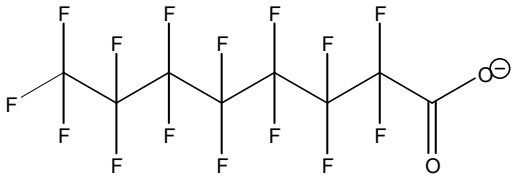
Environmental Testing, Biomonitoring and Partnerships: A Public Health Intervention Story to Address PFAS Groundwater Contamination in Minnesota

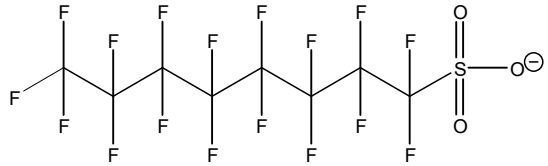
Carin Huset, PhD; Jessica Nelson, PhD; James Kelly, MS
Minnesota Department of Health
August 9, 2018

What are PFAS?

- Perfluoroalkyl substances

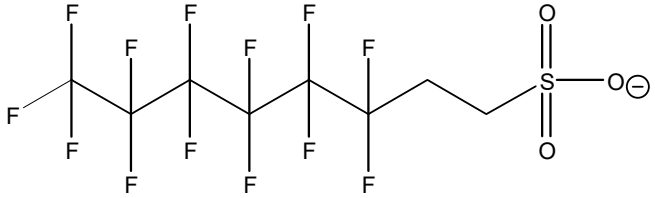


PFOA



PFOS

- Polyfluoroalkyl substances



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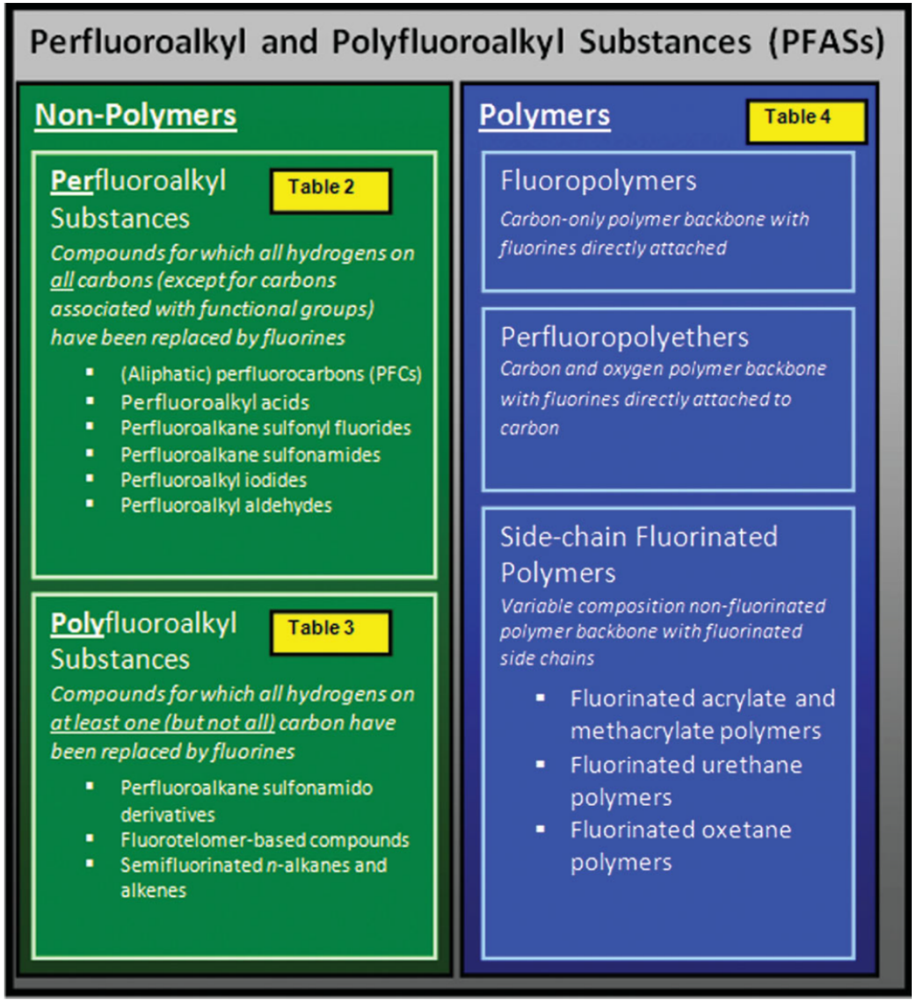


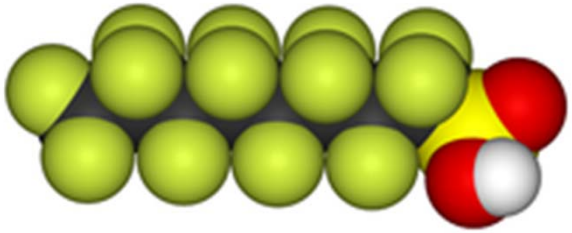
Figure from Buck et al, IAEM, 2011

Why do we study PFAS?

- Persistent and do not biodegrade
- They are globally distributed
  - Found in air, water, sediments, wildlife & humans
- They bioaccumulate and biomagnify
  - Half-lives (human serum elimination)
    - PFOA 3.5 years
    - PFOS 4.8 years
    - PFHxS 7.3 years
- Toxicological effects not fully understood
  - PFOA probable carcinogen

Application and Use of PFAS

- Surfactant properties
- Strength of the C-F bond
- Commercial applications
  - Stain and water repellant coatings
    - Paper & packaging
    - Textiles & Carpets
  - Performance chemicals
    - Industrial surfactants
    - AFFF
    - Insecticides



Background - Why Are PFAS An Issue in MN?

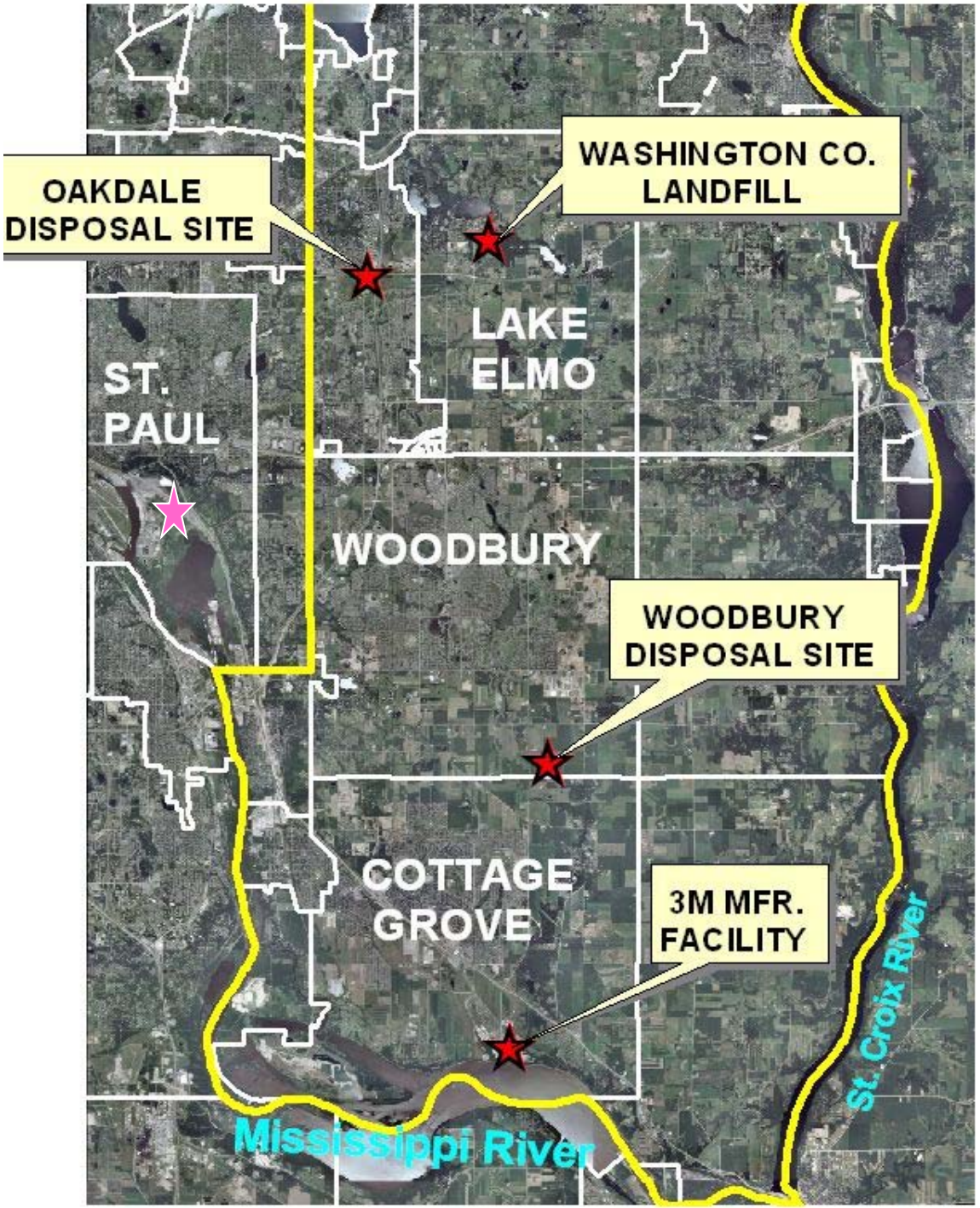
- We are the home of 3M, originally known as Minnesota Mining and Manufacturing
- 3M operates a large chemical plant on the banks of the Mississippi River in Cottage Grove, Minnesota
- PFAS were manufactured at the plant for decades
- PFAS production wastes and wastewater treatment sludge was disposed of both on and off site; primary PFC waste disposal sites are located in Washington Co., Minnesota

FROM: 3M

History of PFAS in Minnesota

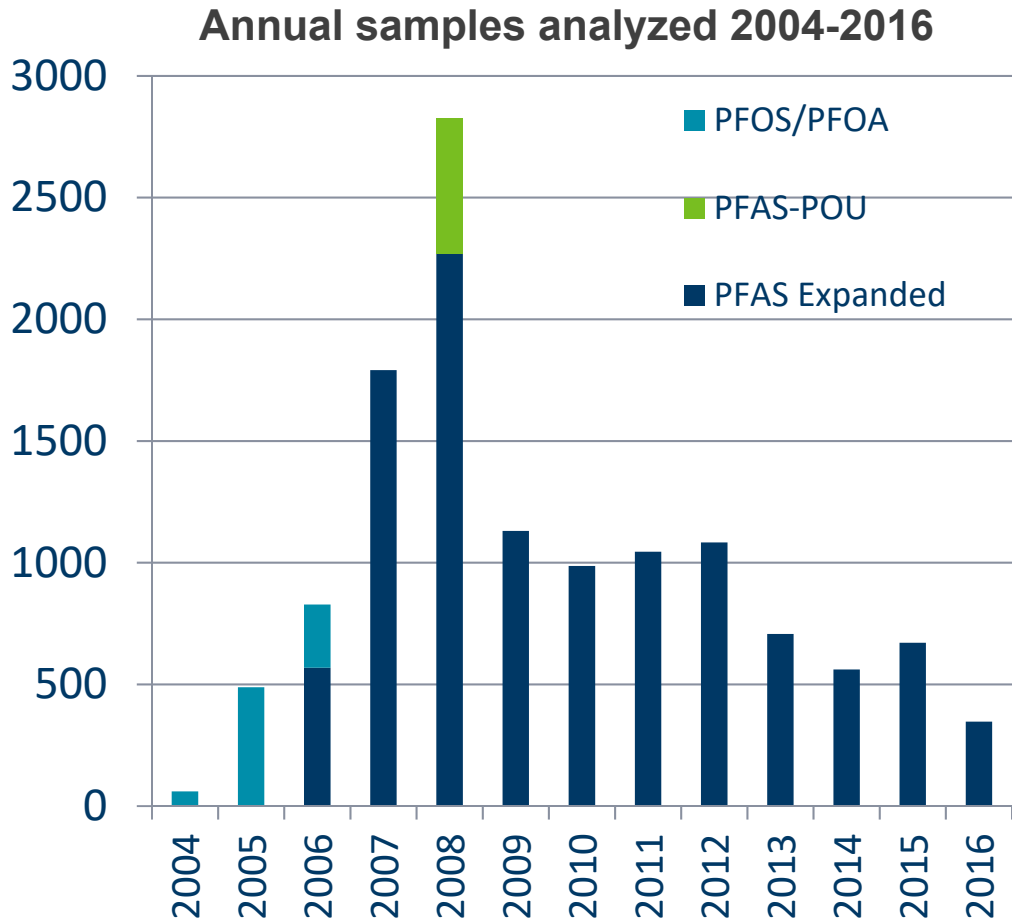
- Washington County Landfill
  - In operation 1969-1975
  - Used by 3M
- PFAS detected private and municipal drinking water wells 2004
  - Increased monitoring
- Cessation of drinking water exposure
  - Bottled water, GAC home filters, (clean) municipal water, municipal treatment plant with GAC filters
- Drinking water guidelines
  - Health based values

LOCATION OF 3M SITES IN WASHINGTON CO. MINNESOTA

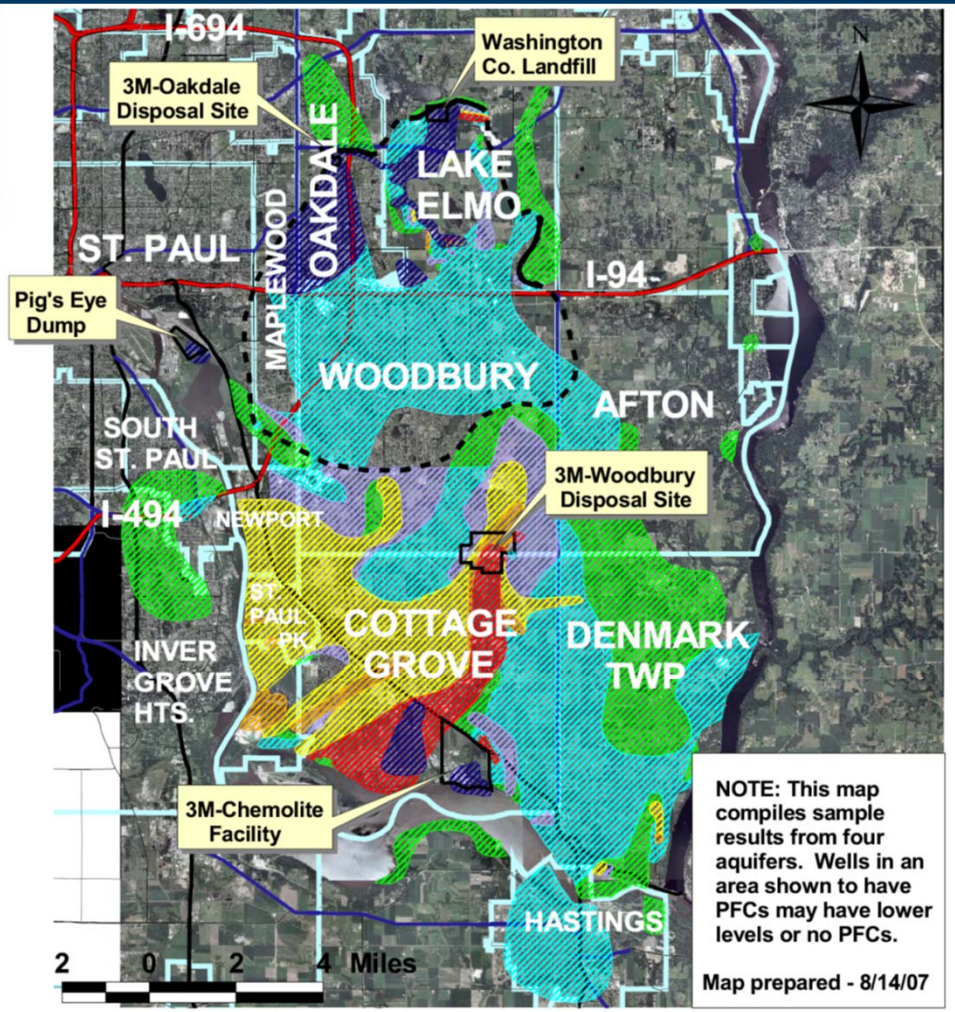


Drinking Water Analysis

- LC/MS/MS Method
  - Direct injection
  - RP chromatography
  - Isotope dilution quantitation
  - Report levels:
    - 2007: 300ng/L
    - 2016: 25-50ng/L
  - Method Performance
    - Precision
      - 2-7%
    - Accuracy
      - 99-106%



2007 Map



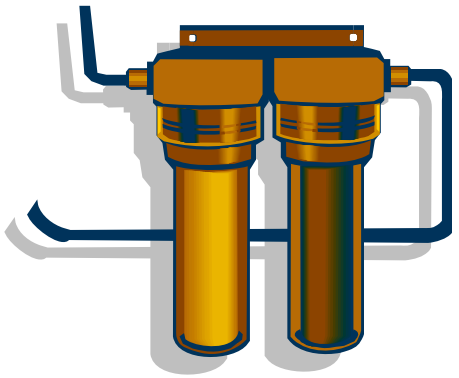
PFCs in the Southeast Metro Area

- PFCs not detected
- PFBA only, 0.2 - 0.5 ppb
- PFBA only, 0.6 - 0.9 ppb
- PFBA only, 1.0 - 1.5 ppb
- PFBA only, 1.6 - 1.9 ppb
- PFBA only, > 2.0 ppb
- Multiple PFCs detected
- Approximate boundary of northern plumes, dashed where uncertain

- PFOA, PFOS, PFBA detected in ground water
- PFBA most widespread

Water Clean Up Activities

- Landfills
  - On-site treatment
  - Re-line site
  - Screen other sites
- Community Systems
  - GAC
  - Breakthrough monitoring
  - PFAS interactions
- Private Wells
  - Point-of-Use Filtration report
  - GAC
  - RO



Minnesota Environmental Health Tracking and Biomonitoring Legislation (2007)

- Establish Environmental Health Tracking and Biomonitoring Program
- Conduct a pilot biomonitoring program of 4 projects
  - Include 2 communities “likely to be exposed” to PFAS
  - Required inclusion of PFBA
- Created Scientific Advisory Panel

Biomonitoring Pilot: 2008

- Participant recruitment
  - Randomly sampled from water billing records
  - Required residence prior to 2005
- 196 residents participated
  - 98 private well users, 98 municipal drinking water users
- Questionnaires used to get more data on exposure routes
- Local clinic used to collect and process specimens
  - MDH lab trained clinic for collection of serum
  - PFAS analysis at MDH

Biomonitoring Results 2008

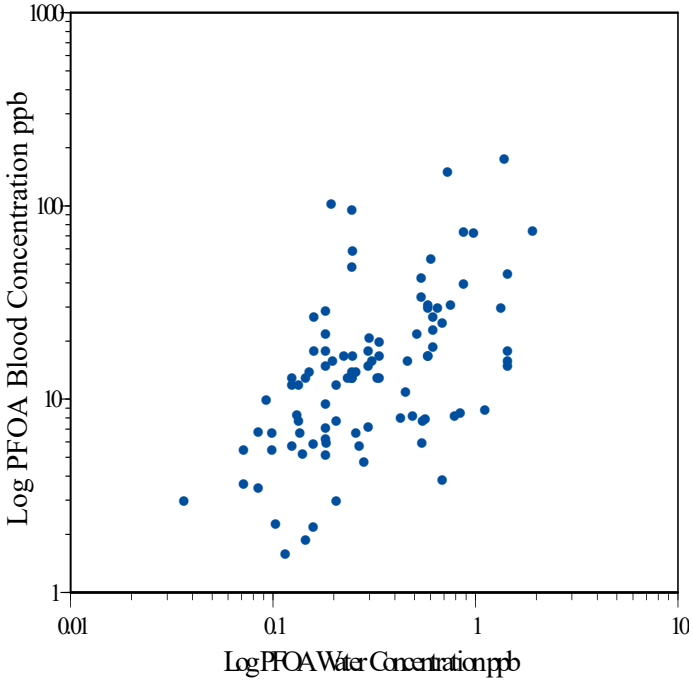
- PFOA, PFOS, PFHxS
  - Detected all 196 samples
  - Higher than NHANES
- PFOA, PFHxS, PFOS
  - Higher in men
  - Concentrations increased with age
- PFOA, PFOS associated with drinking water

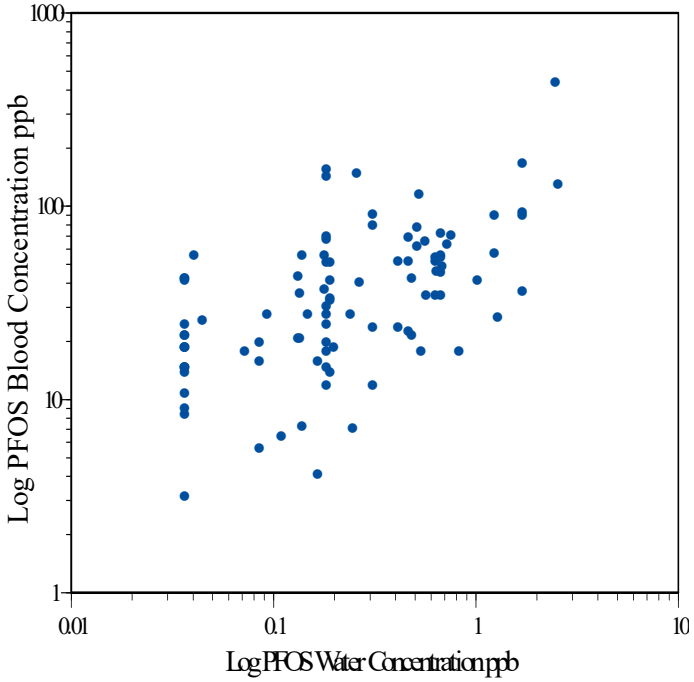
	percent detection	GM (ng/ml)	NHANES (2007-2008) GM(ng/ml)
PFBS	3	NA	*
PFHxS	100	8.4	1.95
PFOS	100	35.9	13.2
PFBA	28	NA	-
PFPeA	0	ND	-
PFHxA	0	ND	-
PFOA	100	15.4	4.12

Landsteiner et al, J Env Health, 2014

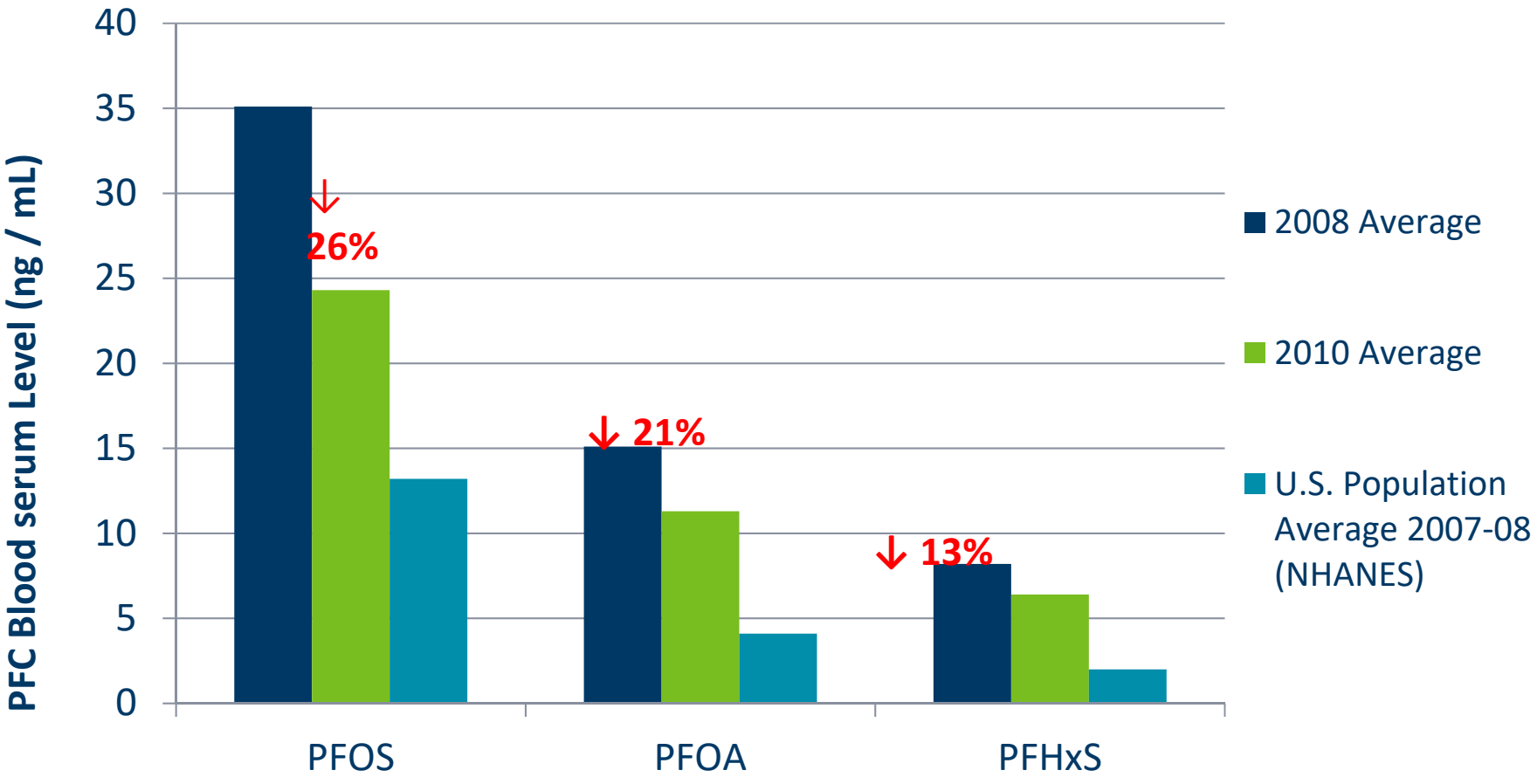
2008 Blood Levels Related to Drinking Water Levels

- Analysis of a subset of private well users (n=98)





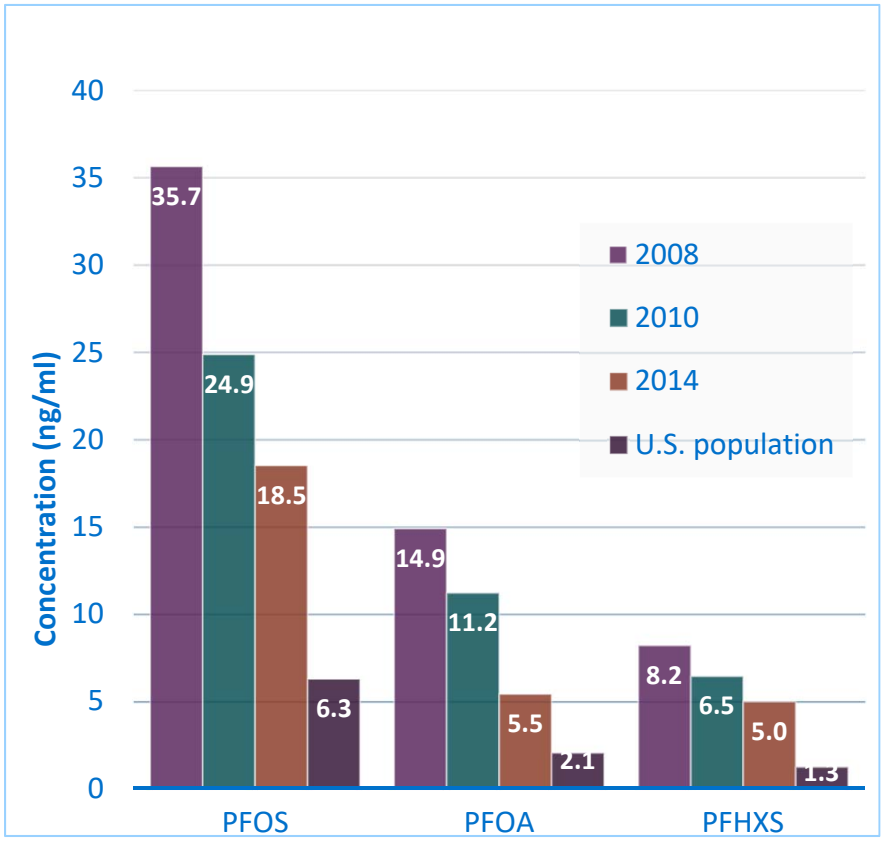
Biomonitoring Follow Up: 2010



Note on PFBA Detects: 2008 = 25%; 2010 - 21%

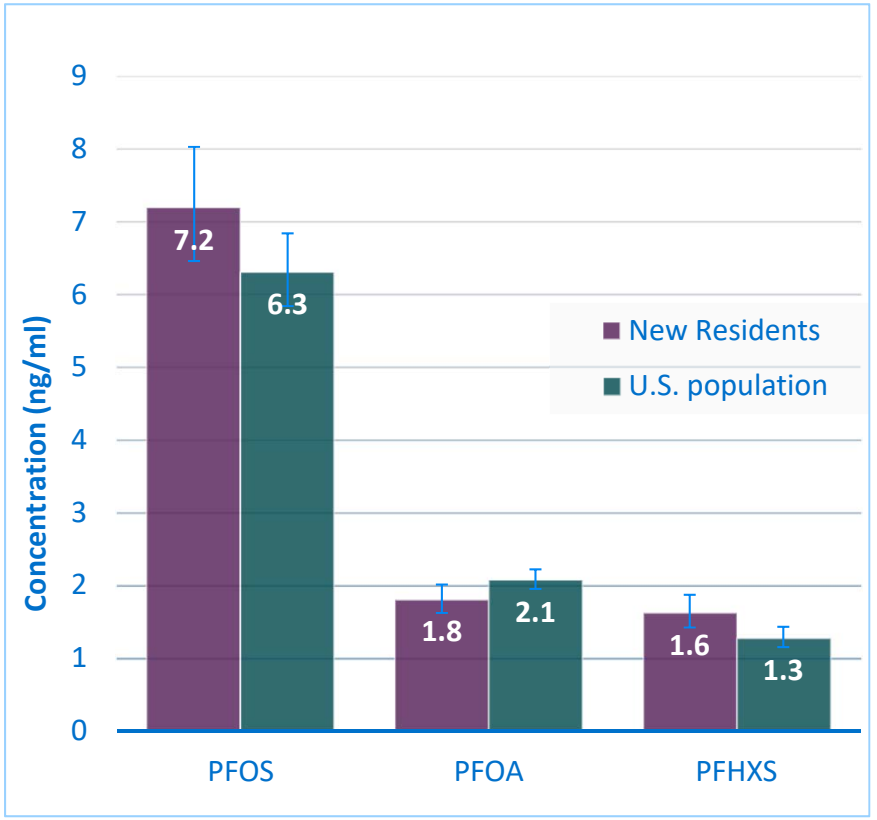
2008, 2010, 2014 Blood PFAS levels compared to NHANES

- Blood levels of long term residents on the decline
- Mean individual percent change 2008-2014 (n=149)
  - PFOS 45% decrease
  - PFOA 59% decrease
  - PFHxS 34% decrease
- Intervention was effective to reduce exposure



PFAS in New Residents (2014)

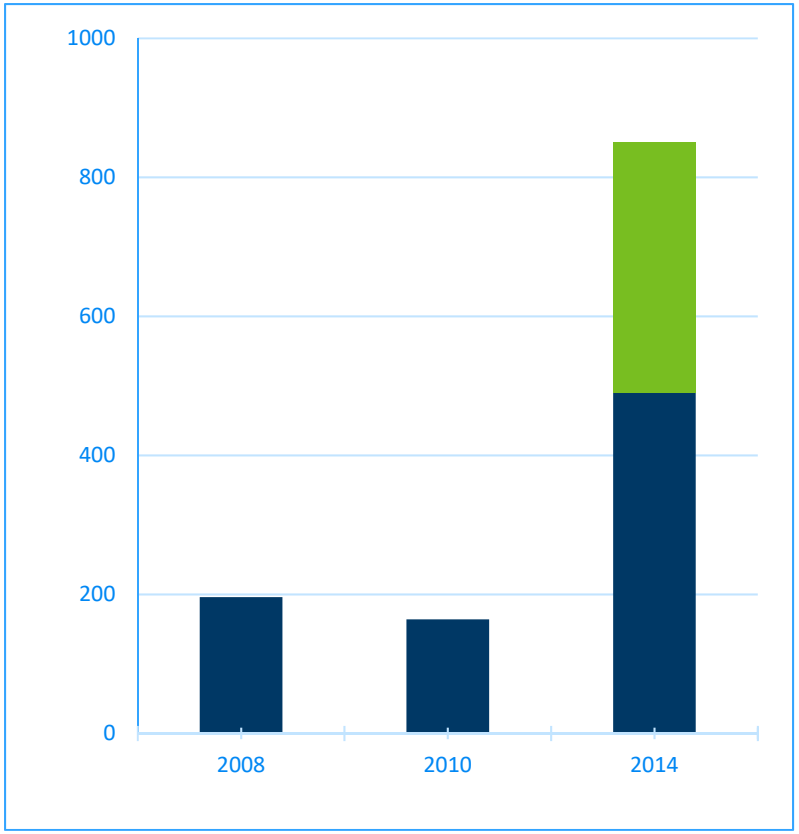
- New residents (n=156)
  - Moved to community after intervention
- Compared to NHANES 2011-2012
  - No significant difference in levels between groups



Serum Analysis

- Method used in 2008 & 2010- Based on Kuklenyik, 2004
  - Uses 1ml serum
  - SPE cartridges
- Method used in 2014 - similar to Flaherty, 2005
  - 400uL serum
  - Protein precipitation
  - 96 well plate
- Both methods:
  - Matrix matched calibration curves & ID
  - Reversed phase HPLC/MS/MS
  - Report level: 0.1 ng/mL
- Method Performance
  - Archived 2008 samples used to validate 2014 method
    - ±20% RPD
  - Precision and Accuracy
    - 2008/2010: 2-8%, 100-115%
    - 2014: 1-8%, 99-115%

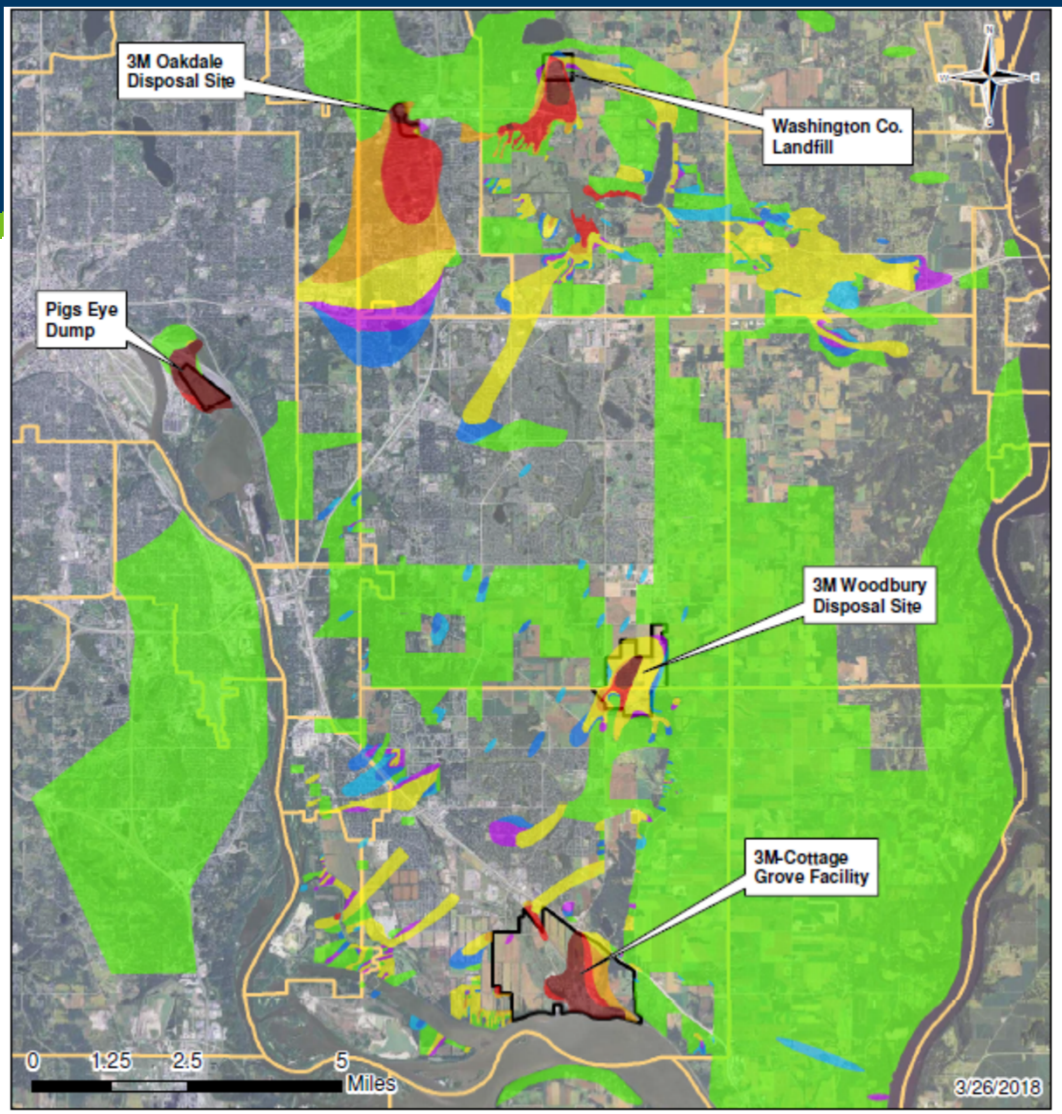
Number of samples analyzed



Biomonitoring Summary

- Biomonitoring projects answered questions from community and legislature
  - PFAS blood levels declining in population with prior exposure
  - PFAS blood levels in new residents comparable to US population
  - Mixed success in teasing out sources of exposure

Current Maps



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PFOA - All Aquifers

March 2018

Phone: 651-201-4897
or 1-800-657-3908

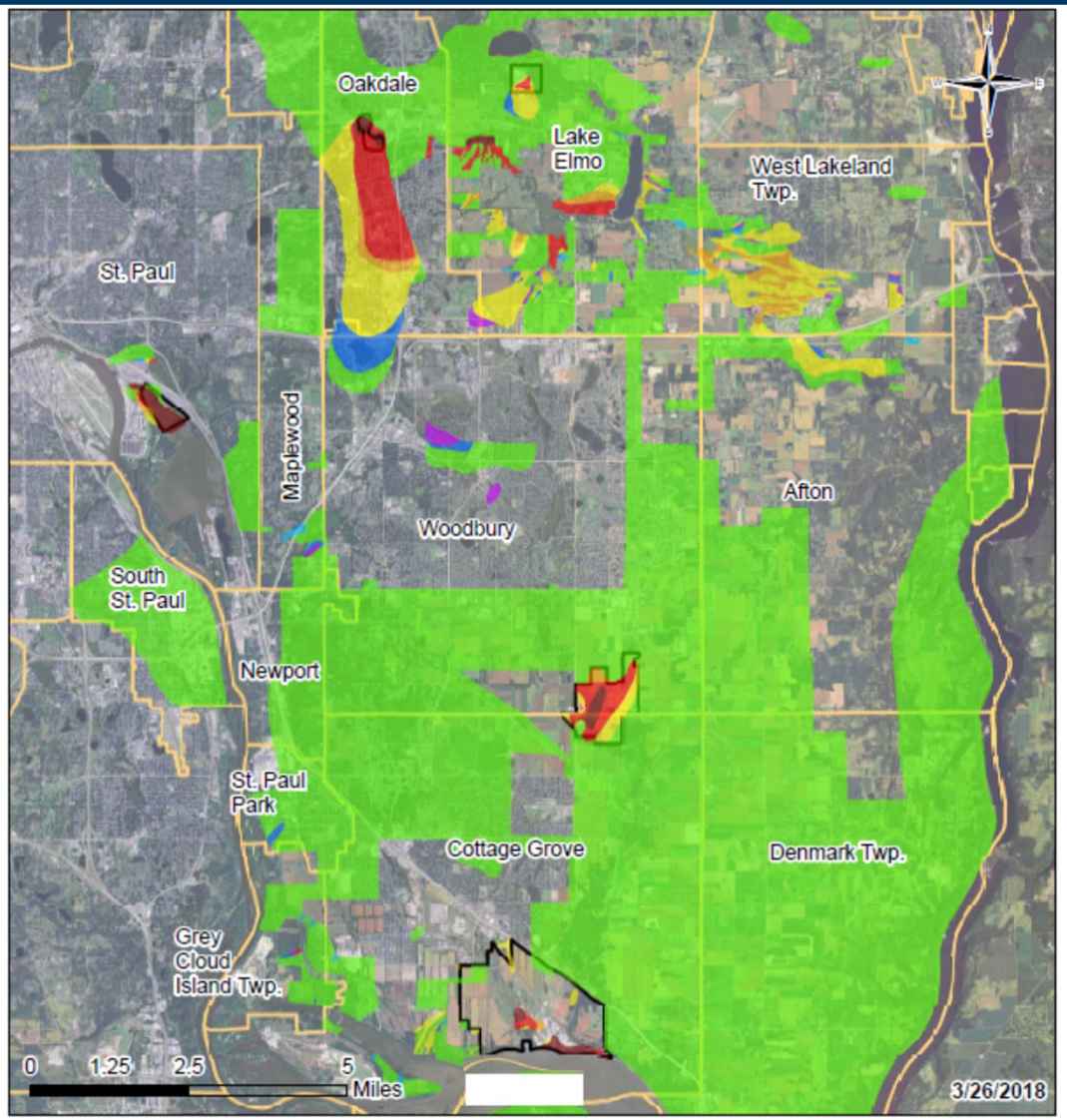
- PFOA greater than 1.75ppb (>50x HBV)
- PFOA 0.35-1.75ppb (10-50x HBV)
- PFOA 0.175-0.35 ppb (5-10x HBV)
- PFOA 0.035-0.175ppb (1-5x HBV)
- PFOA 0.027-0.035ppb (75-100% HBV)
- PFOA 0.0175-0.026ppb (50-75% HBV)
- PFOA 0.004-0.0174ppb (<50% HBV)
- PFOA not detected

MDH Health Based Value (HBV) for PFOA is 0.035 parts per billion (ppb; or 35 parts per trillion)

Map combines data from all aquifers, actual concentrations in any area may vary; blank spaces indicate no sample data

- PFOA - March 2018
- 5 main sources
  - Oakdale Disposal Site
  - Washington County Landfill
  - Pigs Eye Dump
  - 3M Woodbury Disposal Site
  - 3M Cottage Grove Facility
- PFOA HBV 0.035 ng/ml

Current Maps



PFOS - All Aquifers - March 2018

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Phone: 651-201-4897
or 1-800-657-3908

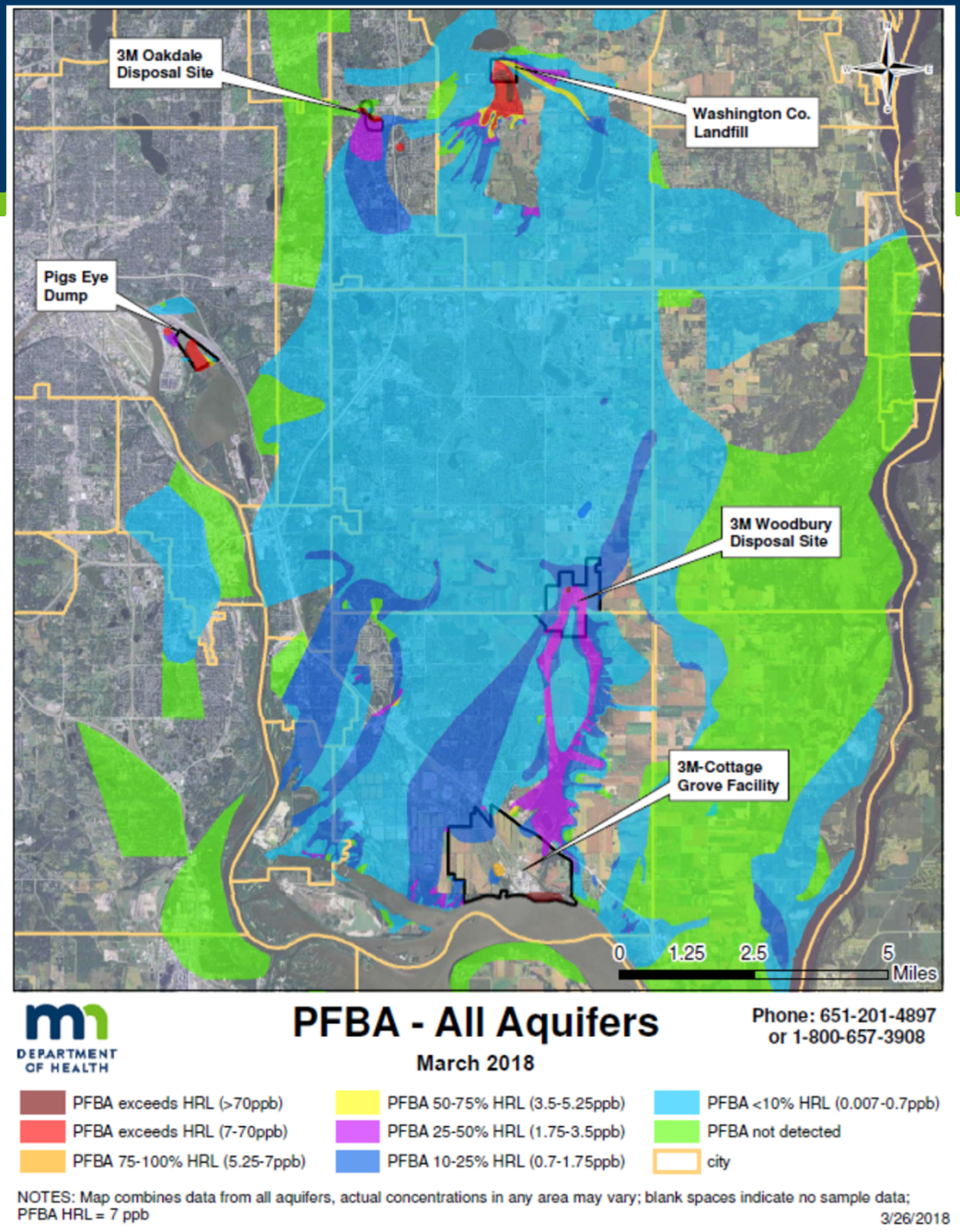
- PFOS greater than 1.35ppb (>50x HBV)
- PFOS 0.271-1.35ppb (10-50x HBV)
- PFOS 0.136-0.27ppb (5-10x HBV)
- PFOS 0.028-0.135ppb (1-5x HBV)
- PFOS 0.021-0.027ppb (75-100% HBV)
- PFOS 0.0136-0.02ppb (50-75% HBV)
- PFOS 0.004-0.0135ppb (<50% HBV)
- PFOS not detected

MDH Health Based Value (HBV) for PFOS is 0.027 parts per billion (ppb; or 27 parts per trillion)

NOTES: Map combines data from all aquifers, actual concentrations in any area may vary; blank spaces indicate no sample data

- PFOS as of March 2018
- 5 main sources
  - Oakdale Disposal Site
  - Washington County Landfill
  - Pigs Eye Dump
  - 3M Woodbury Disposal Site
  - 3M Cottage Grove Facility
- PFOS HBV 0.027 ng/ml

Current Maps



- PFBA - March 2018
- 5 main sources
  - Oakdale Disposal Site
  - Washington County Landfill
  - Pigs Eye Dump
  - 3M Woodbury Disposal Site
  - 3M Cottage Grove Facility
- PFBA HRL 7 ng/ml

Acknowledgements

- MDH Environmental Public Health Tracking and Biomonitoring Program Staff
  - Adrienne Landsteiner, MPH, PhD — Epidemiologist/Project Coordinator
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For More Information

- PFAS in Minnesota
  - http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html
- Minnesota Environmental Health Tracking and Biomonitoring Program
  - http://www.health.state.mn.us/divs/hpcd/tracking/biomonitoring/index.html

References:

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Flaherty et al, Journal of Chromatography B, 2005, 819, 329-338

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Landsteiner et al, Journal of Environmental Health, 2014, 77(5), 14-19

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Questions?