

Potable Reuse in California – Update on Research Topics

Northern California WateReuse Chapter online Meeting August 28, 2020

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#### **Potable Reuse in California – Update Research Topics**

- Background
  - Expert Panel Findings and Research Needs
- Potable Reuse Regulation/Defined
  - Groundwater recharge & Surface Water Augmentation
  - Potable reuse via raw water and treated water augmentation
- Update on Potable Reuse Investigations Microbial Focus
  - Pant Performance and QMRA Tools
  - Pathogen Monitoring including SARS-CoV-2
  - Monitoring outbreak concentration of pathogens

#### **Expert Panel Findings on Direct Potable Reuse**

- CA State Expert Panel assessed DPR feasibility
- Concluded *it is feasible* to create uniform regulations for DPR
- Expert Panel recommended 6 topics for further research



#### SWB Grant 1: 5 DPR Research Projects

#### Research addressing Pathogens

- DPR-1. Quantitative Microbial Risk Assessment\*
- DPR-2. Measure Pathogens in Wastewater\*
- DPR-3. Collecting Pathogens in Wastewater During Outbreaks

#### **Research addressing Chemicals**

- DPR-4. Treatment for Averaging Potential Chemical Peaks
- DPR-5. Low Molecular Weight Unknown Compounds

#### Research implementation late 2018 – late 2020





\*Co-funded by Metropolitan Water District



Public Health Protection

Water Environment

water quality people

Federation



#### **ENVIRONMENTAL BARRIER – GWR and SWA (Reservoir Water**

Augmentation)

- Benefits:
  - Attenuate chemical spikes
  - Robust pathogen barrier
  - Response time
  - Hand of Hygia





#### DPR Pathogen Conc, Risk and Treatment



## **DPR -1 TWG and Research Team**

#### **Technical Working Group**



Charles Haas Drexel University



Nick Ashbolt University of Alberta



Theresa Slifko Metropolitan Water District



Brian Pecson (chair) Trussell Technologies



Dan Gerrity UNLV



Edmund Seto University of Washington

## DPR – 1 Investigation Topics

- Understanding the Benchmark Curve
- Impact of Raw Wastewater Pathogen Concentration
- Impact of Treatment Redundancy
- Impact of Treatment Variability and Failure Assumptions
- Sensitivity Analysis



"So what's this? I asked for a *hammer*! A hammer! *This* is a crescent wrench!

> Well, maybe it's a hammer.... Damn these stone tools."

## **Tools provide clear reproducible approach to** help develop criteria



#### Calculating the Benchmark Treatment Train





Figure 9-2: Cumulative distribution function (CDF) plot of estimated log<sub>10</sub> reduction values (LRVs) for *Cryptosporidium* spp. (based on the dose response in USEPA, 2006) to meet an annual tolerable risk of infection of 10<sup>-4</sup> per person per year (same as plotted in Figure 2-1).

# Tools can be used together to develop DPR criteria



## LOWER REDUNDANCY LEADS TO UPWARDS SHIFTS IN RISK





#### Redundancy is important when considering the impact of low probability failure events



# Investigate impact on risk by changing assumptions of different steps of QMRA



#### **DPR -2 Pathogen Monitoring Project Goals**

#### **Technical Working Group**



George DiGiovanni Metropolitan Water District



Menu Leddy Essential Environmental & Engineering Systems



Kara Nelson UC, Berkeley



Brian Pecson Trussell Technologies



**Channah Rock** University of Arizona



Theresa Slifko (chair) Metropolitan Water District

#### Goals:

- Develop recommendations for the collection and analysis of pathogen data in raw wastewater
- Conduct pathogen monitoring of raw wastewater as inputs to DPR-1



## **DPR – 2 Pathogen Monitoring**

TWG Recommendations for Pathogens and Enumeration Methods

Virus Enterovirus (*culture* and <u>molecular</u>) Adenovirus (*culture* and <u>molecular</u>) Norovirus (<u>molecular</u>) Bacteriophage (*culture* and <u>molecular</u>) **Protozoa** Giardia (microscopy) Cryptosporidium (microscopy)

- Includes historical drinking water and IPR pathogens use existing techniques
- Includes additional viral pathogens and indicators
- Uses both traditional (non-molecular) and molecular enumeration methods

#### **DPR – 2 Methods Pre-Testing for Standard Operating Procedure**

- Developed pre-testing plan to verify methods:
  - Optimum concentration method:





Centrifugation





Beef Extract

• Optimum volume to process:





VS.





#### Task 2 – Methods Pre-Testing: Cryptosporidium



# **DPR-2 SOPs ARE SENSITIVE AND REPRODUCIBLE**

Organism	Fraction of Detects	Mean Recovery
Crypto (cyst/L)	40/41	31%
Giardia (oocyst/L)	41/41	44%
Enterovirus culture (MPN/L)	41/41	70% MS2, 75% PhiX174
Adenovirus culture (MPN/L)	41/41	
Enterovirus molecular (GC/L)	41/41	24% MS2, 55% PhiX174
Adenovirus molecular (GC/L)	41/41	
Norovirus GIA molecular (GC/L)	38/41	
Norovirus GIB molecular (GC/L)	40/41	
Norovirus GII molecular (GC/L)	41/41	

Preliminary results through 4/2020:

- High rate of detection for all organisms
- Effective for wastewater from 5 different facilities
- Reproducible across 3 different labs
- Matrix spike samples providing ability to correct for recovery

# **PRELIMINARY FINDINGS**



Undergoing QA/QC Review – Do Not Cite

# **NEXT STEPS**



## PRESENT

- Conduct Original Pathogen Monitoring Campaign: October 2019 to January 2021
- Conduct SARS-CoV-2 Monitoring Campaign: April 2020 to January 2021

# <u>FUTURE</u>

• Analyze data and develop final report with recommendations

# WHY IS THIS RESEARCH IMPORTANT FOR POTABLE REUSE?

DPR-2 refined Standard Operating Procedures for several waterborne pathogens

QAPP includes strict QA/QC that produces more accurate information

State Water Board expanding DPR-2 to stay vigilant on new SARS-CoV-2 threat

Useful in developing public health criteria for various water-related applications including potable reuse



# DPR3: Feasibility of collecting pathogens in wastewater during outbreaks

Krista Wigginton, University of Michigan

Collaborators: Ali Boehm (Stanford), Nasa Sinnot-Armstrong (Stanford), Rebecca Lahr (UM), Shalina Gupta (UM)

# Feasibility of collecting pathogen concentration data for raw wastewater associated with community outbreaks of disease.

Questions include:

- Can we verify that the data and assumptions on the level of waterborne pathogens in untreated wastewater used to develop DPR criteria is protective of public health?
- Can we use wastewater monitoring to detect an outbreak? Can we use epidemic quantities to predict the wastewater quantities?
- Can we combine data to identify gaps? Using excretion rates, can we calculate how many people in a community have the disease(s)?
- **COVID Update:** In addition to key waterborne pathogens, researchers have added coronavirus to the list of organisms of concern.

#### Surveillance Data: National Outbreak Reporting System

Question: When and where do we expect the highest concentrations to enter treatment plants



#### National Norovirus

# Illnesses per Month

#### California Norovirus

#### Surveillance Data: California Department of Public Health



California cryptosporidiosis

#### **Resources on WRF website**

#### https://www.waterrf.org/california-state-water-board-grant

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#### California State Water Board Grant

in 2018, The Water Research Foundation received a grant totaling \$4.5M from the California State Water Resources Control Board [SWRC8] to support nonpotable and potable reuse research. This funding has been leveraged by WRF and other key partners, including Metropolitan Water District (CA), utilities in CA and across the US, engineering firms, and manufacturing companies to fund WRF reuse research launched in 2017 - 2019. The funding from the SWB is broken into the following two grants.



#### Grant 1

LEARN MORE

Water Research

The first grant [\$1.4M, D1705002] funds 5 projects which were recommended by the SWRCB Expert Panel in their report on the feasibility of developing criteria for Direct Potable Reuse (DPR). The research findings will be used to develop regulations for DPR, driven by CA legislation SB 574 [2017], which established a deadline of 2023.

The following projects were launched by WRF in late 2018:

- Tools to Evaluate Quantitative Microbial Risk and Plant Performance/Reliability
- · Measure Pathogens in Wastewater
- Collecting Pathogens in Wastewater During Outbreaks
- Defining Potential Chemical Peaks and Management Options
- · Low Molecular Weight Unknown Compounds

#### DIRECT POTABLE REUSE

that would enhance SWB efforts to develop DPR criteria and

regulations. Through a \$1.4M grant, The Water Research

Foundation is managing five of these research projects.

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CALIFORNIA STATE WATER BOARD PARTNERSHIP

The California State Water Resources Control Board (SWB) independent panel determined that it is feasible to develop uniform criteria for direct potable reuse (DPR) that adequately protect public health.







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**Evaluating Analytical Methods for Detecting Unknown Chemicals** in Recycled Water



DPR-5 Report: https://www.waterrf.org/research/projects/evaluating-analyticalmethods-detecting-unknown-chemicals-recycled-water

All Reports will be available by mid-2021

