PFAS and Forever Chemicals: Update on Agency Actions

Jeff O'Keefe

Supervising Sanitary Engineer

State Water Resources Control Board

Jeff O'Keefe is a Supervising Sanitary Engineer with the State Water Resources Control Board – Division of Drinking Water, Southern California Field Operations Branch, Southern California Section. He has been with the drinking water regulatory program for 23 years. He has a B.S. in Mechanical Engineering and an M.S. in Civil Engineering and is a licensed professional civil engineer and a certified grade 4 water treatment operator. Prior to working in the drinking water field, Jeff worked as a systems engineer in the aerospace industry for 10 years.

Megan Plumlee

Research Director,

Orange County Water District

Megan Plumlee is the Director of Research and Development (R&D) for the Orange County Water District (OCWD), where she oversees a team of scientists and researchers who conduct applied research that supports the District's core operational needs. This includes evaluations of promising new technologies for recycled water treatment and groundwater recharge. Megan has completed research and engineering projects spanning a wide range of topics including non-potable and potable water reuse, contaminants of emerging concern, costs for advanced treatment, and more. She has authored and contributed to 24 peer-reviewed publications in scientific journals. Her current work includes oversight of OCWD's PFAS pilot study, which is testing various treatment options for removing PFAS from groundwater.

Craig Miller

General Manager

Western Municipal Water District

Craig Miller is General Manager of the 527-square mile Western Municipal Water District (Western), Craig Miller is responsible for managing the day-to-day activities of the organization, including oversight of Finance, Operations, Engineering, Community Affairs and Water Resources. Joining Western in 2014, Mr. Miller currently sits on the Association of California Water Agencies Groundwater Committee. Mr. Miller has more than 30 years of engineering and leadership experience. He is a registered civil engineer in the state of California and he holds a bachelor's degree in civil engineering from California State University, Long Beach.

Southern California Water Dialogue

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PFAS and Forever Chemicals: Update on Agency Actions

January 27, 2021

Megan Plumlee, Orange County Water District
Jeff O'Keefe, Division of Drinking Water, SWRCB
Craig Miller, Western Municipal Water District

Southern California Water Dialogue Co-chairs

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Executive Director

Southern California Watershed Alliance

DEE ZINKE

Assistant General Manager, External Affairs

The Metropolitan Water District of Southern California

Southern California Water Dialogue

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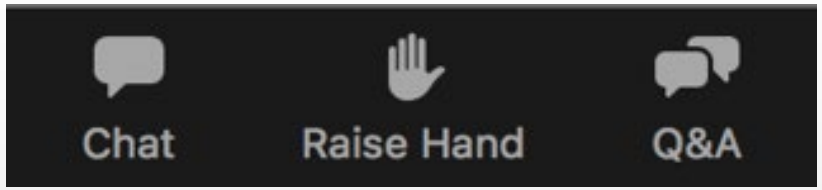
Webinar Ground Rules



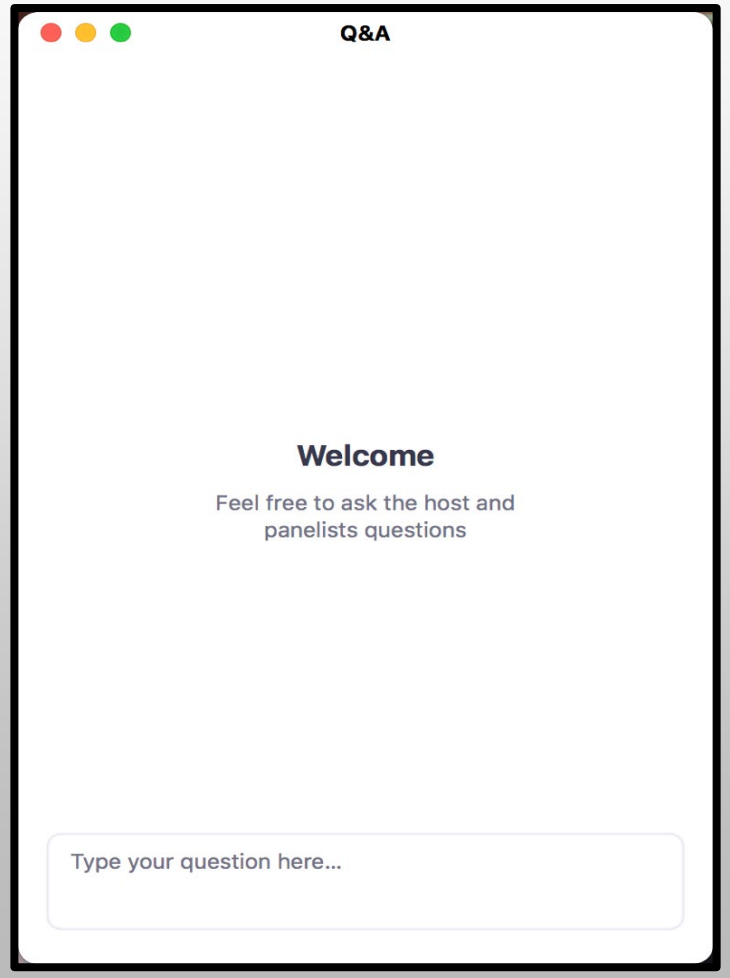
- **Technical Difficulties:** Use chat feature to let us know
- **Asking a Question:** Use Q/A feature, type in question, and click send. Questions addressed after presentation.
- **Poor Connection:** Move closer to your wireless router and turn off other services using bandwidth (e.g. Netflix)
- **Audio Muted:** Attendee audio on mute by default
- **Timetable**: Presentation runs apx. 45 minutes followed by Q/A session

How to Ask A Question

On the bottom of your screen, click “Q&A”

Southern California Water Dialogue

Type in question, then click send



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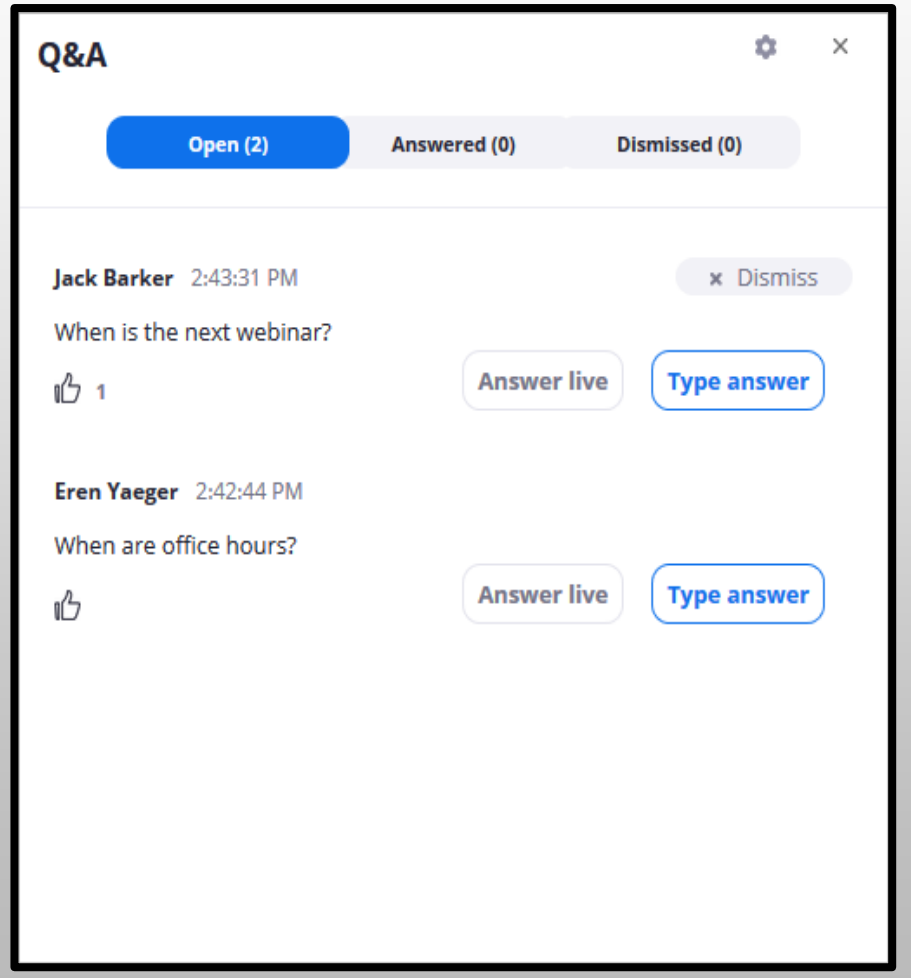

Southern California Water Dialogue

Agenda

- Announcements and Introductions
- Introduction of Speakers
- Presentation
- Dialogue (Q/A)
- Concluding remarks

Speakers

Jeff O'Keefe
Supervising Sanitary Engineer
State Water Resources Control Board

Megan Plumlee
Research Director,
Orange County Water District

Craig Miller
General Manager,
Western Municipal Water District

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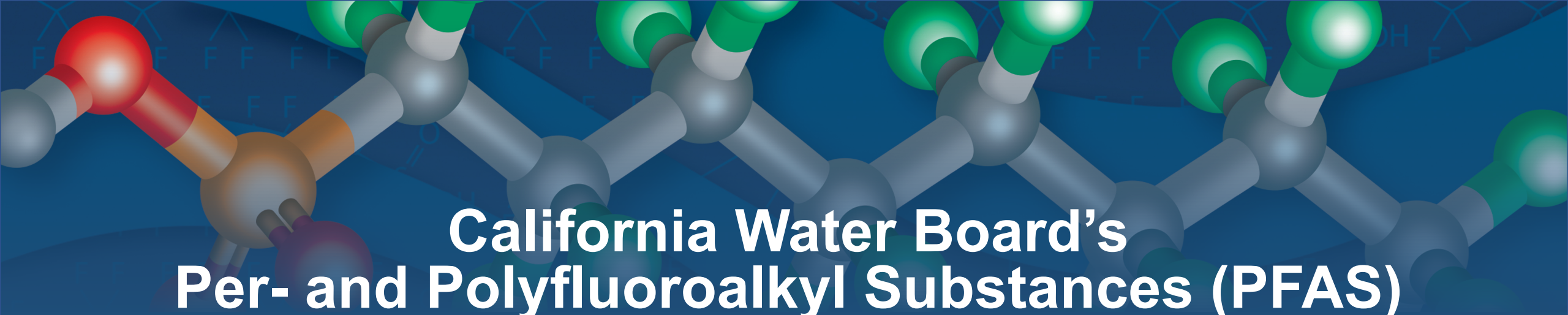


California Water Board's Per- and Polyfluoroalkyl Substances (PFAS)

State Water Board Update

Southern California Water Dialogue

January 27, 2021

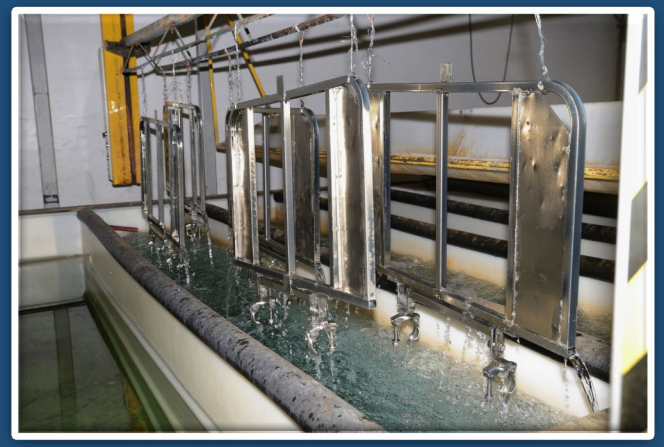
STATE WATER RESOURCES CONTROL BOARD

Wide Range of Historical PFAS Uses

Class B Firefighting Foam

Carpets, Rugs, Textiles

Non-Stick Cookware

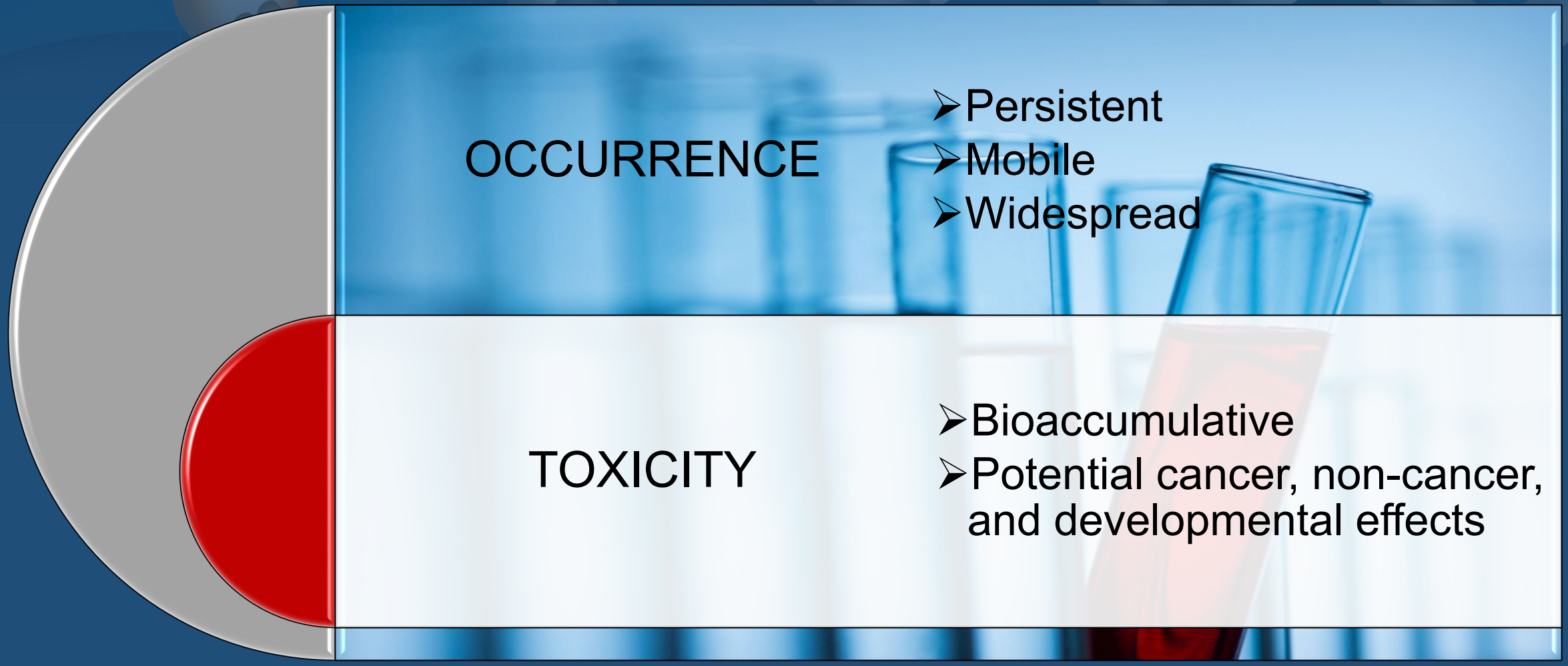


Metal Plating

Tech Industry

Food Packaging

PFAS is a Concern



Human and Ecological Health Concerns

Studies indicate that certain PFAS…

Human Health

- Affect growth, learning, and behavior of infants and older children
- Lower a woman's chance of getting pregnant
- Interfere with body's natural hormones
- Increase cholesterol
- Affect the immune system
- Increase the risk of cancer

Ecological Health

- Affect reproduction, development, metabolism, and growth
- Sensitive organisms:
  - Birds
  - Marine mammals

CalEPA Coordination

- California Water Boards
- Department of Toxic Substances Control
- Office of Environmental Health Hazard Assessment
- California Air Resources Control Board
- Cal Recycle
- Department of Pesticide Regulations

Water Boards – Who is Doing What?

Drinking Water (DDW)

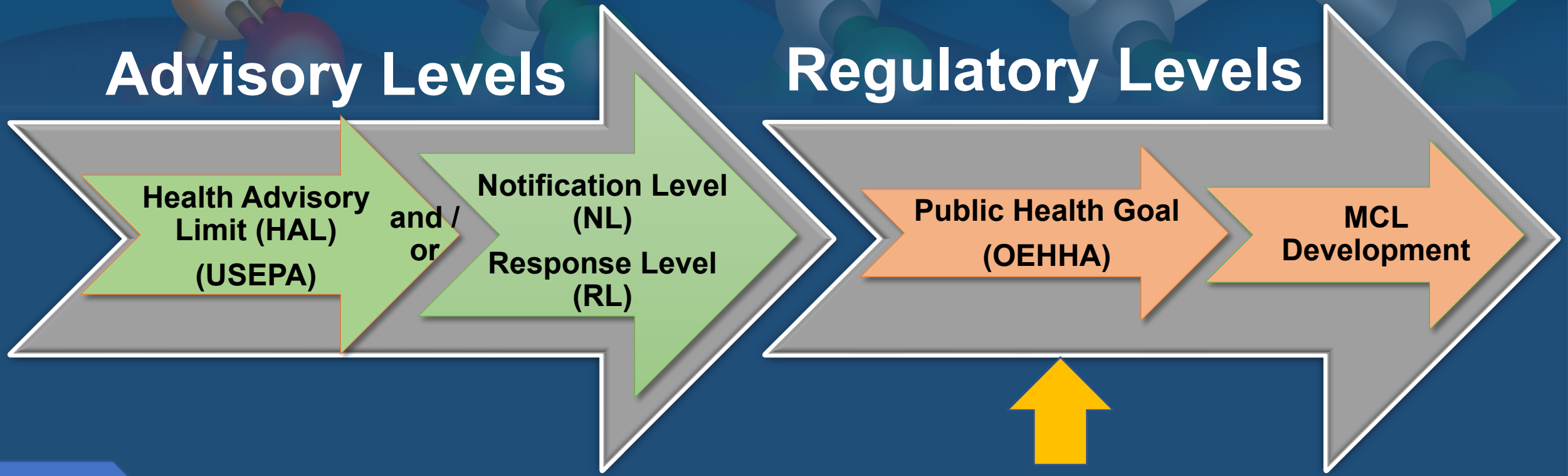
- Health & Safety Code
- Drinking Water
- NLs, RLs, MCLs
- ELAP (Laboratory Accreditation)

Water Quality (DWQ and Regional Boards)

- Water Code
- Soil, Groundwater, Surface Water
- WQOs

Acronyms:
NL = Notification Level
RL = Response Level
MCL = Maximum Contaminant Level
WQO = Water Quality Objectives
DDW = Division of Drinking Water
DWQ = Division of Water Quality

Path to a Drinking Water MCL



PFOS PFOA	70 ppt combined	NL 6.5 ppt; RL 40 ppt NL 5.1 ppt; RL 10 ppt	1st Draft Early 2021	TBD

Other PFAS NLs/RLs Under Consideration

- PFBS
  - OEHHA NL recommendation of 500 ppt posted on Jan 14, 2021
    https://oehha.ca.gov/media/downloads/water/chemicals/nl/pfbsnl121820.pdf
  - DDW has initiated the process to develop NL and RL
  - New AB 2560 H&S Code 116456 process to be followed
  - Issuance expected in Spring 2021
  - 3rd most frequently detected PFAS in DW samples
  - 120 ppt max detection

- Other PFAS under consideration based on frequency of detections in DW samples
  - PFHxS, PFNA, PFHxA, PFHpA, PFDA, ADONA

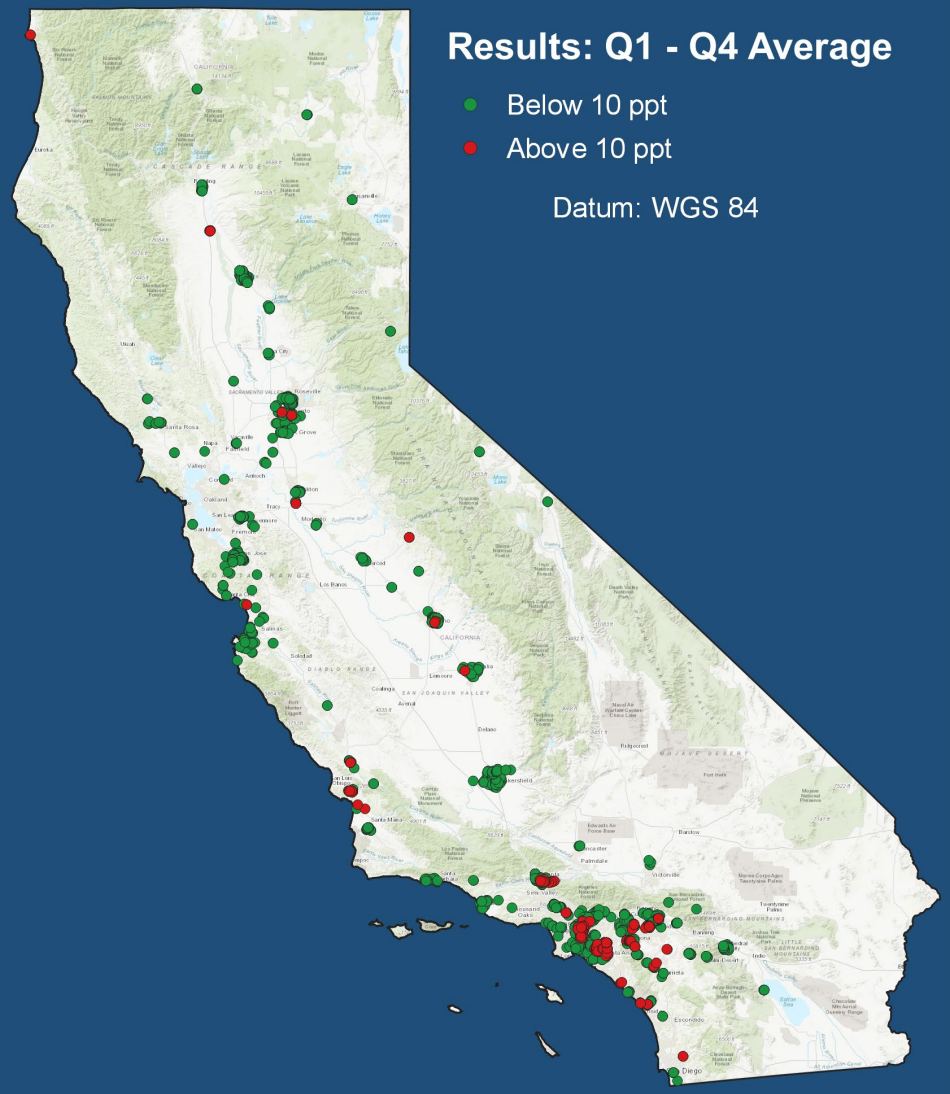
DWQ Site Investigation Orders

	Airports (Source)	Landfills (Secondary Source)	Chrome Platers (Source)	POTWs (Secondary Source)
Order Issued	March 2019	March 2019	October 2019	July 2020
Number of Orders	30	196	271 (~100 sites moved from Questionnaire to Workplan)	259 (12 Orders rescinded)
Order Timeframe	One-time sampling event			1 year (started 4Q2020)
Number of Data Submittals	23 of 30	187 of 196	6 of ~100	1 of 247
% PFAS Detected	100	97	Sampling in progress	Sampling in progress
Matrices sampled	Soil, GW, SW	GW, Leachate	Soil, GW, SW, WW Effluent	Influent, Effluent, Biosolids, RO Concentrate, GW MWs
Est. Completion Date	Early 2021	Early 2021	2021	Late 2021

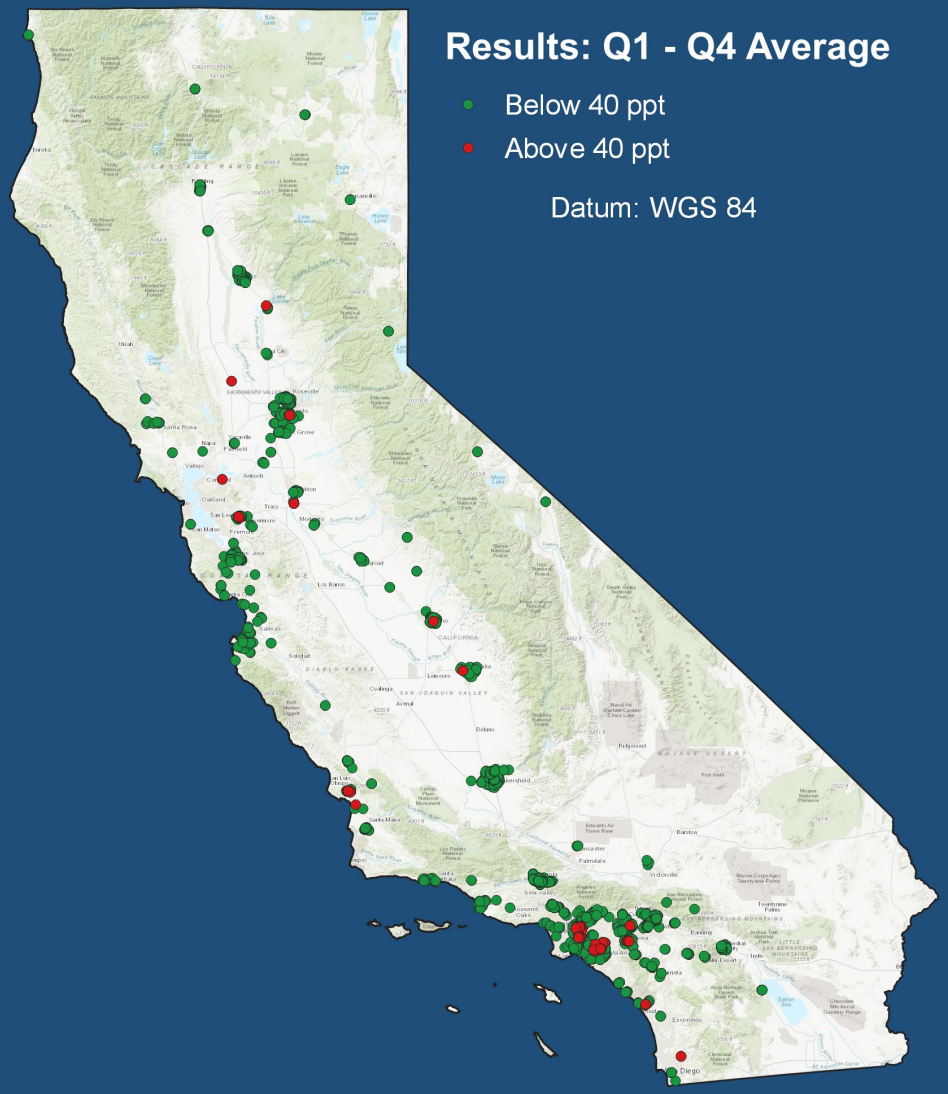
Division of Drinking Water Orders

- Monitoring Orders issued in March 2019 (~600 wells)
  - Adjacent to March 2019 DWQ orders (landfills and airports)
  - Adjacent to EPA's UCMR3 detections
  - 4 quarters of sample - **COMPLETE**
- General Order issued in September 2020 (~900 wells)
  - Expanding outward from previous detections
  - Incorporates AB756 H&S Code 116378 requirements
  - Ongoing quarterly sampling
- Next action planned for Early 2021 to address DoD sites (off base ~400 wells). DWQ is handling on base military owned sites.
- Future actions informed by data collected at POTWs, Cr plating facilities, and Bulk Fuel Terminals/Refineries

PFOA Sampling in California: Public Water Supply Wells, QRAA Data



PFOS Sampling in California: Public Water Supply Wells, QRAA Data



Public Water System 2019 Orders - *Highlights*

2,900
Sampling events in 2019 (Over 450 wells sampled voluntarily)

60%
of the Water Systems that tested reported PFAS detections

Aprox. 100
Water systems will report PFOA/PFOS above the RLs under a new monitoring order

9
PFOA, PFOS, and 7 other compounds being detected each quarter (same compounds detected in airports and landfill samples)

2
Short-chain PFAS analytes with high detections (>50%) not analyzed in the PWS samples

Drinking Water Treatment Technologies

Treatment Type	Percentage Reduction	Effectiveness
Anion Exchange Resin (IX)	90 - 99%	High
High Pressure Membrane (Reverse Osmosis)	93 - 99%	High
Granular Activated Carbon (GAC)	89 - 99%	High
Novel Adsorbents	TBD	High* *based on limited data

Several projects underway – 3 permitted and 20+ pending

Drinking Water Treatment Plant Permits

- H&S Code 116550

"No person operating a public water system shall modify, add to or change his or her source of supply or method of treatment of, …unless the person first submits an application to the department and receives an amended permit …authorizing the modification, addition, or change in his or her source of supply or method of treatment."

- Establish appropriate treatment and operating conditions for contaminant removal from drinking water
- Technical evaluation of permit application including design, operations and monitoring plan, and compliance with all drinking water regulations
- Permit review process considers treatment applied and impacts to water system quality

Permit Timeline

- Time needed to issue permit is dependent on multiple factors
  - CEQA completion
  - Submittal and quality of all documents requested
- Streamlining our process
  - DDW interoffice coordination
  - Suggest PWS meet with DDW District Office early and regularly
  - Obtain comments on design and specifications before construction begins
  - Results of modeling, bench-scale, or pilot testing
  - Plan how treatment plant operations will integrate with all water system operations
    - Will multiple well operations be limited by treatment plant capacity?

PFAS in Ocean Discharges

- POTW PFAS Order included NPDES and WDR permittees of greater than 1MGD inflow
  - No current requirements for the mitigation of PFAS discharging into the ocean. However, after the data collected, permits will be updated for monitoring and the process of determining effluent discharge limits begins.
- Ocean Plan Updates
  - No planned revisions to the Ocean Plan to address PFAS
  - December 1, 2019, the State Water Board adopted the 2019 Triennial Review of the Ocean Plan. There are 22 issues identified in the 2019 Triennial Review. PFAS was not included in the 2019 Ocean Plan Review.
  - DWQ may consider adding in a PFAS issue in the 2021 Triennial Review of the Ocean Plan.

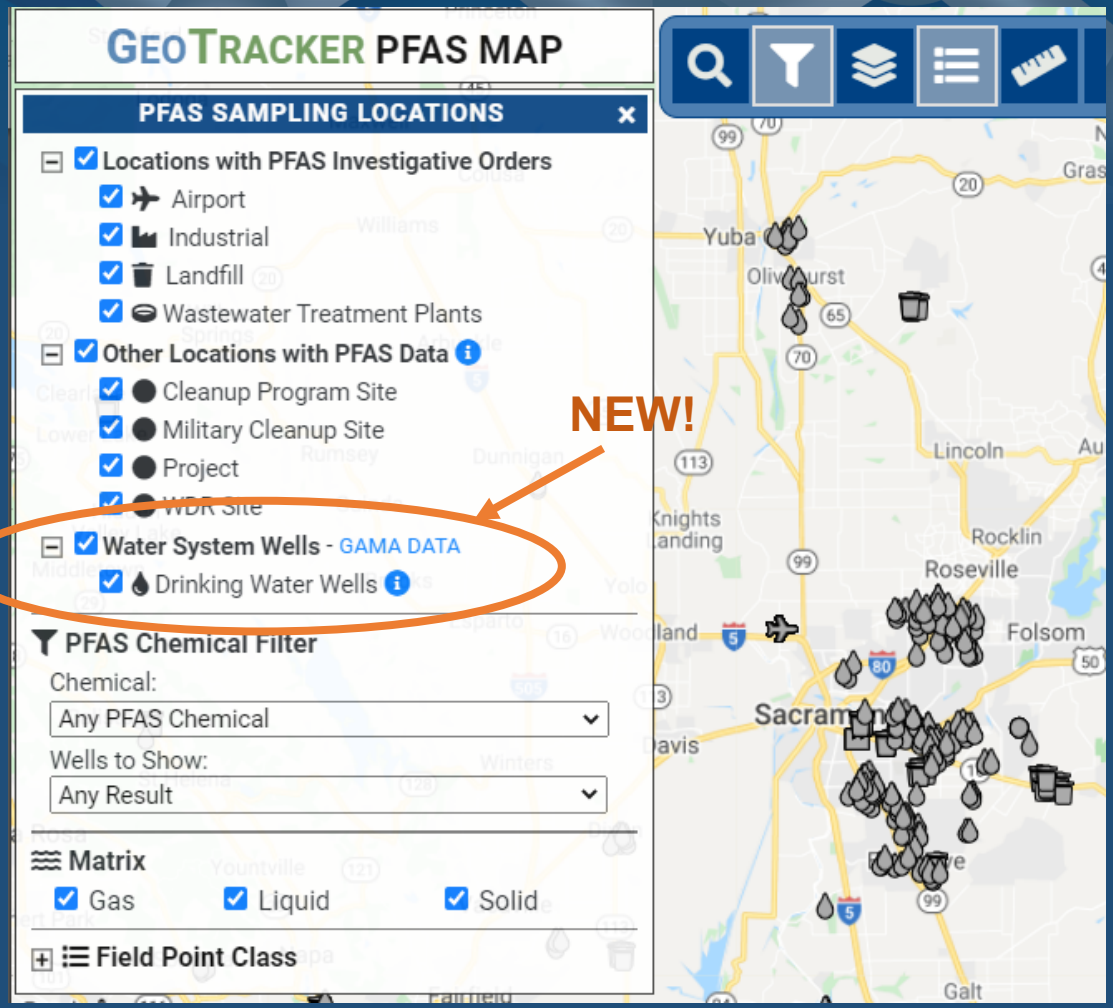
GeoTracker Mapping Tool

https://geotracker.waterboards.ca.gov/map/pfas_map

DATA SUMMARY - 842 SAMPLE POINTS FOUND - EXPORT

CHEMICAL	# WELLS SAMPLED	MAX VAL	UNITS	MATRIX		
PFOS	686	>62000	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFHxS	637	=1330000	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFOA	895	=79000	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFBS	637	=242000	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFHxA	697	=616000	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFHpA	874	=48700	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFNA	874	=19100	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]
PFDA	761	=146	NG/L	Liquid	[HIGHLIGHT]	[ZOOM]

Export all PFAS data for sites included in map view!



Resources

jeff.okeefe@waterboards.ca.gov

https://waterboards.ca.gov/pfas

https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/pfos_and_pfoa/pfas_ab756_factsheet.pdf

https://geotracker.waterboards.ca.gov/map/pfas_map

https://faast.waterboards.ca.gov/

Southern California Water Dialogue

PFAS Treatment Study Including Pilot Program at Orange County Water District

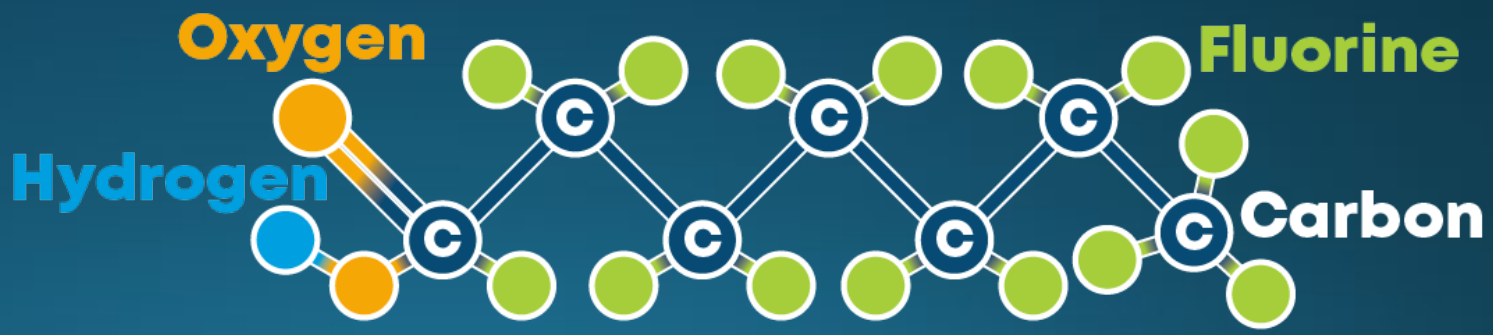
Megan H. Plumlee, Ph.D., P.E., Orange County Water District

01/27/2021

Introduction to PFAS

What Are PFAS, PFOA & PFOS?

- PFAS = Per- and Polyfluoroalkyl Substances **(family of 1000s of chemicals)**
- PFOA = Perfluorooctanoic Acid ($C_8HF_{15}O_2$)
- PFOS = Perfluorooctane Sulfonate ($C_8HF_{17}O_3S$)



Wide Range of Historical PFAS Uses

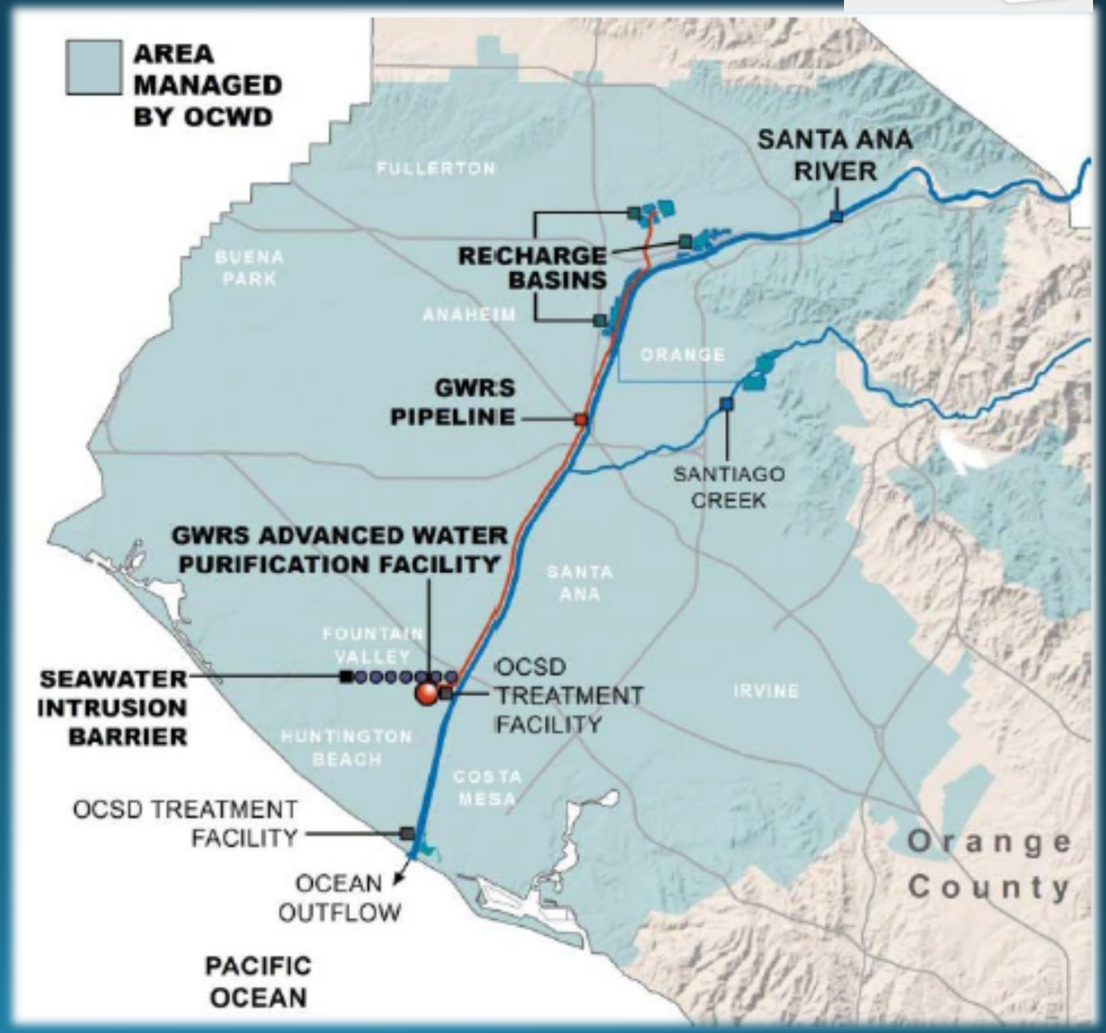
Commercial and Consumer Products Containing PFAS:

- paper and packaging
- clothing and carpets
- outdoor textiles and sporting equipment
- ski and snowboard waxes
- non-stick cookware
- cleaning agents and fabric softeners
- polishes and waxes, and latex paints
- pesticides and herbicides
- hydraulic fluids
- windshield wipers
- paints, varnishes, dyes, and inks
- adhesives
- medical products
- personal care products (for example, shampoo, hair conditioners, sunscreen, cosmetics, toothpaste, dental floss)

PFAS Impact on OCWD in Orange County, California

Orange County Water District (OCWD)

- OCWD was formed in 1933 to
  - Manage the OC Groundwater Basin
  - Protect rights to Santa Ana River water
- Provide groundwater to
  - 19 municipal and special water districts
  - 2.5 million residents
- Basin provides 77% of the water supply for north & central OC

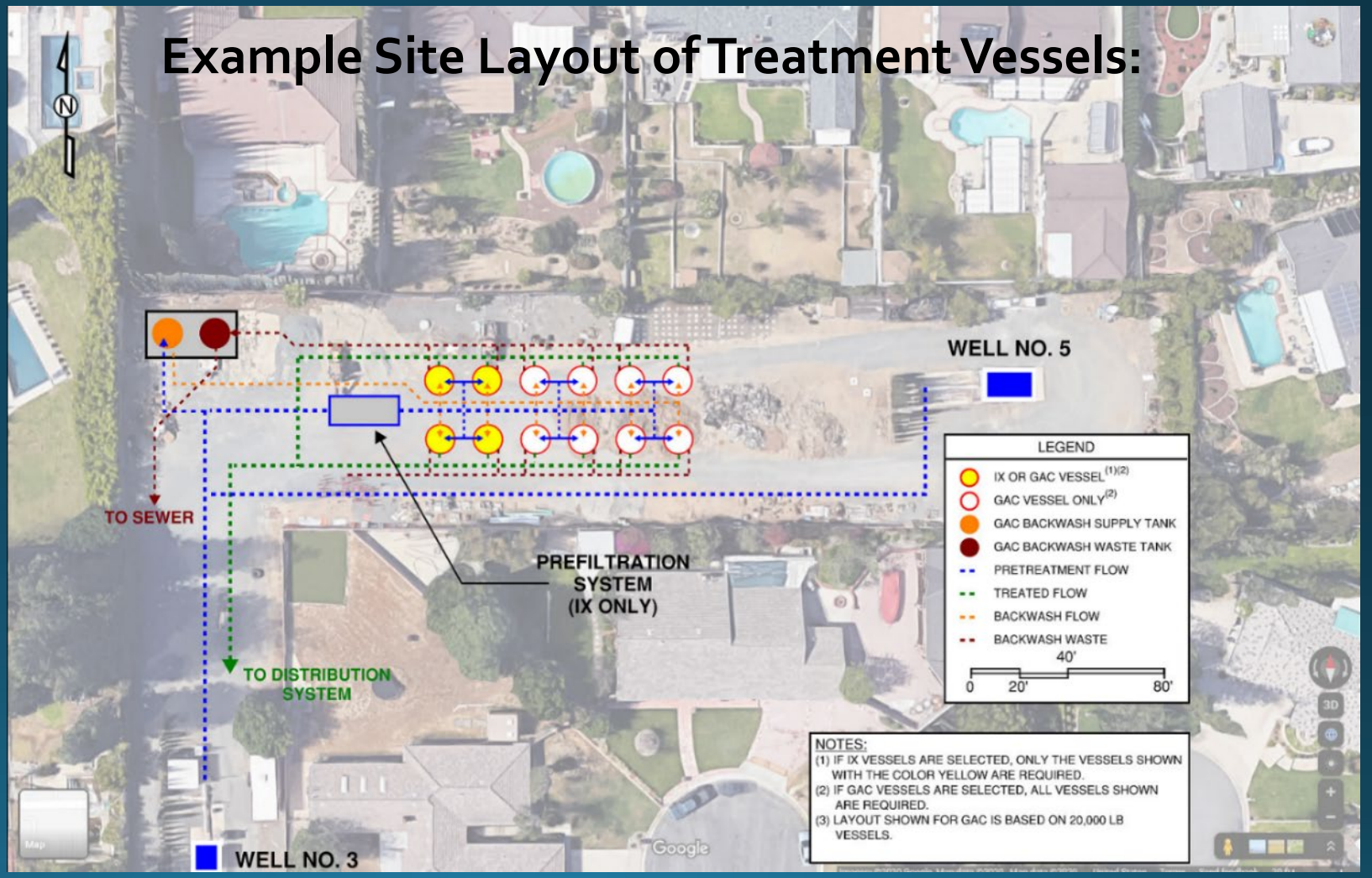


Sources of PFAS to the Nation's Drinking Water Supplies

* *Diagram references generally-recognized sources of PFAS and is not meant to depict Orange County's PFAS contamination or sources.*

To Restore our Drinking Water Source – Design of Groundwater Treatment Systems is Underway

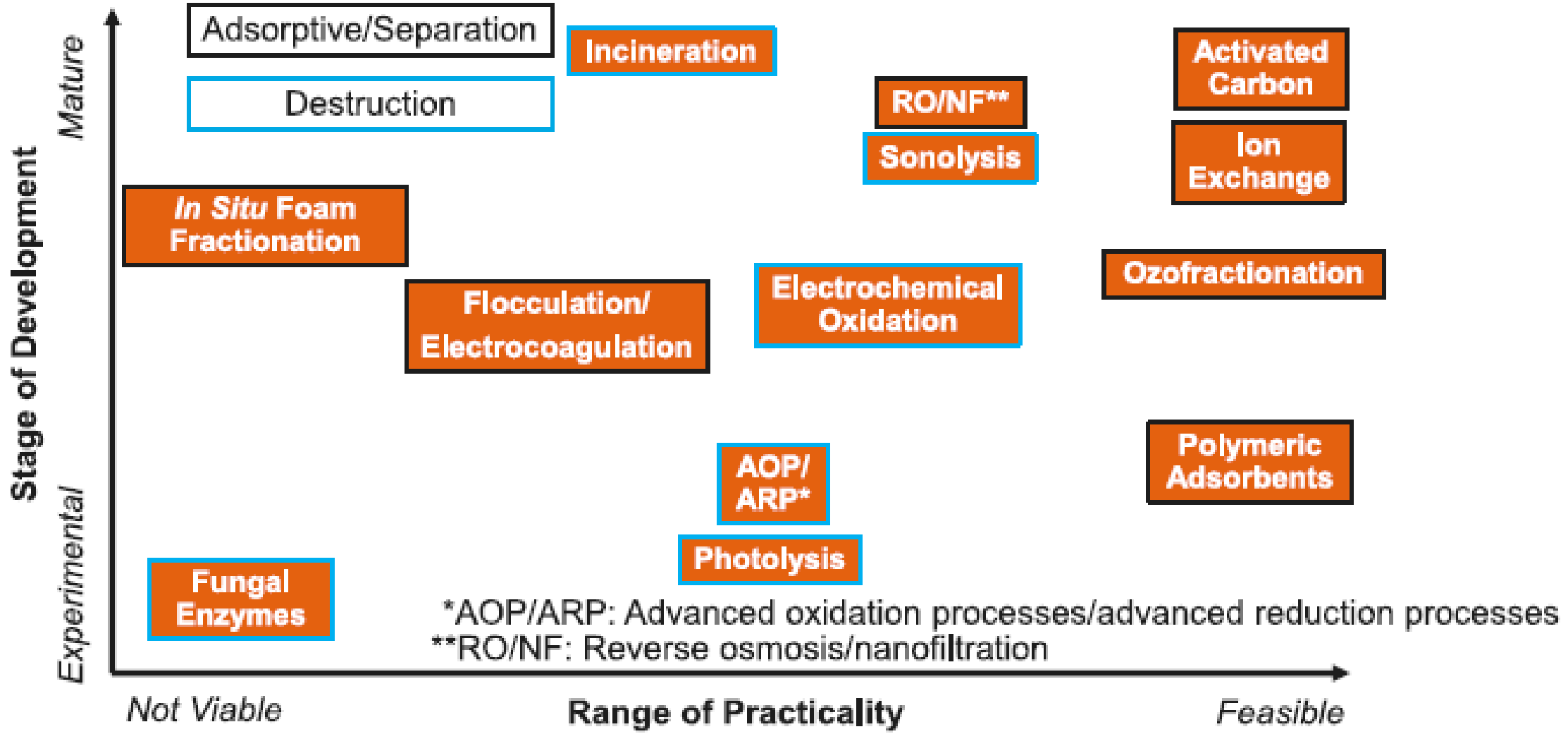
- OCWD is a groundwater wholesaler; we serve 19 local water retailers/districts
- OCWD supporting design/ construction of PFAS treatment for 10 impacted water retailers
- OCWD funding capital costs and 50% of O&M
- Goal: bring online within 1 to 3 years
- OCWD PFAS Treatment Study in parallel to inform design



Treatment Study to Select Technology

PFAS Treatment Technologies for Water

Reference: Ross et al., 2018



PFAS Treatment Study at OCWD

Granular Activated Carbon (GAC)

Ion Exchange (IX) Resin

Alternative Adsorbents

- OCWD objective:
  - Meet California's PFAS water quality guidelines in order *to ensure water quality and promote public health*
- Treatment study objectives:
  - Determine which adsorbent(s), to be used in treatment vessels, would best remove PFAS, and for the best value for the community

PFAS Treatment Study at OCWD

Granular Activated Carbon (GAC)

Ion Exchange (IX) Resin

Alternative Adsorbents

- Study tested various adsorbent products at ***lab*** and ***pilot*** scale

JACOBS®

BATTELLE

It can be done

PFAS Treatment Study at OCWD

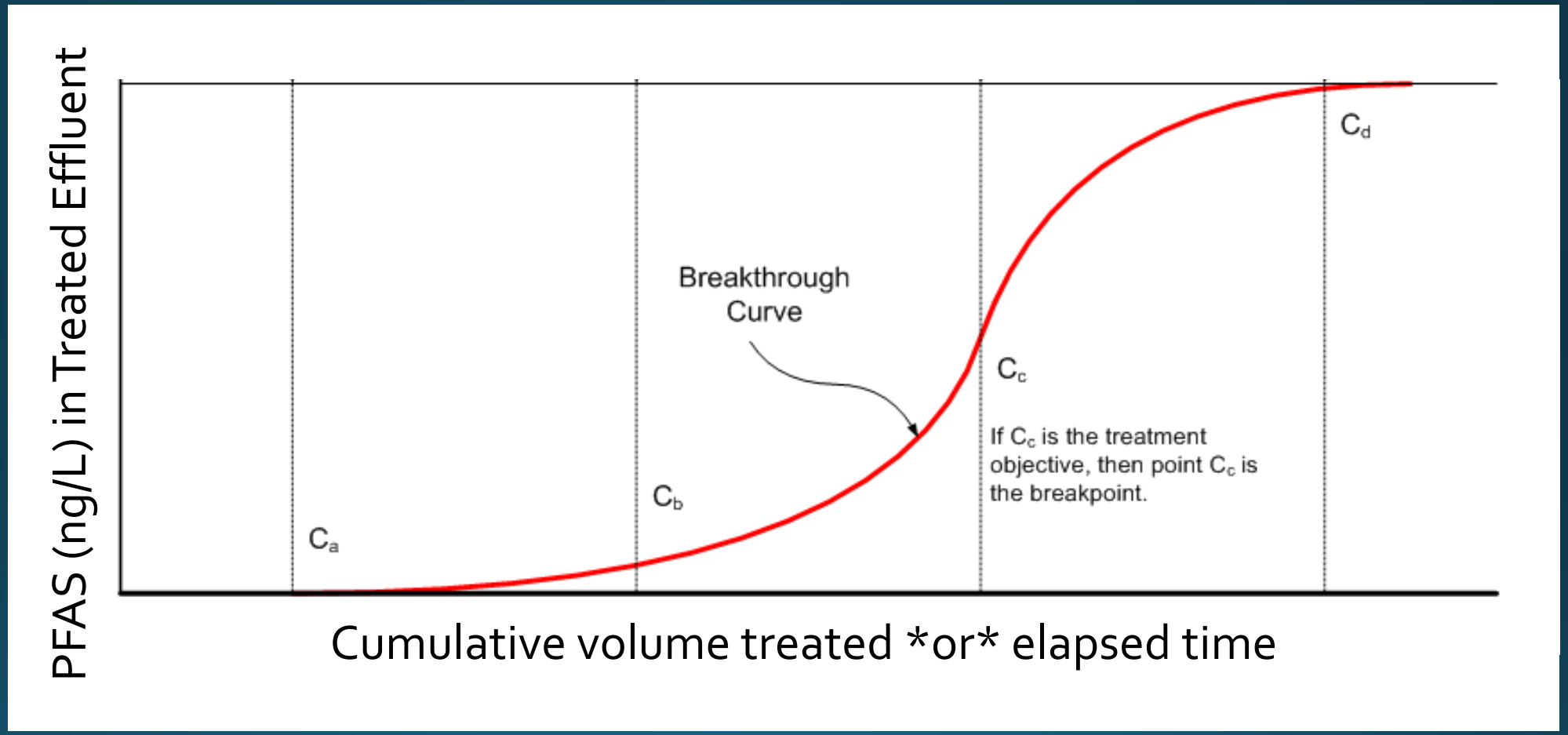
Granular Activated Carbon (GAC)

Ion Exchange (IX) Resin

Alternative Adsorbents

- Laboratory-scale: **rapid**
  - Rapid small-scale column testing (RSSCT) for 8 crushable adsorbents: 7 GACs and 2 novels (1 novel each round), for **10** different groundwaters
- Pilot-scale test **slow**
  - **1** groundwater
  - 8 GAC, 4 IX, 2 novels

Data from pilot or lab columns = PFAS "breakthrough" curve



Using this information (breakthrough curves from lab and/or pilot-scale) to project full-scale breakthrough curve, including in a lead-lag configuration (i.e., two adsorbent beds in series)

PFAS Treatment Pilot Test

PFAS Pilot Test

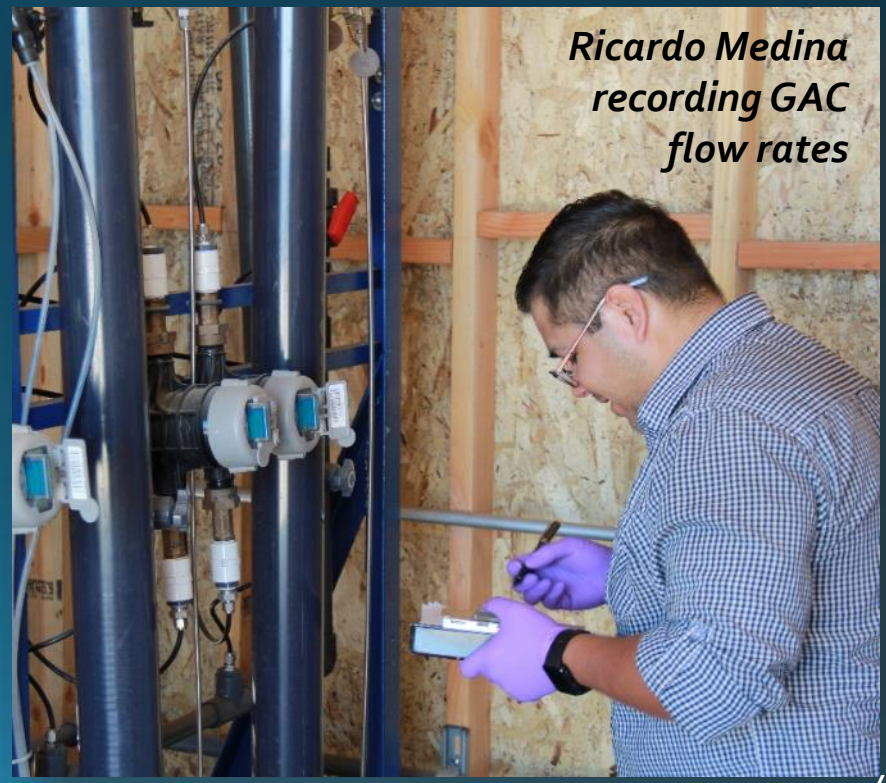
- Pilot★adjacent to OCWD-owned non potable well in Anaheim that supplies the water

PFAS Detected in Pilot Influent (groundwater)	Mean (ng/L)
PFOA *(long-chain)*	16
PFOS *(long-chain)*	23
PFHxS *(long-chain)*	11
PFBS *(short-chain)*	15
PFHxA *(short-chain)*	3

PFAS Pilot Test – GAC, IX, Novel

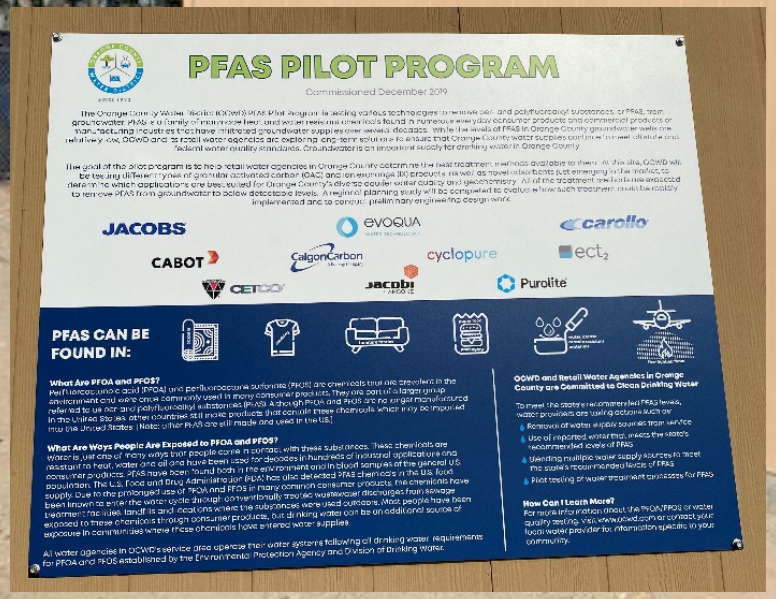
Pilot Adsorbents	No. Products Tested	Empty Bed Contact Time (EBCT)	Supplier(s)/ Manufacturers
GAC	8	10 min	Cabot, Calgon, Evoqua, Jacobi
IX	4	2 min	Calgon, ECT2, Evoqua, Purolite
Alternative (Cyclodextrin-based media)	1	5 min	Cyclopure (DEXSORB+)
Alternative (Surface-mod. bentonite)	1	2 min	Cetco (FLUORO-SORB 200)

Pilot commissioned December 2019



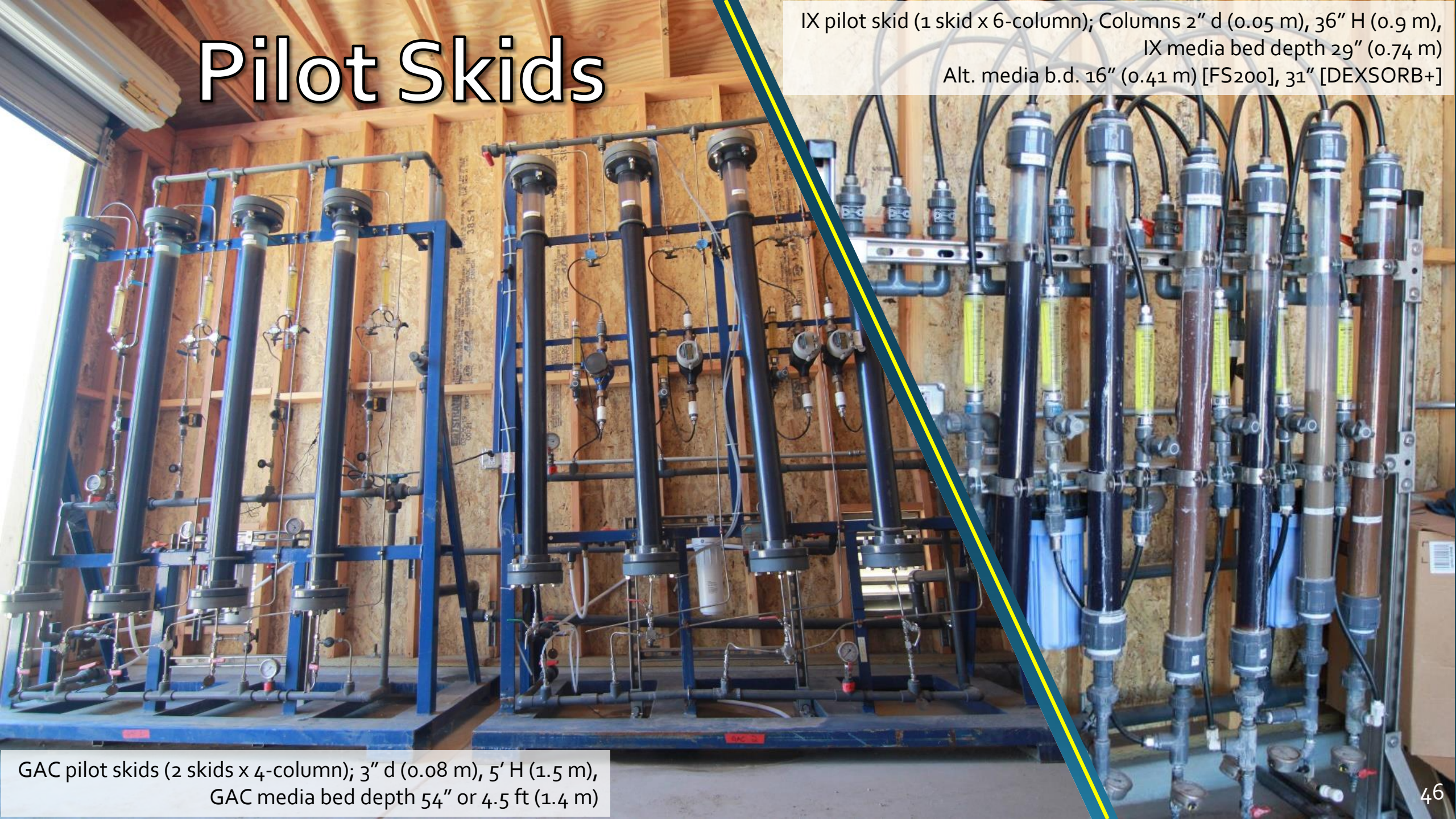
Ricardo Medina recording GAC flow rates

Installed pre-fab building to house pilot



***lab-scale testing performed in parallel**

Pilot Skids

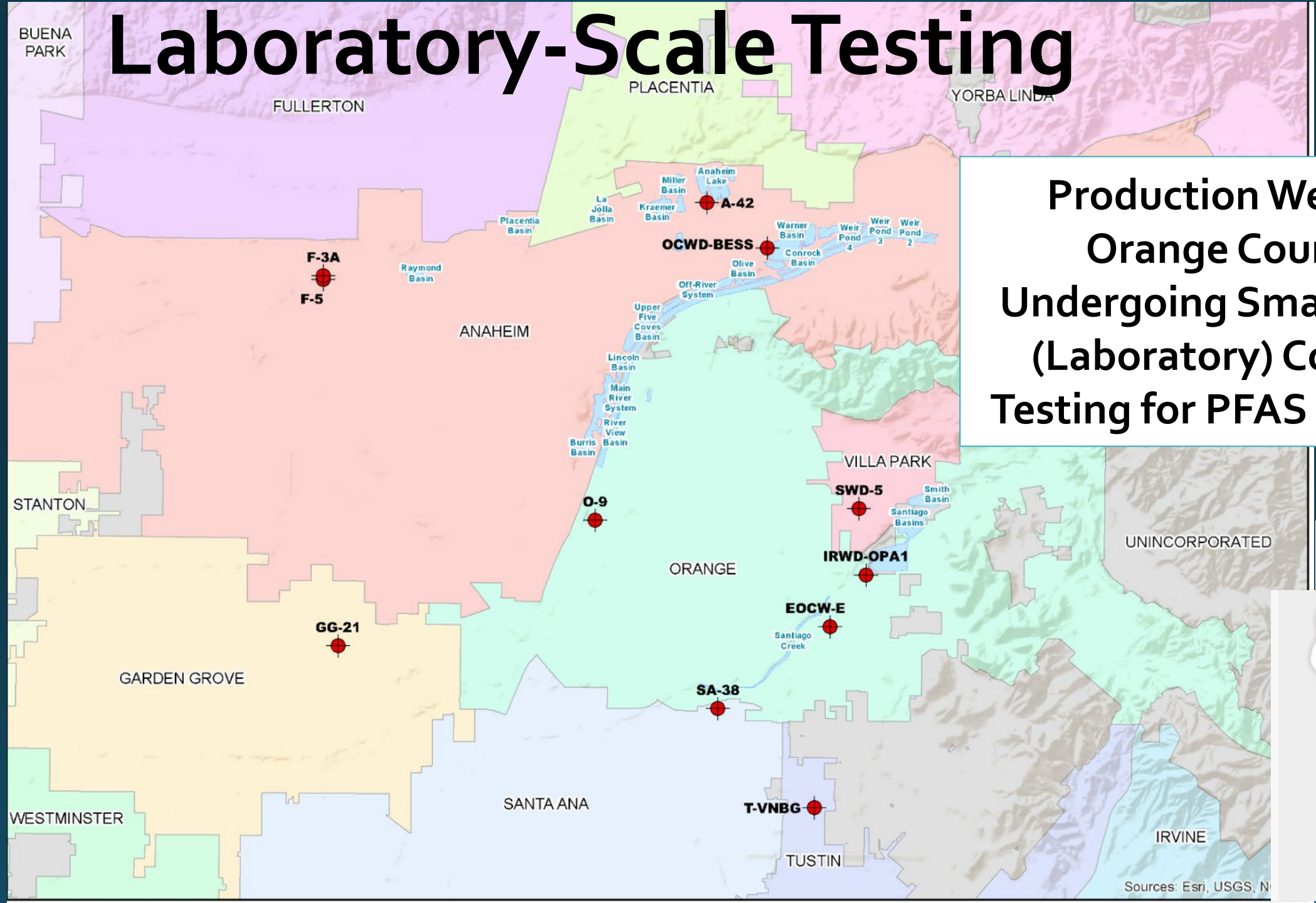


IX pilot skid (1 skid x 6-column); Columns 2″ d (0.05 m), 36″ H (0.9 m),
IX media bed depth 29″ (0.74 m)
Alt. media b.d. 16″ (0.41 m) [FS200], 31″ [DEXSORB+]

GAC pilot skids (2 skids x 4-column); 3″ d (0.08 m), 5′ H (1.5 m),
GAC media bed depth 54″ or 4.5 ft (1.4 m)

PFAS Treatment Lab-Scale Test

Laboratory-Scale Testing



Production Wells in Orange County Undergoing Small-Scale (Laboratory) Column Testing for PFAS (GAC + novel)

Project Status Update – RSSCT (Lab Testing)

Round	Water Source Treated by GAC /Novel Adsorbents	Media Tested by RSSCT
1	OCWD Bessie Well	7 GACs and 1 alt. adsorbent
2	Serrano Water District	
3	Anaheim	
4	Fullerton, Rd 1	
5	Fullerton, Rd 2 (with VOCs spiked)	3 GACs
6	Santa Ana	3 GACs and 1 alt. adsorbent
7	Tustin	
8	Orange	2 GACs and 2 alt. adsorbents
9	Garden Grove	
10	IRWD	3 GACs and 1 alt. adsorbent
11	EOCWD	1 alt. adsorbent
12	OCWD Bessie Well	1 GAC and 2 alt. adsorbents

LAB (Battelle, Ohio)

Rapid Small-Scale Column Testing (Lab)

- For crushable media (GAC and alternative adsorbents), to predict full-scale performance
  - Identify longest-lasting media and estimate life (convert PFAS breakthrough that occurred in weeks to months at full-scale)
- Data interpretation in progress
- Preliminary results show different DOC impacts depending on DOC's *character*

0.7 cm diameter
1.0 - 3.4 cm bed depth

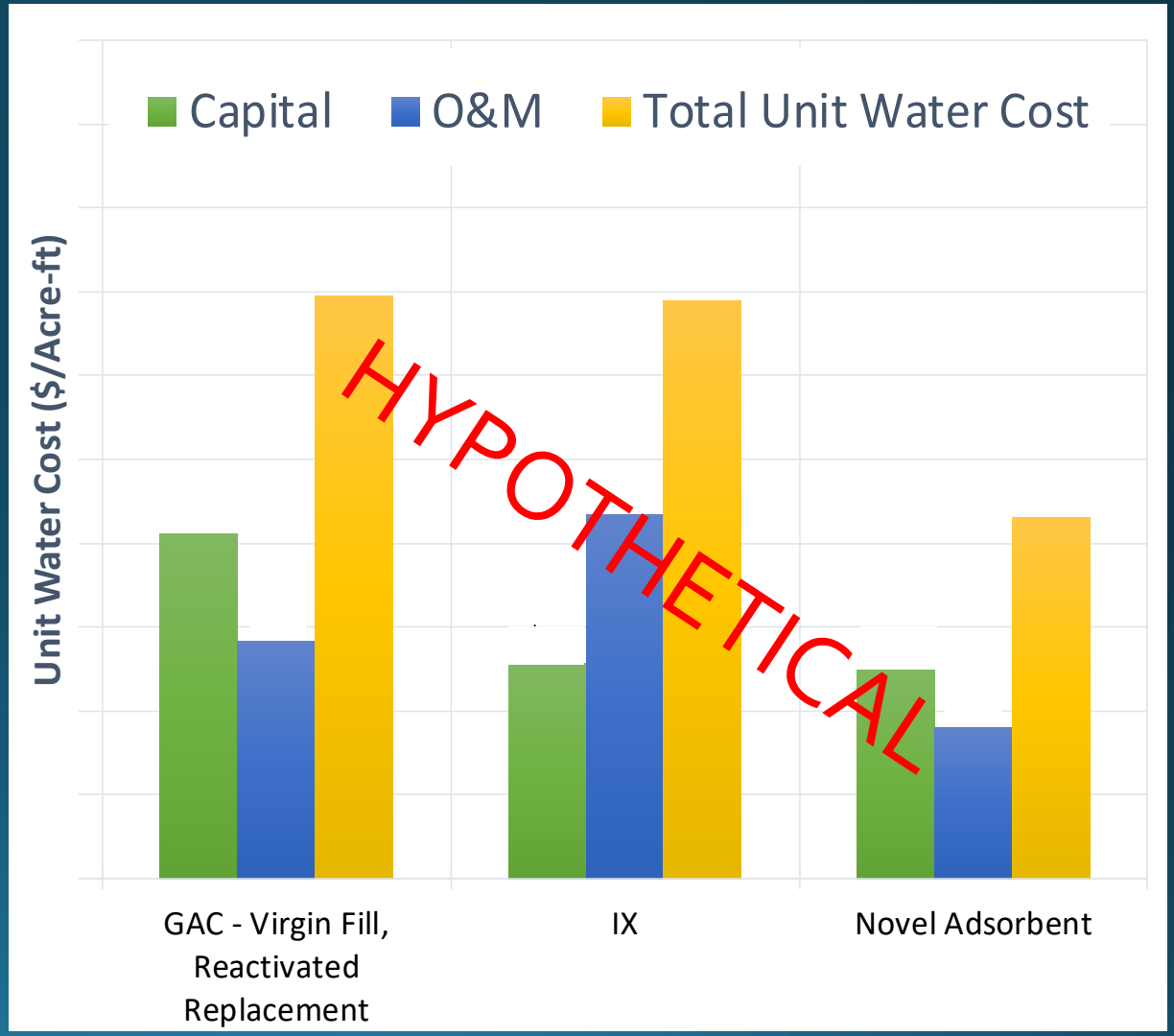
Unit Cost Analysis – In Progress

- Unit cost analysis:

  $/acre-ft = capital + O&M

- Compare GAC, IX, and novel media as well as membrane treatment

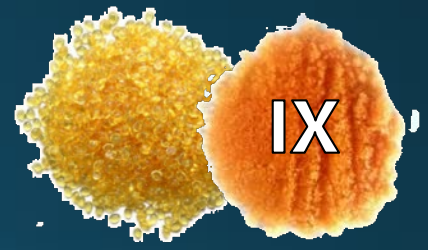
- Depends on:
  - Media bids ($/lb)
  - Media life (per RSSCT and pilot findings)
  - Key engineering assumptions



Summary of Findings (Preliminary)

Preliminary Conclusions

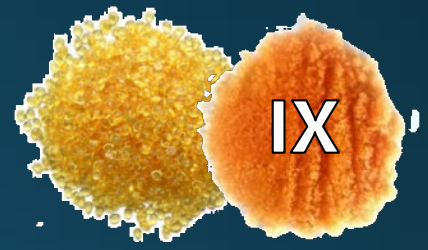
- All adsorbents tested can successfully remove PFAS to meet California water quality guidelines to ensure water quality and promote public health
- Site-specific testing (bench or pilot) useful to select adsorbent: we saw certain GAC, IX, and alternative adsorbents emerge as superior
- All of these removed PFAS from water, but performance (i.e., *lifetime* between media change-outs) varied (dramatically) by product. A few months longer life = $$$ annual O&M savings.



Preliminary Conclusions

- Short chain PFAS: from pilot, all 4 IX products outperformed all 8 GAC products with respect to PFBS breakthrough (i.e., earlier breakthrough for GAC) vs. mixed results for PFHxA

- Alternative adsorbents: Encouraging results though varies by product; could be very promising for low-footprint (akin to IX) and long-life removal of PFAS



Per- and Polyfluoroalkyl Substances (PFAS) on an Agency Level

Craig Miller, General Manager

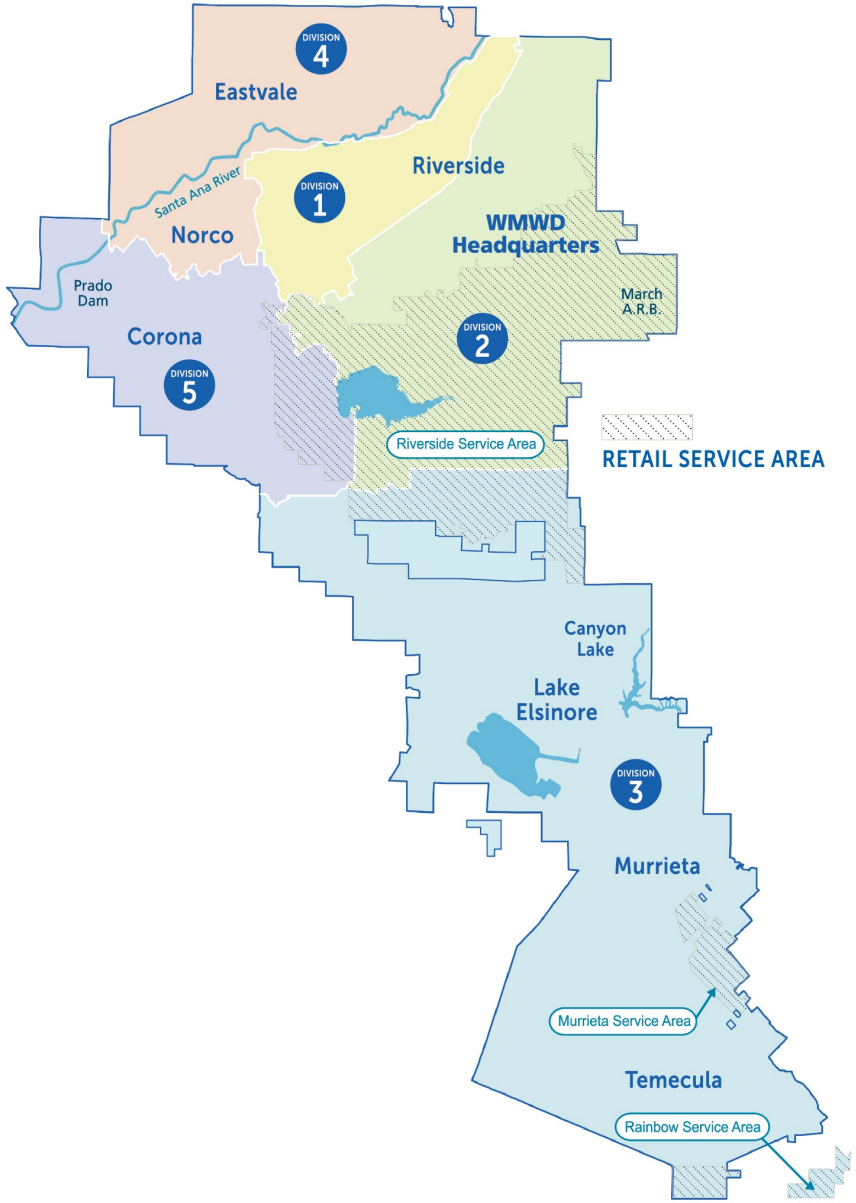
January 27, 2021

Overview

- About Western
- PFAS in Western's sewer
- Local challenges
- Key Takeaways

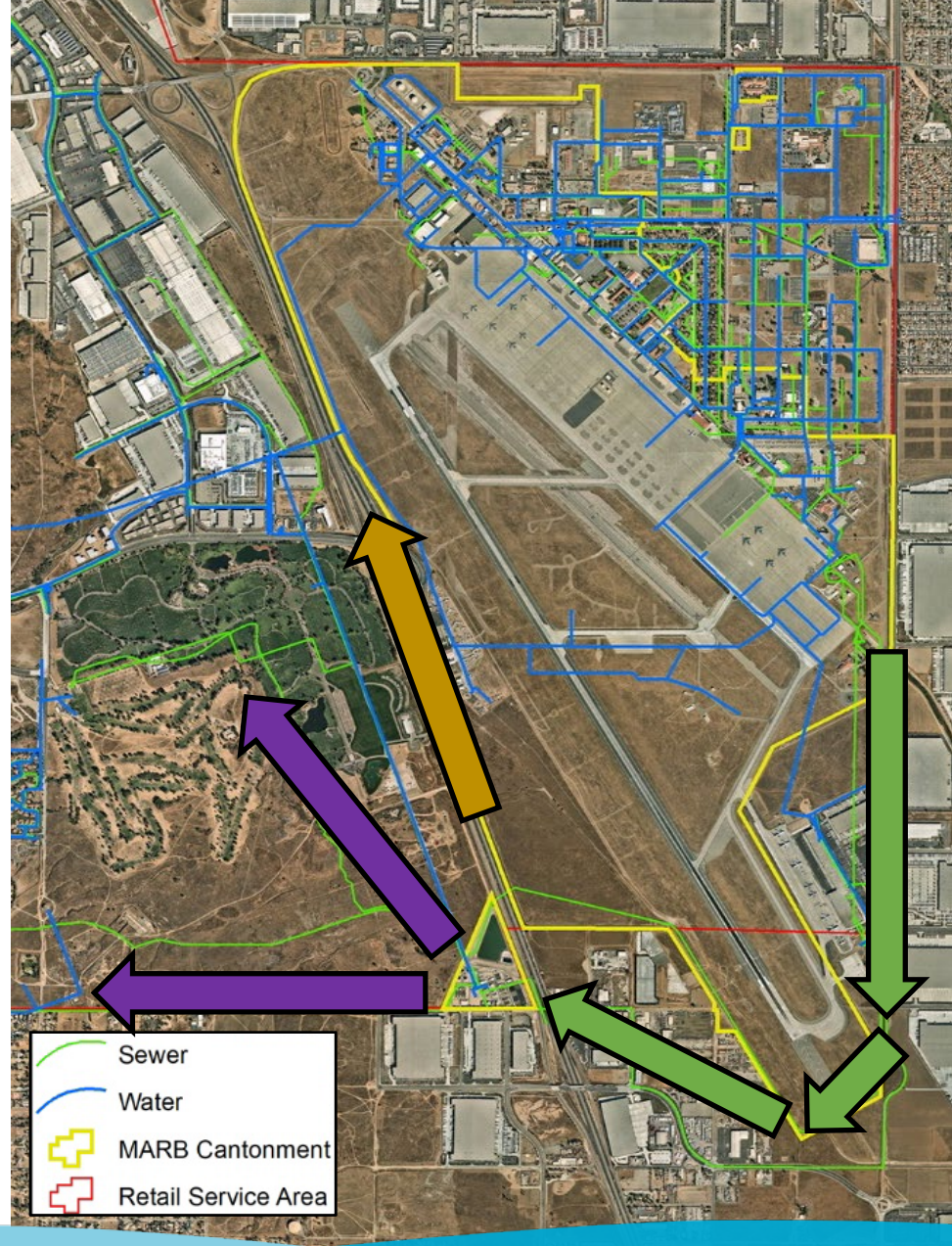
Western's Service Area

- Providing water & wastewater to nearly 1 million people
- Serving 25,000+ retail connections
- Partnership of 13 agencies with 8 wholesale customers
- Member agency of the Metropolitan Water District of Southern California



Reserve base: PFAS in sewer

- Western serves local reserve base
- 100+ year old infrastructure
- Western Water Recycling Facility (WWRF) captures and treats, but not for PFAS
  - Application in for grant funding for GAC treatment
- Recharge to groundwater basin
- Discharges to large recycled water users
- Solids go to landfill

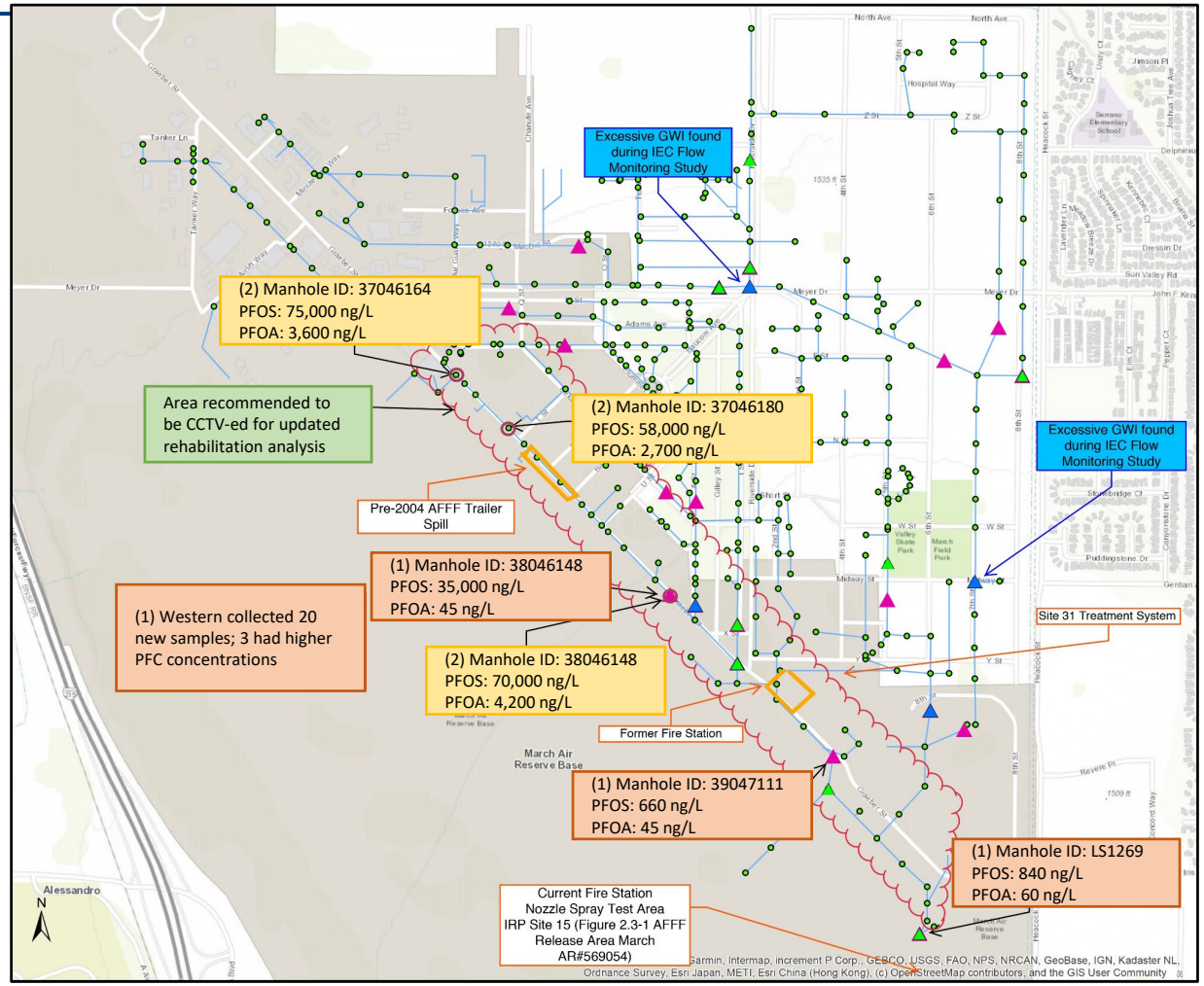


PFAS levels coming into sewer system

ORANGE (1) = The highest levels in 2019
- PFOS: 35,000; 660; and 840 ng/L (PPT)
- PFOA: 45; 45; and 60 ng/L

YELLOW (2) = Recent 2020 results
- PFOS: 75,000; 58,000; and 70,000 ng/L
- PFOA: 3,600; 2,700; and 4,200 ng/L

U.S. EPA health advisory level: 70 PPT for PFOS and PFOA



Impacts to future projects

- Concept: Move recycled water from WWRF to Victoria Basin
- Currently water flow from Riverside Canal to Western through three pump stations
  - Pumps can allow flow to go in reverse
- System ready for recycled water replenishment in Victoria Basin
- Cannot move forward until PFAS treatment


Diamond Valley Lake


Markham Reservoir


Lake Mathews

Connecting the Drops: Victoria Recharge Basin

Connecting the Drops: La Sierra Pipeline

Connecting the Drops: Sterling Pump Station


Lake Mathews

1

City A

- 41 wells impacted
- Treatment currently keeps levels below notification and response levels

2

City B

- 11 wells impacted
- Treatment currently keeps levels below notification and response levels

3

Agency C

- 4 impacted wells
- Water loss of 10,000 GPM
- No alternative water supply
- Evaluating $50 million new connection to MWD
- Collaborating to use Western regional infrastructure
- Regional solution available

Key Takeaways

- Water quality regulations issues such as PFAS must be science-based
  - Example: Acetaminophen in the Santa Ana River
- Cost to treat versus health effects at parts per trillion
- Currently concerned that decision makers are bypassing regulatory process through legislation
- Agencies need to have time to implement solutions

Question and Answer

Southern California Water Dialogue

How to Ask a Question

Click “Q&A” on the bottom of your screen

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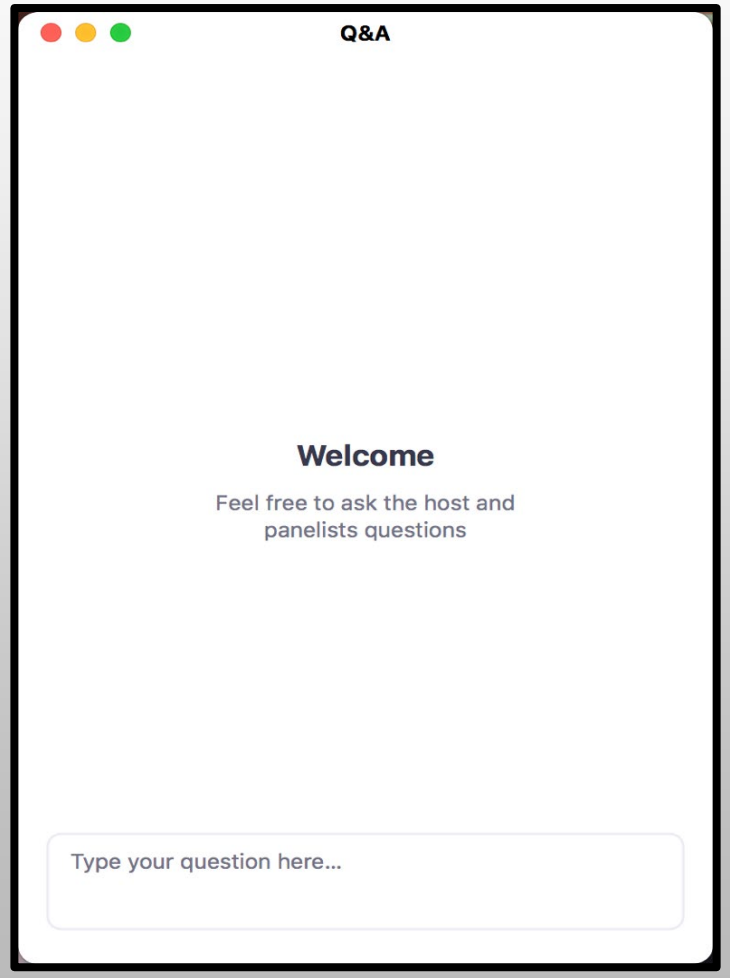
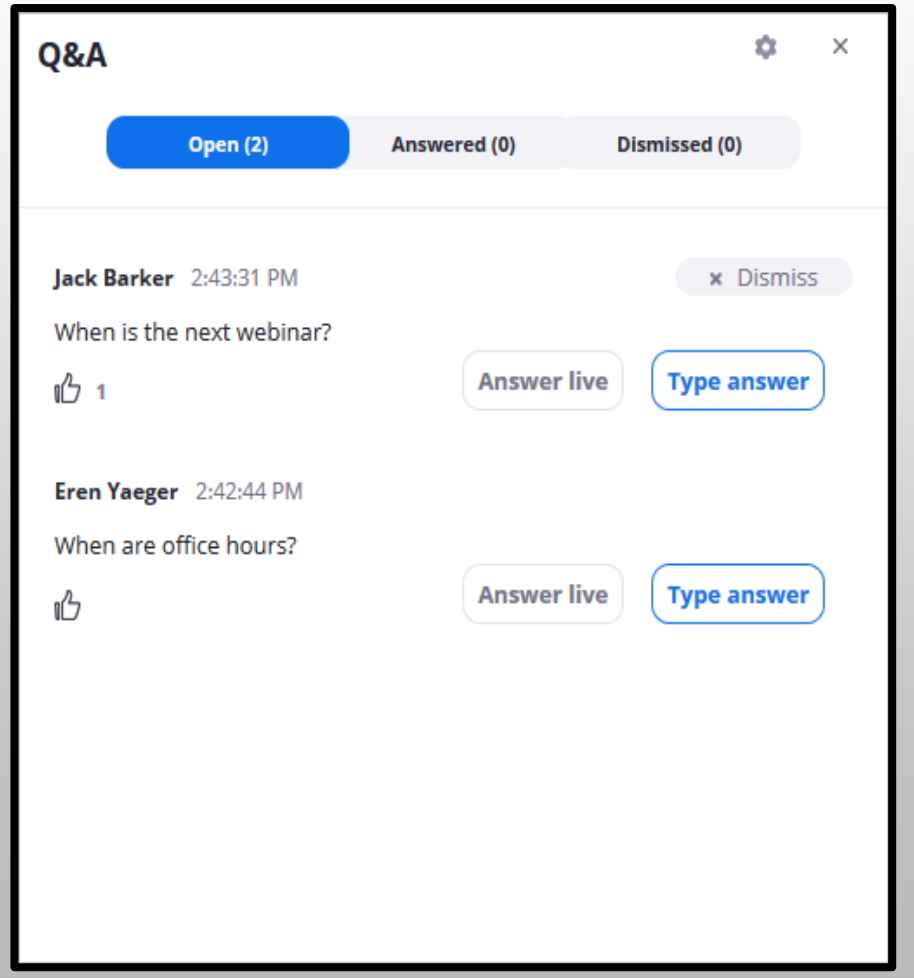
Type in question, then click send



You can upvote by clicking “thumbs up” icon



Southern California Water Dialogue

Next So Cal Water Dialogue Webinar

Wednesday February 24, 2021

12:00 noon – 1:30 pm

Topic:

"Water Tomorrow: Integrated Resource Planning Process Stakeholder Forum"

Your feedback on today's meeting is important to us.
For the next ten minutes, you can use the Zoom Chat feature to send us any comments.

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