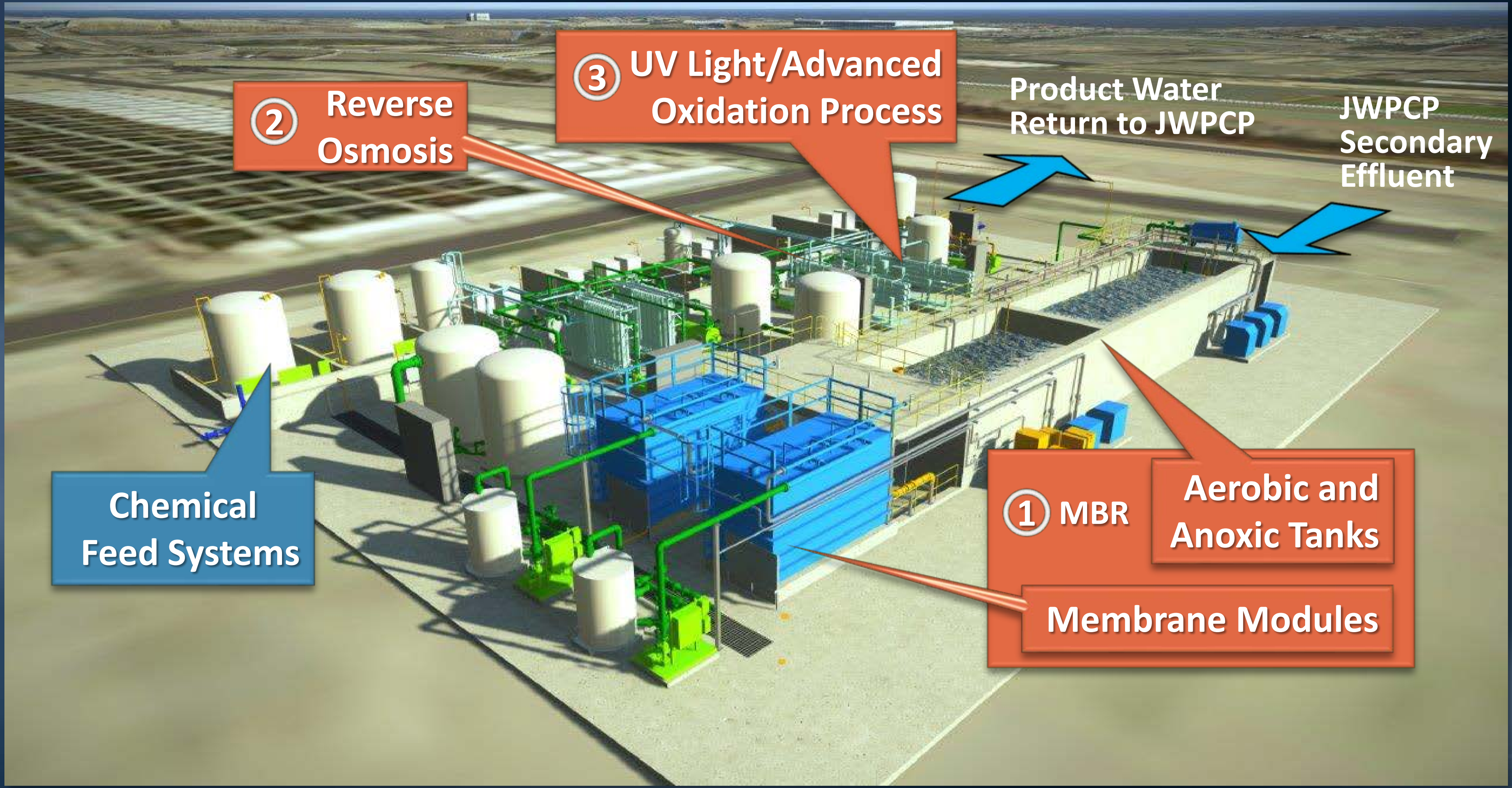
Innovative Research at the Advanced Purification Center

Engineering and Operations Committee
Item 6a
May 10, 2021

Outline

- Demonstration Project Overview
- Advanced Water Treatment
- Microbial Testing
- Industry Benefits and Collaboration
- Current Testing and Next Steps

Demonstration Facility Processes



Demonstration Project Objectives

- Provide data for regulatory acceptance
- Confirm viability of membrane bioreactor (MBR) process

ONGOING

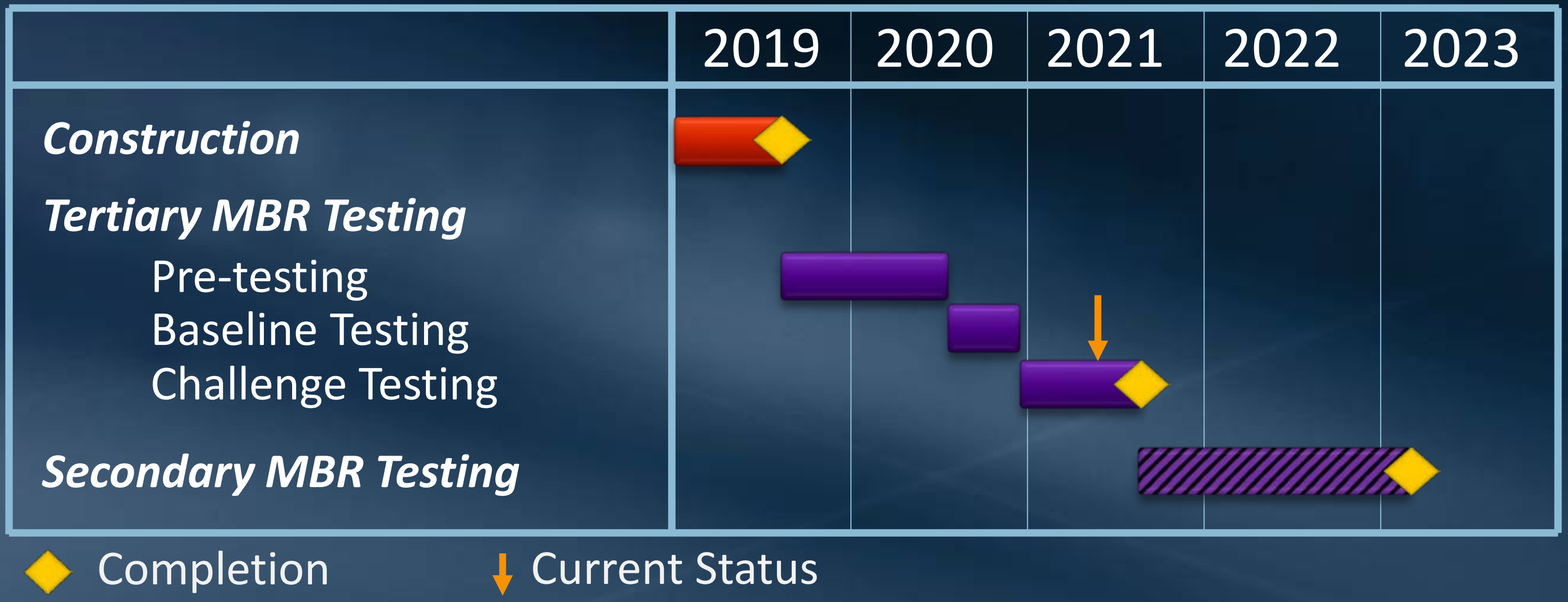
- Confirm operational dependencies/interfaces with LACSD
- Provide vehicle for public outreach and acceptance

ONGOING

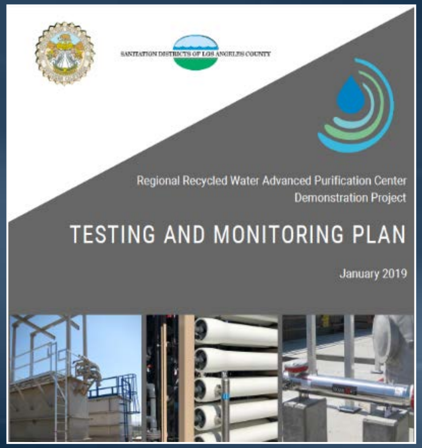
- Optimize treatment process, develop design criteria, and establish cost clarity
- Develop Raw Water Augmentation approach

FUTURE TESTING PERIODS

Demonstration Facility Testing Schedule



- The MBR currently treats JWPCP secondary effluent, operating in a <u>tertiary</u> mode (or **tMBR**)
- In the next phase of testing, the MBR will treat primary effluent in a <u>secondary</u> mode (or **sMBR**)



Tertiary MBR (tMBR) Testing Status

- Preliminary results show that the demonstration train meets water quality targets for chemical constituents in the groundwater recharge regulations
- Additional evaluations are ongoing to confirm results and refine operational conditions

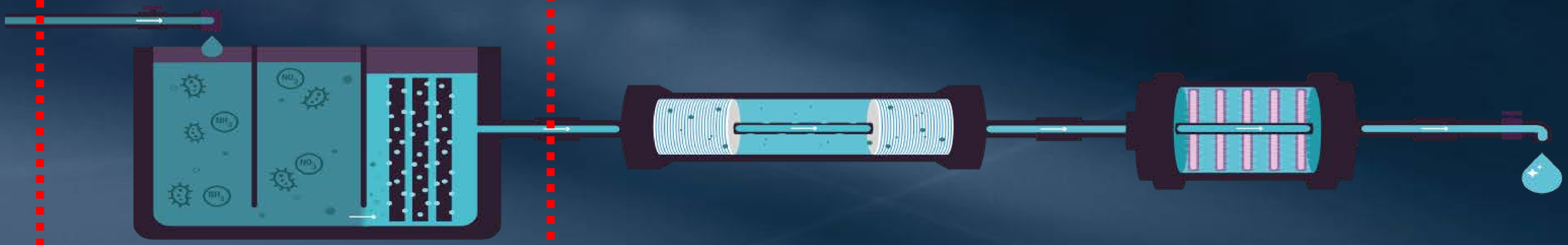


Advanced Water Treatment Process

1

2

3



Membrane Bioreactors (MBR)

Microorganisms remove ammonia and other biodegradable compounds while membranes filter tiny particles

Reverse Osmosis (RO)

Pressurized membranes further remove microscopic materials, eliminating more than 99% of all impurities

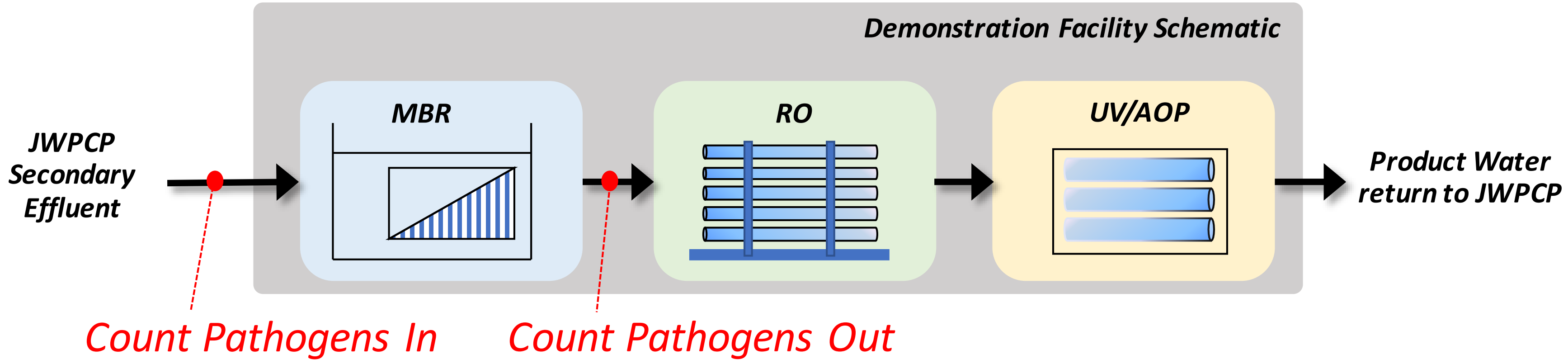
Ultraviolet/Advanced Oxidation Process (UV/AOP)

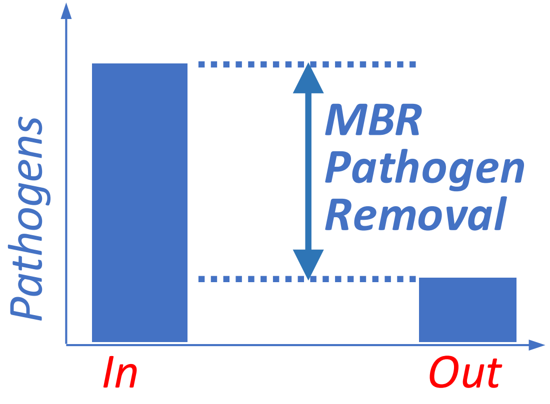
Ultraviolet light/oxidant destroy any remaining viruses and trace chemical compounds

Membrane Process Selection

- Membrane filtration (MF) is commonly used globally in potable reuse without a biological process
- An MWD/LACSD pilot study in 2010-2012 showed performance advantages of MBR over MF
  - MBRs provide biological treatment upstream of the MBR membrane
- No MBR systems are currently permitted in CA for potable reuse
- Two MBR systems available for testing at the demonstration facility

Demonstrating ≥2.5 Pathogen LRV through MBR

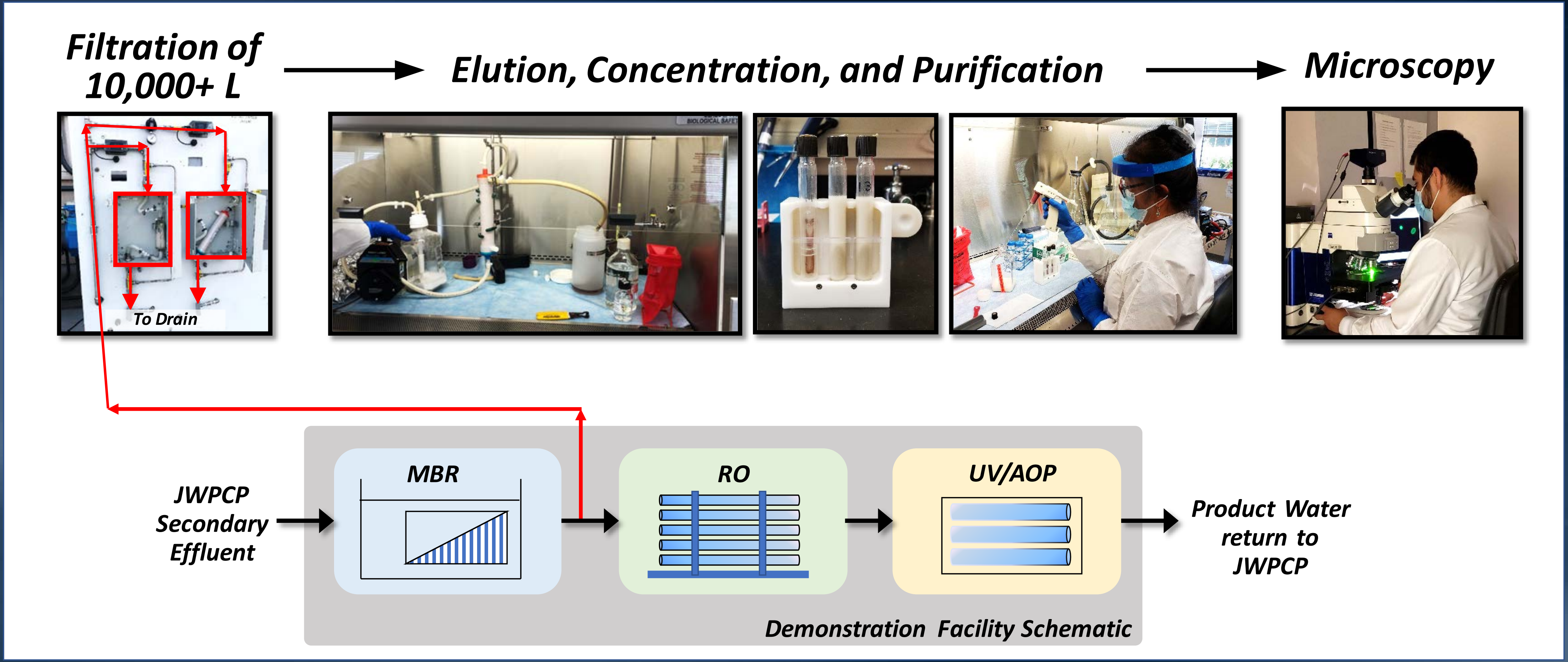




Example Log Removal Value (LRV) Calculations

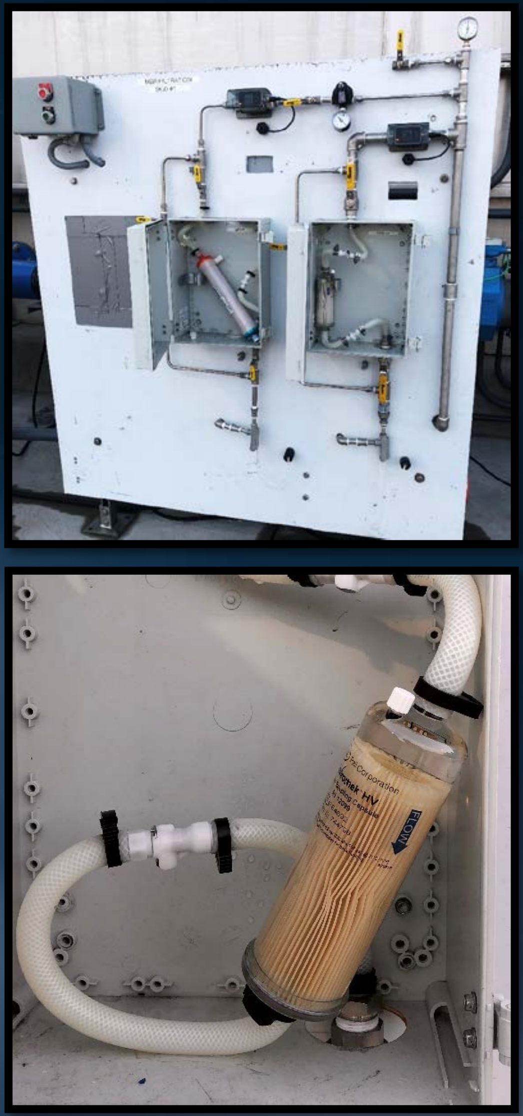
Pathogens In (organisms/L)	Pathogens Out (organisms/L)	Percent Removal	LRV
100	10	90%	1.0
100	1	99%	2.0
100	**0.3**	**99.7%**	**2.5**
100	0.1	99.9%	3.0
100	0.01	99.99%	4.0

Measuring Pathogens in MBR Filtrate Water



Pathogen Method Improvements

- Much larger sample volumes than previous industry studies
- Pathogen detection methods modified to improve recovery efficiency and detection limits
- Unlike most reuse studies, recovery efficiency for each sample is being determined
- Higher method sensitivity, quality control, and better data integrity



Large volume sample collection

Pathogen Method Improvements *(cont.)*

Less Interfering Debris

Cryptosporidium and *Giardia* Analysis Method

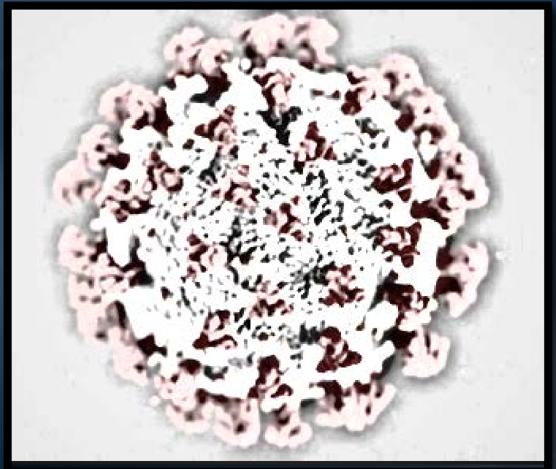
	Previous Reuse Projects	Advanced Purification Center
MBR Filtrate Sample Volume	≤250 L	**>10,000 L**
Sampling Duration	<1 hr	**~16 hrs**
Recovery	<10%	**45-55%**

Lab Work During the Pandemic

- Concentrating samples that probably contain SARS-CoV-2, the cause of the COVID-19 pandemic, is unprecedented
- With LACSD, developed a novel SARS-CoV-2 inactivation method (cholate from bile) that allows staff to work safely while analyzing target organisms

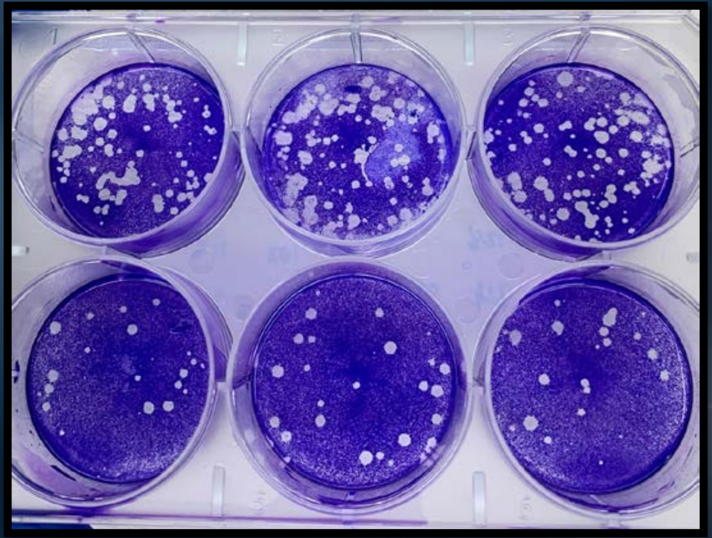
Training staff

Cholate treatment and sample elution



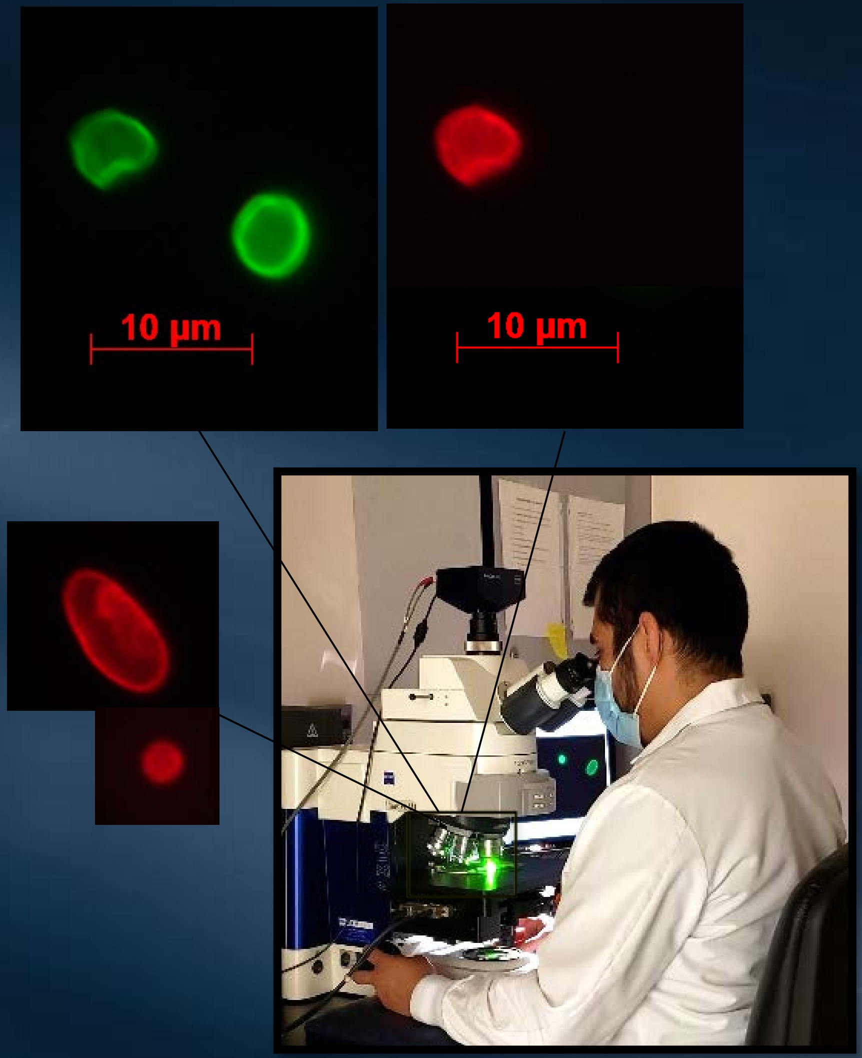
Inactivating Coronaviruses

Virus Analysis in the Lab



Benefits of Using Indicators Instead of Pathogens

- Pathogens are difficult to analyze
  - Resource and time intensive processes
  - Highly trained staff and specialized facilities
- Appropriate indicators (or surrogates) that conservatively represent pathogens
  - Safer to work with
  - Easily measurable
  - Results obtained with faster turnaround
  - Higher frequency monitoring



Evaluate Correlation Between Pathogen LRVs and Indicators

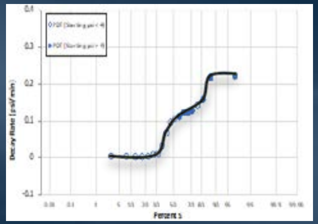
Microorganisms

Type of Microbe	Microorganism	LRVs* (%)
Pathogens	*Cryptosporidium*	**4.4 (>99.99%) ^**
	Giardia	**5.8 (>99.999%) ^**
Indicators	Total Coliforms	**6.3**
	Escherichia coli	**7.0**
	Aerobic Bacterial Spores	**3.7**
	Clostridium perfringens Spores	**4.8**

**Results during Baseline Testing*
^LRV using daily matrix spike corrections, lowest 5% pathogen removal

Non-microbial surrogates

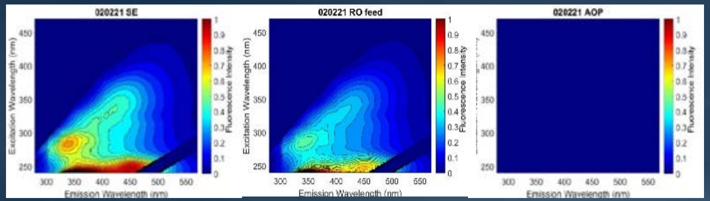
Pressure Decay



Suspended Solids

Turbidity

Electrical Excitation Matrices

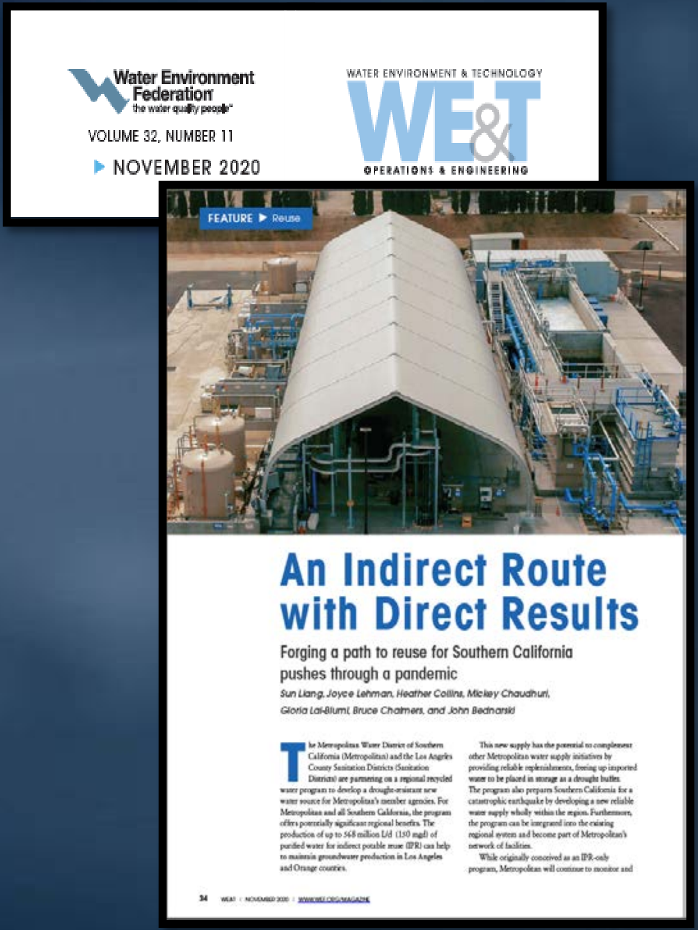


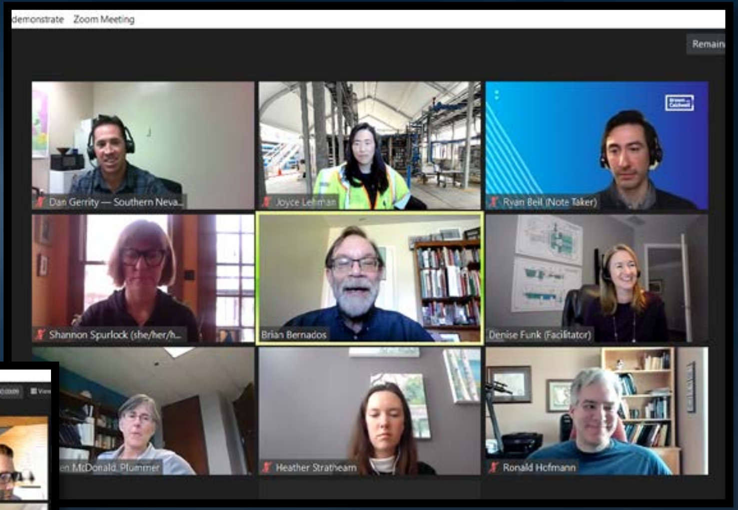
Other surrogates with continuous monitoring:
- *Adenosine triphosphate*
- *Particle Counts*

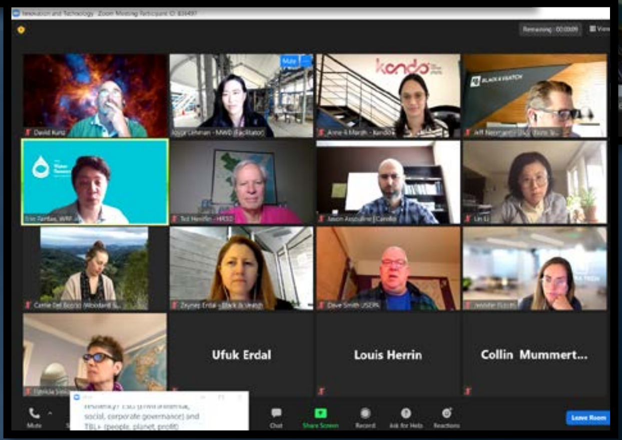
Industry Benefits

- High quality pathogen and indicator organism data sets
- Demonstrated baseline MBR removal of *Cryptosporidium* and *Giardia* much higher than minimum 2.5 LRV needed for regulatory compliance

Industry Outreach and Collaboration



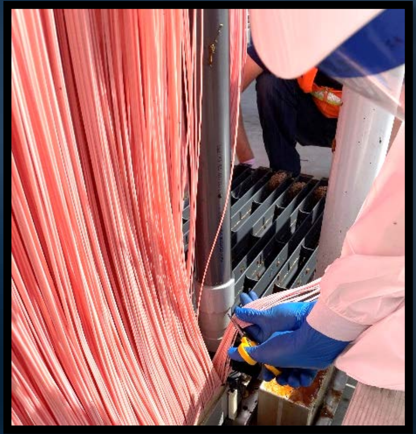




AWWA Research Webinar:
Leading Research in the Field of Potable Reuse
April 2021

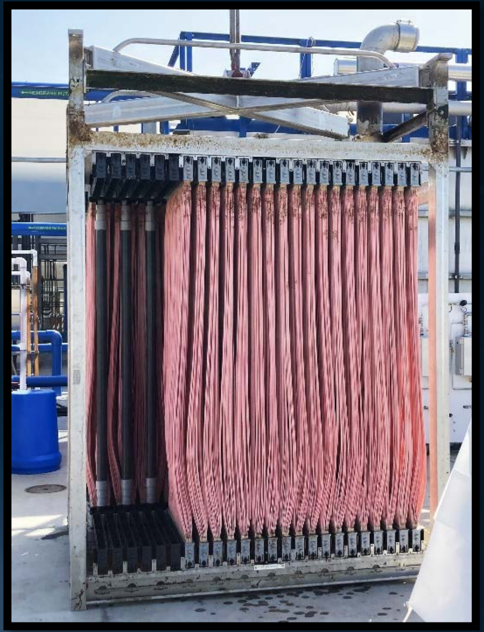
Current MBR Challenge Testing Phase

- Assessing performance under damaged conditions to evaluate robustness and integrity of the MBR
- Three challenge test conditions to evaluate pathogen removal through intentionally cut membranes and the reduction in LRVs
- LACSD is sampling RO concentrate to evaluate compliance with ocean discharge requirements



Next Steps

- Tertiary MBR testing anticipated to be completed in fall 2021
- Secondary MBR testing scheduled for late 2021
  - RFP has been issued for operational support
- Ongoing coordination with LACSD partners, regulators and the Independent Science Advisory Panel (ISAP)
- Sharing research and testing results through industry forums and publications



THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

1928

Targeting ≥2.5 LRV (99.7%) Removal of Pathogens through MBR

Unit Process		Typical Reuse Project LRVs			Metropolitan's Proposed LRVs		
		Virus	*Crypto.*	*Giardia*	Virus	*Crypto.*	*Giardia*
MBR		-	-	-	-	2.5	2.5
MF		-	4.0	4.0	-	-	-
RO		1.5	1.5	1.5	1.5	1.5	1.5
UV/AOP		6.0	6.0	6.0	6.0	6.0	6.0
Free Chlorine		6.0	-	-	6.0	-	-
Train Total LRVs	MF + RO + UV/AOP	13.5	11.5	11.5			
	MBR + RO + UV/AOP				13.5	10	10
	Minimum Required	12	10	10	12	10	10