2023 NEMC

Seasonal Analysis of PFAS in Groundwater Wells

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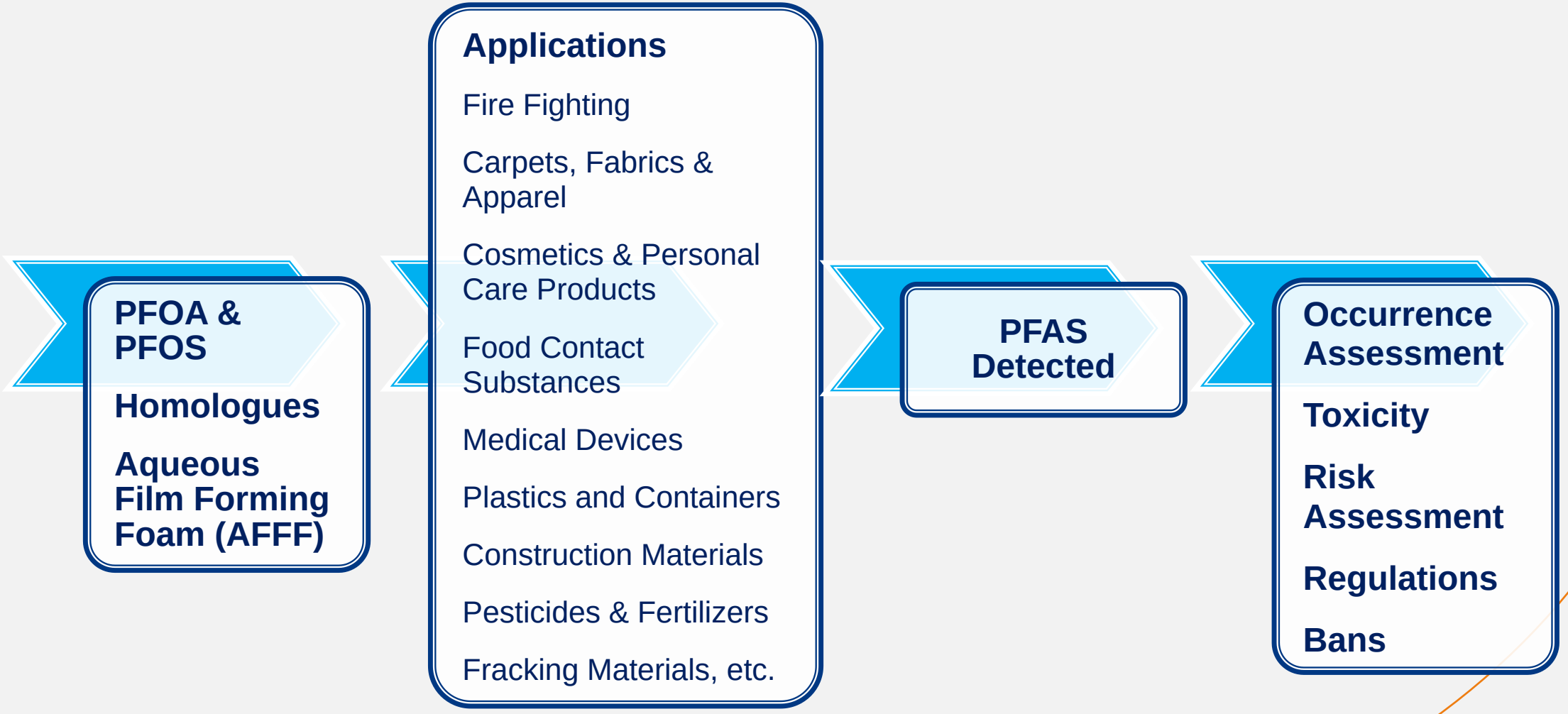
Presentation Outline

- PFAS Introduction
- PFAS in Groundwater Wells
- Modified EPA Method 533
- PFAS Seasonal Analysis Results
- Conclusions

PFAS: 1940s to 2020s

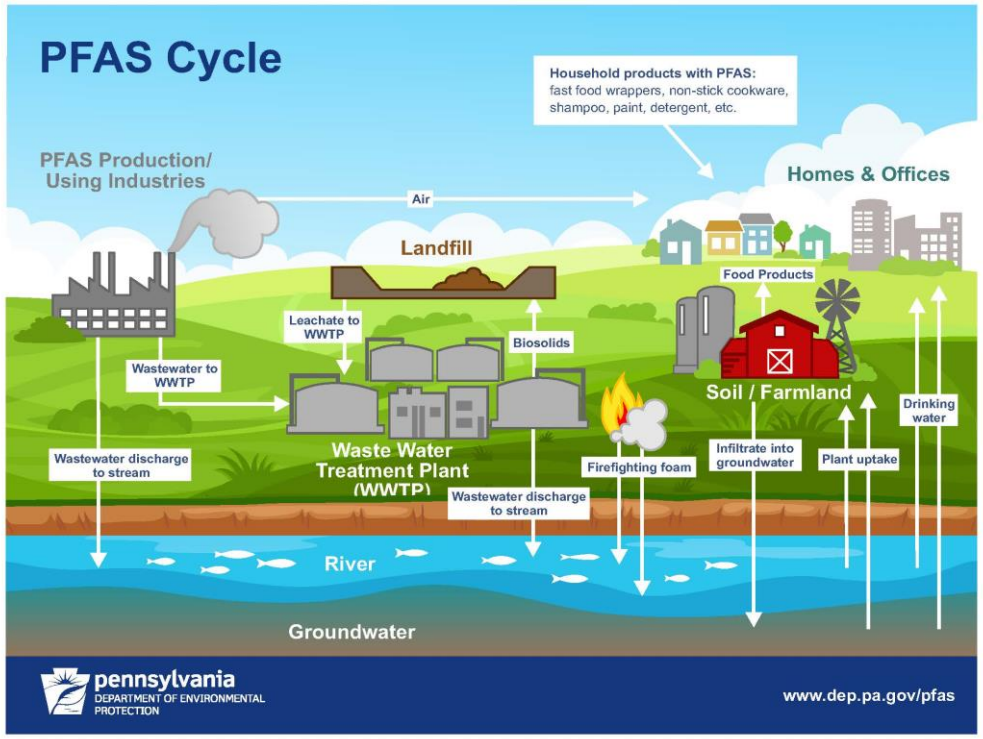


How many PFAS have been made?

- More than 3000 PFASs are, or have been on the global market……

  Wang et al., *Environ. Sci. Technol.* 2017, 51(5), 2508-2518

- EPA's Comptox Chemicals Dashboard PFAS Master List – Identified over 9000 PFAS substances and structures.
  https://comptox.epa.gov/dashboard/chemical-lists/pfasmaster



PFAS Drinking Water Regulations

- ~ 22 states have had drinking water regulations for PFAS. Some regulations are more stringent than the others.
  - **Currently include 11 PFAS.**
  - **NJ MCLs are 13 ng/L PFNA, 14 ng/L PFOA, and 13 ng/L PFOS.**
  - **MA MCL = PFOA + PFHxS + PFOS + PFHpA + PFNA + PFDA = 20 ng/L**
- EPA established new health advisory levels (June, 2022).
  - **Interim HA of 0.004 ng/L for PFOA**
  - **Interim HA of 0.02 ng/L for PFOS**
  - **Final HA of 10 ng/L for HFPO-DA**
  - **Final HA of 2,000 ng/L for PFBS**

PFAS Drinking Water Regulation (Cont'd)

- EPA proposed drinking water standards for six PFAS known to occur in drinking water (March, 2023)
  - **Enforceable Maximum Contaminant Levels (MCLs) for PFOA and PFOS**
  - **Enforceable Hazard Index (HI) for combined PFBS, PFHxS, PFNA, and HFPO-DA (referred to as GenX chemicals)**
  - **Health-Based Water Concentrations (HBWCs) for PFBS, PFHxS, PFNA, and HFPO-DA**
  - **Maximum Contaminant Level Goals (MCLGs)**
  - **Practical Quantitation Levels (PQLs)**
  - **Reduced-Monitoring Rule Trigger Levels (RTLs)**
  - **Monitoring requirements for public water systems**
  - **Does not set any requirements or standards for private well owners.**

Proposed PFAS NPDWR Summary

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PFAS	HBWC (ng/L)	MCLG (ng/L)	MCL (ng/L)	RTL (ng/L)	PQL (ng/L)
PFOA	0.004 (interim HA)	0	4.0	1.3	4.0
PFOS	0.02 (interim HA)	0	4.0	1.3	4.0
PFBS	2,000	1.0 (unitless HI)	1.0 (unitless HI)	0.33 (unitless HI)	3.0
PFHxS	9.0				3.0
PFNA	10				4.0
HFPO-DA	10				5.0

Ongoing UCMR5: Assessment Monitoring Scopes

UCMR 5 Applicability to PWSs per AWIA

System[1] Size (# of people served)	National Sample: Assessment Monitoring Design	Total # of Systems per Size Category
Small Systems (25 – 3,299)	800 randomly selected systems (CWSs and NTNCWSs)	800
Small Systems (3,300 – 10,000)	All systems (CWSs and NTNCWSs)	~5,100
Large Systems (10,001 and over)	All systems (CWSs and NTNCWSs)	~4,400
TOTAL		**~10,300**

[1] Systems provide water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year

Courtesy to EPA UCMR5 shareholder meeting presentation, 04/16/2022.

29 PFAS analyzed by EPA 533 and 537.1

Lithium (Li) by EPA 200.7, etc.

Ongoing UCMR5: Analytes, Methods, and MRLs

EPA 533 (2 – 5 ng/L)	PFBA 5	PFPeA 3	PFHxA 3	PFHpA 3 (10 for UCMR3)	PFOA 4 (20 for UCMR3)
	PFNA 4 (20 for UCMR3)	PFDA 3	PFUnA 2	PPDoA 3	PFBS 3 (90 for UCMR3)
	PFPeS 4	PFHxS 3 (30 for UCMR3)	PFHpS 3	PFOS 4 (40 for UCMR3)	PFEESA 3
	4:2 FTS 3	6:2 FTS 5	8:2 FTS 5	HFPO-DA 5	ADONA 3
	9Cl-PF3ONS 2	11Cl-PF3OUdS 5	PFMBA 3	PFMPA 4	NFDHA 20
EPA 537.1 (5 – 8 ng/L)		MMeFOSAA 6	NEtFOSAA 5	PFTrDA 7	PFTeDA 8
EPA 200.7, SM 3120 B (2017), SM 3120 B–99 (1999), or ASTM D1976–20 (µg/L)					Li 9

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PFAS in Groundwater Wells

- EPA estimates that more than 23 million households rely on private wells for drinking water in the United States.
  - EPA does not regulate or set standards for private wells.
  - EPA offers information and guidance regarding:
    - Importance of testing private wells
    - Treatment technologies of any contaminants
  - Private well owners are responsible for the safety of their water.

- Some states have provided information about PFAS in private wells.
  - NY Department of Health
  - CT Department of Public Health
  - MA Department of Environmental Protection
  - MN Department of Health (MDH)

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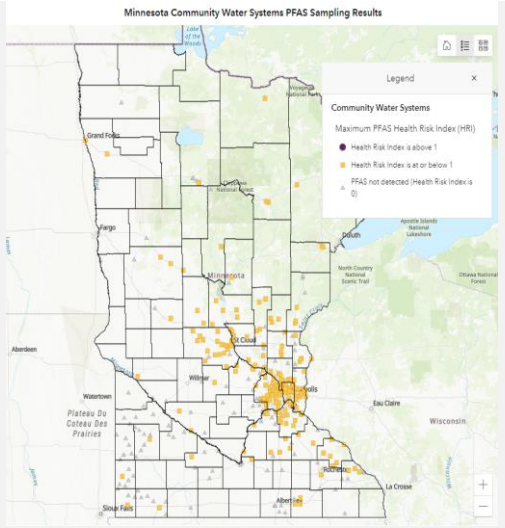
PFAS in Groundwater Wells (Cont'd)

- MN Department of Health Interactive Dashboard for PFAS
  - Eight (PFBA, PFBS, PFPeA, PFPeS, PFHxA, FHxS, PFOA, and PFOS) or fewer PFAS were detected in many community water systems.



- 14 out of 24 PFAS detected in 60% of public wells and 20% of private wells, McMahon et al., *Environ. Sci. Technol.* 2022, 56, 4, 2279–2288, https://pubs.acs.org/doi/10.1021/acs.est.1c04795.
  - Based on 254 samples collected from 5 aquifer systems in groundwater used as a source of drinking water in 16 eastern states.

Objectives

- Assess the presence and seasonal variations of PFAS in groundwater wells in the suburban areas.
  - 54 PFAS analyzed by using modified EPA Method 533.
- Evaluate potential impacts of household plumbing on PFAS detection.

Modified EPA Method 533

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All 29 EPA 533 and 537.1 PFAS Included

EPA 533		EPA 533 & 537.1			EPA 537.1
PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFTrDA
PFPeS	PFHpS	PFNA	PFDA	PFUnA	PFTeDA
PFMBA	PFMPA	PPDoA	PFBS	PFHxS	NMeFOSAA
PFEESA	NFDHA	PFOS	HFPO-DA	ADONA	MEtFOSAA
4:2 FTS	6:2 FTS	9Cl-PF3ONS	11Cl-PF3OUdS		
8:2 FTS					

Modified EPA Method 533 (Cont'd)

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25 Additional PFAS Included

PFHxDA	PFODA	PFIpOBA	PFPrS	PFNS
PFDS	PFDoS	Nafion BP1	Nafion BP2	PFBSA
PFHxSA	PFOSA	PFDSA	NMeFOSA	NEtFOSA
NMeFBSA	NMeFOSE	NEtFOSE	10:2 FTS	3:3 FTA
5:3 FTA	7:3 FTA	6:2 FTUA	8:2 FTUA	10:2 FTUA

Modified EPA Method 533 (Cont'd)

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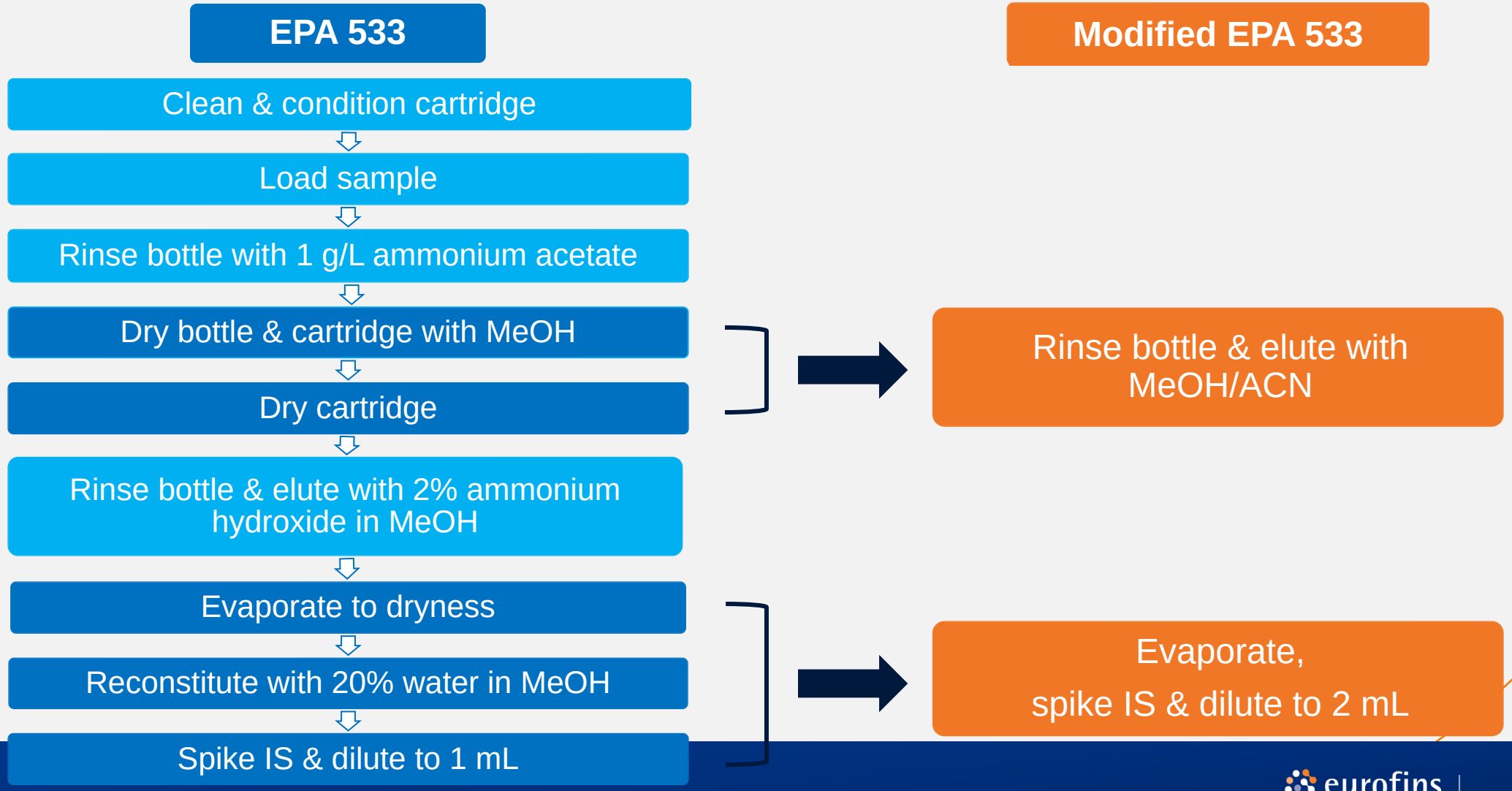
3 IPS and 28 IDA

3 EPA 533 IPS	18 EPA 533 IDA			10 Additional IDA	
PFBA-13C3	PFBA-13C4	PFDA-13C6	PFOS-13C8	PFTeDA-13C2	NMeFOSE-d7
PFOA-13C2	PFPeA-13C5	PFUnA-13C7	4:2 FTS-13C2	PFHxDA-13C2	NEtFOSE-d9
PFOS-13C4	PFHxA-13C5	PFDoA-13C2	6:2 FTS-13C2	PFOSA-13C8	NMeFOSA-d3
	PFHpA-13C4	HFPO-DA-13C3	8:2 FTS-13C2	6:2 FTUA-13C2	NEtFOSA-d5
	PFOA-13C8	PFBS-13C3	NMEFOSAA-d3	8:2 FTUA-13C2	10:2 FTUA-13C2
	PFNA-13C9	PFHxS-13C3	NEtFOSAA-d5		

Modified EPA Method 533: SPE Procedures



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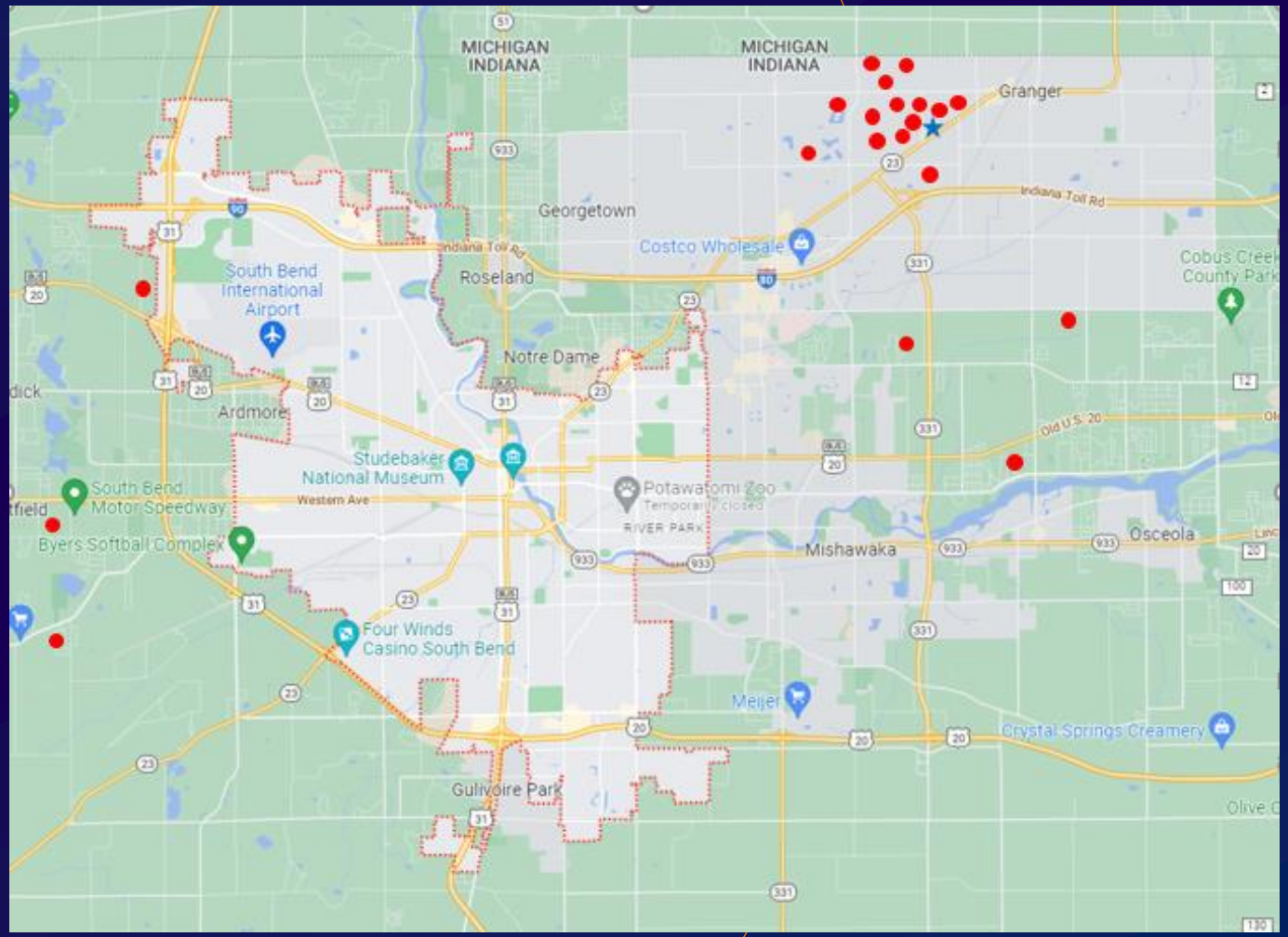
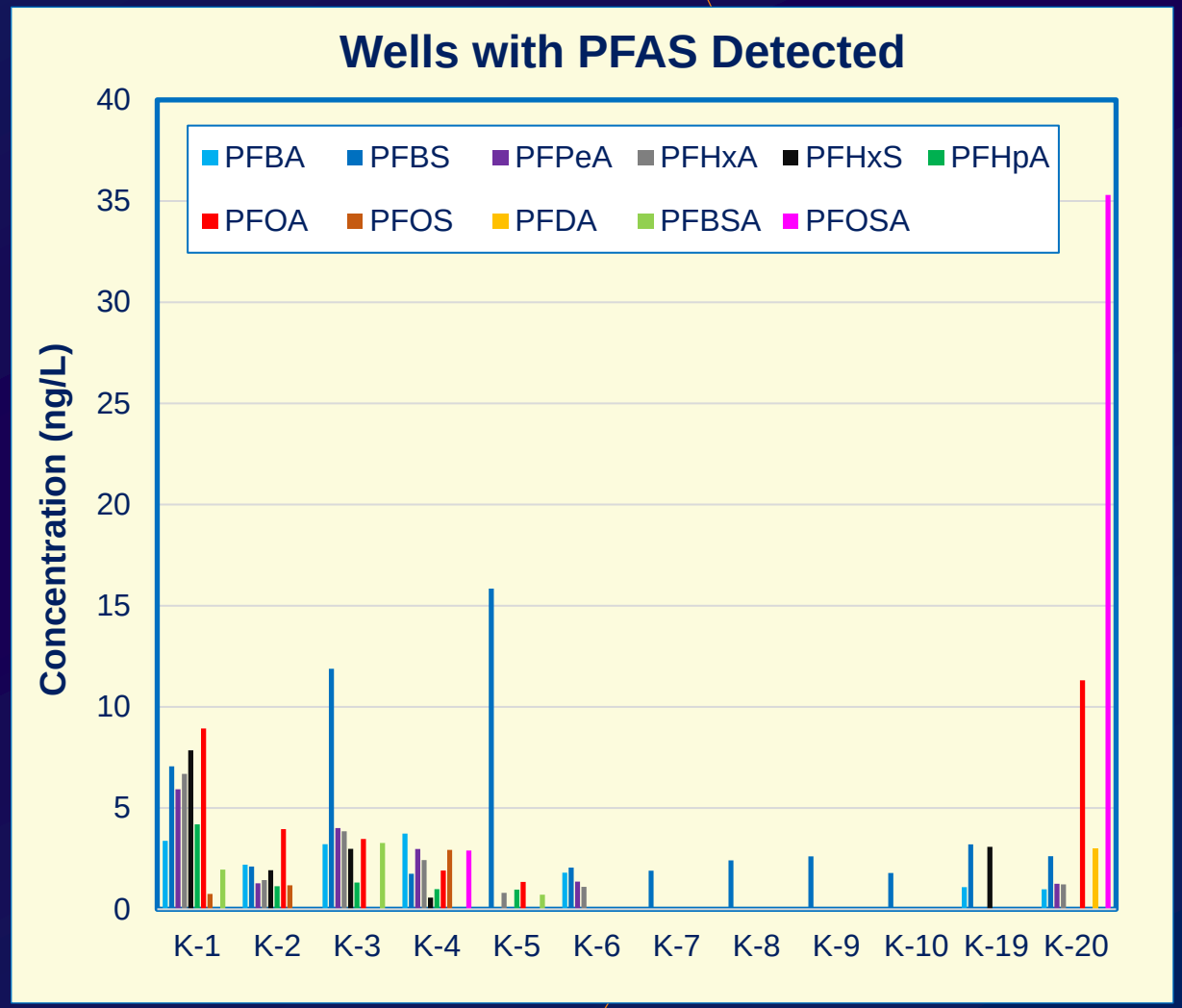
Sampling Sites

- All groundwater wells are in the suburban areas.
  - 17 private wells
  - 3 library and church wells
  - Kitchen tap and garden hose sampling
- Potential PFAS contamination sources
  - An airport
  - A fire-fighting station

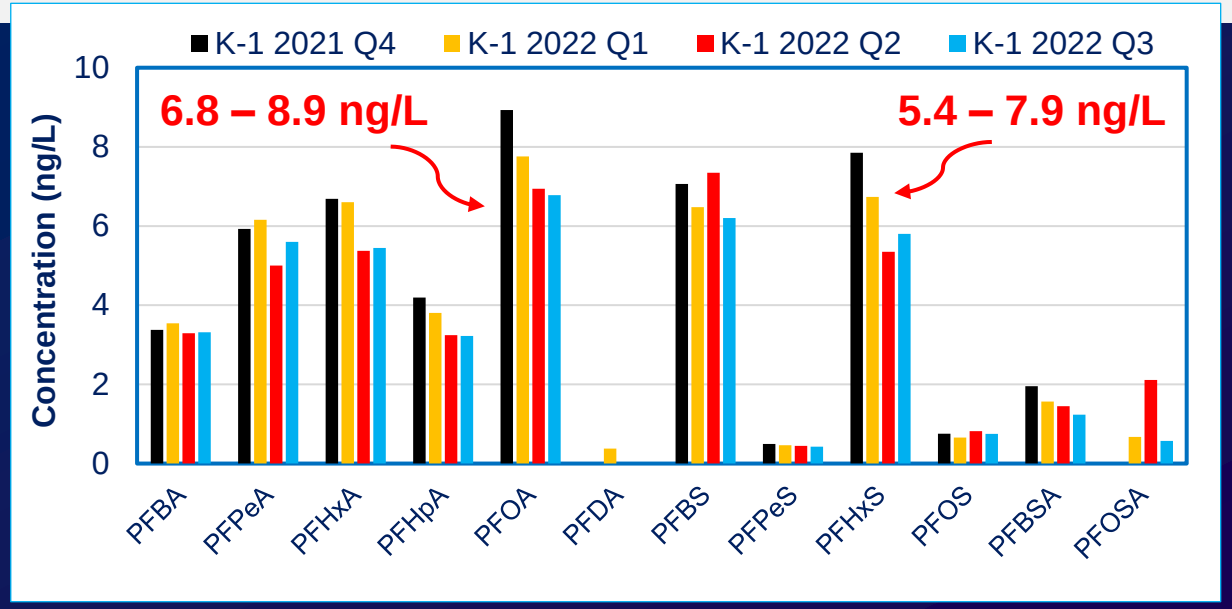


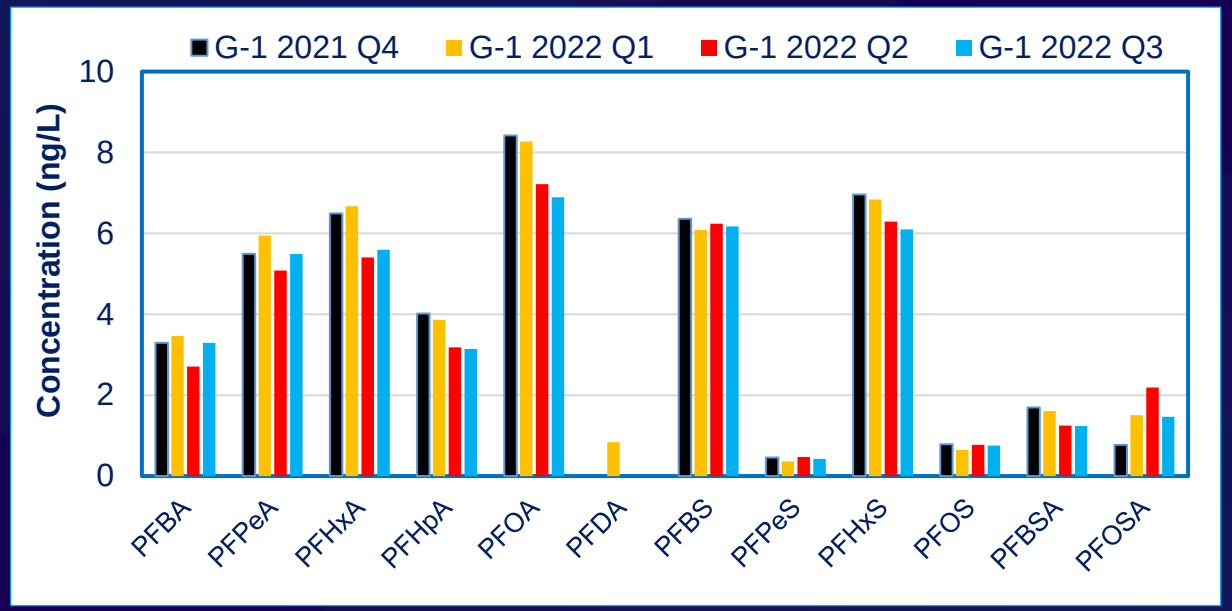
Initial Results

- 11 out of 19 wells were initially detected positive with one or more PFAS at ≥ 2 ng/L.
  - PFBA, PFPeA, PFHxA, PFHpA, PFOA, and PFDA
  - PFBS, PFHxS, and PFOS
  - PFBSA and PFOSA.
- 10 wells were selected for continuous seasonal analysis.
- Well #20 was detected with PFOA at 11.3 ng/L, PFDA at 3.0 ng/L, PFBS at 2.6 ng/L, 6:2–FTS at 7.5 ng/L, and PFOSA at 35.3 ng/L.

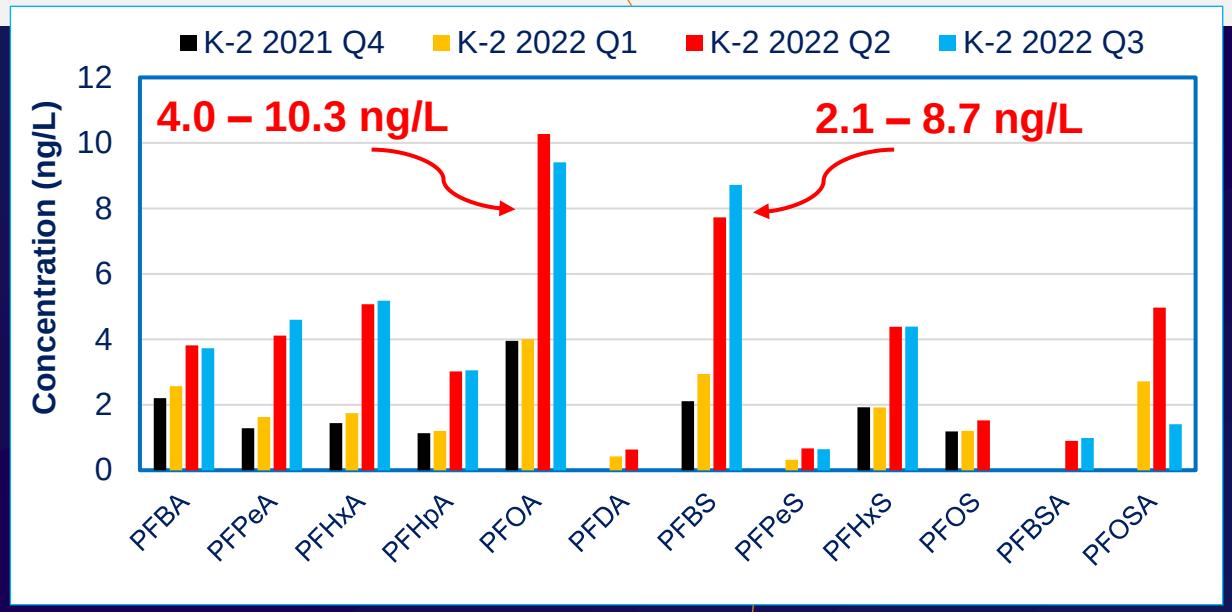


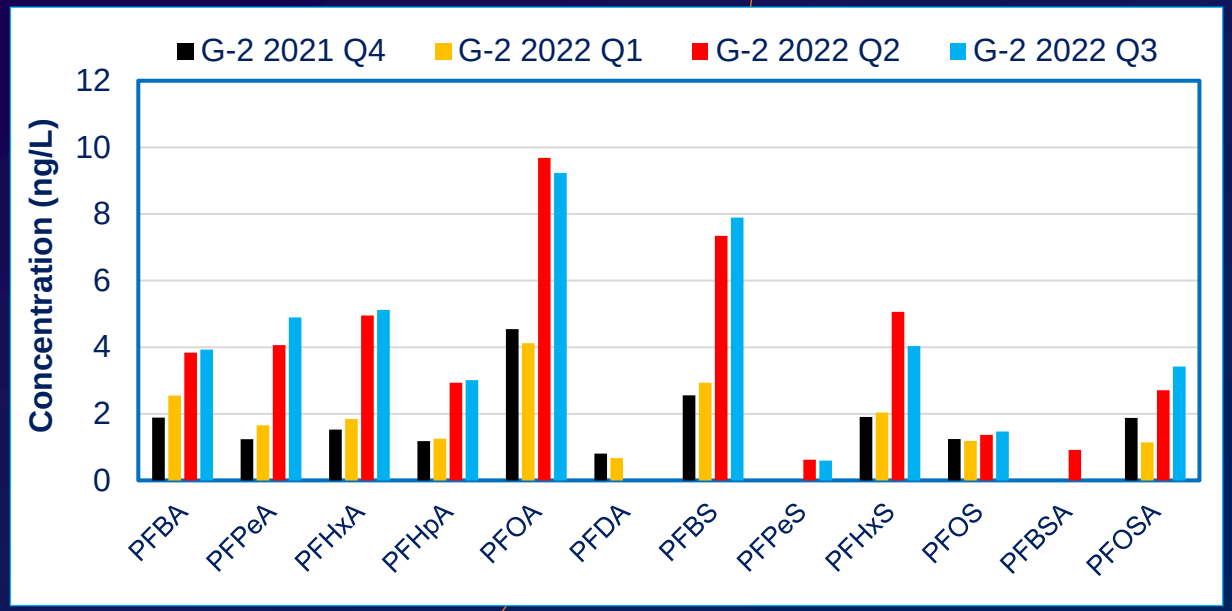
Well #1


K-1 2021 Q4
K-1 2022 Q1
K-1 2022 Q2
K-1 2022 Q3
6.8 – 8.9 ng/L
5.4 – 7.9 ng/L
Concentration (ng/L)
0
2
4
6
8
10
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

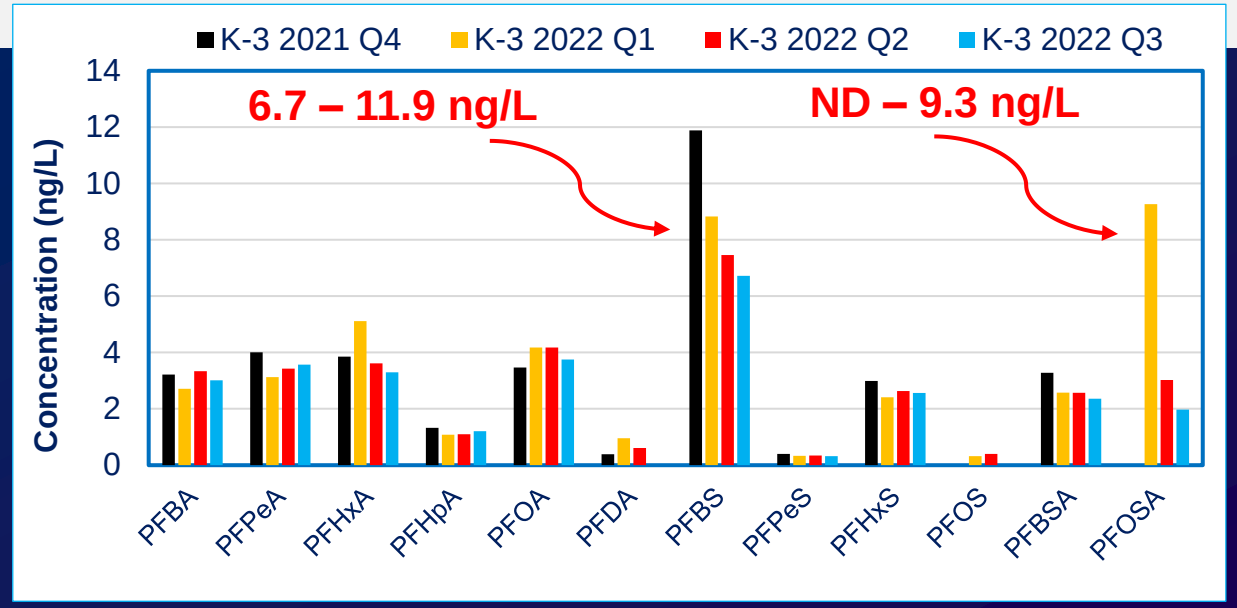

G-1 2021 Q4
G-1 2022 Q1
G-1 2022 Q2
G-1 2022 Q3
Concentration (ng/L)
0
2
4
6
8
10
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

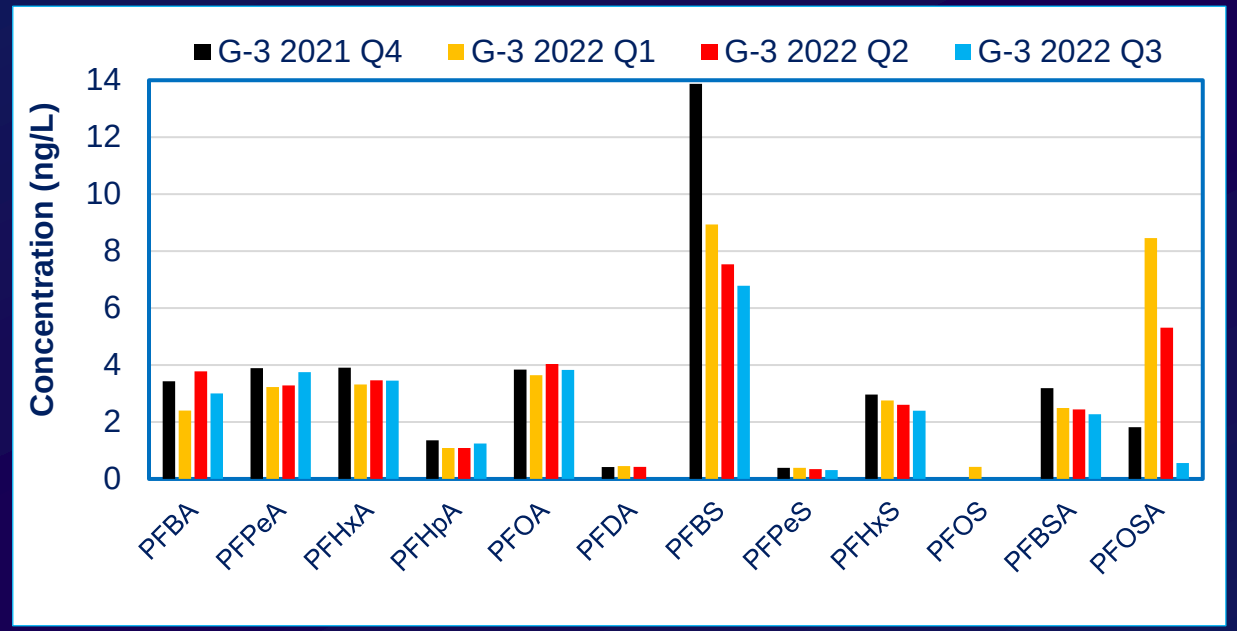
Well #2


K-2 2021 Q4
K-2 2022 Q1
K-2 2022 Q2
K-2 2022 Q3
4.0 – 10.3 ng/L
2.1 – 8.7 ng/L
Concentration (ng/L)
0
2
4
6
8
10
12
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

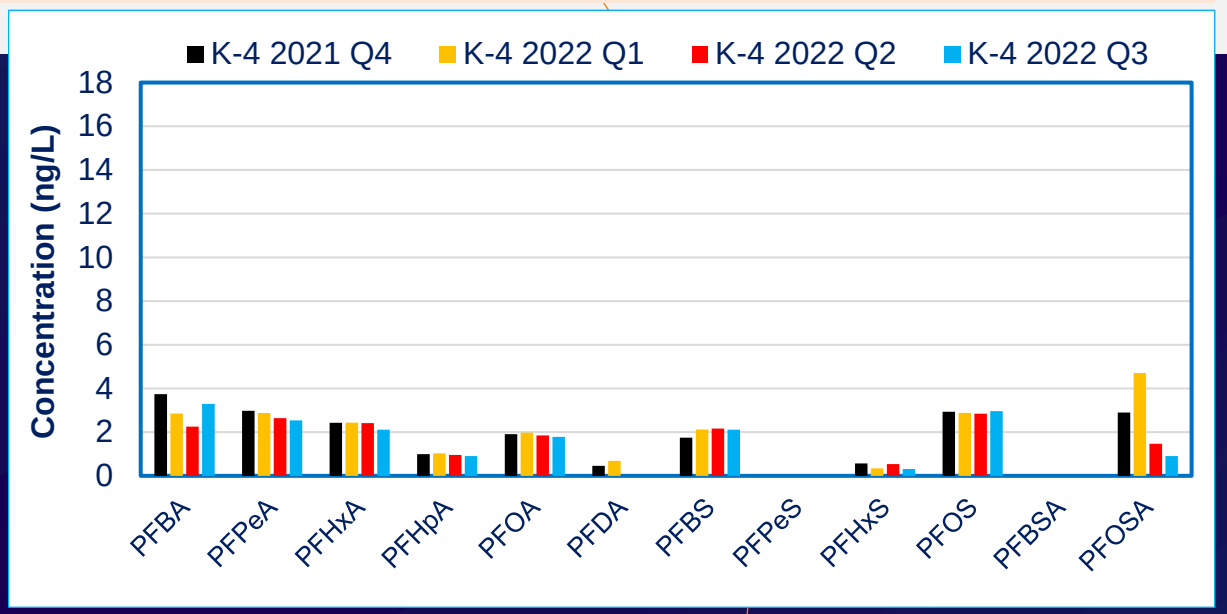

G-2 2021 Q4
G-2 2022 Q1
G-2 2022 Q2
G-2 2022 Q3
Concentration (ng/L)
0
2
4
6
8
10
12
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

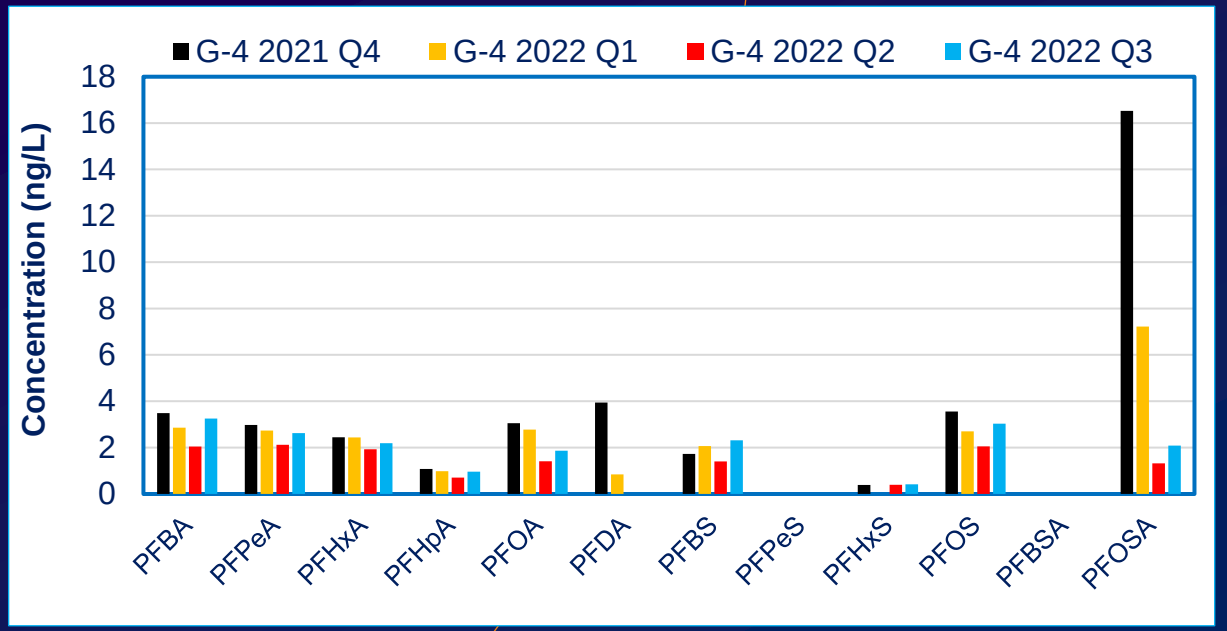
Well #3


K-3 2021 Q4
K-3 2022 Q1
K-3 2022 Q2
K-3 2022 Q3
6.7 – 11.9 ng/L
ND – 9.3 ng/L
Concentration (ng/L)
0
2
4
6
8
10
12
14
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

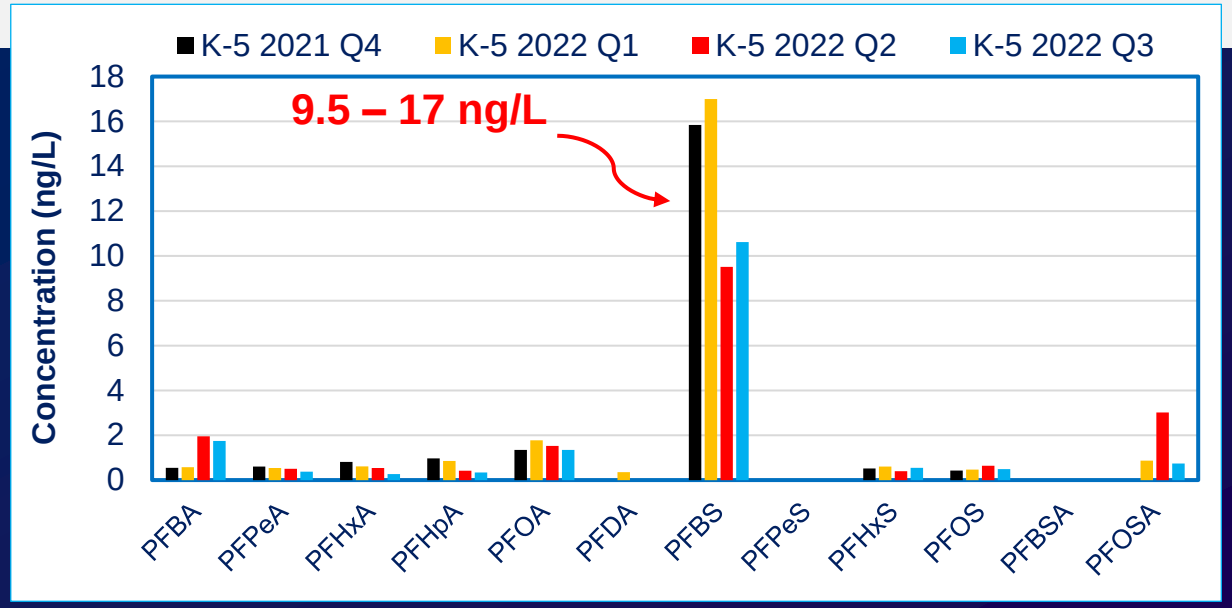

G-3 2021 Q4
G-3 2022 Q1
G-3 2022 Q2
G-3 2022 Q3
Concentration (ng/L)
0
2
4
6
8
10
12
14
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

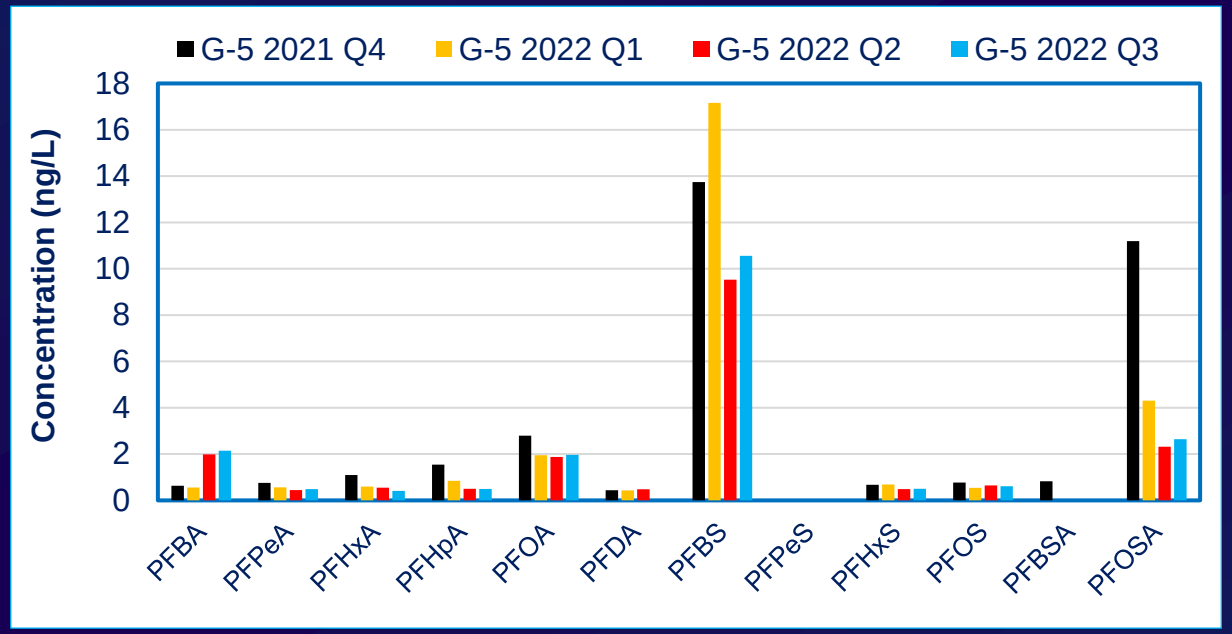
Well #4


K-4 2021 Q4
K-4 2022 Q1
K-4 2022 Q2
K-4 2022 Q3
Concentration (ng/L)
0
2
4
6
8
10
12
14
16
18
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

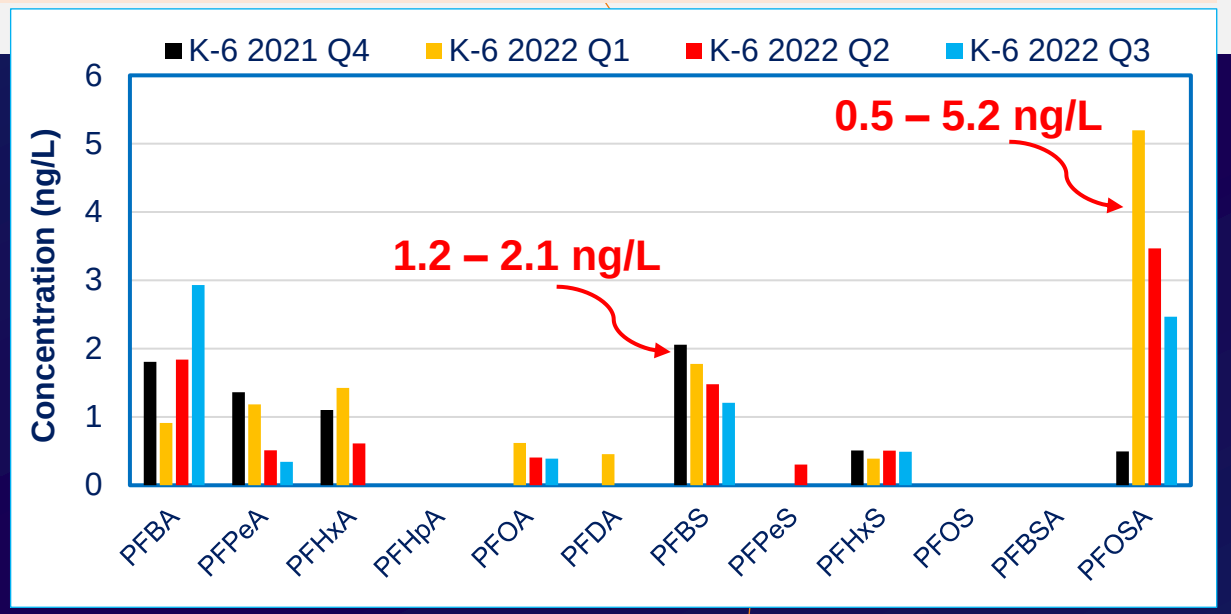

G-4 2021 Q4
G-4 2022 Q1
G-4 2022 Q2
G-4 2022 Q3
Concentration (ng/L)
0
2
4
6
8
10
12
14
16
18
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

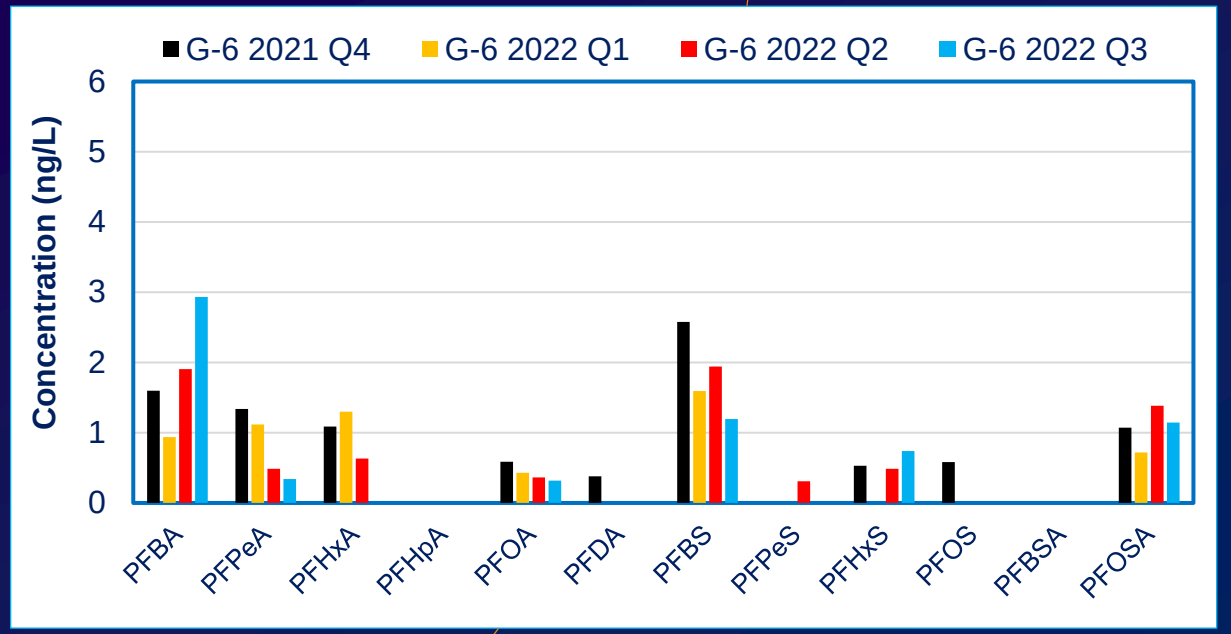
Well #5


K-5 2021 Q4
K-5 2022 Q1
K-5 2022 Q2
K-5 2022 Q3
9.5 – 17 ng/L
Concentration (ng/L)
0
2
4
6
8
10
12
14
16
18
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

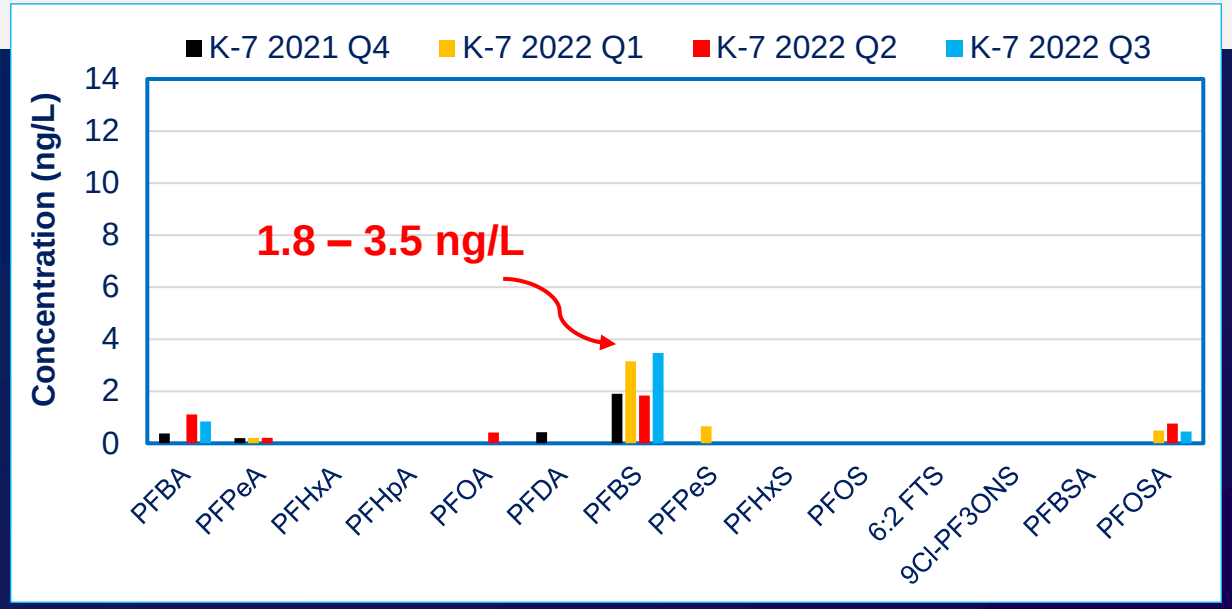

G-5 2021 Q4
G-5 2022 Q1
G-5 2022 Q2
G-5 2022 Q3
Concentration (ng/L)
0
2
4
6
8
10
12
14
16
18
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

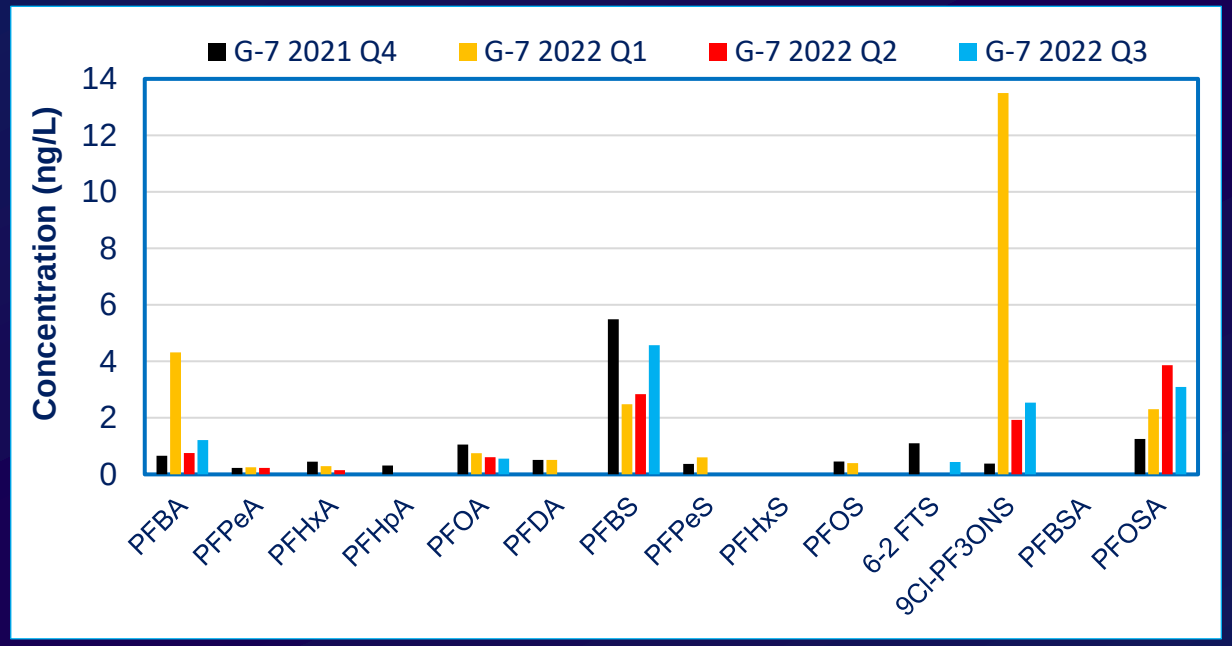
Well #6


K-6 2021 Q4
K-6 2022 Q1
K-6 2022 Q2
K-6 2022 Q3
0.5 – 5.2 ng/L
1.2 – 2.1 ng/L
Concentration (ng/L)
0
1
2
3
4
5
6
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

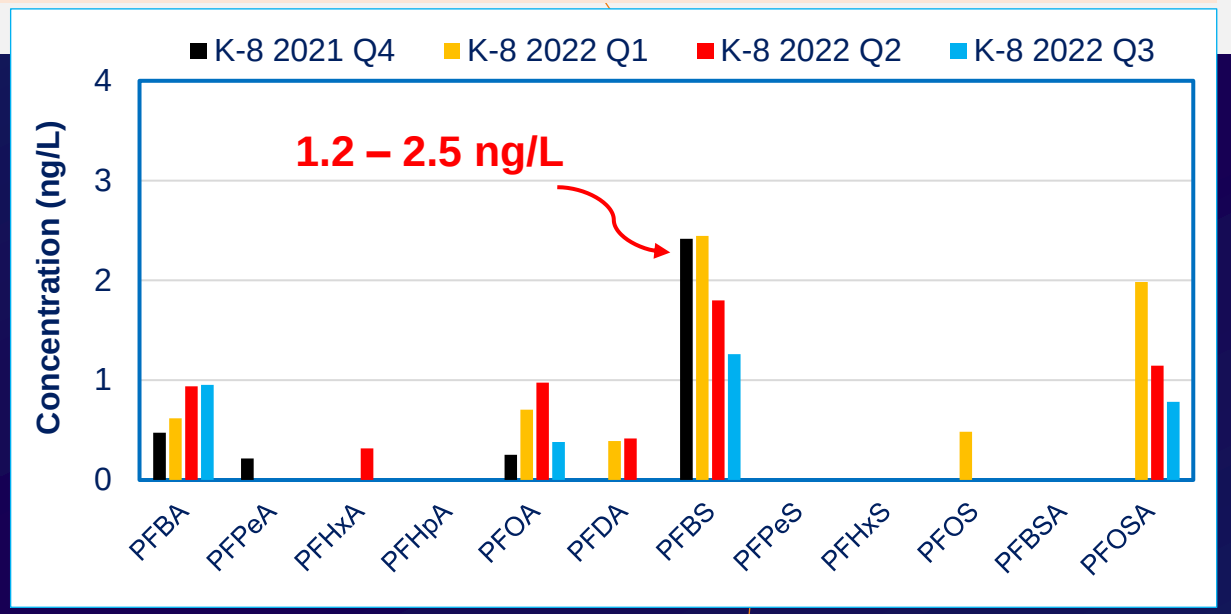

G-6 2021 Q4
G-6 2022 Q1
G-6 2022 Q2
G-6 2022 Q3
Concentration (ng/L)
0
1
2
3
4
5
6
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

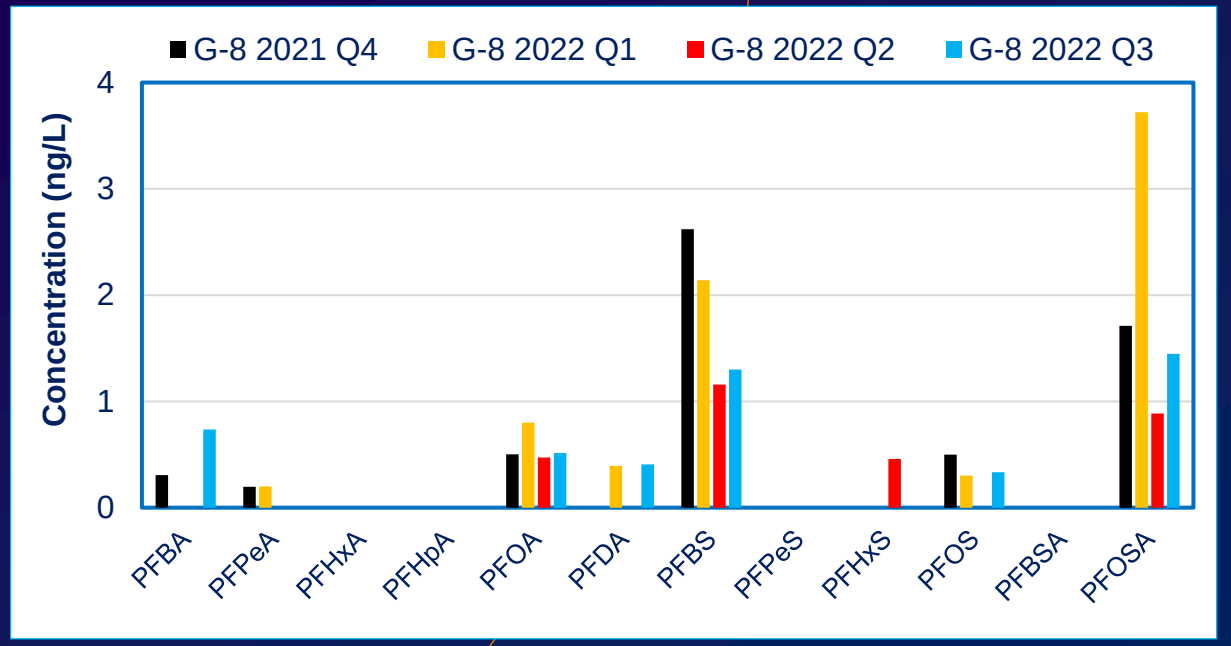
Well #7


K-7 2021 Q4
K-7 2022 Q1
K-7 2022 Q2
K-7 2022 Q3
Concentration (ng/L)
1.8 – 3.5 ng/L
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
6:2 FTS
9Cl-PF3ONS
PFBSA
PFOSA

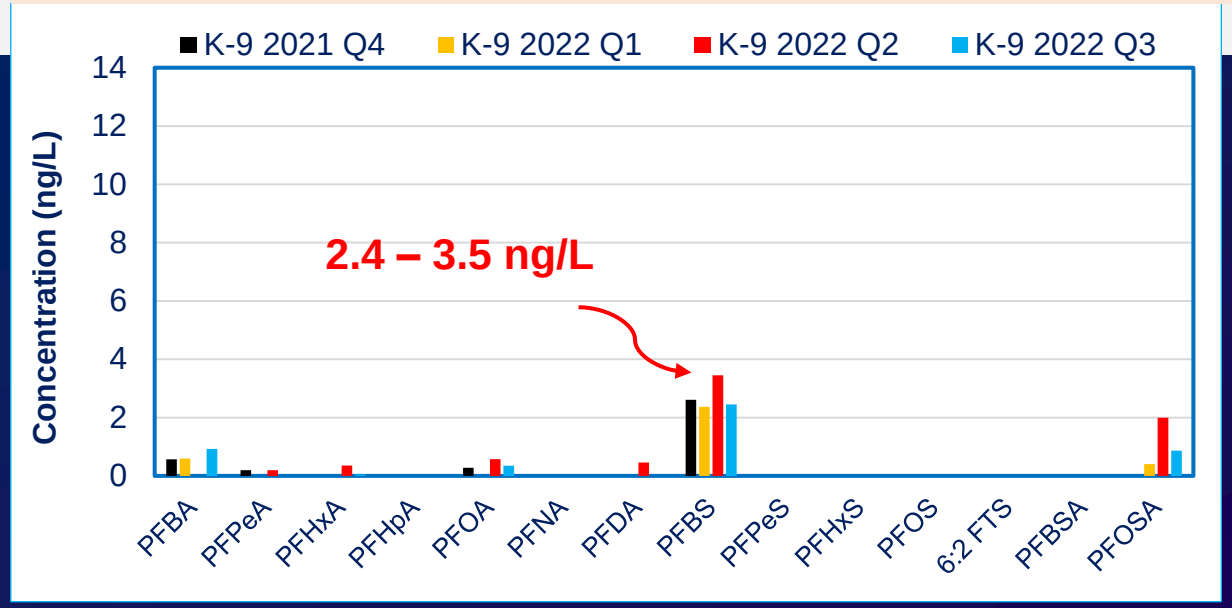

G-7 2021 Q4
G-7 2022 Q1
G-7 2022 Q2
G-7 2022 Q3
Concentration (ng/L)
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
6-2 FTS
9Cl-PF3ONS
PFBSA
PFOSA

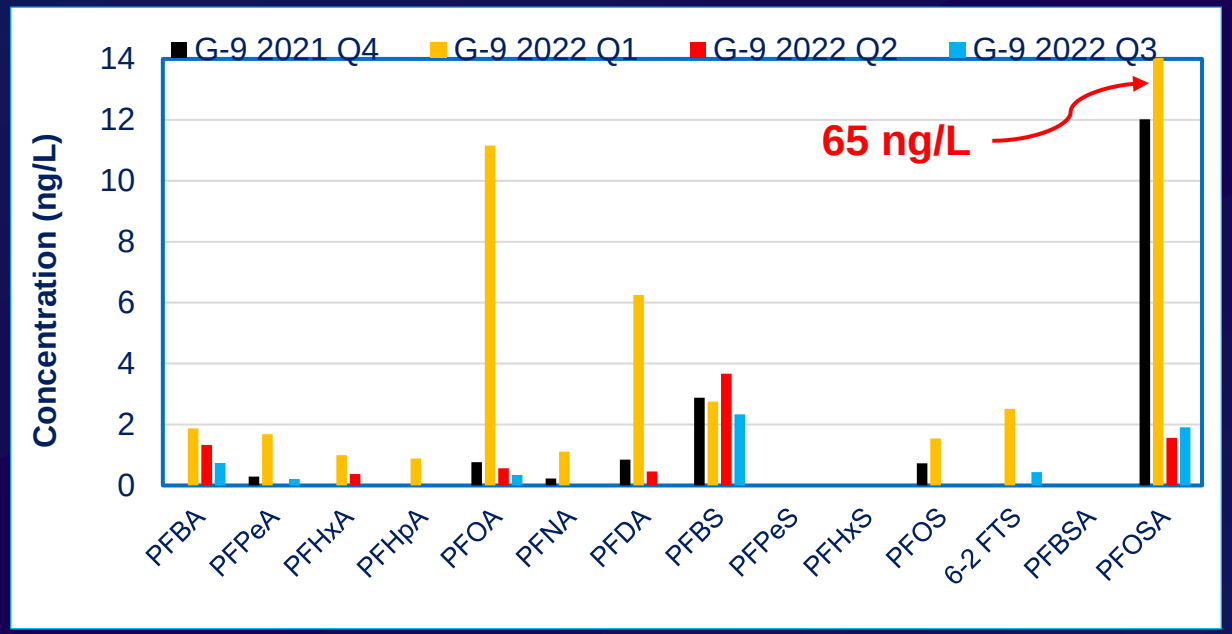
Well #8


K-8 2021 Q4
K-8 2022 Q1
K-8 2022 Q2
K-8 2022 Q3
Concentration (ng/L)
1.2 – 2.5 ng/L
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

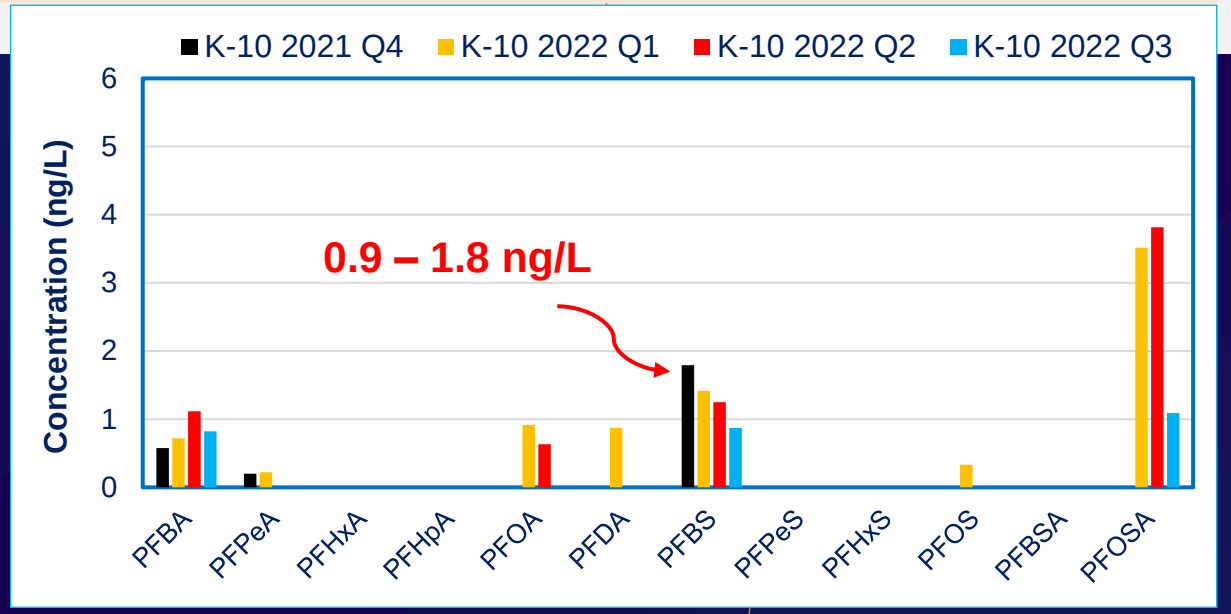

G-8 2021 Q4
G-8 2022 Q1
G-8 2022 Q2
G-8 2022 Q3
Concentration (ng/L)
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFDA
PFBS
PFPeS
PFHxS
PFOS
PFBSA
PFOSA

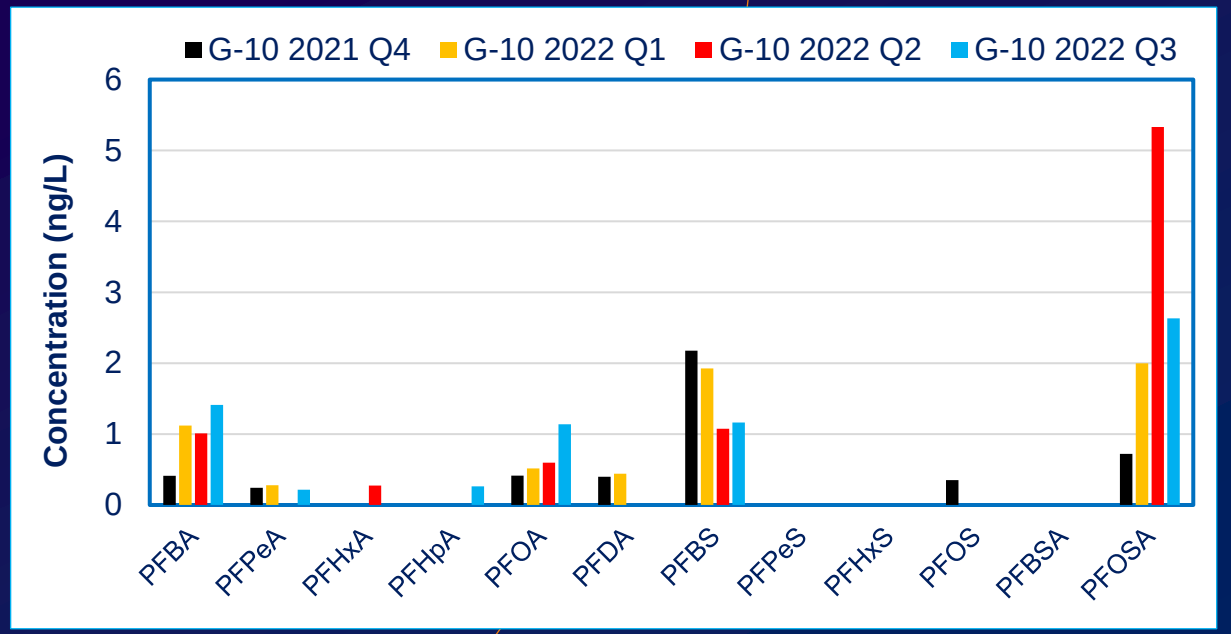
Well #9



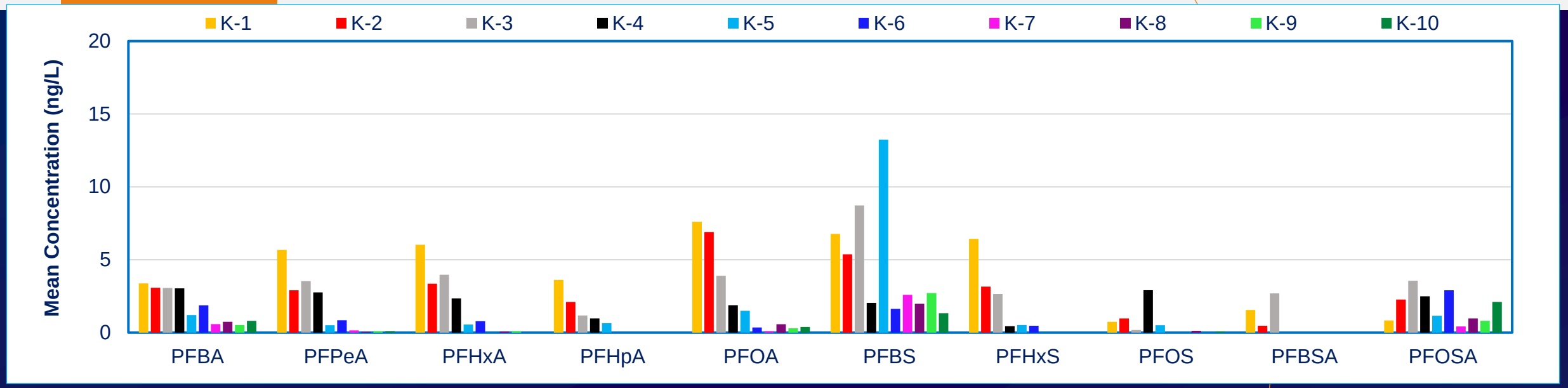


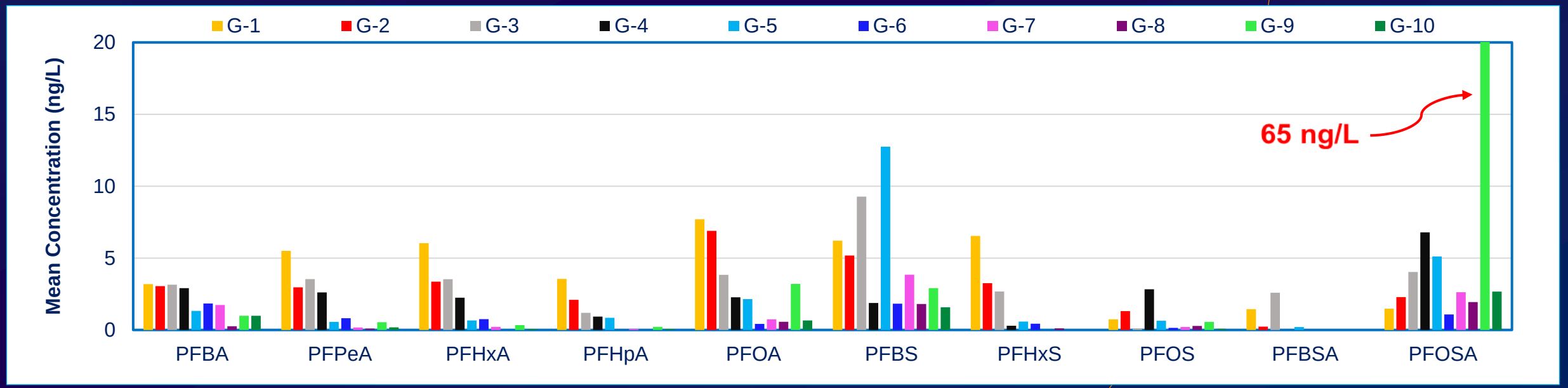
Well #10





Annual Average Results





Annual Average Results

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	K-1	K-2	K-3	K-4	K-5	K-6	K-7	K-8	K-9	K-10	K-20
SUM	43.3	31.4	34.4	19.7	19.9	9.2	4.1	4.8	4.7	5.2	63.2
PFOA	7.6	6.9	3.9	1.9 *	1.5 *	ND	ND	ND	ND	ND	11.3
PFOS	0.7 *	1.0 *	ND	2.9	ND	ND	ND	ND	ND	ND	ND
PFBS	6.8	5.4	8.7	2.0	13.2	1.6 *	2.6	2.0	2.7	1.3 *	2.6
PFHxS	6.4	3.2	2.7	ND	ND	ND	ND	ND	ND	ND	ND
PFNA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HFPO-DA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MA MCL	18.5	13.4	8.4	6.9	3.3	ND	ND	ND	ND	ND	14.3
HI	0.72	0.35	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33

Conclusions

- Among the 20 wells, 3 wells were detected above the proposed PFOA MCL of 4.0 ng/L, 3 wells were detected above the proposed PFOA MCL RTL of 1.3 ng/L, and 2 wells were detected above the proposed HI RTL of 0.33.
- Different degrees of seasonal variations of PFAS levels were detected for multiple wells for varied PFAS.
- Impacts of household plumbing on PFAS results were likely insignificant.
- Garden hoses could result in elevated levels of PFBA, PFOA, PFDA, PFOSA, and 9Cl-PF3ONS (also called F-53B major) while samples were not collected directly from the faucets.

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THANK YOU

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