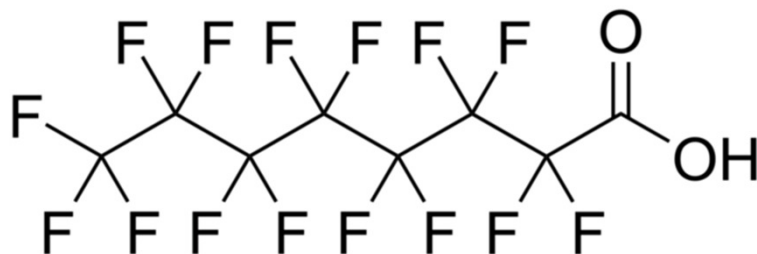


Common uses:
Firefighting, stain repellent

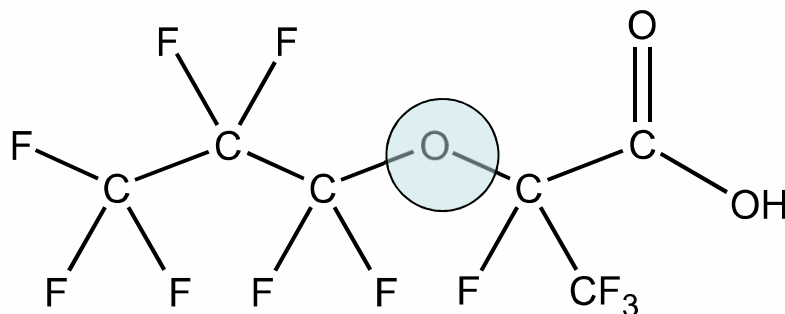


Long-chain PFAS are being replaced by shorter-chain PFAS

PFOA (C8)...



Was replaced by GenX...

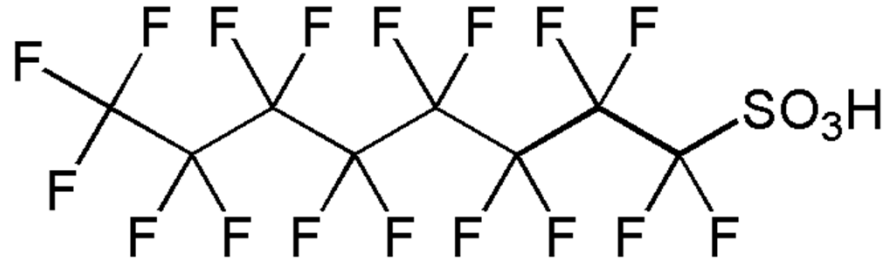


To manufacture Teflon products

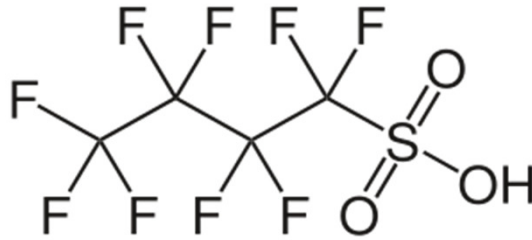


... similarly ...

PFOS...



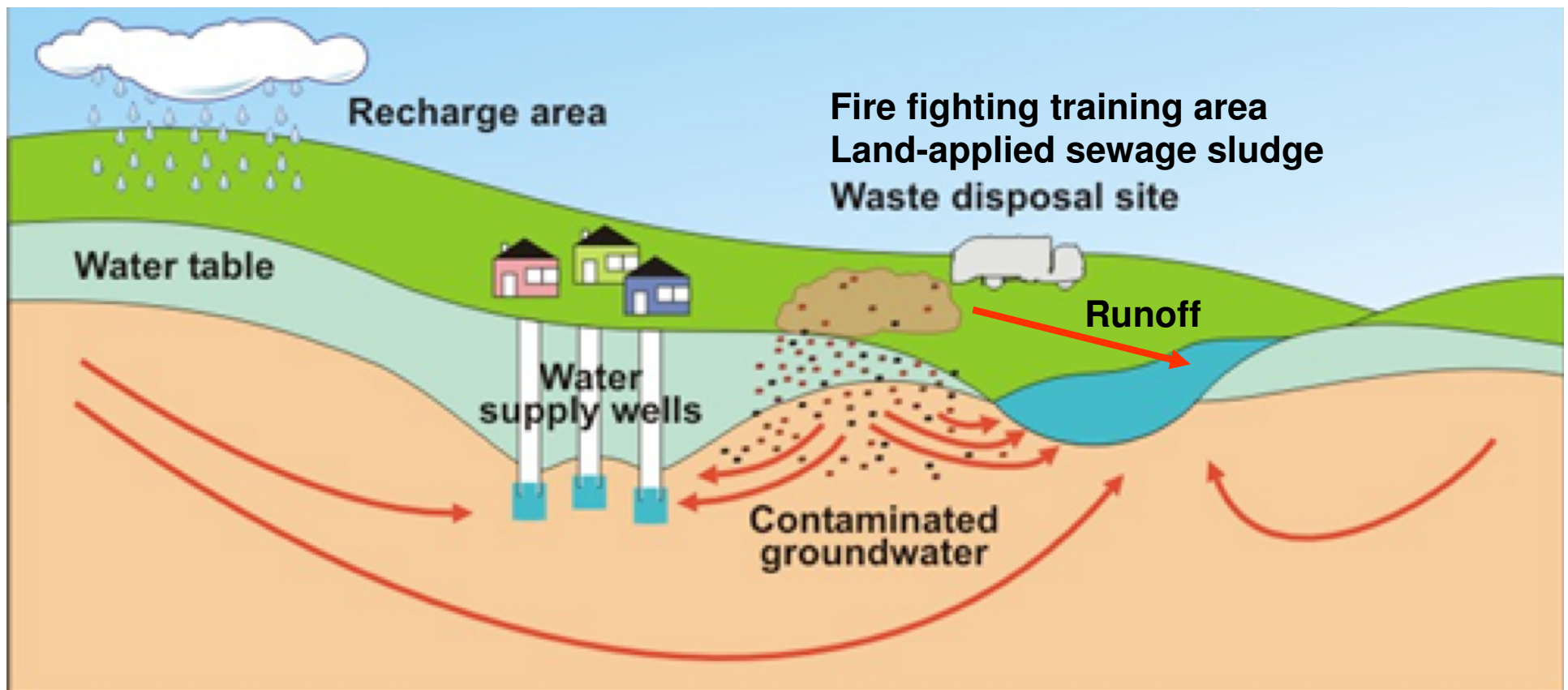
Was replaced by PFBS...



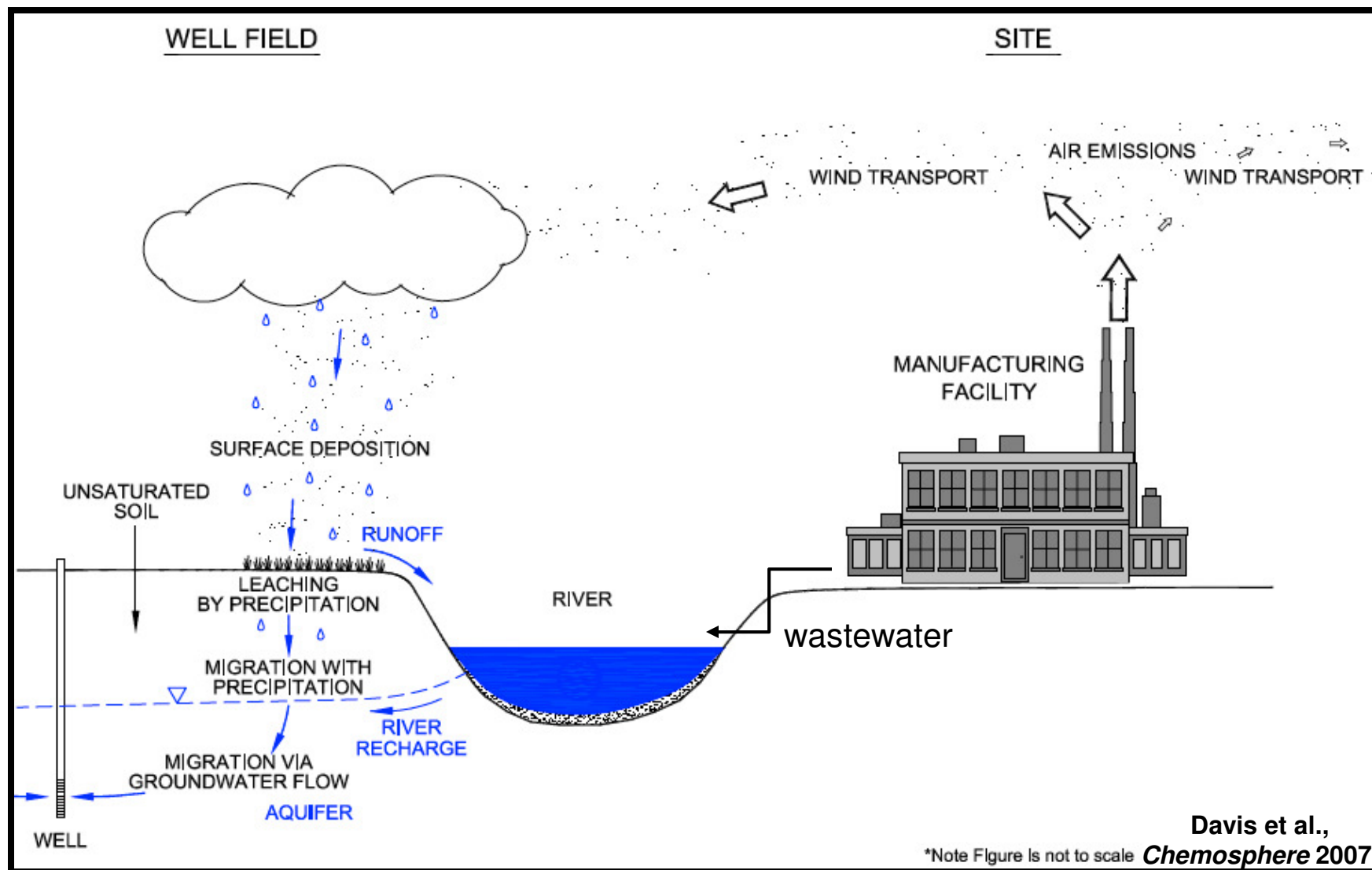
To impart stain repellency



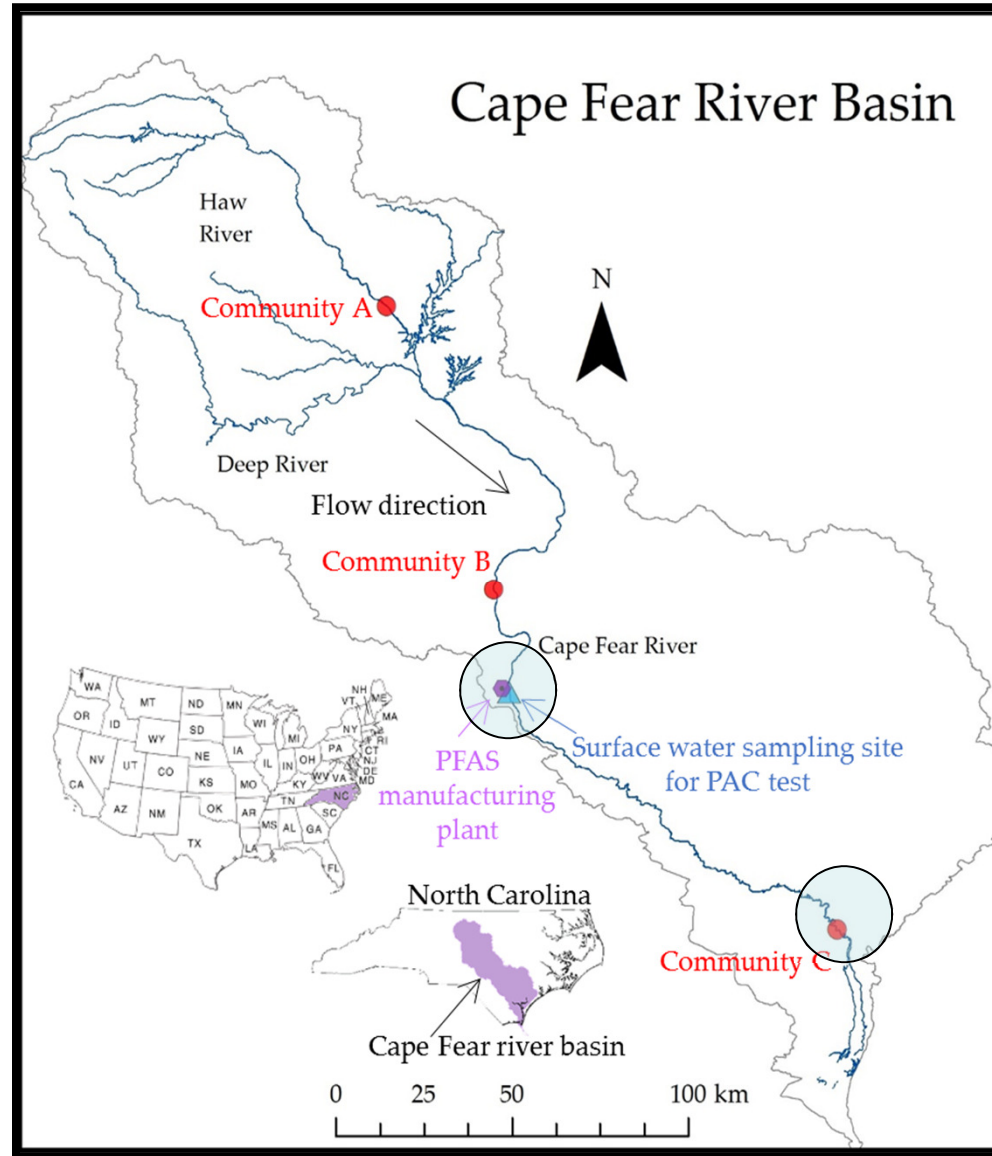
Disposal of **waste** and **sewage sludge** as well
as **fire fighting training** can contaminate
groundwater and **surface water** with **PFAS**



Also, fluorochemical manufacturers and industries using fluorochemicals
emit PFAS to air and water

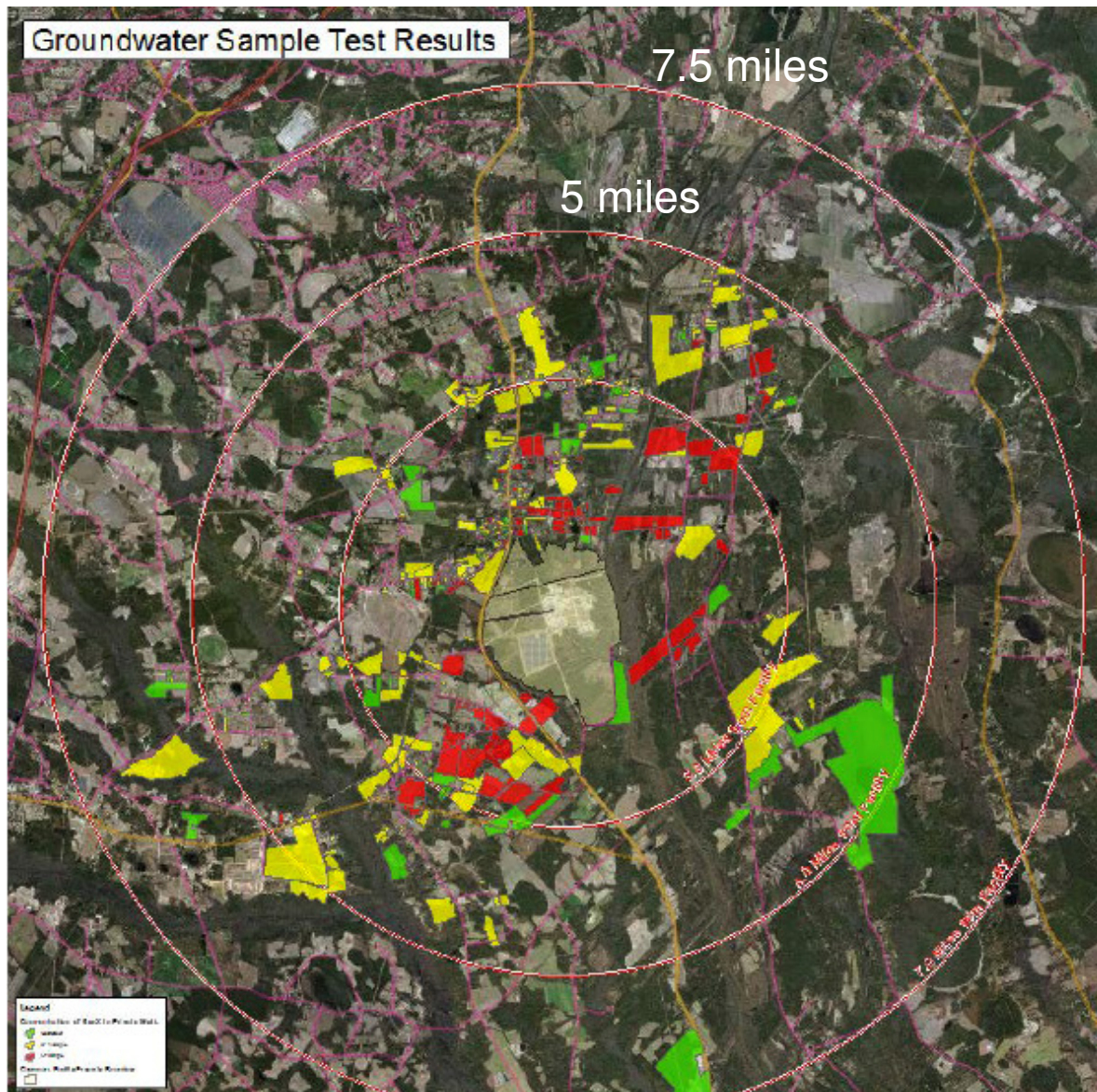


North Carolina's **largest watershed**



Drinking water for **~1.5M people**

High GenX levels in **private wells** near fluorochemical manufacturer



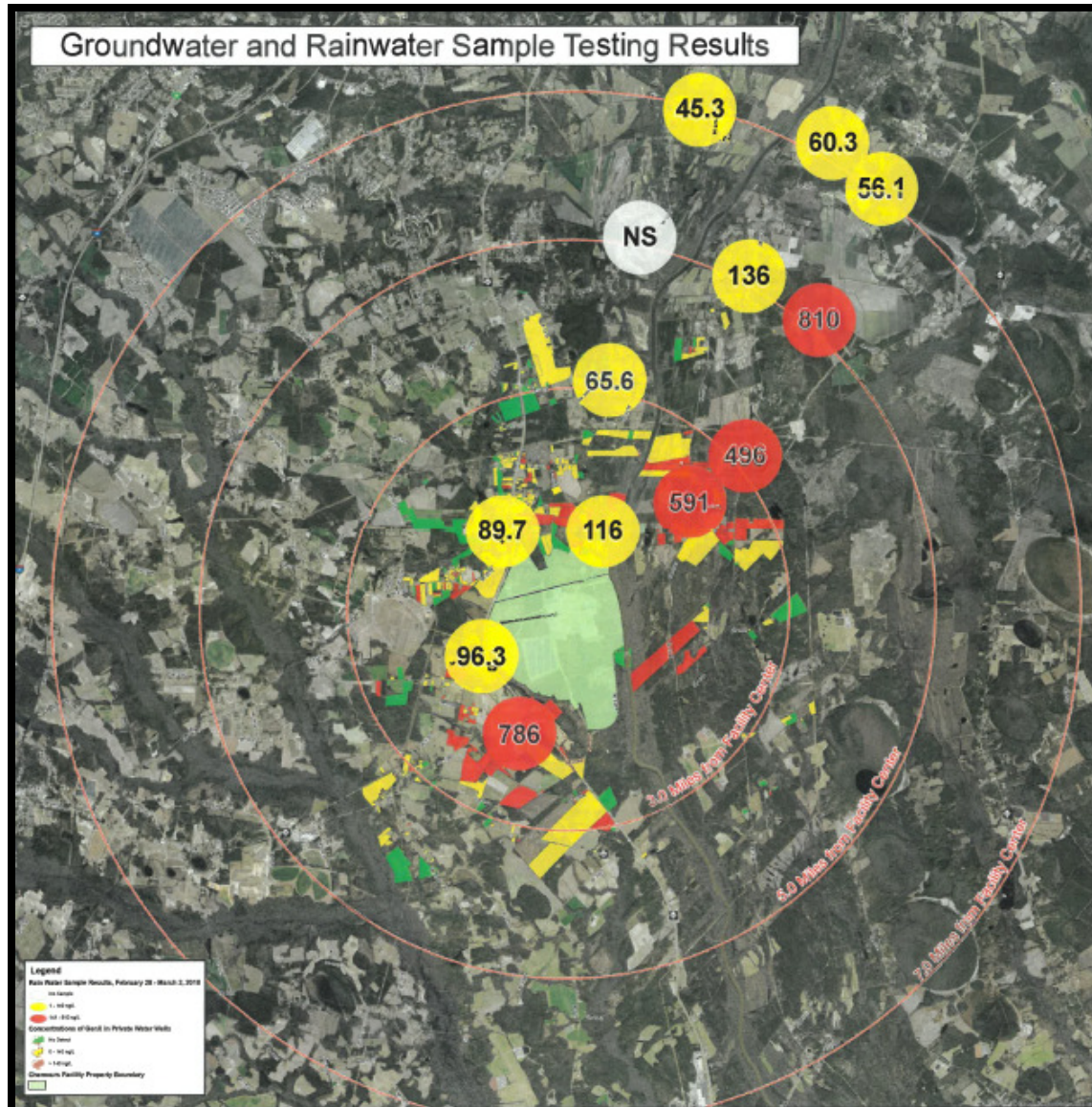
NC Health Goal for GenX:
140 ng/L

Red: >140 ng/L
(max. 4,000 ng/L)

Yellow: detectable – 140 ng/L

Green: not detected

How did GenX get into the wells?



Whole house granular activated carbon filters are currently being pilot tested

- 2 filters in series
- 200 pounds of activated carbon per filter
- GenX broke through first filter after treating ~25,000 gallons ($n = 1$)



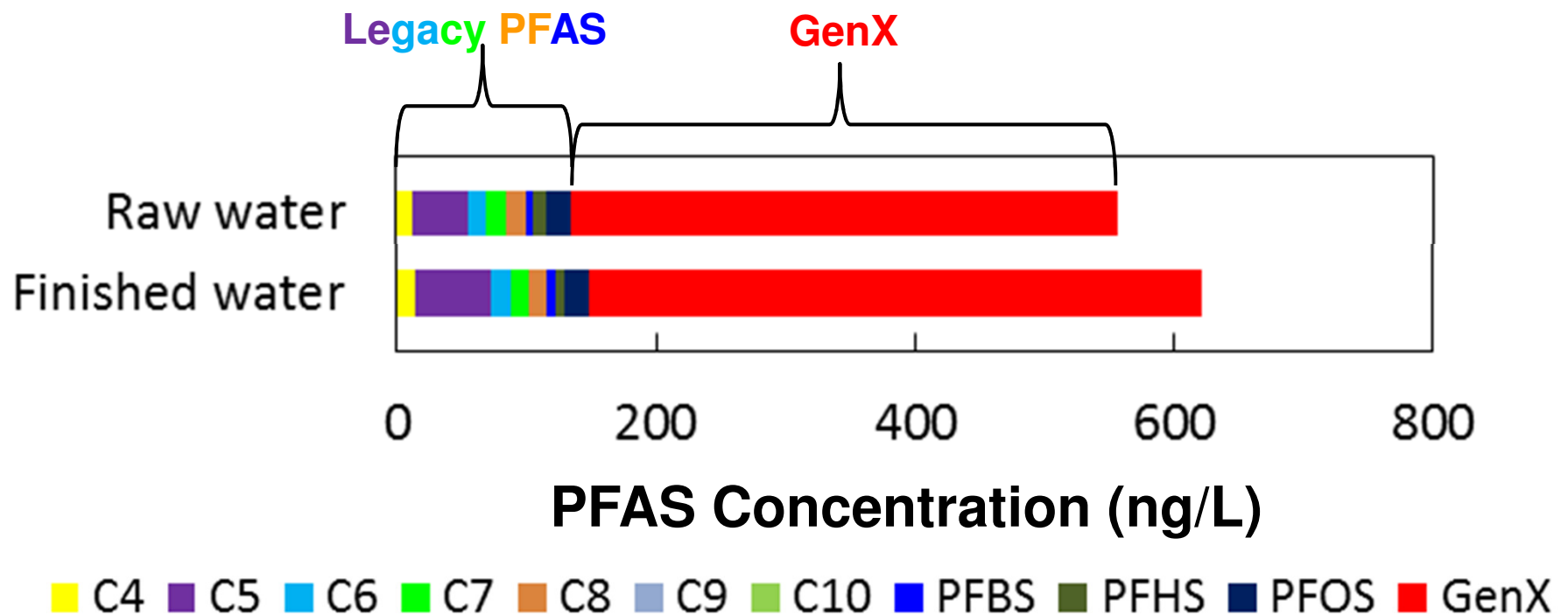
There are also concerns about PFAS contamination of food

- Contaminated soil
- Contaminated rain water
- Contaminated groundwater (for irrigation)
- Fruit
- Vegetables
- Milk
- Honey
- Eggs
- Fish
- Wild game
- Poultry
- Pork
- Beef

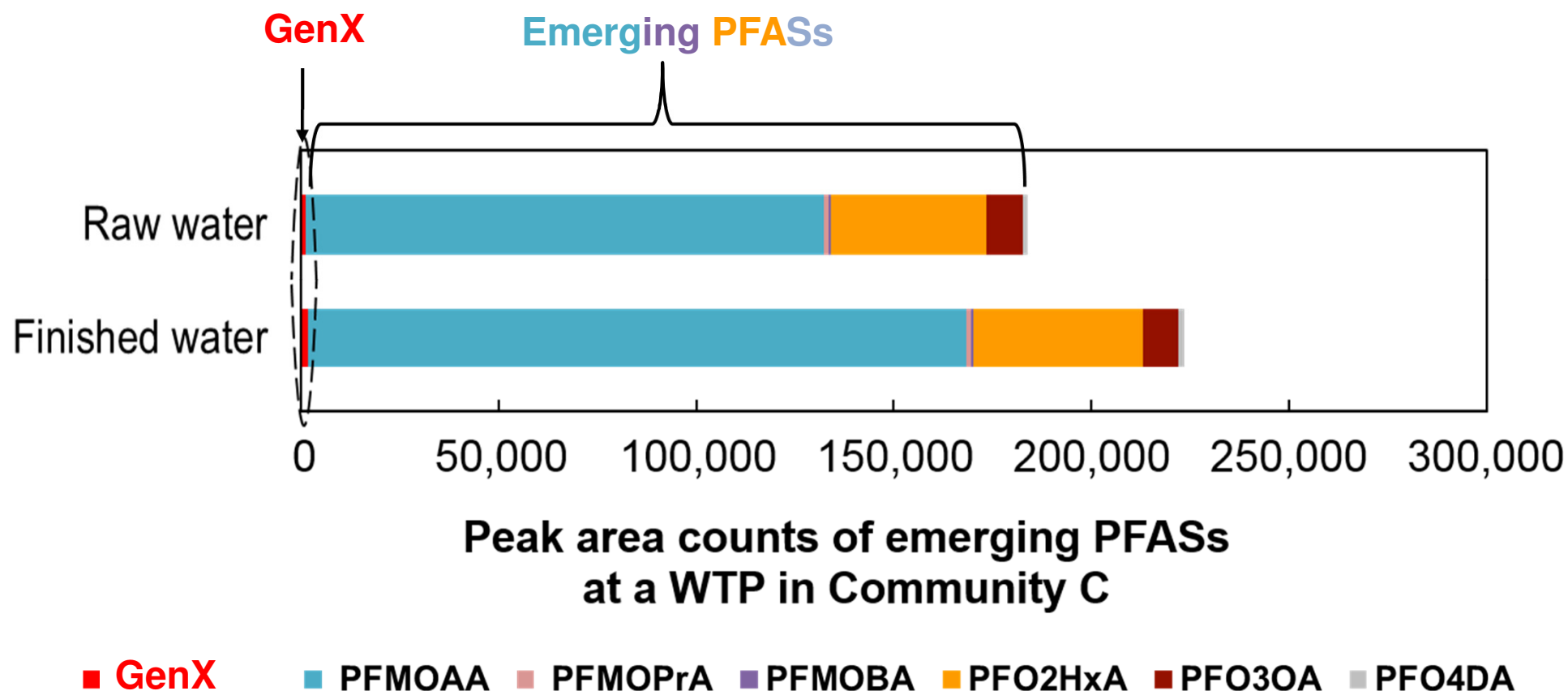


We are starting a citizen science project with a member of the private well community to investigate fluorochemical uptake by vegetables

Conventional and advanced water treatment not effective for removal of legacy PFAS and GenX from drinking water



**Also, other similar substances
occur at much higher concentrations
than legacy PFASs and GenX and are not removed**





Chemours: GenX polluting the Cape Fear since 1980

By Adam Wagner and Tim Buckland GateHouse Media

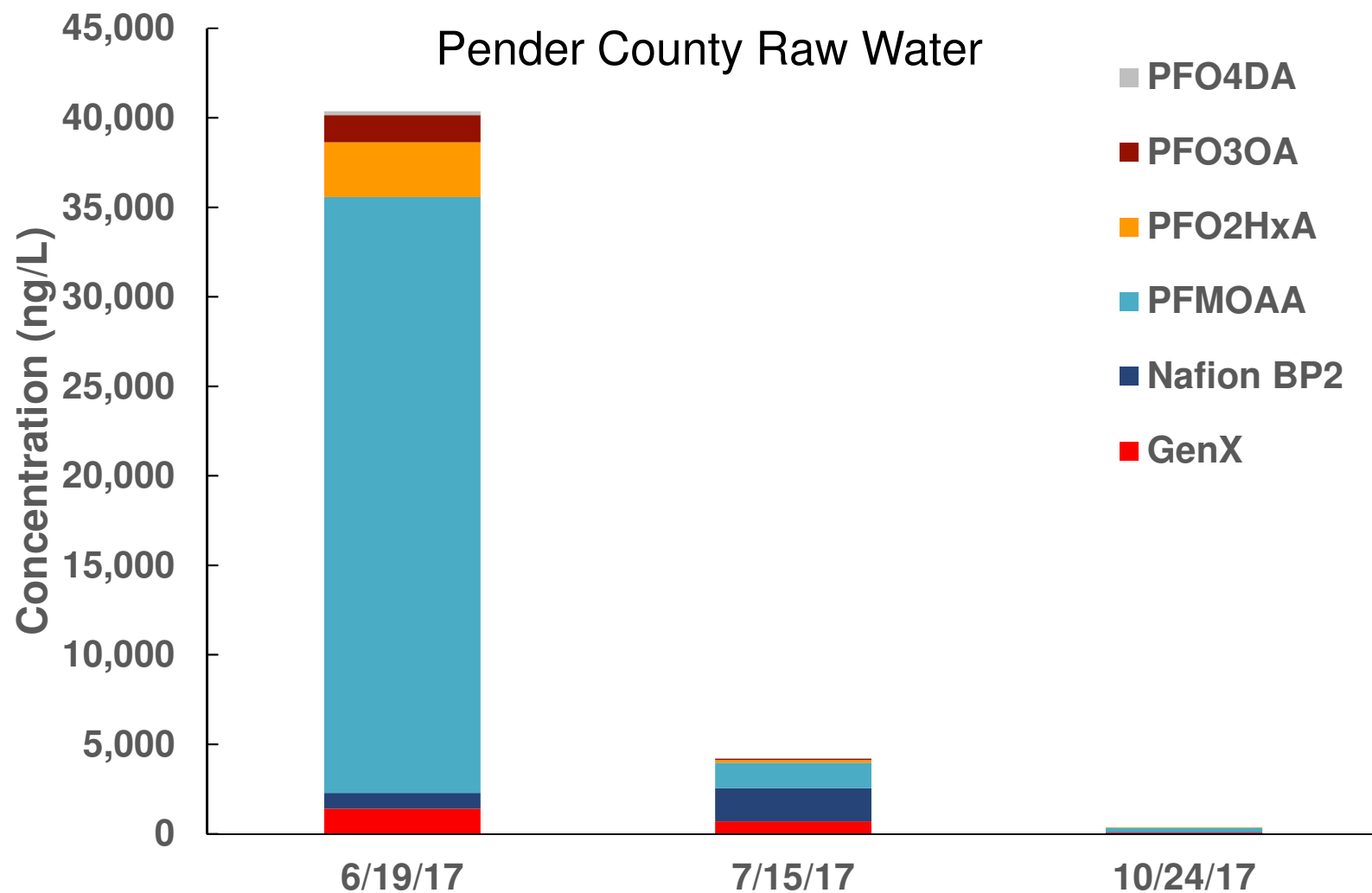
Posted Jun 15, 2017 at 2:00 PM

Updated Jun 16, 2017 at 12:06 AM

Wilmington-area officials demand answers, action during invitation-only meeting with company

WILMINGTON -- A former DuPont plant has been discharging an unregulated toxic chemical into the Cape Fear River since 1980, company officials revealed Thursday at a meeting with local and state officials.

PFAS concentrations have dropped dramatically since mid-June, 2017



Treatment Options for Municipal Drinking Water Treatment Plants

- Activated carbon adsorption
 - More effective for long-chain PFAS, less effective for short-chain PFAS
 - More effective for groundwater, less effective for surface water
- Anion exchange
- Nanofiltration
- Reverse osmosis

Take Home Messages

Sources

- PFAS **manufacturing and use** contaminates:

- **water, air, food**



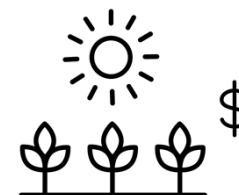
- Many unknown PFAS



Impacts



- Public health
- Property values
- Agricultural product values



Education



- **Consumers lack information** on what was made with or contains PFASs

- www.sixclasses.org



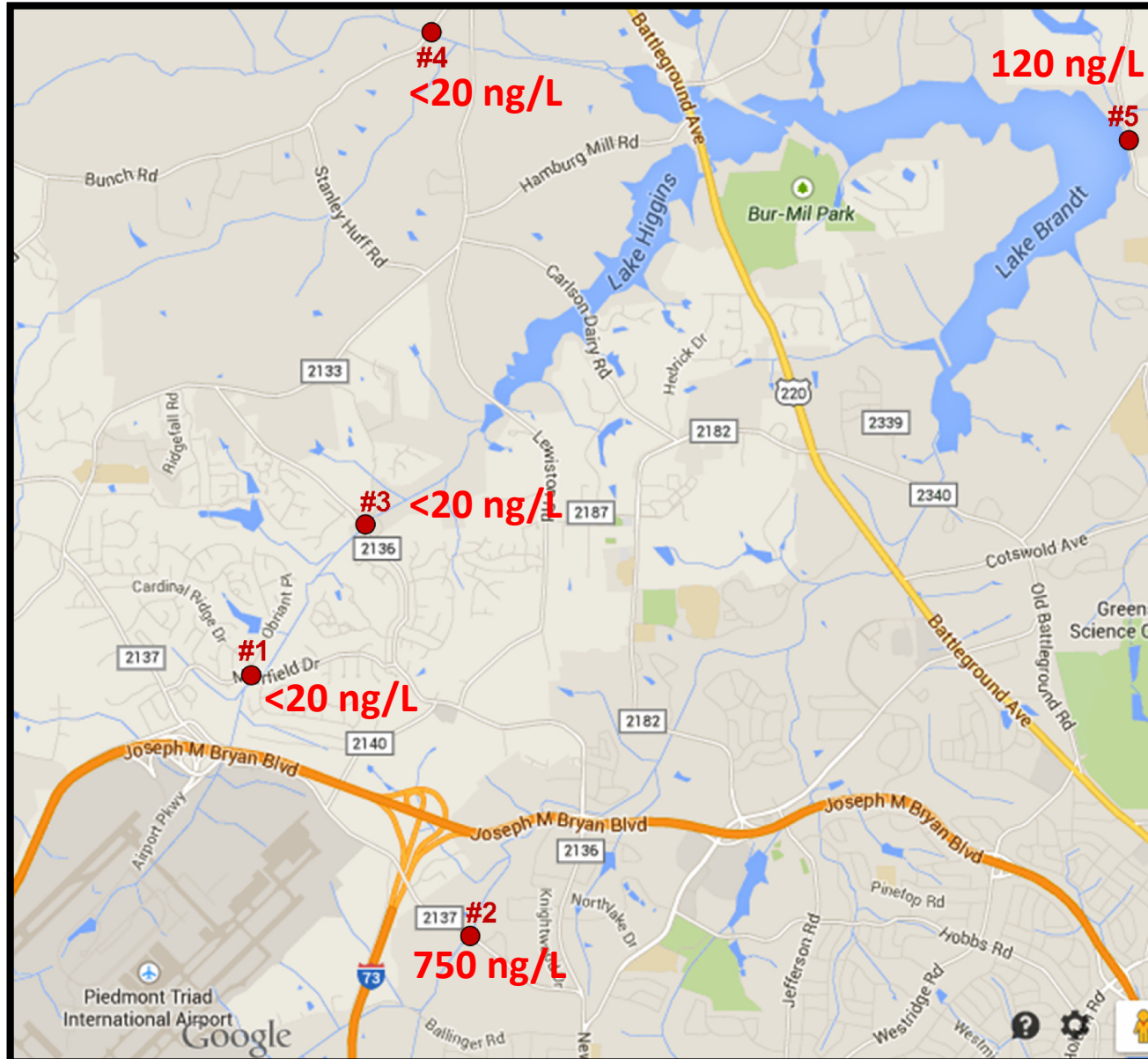


Questions?

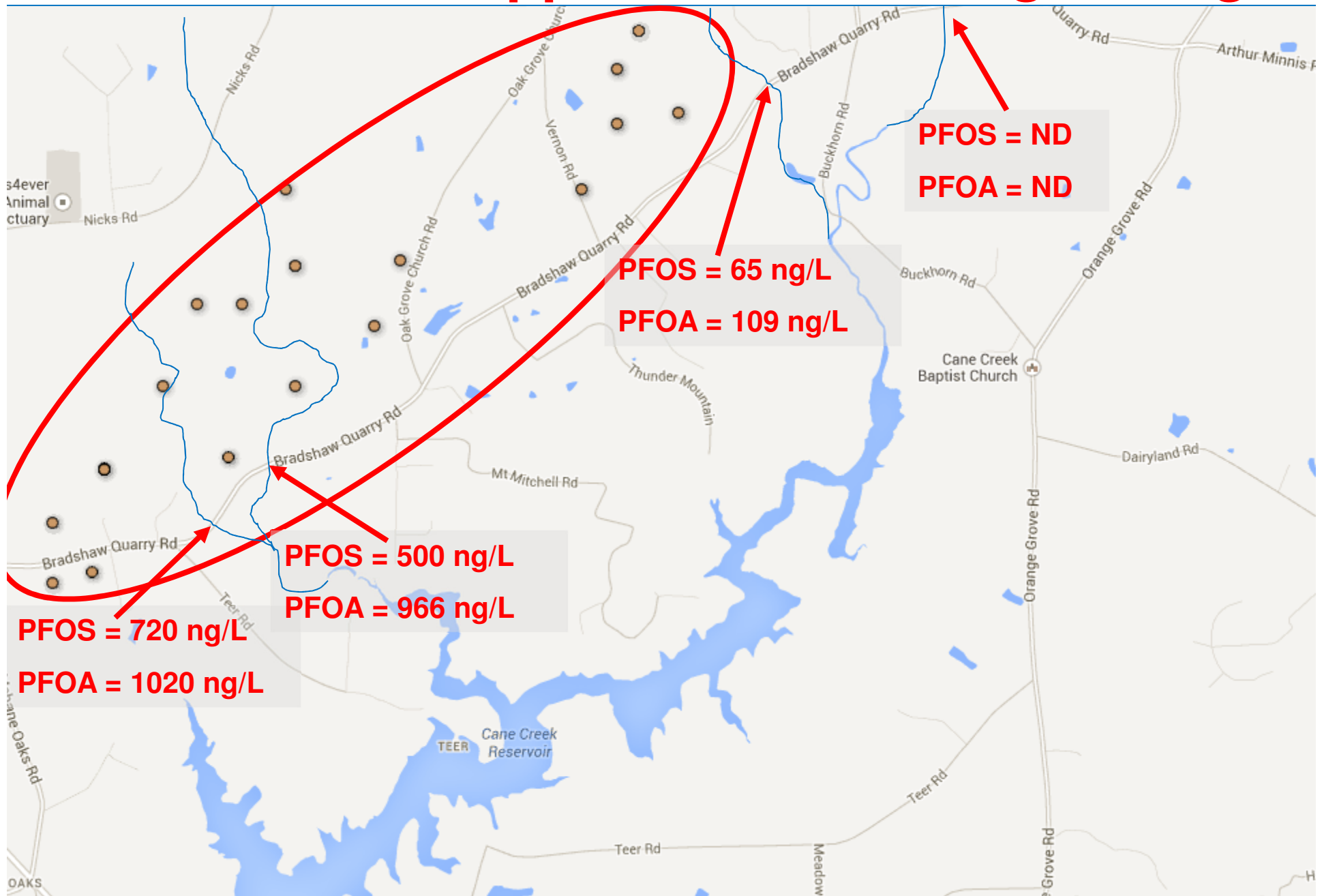
knappe@ncsu.edu



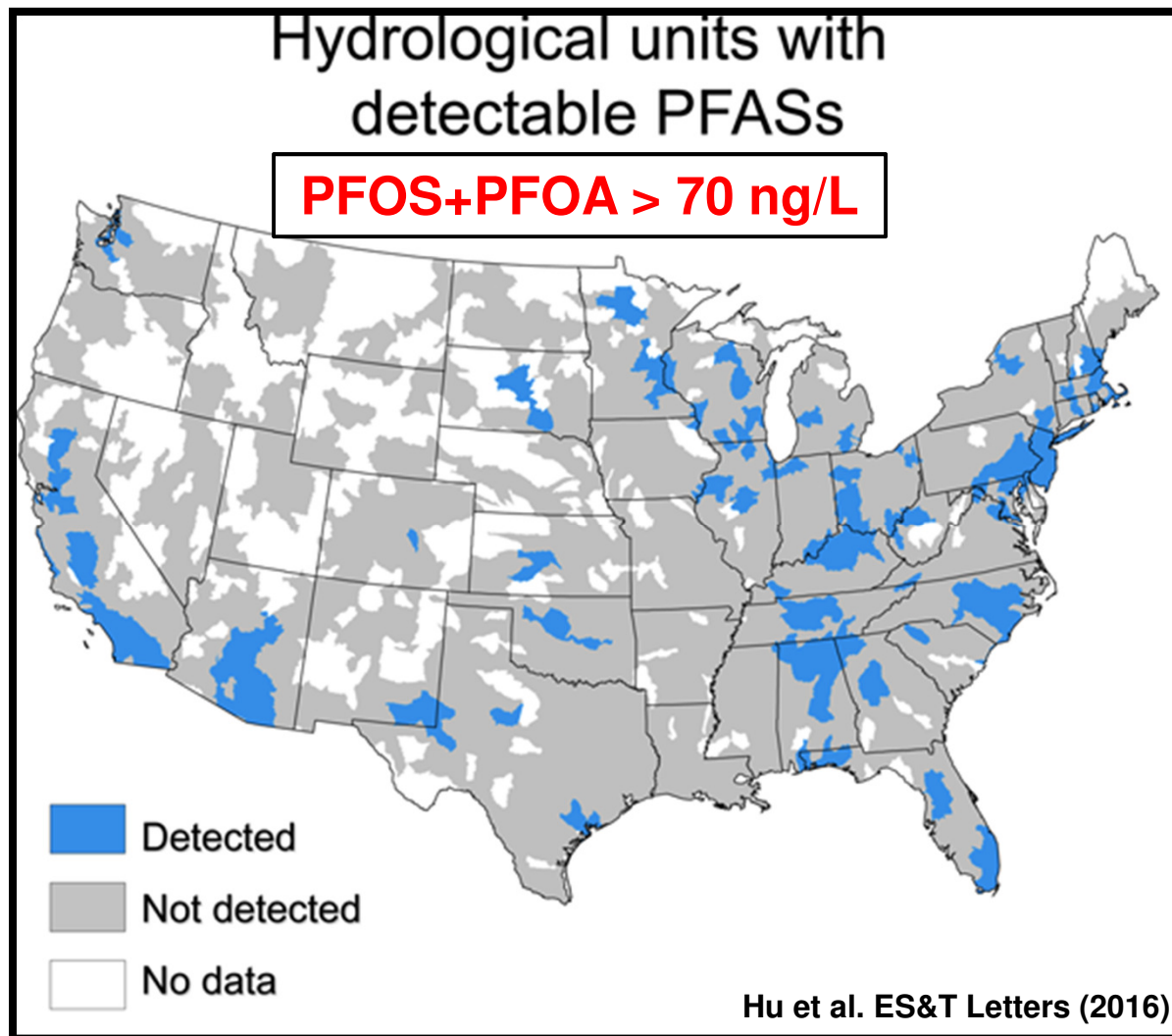
Firefighting foam can contaminate drinking water sources with PFASs...



...So can land application of sewage sludge



Elevated PFAS levels affect many US residents



PFOS and PFOA levels estimated to exceed health advisory levels in drinking water of 6 million US residents

What did we test?

- 8 samples from under-sink **reverse osmosis (RO)** systems →



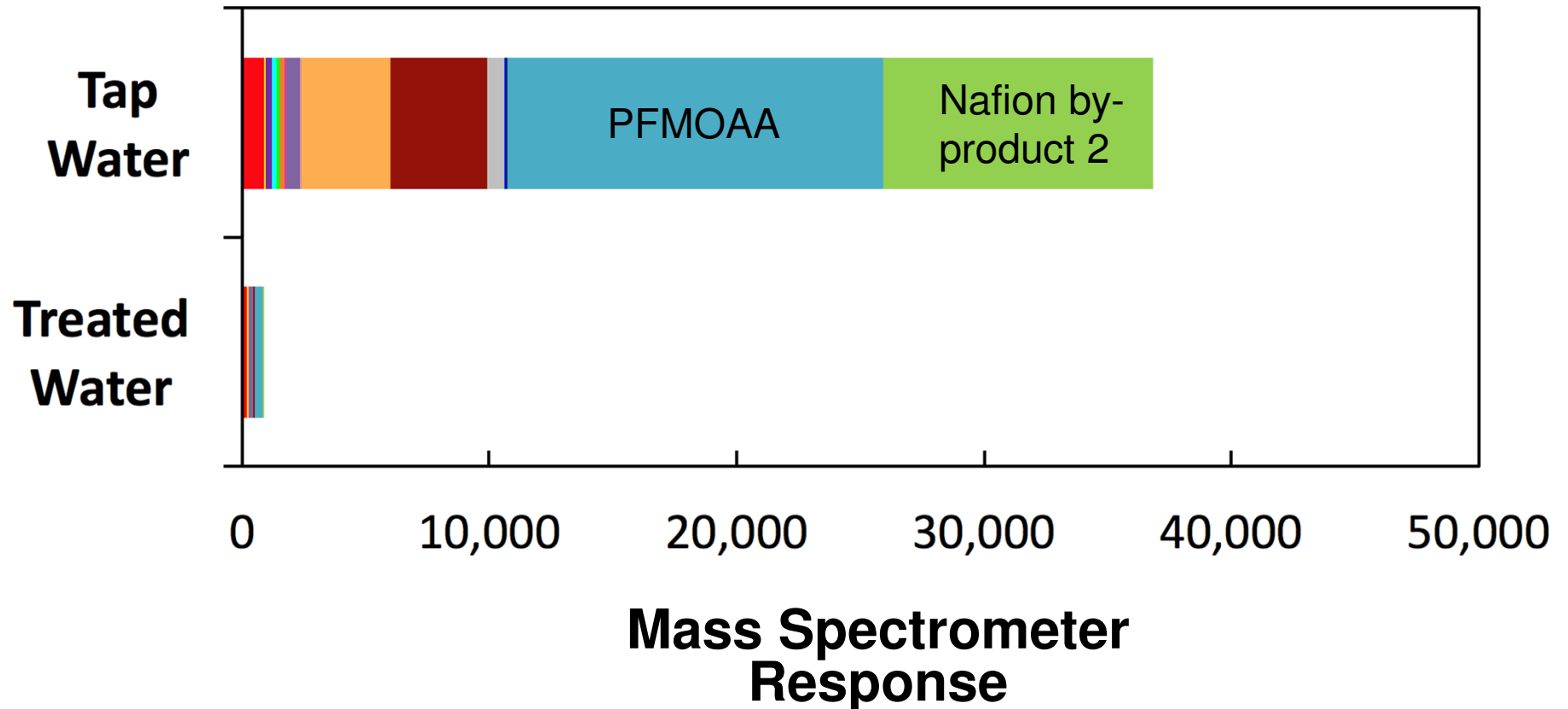
- 12 samples from **activated carbon block filters** (under-sink, refrigerator, counter-top)



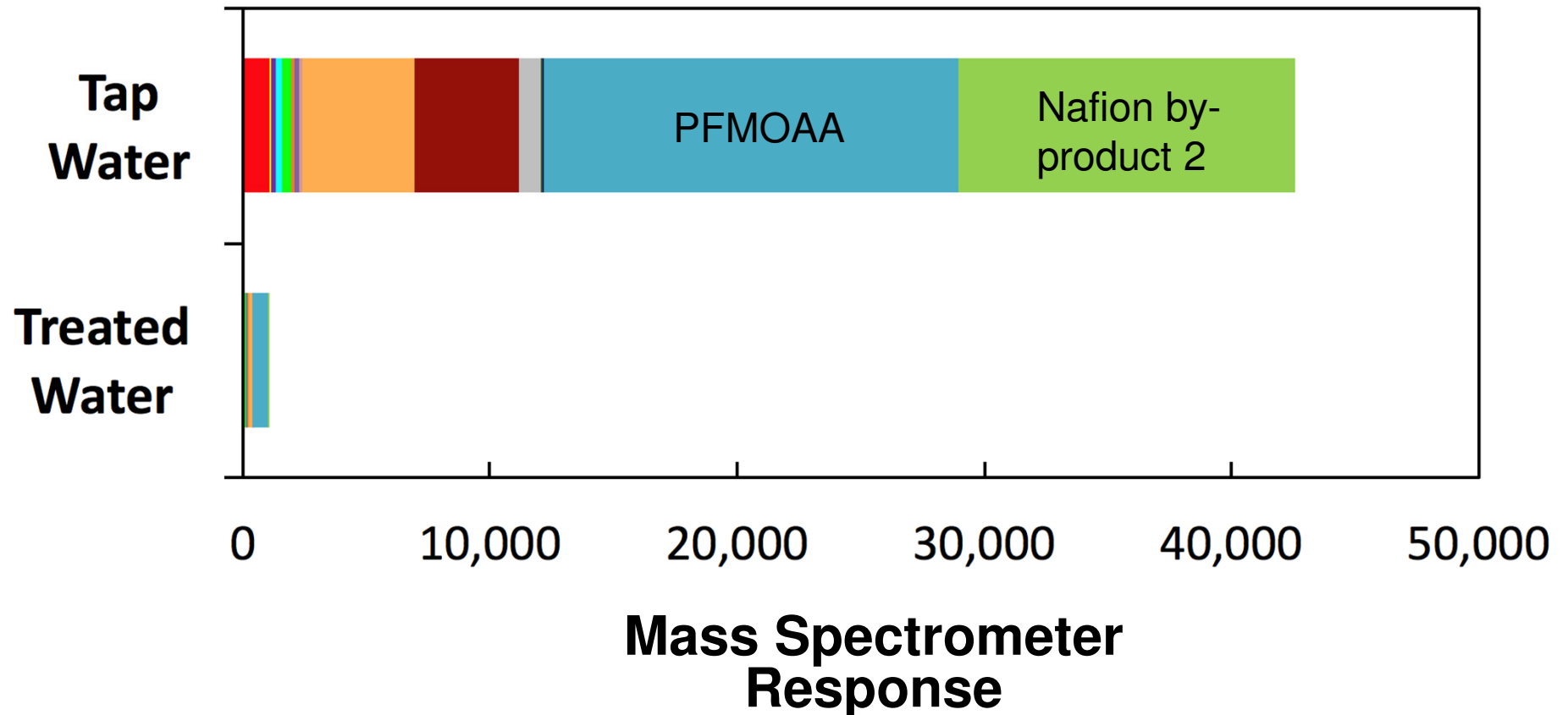
- 7 samples from **whole-house filters** (activated carbon, cation exchange) →



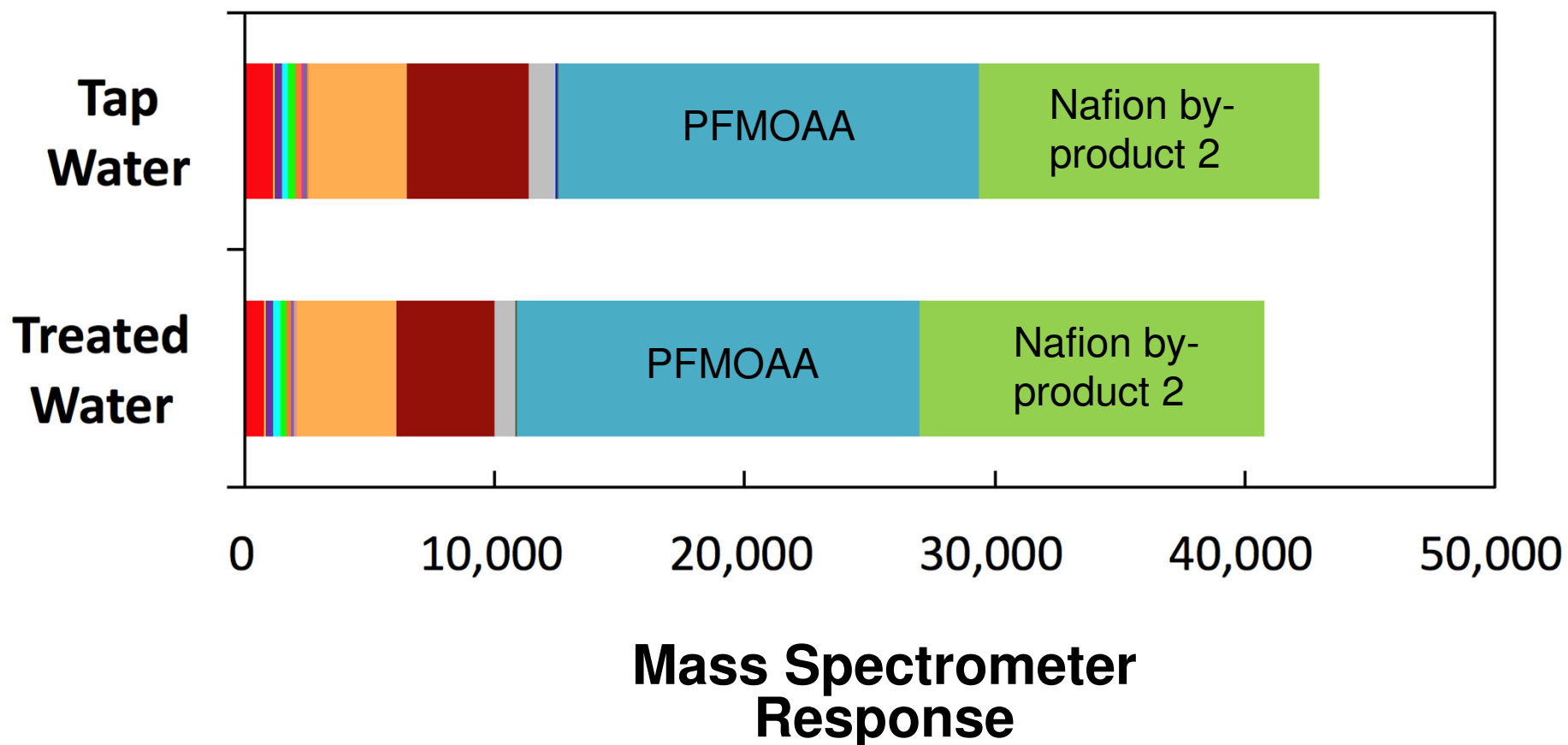
All under-sink reverse osmosis (RO) systems worked



Most activated carbon block filters worked...

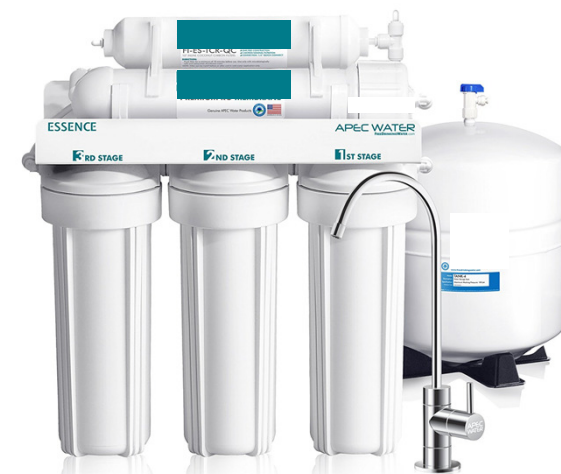


**...But you have to change
the filter!**



What does an under-sink RO system cost to buy and maintain?

- Purchase cost:
 - ~\$200 (do-it-yourself)
 - >\$1,000 (with installation)
- Maintenance:
 - Monitoring (~\$10)
 - Annual maintenance (~\$30 do-it-yourself, ~\$200 professional)



Change RO membrane every 3-5 years (~\$100 do-it yourself, ~\$300 professional)



What do activated carbon systems cost to buy and maintain?

- Purchase cost:
 - ~\$100 (under sink)
 - Many refrigerators pre-configured
 - ~\$100+ (countertop)

Maintenance (every 3-6 months):

- ~\$20 for under sink filters
- ~\$20-50 for refrigerator filters
- ~\$20-150+ for countertop filters



GAC Performance

