2022 Fall Conference

Hyatt Regency-Indian Wells, CA

November 29th, 2022

PFAS Contamination:

The Risks and Realities for Water Districts

Presented by:

Tom Lee, Bryan Cave Leighton Paisner, LLP and Dr. Sarahann Rackle, Exponent

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PFAS CONTAMINATION

The Risks and Realities for Water Districts

November 29, 2022

INTRODUCTION TO PFAS

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What is "PFAS"?

- PFAS is the general name for a large family of man made chemical substances: 5,000-12,000 fluorinated chemicals
  - Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were the initial widely-used compounds
- Manufacturing:
  - First manufactured in the 1940's
  - PFOA and PFOS are not currently produced in the United States
  - Replacement chemistry is still widely used

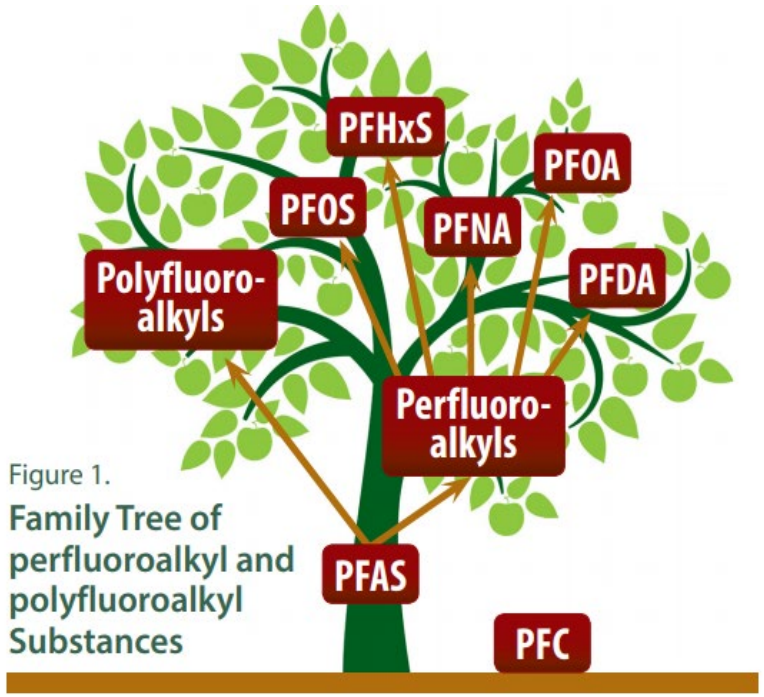

Figure 1.
Family Tree of perfluoroalkyl and polyfluoroalkyl Substances

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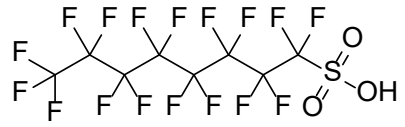
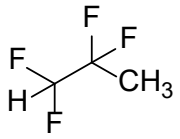
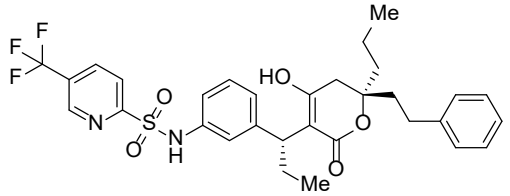
Multiple regulatory definitions for PFAS



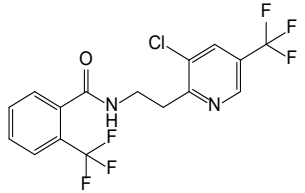
PFOS
(Surfactant)



R-254cb
(Refrigerant)



Tipranavir®
(HIV Treatment)



Fluopyram
(Fungicide)

	TSCA (PFAS = fully fluorinated carbon chain)	EPA PFAS Master List (no definition)	Maine LD 1503/ California AB 652 (PFAS = 1 fully fluorinated carbon)
# of unique structures	1,364	12,049	> 12,049
PFOS	Yes	Yes	Yes
1,1,2,2-tetrafluoropropane	No	Yes	Yes
Tipranavir & Fluopyram	No	No	Yes

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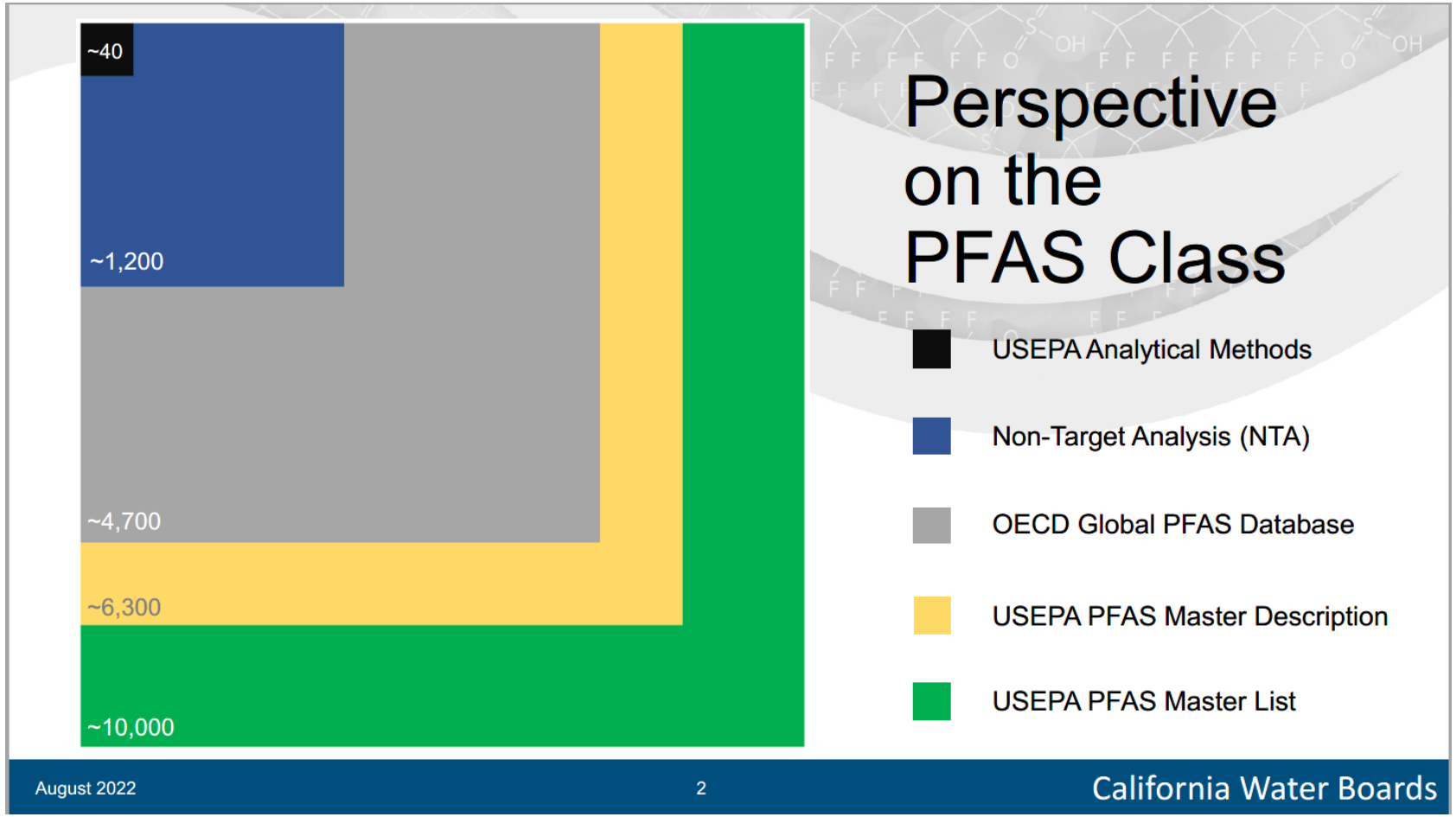
PFAS Groupings



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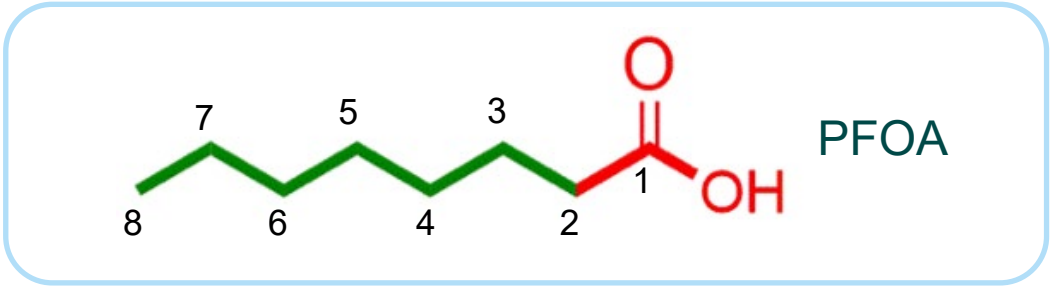
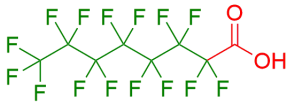
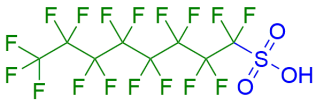
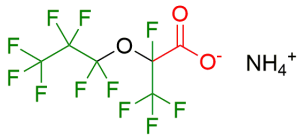
Diverse PFAS chemistries with key similarities

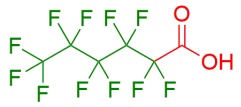
- Thousands of these substances exist
- Compounds are most often differentiated by chain length and end group(s):
  - Chain length groups: C8, C4, etc.
  - End groups: carboxylic acids and salts thereof, sulfonic acids, alkoxy, etc.
- Variety of chemical and physical properties dictate commercial relevance and life cycle in ecosystems.

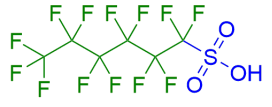


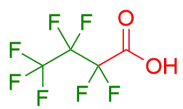

PFOA

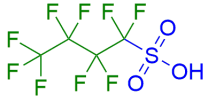

PFOS

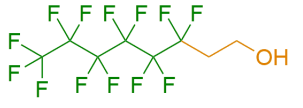

Gen X


PFHxA


PFHxS


PFBA


PFBS


6:2 FTOH

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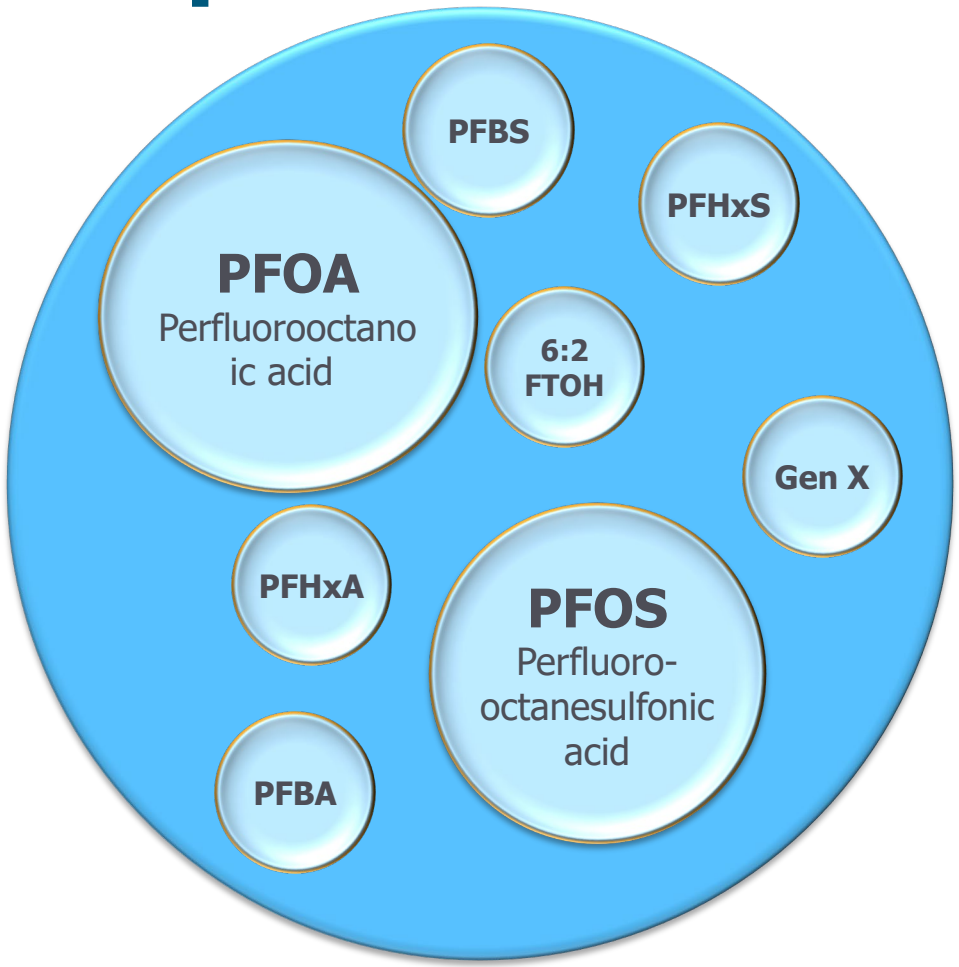
PFAS acronyms – word soup!

- Acronyms are frequently used as shorthand for full structure
- Efforts to harmonize nomenclature are improving, but inconsistencies exist
  - Laboratory acronyms frequently differ from USEPA
  - USEPA and CA OEHHA use different acronyms
    - e.g., NMeFOSE vs. MePFOSE
- Important: "PFAS" is the general term for the family of chemicals, but is not specific!
  - PFOA is a PFAS
  - PFAS ≠ PFOA



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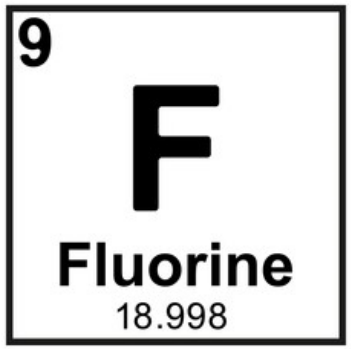
Fluorine exists in many forms, but not all of it is PFAS!



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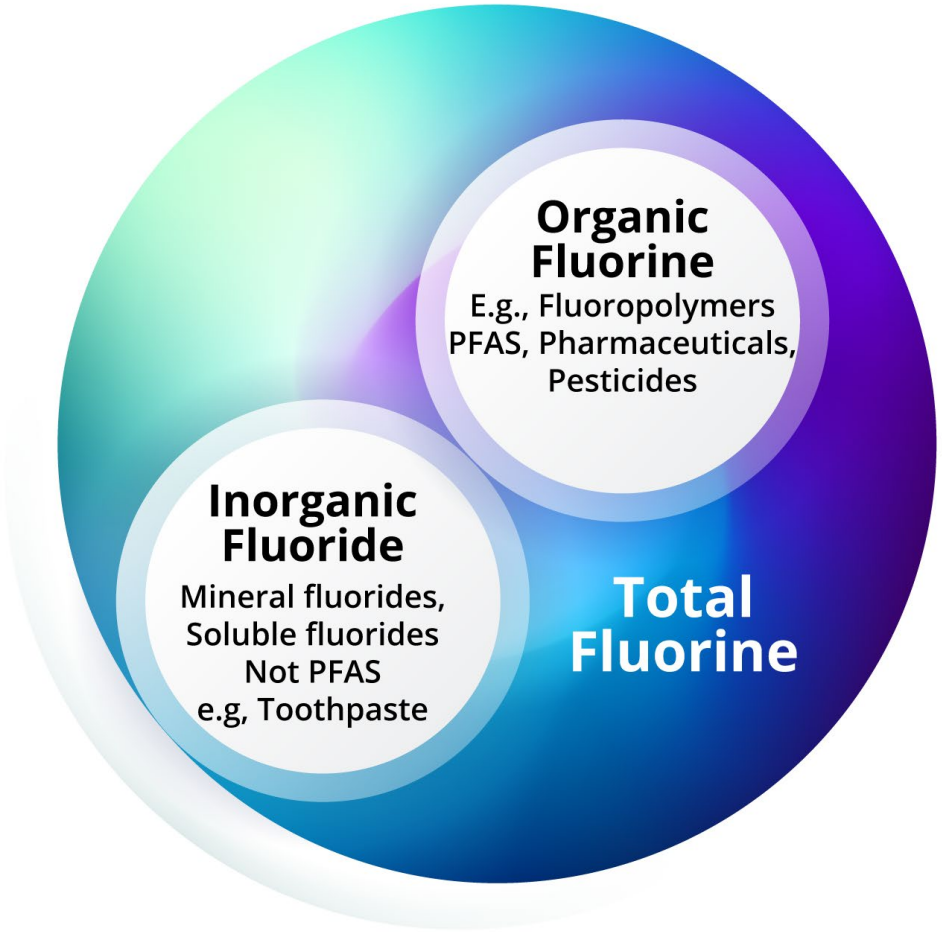
≠ PFAS



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Where Have PFAS Been Used?

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Is PFAS Still Being Used in the United States?

- Yes. USEPA supervised the voluntary phase-out of PFOA and PFOS starting in the early 2000s, so those two compounds are no longer manufactured in the U.S.
  - USEPA also issued Significant New Use Rules ("SNURs") under TSCA restricting production and future use of those compounds, and has subsequently issued similar SNURs for other PFAS compounds
  - However, PFOA and PFOS are still being manufactured abroad and imported to the United States
- After PFOA and PFOS were phased out, shorter chain length PFAS compounds were introduced as replacements

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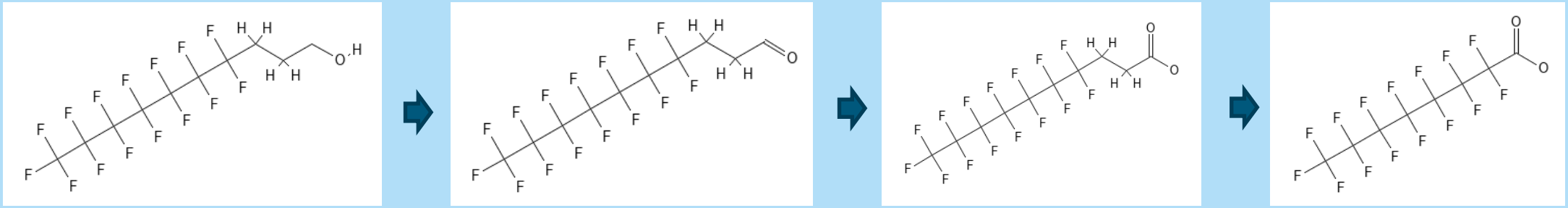
Some molecules can degrade into PFAS or other PFAS chemistries

- Certain PFAS are not environmentally stable and persistent, but can degrade to a PFAS molecule that is stable
- Important consideration for the life cycle of consumer products



7:3 Fluorotelomer alcohol → PFOA

Where Is PFAS Found?

- Most PFAS compounds break down slowly
- Depending on their structure, some PFAS travel quickly through soil and into water while some can adhere to the soil matrices
- PFAS compounds have been identified in drinking water, groundwater, and surface water across the country
  - As a result, states and the federal government have started regulating PFAS in those types of waters
  - PFAS is also found in landfills, at POTWs, in wastewater, and at airports
- PFAS has also been identified in industrial air emissions

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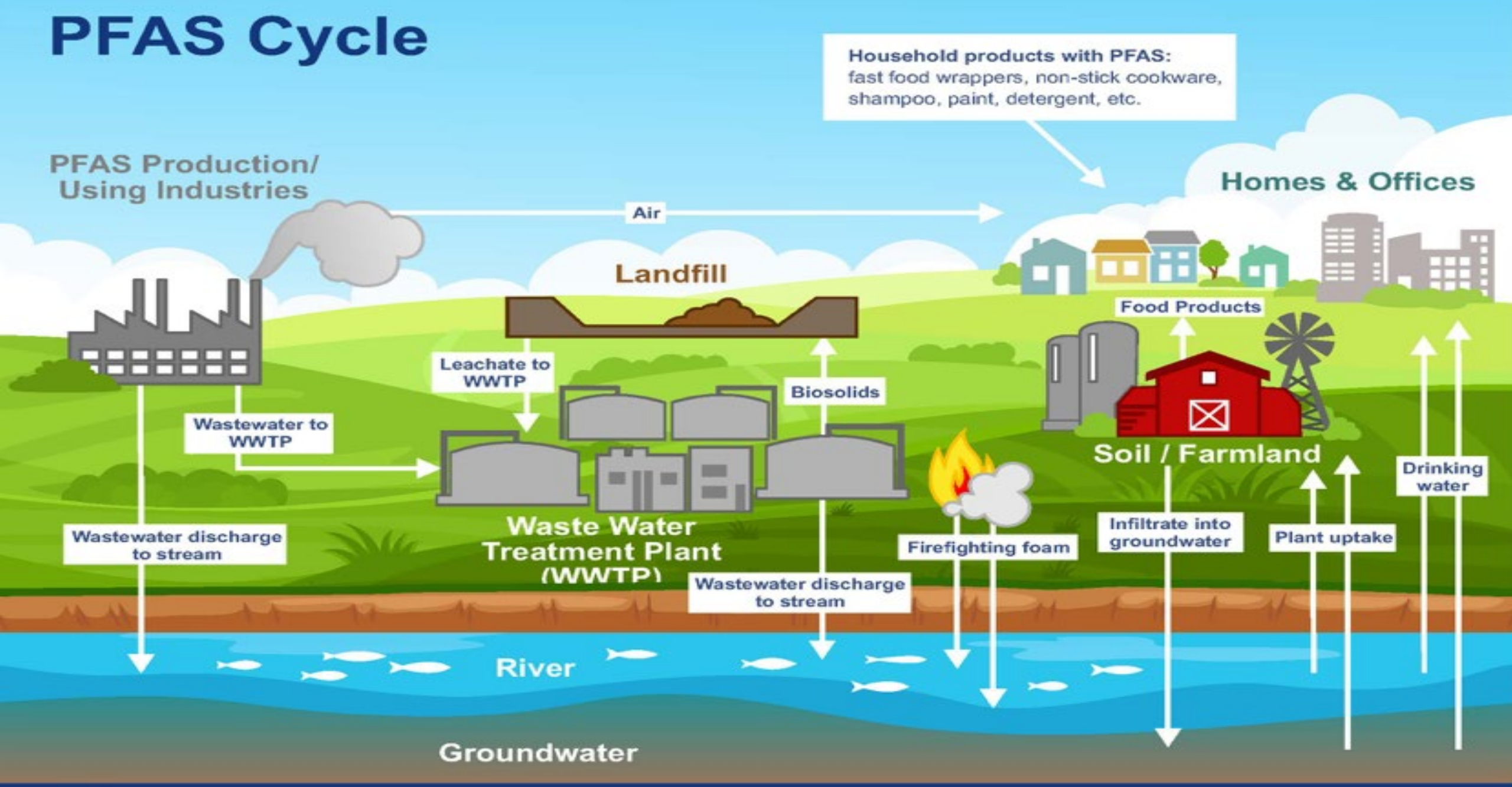
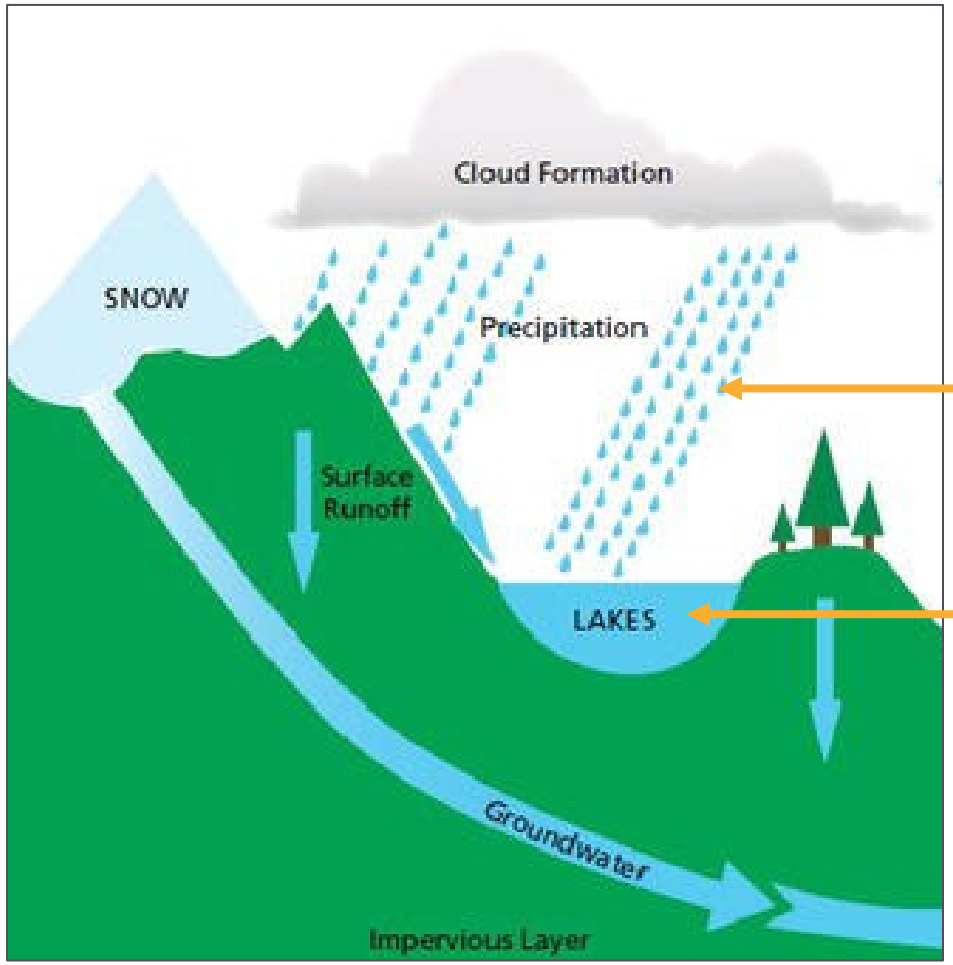
PFAS Cycle



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.dep.pa.gov/pfas

PFOS May Be Present in Rainwater



Great Lakes Study found that PFOS in precipitation may be a source to surface water

Rainwater: up to 2.5 ppt PFOS

Surface water: up to 2 ppt PFOS

Source: Gewurtz et al. 2019 ES&T Perfluoroalkyl Acids in Great Lakes Precipitation and Surface Water (2006–2018) Indicate Response to Phase-outs, Regulatory Action, and Variability in Fate and Transport Processes

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Human Exposure to PFAS

- In the early 1990s, certain PFAS were detected in the blood of the U.S. general population
- Since then, the FDA and others have detected certain PFAS in snack foods, vegetables, meat, dairy products, and fish
- USEPA considers the diet to be the most common route of exposure to PFOA and PFOS, according to the USEPA Drinking Water Health Advisory for PFOA and PFOS
  - Drinking water
  - At least one study concluded that frequent consumption of prepare food – specifically french fries – in coated cardboard containers was associated with higher blood levels of four PFAS compounds. (Boronow et al. 2018, https://www.nature.com/articles/s41370-018-0109-y.pdf)

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FEDERAL PFAS REGULATIONS

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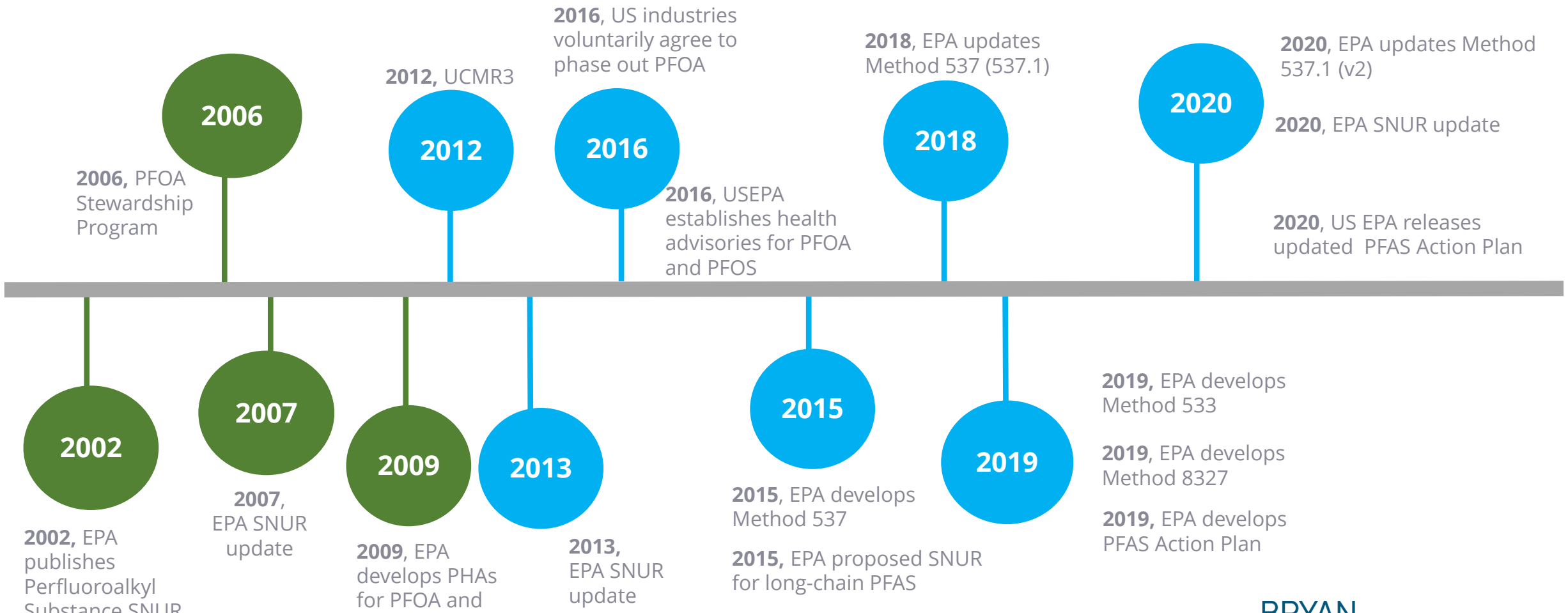
Evolution of Federal PFAS Policy



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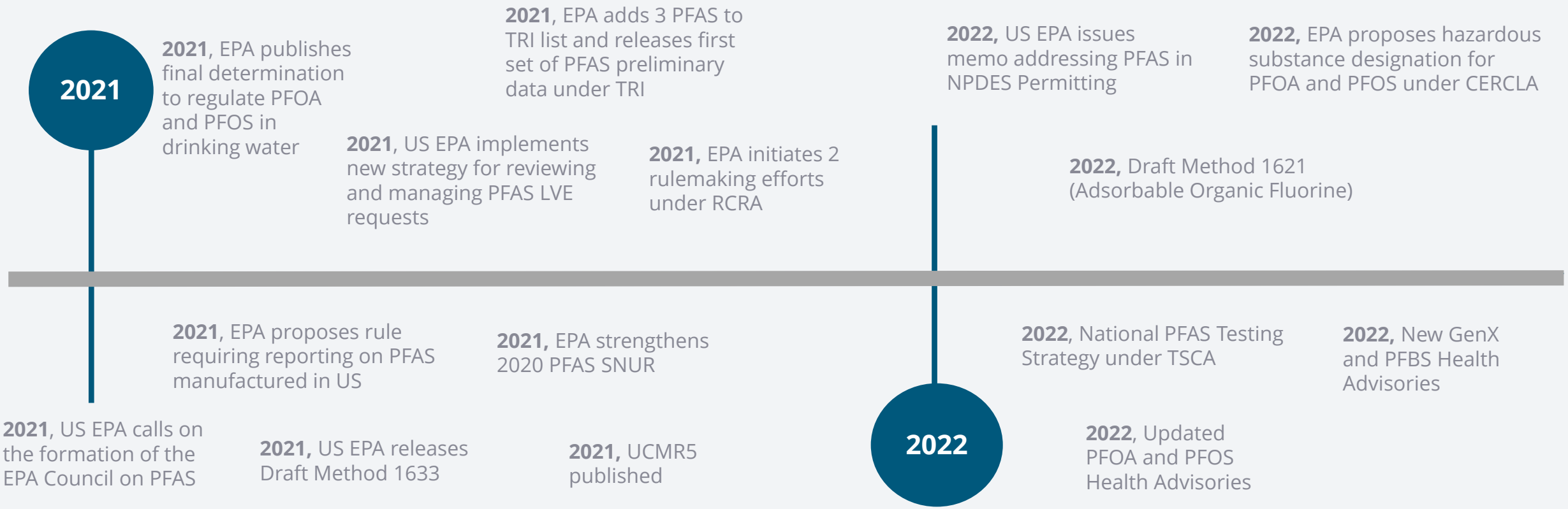
Evolution of federal PFAS policy (cont).



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Updated Health Advisory Levels ("HAs")

- EPA issued four HAs on June 15, 2022
- Not binding or legally enforceable
- Supersedes and significantly reduces the 70 ppt (PFOS + PFOA) advisory issued by EPA in 2016
- HA levels:
  - PFOA: 0.004 ppt
  - PFOS: 0.02 ppt
  - HFPO-DA (GenX): 10 ppt
  - PFBS: 2,000 ppt

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World Health Organization ("WHO") Report

- Issued on September 29, 2022, a draft "PFOS and PFOS In Drinking-Water" document
- Guidance for countries and water suppliers in assessing necessary PFAS regulatory or remediation activity
- Amounts:
  - 100 ppt individually for PFOA and PFOS
  - 500 ppt for total combined PFAS
- The WHO PFAS recommendations are significantly higher than:
  - USEPA's prior guidance level of 70 ppt for PFOS and PFOA combined
  - USEPA's updated HAs for certain PFAS discussed in the prior slide
- The report acknowledges that some countries may not have the technological means to test and remediate PFAS to the same degree as the United States

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What is the Federal Government Doing to Regulate PFAS?

- Establishing Maximum Concentration Levels for PFOA, PFOS, and possibly other compounds under the Safe Drinking Water Act
- Listing PFOA, PFOS, and possibly other compounds as "Hazardous Substances" under CERCLA
- Prohibiting the manufacture and use of certain PFAS compounds through SNURs under TSCA
- Increasing reporting requirements for PFAS use and emissions
- Including PFAS testing and possibly discharge limits in EPA-issued NPDES permit
- Unregulated Contaminant Monitoring Rule 5 Testing

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What is the Federal Government Doing to Regulate PFAS?

- Contaminant Candidate List 5 ("CCL 5")
  - USEPA released the final version on November 2, 2022
  - Groups PFAS based on structural definition, rather than prior regulatory actions targeted as specific PFAS
  - The new definition has the potential to implicate thousands of individual PFAS chemicals for future regulation under the Safe Drinking Water Act

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PFAS Environmental and Drinking Water Monitoring

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Advancements in analytical procedures

Detecting the needle in the haystack

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EPA Testing Methodologies

- **Method 533 and 537.1 – PFAS in drinking samples**
  - Specific or targeted PFAS analysis
  - Independent laboratory validation for sum of 29 PFAS
  - Commercial laboratories expanded list of 70-90 PFAS
- **DRAFT Method 1621 - Adsorbable Organic Fluorine (AOF)**
  - Screening methodology
  - Estimates an aggregate of organofluorine compounds
  - Picks of other organoflourine molecules
  - Can not eliminate background fluoride levels completely
- **DRAFT Method 1633 in Aqueous, Solid, Biosolids, and Tissue Samples**
  - 40 specific PFAS analytes

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Unregulated Contaminant Monitoring Rule (UCMR)

- **UCMR 3 - 2013–2015**
  - required testing of 6 PFAS compounds
  - PFOS, PFOA, PFNA, PFHxS, PFHpA and PFBS
- **UCMR 4 – 2018 – 2020**
  - PFAS not included
- **UCMR 5 – 2023 – 2025**
  - 29 PFAS in water
  - Method 533 and 537.1 combined
  - https://www.epa.gov/system/files/documents/2022-02/ucmr5-factsheet.pdf

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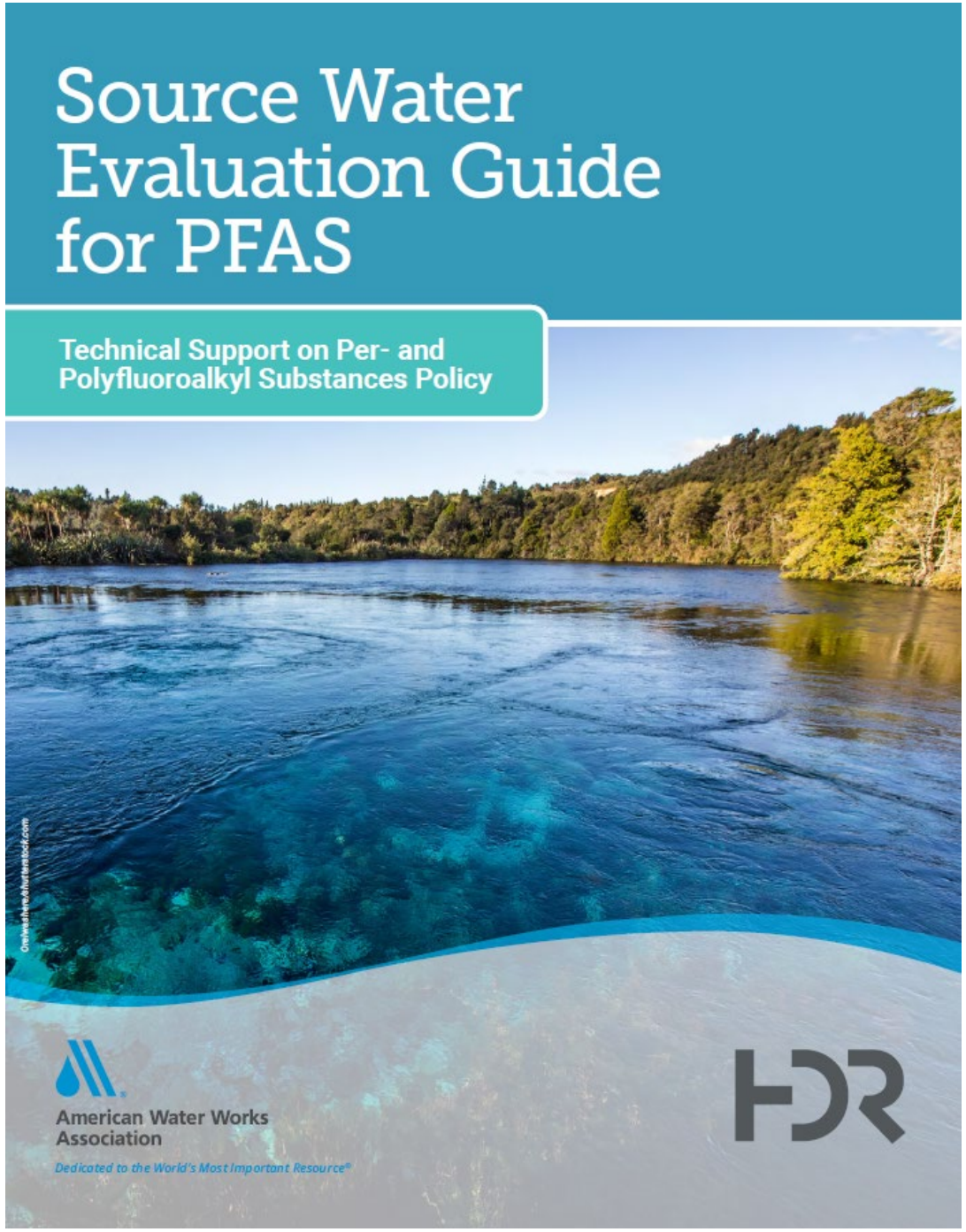
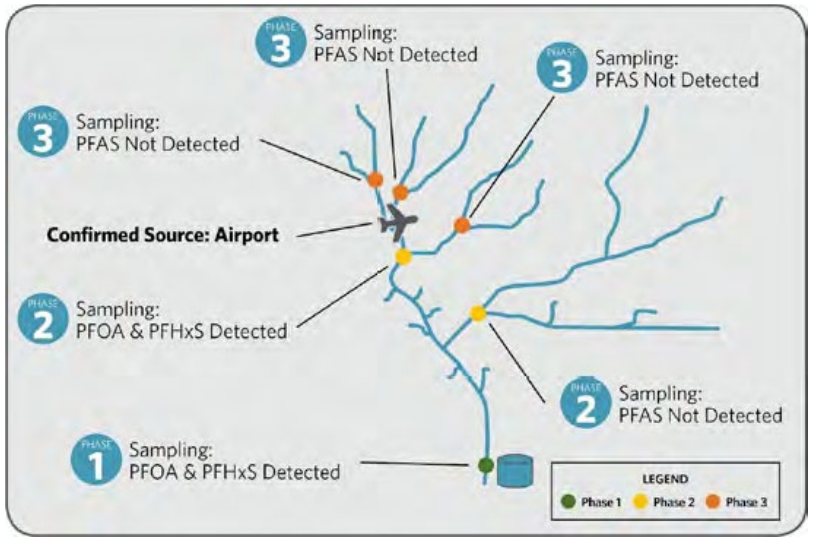


- Airports (military and civilian)
- Firefighting training facilities
- Industrial and commercial facilities associated with PFAS manufacture or use
- Waste management facilities (landfills)
- Wastewater residual disposal sites where there is an industrial source known to use PFAS



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California State Water Board state-wide PFAS source investigation strategy

- Implemented in 2019 to evaluate PFAS concentrations in drinking water supply, groundwater and soil
  - Initial 2019 investigative orders went out to 30 airports and 196 landfills and sampling orders to water systems with public water supply in the vicinity of airports and landfills
- In 2020, 249 Investigative Orders to Publicly Owned Treatment Works (249) assessment of wastewater effluent , biosolids, and reverse osmosis concentrate for 31 specific PFAS compounds
- Additional orders continued in 2021 and 2022 for locations believed to have high usage of Aqueous Film Forming Foam (AFFF), Department of Defense locations, or manufacturing that used PFAS

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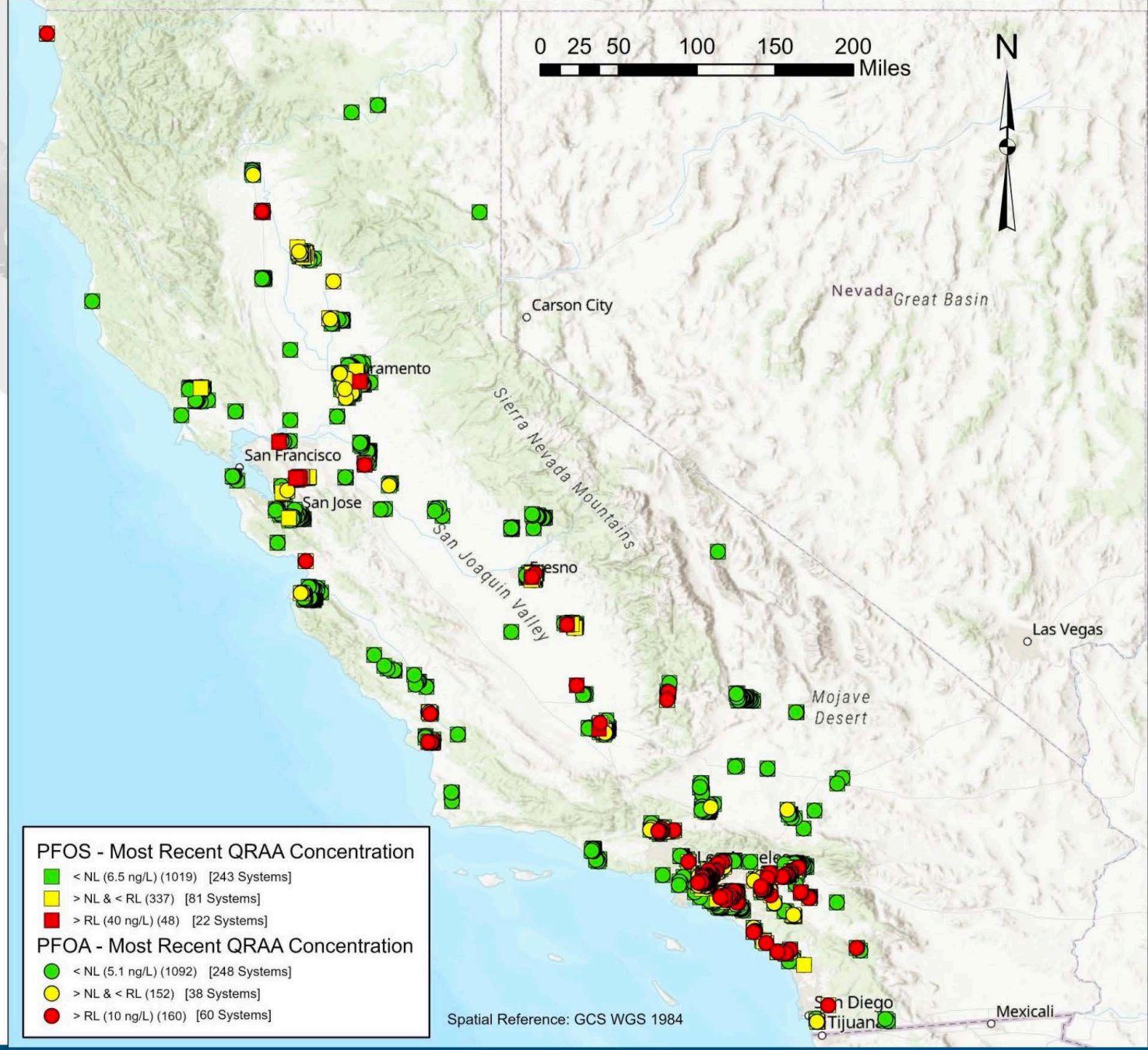
State-wide Industry Investigative Orders has provided vital information but there are gaps

Media	Chrome Platers	Airports	Landfills	POTWs	Bulk Fuel Terminals/ Refineries
Soil				* *Includes biosolids*	
Groundwater					
Stormwater					
Surface Water/ Sediment					
Wastewater			* *Includes leachate*		

To be assessed	Not Detected to Low Concentrations (<100 ppt)	Moderate Concentrations (100 ppt to 5,000 ppt)	Significant Concentrations (>5,000 ppt)

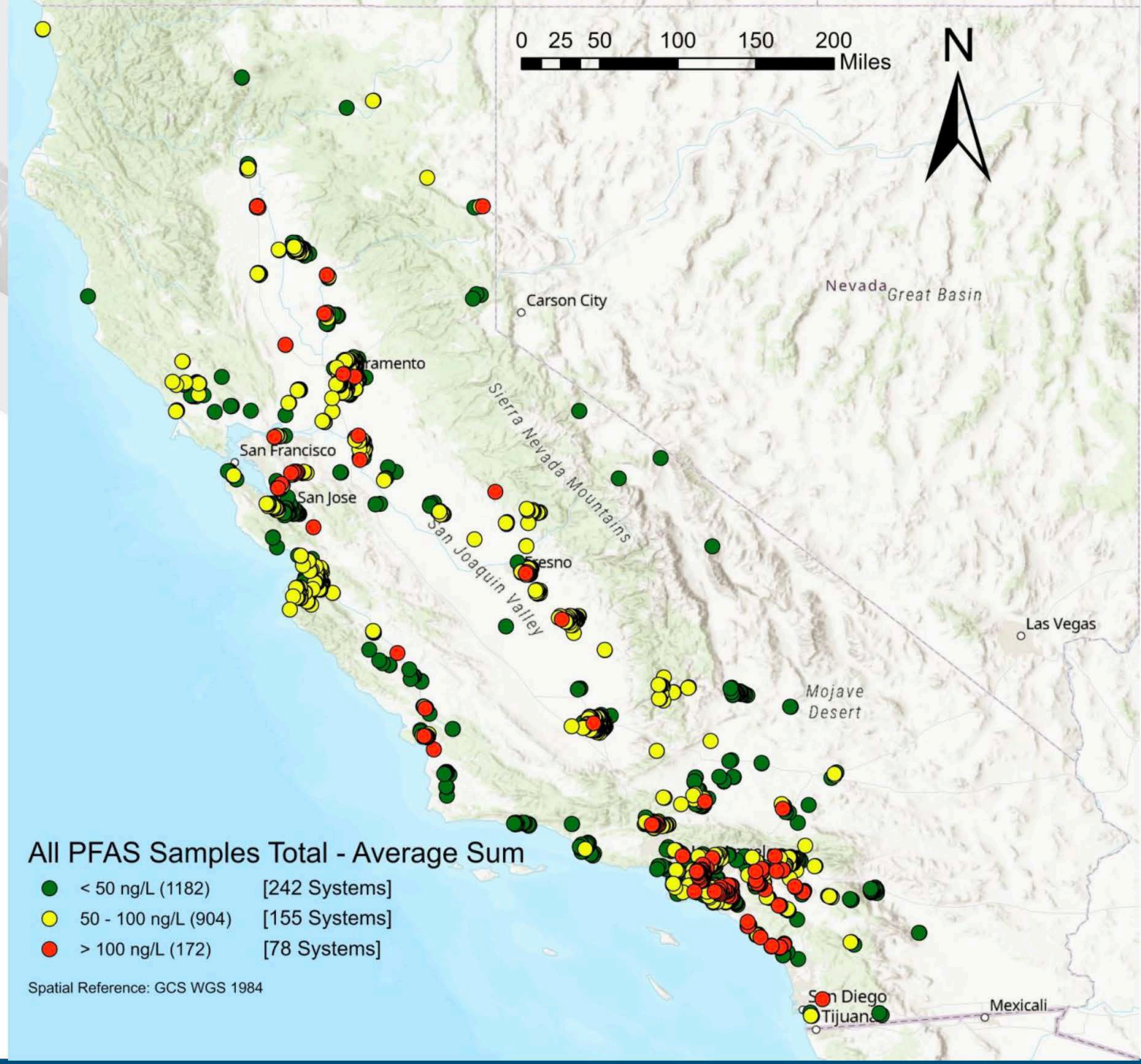
All matrices were analyzed using the DoD QSM with 25 to 38 analytes.

Drinking Water Supply Wells - PFOA/PFOS Notification Level /Response Level Exceedances



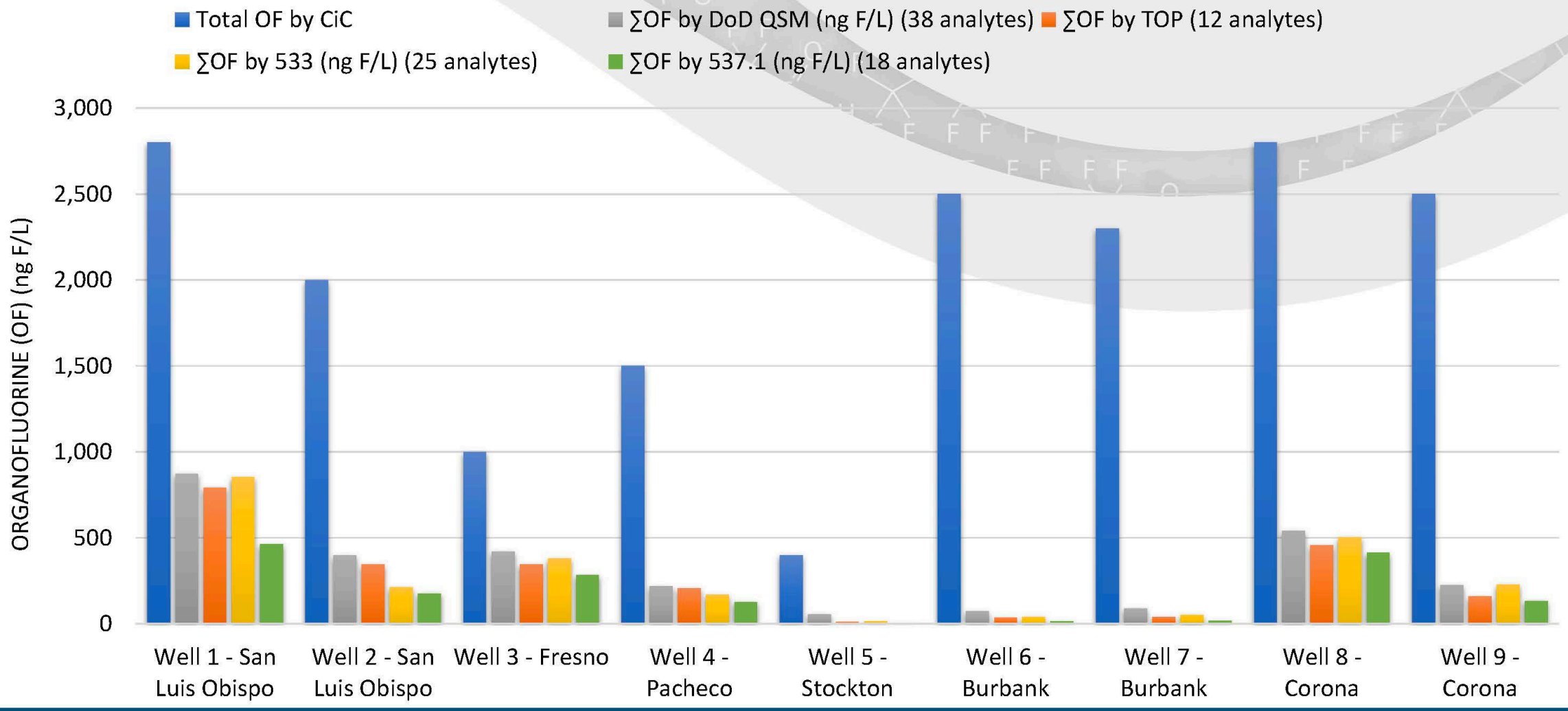
Data downloaded in February 2022 – raw water results
NL = Notification Level; QRAA = Quarterly Running Annual Average
RL = Response Level
PFOA and PFOS analyzed using EPA Method 537.1
PFOA: = NL = 5.1 ng/L, RL = 10 ng/L | PFOS: NL = 6.5 ng/L, RL = 40 ng/L

Method 537.1 Cumulative PFAS provides a broader understanding of Occurrence in Drinking Water



Data downloaded in February 2022
Total PFAS sums based on EPA Method 537.1 (18 analytes) –
Averages based on the PFAS sums for the last 4 quarters

Estimates of Total Organofluorine in Drinking Water Reveals Interesting Results



CALIFORNIA DRINKING WATER PFAS REGULATIONS

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Drinking Water Regulations

- **Notification Levels:**
  - 5.1 ppt – PFOA
  - 6.5 ppt – PFOS
  - 500 ppt – PFBS
  - 3 ppt -- PFHxS

- **Response Levels:**
  - 10 ppt – PFOA
  - 40 ppt -- PFOS
  - 5,000 ppt – PFBS
  - 20 ppt -- PFHxS

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Proposition 65

- Several PFAS compounds have been listed under the California Safe Drinking Water and Toxic Enforcement Act of 1986, better know as Proposition 65
  - PFOA
  - PFOS and its salts and transformation and degradation precursors
  - PFNA

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Public Health Goals (PHGs)

- Interim Guidance as of June 15, 2022
- Amounts:
  - PFOA – .007 ppt
  - PFOS – 1 ppt
- PHGs are not regulatory standards
- PHGs are used to create enforceable drinking water standards

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California Drinking Water MCLs

- Final MCLs are not expected until 2025
- The PHGs may influence MCLs
- The California Water Resources Control Board has indicated that it wants to incorporate PFAS monitoring requirements into NPDES permits
- The California Division of Drinking Water has already issued approximately twenty (20) permits for the treatment of PFAS in drinking water sources, and thirty (30) additional permits are in process

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EPA Office of Research and Development Collaboration with CA State Water Resources Control Board

- Evaluating benefits and drawbacks of regulating PFAS based on;
  - Absorbable organic fluorine,
  - Treatment techniques,
  - Specific PFAS, or
  - Combination

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Treatment and Mitigation

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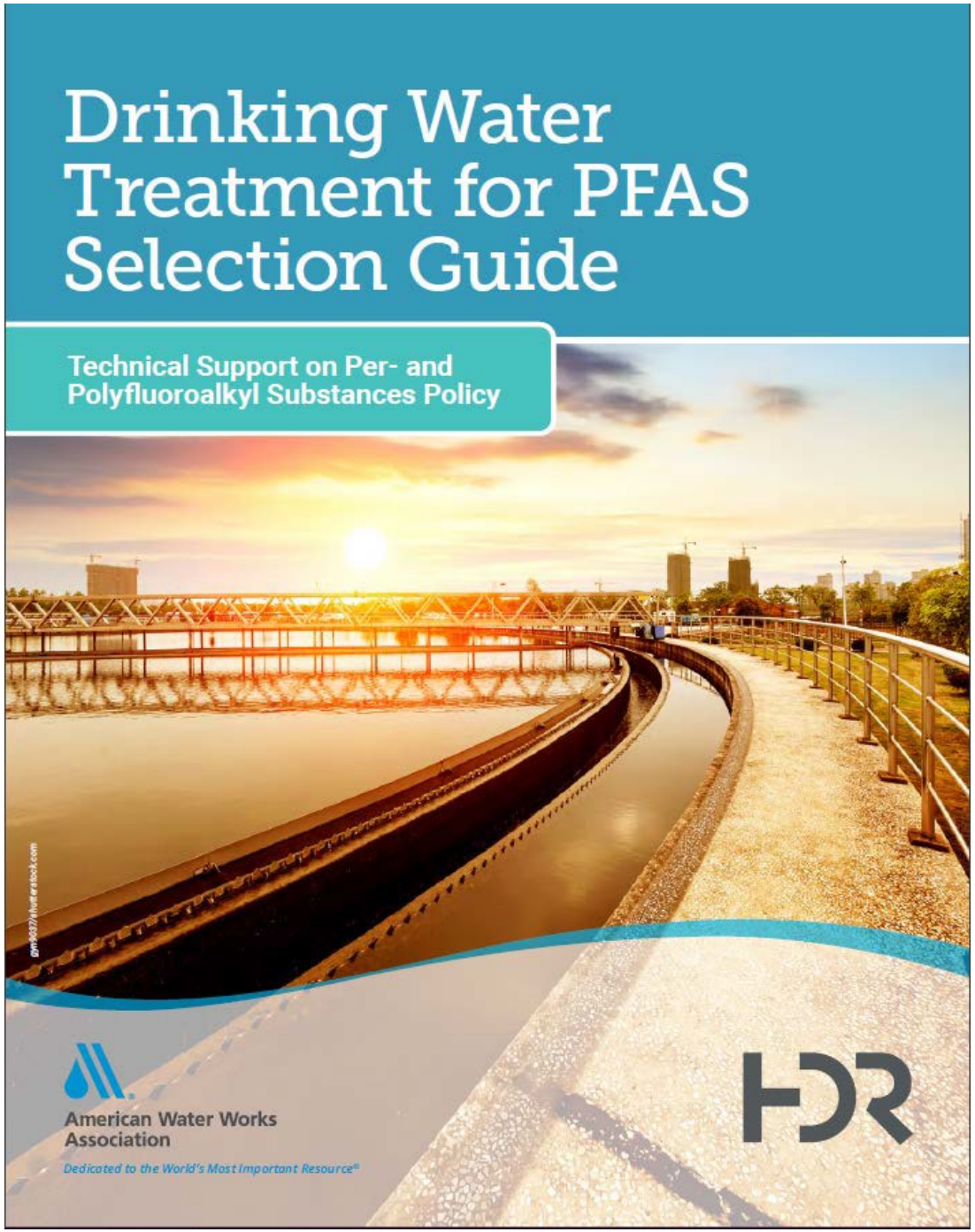

- Comprehensive guide to current treatment options
- Key treatment technologies include;
  - Powder Activated Carbon (PAC)
  - **Granular Activated Carbon (GAC)**
  - Ion Exchange
  - **Nanofiltration (NF) and Reverse Osmosis (RO) Membrane Technologies**

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Granular Activated Carbon (GAC)

- Results in the adsorption of PFAS
- Advantages
  - Reliable process
  - High PFAS removal
  - Flexibility in implementation at existing water treatment plants
  - Numerous secondary water quality benefits
- Disadvantages
  - Not as effective at short chain PFAS removal
  - Competitive adsorption (organic carbon)
  - Requires media replacement
- High heat applications of spent GAC media could potentially be completely destructive of PFAS

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Nanofiltration (NF) and Reverse Osmosis (RO) Membrane Technologies

- Create a physical barrier to prevent passage of PFAS
- Advantages
  - RO removes >99% of all PFAS
    - NF larger poor size can allow some small chain PFAS to pass through
  - Compact system/foot print
  - Removes many other contaminants of concern
- Disadvantages
  - Significant capital and O&M costs
  - Requires reliable and robust pretreatment for surface water treatment
  - Requires extensive corrosion control finishing
  - High concentration of PFAS in rejected concentration (brine) disposal challenging
    - 10 – 20% of produced water

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Drinking Water Wells Are Being Removed From Service Based On PFAS Detections

NEWS > ENVIRONMENT

'Forever chemicals' trigger widespread closure of water wells

State lowers threshold for toxic PFAS chemicals.

Ricardo Medina, an Orange County Water District research associate, loads ion exchange resins into a treatment system to filter out PFAS toxins. The district is testing 14 different products to determine the best to remove the carcinogenic chemicals from dozens of Orange County groundwater wells. (File photo courtesy of the Orange County Water District)

New research confirms presence of toxic "forever chemicals" in scores of NC water supplies

By **Lisa Sorg** - 7/1/2020 - in Environment, Top Story Print This Article

Facebook **2.0K** Twitter **23** Email **48**

The Cape Fear Public Utility Authority Sweeney water treatment plant (File photo: Lisa Sorg)

GenX study shows contamination in 80% of wells tested; mice studies show liver damage from Nafion Byproduct 2

Raw water supplies for at least 150 public utilities in North Carolina contained some level of toxic PFAS, underscoring the call of many scientists this week to regulate the thousands of perfluorinated compounds as a class.

Some of those raw water samples contained **GenX and Nafion Byproduct 2,** which new findings published this month show the detrimental health effects of these compounds on mice. Other studies have suggested similar effects on humans.

Samples of raw water — which has not yet been treated at the plant — were collected by scientists with the NC PFAST Testing Network from April through November 2019. The NC PFAST Testing Network is composed of scientists from seven universities working under the auspices of the NC Policy Collaboratory, which is funded by the state legislature and grants.

BREAKING TOPICAL TOP STORY

Madison shutting down PFAS-contaminated well while insisting water is safe

Steven Verburg | Wisconsin State Journal Mar 5, 2019

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Conclusion

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PFAS is here to stay, but impacts can be managed

- State and federal regulations are expected to expand the scope of PFAS restrictions in drinking water
- Understanding the nature and extent of PFAS impacts in water sources is essential in order to make informed decisions, and ensure regulatory compliance
- An understanding of the issue will also allow impacted water systems to explore possible funding for remedial systems

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Contact Information and Resources

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CONTACT INFORMATION

Sarahann M. Rackl, PhD. P.E.
Senior Managing Engineer, Exponent
Email: srackl@exponent.com
T: 925-209-3076

Tom Lee
Partner, BCLP
Email: tom.lee@bclplaw.com
T: +1 415 675 3447
F: +1 415 675 3647

Resources (Part I – General)

- EPA PFAS Information: https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas
- PFAS Strategic Roadmap: https://www.epa.gov/system/files/documents/2021-10/pfas-roadmap_final-508.pdf
- HA Information: https://www.epa.gov/sdwa/questions-and-answers-drinking-water-health-advisories-pfoa-pfos-genx-chemicals-and-pfbs

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Resources (Part II – General)

- CCL 5 Information: https://www.epa.gov/ccl/contaminant-candidate-list-5-ccl-5
- UCMR 5 Information: https://www.epa.gov/dwucmr/fifth-unregulated-contaminant-monitoring-rule
- WHO Draft Report: https://www.cmbg3.com/library/WHO-Draft-Drinking-Water-Document.pdf

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Resources (Part III – California)

- California Water Boards PFAS Information: https://www.waterboards.ca.gov/pfas/
- California Water Boards PFAS Drinking Water Information: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/pfas.html
- California Water Boards PFAS Timeline: https://www.waterboards.ca.gov/pfas/ca_pfas_timeline.html#:~:text=Beginning%20on%20January%201%2C%202025,to%20sample%20and%20report%20PFAS.

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Resources (Part IV – California)

- Proposition 65 Information: https://oehha.ca.gov/proposition-65/proposition-65-list
- Public Health Goal Information: https://oehha.ca.gov/water/report/perfluorooctanoic-acid-pfoa-and-perfluorooctane-sulfonic-acid-pfos-drinking-water#FirstPubDraft

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PFAS CONTAMINATION

The Risks and Realities for Water Districts

November 29, 2022