

# PFAS as emerging unregulated contaminants



Center for Environmental and  
Health Effects of PFAS

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# Per- and Polyfluoroalkyl Substances (PFAS)

## Resistant to:

- Water
- Stains
- UV radiation

## Used in consumer products since the 1950s:

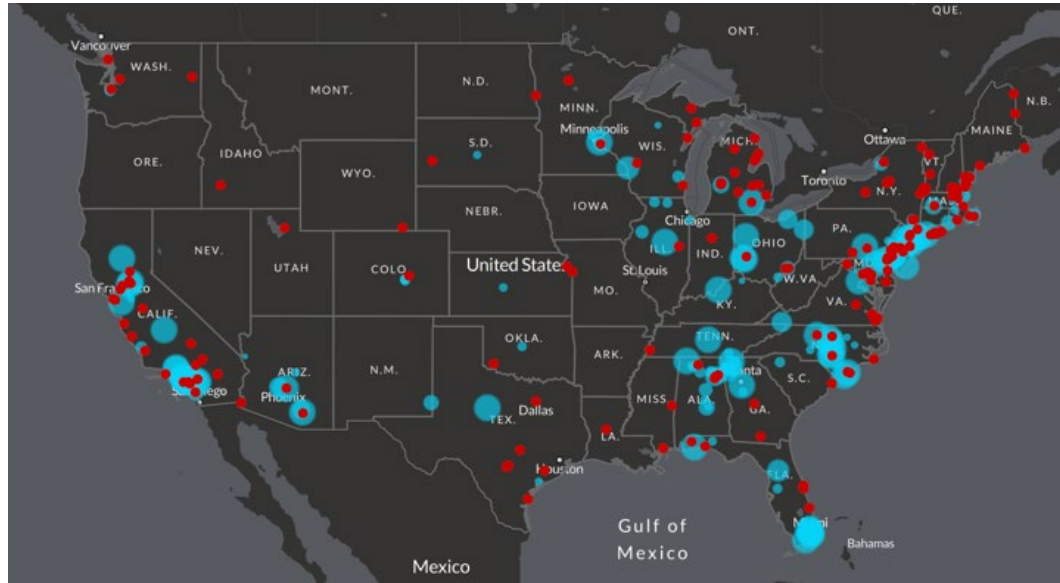
- Surfactants, lubricants, adhesives
- Carpet, upholstery, clothing
- Car interiors
- Food packaging
- Nonstick cookware
- Cleaning products
- Personal care products
- Fire-fighting foam**

## Chemical Properties Lead to:

- Persistence and bioaccumulation
- Water solubility and water contamination*
- Ubiquitous in indoor environment and blood
- Transport around globe in ocean currents and atmosphere

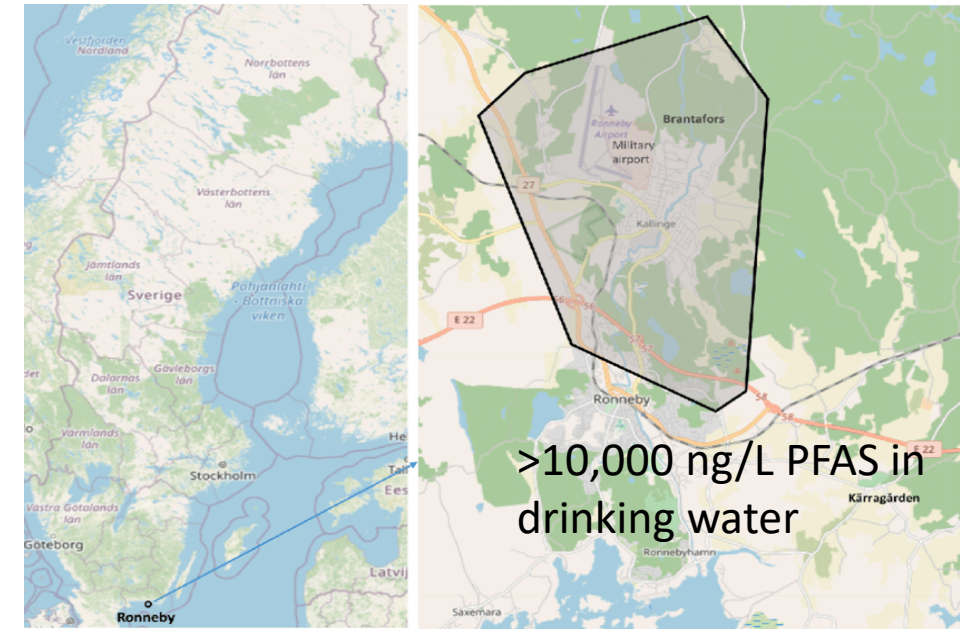


# A Global Problem



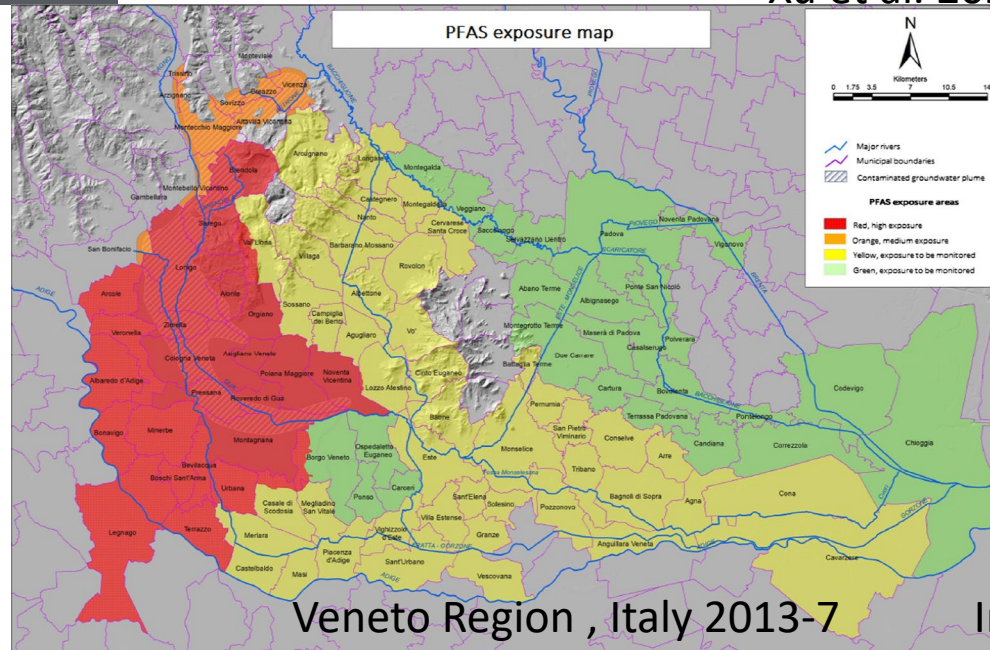
## Contamination Sites EPA Tap Water Detection

Source: [https://www.ewg.org/interactive-maps/2017\\_pfa/](https://www.ewg.org/interactive-maps/2017_pfa/)



Ronneby, Sweden 2013

Xu et al. 2021



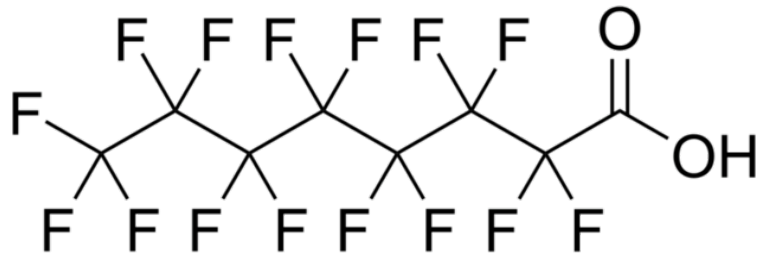
Veneto Region , Italy 2013-7

Ingelido et al 2020



Two PFAS have been widely studied → “Legacy Compounds”

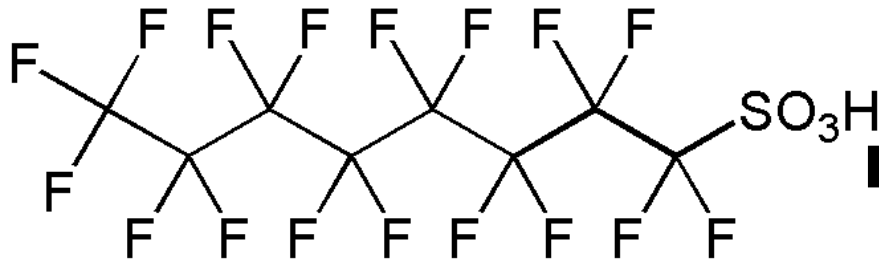
**Perfluorooctanoic acid (PFOA / C8)**



**Common uses:**  
Goretex, Teflon



**Perfluorooctane sulfonate (PFOS)**



**Common uses:**  
Firefighting, stain repellent



# Guidance on PFAS Exposure, Testing, and Clinical Follow-Up

July 2022

<https://www.nationalacademies.org/our-work/guidance-on-pfas-testing-and-health-outcomes>



# Health Effects of PFAS: Conclusions

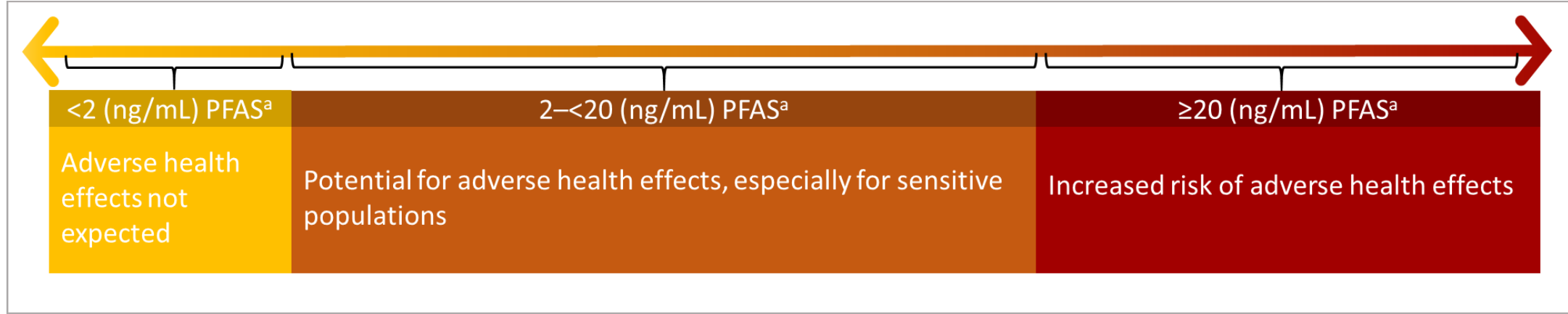
## **Sufficient evidence of an association**

- Decreased antibody response (in adults and children)
- Dyslipidemia (in adults and children)
- Decreased infant and fetal growth
- Increased risk of kidney cancer (in adults)

## **Limited suggestive evidence of an association**

- Increased risk of breast cancer (in adults)
- Increased risk of testicular cancer (in adults)
- Liver enzyme alterations (in adults and children)
- Increased risk of pregnancy-induced hypertension (gestational hypertension and preeclampsia)
- Thyroid disease and dysfunction (in adults)
- Increased risk of ulcerative colitis (in adults)

# PFAS Testing and Concentrations that Can Inform Clinical Care Recommendations



Recommendation 5-3: Clinicians should use serum or plasma concentrations of the sum of PFAS\* to inform clinical care of exposed patients, using the following guidelines for interpretation:

- Adverse health effects related to PFAS exposure are not expected at less than 2 nanograms per milliliter (ng/mL).
- There is a potential for adverse effects, especially in sensitive populations, between 2 and 20 ng/mL.
- There is an increased risk of adverse effects above 20 ng/mL.

\*Simple additive sum of MeFOSAA, PFHxS, PFOA (linear and branched isomers), PFDA, PFUnDA, PFOS (linear and branched isomers), and PFNA in serum or plasma. Caution is warranted when using capillary blood measurements as levels may differ from serum or plasma levels.

# GenX Exposure Study



Started in response to community concerns

Designed to answer the community questions:

What is GenX?

Is it in me?

Does it have health effects?

## Partners

CHHE (NC State, ECU)

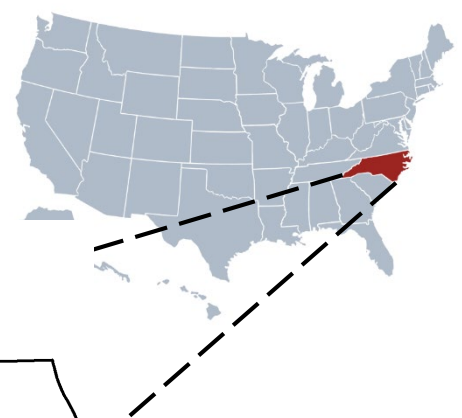
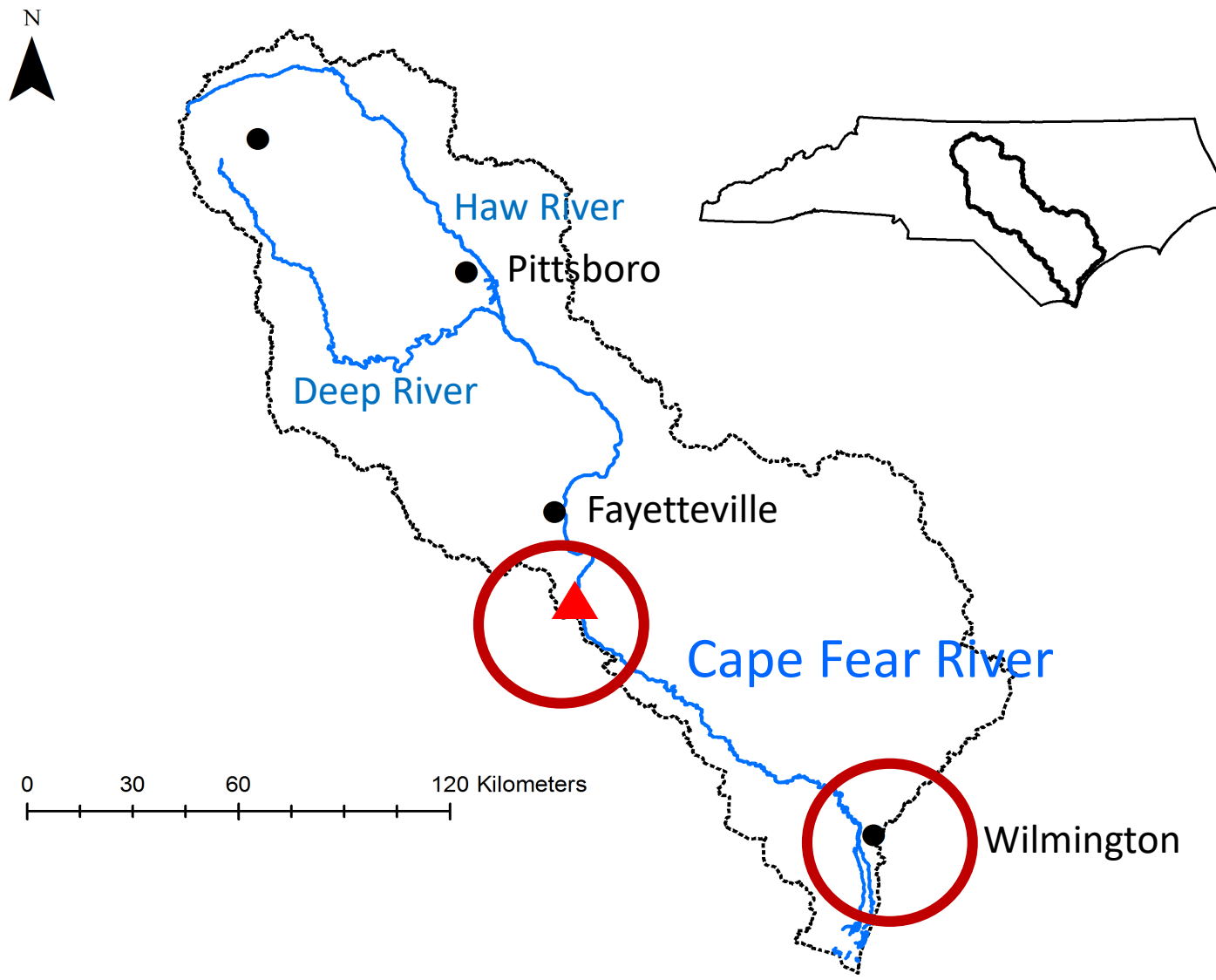
Cape Fear River Watch

New Hanover County Health Department





# Cape Fear River Basin, North Carolina



Largest watershed in NC

Supplies ~1.5M people with drinking water

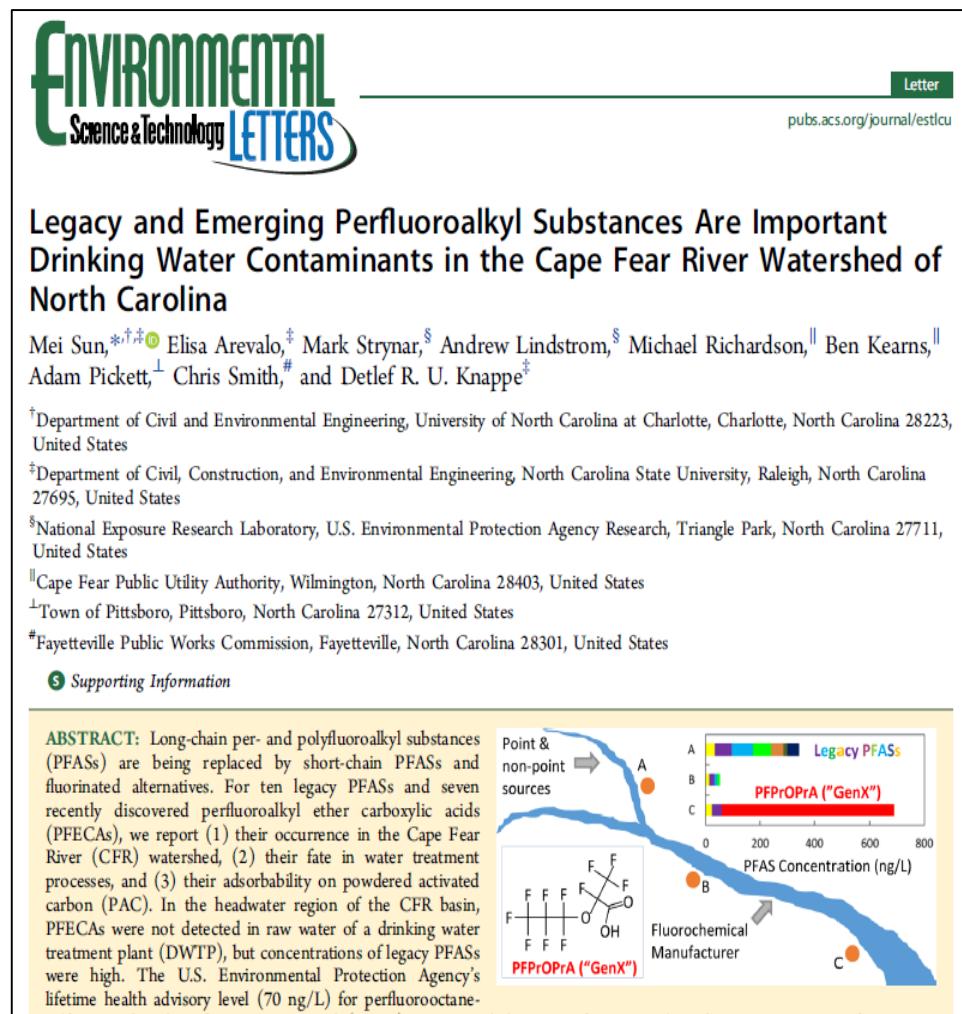


# PFAS in River AND Drinking Water

Detlef Knappe, NCSU

Mark Strynar, USEPA

Andy Lindstrom, USEPA



June 15, 2017

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## Chemours: GenX polluting the Cape Fear since 1980

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By Adam Wagner and Tim Buckland GateHouse Media

Posted Jun 15, 2017 at 2:00 PM

Updated Jun 16, 2017 at 12:06 AM

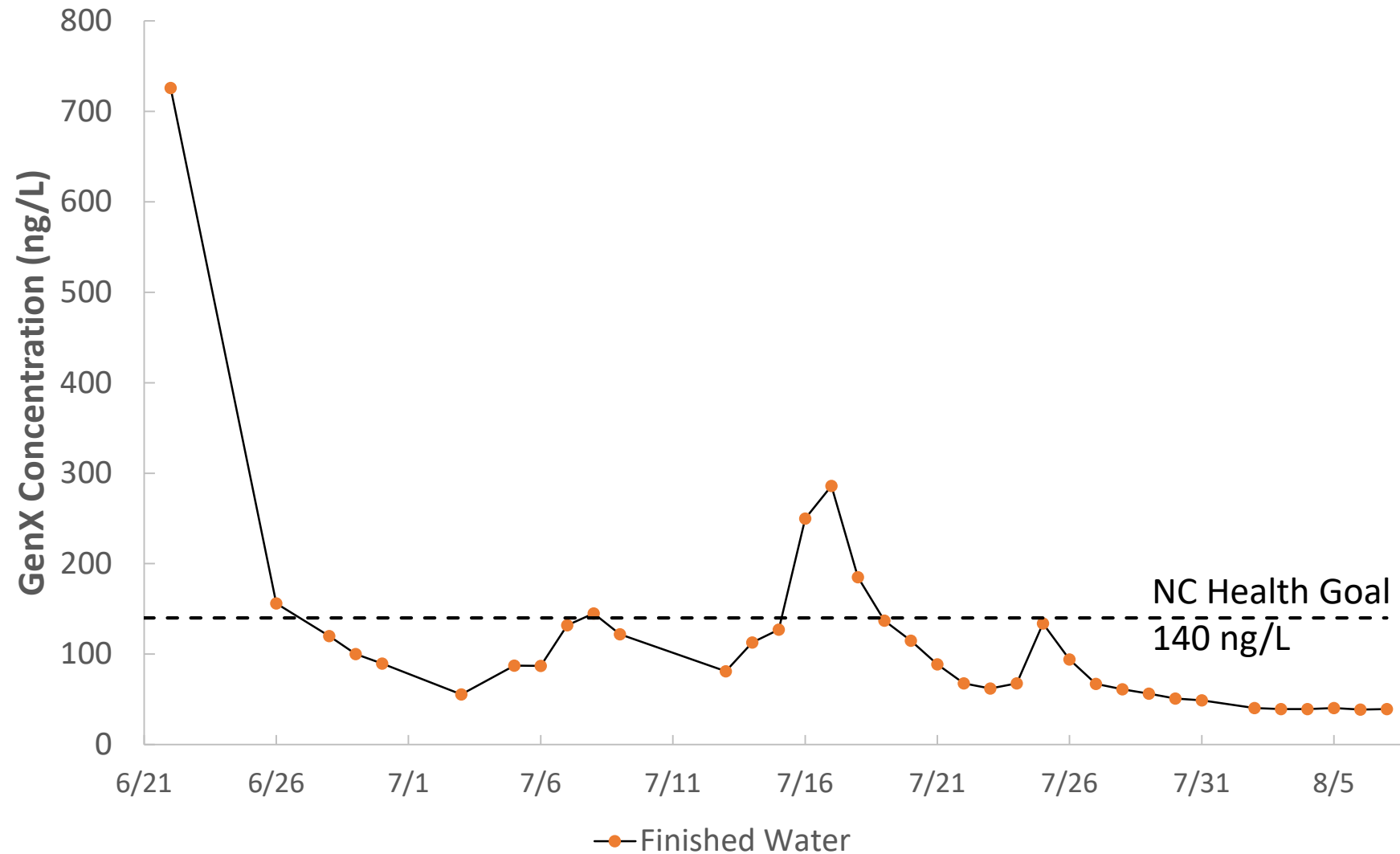
Wilmington-area officials demand answers, action during invitation-only meeting with company

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.



Public meeting  
Wilmington, North Carolina, June 2017

GenX concentrations after fluorochemical manufacturer announced on 6/21/2017 that it stopped discharging GenX





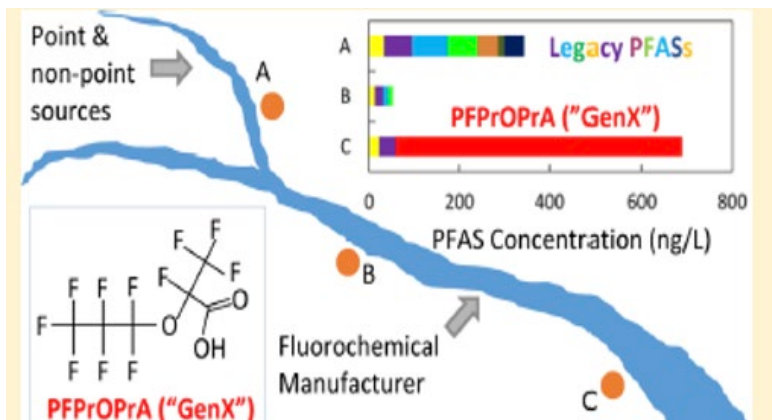
# Responding to Community Concerns

## People want to know:

# Am I exposed?

# Is the chemical in my body?

## What are the health effects?



## Challenges at the time:

## What chemicals to look for?

## No analytical standards

## No half life information

## Little or no toxicology data

## No comparison populations

# Study Design

Wilmington residents on Cape Fear Public Utility Authority water, ages 6 and older

344 total

44 provided samples 6 months apart  
(Nov 2017, May 2018)

Collect blood and drinking water

Analyze for GenX and other PFAS

Analyzed for lipids, thyroid hormones, and comprehensive metabolic panel

Measured BMI

Report back results to community, individuals



# PFAS Serum Results

We detected 7 PFAS in the blood of almost everyone in Wilmington

## Three brand new PFAS

Nafion byproduct 2

PFO4DA

PFO5DoA

Also: PFO3DoA, NVHOS, Hydro-Eve

We did not detect GenX in anyone.

## Legacy PFAS

PFOA

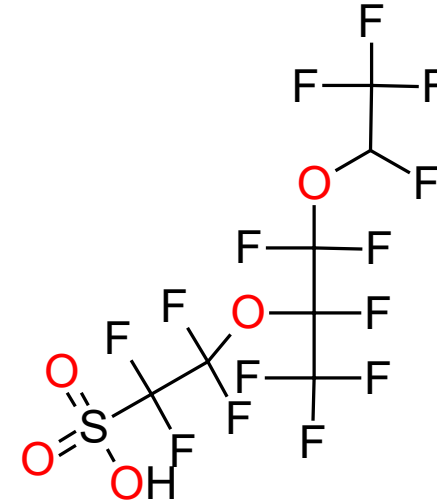
PFOS

PFNA

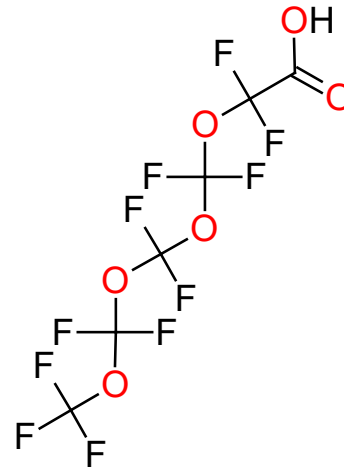
PFHxS

# Three long chain fluoroethers in Wilmington blood

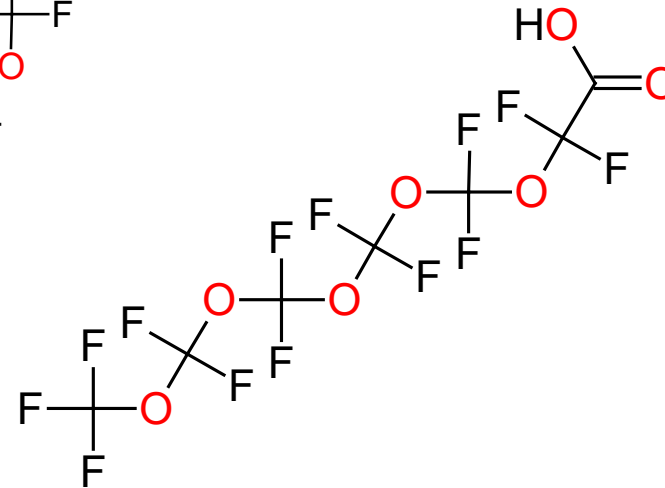
1. Nafion byproduct 2 (99%)



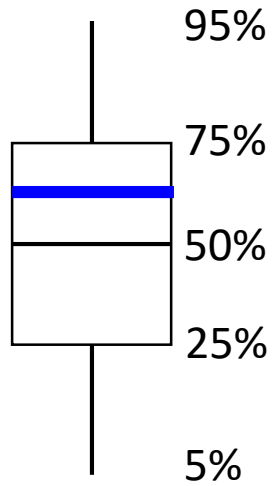
2. PFO4DA (98%)



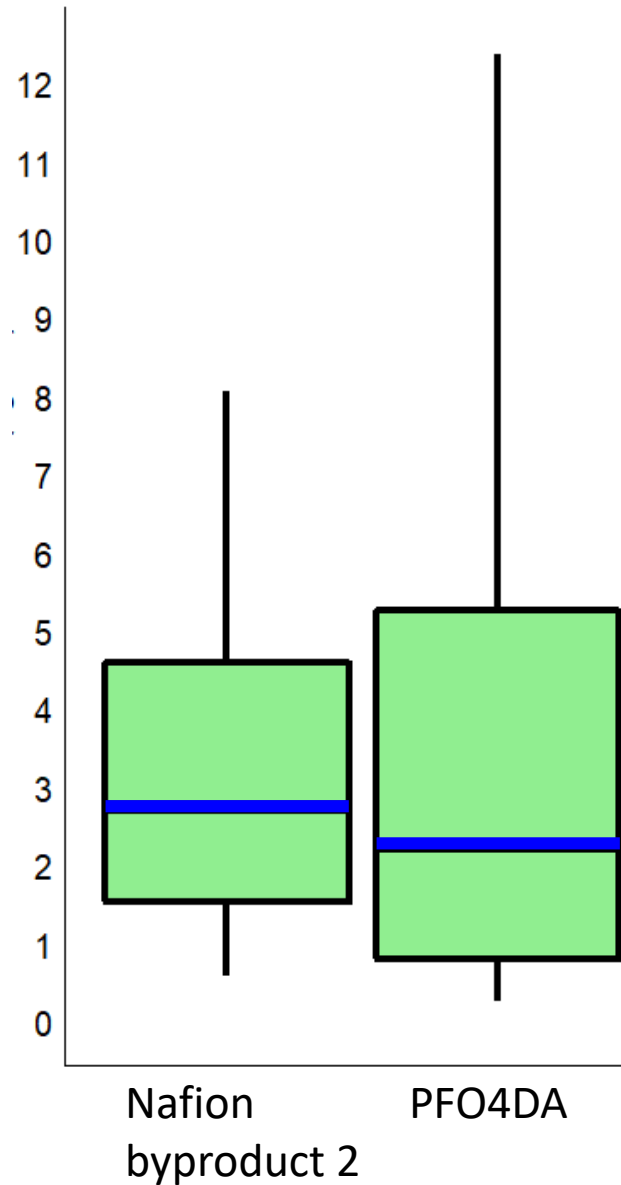
3. PFO5DoA (87%)



# How much was found?

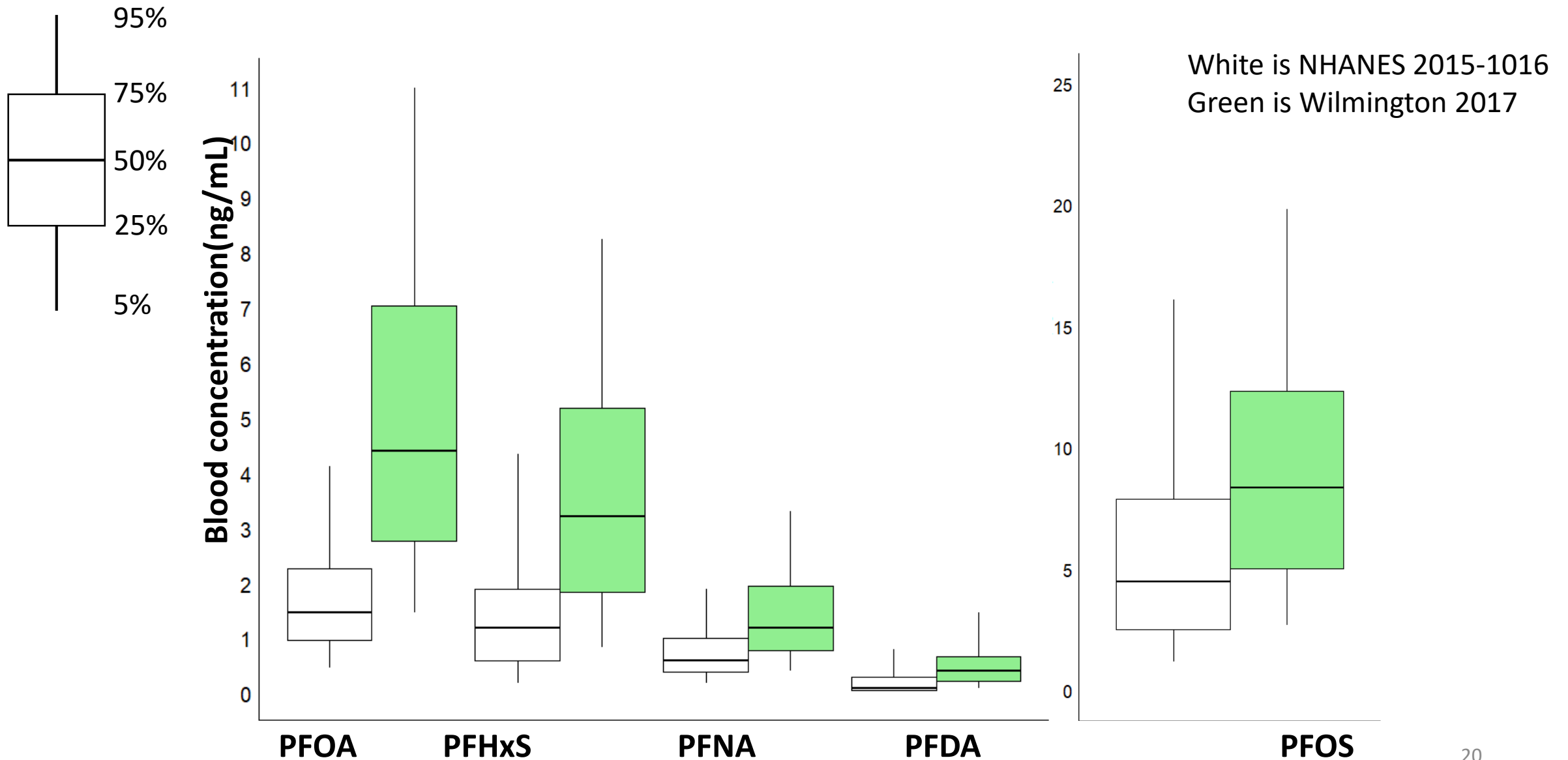


Blood  
concentration  
(ng/mL)

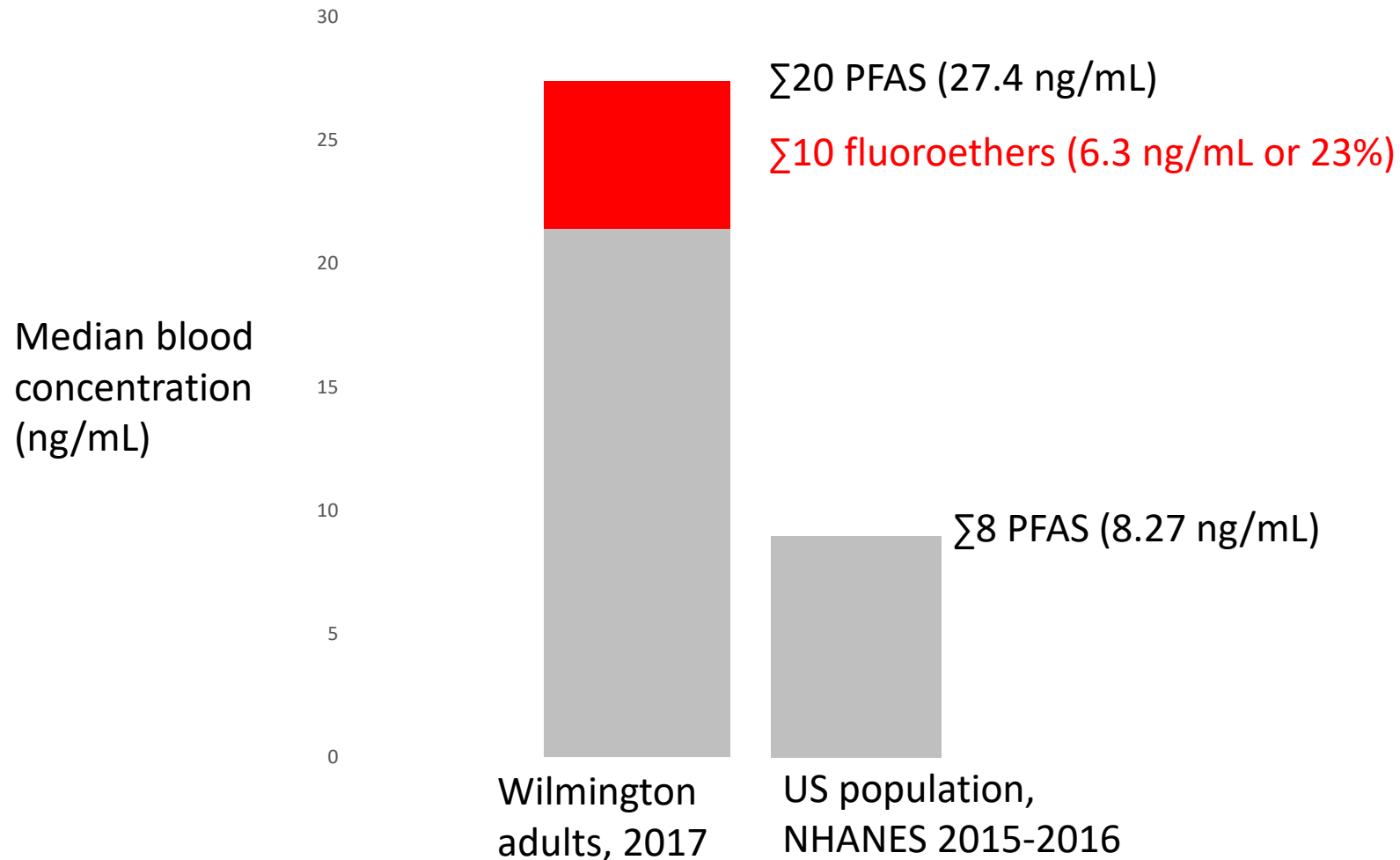




# Elevated legacy PFAS in **Wilmington**

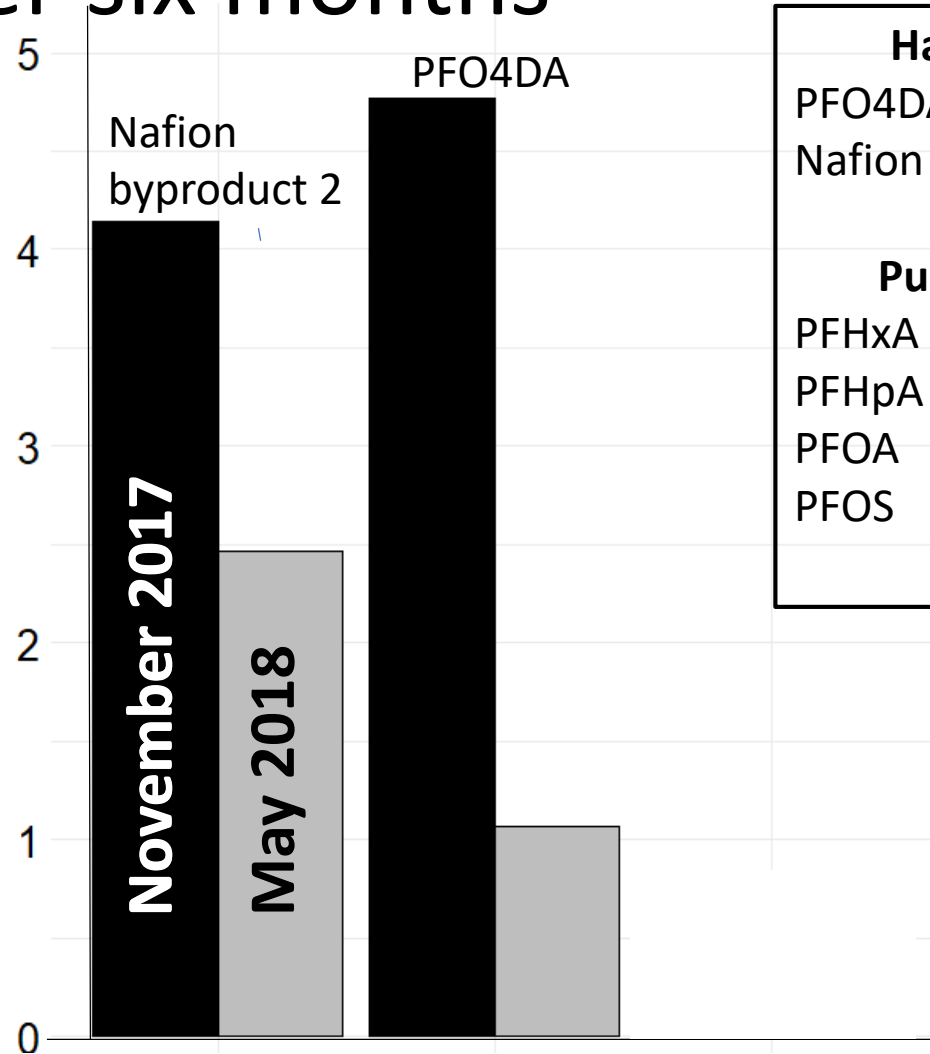


# Elevated body burden in Wilmington relative to US population



# Blood concentrations of fluoroethers decreased after six months

Median blood concentration  
for 44  
participants  
(ng/mL)



## Half life estimates (days)

|                    |           |
|--------------------|-----------|
| PFO4DA             | ~120 days |
| Nafion byproduct 2 | ~300 days |

## Published half lives (days)

|       |           |
|-------|-----------|
| PFHxA | 32 days   |
| PFHpA | 62 days   |
| PFOA  | 840 days  |
| PFOS  | 1241 days |

# If GenX is not in your blood, what does it mean?

GenX has a very short biological half-life (~3 days)

What we measure in the body represents recent exposure

It does not mean that there's no risk from past exposures.

To understand long term health effects, we need to estimate past exposure using information on water levels, water consumption, for the 40 years that these chemicals were discharged to the river.

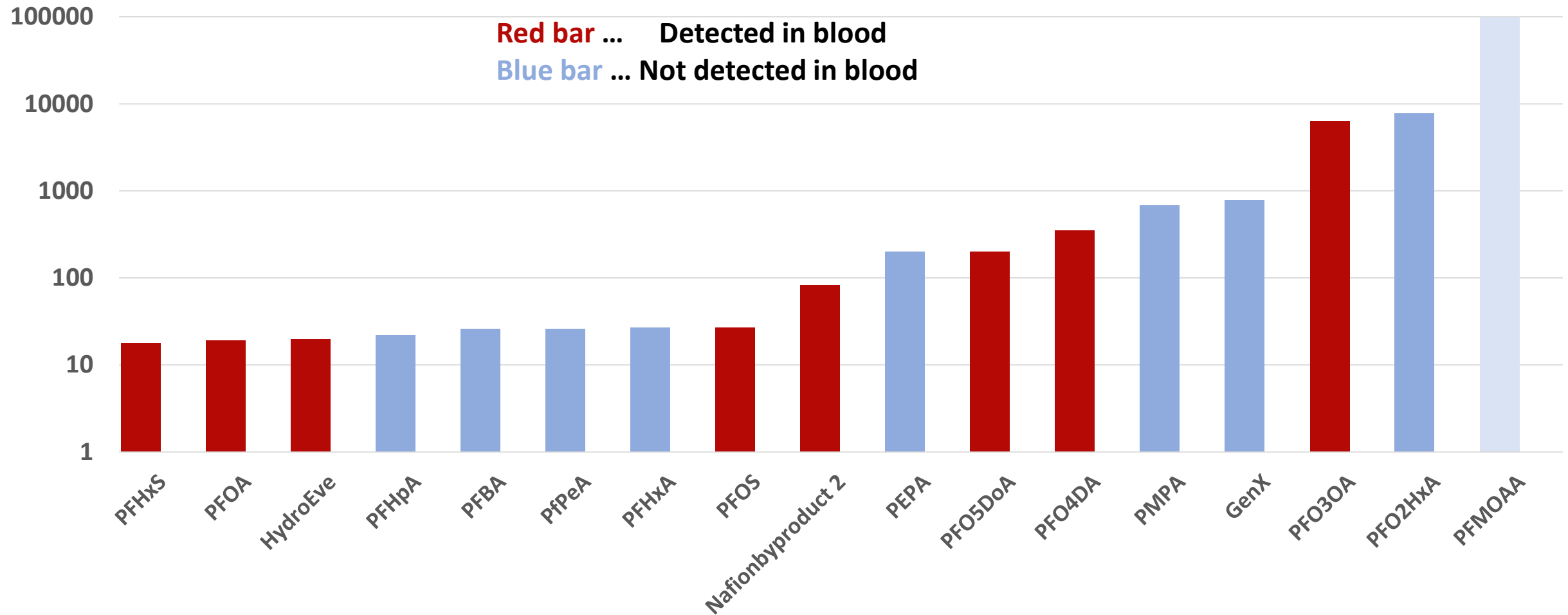


The diagram illustrates a river system with three sampling points labeled A, B, and C. An arrow labeled "Point & non-point sources" points to the upper reaches of the river. A chemical structure of PFPrOPrA ("GenX") is shown, with the label "PFPrOPrA ("GenX")" below it. A "Fluorochemical Manufacturer" is indicated by an arrow pointing to the river between points B and C. A graph on the right shows "PFAS Concentration (ng/L)" on the x-axis (0 to 800) and three categories on the y-axis: A (Legacy PFASs), B (PFPrOPrA ("GenX")), and C (PFPrOPrA ("GenX")). The graph shows a high concentration of Legacy PFASs at point A and a high concentration of PFPrOPrA ("GenX") at points B and C.

We could not measure and quantify all new chemicals, so this is an underestimate.



# PFAS levels in Cape Fear River water (ng/L) in 2015



# Evaluating PFAS Exposure

Some PFAS are biologically persistent (legacy)

- Biomarkers are good integrated measures on long term exposure

- Half-life ranging from 2-7 years

Fluoroethers have short half lives

- 3 days for GenX

- ~1 year for Nafion byproduct 2

- Biomarkers may be poor measures of long term exposure

- May need to reconstruct exposure history

All exposures happen together. Difficult to disentangle individual chemicals



# Acknowledgements



## GenX Study Team

Jane Hoppin, Nadine Kotlarz, Detlef Knappe, Claire Critchley, Katy May, Michael Cuffney, Julia Kaplan, Dylan Wallis, Morgan Lennon, Rob Smart, Grace Campbell, Marisa Incremona, Adrien Wilkie, Charlie Reed, Gracie Miller

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Andy Lindstrom, Mark Strynar, Theresa Guillette, James McCord

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