THE Water Research FOUNDATION

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

DPR Virtual Research Workshop

June 12, 2020

10:00AM – 12:30PM PT

Agenda

• 10:00am	Welcome, Introductions	Adam, Jim, Julie
• 10:10am	SWB Updates, status of reg dev.	Tricia Lee, Jing Chao
• 10:25pm	Review of DPR-1; Demo tool	Brian Pecson & team
• 10:50am	DPR-2; Prelim. Results + Covid-19	Brian Pecson & team
• 11:15am	DPR-3 Status	Krista Wigginton
• 11:30am	DPR-4 Project results	Jean Debroux, Shane Trussell
• 12:00pm	Closed Discussion/Questions	All
• 12:30pm	Adjourn	

Welcome and Introductions

SWB:

- Randy Barnard
- Mark Bartson
- Bob Brownwood
- Jing Chao
- Bob Hultquist
- Tricia Lee
- Laura McLellan
- Claire Waggoner
- Brian Bernados
- Karen Mogus
- Candida Granillo-Dodds
- Faraz Asad
- Kurt Souza
- Saeedreza Hafeznezami
- Stefan Cajina
- Aide Ortiz
- Dave Spath
- Shahla Farahnak
- Sherly Rosilela

Coordinating Committee:

- James Crook
- Adam Olivieri
- Julie Minton
- Erin Partlan

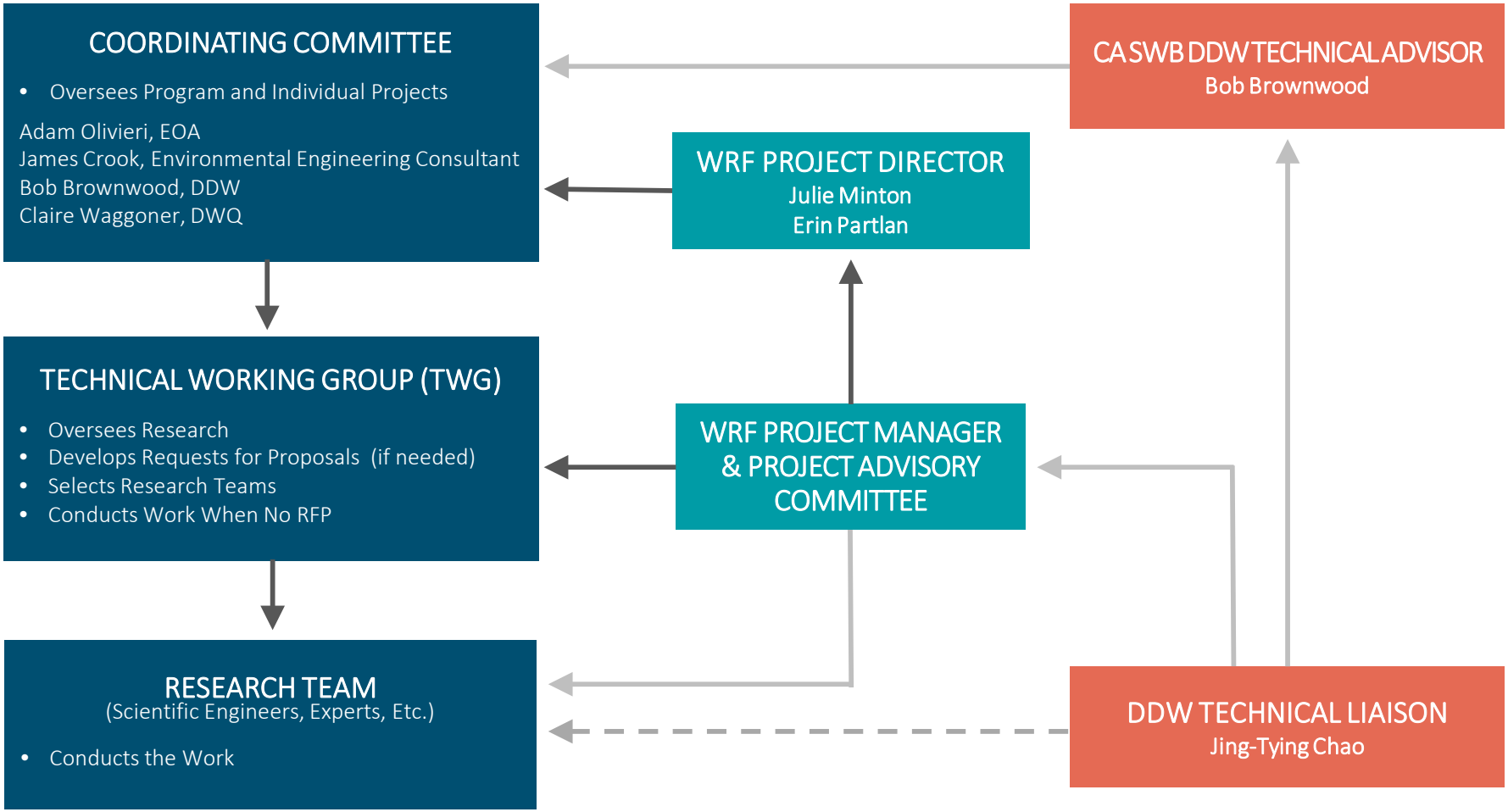
WRF Staff:

- Julie Minton
- Erin Partlan
- Courtney Tharpe

Grant 1 Research Teams:

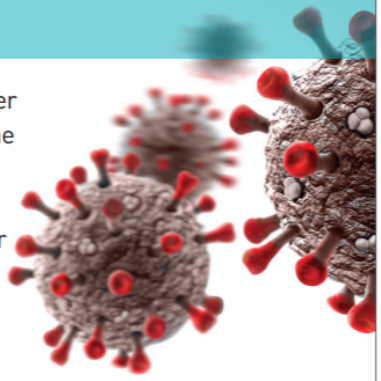
- Brian Pecson, Trussell Tech
- Anya Kaufmann, Trussell Tech
- Edmund Seto, U of Washington
- Daniel Gerrity, SNWA
- George DiGiovanni, MWD
- Megan Plumlee, OCWD
- Krista Wigginton, U of Michigan
- Jean Debroux, Kennedy Jenks
- Shane Trussell, Trussell Tech

Grant 1: Research Oversight and Communication



Response to COVID-19

RESPONDING TO COVID-19



The pathogen monitoring project is aimed at collecting untreated wastewater from five utilities in California where it is being analyzed for key waterborne pathogens (protozoa and certain viruses). A number of pre-tests were conducted in order to modify current industry protocols for protozoa and molecular virus to be more sensitive and specific in an untreated wastewater matrix. The full monitoring campaign was initiated in November 2019 and the team has been archiving samples since then. Three national labs are analyzing the samples following the quality assurance plan (QAPP).

Since the early 2020 SARS-CoV-2 outbreak, the team has been confirming methods for measuring (molecular) archived samples and untreated wastewater samples for quantitative analysis of SARS-CoV-2 (molecular). In late April, the analysis of archived samples, as well as untreated wastewater samples was started. The pathogen monitoring program will collect and analyze untreated wastewater samples through January 2021. The goal is to have approximately 120 analyses for each of the waterborne pathogens and indicator organisms. The results will be published by The Water Research Foundation (WRF) after a peer-review process and posted to the WRF and SWB websites. The team will prepare a technical publication specific to the SARS-CoV-2 effort.

WRF/SWB Flyer available https://www.waterrf.org/sites/default/files/file/2020-05/Direct-Potable-Reuse-CA-SWB.pdf

DPR-2 QAPP Available

Project #4989

Measure Pathogens in Wastewater

Quality Assurance Project Plan: Analytical Microbiology Services

PROJECT PAPER 05/14/2020

05/14/2020

https://www.waterrf.org/research/projects/measure-pathogens-wastewater

Open RFQ due June 19th

RFQ for SARS-CoV-2 Study

WRF released a Request for Qualifications (RFQ) to identify a research team to lead a project evaluating existing methods and testing reliability for the genetic signal for SARS-CoV-2 in untreated wastewater.

State Water Board DWQ Research Funding

Tricia Lee, State Water Resources Control Board

WRF-SWB DPR Virtual Research Workshop

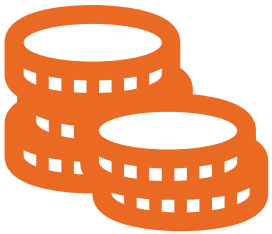
Tricia Lee

Tricia.Lee@waterboards.ca.gov

https://www.waterboards.ca.gov/recycledwaterpolicy

Funding Program

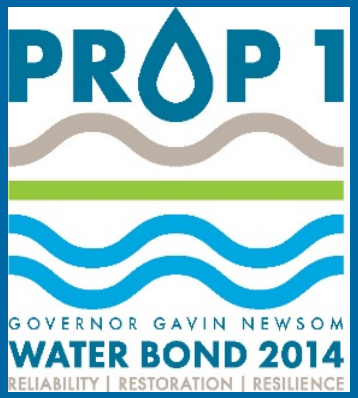
The Water Recycling Funding Program (WRFP) provides technical and financial assistance to agencies and other stakeholders in support of water recycling projects and research.



WATER RECYCLING FUNDING PROGRAM

Funding Sources

WATER RECYCLING FUNDING PROGRAM



Prop 13 (2000)

Proposition 68 (2018)
$72 Million for recycled water projects currently being processed

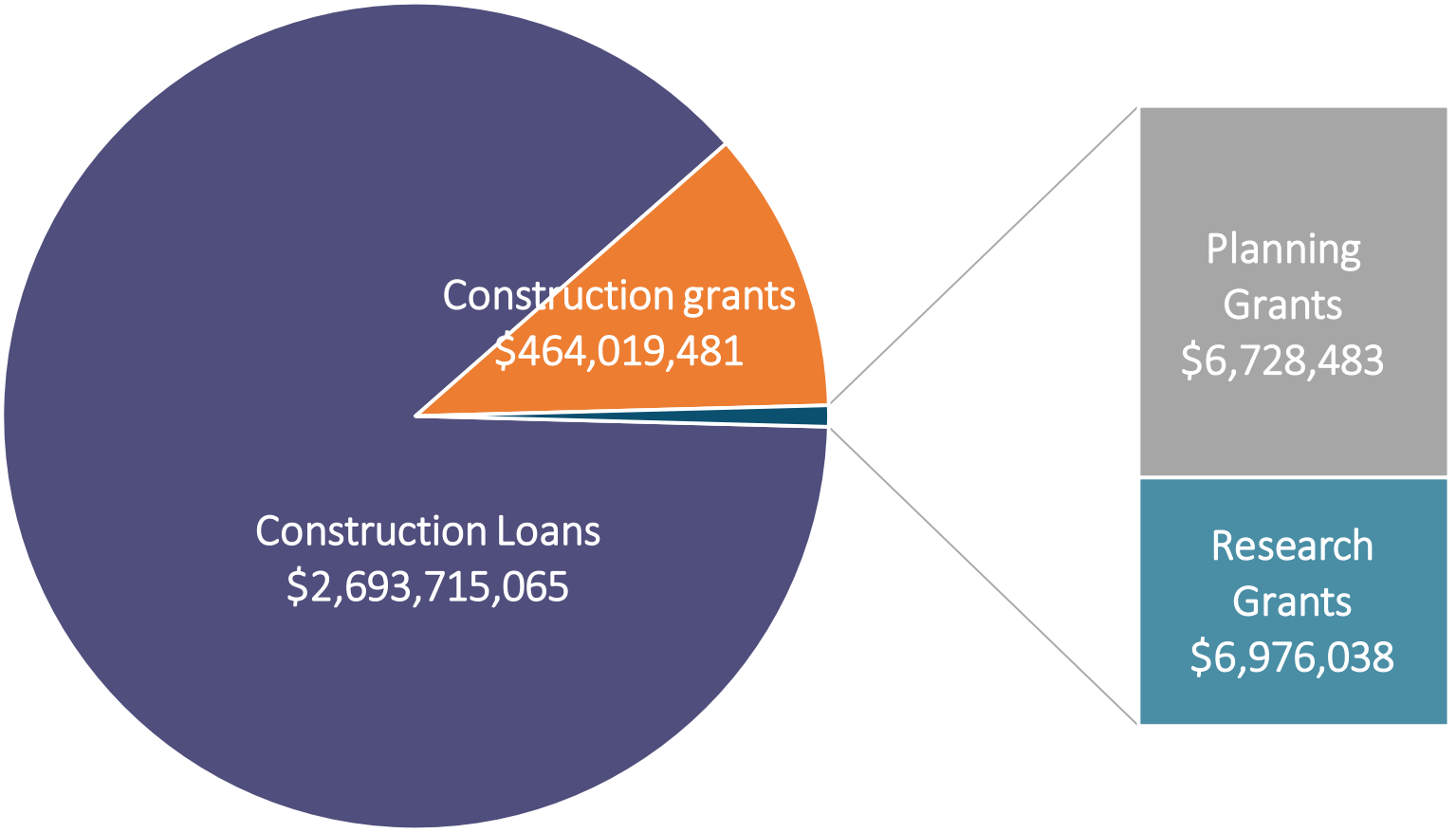
Proposition 1 (2014)
$105 million for recycled water projects currently being processed.

Proposition 13 (2000)
Financial assistance for loans and grants for recycled water projects

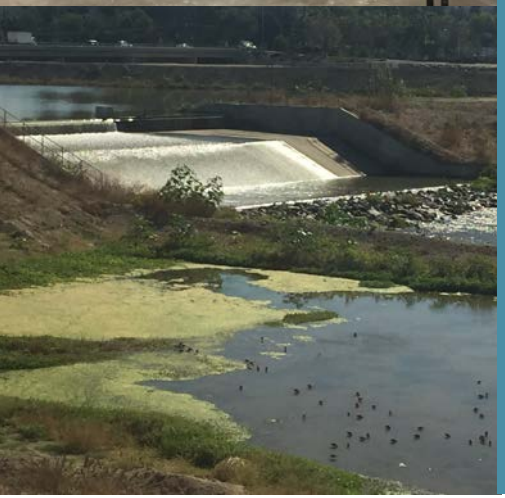
Current WRFP Portfolio

WATER RECYCLING FUNDING PROGRAM

1978 - March 2020: $3.2 Billion Total



Research Funding Objective



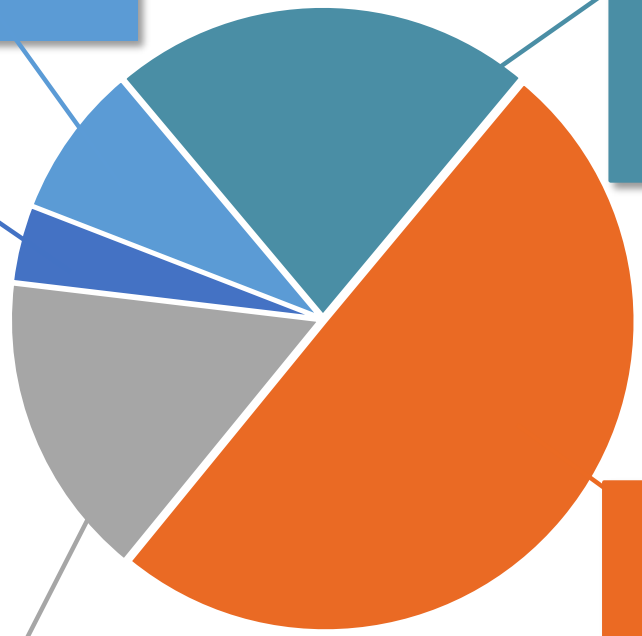
To identify and fill **high priority knowledge gaps** in recycled water research, including potable and non-potable applications, to **promote California's sustainable production and use of recycled water** and inform management priorities for recycled water.

Current Research Funded

Topic: Follow-up research needs
Grantee: TBD

Topic: Support Understanding of Potable Reuse Projects
Grantee: Water Research Foundation
Est. completion 2021

Topic: RO concentrate management
Grantee: Valley Water
Completed



Topic: Advance Potable and Non-Potable Reuse in California
Grantee: Water Research Foundation
Est. completion 2024

Topic: Developing Bioanalytical Toolbox
Grantee: SCCWRP
Est. completion 2024

Current Research Funded

THE Water Research FOUNDATION

3-phased Grant Agreement

Potable and Non-Potable

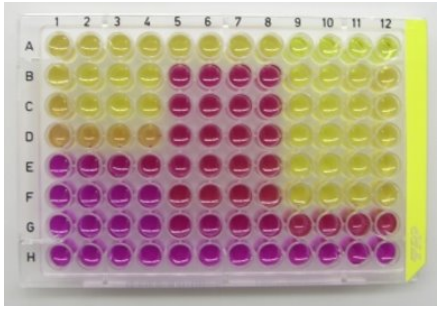
Est. Completion: April 2024

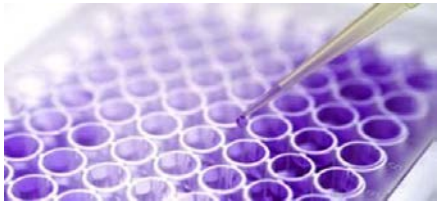
Practical Applications

Promote California's sustainable production and use of recycled water

Inform management priorities for recycled water.

Fill high priority knowledge gaps for recycled water





State Water Board
DDW
Update on Regulation Development

Jing Chao, State Water Resources Control Board

STATUS OF REGULATION DEVELOPMENT

Division of Drinking Water

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

REGULATION DEVELOPMENT MILESTONES

- 2016 Report to Legislature
- 2017 DPR Research & Source Control
- 2018 Framework for Regulating DPR
- 2019 Second Edition Framework for Regulation DPR
- 2020-2021 DPR Research & Source Control Findings
- 2021-2022 Expert Panel
- 2023 Regular Rulemaking Process under APA

EXPERT REVIEW PANEL

AB 574

- The state board shall establish and administer an expert review panel.
- Before adopting uniform water recycling criteria for raw water augmentation, the state board shall submit the proposed criteria to the expert review panel.
- The expert review panel shall review the proposed criteria and shall adopt a finding as to whether, in its expert opinion, the proposed criteria would adequately protect public health.
- The state board shall not adopt uniform water recycling criteria for raw water augmentation unless and until the expert review panel adopts a finding that the proposed criteria would adequately protect public health.

TIMELINE

2020
Start Expert Panel Contracting Process

2021
DPR research contract/agreement ends
Expert Panel in place

2022
Obtain Expert Panel findings
CalEPA Peer Review & CEQA

2023
Regular Rulemaking Process under APA
Adopt regulations by December 31, 2023

AB 574

Determine if 18-month deadline extension needed	June 30, 2023
If deadline beyond 18 months is needed, consult with expert review panel and post findings per CWC 13561.2(a)(5) process	June 30, 2024

DPR RESEARCH

- DPR 1 QMRA
- DPR-2 PATHOGEN MONITORING
- DPR-3 FEASIBILITY OF PATHOGEN MONITORING DURING OUTBREAK
- DPR-4 ADDRESSING CHEMICAL PEAKS
- DPR-5 NON-TARGET ANALYSIS WHITE PAPER

DPR-1
Tools to Evaluate Quantitative Microbial Risk and Plant Performance/Reliability

Brian Pecson and team, Trussell Technologies

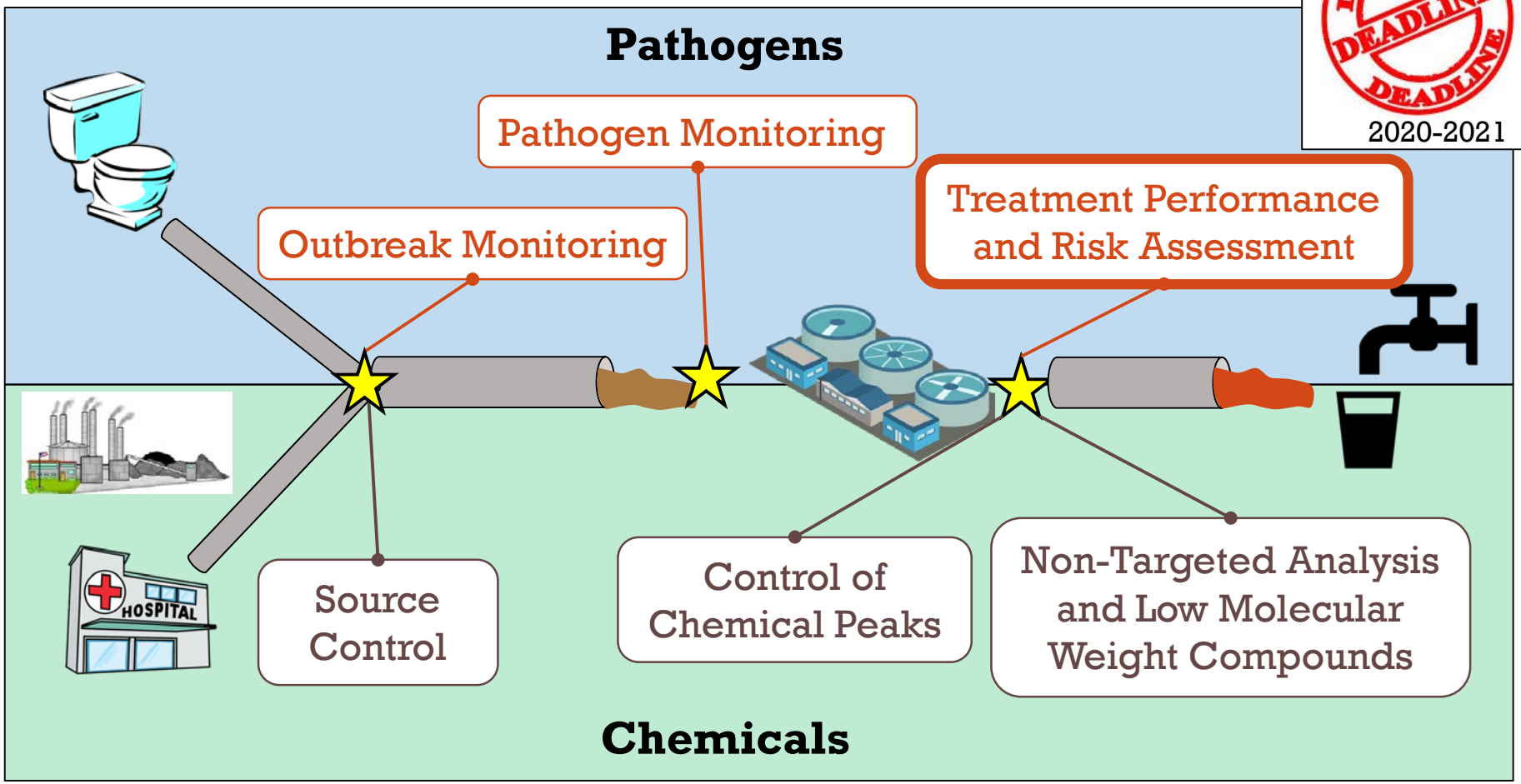
DPR-1 — PATTP/QMRA

June 12, 2020

Brian Pecson, Trussell Tech

Anya Kaufmann, Trussell Tech

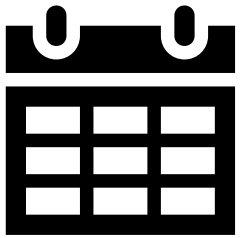
PRIORITY DPR RESEARCH PROJECTS



PATTP AND QMRA OVERVIEW

- State Board can use a probabilistic assessment of treatment train performance (PATTP) and QMRA to gain insight on multiple public health aspects
  - Ability of DPR treatment trains to reliably meet risk goals
  - Benefit of additional redundancy in treatment in achieving goals
  - Benefit of the diversity of treatment barriers (i.e., robustness)
  - Impact of a range of treatment failures with varying frequency, magnitude, duration

PROGRESS TO DATE



PAST

- Literature Review: June 2019
- Specifications for PATTP/QMRA Tools: August 2019
- Research Team Scope of Work: August 2019
- Kick-Off Meeting with Research Team on PATTP/QMRA Tools: December 2019
- Working Session with TWG and Research Team: April 2020

PRESENT

- DPR Grant Virtual Workshop

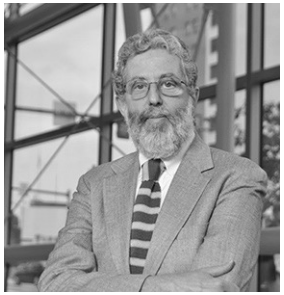
FUTURE

- Webinar with State Board, TWG, and Research Team to Introduce PATTP/QMRA Tools: July 14, 2020
- In-Person Workshop for hands-on training with PATTP/QMRA Tools: August 4, 2020

TWG AND RESEARCH TEAM

Technical Working Group

Nick Ashbolt
University of Alberta



Charles Haas
Drexel University

Brian Pecson (chair)
Trussell Technologies

Theresa Slifko
Metropolitan Water District

Research Team

Dan Gerrity
SNWA/UNLV

Edmund Seto
University of Washington

<u>Additional Staff</u>

- Anya Kaufmann (Trussell Tech)

<u>WRF/State Board Coordination</u>

- Adam Olivieri

DPR Pathogen Risk and Treatment

Drinking water

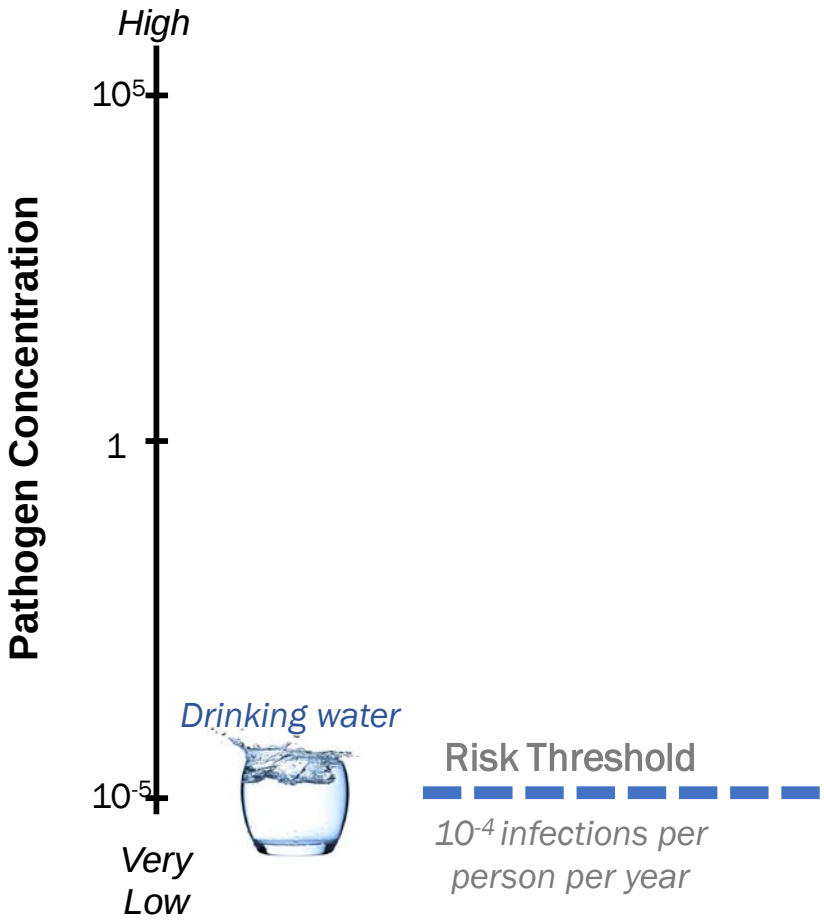
DPR Pathogen Risk and Treatment

Drinking water

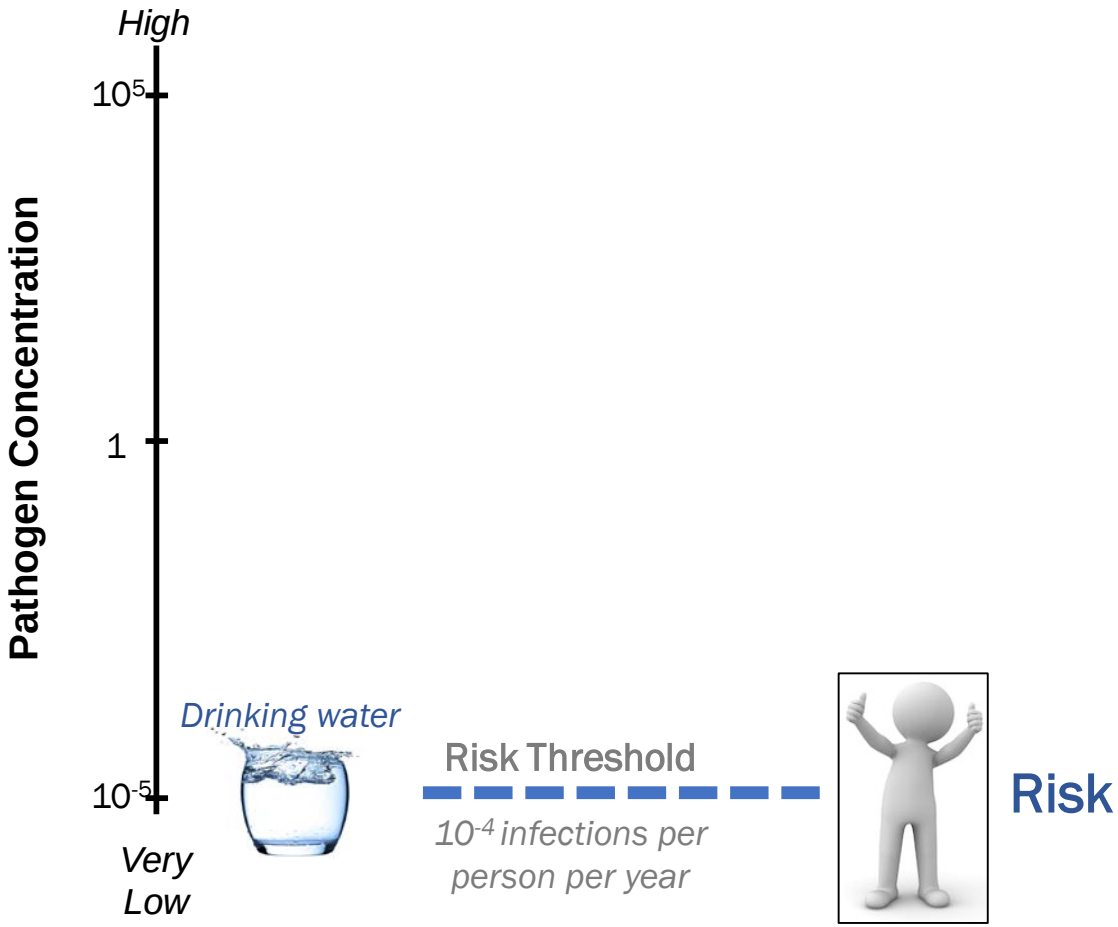
Risk Threshold

10^{-4} infections per person per year

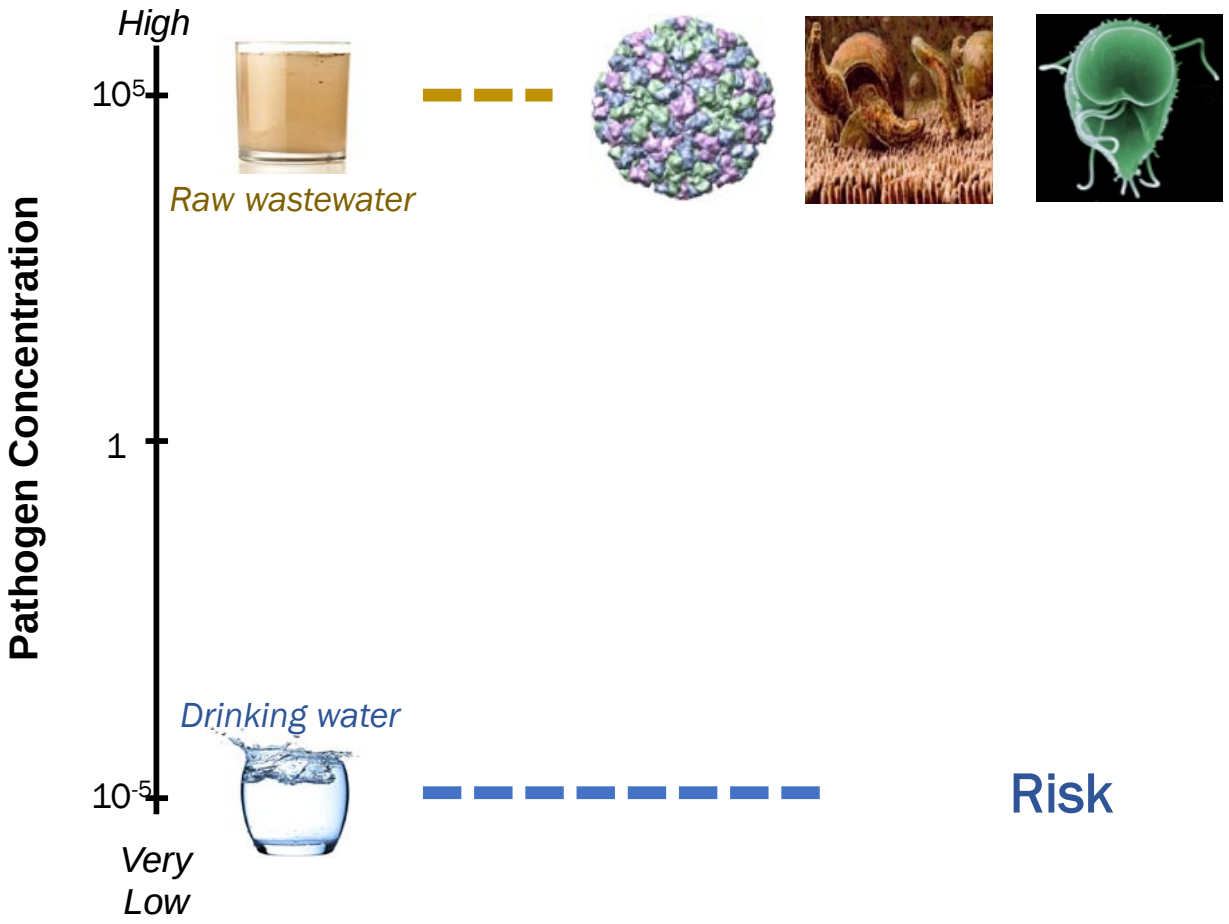
DPR Pathogen Risk and Treatment



DPR Pathogen Risk and Treatment



DPR Pathogen Risk and Treatment



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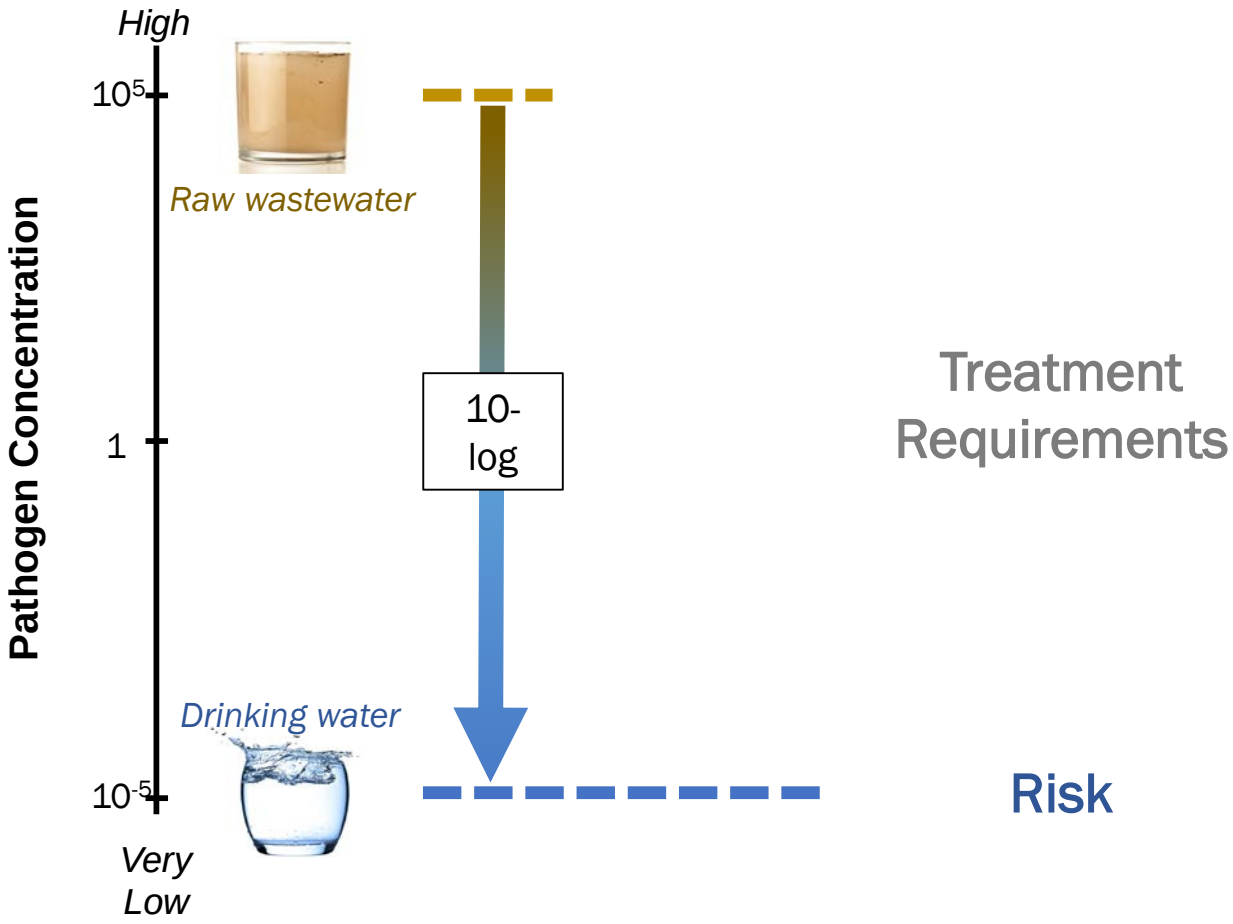

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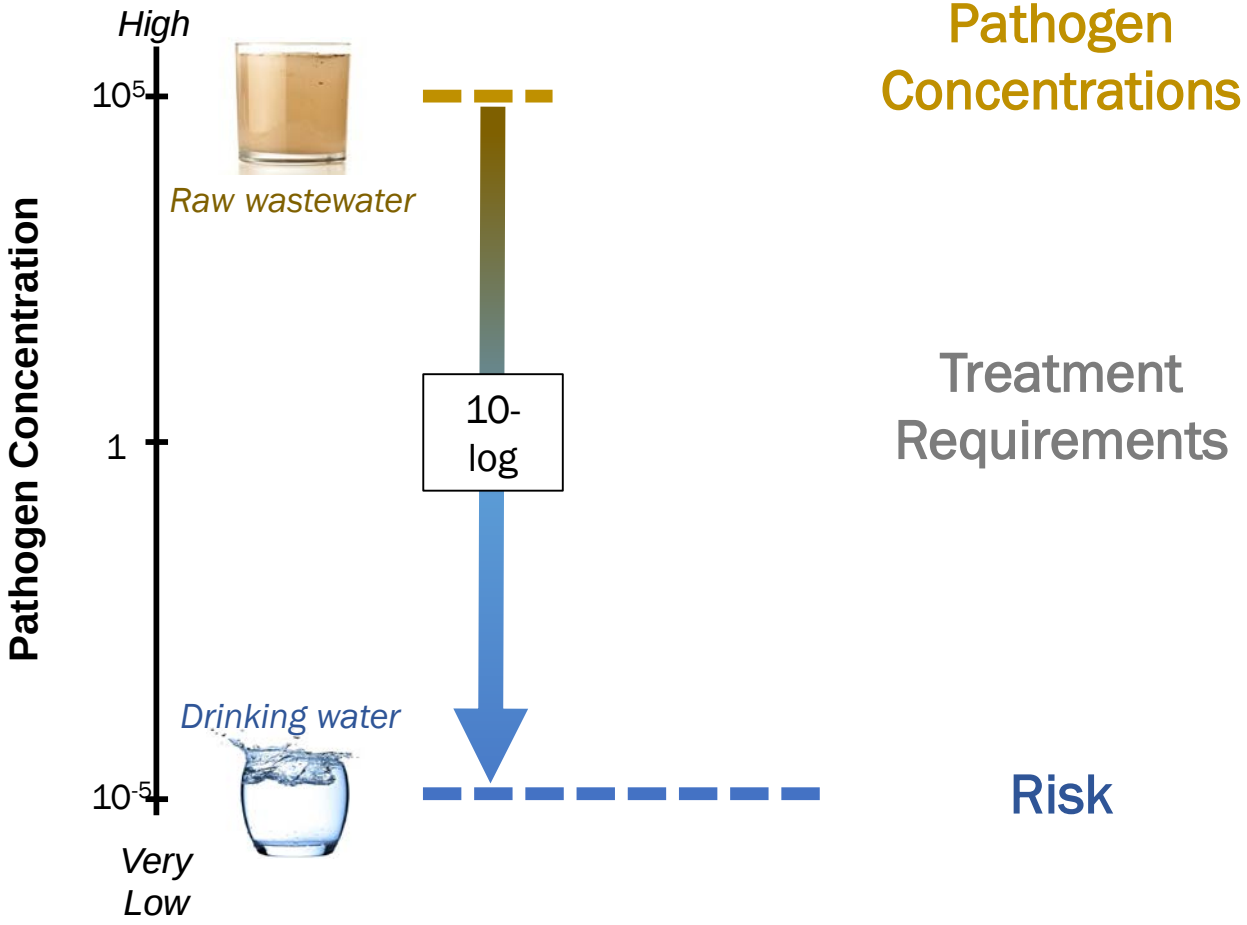

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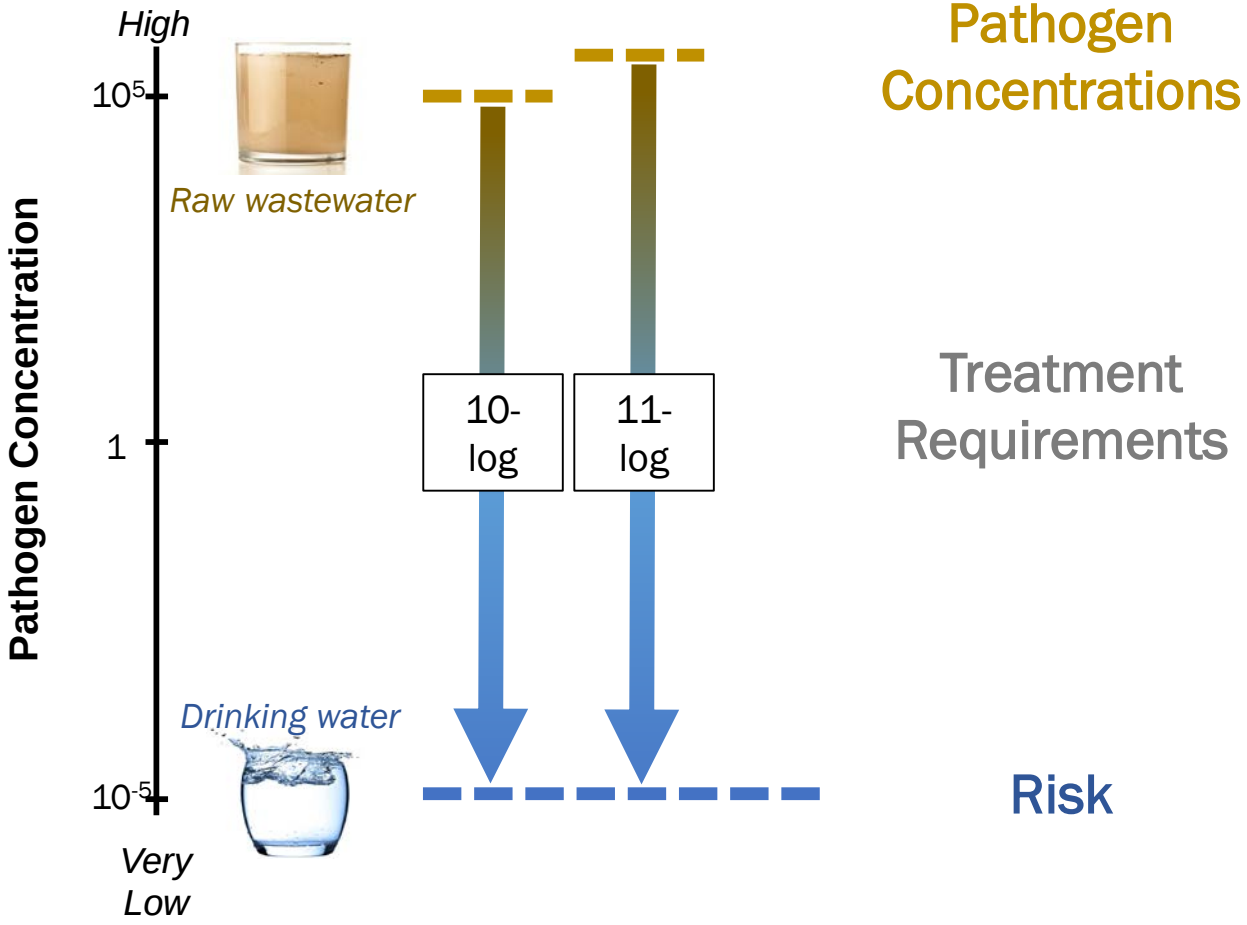
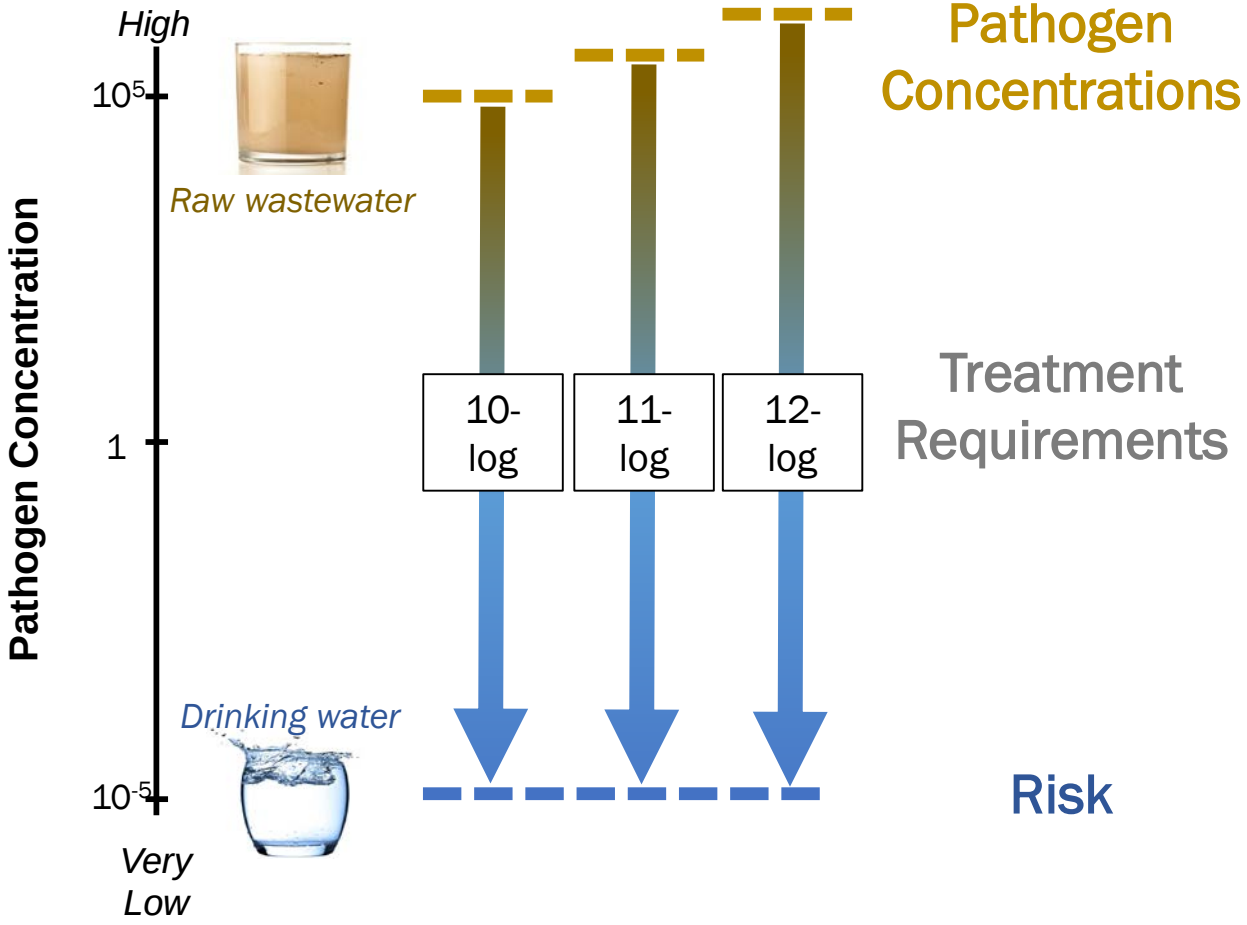
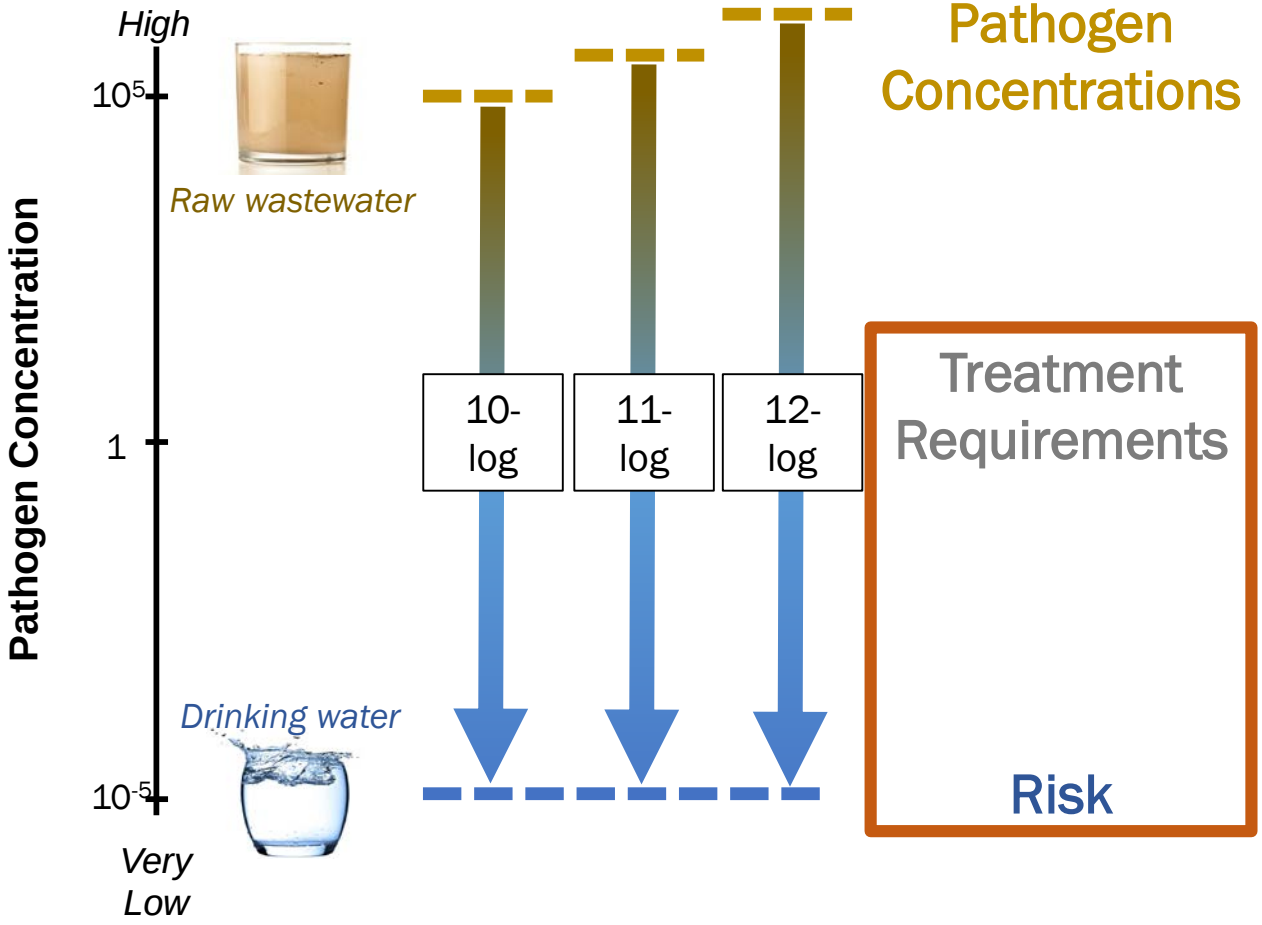


DPR Pathogen Risk and Treatment

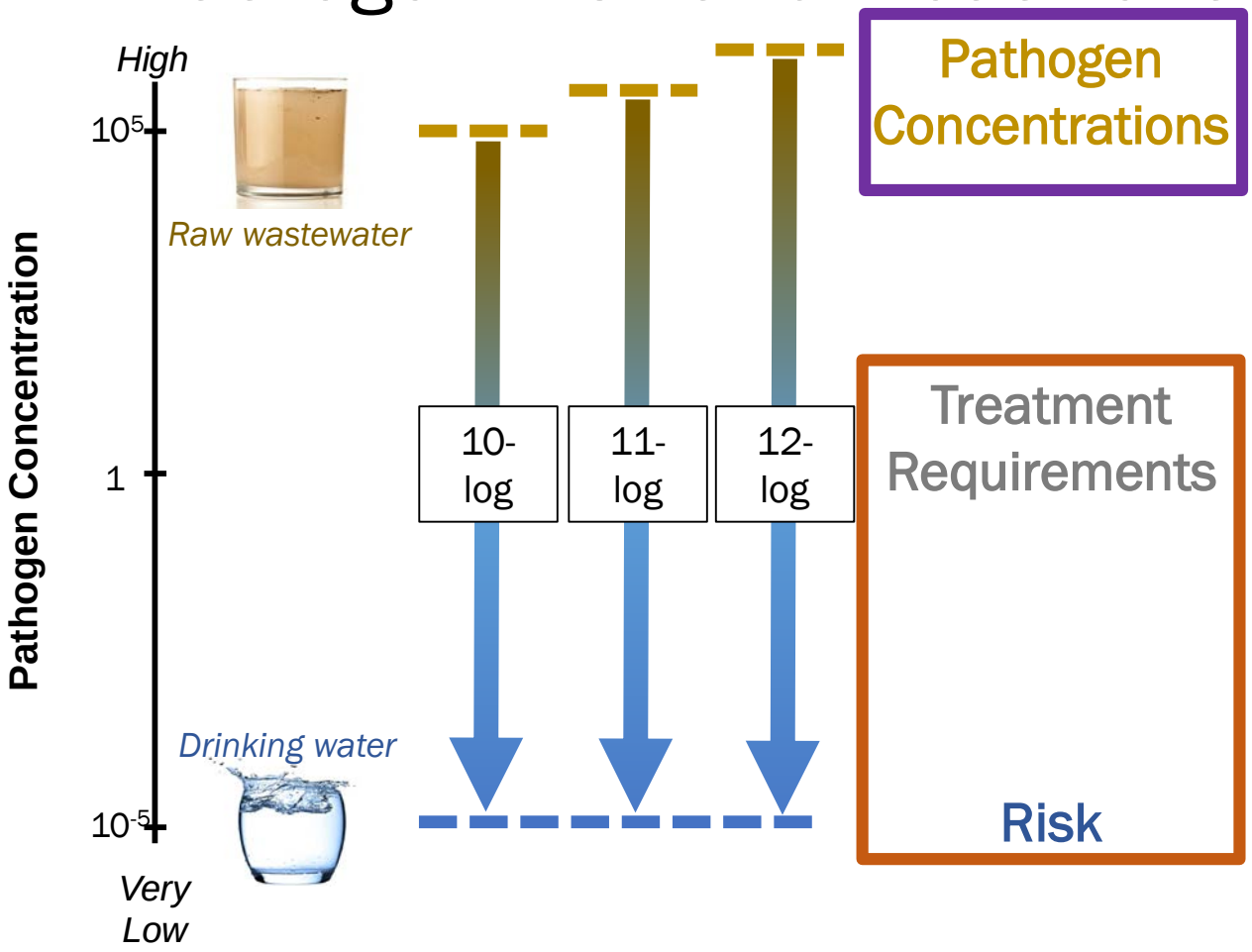


DPR Pathogen Risk and Treatment



DPR-1: Implementation of Probabilistic Treatment Train Performance and QMRA

DPR Pathogen Risk and Treatment



DPR-2: Pathogen Monitoring

DPR-1: Implementation of Probabilistic Treatment Train Performance and QMRA

Steps in QMRA

1. Exposure Assessment

Raw wastewater

Treatment

Drinking water levels

Drinking water consumption

Exposure

Steps in QMRA

1. Exposure Assessment

Raw wastewater

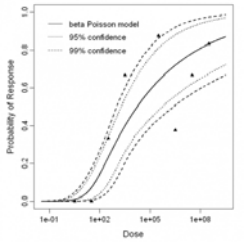
Treatment

Drinking water levels

Drinking water consumption

Exposure

2. Dose-Response



Dose-response

Steps in QMRA

1. Exposure Assessment

Raw wastewater

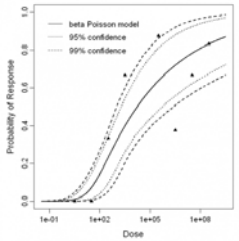
Treatment

Drinking water levels

Drinking water consumption

Exposure

2. Dose-Response



Dose-response

3. Risk Characterization

Risk

Steps in QMRA

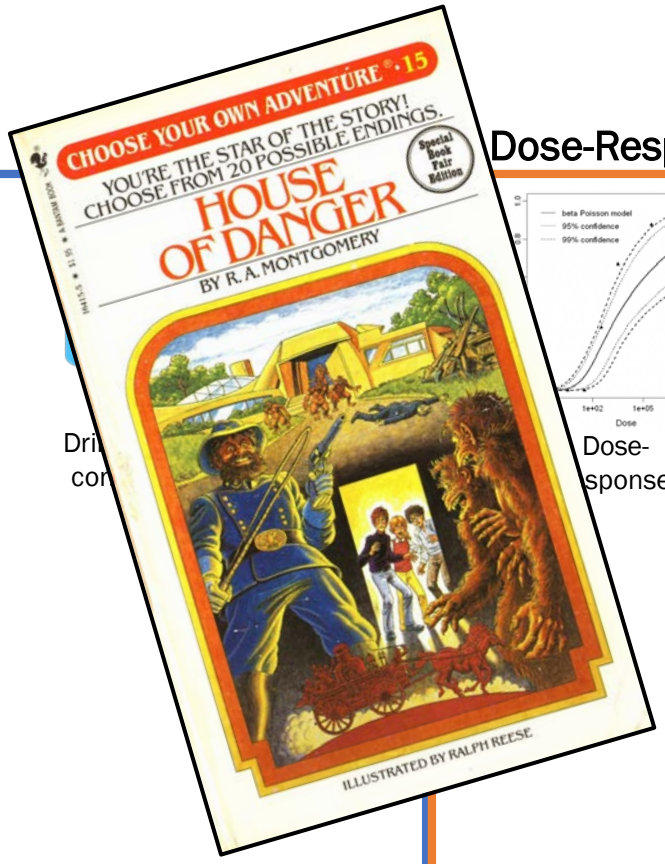
1. Exposure Assessment

Raw wastewater

Treatment

Drinking water levels

Dri
cor



Dose-Response

Dose-
sponse

3. Risk Characterization

Risk

There are a lot of decisions….

1. Exposure Assessment

Raw wastewater

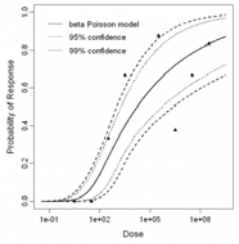
Treatment

Drinking water levels

Drinking water consumption

Exposure

2. Dose-Response

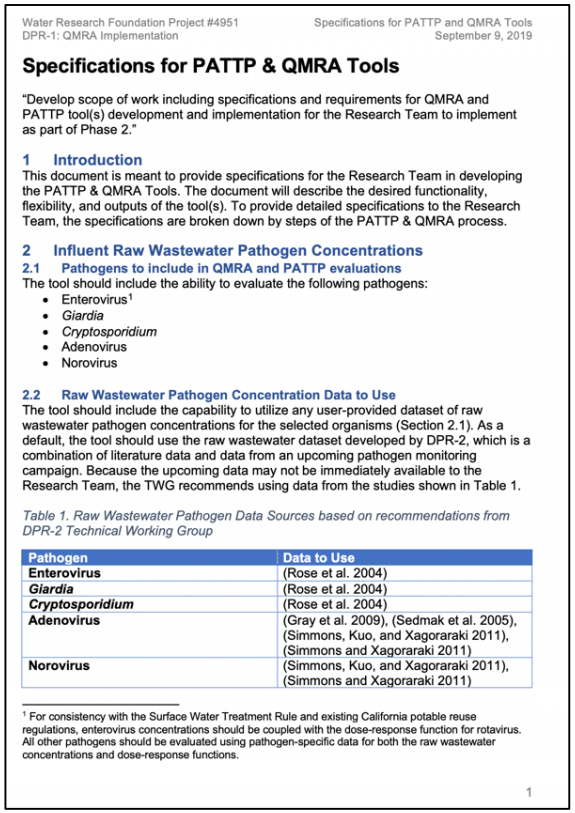


Dose-response

3. Risk Characterization

Risk

CONSISTENT FRAMEWORK FOR PATTP/QMRA



Specifications for PATTP & QMRA Tools

"Develop scope of work including specifications and requirements for QMRA and PATTP tool(s) development and implementation for the Research Team to implement as part of Phase 2."

1 Introduction

This document is meant to provide specifications for the Research Team in developing the PATTP & QMRA Tools. The document will describe the desired functionality, flexibility, and outputs of the tool(s). To provide detailed specifications to the Research Team, the specifications are broken down by steps of the PATTP & QMRA process.

2 Influent Raw Wastewater Pathogen Concentrations

2.1 Pathogens to include in QMRA and PATTP evaluations

The tool should include the ability to evaluate the following pathogens:

- Enterovirus[1]
- *Giardia*
- *Cryptosporidium*
- Adenovirus
- Norovirus

2.2 Raw Wastewater Pathogen Concentration Data to Use

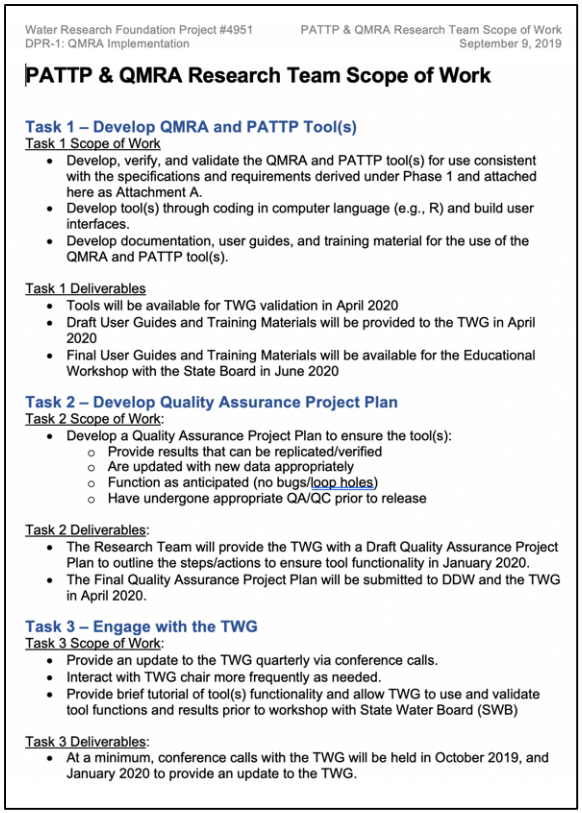
The tool should include the capability to utilize any user-provided dataset of raw wastewater pathogen concentrations for the selected organisms (Section 2.1). As a default, the tool should use the raw wastewater dataset developed by DPR-2, which is a combination of literature data and data from an upcoming pathogen monitoring campaign. Because the upcoming data may not be immediately available to the Research Team, the TWG recommends using data from the studies shown in Table 1.

Table 1. Raw Wastewater Pathogen Data Sources based on recommendations from DPR-2 Technical Working Group

Pathogen	Data to Use
Enterovirus	(Rose et al. 2004)
Giardia	(Rose et al. 2004)
Cryptosporidium	(Rose et al. 2004)
Adenovirus	(Gray et al. 2009), (Sedmak et al. 2005), (Simmons, Kuo, and Xagoraraki 2011), (Simmons and Xagoraraki 2011)
Norovirus	(Simmons, Kuo, and Xagoraraki 2011), (Simmons and Xagoraraki 2011)

[1] For consistency with the Surface Water Treatment Rule and existing California potable reuse regulations, enterovirus concentrations should be coupled with the dose-response function for rotavirus. All other pathogens should be evaluated using pathogen-specific data for both the raw wastewater concentrations and dose-response functions.

July 2019



PATTP & QMRA Research Team Scope of Work

Task 1 – Develop QMRA and PATTP Tool(s)

Task 1 Scope of Work

- Develop, verify, and validate the QMRA and PATTP tool(s) for use consistent with the specifications and requirements derived under Phase 1 and attached here as Attachment A.
- Develop tool(s) through coding in computer language (e.g., R) and build user interfaces.
- Develop documentation, user guides, and training material for the use of the QMRA and PATTP tool(s).

Task 1 Deliverables

- Tools will be available for TWG validation in April 2020
- Draft User Guides and Training Materials will be provided to the TWG in April 2020
- Final User Guides and Training Materials will be available for the Educational Workshop with the State Board in June 2020

Task 2 – Develop Quality Assurance Project Plan

Task 2 Scope of Work:

- Develop a Quality Assurance Project Plan to ensure the tool(s):
  - Provide results that can be replicated/verified
  - Are updated with new data appropriately
  - Function as anticipated (no bugs/loop holes)
  - Have undergone appropriate QA/QC prior to release

Task 2 Deliverables:

- The Research Team will provide the TWG with a Draft Quality Assurance Project Plan to outline the steps/actions to ensure tool functionality in January 2020.
- The Final Quality Assurance Project Plan will be submitted to DDW and the TWG in April 2020.

Task 3 – Engage with the TWG

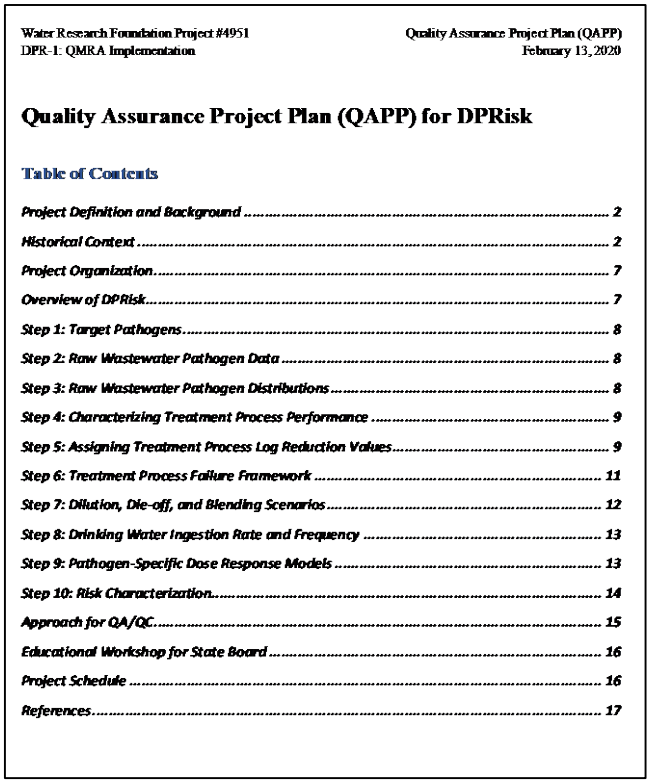
Task 3 Scope of Work:

- Provide an update to the TWG quarterly via conference calls.
- Interact with TWG chair more frequently as needed.
- Provide brief tutorial of tool(s) functionality and allow TWG to use and validate tool functions and results prior to workshop with State Water Board (SWB)

Task 3 Deliverables:

- At a minimum, conference calls with the TWG will be held in October 2019, and January 2020 to provide an update to the TWG.

August 2019



Quality Assurance Project Plan (QAPP) for DPRisk

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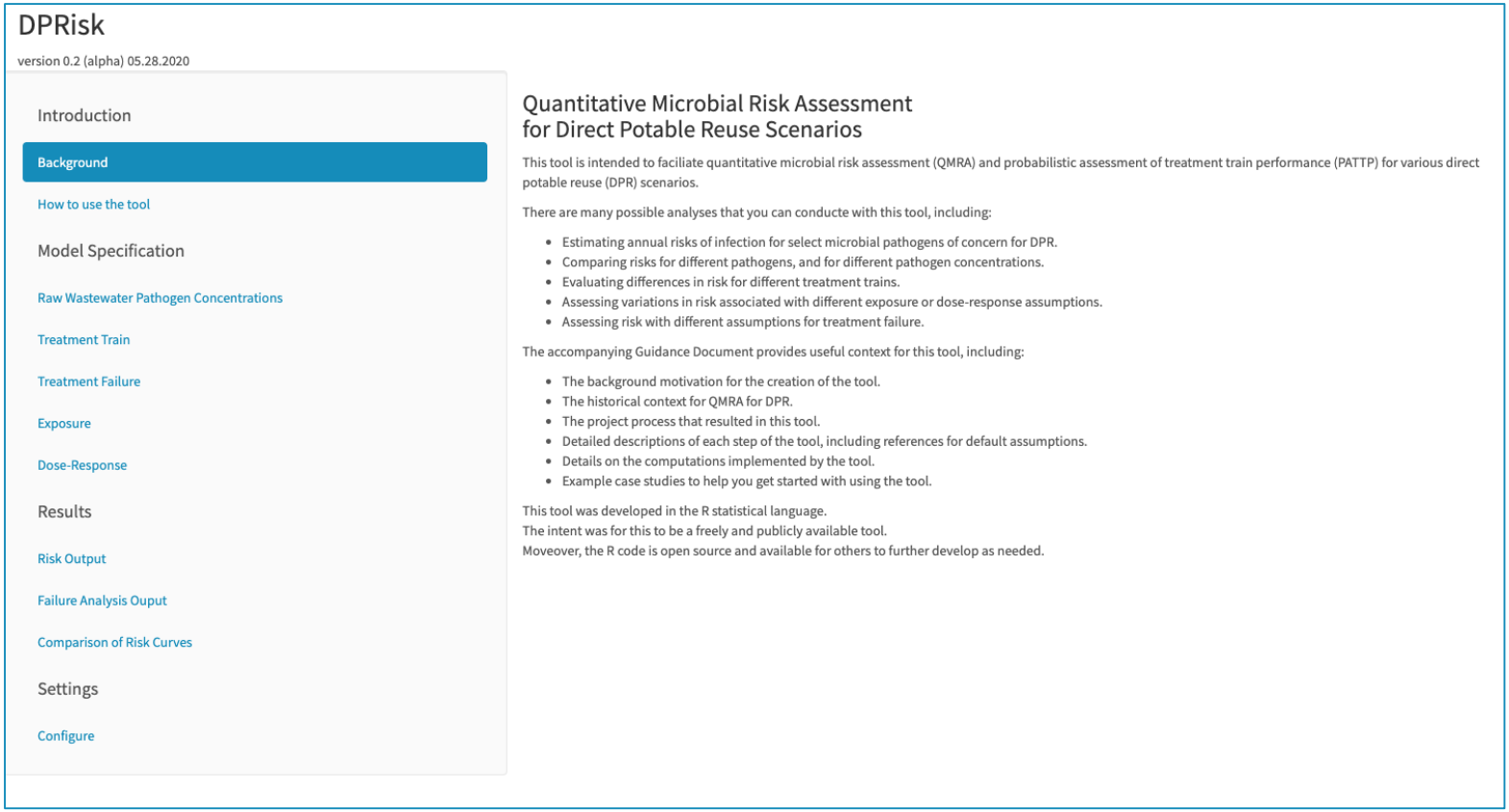
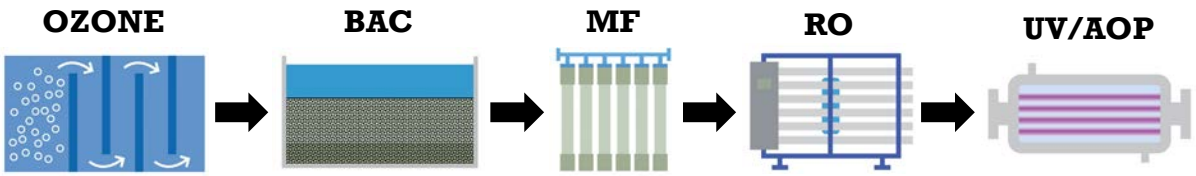
February 2020

QMRA/PATTP TOOL

DPRisk LIVE DEMO



PATTP: BENCHMARK PERFORMANCE DATA SET



- Data for the PATTP drawn from work done at the North City Demonstration Facility
- Continuous data collected for a year – probability distributions

Table 4
Fitted distribution parameters for unit process modeling.

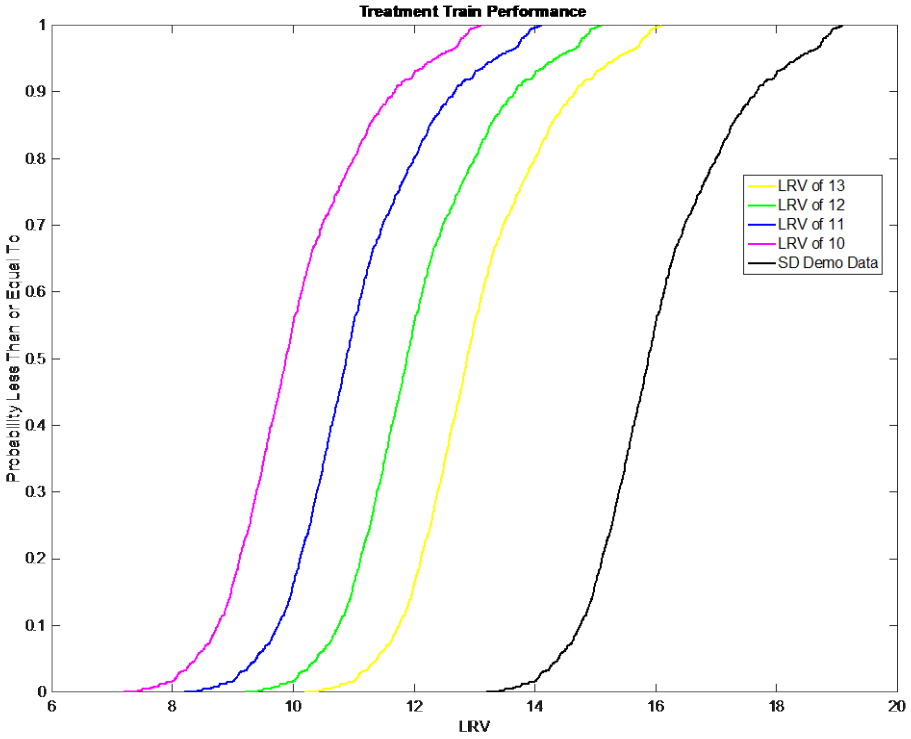
Process	Virus	*Cryptosporidium*	*Giardia*
Ozone	No distribution; LRV is either 6 or 0	Inverse Gaussian μ: 3.38; λ: 29.4[a]	No distribution; LRV is either 6 or 0
RO – TOC[b]	Inverse Gaussian; μ: 2.14; λ: 671.6		
RO – EC[b]	Inverse Gaussian; μ: 1.32; λ: 449.3		
MF	No LRV credit	Inverse Gaussian; μ: 4.68; λ: 12,286	
UV/AOP	No distribution; LRV is either 6 or 0		

[a] Distribution was truncated such that maximum allowed credit is 6 logs.
[b] Bimodal distribution due to EC being used as monitoring backup; 15% of distribution is EC, 85% is TOC.

Pecson et. al, 2017

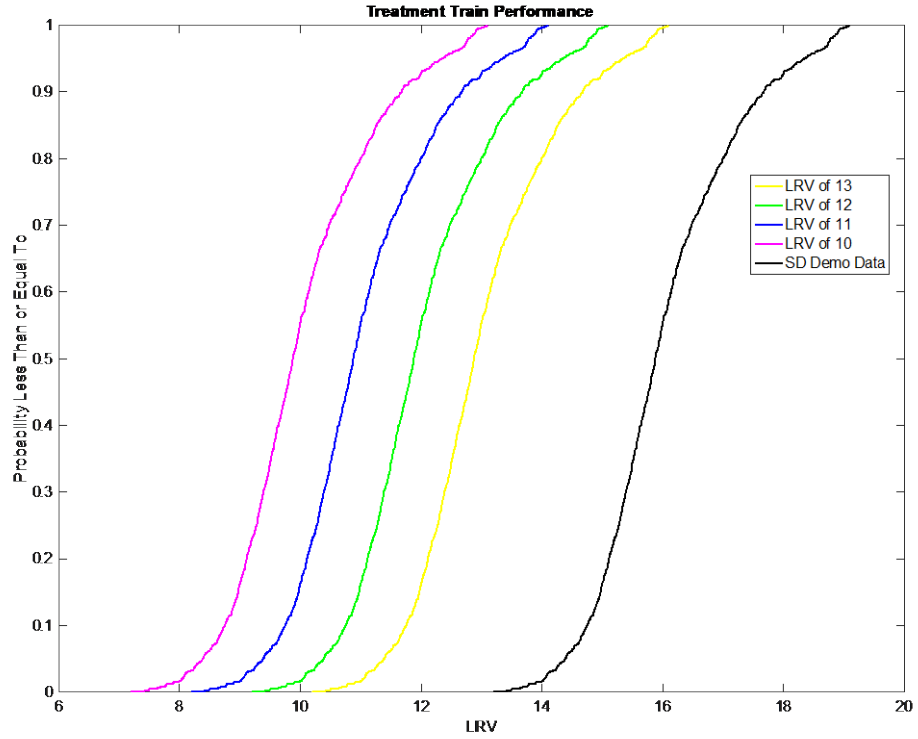
USING THE TOOL

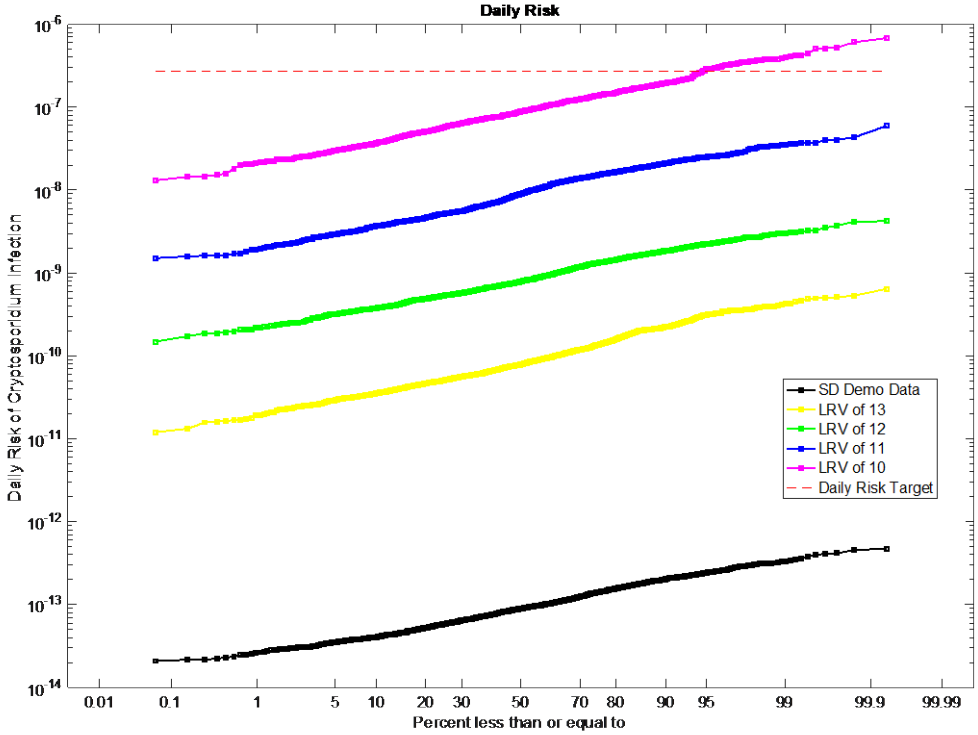
TOOLS CAN BE USED TOGETHER TO EVALUATE DIFFERENT DPR CRITERIA



Tool can compare performance curves for different treatment trains against each other and against baseline curves

TOOLS CAN BE USED TOGETHER TO EVALUATE DIFFERENT DPR CRITERIA





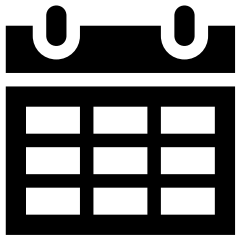
If we shift the treatment requirements....

...what is the impact on public health?

PATTP AND QMRA OVERVIEW

- State Board can use a probabilistic assessment of treatment train performance (PATTP) and QMRA to gain insight on multiple public health aspects
  - Ability of DPR treatment trains to reliably meet daily risk goals
  - Benefit of additional redundancy in treatment in achieving goals
  - Benefit of the diversity of treatment barriers (i.e., robustness)
  - Impact of a range of treatment failures with varying frequency, magnitude, duration

NEXT STEPS



PAST

- Literature Review: June 2019
- Specifications for PATTP/QMRA Tools: August 2019
- Research Team Scope of Work: August 2019
- Kick-Off Meeting with Research Team on PATTP/QMRA Tools: December 2019
- Working Session with TWG and Research Team: April 2020

PRESENT

- DPR Grant Virtual Workshop

FUTURE

- Webinar with State Board, TWG, and Research Team to Introduce PATTP/QMRA Tools: July 14, 2020
- In-Person Workshop for hands-on training with PATTP/QMRA Tools: August 4, 2020

DPR-2
Measuring Pathogens in Wastewater with Addition of Monitoring SARS-CoV-2

Brian Pecson and team, Trussell Technologies

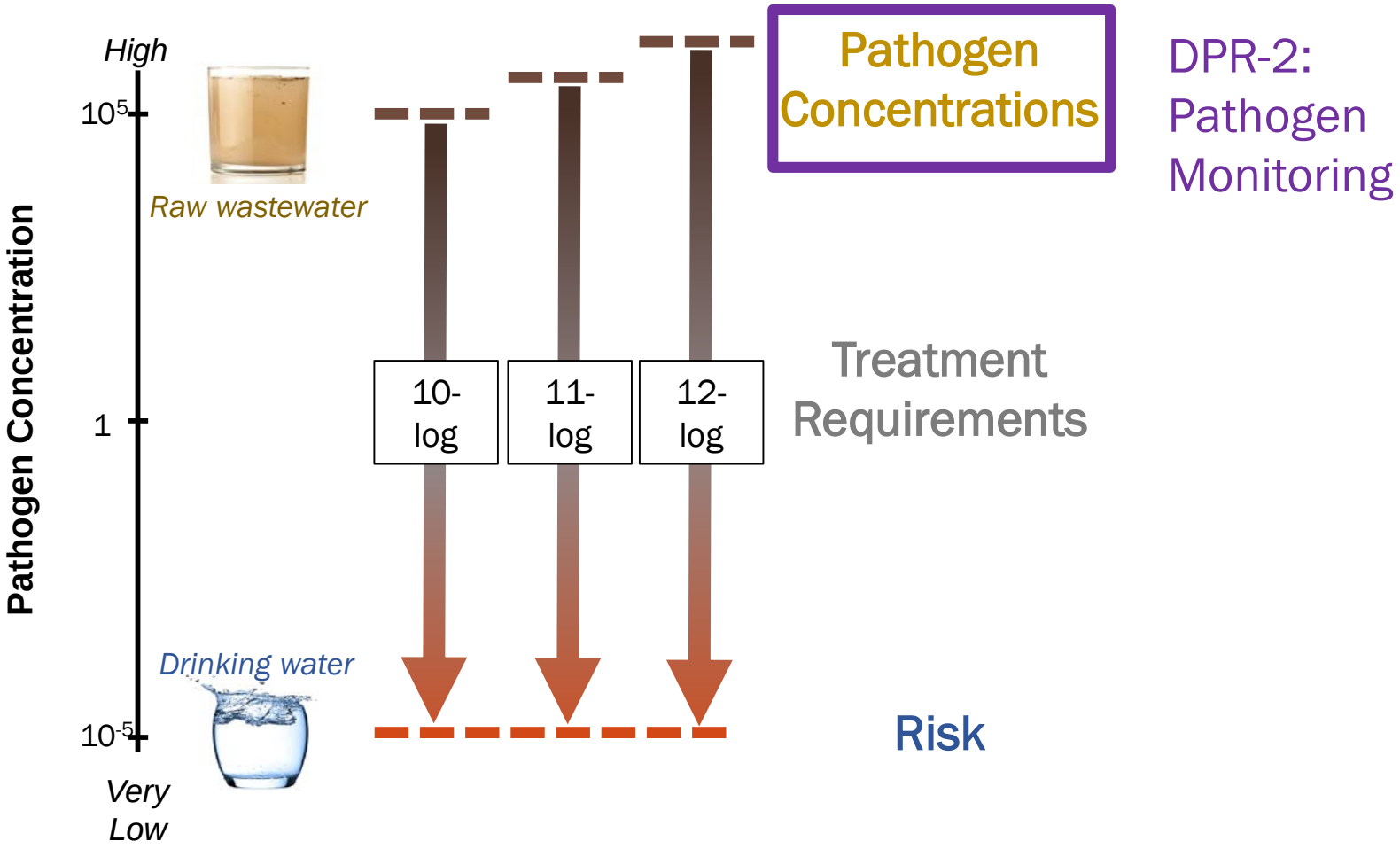
DPR-2: PATHOGEN MONITORING

June 12, 2020

Brian Pecson, Trussell Tech

Emily Darby, Trussell Tech

DPR Pathogen Risk and Treatment



IMPORTANCE OF PATHOGEN MONITORING

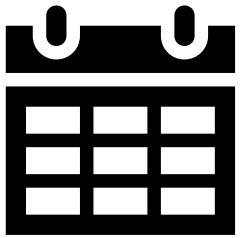
BACKGROUND

- Raw WW pathogen concentrations a key input for evaluations of DPR
- Industry does not have sufficient high-quality pathogen data

PROJECT OBJECTIVES

- New SOPs to address the limitations of previous monitoring efforts
- Provide industry with the largest dataset of raw pathogen concentrations
- Data from DPR-2 will feed into evaluation in DPR-1

PROGRESS TO DATE



PAST

- Literature and Methods Review: March 2019
- Develop Monitoring Plan and RFQ: July 2019
- Develop SOPs to Monitor for SARS-CoV-2: March to April 2020

PRESENT

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

FUTURE

- Analyze data and develop final report with recommendations

DPR-2 TECHNICAL WORK GROUP

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

Additional Staff

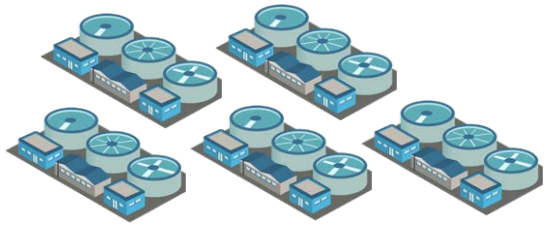
- Emily Darby (Trussell Tech)

WRF/State Board Coordination

- Adam Olivieri

WASTEWATER AGENCIES IN FULL-SCALE CAMPAIGN

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission



SANITATION DISTRICTS OF LOS ANGELES COUNTY

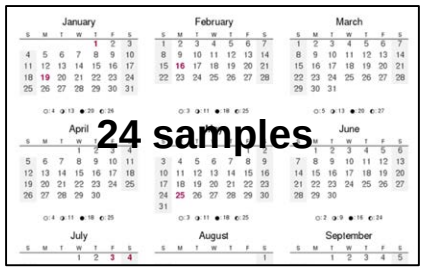
ORANGE COUNTY SANITATION DISTRICT
PROTECTING THE ENVIRONMENT

ORANGE COUNTY WATER DISTRICT

environment LA SANITATION
CITY OF LOS ANGELES

The City of SAN DIEGO

Five facilities



24 samples

DPR-2 COMMERCIAL LABORATORIES

cel analytical, inc.
water, wastewater, and soil laboratory services

Lead Lab

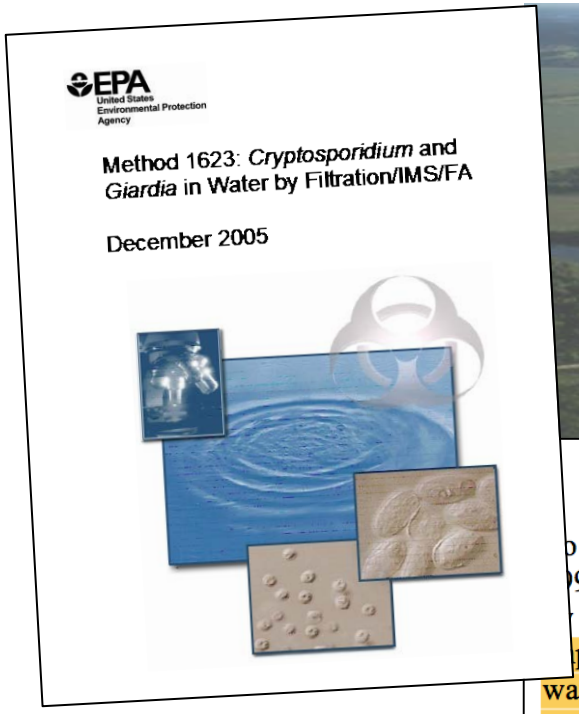
inc. BIOLOGICAL CONSULTING SERVICES OF NORTH FLORIDA, INC.

Method Development Lab

SCIENTIFIC METHODS

INDUSTRY NEEDS HIGH QUALITY PATHOGEN DATA

- Drinking water methods pose challenges for wastewater matrices



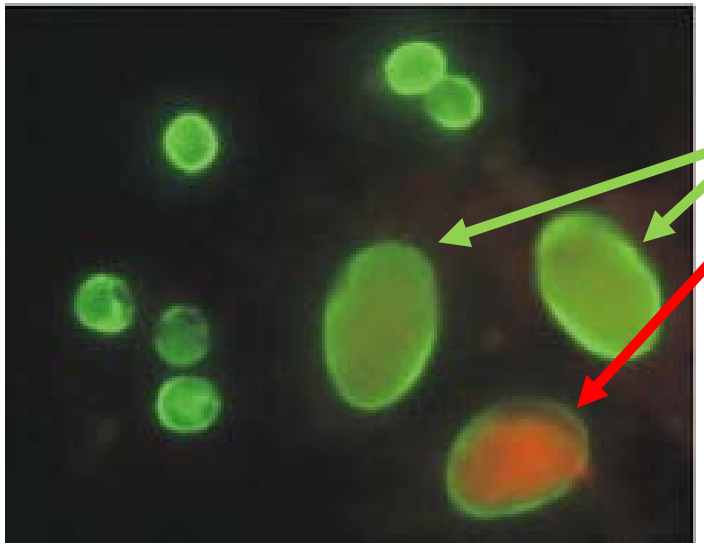
Introduction

o support future regulation of protozoa in drinking water, the Safe Drinking Water Act Amendments of 996 require the U.S. Environmental Protection Agency (EPA) to evaluate the risk to public health posed drinking water contaminants, including waterborne parasites, such as *Cryptosporidium* and *Giardia*. To plement these requirements, EPA must assess *Cryptosporidium* and *Giardia* occurrence in raw surface waters used as source waters for drinking water treatment plants. EPA Method 1623 was developed to support this assessment.

- Non-detect values are common and difficult to use

INDUSTRY NEEDS HIGH QUALITY PATHOGEN DATA

- Previous studies have not reported recoveries
- Leads to underestimation of pathogen concentrations

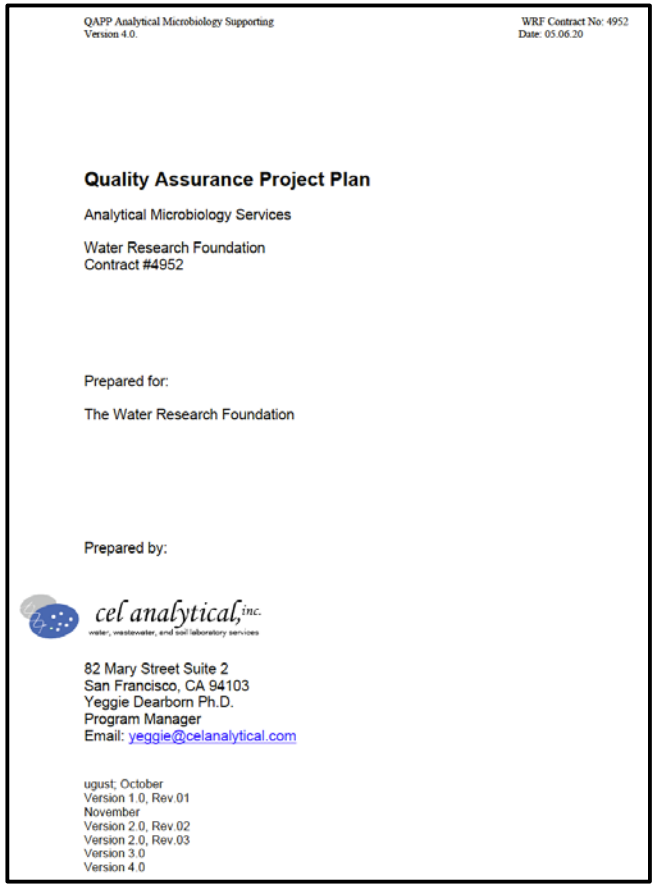


Giardia counted: 2
Colorseed counted: 1
Colorseed added: 10
Recovery percentage: 10%

Actual Giardia in sample: 2 x 10 = 20

- QA/QC is important for high-quality data

DPR-2 STANDARD OPERATING PROCEDURES SET NEW BAR FOR WASTEWATER MONITORING



QAPP Analytical Microbiology Supporting
Version 4.0.

WRF Contract No: 4952
Date: 05.06.20

Quality Assurance Project Plan

Analytical Microbiology Services

Water Research Foundation
Contract #4952

Prepared for:

The Water Research Foundation

Prepared by:

cel analytical, inc.
water, wastewater, and soil laboratory services

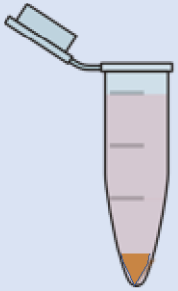
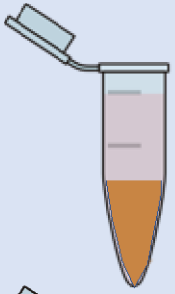
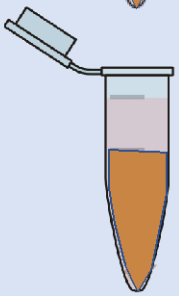
82 Mary Street Suite 2
San Francisco, CA 94103
Yeggie Dearborn Ph.D.
Program Manager
Email: yeggie@celanalytical.com

ugust; October
Version 1.0, Rev.01
November
Version 2.0, Rev.02
Version 2.0, Rev.03
Version 3.0
Version 4.0

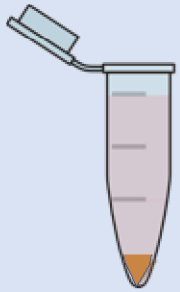
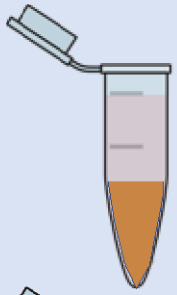
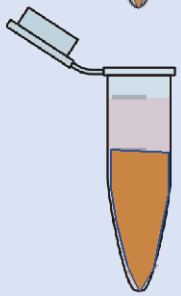
May 2020

- Developed through **lit review** and **methods pre-testing** study (Tasks 1 & 2)
- Further refined through **methods optimization study** using multiple wastewaters (Task 3)
- Findings **compared across three laboratories** (Task 3)

IMPROVED SENSITIVITY AND ACCURACY

Concentration Step	Sample Volume	Pellet Volume	Concentration (oocysts/L)
 *Filtration*	 *100 mL*	 *1 mL*	**ND** (<10-12)
	 *500 mL*	 *2 mL*	**ND** (<3-6)
 *Centrifugation*	 *1000 mL*	 *4 mL*	***Site 1*** 5-9 ***Site 2*** 18-32

IMPROVED SENSITIVITY AND ACCURACY

Concentration Step	Sample Volume	Pellet Volume	Concentration (oocysts/L)	Average Recovery	Corrected Conc. (oocysts/L)
 *Filtration*	 *100 mL*	 *1 mL*	**ND** (<10-12)		
 *Centrifugation*	 *500 mL*	 *2 mL*	**ND** (<3-6)		
	 *1000 mL*	 *4 mL*	*Site 1* 5-9 *Site 2* 18-32	26% 30%	6-18 40-55

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 from 12/2019 to 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

SARS-CoV-2

HOW DOES SARS-COV-2 FIT IN?

HOW DOES SARS-COV-2 FIT IN?

2020

Sept

Nov

Mar

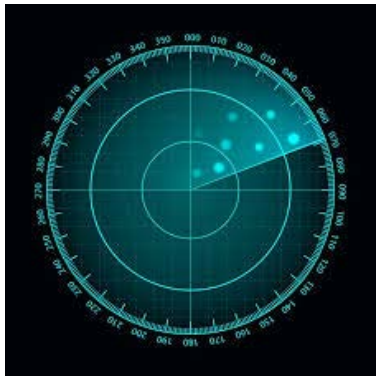
2021

Jan

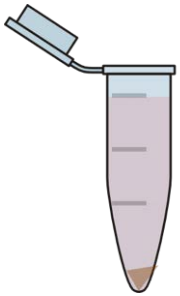
Methods for DPR-2 pathogen campaign

Start Full-Scale Campaign

Shelter-in-Place and initial COVID discussion

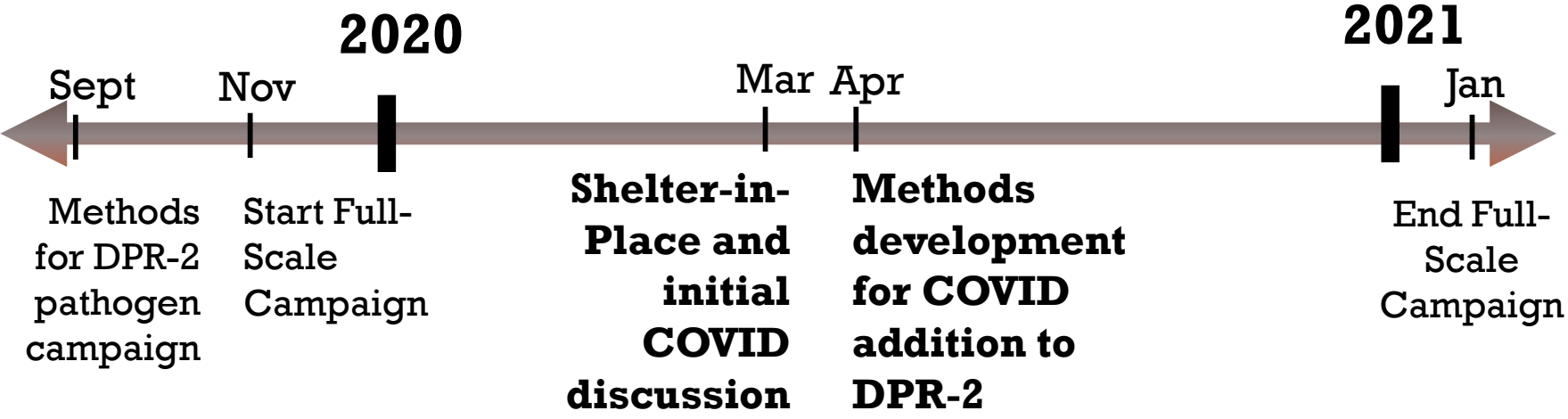


End Full-Scale Campaign



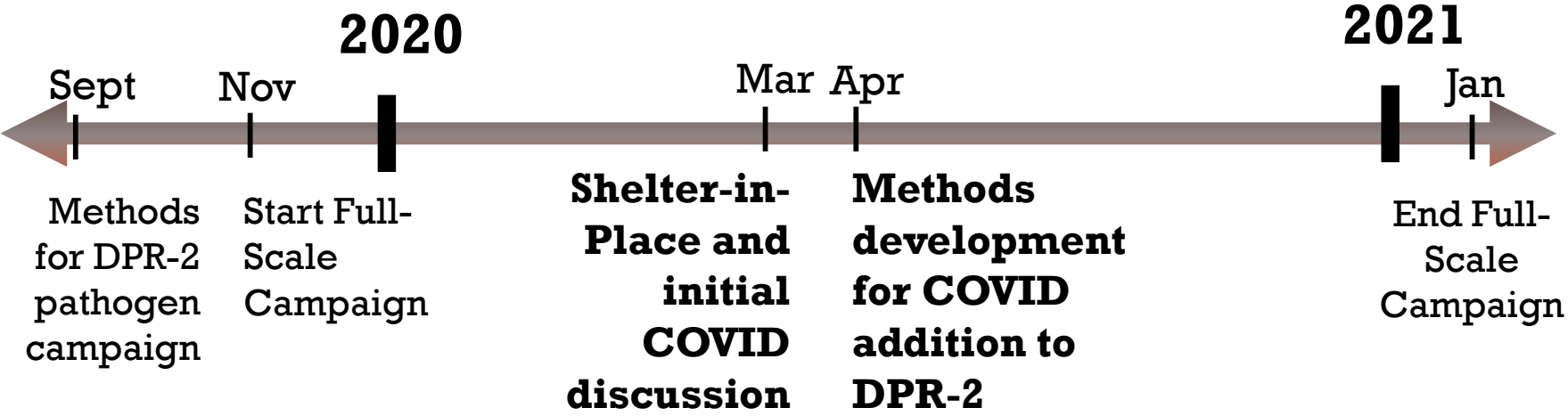
- State Water Board mobilizes to expand surveillance for SARS CoV-2
- Campaign has archived DNA/RNA extracts since November 2019
- Previous SOPs not optimized for SARS-CoV-2

HOW DOES SARS-COV-2 FIT IN?



- Methods: optimize concentration and extraction methods
- QA/QC: apply same rigor to COVID as other DPR-2 pathogens
- Finalized SOPs in May 2020 and expanded scope for initial phase

HOW DOES SARS-COV-2 FIT IN?



Phase 1: Evaluate archived samples with previous SOP

Phase 2: Evaluate future samples with optimized COVID SOP

WHY IS THIS RESEARCH IMPORTANT?

- Much remains unknown about epidemiology of SARS-CoV-2

A Coronavirus Death in Early February Was 'Probably the Tip of an Iceberg'

The startling discovery that the virus was responsible for a Feb. 6 death in California raises questions about where else it might have been spreading undetected.

The New York Times
April 22, 2020

- Samples may provide insight into the timing and spread of SARS-CoV-2 in the community

WHY IS THIS RESEARCH IMPORTANT FOR POTABLE REUSE?

- Initial data show SARS-CoV-2 **unlikely to drive treatment requirements**
- Allows State Water Board to stay vigilant on new microbial threats
- Contributes to understanding of the impact of outbreaks on pathogen control (DPR-3)
- Useful in developing public health criteria for various water-related applications including potable reuse

WILL SARS-CoV-2 RESET OUR REQUIREMENTS?

Environmental Science
Water Research & Technology

ROYAL SOCIETY OF CHEMISTRY

EDITORIAL

View Article Online
View Journal

Check for updates

Cite this: DOI: 10.1039/d0ew90031a

Editorial Perspectives: will SARS-CoV-2 reset public health requirements in the water industry? Integrating lessons of the past and emerging research

Brian Pecson, †*[a] Daniel Gerrity, †*[b] Kyle Bibby, [c] Jörg E. Drewes, [d] Charles Gerba, [e] Richard Gersberg, [f] Raul Gonzalez, [g] Charles N. Haas, [h] Kerry A. Hamilton, [i,j] Kara L. Nelson, [k] Adam Olivieri, [l] Channah Rock, [m] Joan Rose [n] and Mark Sobsey [o]

DOI: 10.1039/d0ew90031a

rsc.li/es-water

Naddeo and Liu recently published the following editorial: "2019 novel coronavirus (SARS-CoV-2): what is its fate in urban water cycle and how can the water research community respond?"[1] The editorial raises important questions about the impact of SARS-CoV-2 on our water systems, and rightfully encourages the water community to ensure that our treatment systems are providing protection against this new threat. The dialogue also highlights a broader question, namely, have we developed water systems that are sufficiently robust to handle not just SARS-CoV-2, but emerging and unknown pathogens both today and in the future? As researchers and engineers who have focused on the detection and fate of viruses through natural and engineered treatment processes (*e.g.*, physical removal and disinfection), we would like to provide perspective on what is known, what is being learned through current research, and how it will help to answer the essential question: do our existing water systems adequately protect public health?

To begin, the water industry should be commended for the speed with which it identified SARS-CoV-2's potential importance and mobilized resources to better understand it. For example, the March 2020 recommendation by Drs. Naddeo and Liu for targeted SARS-CoV-2 monitoring campaigns has already materialized—even as early as February and March in the Netherlands, France, Australia, the United States, and other countries—and the effort has helped address critical knowledge gaps.[2–4] Beyond individual research studies, the Water Research Foundation (WRF) also convened a virtual research summit comprised of ~50 scientists, engineers, public health experts, and other water industry professionals to establish best practices for environmental surveillance of SARS-CoV-2. Other professional organizations, such as the Water Environment Federation (WEF), quickly published documents providing general information about SARS-CoV-2 and specific guidance for the wastewater industry, much of which was also applicable to drinking water and water reuse.[5]

Numerous groups throughout the world continue to track concentrations of SARS-CoV-2 RNA in wastewater with the aim of addressing questions specific to the water industry and also broader questions relevant to public health. By coupling these data with clinical research findings, we can reduce some of the uncertainty around SARS-CoV-2, better understand the magnitude of the potential threat, and also evaluate the effectiveness of existing treatment systems. Collaborations and funding for these campaigns have materialized rapidly, with widespread support from universities, local agencies and utilities, and state and national research programs. These recent efforts support the wealth of information that the industry has already accumulated on similar viruses from past outbreaks (*e.g.*, SARS, MERS, and Ebola).[6,7] We are able to

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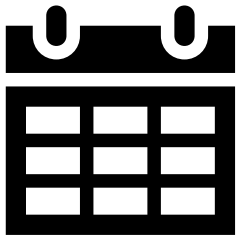
[b] *Applied Research and Development Center, Southern Nevada Water Authority, P.O. Box 99954, Las Vegas, NV 89193-9954, USA. E-mail: daniel.gerrity@snwa.com*
[c] *Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN 46556, USA*
[d] *Chair of Urban Water Systems Engineering, Technical University of Munich, Garching, Germany*
[e] *Department of Environmental Science, Water and Energy Sustainable Technology (WEST) Center, University of Arizona, Tucson, AZ, USA*
[f] *College of Public Health, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182, USA*
[g] *Hampton Roads Sanitation District, 1434 Air Rail Blvd, Virginia Beach, Virginia 23455, USA*
[h] *Department of Civil, Architectural and Environmental Engineering, Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104, USA*
[i] *The School of Sustainable Engineering and the Built Environment, Arizona State University, 1001 S McAlister Ave, Tempe, AZ 85281, USA*
[j] *The Biodesign Institute Center for Environmental Health Engineering, Arizona State University, 1001 S McAlister Ave, Tempe, AZ 85281, USA*
[k] *Department of Civil and Environmental Engineering, University of California, Berkeley, California 94720, USA*
[l] *EOA, 1410 Jackson Street, Oakland, CA 94612, USA*
[m] *Department of Environmental Science, University of Arizona, Maricopa, AZ, USA*
[n] *Department of Fisheries and Wildlife, Michigan State University, 480 Wilson Road, East Lansing, MI 48824, USA*
[o] *Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina Chapel Hill, Chapel Hill, NC, USA*
† Co-primary authors equally contributed to this work.

- SARS-CoV-2 unlikely to drive new, stricter requirements for the treatment of potable water supplies
- Evaluated the three main topics of risk assessment:
  - Present at lower concentrations in source waters
  - More sensitive to treatment
  - Less infective than viruses upon which existing drinking water and potable reuse regulations are based
- "*Our current requirement for robust, multiple-barrier treatment systems evolved to reliably control a diversity of waterborne pathogens identified in the past. This same approach appears to be a solid foundation for the control of emerging and future pathogens as well.*"

NEXT STEPS



PAST

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- Develop Monitoring Plan and RFQ: July 2019
- Develop SOPs to Monitor for SARS-CoV-2: March to April 2020

PRESENT

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

FUTURE

- Analyze data and develop final report with recommendations

DPR-3
Collecting Pathogens in Wastewater During Outbreaks

Krista Wigginton, Univ. of Michigan

DPR3: Feasibility of collecting pathogens in wastewater during outbreaks

Krista Wigginton, University of Michigan

Collaborators:
Ali Boehm (Stanford)
Nasa Sinnot-Armstrong (Stanford)
Kathryn Langenfeld (UM)
Nicole Rockey (UM)

3 Collecting Pathogens in Wastewater During Outbreaks

Scope:

This topic will investigate the feasibility of collecting pathogen concentration data for untreated wastewater associated with community outbreaks of disease. Information collected as part of a focused literature review on specific pathogens and public health surveillance as part of this project and data collected as part of the pathogen monitoring campaign will also be used to help frame and address the following questions:

- 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 all of this 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.

Milestone 1: Collection of literature

- Collect literature on municipal and hospital wastewaters where human norovirus, adenovirus, and Cryptosporidium were quantified
- Collect literature on fecal concentrations of norovirus, adenovirus, and Cryptosporidium *Builds off of work from DPR 2*
- Consult literature, epidemiologists, and governmental databases about the seasonality and scale of enteric pathogen outbreaks in California.
- Collect that links public health surveillance information linked to the organisms of concern and concentrations found in raw wastewater.

Milestone 2: Summarize relevant information in summary tables

- Review collected literature and create summary tables of sewage location, dates of collection, collection method, concentration approaches, concentration factors, if and how virus recoveries were assessed, primer/probe sequences, qPCR QA/QC details provided, ultimate pathogen concentrations reported, and outbreak metrics.

- Integrate collected disease surveillance data from different sources into tables and figures

- Studies will be removed that do not meet minimum QA/QC parameters (e.g., no virus recovery test included)

Milestone 3: Develop feasibility report based on literature review and initial results from DPR-2

- Based on combined results from Milestone 2, assess the remaining research needs for outbreak detection in CA.

- With combined disease surveillance along with fecal and wastewater concentrations, test forward and backwards model to predict concentrations in wastewater

- Prepare feasibility report summarizing results of feasibility study. Include a prioritized list of remaining research questions as well as candidate research team members necessary to carry out the most pressing research identified (if any identified).

Milestone 3: Develop feasibility report based on literature review and initial results from DPR-2 (Cont.)

- Review results of feasibility report with SWB and WRF staff prior to proceeding with scope of work for collecting additional pathogen/organism data.

- Prepare a proposed scope of work for the collection of raw wastewater adjacent to a local hospital (or other location based on results of literature review) associated with the DPR-2 investigation including a discussion on potential partnerships, communications approach, and surveillance. (if the need is a high priority).

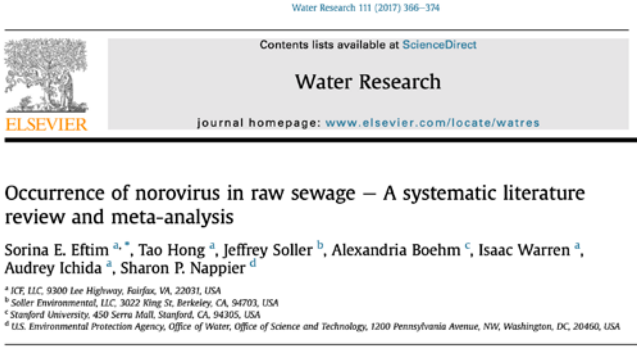
- Collect reportable infectious disease data (waterborne) from the identified hospital/community.

Milestone 4: Peer Review of Draft Feasibility Report

Milestone 5: Finalize Feasibility Report

Milestone 1 underway

1. Wastewater Concentrations



Water Research 111 (2017) 366–374

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Occurrence of norovirus in raw sewage – A systematic literature review and meta-analysis

Sorina E. Eftim [a, *], Tao Hong [a], Jeffrey Soller [b], Alexandria Boehm [c], Isaac Warren [a], Audrey Ichida [a], Sharon P. Nappier [d]

[a] ICF, LLC, 9300 Lee Highway, Fairfax, VA, 22031, USA
[b] Soller Environmental, LLC, 3022 King St, Berkeley, CA, 94703, USA
[c] Stanford University, 450 Serra Mall, Stanford, CA, 94305, USA
[d] U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, 1200 Pennsylvania Avenue, NW, Washington, DC, 20460, USA

2. Past WW Epidemiology Studies

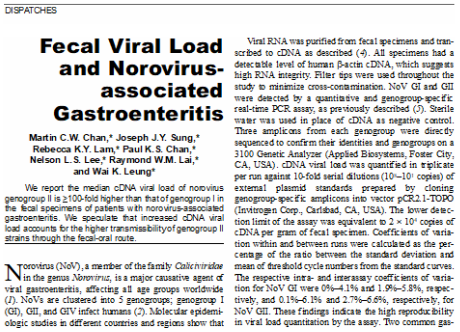
AEM Journals.ASM.org

Detection of Pathogenic Viruses in Sewage Provided Early Warnings of Hepatitis A Virus and Norovirus Outbreaks

Maria Hellmér,[a] Nicklas Paxéus,[b] Lars Magnius,[c] Lucica Enache,[b] Birgitta Arnholm,[d] Annette Johansson,[b] Tomas Bergström,[a] Heléne Norder[a,c]

Department of Clinical Microbiology, Sahlgrenska Academy, Gothenburg University, Gothenburg, Sweden[a]; Gryaab AB, Gothenburg, Sweden[b]; MTC, Karolinska Institutet, Stockholm, Sweden[c]; Department of Communicable Disease Control, Västra Götaland Region, Sweden[d]

3. Fecal Loads



DISPATCHES

Fecal Viral Load and Norovirus-associated Gastroenteritis

Martin C.W. Chan,* Joseph J.Y. Sung,* Rebecca K.Y. Lam,* Paul K.S. Chan,* Nelson L.S. Lee,* Raymond W.M. Lai,* and Wai K. Leung*

We report the median cDNA viral load of norovirus genogroup II is ≥100-fold higher than that of genogroup I in the fecal specimens of patients with norovirus-associated gastroenteritis. We speculate that increased cDNA viral load accounts for the higher transmissibility of genogroup II strains through the fecal-oral route.

Norovirus (NoV), a member of the family *Caliciviridae* in the genus *Norovirus*, is a major causative agent of viral gastroenteritis, affecting all age groups worldwide (*1*). NoVs are clustered into 5 genogroups; genogroup I (GI), GII, and GIV infect humans (*2*). Molecular epidemiologic studies in different countries and regions show that

Viral RNA was purified from fecal specimens and transcribed to cDNA as described (*4*). All specimens had a detectable level of human β-actin cDNA, which suggests high RNA integrity. Filter tips were used throughout the study to minimize cross-contamination. NoV GI and GII were detected by a quantitative and genogroup-specific real-time PCR assay, as previously described (*3*). Sterile water was used in place of cDNA as negative control. Three amplicons from each genogroup were directly sequenced to confirm their identities and genogroups on a 3100 Genetic Analyzer (Applied Biosystems, Foster City, CA, USA). cDNA viral load was quantified in triplicate per run against 10-fold serial dilutions (10^1–10^7 copies) of external plasmid standards prepared by cloning genogroup-specific amplicons into vector pCR2.1-TOPO (Invitrogen Corp., Carlsbad, CA, USA). The lower detection limit of the assay was equivalent to 2×10^3 copies of cDNA per gram of fecal specimen. Coefficients of variation within and between runs were calculated as the percentage of the ratio between the standard deviation and mean of threshold cycle numbers from the standard curves. The respective intra- and interassay coefficients of variation for NoV GI were 0%–4.1% and 1.9%–5.8%, respectively, and 0.1%–6.1% and 2.7%–6.8%, respectively, for NoV GII. These findings indicate the high reproducibility in viral load quantitation by the assay. Two common gas-

4. Disease Prevalence

EClinicalMedicine 2–3 (2018) 50–58

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EClinicalMedicine Published by THE LANCET

Research Paper

Global Prevalence of Asymptomatic Norovirus Infection: A Meta-analysis

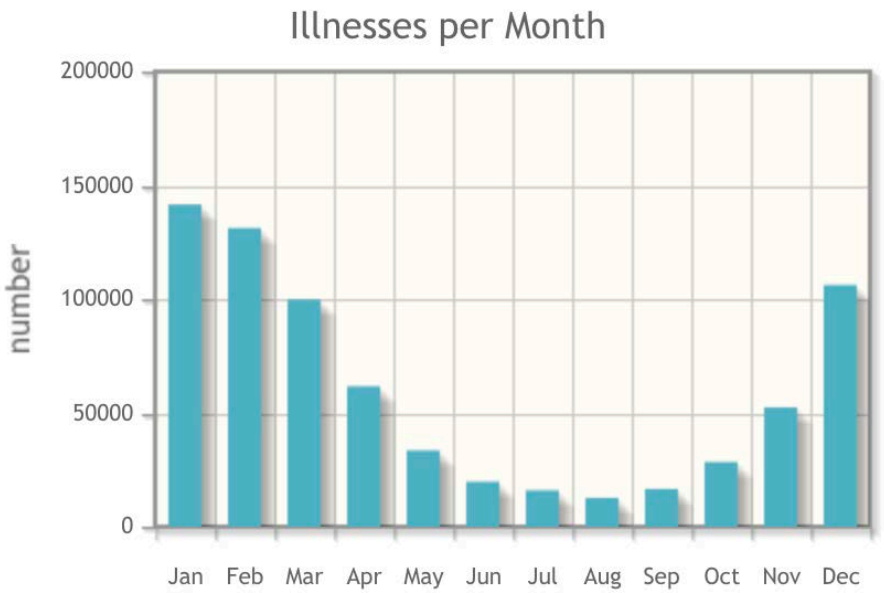
Rui Qi [a], Yu-ting Huang [b], Jian-wei Liu [a], Yue Sun [b], Xi-feng Sun [b], Hui-Ju Han [a], Xiang-Rong Qin [a], Min Zhao [a], Li-jun Wang [a], Wenqian Li [b], Jun-hong Li [c], Cong Chen [c], Xue-Jie Yu [a,d,*]

[a] School of Health Sciences, State Key Laboratory of Virology, Wuhan University, Wuhan, Hubei Province, China
[b] School of Public Health, Shandong University, Jinan, Shandong Province, China
[c] Changzhou Center for Disease Control and Prevention, Changzhou, Jiangsu Province, China
[d] Departments of Pathology, University of Texas Medical Branch, Galveston, TX, USA

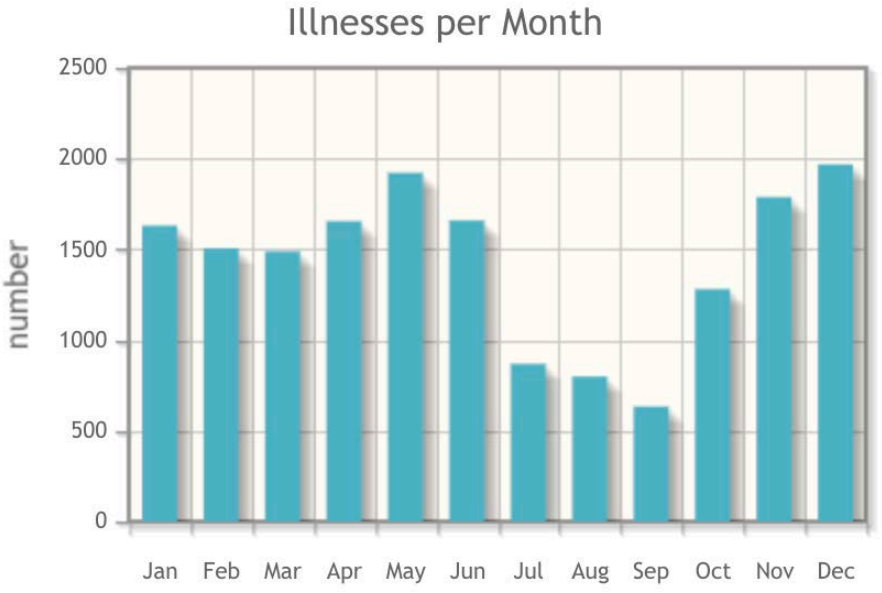
Surveillance Data: National Outbreak Reporting System

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

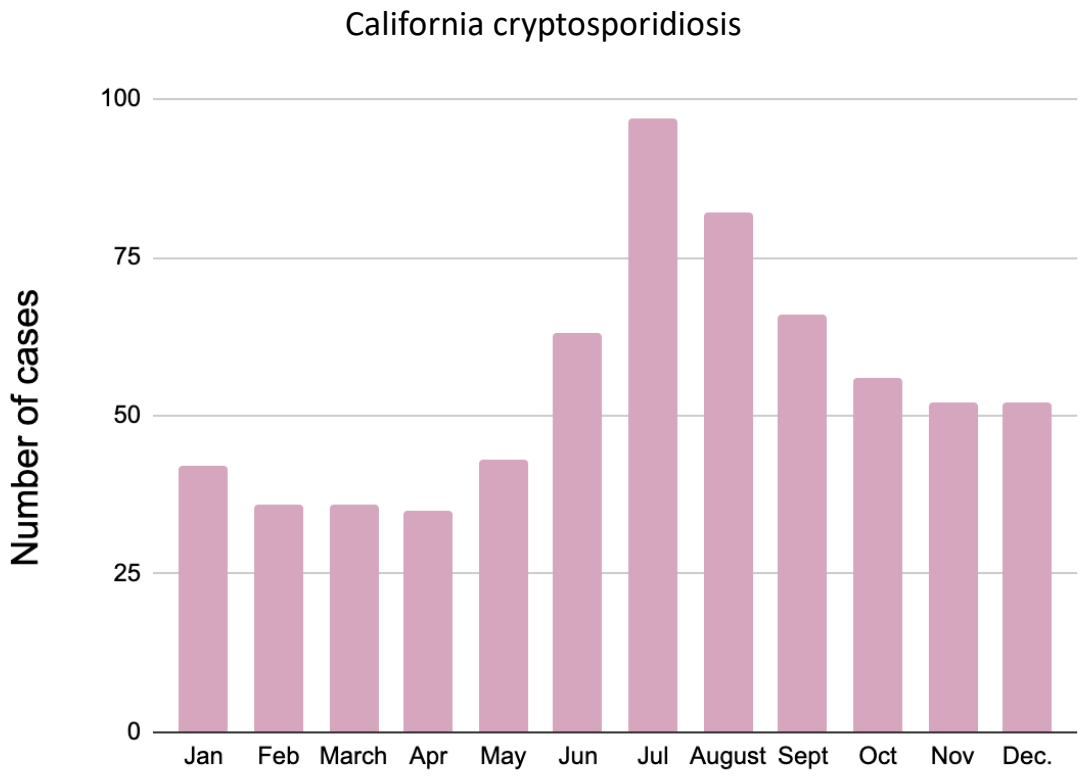
National Norovirus



California Norovirus



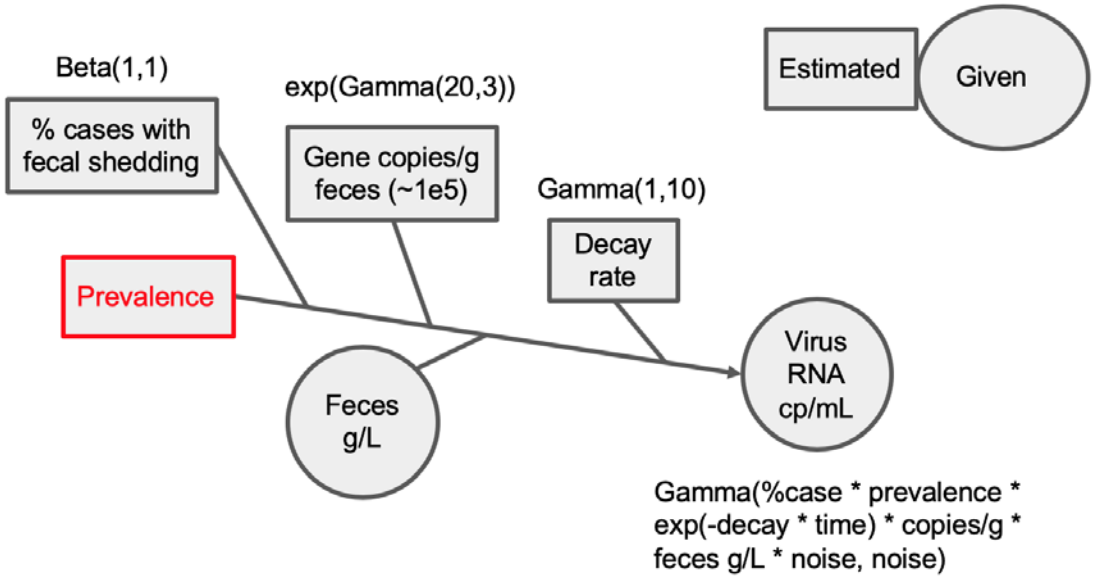
Surveillance Data: California Department of Public Health



Milestone 3 underway (informing milestones 1 and 2)

Question: Can we use prevalence data to predict wastewater concentrations?

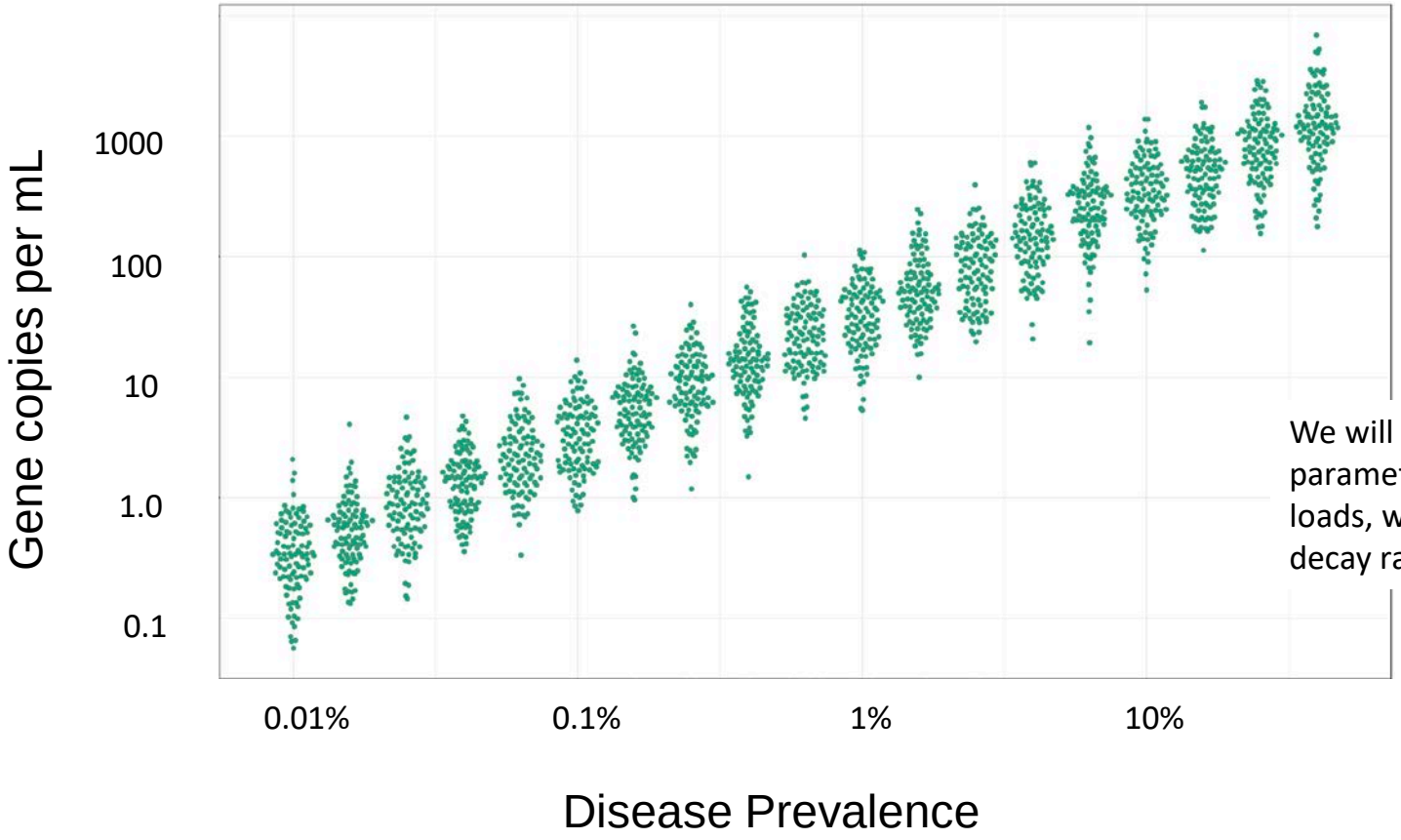
Question: Can we use wastewater concentrations to predict prevalence?



Nasa S.-A.

Ali Boehm

Model linking norovirus concentrations in WW to prevalence



We will continue to refine parameters with data on fecal loads, wastewater concentrations, decay rates, prevalence, etc.

DPR-4
Defining Potential Chemical Peaks and Management Options

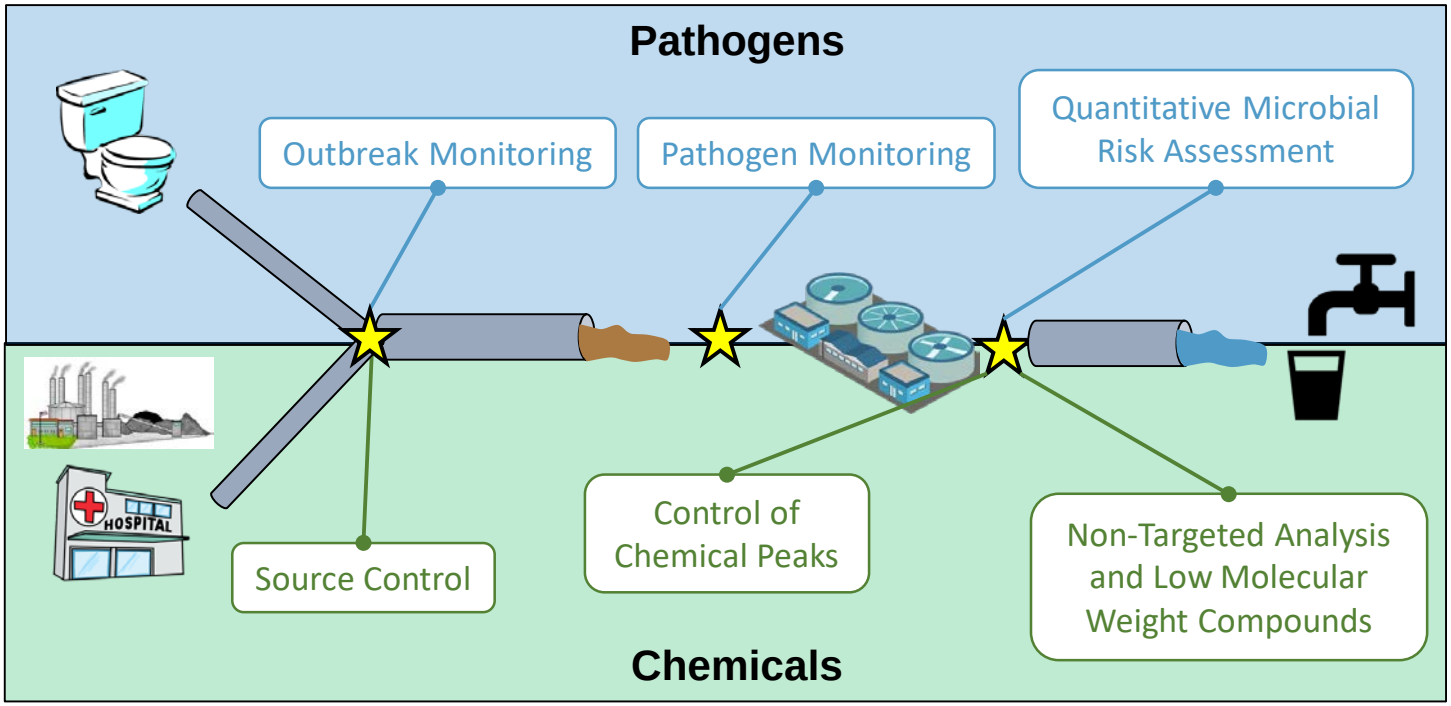
Jean Debroux, Kennedy Jenks
Shane Trussell, Trussell Technologies

DPR-4:Treatment for Averaging Potential Chemical Peaks

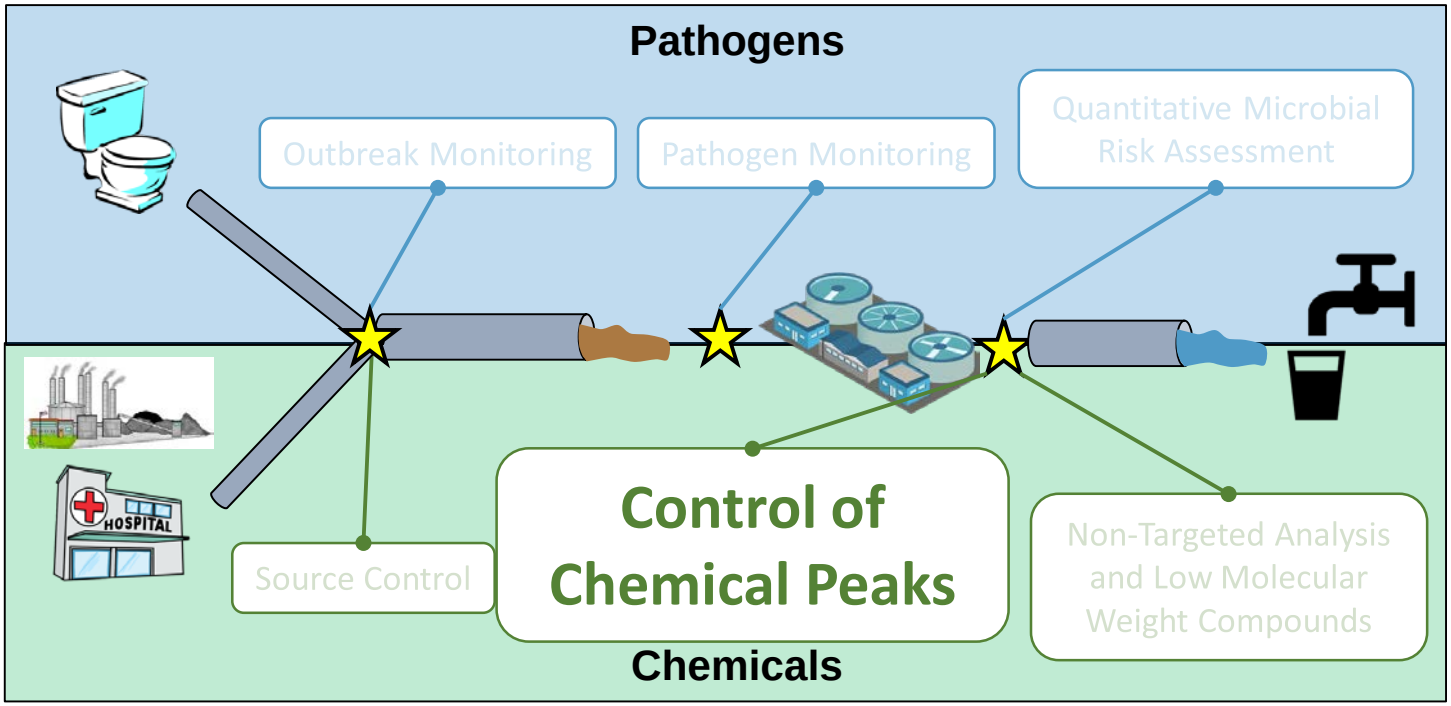
Jean Debroux, PhD, Kennedy Jenks Consultants
Shane Trussell, PhD, PE, BCEE, Trussell Technologies
Megan H. Plumlee, PhD, PE, Orange County Water District

DPR Grant Virtual Workshop June 12, 2020

Research Topics Relate to Public Health Protection

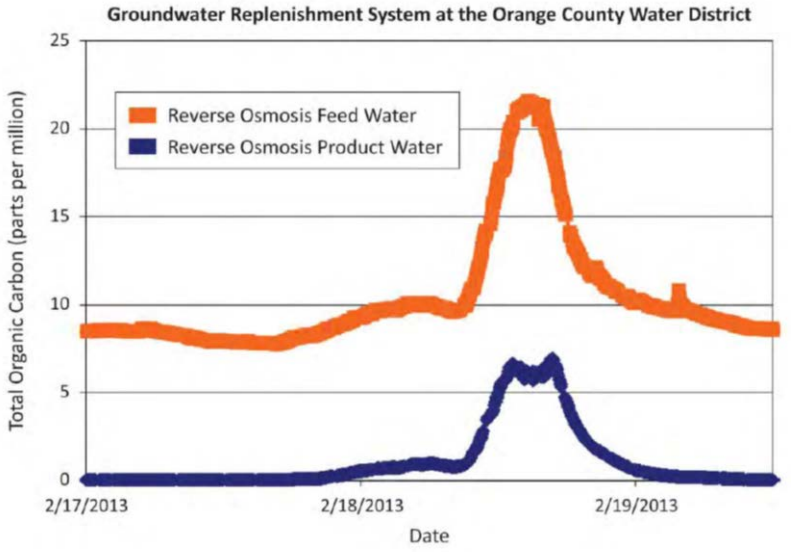


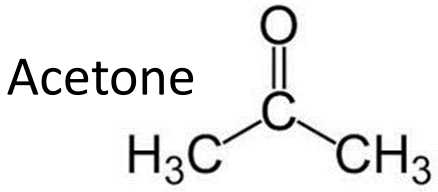
Research Topics Relate to Public Health Protection



DPR-4: Treatment for Averaging Potential Chemical Peaks

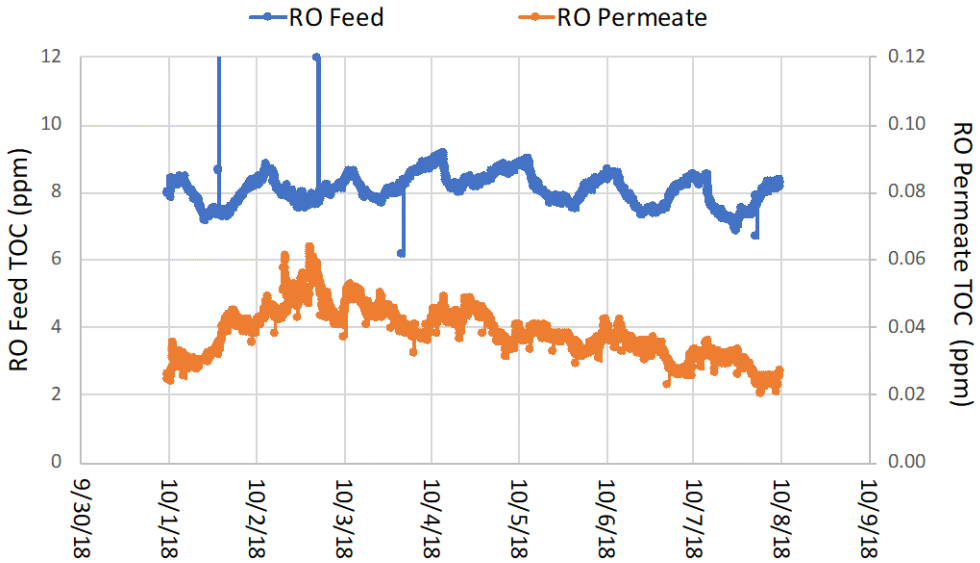
- Full advanced treatment (MF/RO/UV-AOP) is a highly effective treatment train employed today for groundwater recharge
- Water quality excursions have been observed





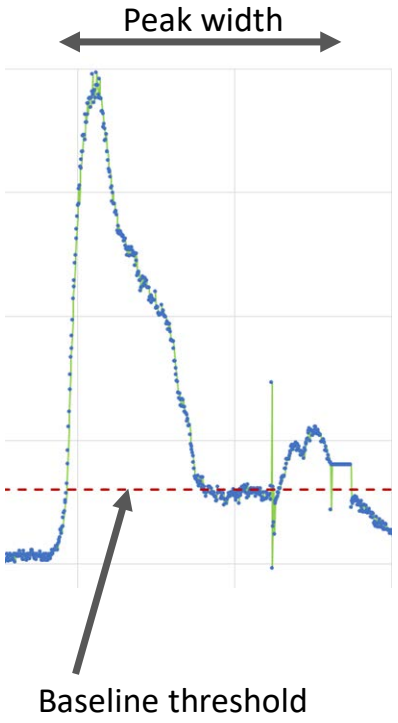
What is a chemical peak?

- Diurnal and process-related TOC baseline variations
- Outliers

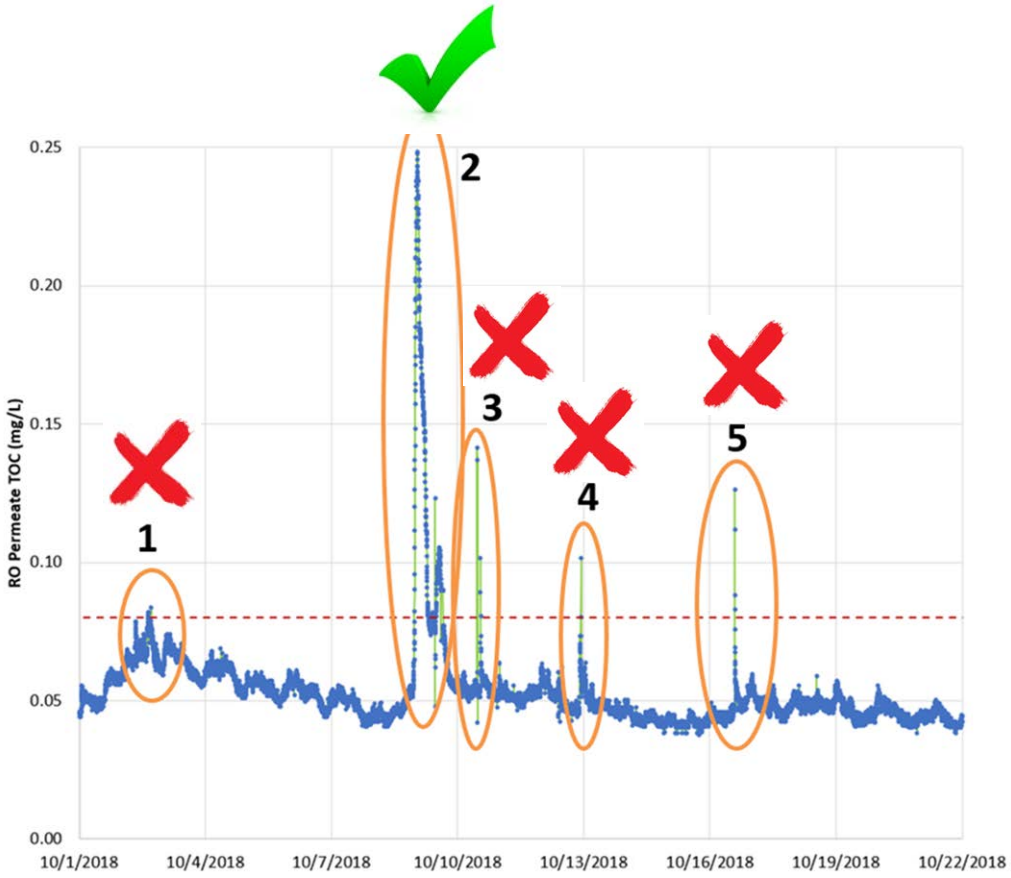


Defining a chemical peak

- Peak height – must exceed baseline threshold
  - Due to outliers, non-normal distribution
  - All data used
  - Baseline Threshold = Q3 + 1.5 * IQR, where IQR = Q3- Q1
- Peak width – Due to non-plug flow processes and recycle flows in WWTP, an instantaneous illicit discharge results in a peak width of hours to days
  - On-line data every 15 minutes



Example excursions from baseline



What chemicals can pass through FAT?

Summary of RO rejection of organic compounds and chemical families

Chemical Family	Sub-group	Good (>90%)	Intermediate (50-90%)	Poor (<50%)
VOCs	Solvents and Industrial Compounds	Ethers	Halobenzenes; 1,1,2-TCE	Nitriles; Haloalkenes
	Haloalkanes	CCl_4; Ethanes with 3-4 Cl atoms; Most C_{4+} haloalkanes	Some C_1-C_3 haloalkanes	C_1-C_2 haloalkanes with 1-2 halogen atoms
	Alkylbenzenes	C_{10+}	C_6-C_9	
	Pesticides/ Herbicides	1,2,3-TCP		MITC
LMW Oxygenated Compounds	Alcohols	Branched C_{4+} alcohols	Isopropyl alcohol; Most unbranched alcohols	Methanol; Ethanol;
	Aldehydes, Ketones	Methyl isobutyl ketone (MIBK)	Acetone; Most Ketones	Formaldehyde; Most Aldehydes
PPCPs	Flame Retardants	Chlorophosphates; PFAS		
	Pharmaceuticals	Steroids; β-blockers; NSAIDs; X-ray Contrast Media		
DBPs	Nitrosamines	C_{4+} nitrosamines; NMOR	NDMA; NDEA	
	Halogenated DBPs	HAAs	HANs	THMs

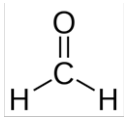
References: Howe 2019, Zeng 2016, Rodriguez 2011, Snyder 2007, Kiso 2011, Tackaert 2019, Fujioka 2012; Doederer 2014

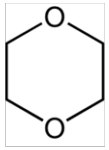
Predicted removal of organic compounds via AOP

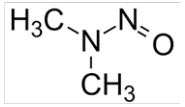
Family	Greater than 1,4-dioxane	Less than 1,4-dioxane
VOCs	Haloalkenes Halobenzenes Alkylbenzenes C_4+ Alcohols C_4+ Aldehydes C_6+ Ketones Acrylonitrile	C_1-C_3 Haloalkanes C_1-C_3 Alcohols C_1-C_3 Aldehydes C_3-C_5 Ketones Acetonitrile MITC
PPCPs	Most pharmaceuticals	Flame Retardants
DBPs	Nitrosamines[1]	THMs

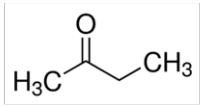
Notes: 1. High removal in UV/AOP systems

References: Drewes 2008, Howe 2019, Ahmed 2017, Drewes 2006, Buxton 1988, Swancutt 2010



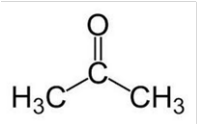






Organic compounds poorly removed by FAT

Family	Compounds poorly removed by FAT
VOCs	LMW haloalkanes LMW alcohols, aldehydes, ketones Acetonitrile MITC
DBPs	THMs



Potential Treatment/Blending Technologies

Ozone/BAC Pre-treatment

Blending

Air Stripping

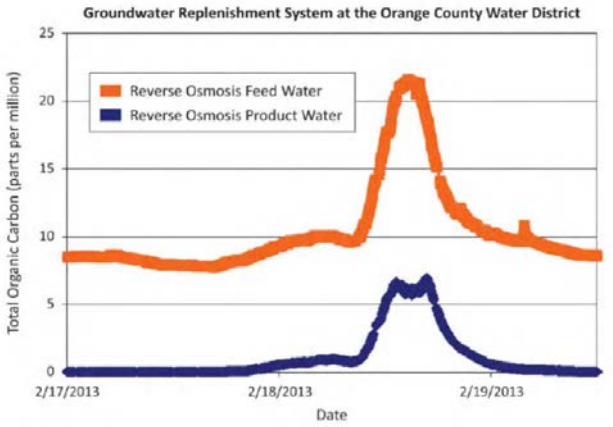
Additional RO/AOP Treatment

Activated Carbon

Case Studies

- Compare elements of source control measures, experiences, monitoring and detection of chemical peaks
  - Orange County Water District Ground Water Replenishment System
  - Singapore Public Utilities Board
  - City of San Diego North City Pure Water Demonstration Facility
- Compare strategies for averaging Chemical Peaks

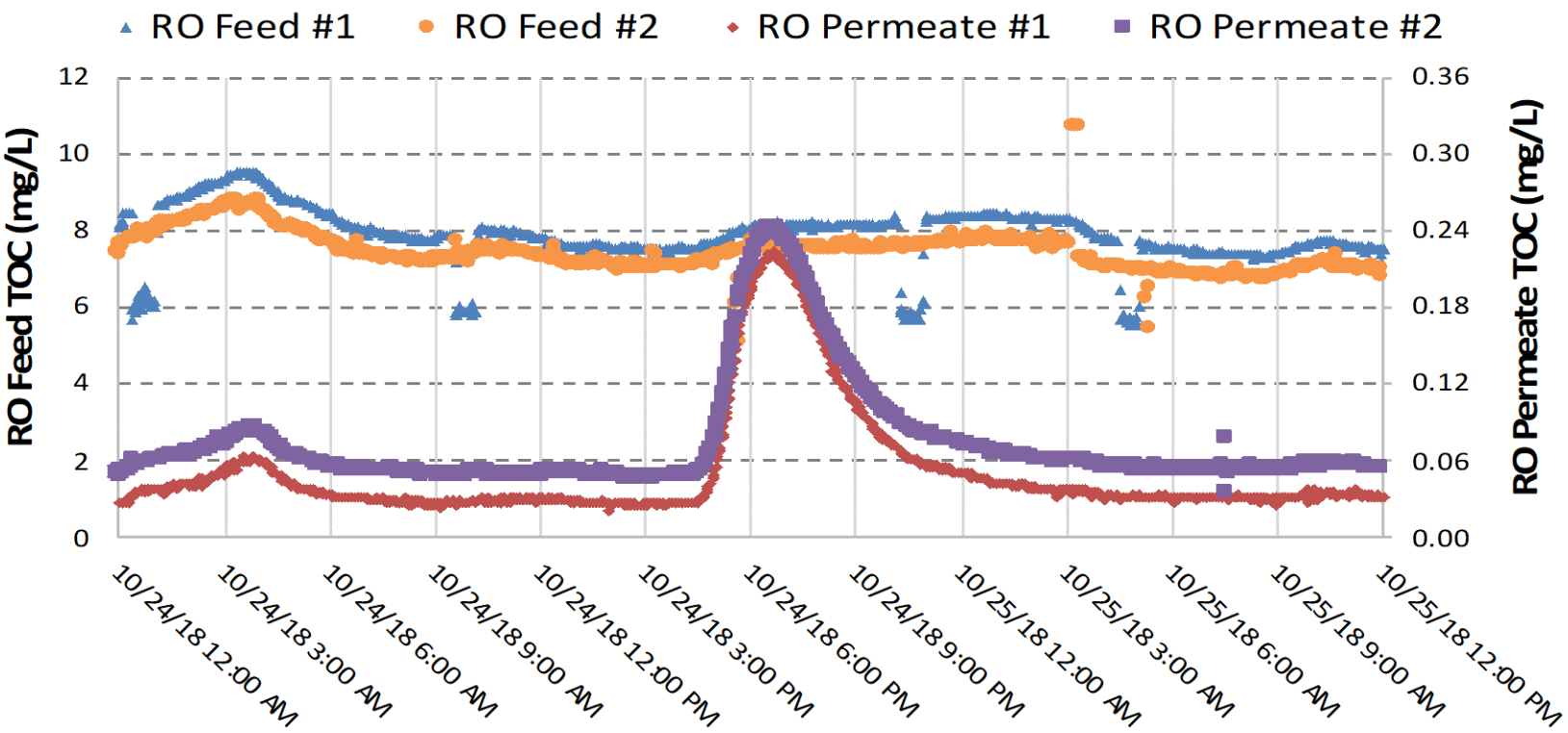
TOC and Acetone grab sample results during 2013 GWRS Acetone event



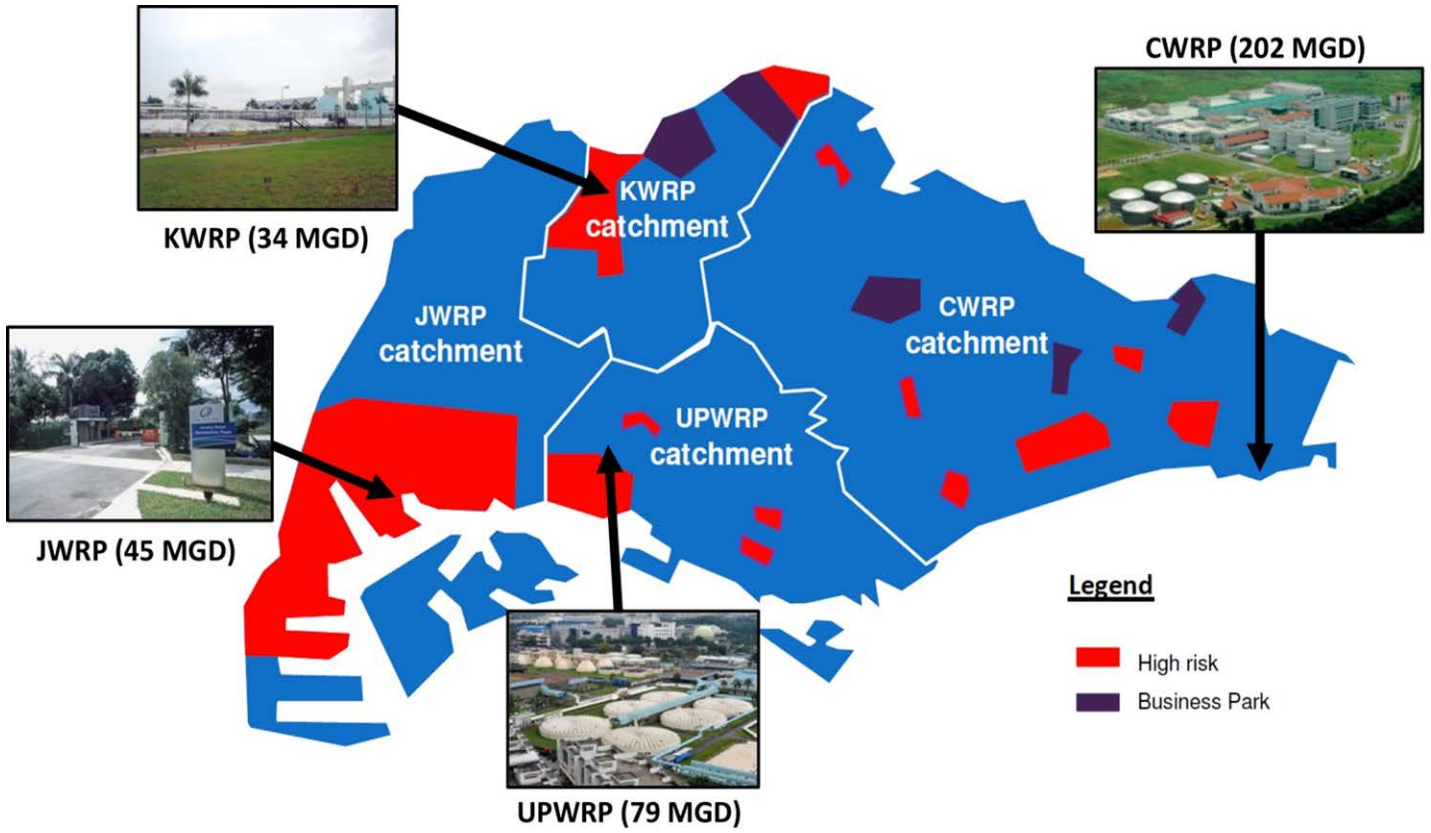
Sample Date	Sample Location	EPA 524.2 Acetone	Theoretical TOC from Acetone[1]	EPA 415.3 TOC	Baseline TOC[2]	Acetone Contribution to Elevated TOC[3]
2/18/2013 6:00AM	RO Feed	1,940 µg/L	1.2 mg/L	9.39 mg/L	~ 8.0 mg/L	~ 86%
	RO Permeate	1,410 µg/L	0.9 mg/L	1.18 mg/L	~ 0.025 mg/L	~ 78%

1 – acetone carbon contribution is approximately 62%
2 – from online TOC data preceding the acetone event
3 – Baseline TOC subtracted from EPA 415.3 TOC used to calculate % acetone that contributed to elevated TOC
(e.g., for RO feed → 1.2 mg/L / (9.39 mg/L – 8.0 mg/L) = 86%

OCWD TOC monitoring October 24, 2018 acetone event



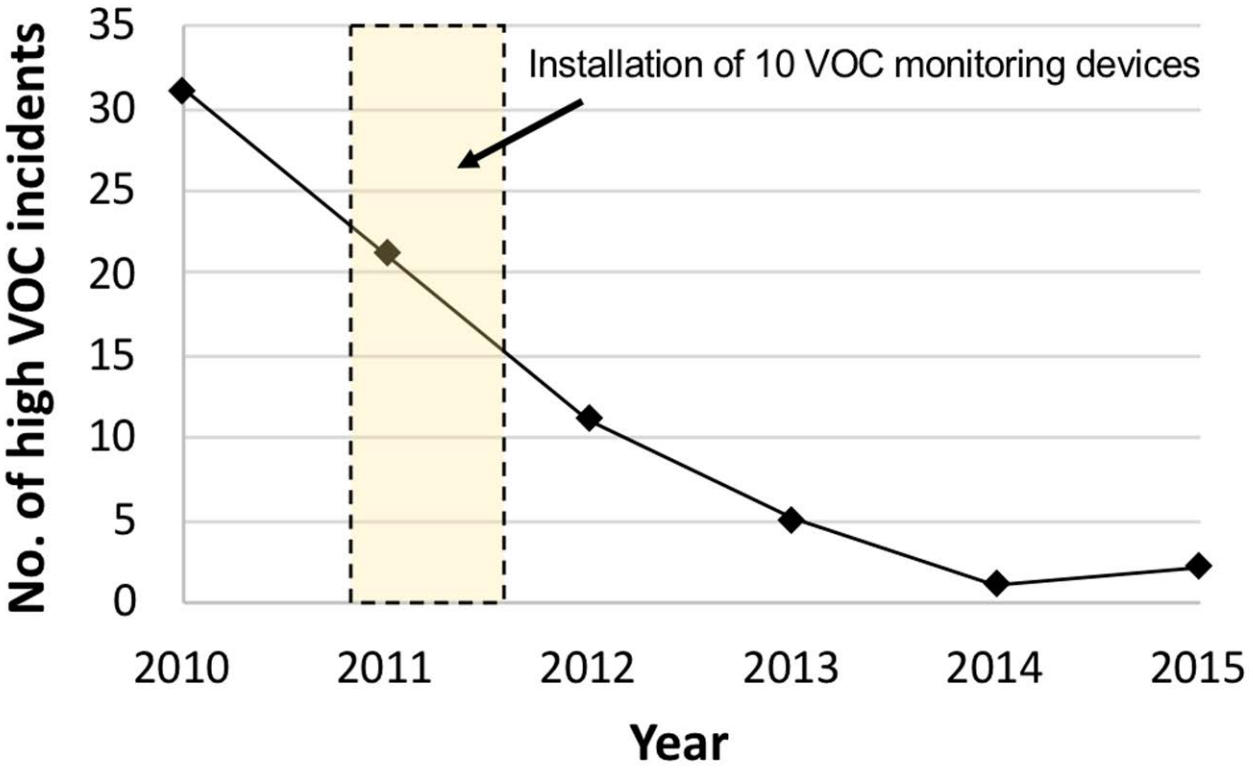
Singapore PUB



Singapore PUB

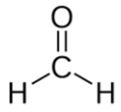
List of Prohibited Organic Compounds (PUB)		
1,2,4-Trimethylbenzene	Furan	Octane
1,1,1-Trichloroethane	Heptane	Polybrominated diphenyl ether
1,1,2-Trichloroethane	Hexane	Styrene
Benzene	Isobutanol	Tetra-chloromethane
Decane	Isopropyl ether	Tetra-chloroethylene
Diethyl ether	Methyl ethyl ketone	THF (Tetrahydrofuran)
Dimethyl sulphide	Methyl isobutyl ketone	Toluene
Dimethyl sulphoxide	Methyl tert-butyl-ether	Trichloroethylene
DMF (N,N-Dimethylformamide)	Methylene chloride	Turpentine
Ethylbenzene	Nonane	Xylene (o,m,p)

Singapore PUB VOC Monitoring in the Sewershed

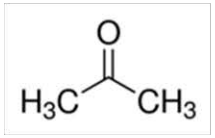


San Diego Pure Water Demonstration Facility Chemical Challenge Testing

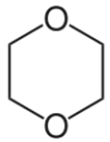
- Spike of Acetone, NDMA, Formaldehyde, and 1,4-dioxane into Feed Water
- Evaluate O_3 & BAC as additional barrier
- Test removal of O_3-BAC-MF-RO-UV/AOP vs. MF-RO-UV/AOP



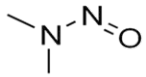
Formaldehyde
~300 µg/L



Acetone
~2,600 µg/L

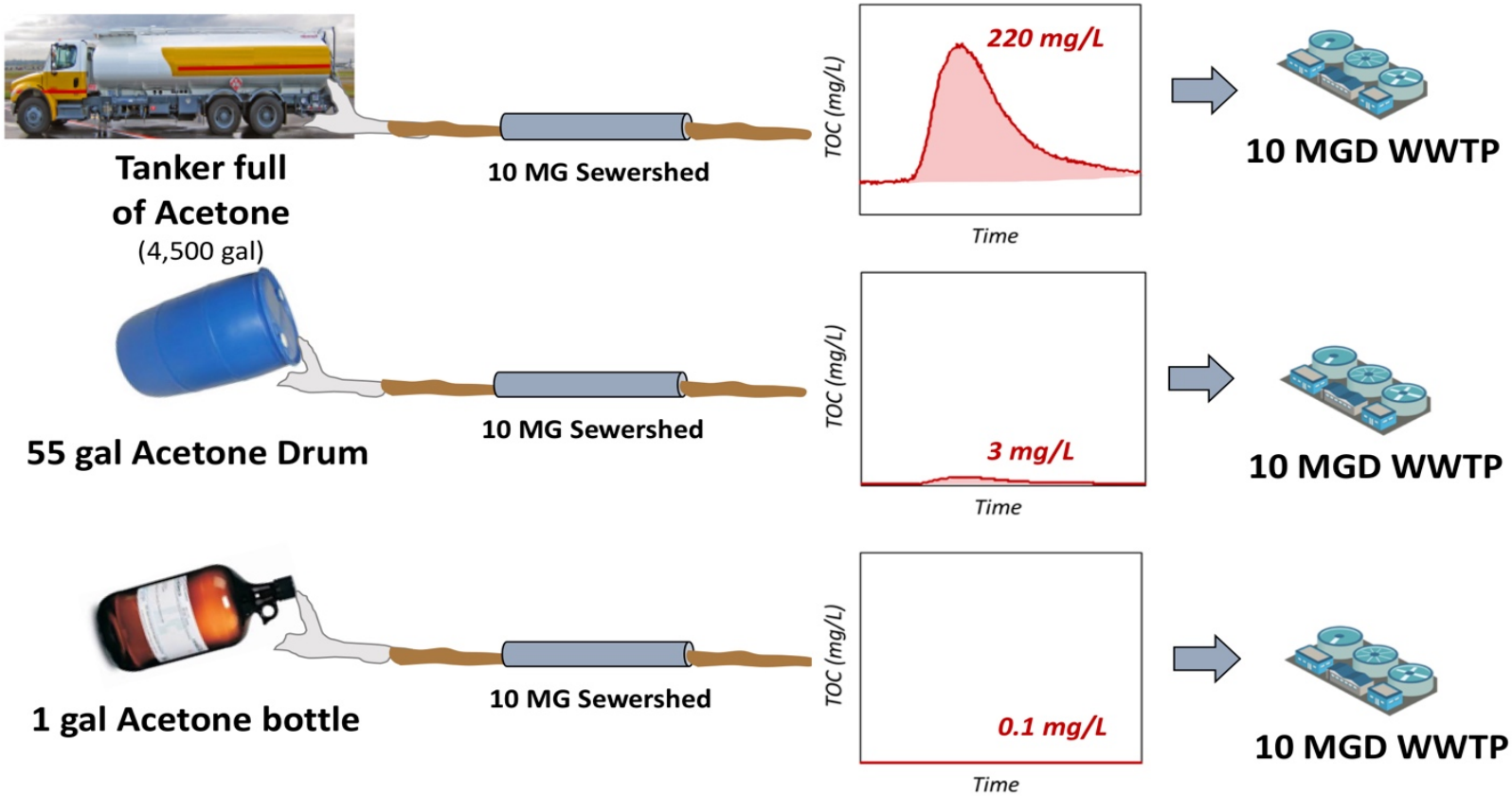


1,4-dioxane
~900 µg/L

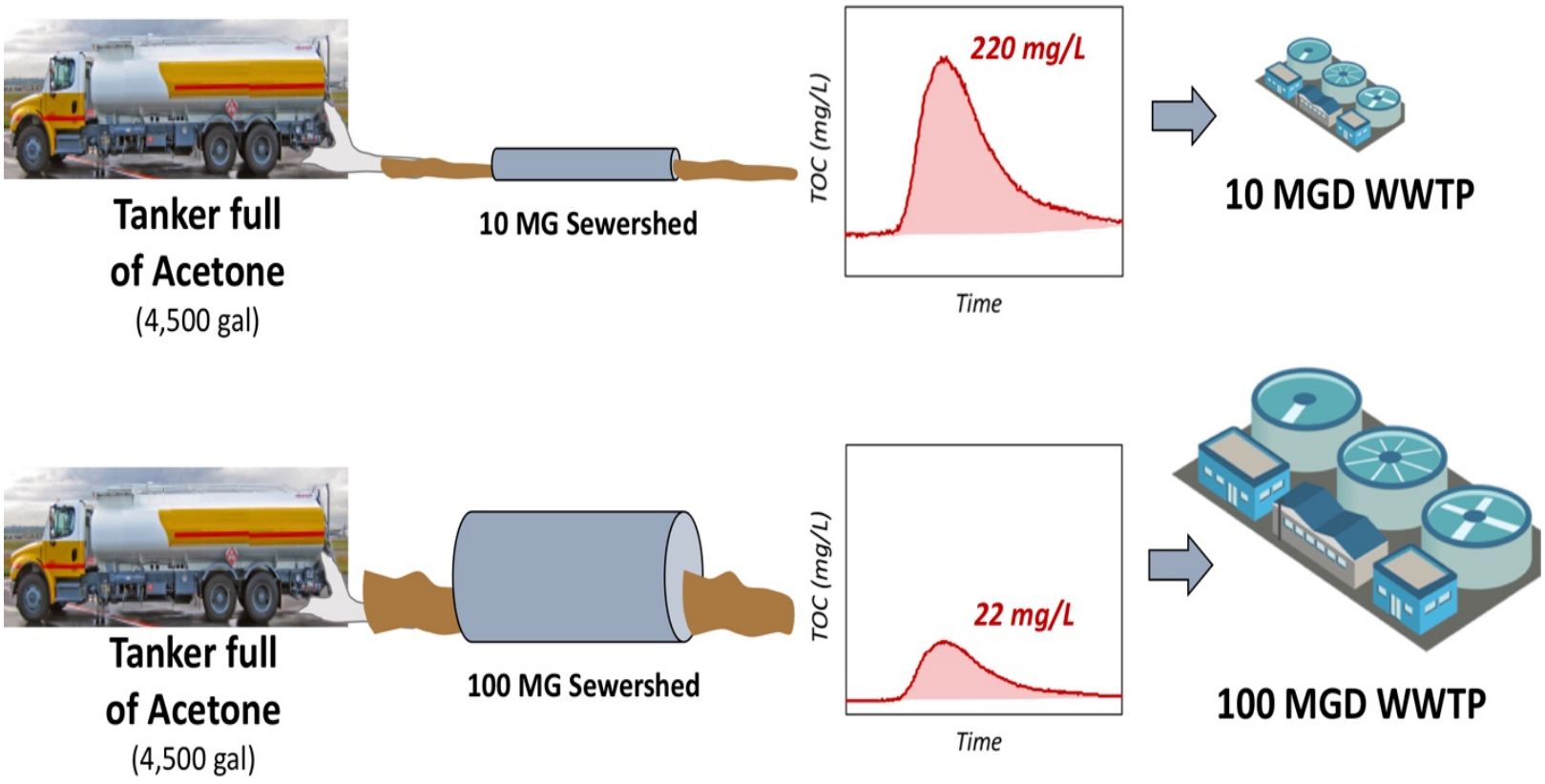


NDMA
~500 ng/L

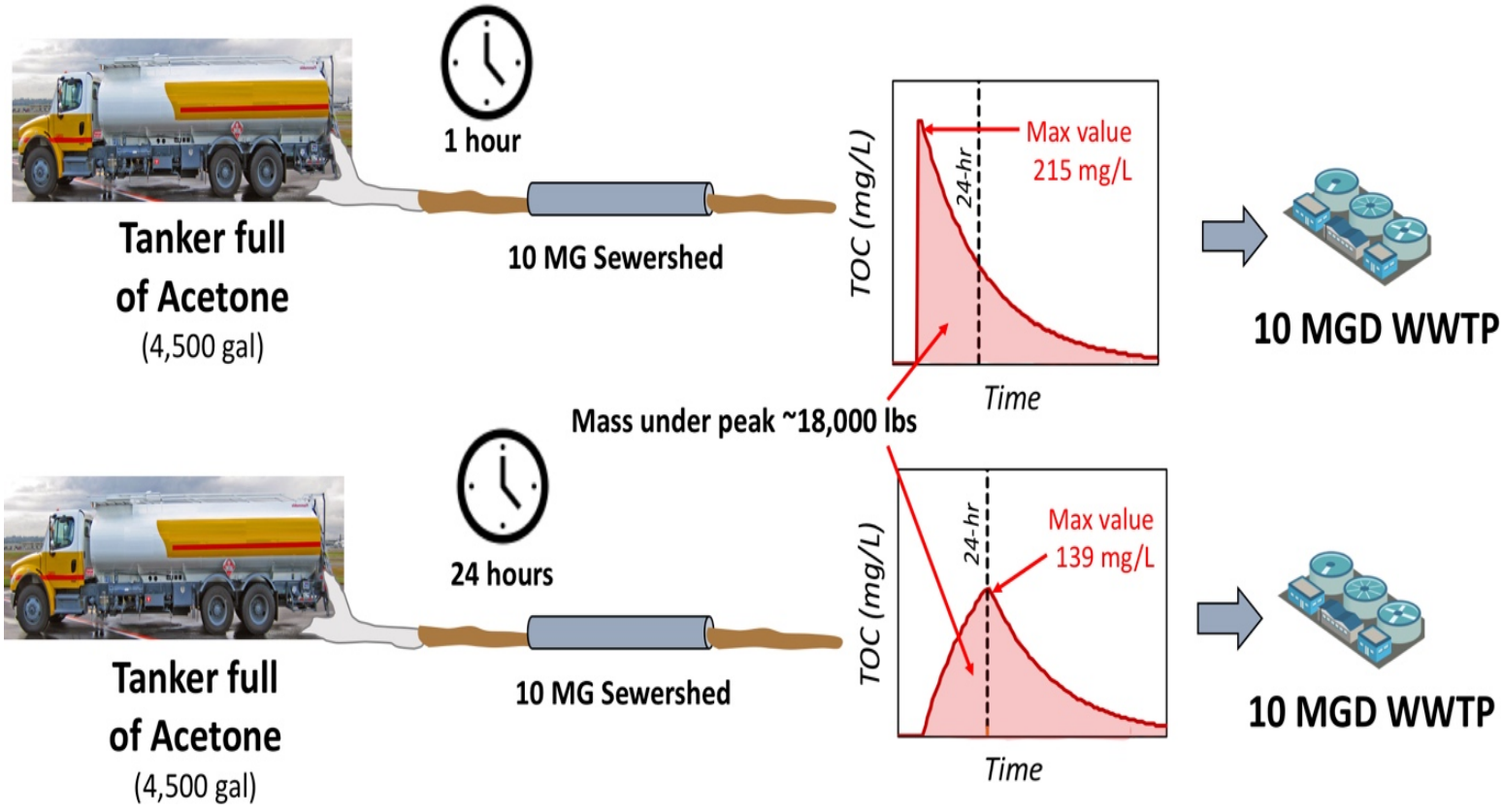
Discharge Volume



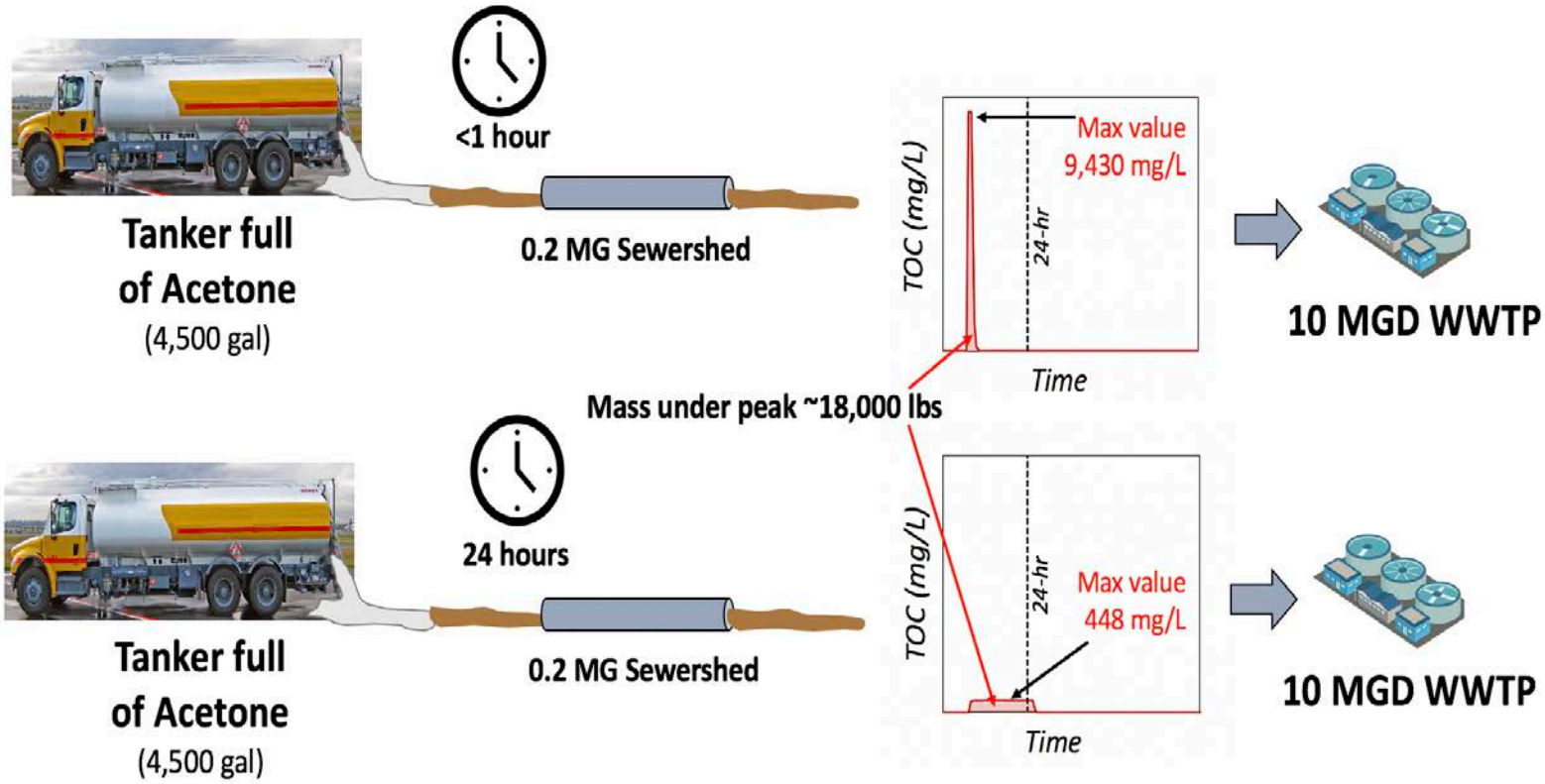
Impact of Sewershed Size



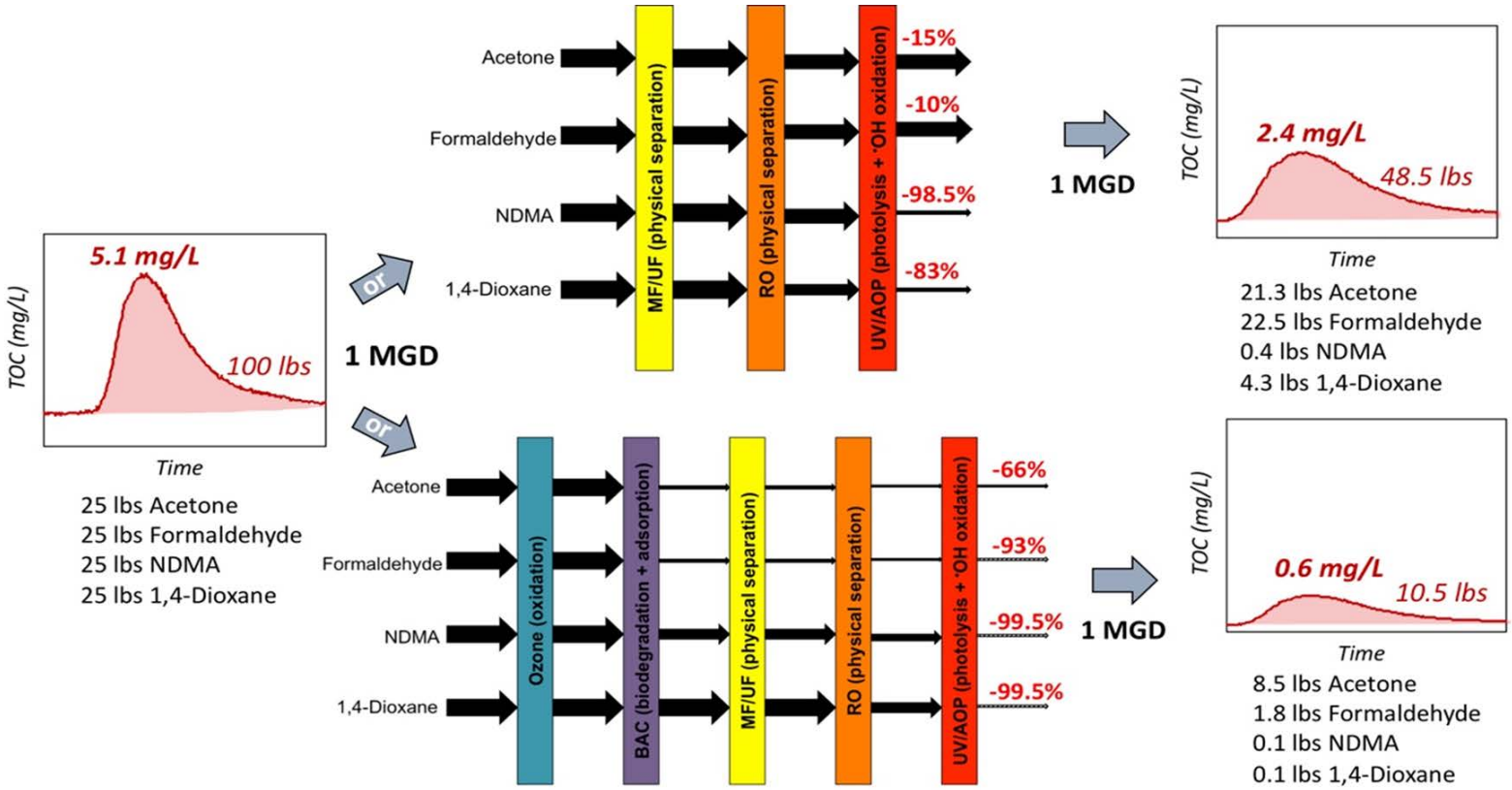
Chemical Discharge Duration *(previous)*



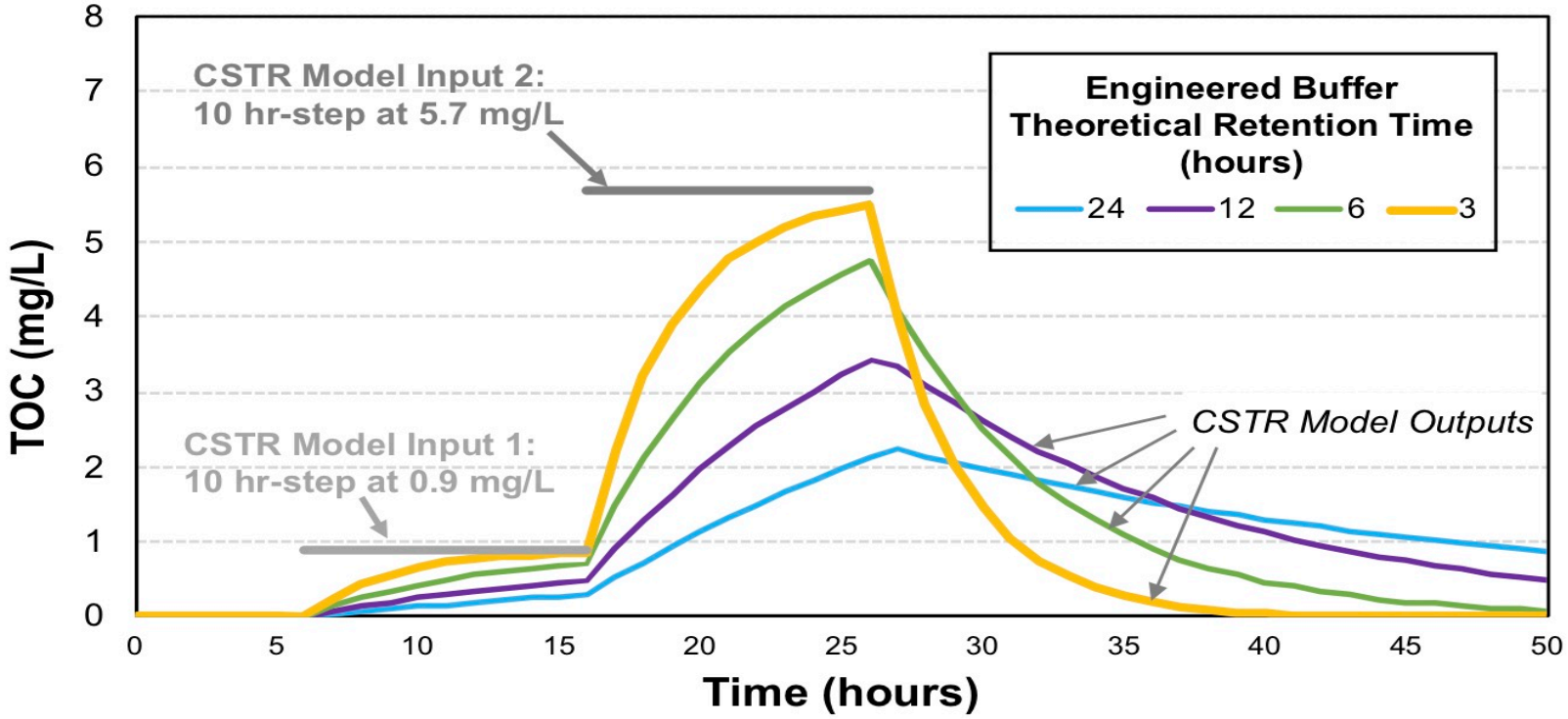
Chemical Discharge Duration *(revised)*



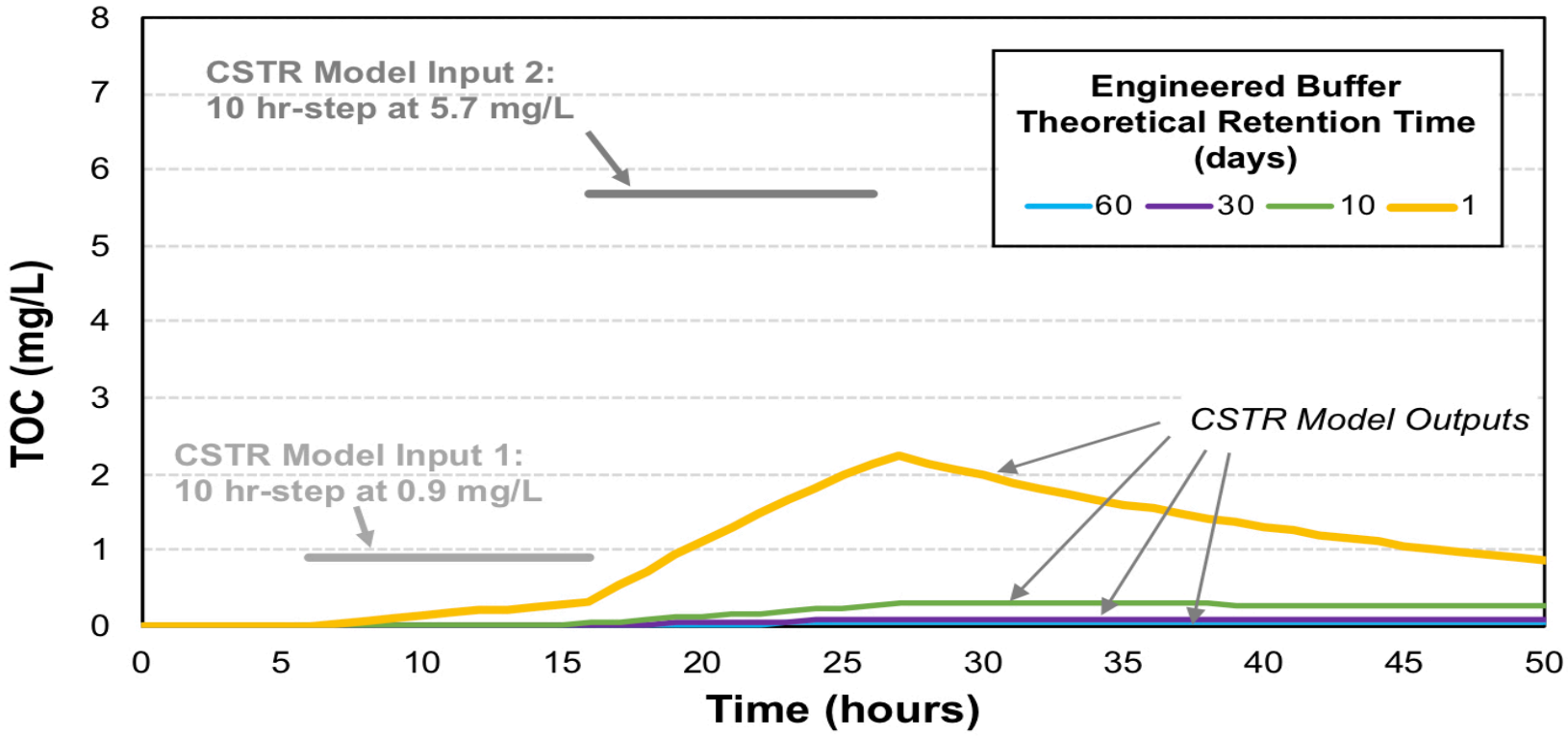
Treatment Robustness for Averaging Chemical Peaks



Engineered Buffer with Residence up to 24 Hours



Engineered Buffer with Residence up to 60 Days



How will online TOC analyzers be used?

- Advanced oxidation reactions are used to mineralize organic carbon in the sample (UV/persulfate and O_3/hydroxide)
- Expert panel expressed concern that highly volatile organics might not be captured with online TOC

Experimental Portion of the Project

- Task 1 – Target VOC Screening and Hold Study
- Task 2 – Participant Survey and Selection
- Task 3 – Conducting Two Rounds of Round Robin Sampling
- Task 4 – Summarizing Findings into a Report

SNWA Team Members:

Principal Investigator: Eric Dickenson, PhD, PE

Postdoctoral Researcher: Stephanie Riley, PhD

Postdoctoral Researcher: Mahmut Ersan, PhD

Research Chemist: Janie Holady

Southern Nevada Water Authority

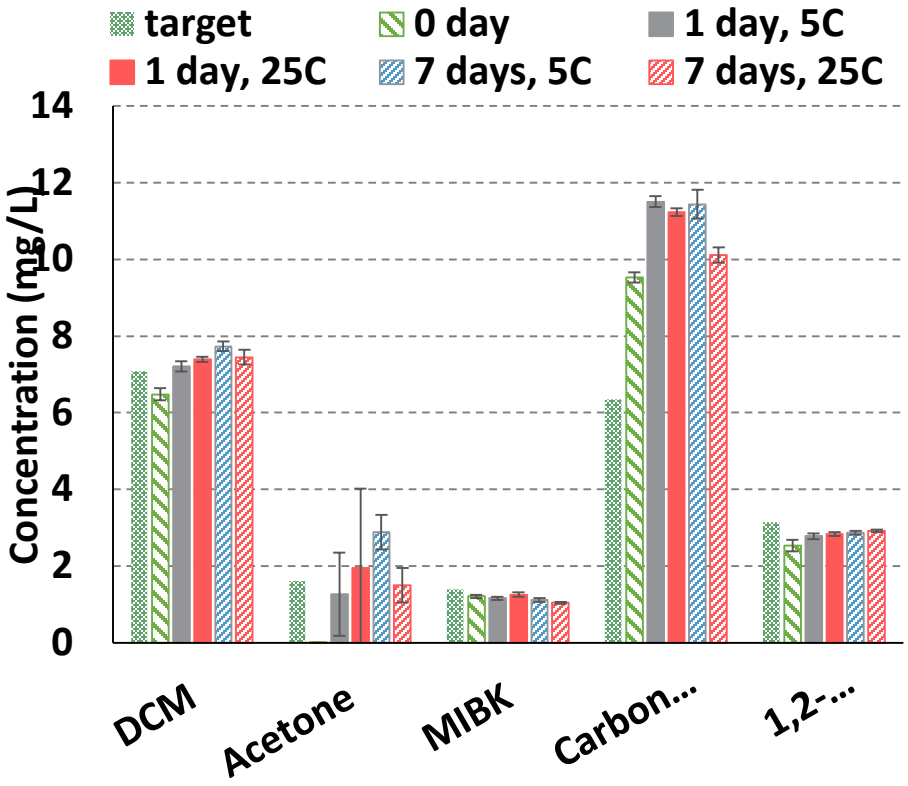
Task 1 - Screening of Target VOCs

Compounds Considered and Tested:

- Carbon tetrachloride
- Vinyl Chloride
- Toluene
- Carbon Disulfide
- 1,2-dichloropropane
- Methylene Chloride (Dichloromethane)
- Acetone
- Methyl isobutyl ketone

Task 1 - Screening of Target VOCs

- 7-day Hold Study at 4°C and Room Temperature
- Evaluated Compound Recovery from Day 0, Day 1, and Day 7
- Considered solubility limitations and miscibility with water for target spike concentrations
- 2 Rounds of Hold Study and analytical method results comparison with 2 different analytical labs



Selected VOCs Volatility and Reactivity Properties

More Reactive

Less Reactive

*OH rate constant (k_{*OH}, L/Mol*s)	Henry's Law Constant (Hyc)		
	HYC > 0.5	**0.1 < HYC < 0.5**	**0.01 < HYC < 0.1**
$k_{*OH} > 1 \times 10^9$	Carbon Disulfide		MIBK
$1 \times 10^8 < k_{*OH} < 1 \times 10^9$		1,2-dichloropropane	Acetone
$1 \times 10^7 < k_{*OH} < 1 \times 10^8$		Methylene chloride	

More Volatile ⟷ Less Volatile

Study Participants

Round 1 Samples (RO permeate): June 2, 2020

Round 1 Participants	Model	Instrument Type		Measured Parameters
		Bench Top	Online	
OCWD	M9 portable		√	TOC/TC/TIC
City of San Diego	M5310C		√	TOC/TC/TIC (w/ and w/o ICR)
	Shimadzu TOC-L (Low Level)	√		TOC (w/ ICR)
Suez	M9 portable		√	TOC (w/ ICR)
	M5310C	√		TOC/TC/TIC (w/ and w/o ICR)
Shimadzu	Shimadzu TOC-L	√		TOC/TC/TIC (w/ and w/o ICR)
Valley Water	M5310C		√	TOC/TC/TIC
Hach	Biotector 3500		√	TOC/TC/TIC
SNWA	Shimadzu TOC-L	√		TOC (w/ and w/o ICR)

Round 2 Samples (RO feed): mid July, 2020

- All participants from Round 1
- East County JPA

Prevention

Source Control

Abatement

Blending &
Treatment

Response

Monitoring

Mitigating chemical peaks

DPR-4:Treatment for Averaging Potential Chemical Peaks

Thank you to:

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Closed Session

Discussion / Question and Answer