FUTURE SUPPLY ACTIONS PROGRAM
WEBINAR SERIES

Reverse Osmosis: Pilot Studies Spotlight
December 7, 2021

One Water
THE METROPOLITAN WATER DISTRICT of SOUTHERN CALIFORNIA

CITY OF FULLERTON CALIFORNIA

ORANGE COUNTY WATER DISTRICT
SINCE 1933

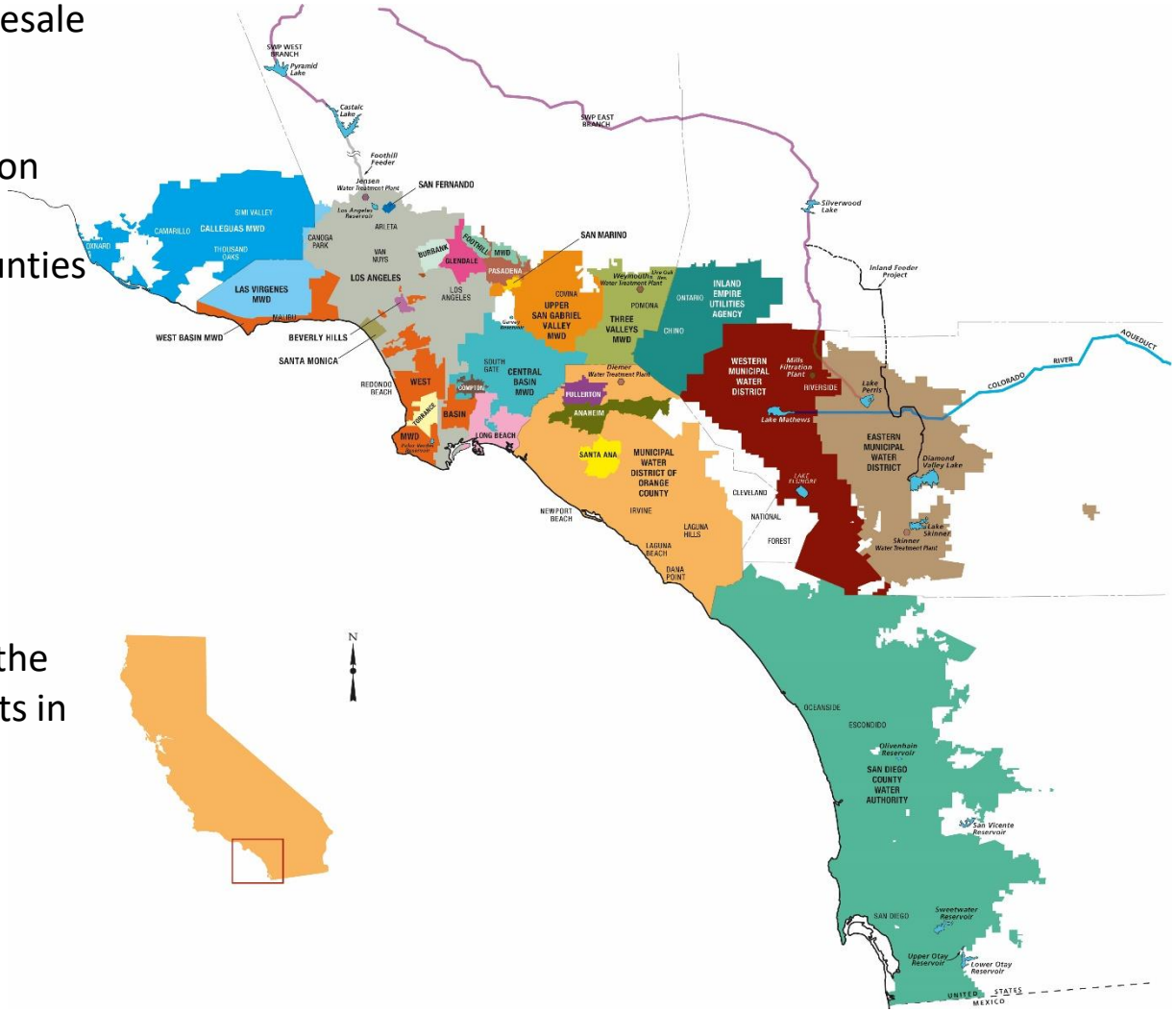
emwd EASTERN MUNICIPAL WATER DISTRICT

CDM Smith

Agenda

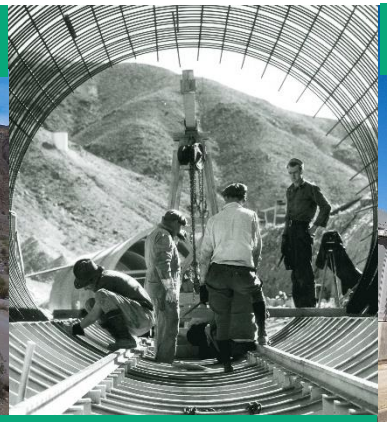
The Metropolitan Water District of Southern California

- Nation's largest wholesale water provider
- Service area: 19 million people/5,200 square miles/parts of six counties
- 26 member agencies
- Supports $1 trillion regional economy
- Imports water from Northern Sierra and the Colorado River, invests in local projects



Metropolitan's Role for Southern CA

REGIONAL PROVIDER

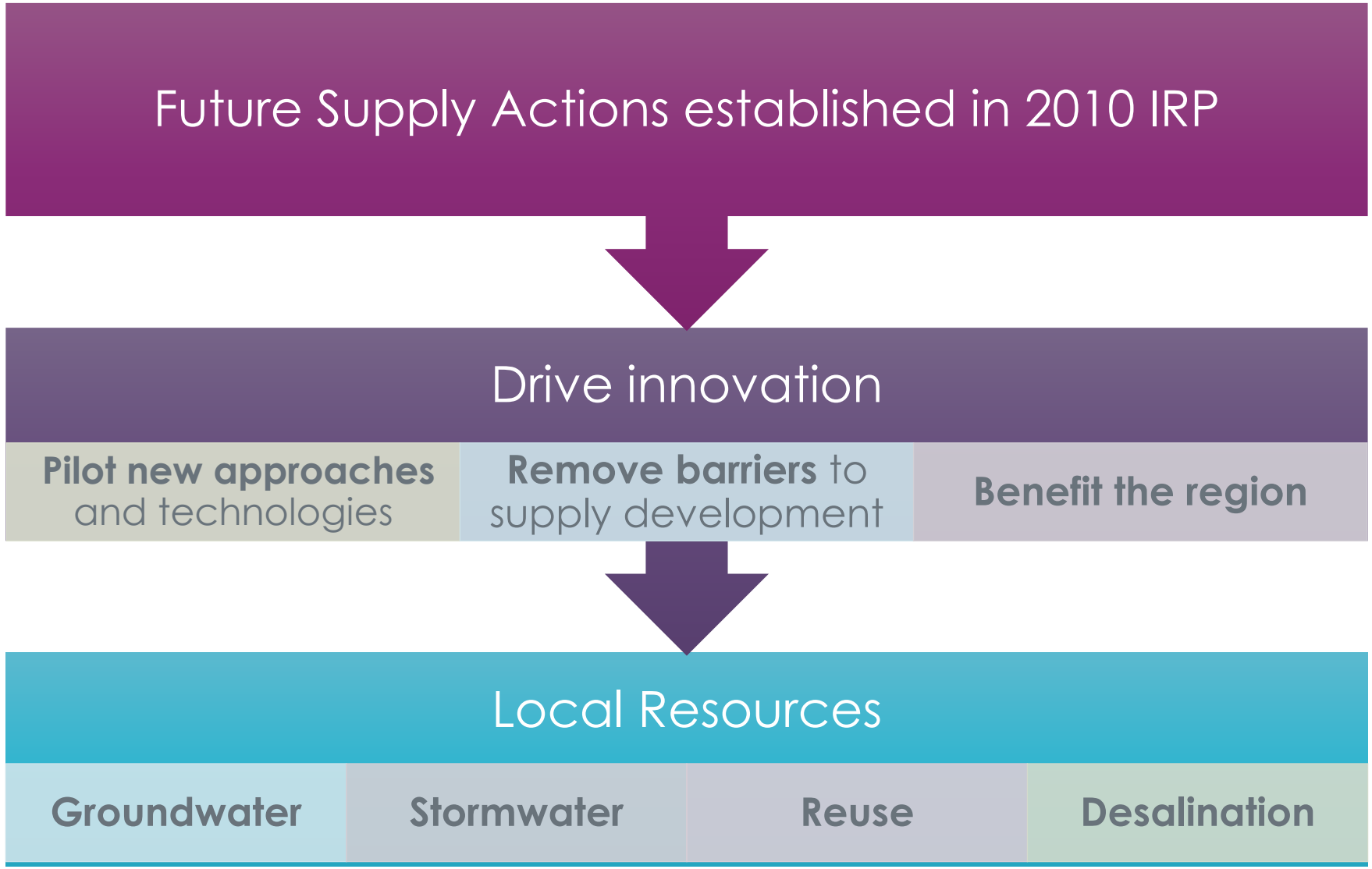


INNOVATION

VISION

SAFE & RELIABLE

Future Supply Actions Funding Program



Current Program

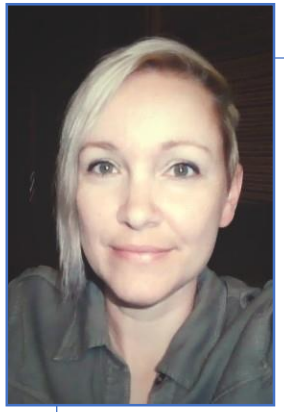
Member Agency

- 14 studies
- $3.1 million

Water Research Foundation

- 6 potable reuse studies
- 1 agricultural reuse study
- $975k

Speaker Spotlight



Megan Plumlee, Ph.D., P.E.

Research Director

Orange County Water District

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Orange County Water District

Demonstrating Virus Log Removal in Potable Reuse to Increase Regulatory Confidence

MWD Future Supply Actions
Program Webinar Series
December 7, 2021

Megan Plumlee and Julio Polanco
Orange County Water District

Acknowledgments

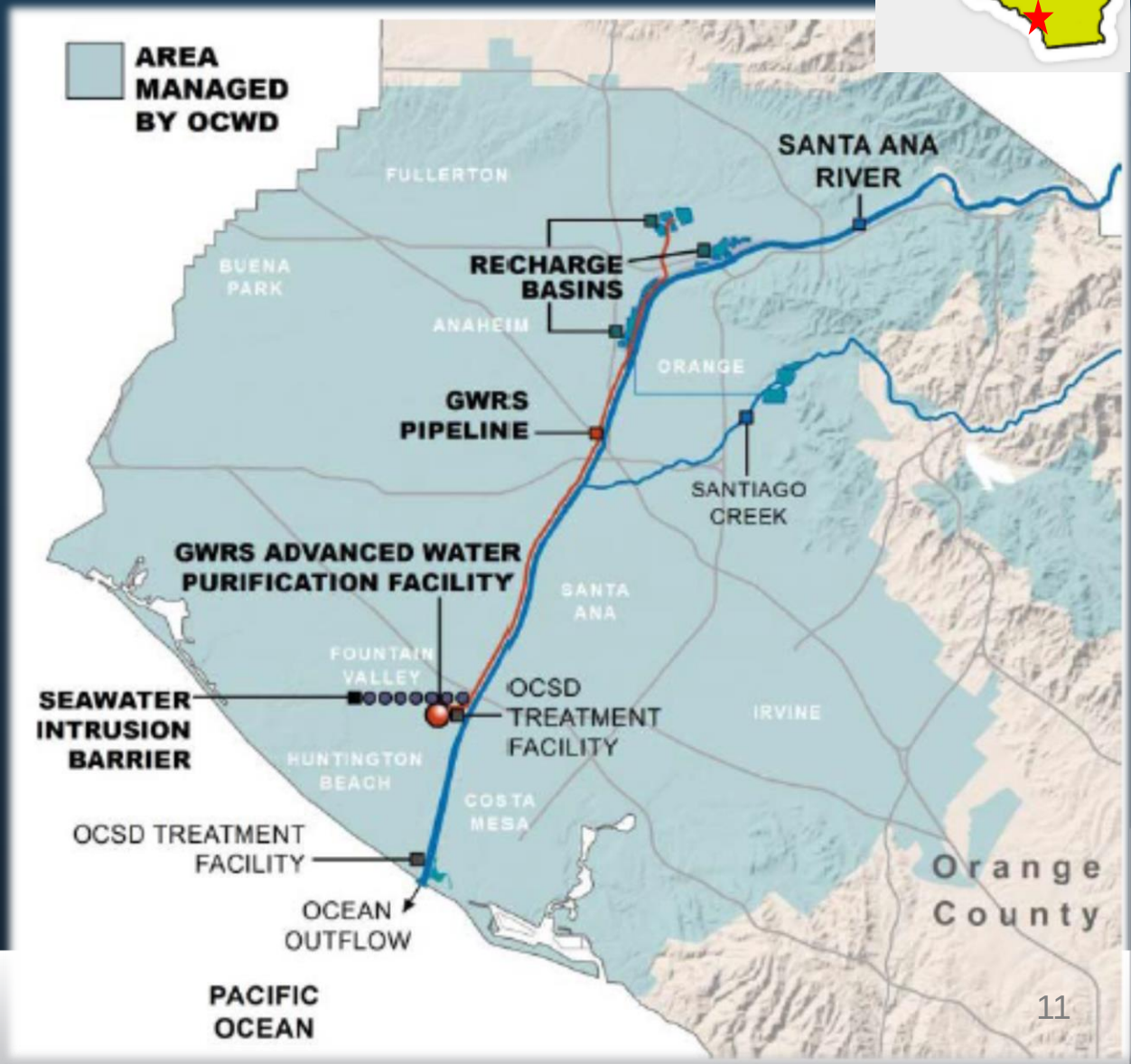
- Funding from MWD Future Supply Actions Funding Program, The Water Research Foundation (Project No. 5041), and the United States Bureau of Reclamation
- OC San staff and laboratory

Outline

- Background
- OC San Virus LRV Study
- RO LRV Study
- Q&A

Orange County Water District

- 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
- OCWD replenishes the groundwater basin via spreading ponds and injection wells



GWRS

- Operation since January 2008 for advanced water purification
- Largest potable reuse facility in the world (100 MGD)
- Provides a 103,000 acre-ft/yr source of water for nearly 850,000 OC residents

- Reclaims treated wastewater that would otherwise be wasted to the ocean, purifies it and recharges it to groundwater basin

GWRS Overview

OC San
Secondary Effluent

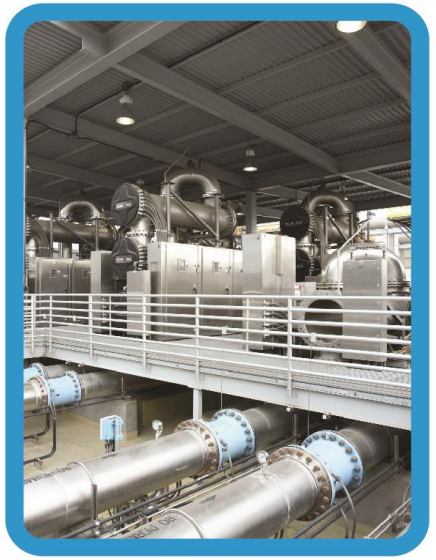
Microfiltration (MF)
Ultrafiltration (UF)

Backwash
Sent to OCSD

Reverse Osmosis (RO)

Concentrate Discharged
to OCSD Outfall

Ultraviolet Light (UV)
with Hydrogen Peroxide



Recharge Basins in Anaheim

Seawater Barrier

Summary of OCWD LRV Credit and Proposals

Pathogen (Log Reduction Required)	Log Reduction Attained by GWRS Treatment Process					
	OC San	MF+Cl_2	RO	UV/AOP	Underground Retention Time	Total
Current** / **New proposed as a result of this study						
Giardia (10)	0	4+	2+ / 3+ **	6	0	12+ / 13+
Cryptosporidium (10)	0	4+	2+ / 3+ **	6	0	12+ / 13+
Viruses (12)	0 / 0.7 (proposed) *	0	2+ / 3+ **	6	4	12+ / 13.7+

*Virus LRV credit proposed for OC San is pending DDW review of calculation options

**Increased RO LRVs based on enhanced monitoring (e.g., sulfate, strontium)

OC SAN VIRUS LRV STUDY

Study Background

- OCWD GWRS currently receives OC San Plant No. 1 blended secondary effluent from 3 parallel processes: AS1, AS2, and TF
- After GWRS Final Expansion (2023), OCWD GWRS will also receive OC San Plant No. 2 TF/SC effluent
- OCWD currently receives no virus LRV credit for OC San wastewater treatment process
- OC San LRV study focuses specifically on virus credit (not seeking additional *Giardia* / *Crypto* credit)

OC San LRV Study Objectives

- Obtain virus LRV credit for OC San wastewater treatment process

  1) Quantify virus and other microbial targets in raw influent and secondary effluents from Plant No. 1 and Plant No. 2 over 24 sampling events

  2) Calculate LRVs for each monitored treatment process using lognormal statistical modeling techniques

  3) Propose a 5th percentile virus LRV

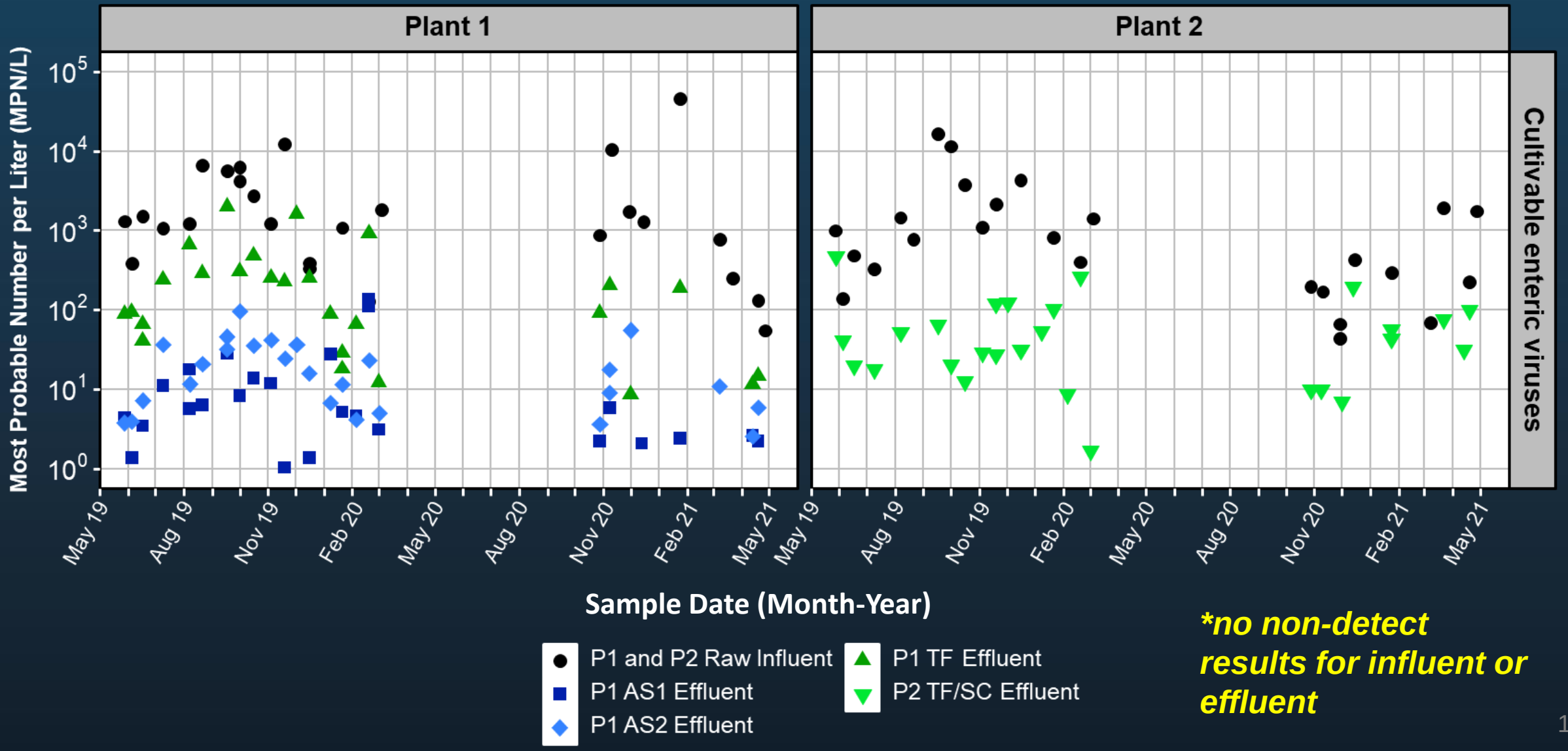
  4) Propose conditional Operating Range Values (ORVs) representing a normal operating envelope

Microbial Targets

Constituent	Analytical Method	Laboratory
Enteric viruses	EPA 1615 infectivity culture assay	Biological Consulting Services (BCS)
Enterovirus and Norovirus GII	EPA 1615 modified ddPCR[1]	Michigan State University (MSU)
Male-specific (MS) and somatic (SOM) coliphage	MS and SOM coliphage[2] by EPA 1602	Michigan State University (MSU)
Total coliform	Membrane Filter (MF) 9222B	OC San
Fecal coliform	Membrane Filter (MF) 9222D	OC San

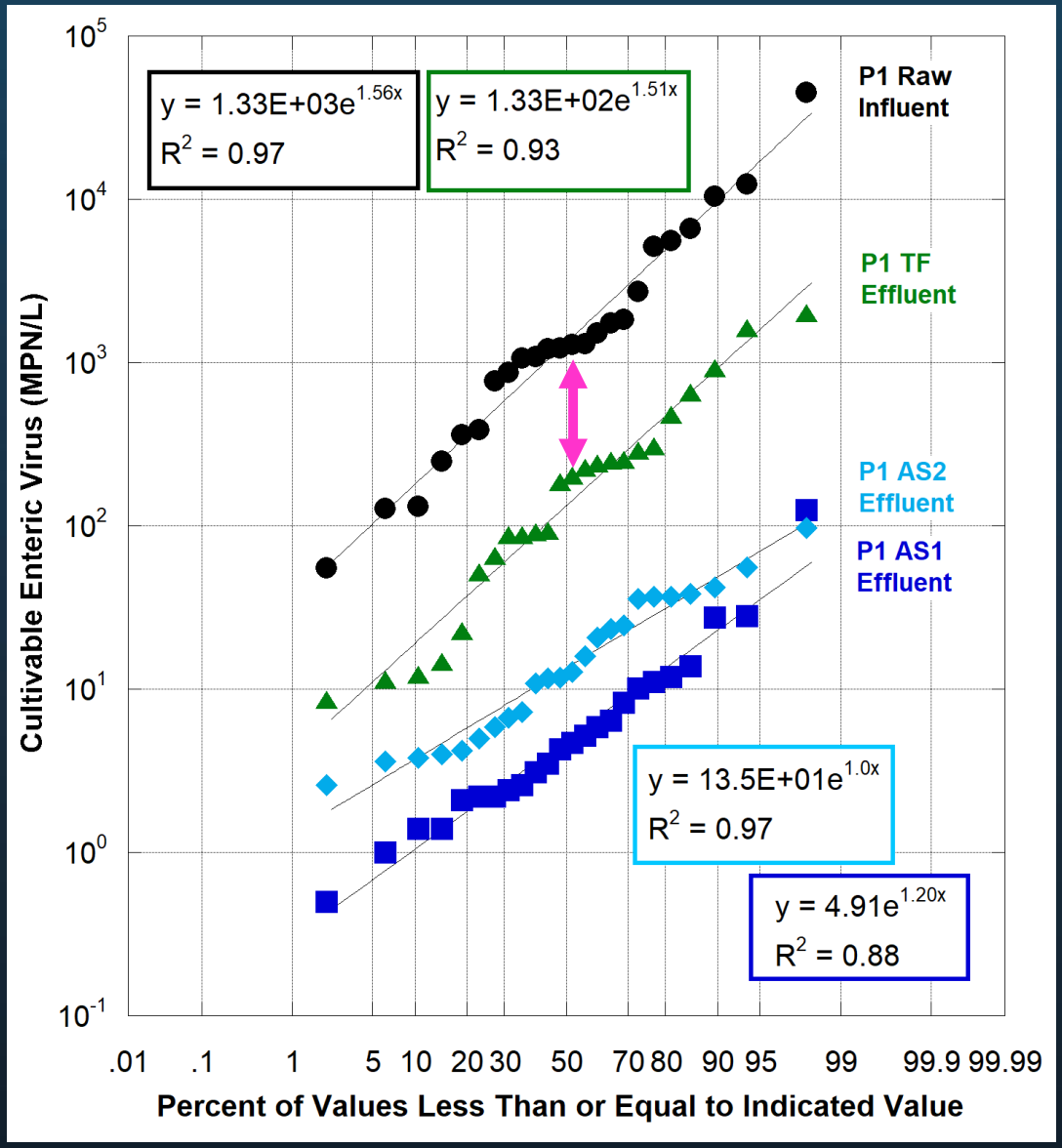
ddPCR = droplet digital polymerase chain reaction; MSU = Water Quality and Environmental Microbiology Laboratory at Michigan State University
(1) Enteric virus analysis with a modified ddPCR assay.
(2) EPA 1602 with double agar overlay modification.

Concentrations of Cultivable Enteric Viruses



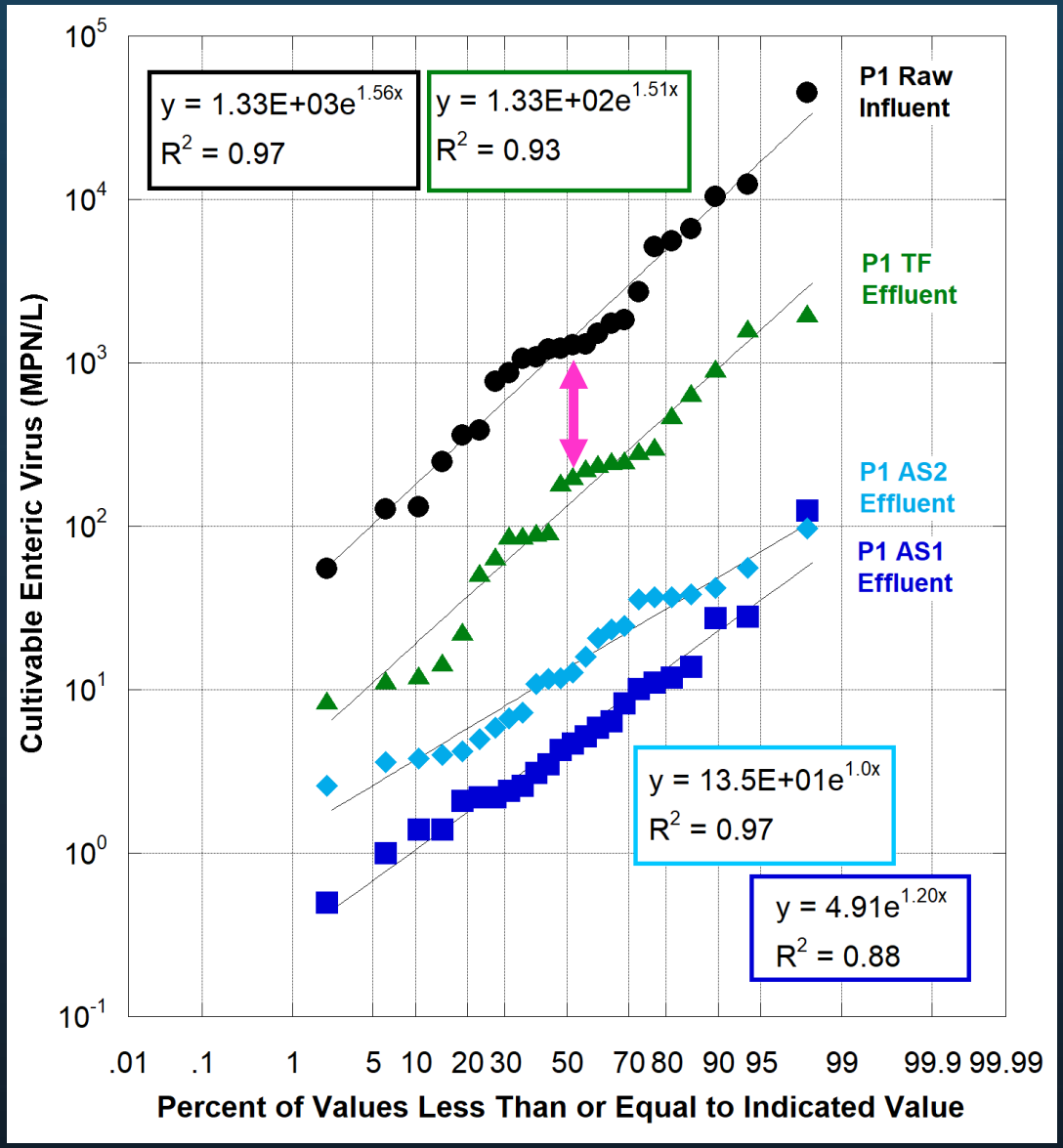
***no non-detect results for influent or effluent**

Probability Distribution



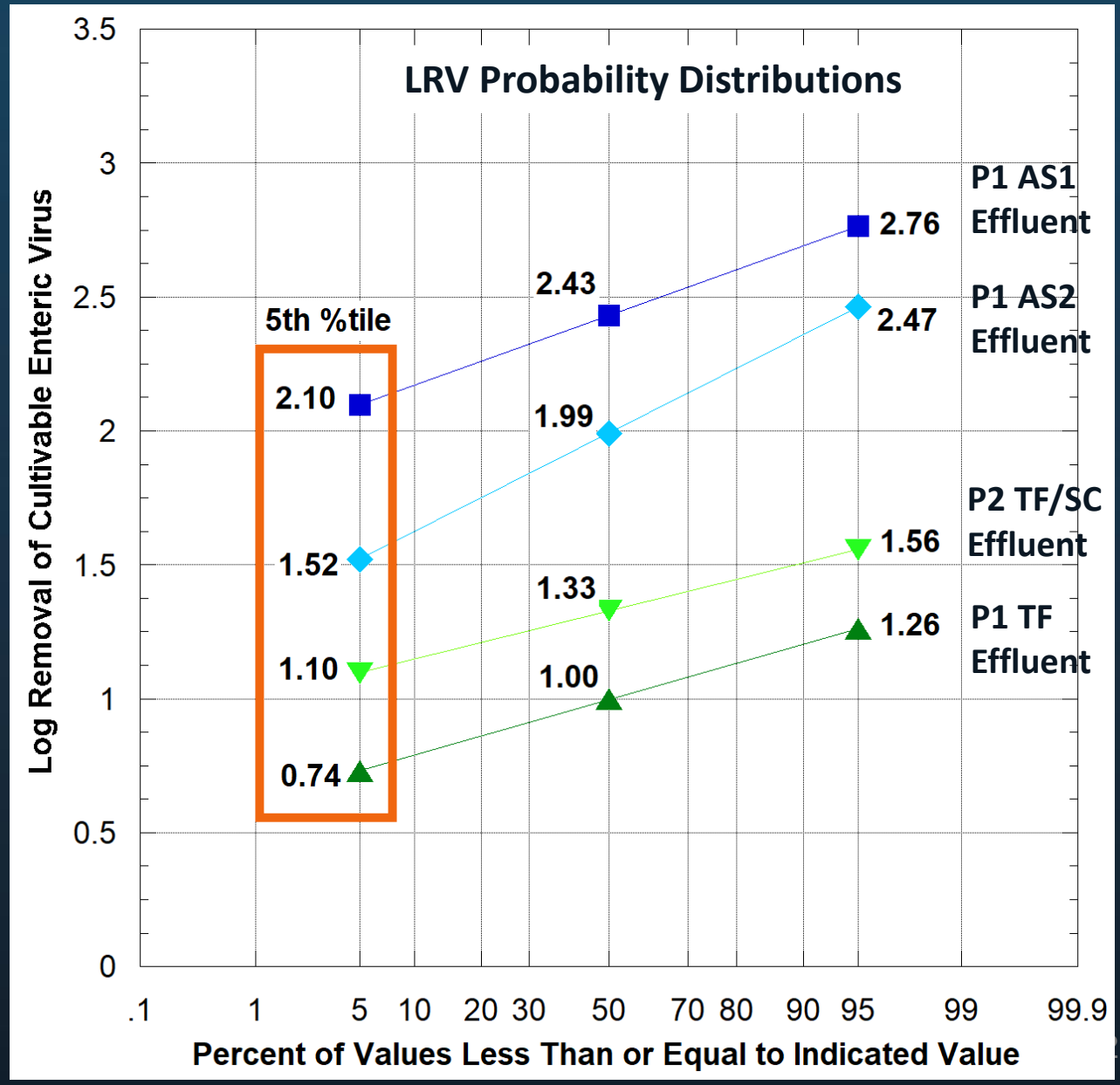
Methods to determine LRV

- LRV calculation methods:
  1) Same day pairing
     - Assumes same water parcel is sampled from influent to effluent.
  2) Monte Carlo approach
     - Iterative log-removal estimation based on influent and effluent statistical parameters (assumed independent).
  3) Covariance approach
     - A parametric evaluation of influent and effluent distributions that tests the variance of two dependent populations.



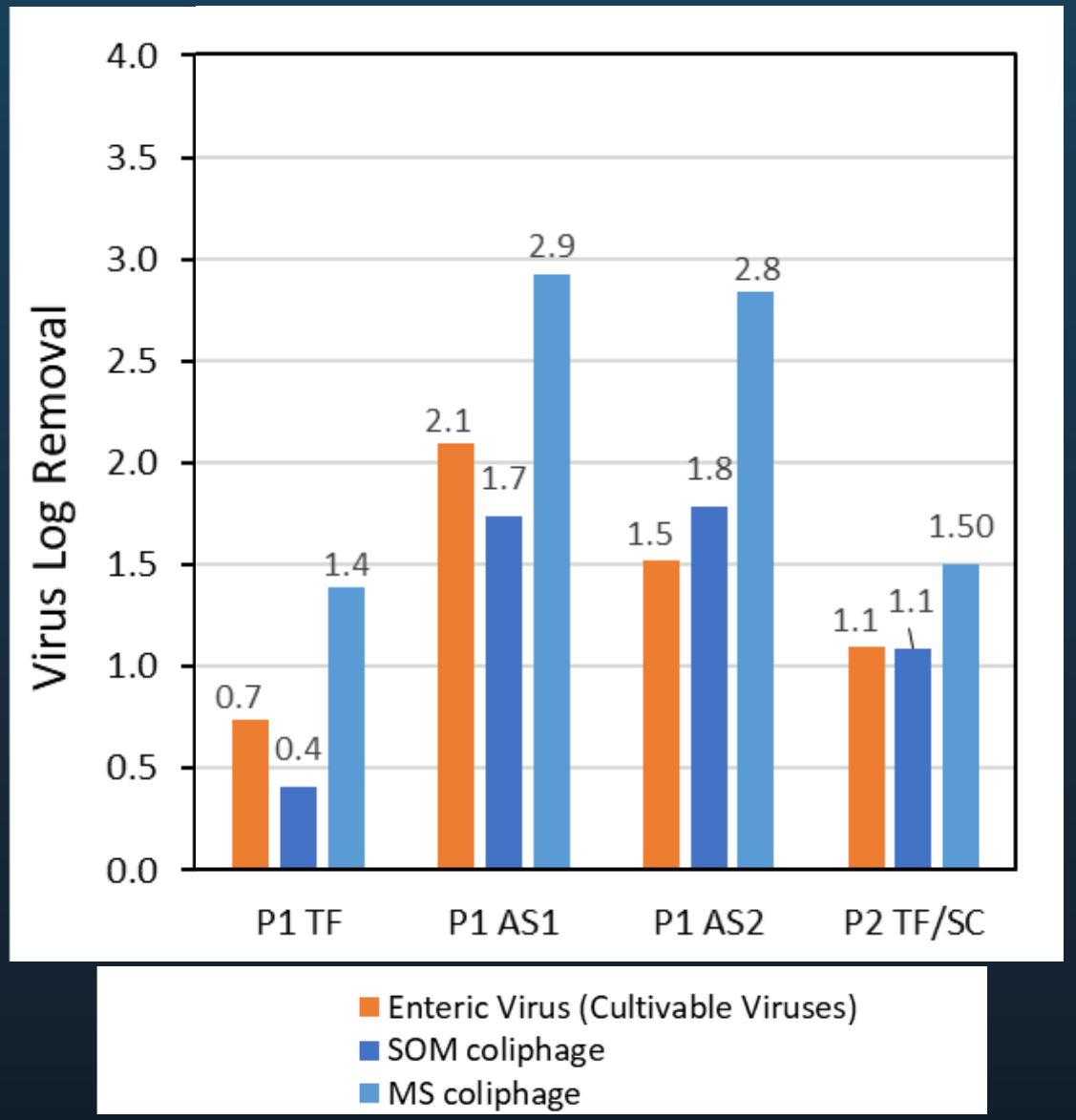
Covariance Analysis

- The probability distribution of LRVs (right) shows 5th, 50th, and 95th percentile for each OC San treatment process.
- P1 TF process has the lowest 5th percentile LRV at 0.74-log
- LRV distributions for P1 AS1 and AS2 processes are higher than that of P1 TF and P2 TF/SC, consistent with concentration values shown previously.
- The covariance approach was recommended since this approach assumes (and tests) the correlation between the log-influent and log-effluent values.



Summary of Microbial LRV Results

- 5th percentile LRVs obtained for cultivable virus and coliphage using the covariance approach.
- Both P1 TF and P2 TF/SC show the lowest 5th percentile log-removal for all virus targets.



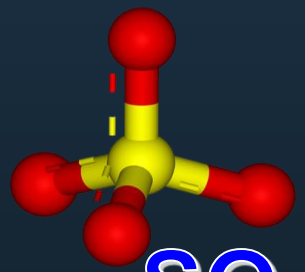
Study Findings and Next Steps

- Covariance approach for determining virus LRV was recommended by the GWRS Independent Advisory Panel (IAP)
- Due to the complexity of calculating an amalgamated estimate of removal for all OC San treatment processes, the 5th percentile value of the least effective treatment process (P1 TF) was chosen as the proposed credit value to conservatively represent the OC San P1 + P2 processes.
- Pending DDW review of the virus LRV calculation options, OCWD is proposing a virus LRV of 0.7 and conditional Operating Range Values (ORVs) into the Title 22 Engineering Report.

RO LRV STUDY

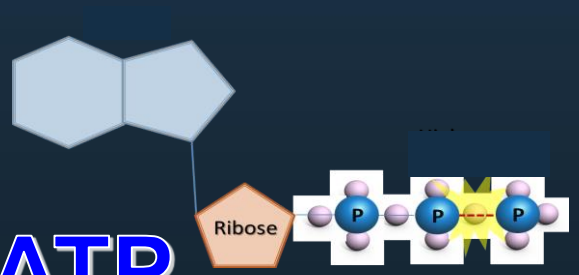
RO LRV Study Objectives

- GWRS LRV credit currently granted via TOC (~2 log) and EC (~1.5 log) surrogate monitoring
- Objective: identify easily monitored alternative surrogates with LRV > TOC via grab sampling and online monitoring over multiple months in a full-scale plant RO unit at OCWD

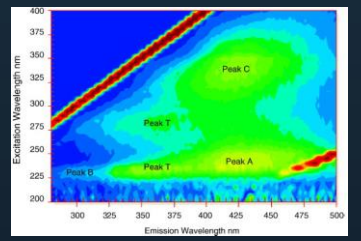


SO_4^{2-}

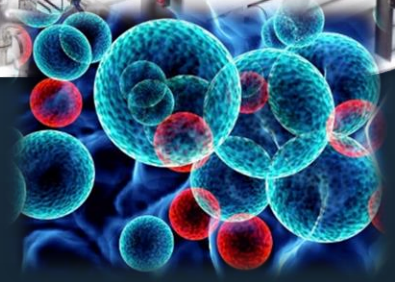
Sr^{2+}



ATP



Fluorescence Peak C



Nanoparticles

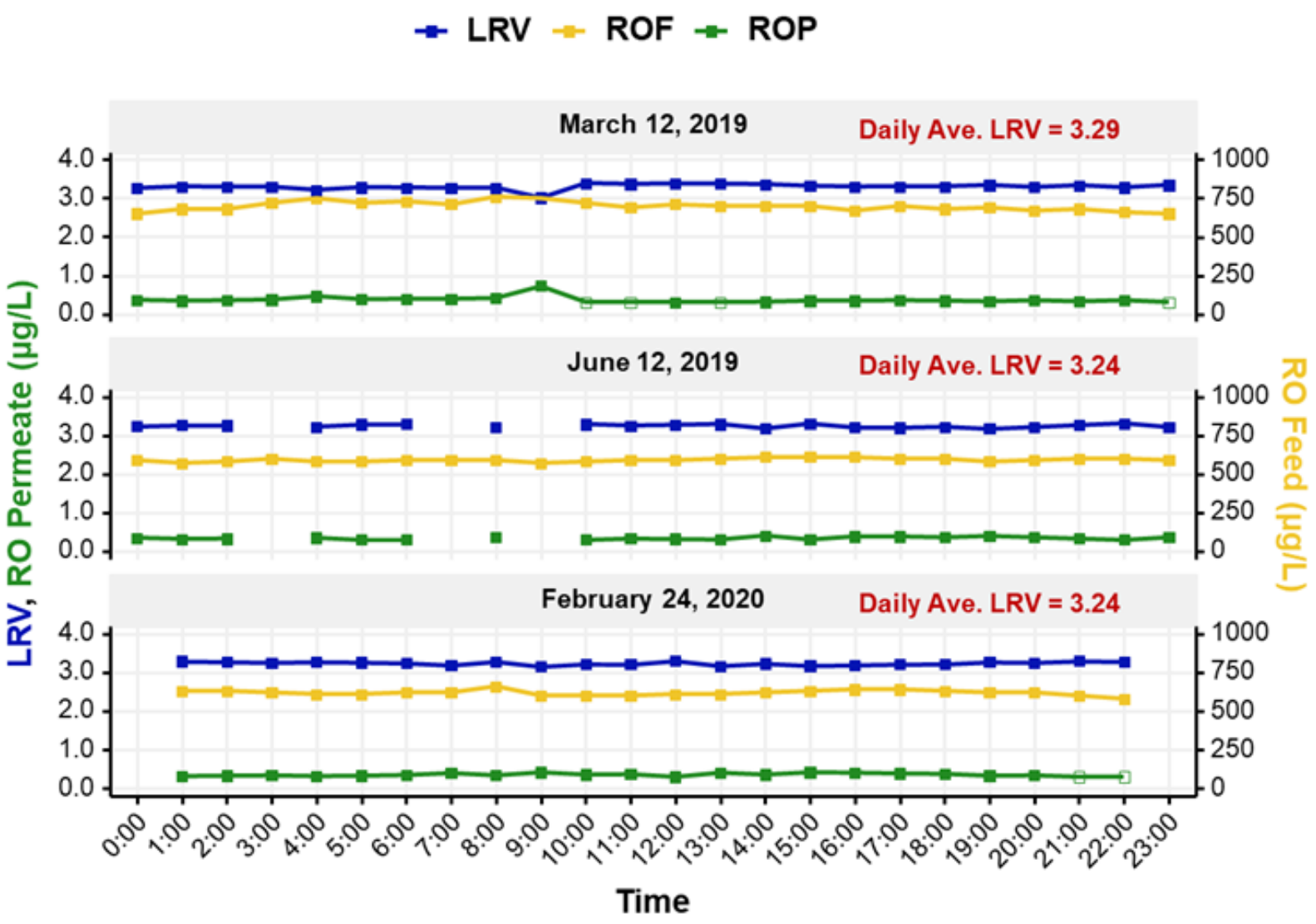
Summary of RO LRV Study Results

Surrogate	Study Average LRV	Min LRV	Max LRV
Strontium[1]	3.28	3.01	3.38
Sulfate [1]	2.90	2.79	3.00
Free ATP [2]	3.03	2.60	3.30
Fluorescence Peak C [2]	2.70	2.27	3.00
TOC [2]	2.01	1.77	2.36
EC [2]	1.50	0.72	1.54

[1]Grab Samples
[2]Continuous (online)

Unit B01 (Membranes: Hydranautics ESPA2-LD)

Strontium (Grab) – Hourly and Daily Average LRV Results



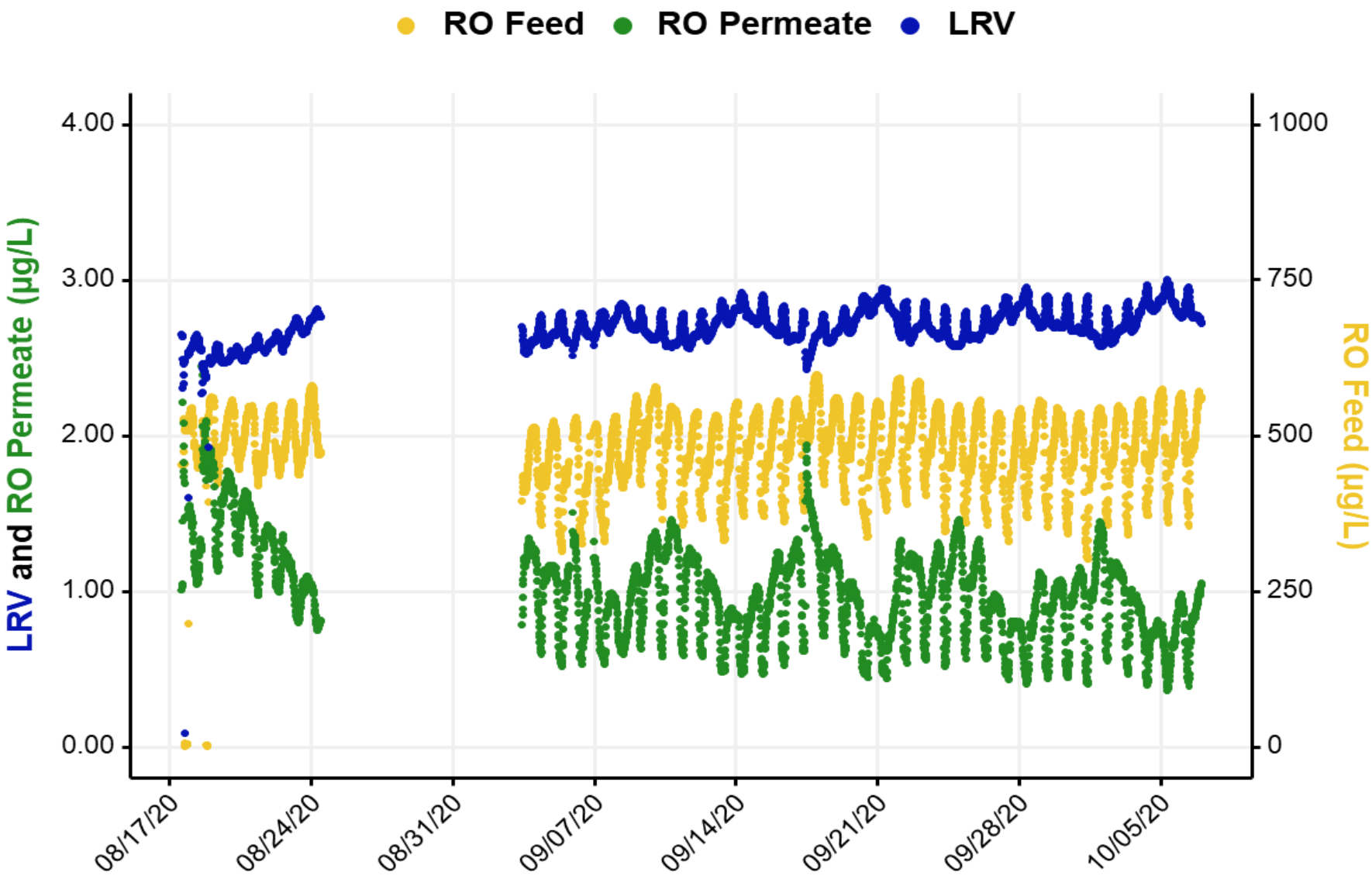
Ave / Min / Max LRV =
3.28 / 3.01 / 3.38
(for the 3 events)

	Method	Instrument	MRL[1]
ROF	EPA 200.7	ICP-AES	10 µg/L
ROP	EPA 200.8	ICP-MS	0.30 µg/L

1) MRL used to calculate LRV when value was < MRL

- ROP measured ≥ MRL
- ROP measured < MRL

Fluorescence Peak C (Online) – Continuous LRV



Ave / Min / Max LRV = 2.70 / 2.27 / 3.00
(over ~2 month period shown)

Continuous = measurement every second

Each graphed data point represents 15 min average of 1-second measurement

Lowest LRV of parameters studied, but inexpensive and easy to operate

Implications of RO LRV Study for OCWD and Other Potable Reuse Facilities

- Novel on-line methods are becoming feasible to enhance RO LRV credit
- Based on the project data, OCWD is proposing a tiered framework using strontium, sulfate, and ATP as alternative RO integrity surrogates into our Title 22 Engineering Report (T22 ER) to supplement TOC and EC (kept as back-up)
- Findings from this study are being translated into direct applications
- Relevant to both IPR and DPR applications

Thank you

Any questions?

Speaker Spotlight

David Ahles, P.E.

Principal Civil Engineer

Eastern Municipal Water District

Christian Sanders, P.E.

Environmental Engineer

CDM Smith

PLACEHOLDER (Eastern)

INSERT SLIDES

Questions & Discussion

Backup Slides