Preliminary Results for PFAS-AWARE:

Health Effects Study on Poly- and Perfluoroalkyl Substances

PFAS AWARE study Team: Adgate, Barton, Higgins, McDonough, Starling

www.PFAS-AWARE.org

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Funders: National Institute of Environmental Health Sciences (NIH)

Objectives:

1. Understand the relationship between exposure to PFASs in drinking water and how quickly the body accumulates and/or eliminates various PFASs
2. Evaluate how exposure to PFASs affects health

Talk Roadmap

- PFAS-AWARE Study
  - Background on PFASs
  - Timeline & Study Progress
- Water Results
- Blood Results
- Future Directions
- Questions

PFAS Exposure

- Poly- and Perfluoroalkyl substances (PFASs)
  - Large number of compounds: it's a mixture
  - Two most common are PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoate)
    - 99% of the US population has measurable levels of these compounds
    - Most health studies in humans look at these two compounds
- These compounds are found in many household products, not just contaminated water. Examples include:

Non-stick cookware

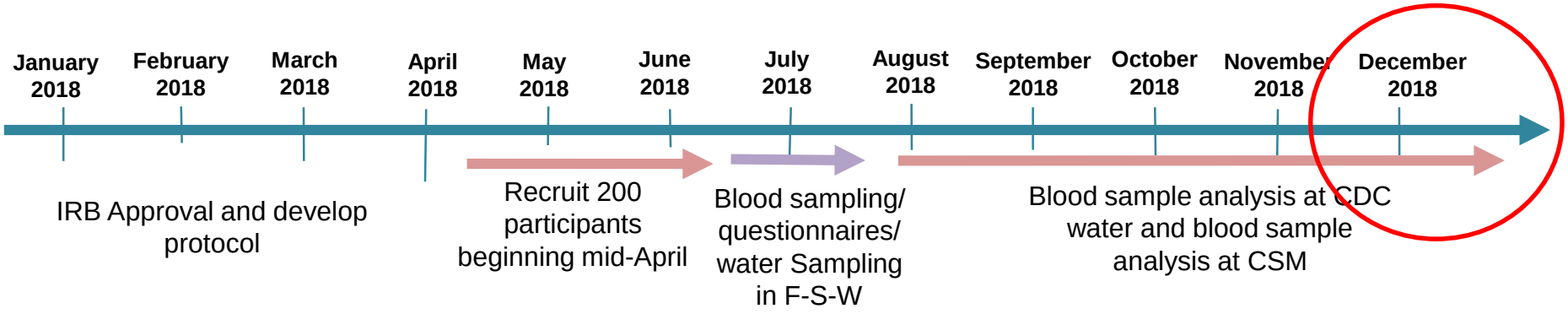
Grease-repellent food wrappers

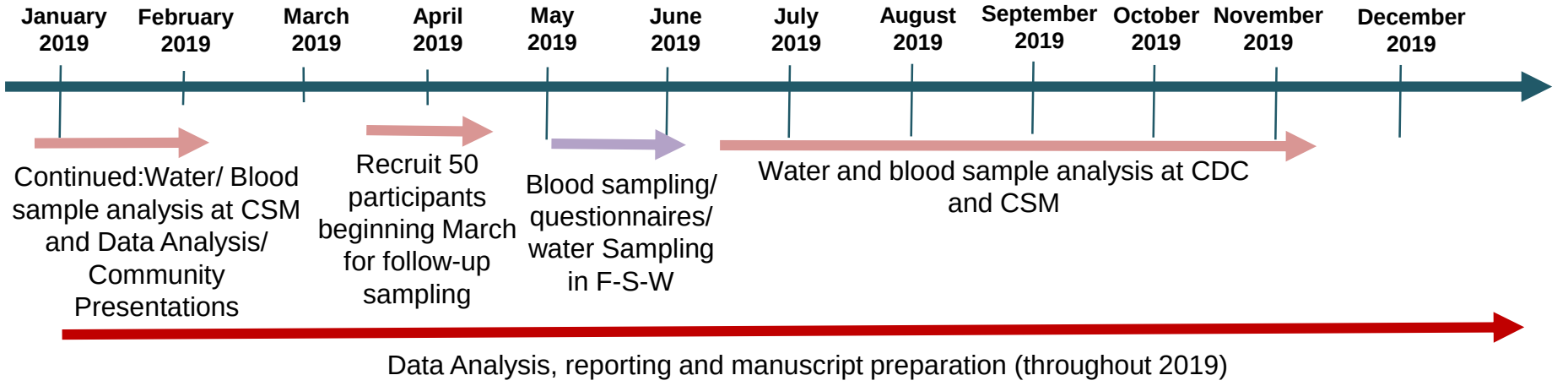
Water- and stain-resistant fabrics

PFAS Exposure in Fountain, Security and Widefield Wells

- AFFF (Aqueous Film Forming Foam) was used at airports, military installations, fire-fighting training sites, manufacturing sites, and other places.
  - PFASs from AFFF are a different mixture from the one in consumer products. This includes **PFHxS** (perfluorohexane sulfonate) and related substances
  - Less is known about exposure and health effects of **PFHxS** than **PFOA/PFOS**
- **If you are on one of the public water systems (Fountain, Security, and Widefield) your exposure ended around August 2015 because of changes in water sources or addition of treatment systems**

PFAS-AWARE Study Timeline





Study Progress

- **Year 1: 2018**
  - Water Sampling
  - Blood Sampling
  - Participant Questionnaires
- **Year 2:** 2019
  - Blood Sampling
  - Questionnaires

Preliminary Water Sampling Results

Preliminary Water Sampling Results:

- We measured PFASs in the *untreated* wells that were used by Security, Widefield, and Fountain before the PFAS issue was known
- Since PFASs were discovered in these systems, each water supplier either changed water sources or added treatment systems specifically to remove PFASs
- We also measured PFASs in private well water samples

Objective: to understand what residents *might have been exposed to in the past*, before EPA health advisories were in effect and additional steps were taken to remove PFASs

Preliminary Water Sampling Results:

- Measured PFASs in ***untreated*** **water** from **private wells** and **public wells** in April-June, 2018
  - 3 in Fountain
  - 3 in Widefield
  - 22 in Security
  - 10 private wells

- **Why *untreated* water?**

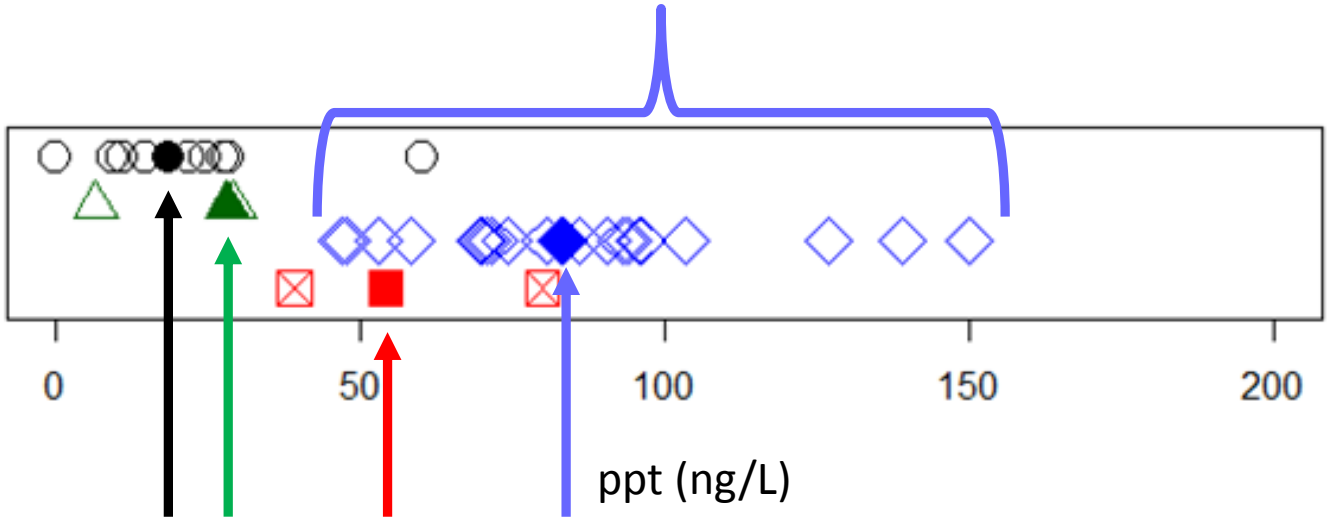
  While PFASs are now being removed from drinking water, concentrations in blood likely reflect *past exposure*

Example Result

These are the water supplies sampled

PRIVATE
FOUNTAIN
SECURITY
WIDEFIELD

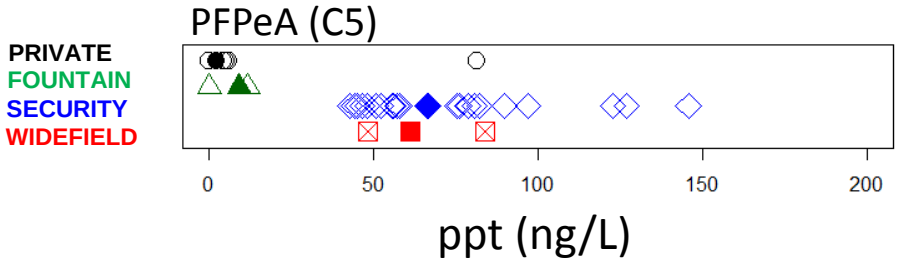
This reflects all the concentrations measured across the sampled water supply

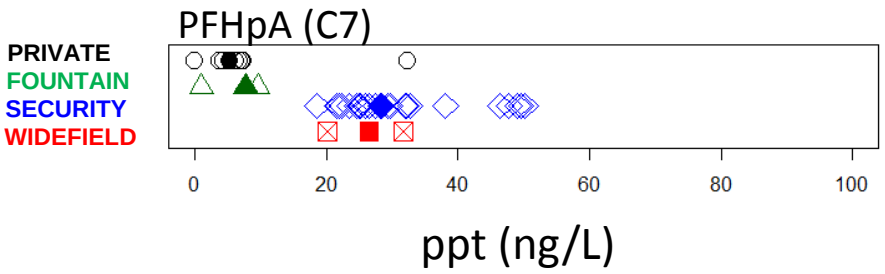


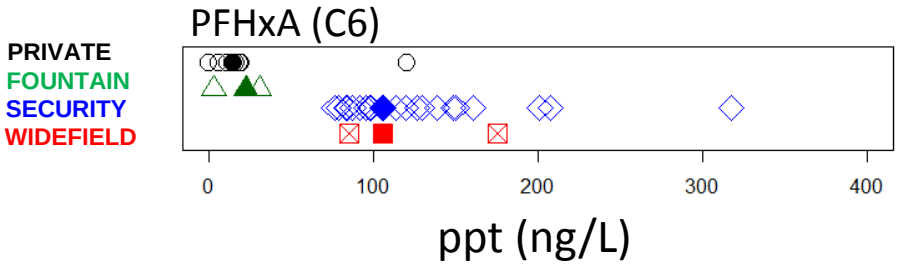
*Filled Shapes are **Median (middle) concentrations** for each water supply:*
50% of values are lower
50% of values are higher

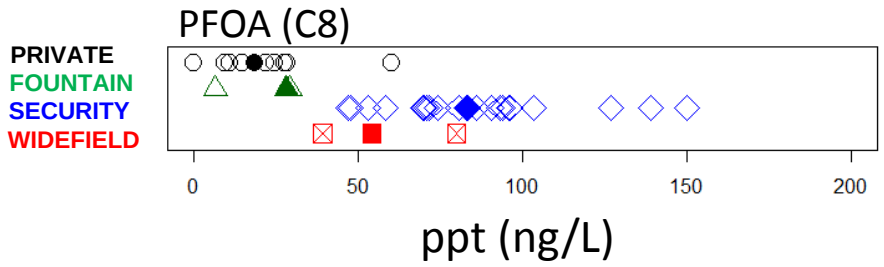
Perfluorocarboxylates in Untreated Well Water

Private wells: black circles; **Fountain:** green triangles; **Security:** blue diamonds; **Widefield:** red squares
Generally, **Private wells < Fountain < Widefield < Security**
**Note scales are different depending on compound*





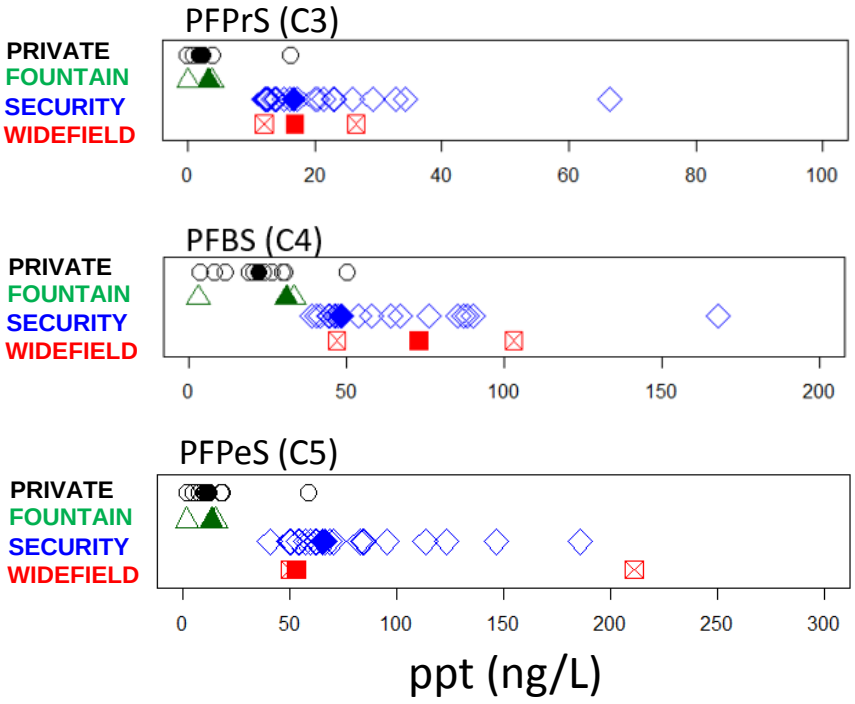


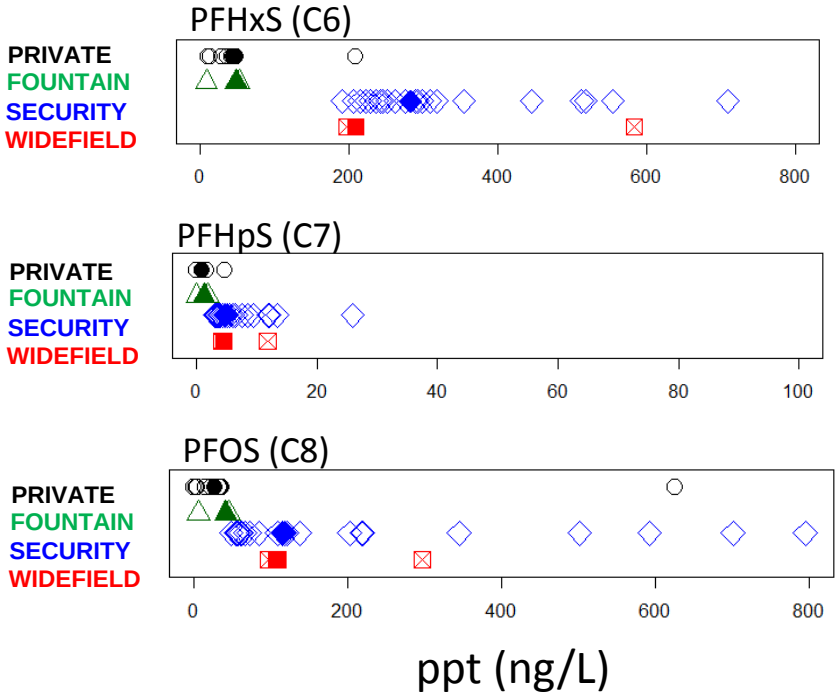


*Filled Shapes are **Median**: 50% of values are lower, 50% are greater, than this value*

Perfluorosulfonates in Untreated Well Water

Private wells: black circles; **Fountain:** green triangles; **Security:** blue diamonds; **Widefield:** red squares
Generally, **Private wells < Fountain < Widefield < Security**
**Note scales are different depending on compound*





*Filled Shapes are **Median**: 50% of values are lower, 50% are greater, than this value*

Data Summary:
PFASs in Untreated Well Water

Total PFASs in *untreated well water* ranged from **18 – 2300 ppt (ng/L)**

- PFASs detected are typical of fire-fighting foam-impacted groundwater
- Combined PFOS+PFOA in *untreated well water* ranged from **0 – 870 ppt (ng/L)**

10 PFASs frequently detected (found in > 80% of samples):

- C5-C8 perfluorcarboxylates – PFPeA, PFHxA, PFHpA, PFOA
- C3-C8 perfluorosulfonates – PFPrS, PFBS, PFPeS, **PFHxS**, PFHpS, **PFOS**
  - PFHxS and PFOS were present at the greatest concentrations

What was sporadically detected?

Compounds	Percent Detection	Concentration Range ppt (ng/L)
C4, C10, C11 perfluorocarboxylates	3-20%	0.47 - 50 ppt (ng/L)
PFNS	13%	0.33 - 2.1 ppt (ng/L)
FOSA (perfluorooctane sulfonamide)	10%	0.19 - 2.0 ppt (ng/L)
6:2 and 8:2 FTS (fluorotelomer sulfonate)	5-28%	0.88 - 15 ppt (ng/L)
Cl-PFOS	10%	0.64 - 1.3 ppt (ng/L)

What was NOT detected above limit of quantitation*?

- GenX; C9, C12-C14, C16, C18 perfluorocarboxylates; C10 and C12 perfluorosulfoantes; Fluorotelomer acids; Sulfonamides besides FOSA; Sulfonamido acetic acids; 4:2 and 10:2 fluorotelomer sulfonates

**Limit of quantitation: The lowest concentration the instrument can measure with confidence*

Water Conclusions

- We found 10 different PFASs in more than 80% these samples
- The range of concentrations is large
- The compounds measured are consistent with PFASs derived from fire fighting foam use

Preliminary Blood Sampling Results

Preliminary Blood Sampling Results

- **In each of 220 Blood Samples we collected we measured or are measuring**:
  - 48 PFAS Compounds → Presenting on 18 today
  - Total Cholesterol, Triglycerides, HDL Cholesterol and LDL Cholesterol
  - Liver Enzymes: AST, ALT, GGT
- **Results to share in a future letter and public meeting:**
  - Interleukins and Other Cytokines: IL-1β, IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, GM-CSF, IFN-ɣ and TNF-α
  - Additional PFASs in serum and water
  - Letters/Presentations in first half of 2019

What Are CDC & NHANES Reference Ranges?

- CDC is the “Centers for Disease Control”
- NHANES is the “National Health and Nutrition Examination Survey”
  - Designed to assess the health and nutrition status of adults and children in the U.S. using interviews, examinations and laboratory testing
  - A nationally representative selection of people participate every other year
  - **Helps to determine U.S. population averages for both diseases and PFAS and other exposures.**

Preliminary Blood Sampling-PFAS Results (in ng/ml):

Current Acronym	This Study 50th Percentile	U.S. 50th Percentile	This Study 90th Percentile	U.S. 90th Percentile	Percent Measurable
PFHxS	14.8	1.4	49.7	4.1	100
Total PFOS	9.7	5.2	28.1	13.9	100
Total PFOA	3.0	2.1	7.4	4.3	100
PFNA	0.4	0.7	0.8	1.6	100
PFHpS	0.2	N/A	0.6	N/A	82
PFDA	0.1	0.20	0.3	0.5	45
Me-FOSAA	0.1	< LOD	0.4	0.4	35
PFHxA	< LOD	N/A	0.2	N/A	25
PFUndA	0.1	< LOD	0.1	0.3	17
PFHpA	< LOD	< LOD	0.1	0.1	9
PFDoDA	< LOD	< LOD	0.1	0.1	2
Et-FOSAA	< LOD	< LOD	0.1	< LOD	2

<LOD stands for below the limit of detection. This means that the value was somewhere between 0 and 0.1 ng/ml. Below 0.1 ng/ml the instrument cannot give a confident answer for the actual value.

Your Letter

The full name of the compound.

Shortened name of the compound.

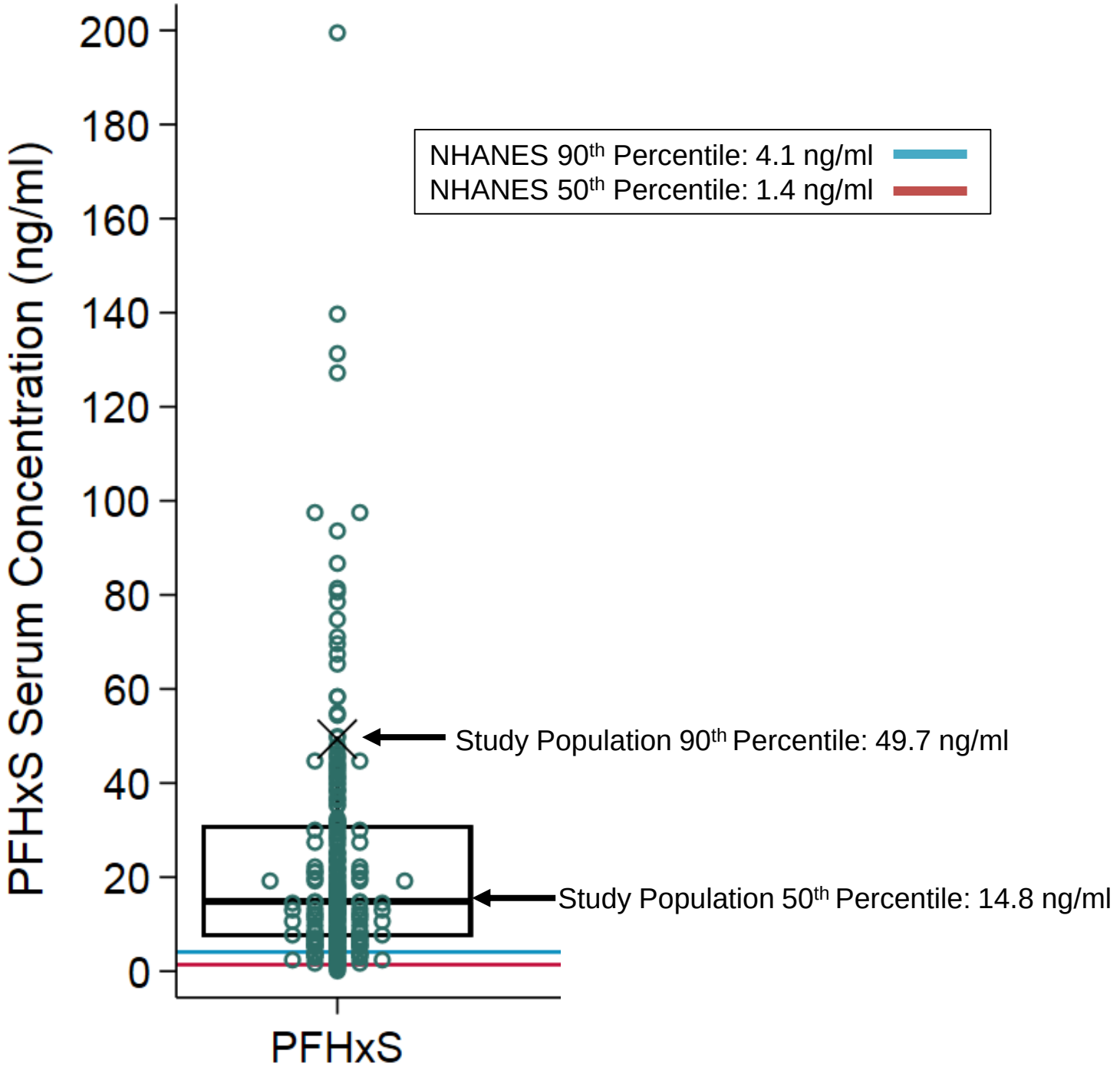
The point at which half the values are above and half are below.

The number and percent of people in this study who had greater than 0.1 ng/ml of PFAS detected in blood.

The point at which 95% of the values are below.

Chemical Name	Abbreviation	Your Result	Lowest Result found in this Study	50th percentile* for this Study	Highest Result found in this study	Number (%) of participants with detectable levels in this study	50th Percentile* for general U.S. Population	95th Percentile** for general U.S. Population
Perfluoroalkanoic acids								
Perfluoro-n-butanoic acid	PFBA		Below Limit of Detection^	Below Limit of Detection^	Below Limit of Detection^	0 (0%)	--	--
Perfluoro-n-pentanoic acid	PFPeA		Below Limit of Detection^	Below Limit of Detection^	Below Limit of Detection^	0 (0%)	--	--
Perfluoro-n-hexanoic acid	PFHxA		Below Limit of Detection^	Below Limit of Detection^	0.5	55 (25%)	--	--
Perfluoro-n-heptanoic acid	PFHpA		Below Limit of Detection^	Below Limit of Detection^	0.5	20 (9%)	Below Limit of Detection^	0.200
Perfluoro-n-octanoic acid	PFOA		Below Limit of Detection^	2.9	13.8	219 (99.5%)	2.07	5.57
Perfluoro-n-nonanoic acid	PFNA		Below Limit of Detection^	0.4	4.2	219 (99.5%)	0.700	2.00

PFHxS Results

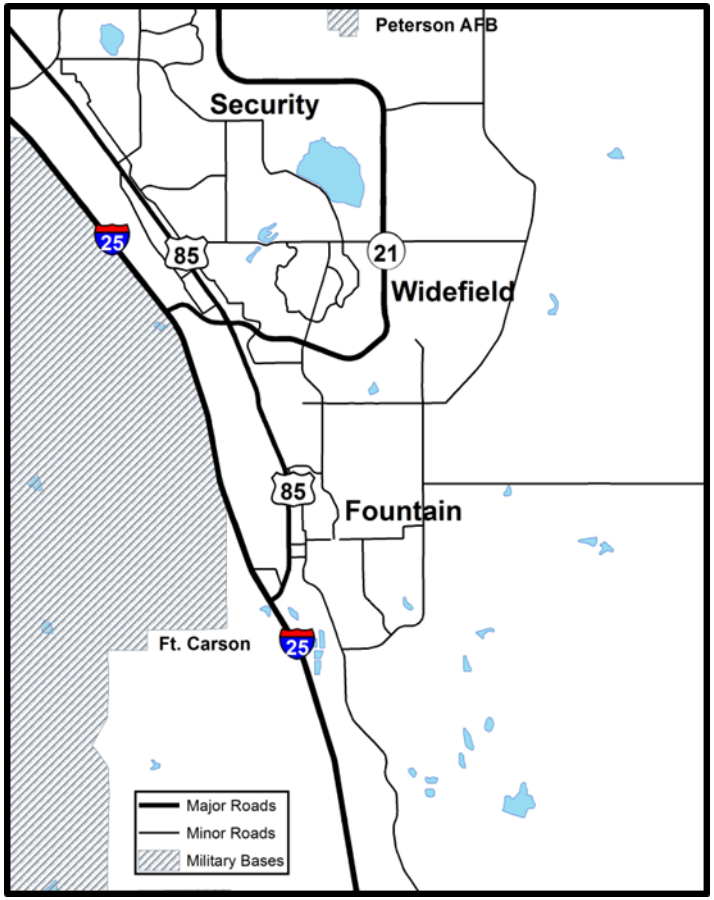


PFHxS Results

- The median is the same as the 50th percentile. The median is the point where half the values are above and half are below.
- The study population had a median serum PFHxS level of 14.8 ng/ml **this is approximately 10 times as high** as the U.S. median serum PFHxS level of 1.4 ng/ml.
- Similarly, the 90th percentile serum PFHxS level **is approximately 12 times as high** as the U.S. 90th percentile serum PFHxS level.

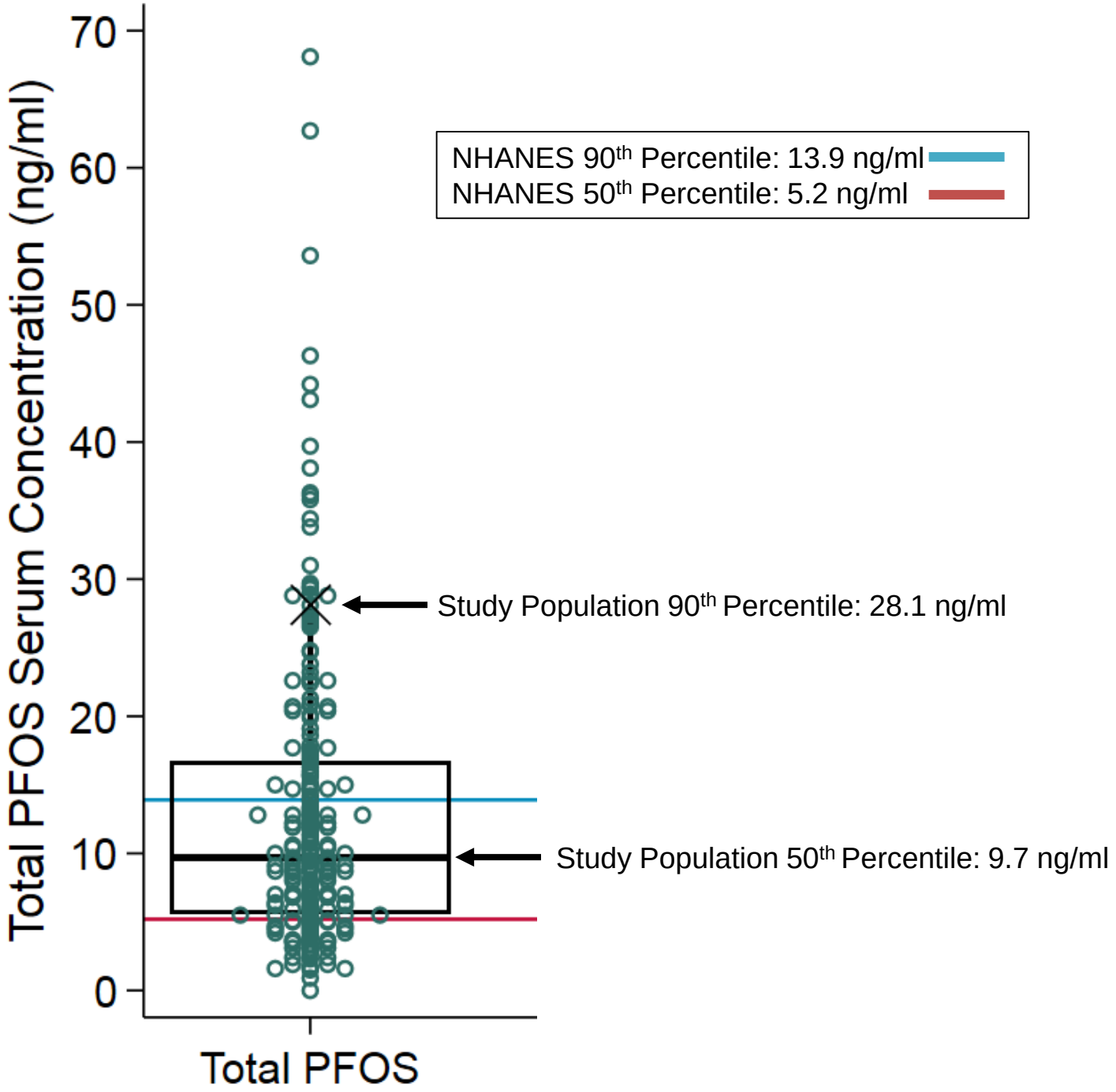
Geographic distribution of serum PFHxS results, **which is likely a result of drinking contaminated water:**

Water District	Range (Median) of PFHxS Serum Levels (ng/ml)
Security	0.1-199.5 (21)
Widefield	1.7-97.5 (13.5)
Fountain	0.5-58.4 (8.85)
Private Well	2.4-139.7 (19.15)



Study Area

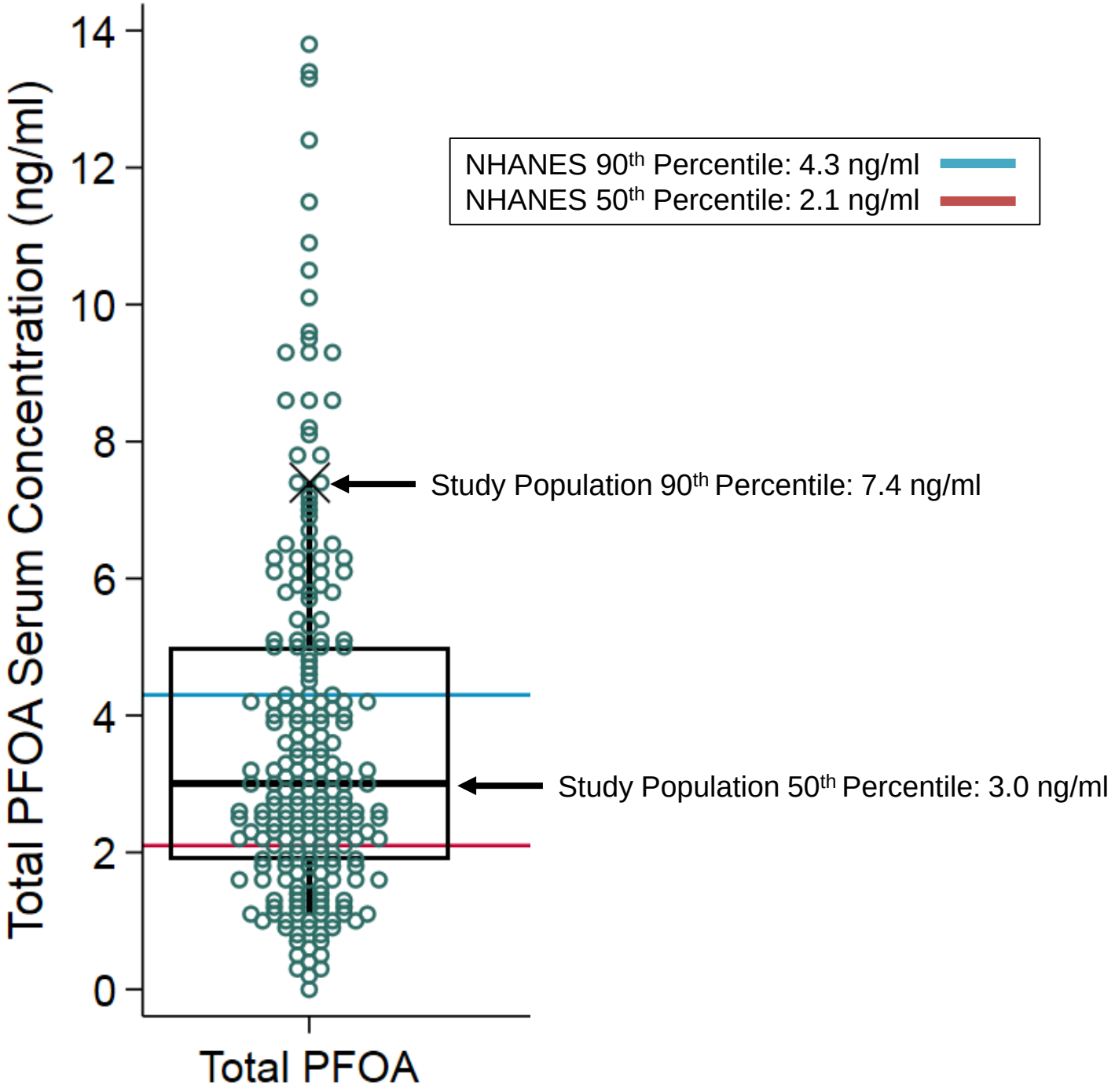
PFOS Results



PFOS Results

- The study population had a median serum PFOS level of 9.7 ng/ml this is **approximately 1.8 times as high** as the U.S. median serum PFOS level of 5.2 ng/ml.
- Similarly, the study population 90th percentile serum PFOS level is **approximately 2 times as high** as the U.S. 90th percentile serum PFOS level.

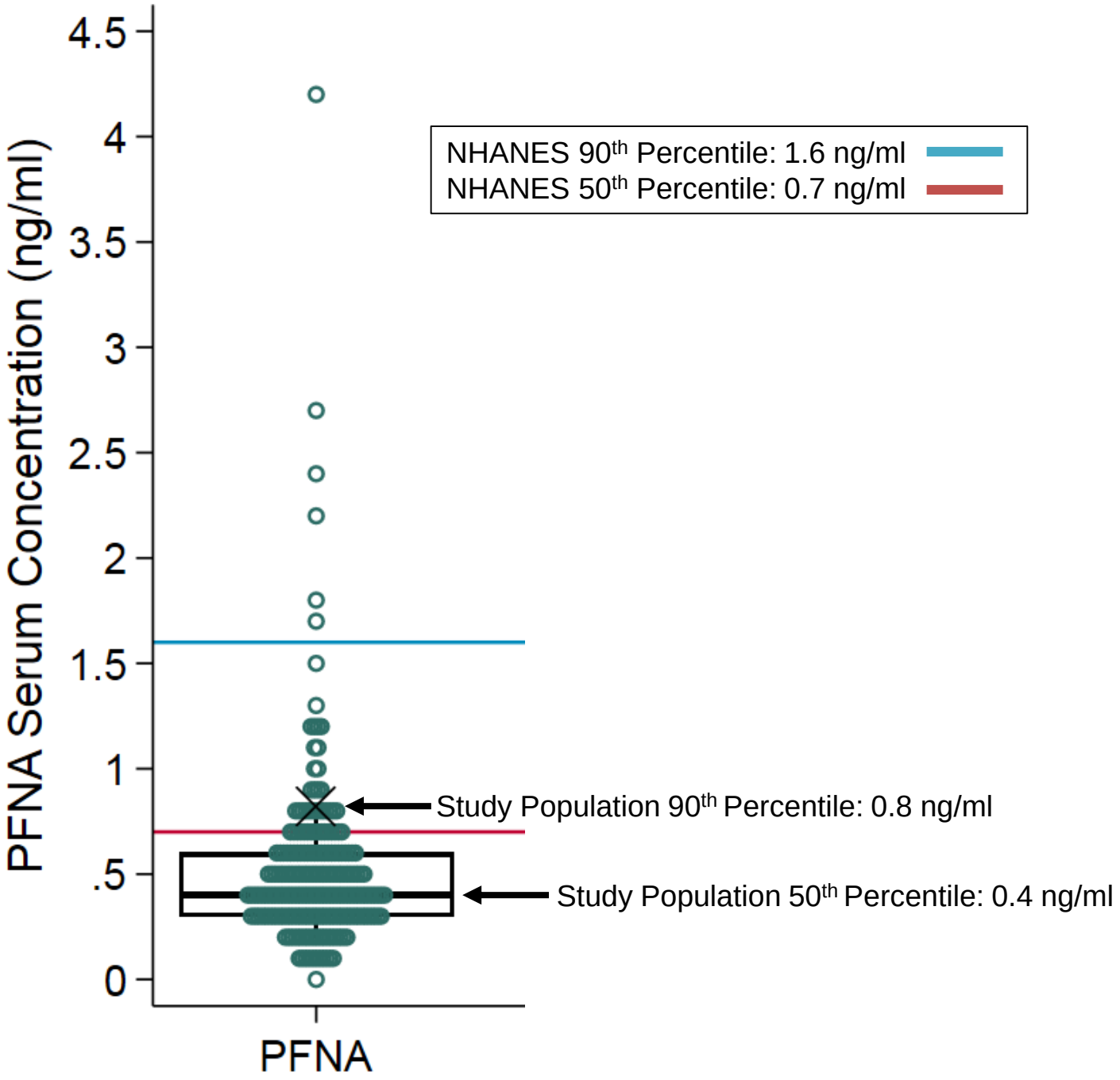
PFOA Results



PFOA Results

- The study population had a median serum PFOA level of 3.0 ng/ml this is **approximately 43% higher** than the U.S. median serum PFOA level of 2.1ng/ml.
- Similarly, the study population 90th percentile serum PFOA level is **approximately 72% higher** than the U.S. 90th percentile serum PFOA level.
- **Overall, the PFOA results from this study population are comparable to the U.S. Reference Levels**

PFNA Results

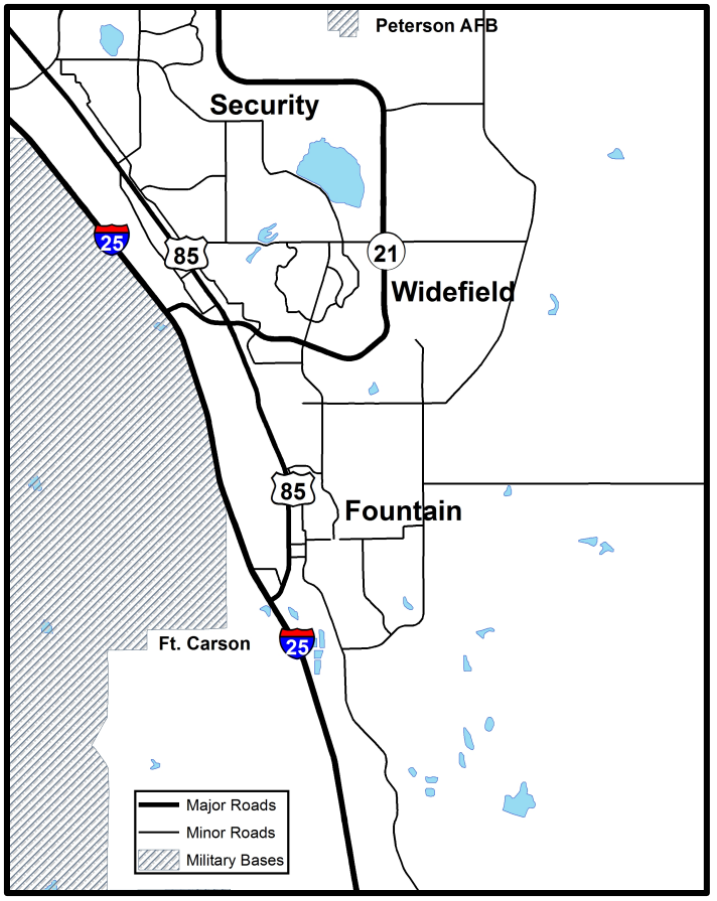


PFNA Results

- The study population had a median serum PFNA level of 0.4 ng/ml this is **approximately 43% lower** than the U.S. median serum PFNA level of 0.7 ng/ml.
- Similarly, the study population 90th percentile serum PFNA level is **approximately 50% lower** than the U.S. 90th percentile serum PFNA level
- **Overall, the PFNA results from this study population are slightly lower than the U.S. reference levels**

Geographic distribution of serum PFNA results, which is likely ***not*** a result of drinking contaminated water:

Water District	Range (Median) of PFNA Serum Levels (ng/ml)
Security	<LOD-2.2 (0.4)
Widefield	0.1-2.4 (0.5)
Fountain	0.1-4.2 (0.4)
Private Well	0.2-1.3 (0.45)



Study Area

Summary: PFOS, PFOA, PFHxS and PFNA Numbers in F-S-W vs. CDC Reference Values

- PFHxS:
  - Median/90th percentile levels in F-S-W are ~10 times as high as the U.S. population reference levels
- PFOS:
  - Median/90th percentile levels in F-S-W are ~2 times as high as the U.S. population reference levels
- PFOA:
  - Median/90th percentile levels in F-S-W are ~40 to 70% higher than the U.S. population reference levels
- PFNA:
  - Median/90th percentile levels in F-S-W are ~40 to 50% lower than the U.S. population reference levels

Blood Sampling-PFAS Results

How do the levels in F-S-W compare to the levels found in other highly exposed U.S. communities?

Community	Primary Exposure Source	PFHxS 50th Percentile (ng/ml)	PFOS 50th Percentile (ng/ml)	PFOA 50th Percentile (ng/ml)
Fountain, Security & Widefield, CO	Water contamination from AFFF	14.8	9.7	3.0
Portsmouth, NH	Water contamination from AFFF	4.16	9.17	3.1
Warminster, Warrington & Horsham, PA	Water contamination from AFFF	7.63 (average)	11.5 (average)	3.3 (average)
Communities in Ohio and West Virginia	Water contamination from chemical manufacturing plant	Not Measured	20.2	27.9
Wilmington, NC	Water contamination from chemical manufacturing plant	3.2	9.0	4.4

Summary of Community Serum Level Comparisons

- Median **PFHxS** levels are higher in PFAS-AWARE participants than in other AFFF impacted U.S. communities.
- Median **PFOS/PFOA** levels are similar to other impacted communities in NH/PA/NC, but lower than in the West Virginia (C8) study.
- Important Point to Note: there are no health-based standards or guidance for PFAS levels in blood

Blood Sampling-PFAS Results:

- **How can I avoid additional exposure to PFAS?**
  - If you are on a private well have it checked for PFAS contamination.
  - Limit eating at fast food restaurants or eating microwave meals that use packaging that may be grease repellent.
  - Avoid buying stain- and water-resistant products where possible.
  - Wash hands before eating and keep floors and surfaces clean to reduce possible exposure from PFASs in dust.

Clinically Actionable Results: Cholesterol and Liver Enzymes

Blood Sampling-Cholesterol Results:

Total Cholesterol	LDL Cholesterol	HDL cholesterol	Triglycerides
Produced and stored in the liver, released into bloodstream as needed	**LDL** = low density lipoprotein =“bad” cholesterol	**HDL** = high density lipoprotein = “good” cholesterol	Main form of fat in the body
			Unused calories are converted into triglycerides
May also be introduced to the body via diet	Can lead to fat buildup in arteries	Carries cholesterol back to liver to prevent buildup along artery walls	Can provide your body with energy
Can build up along artery walls narrowing the arteries			High levels can contribute to hardening of the arteries

Narrowing and hardening of the arteries increases the risk of cardiovascular disease and stroke.

Source: American Heart Association

Blood Sampling-Cholesterol Results:

	Total Cholesterol (mg/dL)	LDL (mg/dL)	HDL (mg/dL)	Triglycerides (mg/dL)
Study 50th Percentile	**178**	**103**	**44**	**133**
Study Range	Min: **99** Max: **302**	Min: **38** Max: **207**	Min: **0** Max: **129**	Min: **34** Max: **499**
Expected Range	**Healthy:** Below 200 **Borderline High:** 200-239 **High:** 240 and above	**Healthy:** Below 100 **Borderline High:** 100-159 **High:** 160-189 **Very High:** 190 and above	**Low:** Below 40 **Borderline Low:** 40-59 **Healthy:** 60 and above	**Healthy:** Below 150 **Borderline High:** 150-199 **High:** 200-499 **Very High:** 500 and above

If you are concerned about your results you should consult your physician.

We are still working on the analysis of any potential relationships between PFAS exposure and Cholesterol

Blood Sampling-Liver Enzyme Results:

ALT (alanine transaminase):

- Enzyme produced by liver cells

AST (aspartate transaminase):

- Enzyme produced by liver cells
- Can also be found in many different organs including the liver, muscles, heart, kidney and red blood cells

GGT (gamma-glutamyl transpeptidase):

- Enzyme produced by liver cells
- Can be found in many different organs including the liver, bile ducts, heart, kidney and pancreas

Elevated levels of any of these enzymes in the blood may indicate damage or inflammation of the liver or bile ducts.

Source: Mayo Clinic

Blood Sampling-Liver Enzyme Results:

	ALT (Units/L):	AST (Units/L):	GGT (Units/L):
Study 50th Percentile Liver Enzyme Levels	Men: 16 Women: 12	Men and Women: 20	Men: 24 Women: 15
Study Range Liver Enzyme Levels	Men: 3 to 62 Women: 3 to 64	Men and Women: 10 to 60	Men: 6 to 151 Women: 6 to 79
Laboratory Reference Values for Liver Enzymes	Men: 0 to 44 Women: 0 to 32	Men and Women: 0 to 40	Men: 0 to 65 Women: 0 to 60

If you are concerned about your results you should consult your physician.

We are still working on the analysis of any potential relationships between PFAS exposure and Liver Enzymes

What is Involved if I Participate in Year 2?

- **Year 1:** 200 Participants
  - Water Sampling
  - Blood Sampling
  - Questionnaires
- **Year 2:** 50 Participants
  - Blood Sampling
  - Questionnaires
  - Further reporting of study results

Future Directions

- We will be back in the first half of 2019 to present other results and analyses
- Will begin recruiting and scheduling for Year 2 blood sampling in April, 2019
- We will be doing detailed residential histories for as many participants as possible to help understand when the exposure may have started
- Currently doing data analysis and developing manuscripts for future presentations and publication in the scientific literature
- We are seeking funding for additional studies from Federal sources

Thank you for Coming!

If you are interested in getting updates related to this study, or learning about participation in future research, please enter your contact information on the sign-in sheet.

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Resources

See www.PFAS-AWARE.org for links

- https://www.atsdr.cdc.gov/pfc/docs/pfas_clinician_fact_sheet_508.pdf
- https://www.epa.gov/pfas
- https://www.colorado.gov/pacific/cdphe/pfcs
- https://www.pfas-aware.org/