State Water Board DPR Pathogen Research

Tools to Evaluate Microbial Risk, Plant Performance, and Reliability (DPR-1)

Raw Wastewater Pathogen Monitoring (DPR-2)

Brian Pecson, P.I. for DPR-1 and DPR-2, Trussell Technologies

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

NWRI
NATIONAL WATER RESEARCH INSTITUTE

How Much Pathogen Treatment?

Wastewater

20-log virus
14-log *Giardia*
15-log *Crypto*

Drinking Water

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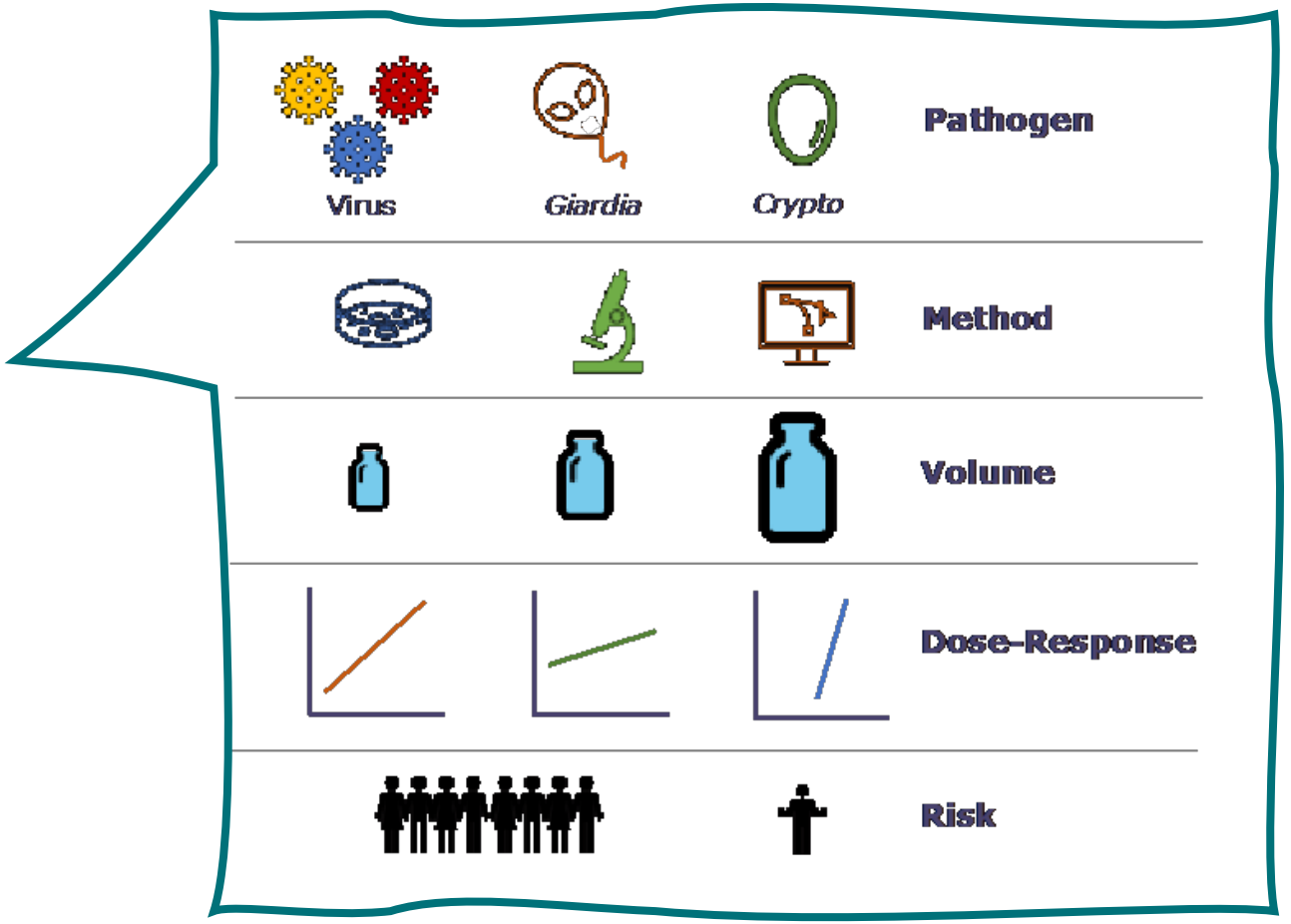
Drinking Water



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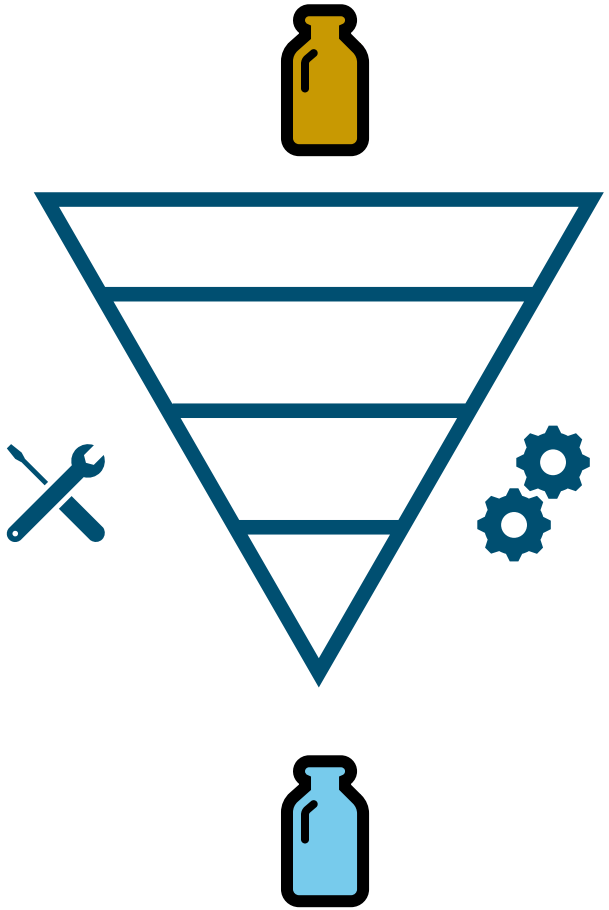


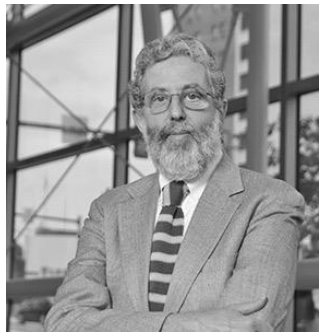
DPR-1: Pathogen Treatment and Risk

DPR-1 Technical Work Group and Research Team

Technical Work Group

Brian Pecson (chair)
Trussell Technologies

Nick Ashbolt
Southern Cross University



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Anya Kaufmann
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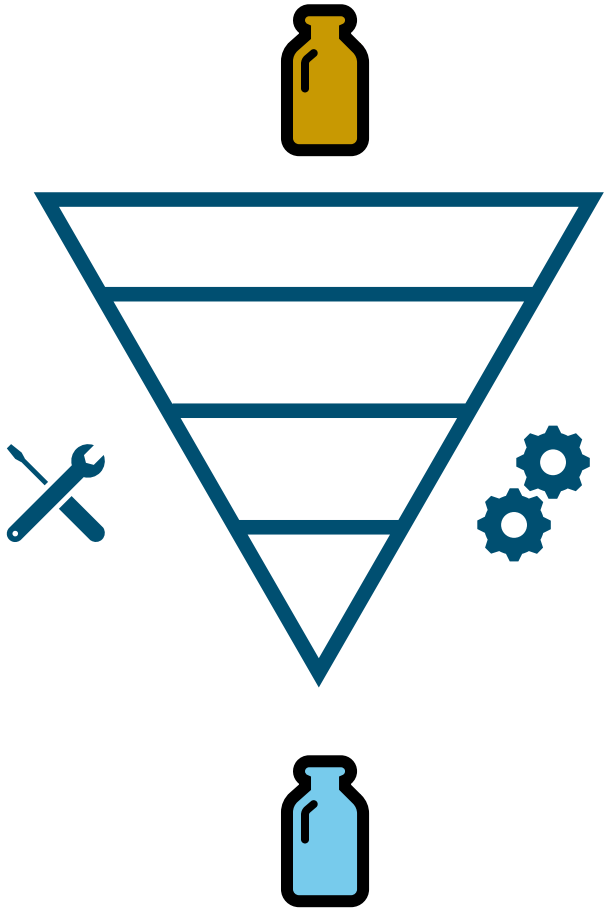
Adam Olivieri
WRF/State Board Coordination

How Much Pathogen Treatment?



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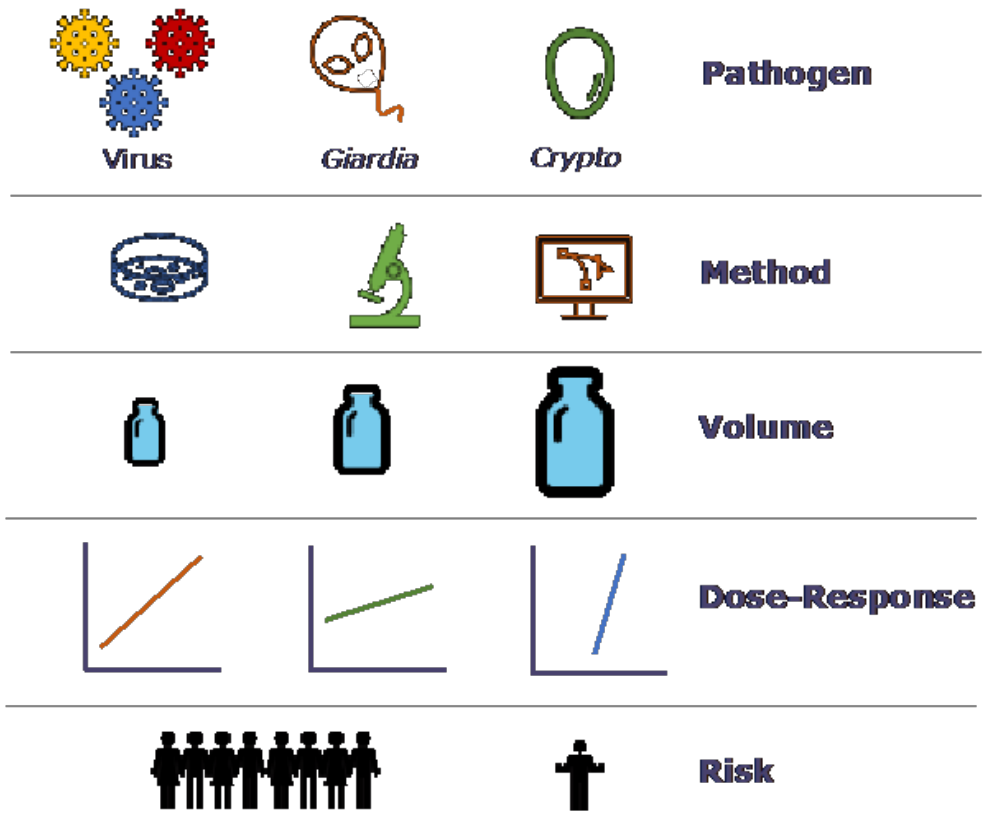

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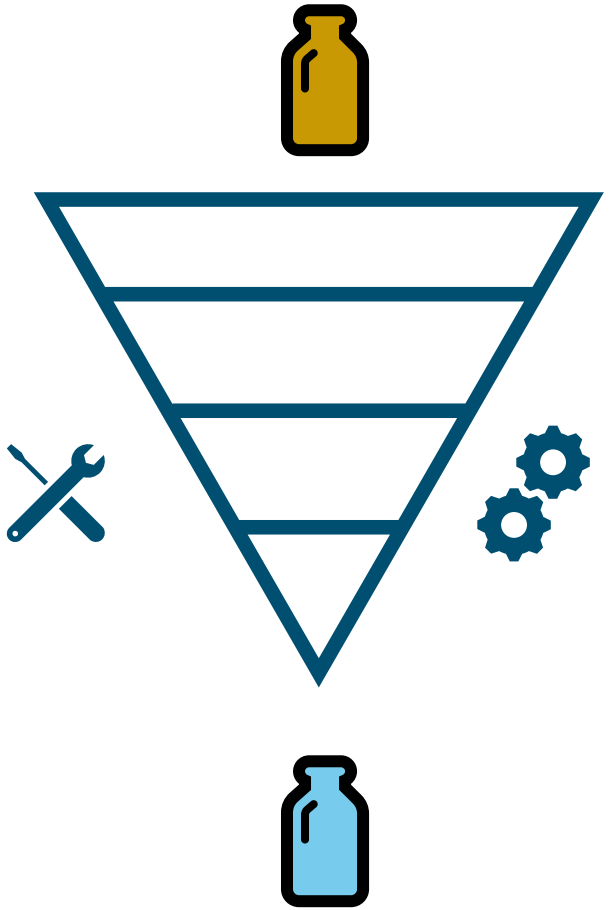
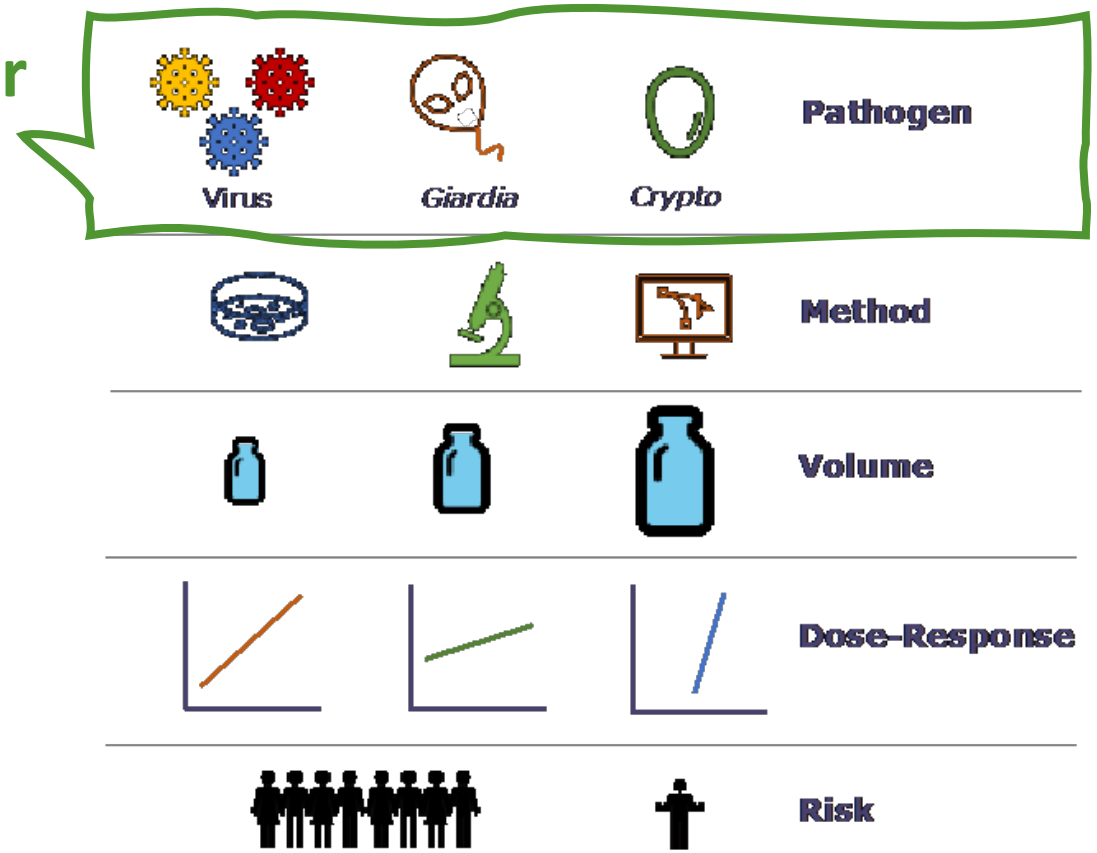
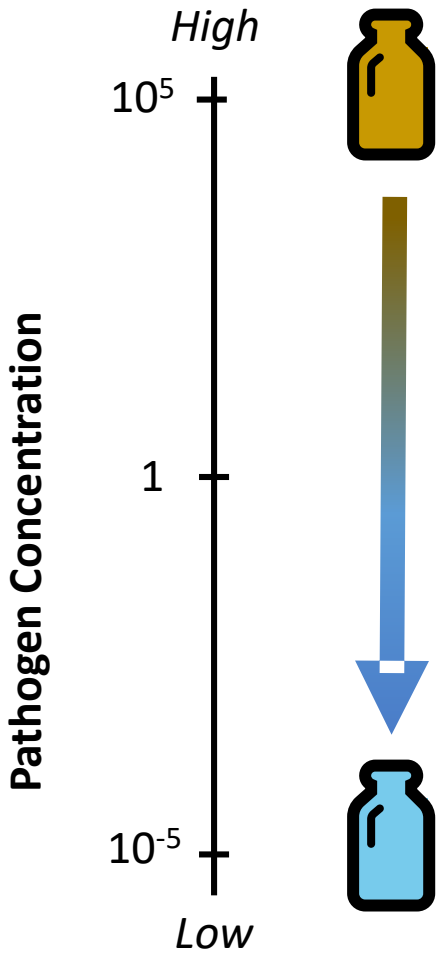


DPR-2: Raw Wastewater Pathogen Monitoring

DPR-1: Pathogen Treatment and Risk



Motivation for Research



- Wastewater pathogen concentrations are key inputs
- Industry does not have sufficient high-quality data
- SOPs needed to address previous limitations

DPR-2 Technical Work Group

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QA/QC Officer

DPR-2 Labs:

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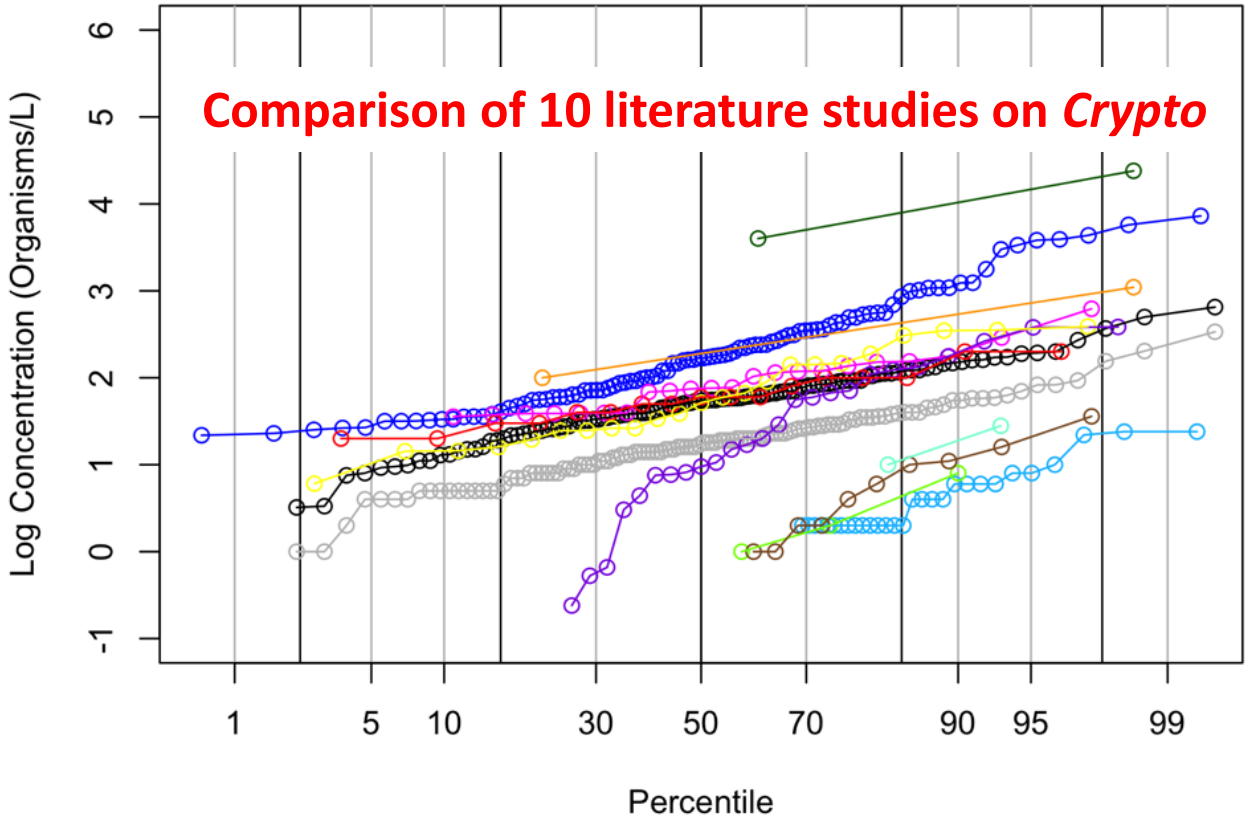
water, wastewater, and soil laboratory services

BSC inc.
BIOLOGICAL CONSULTING SERVICES OF NORTH FLORIDA, INC.

SCIENTIFIC METHODS

Literature Review

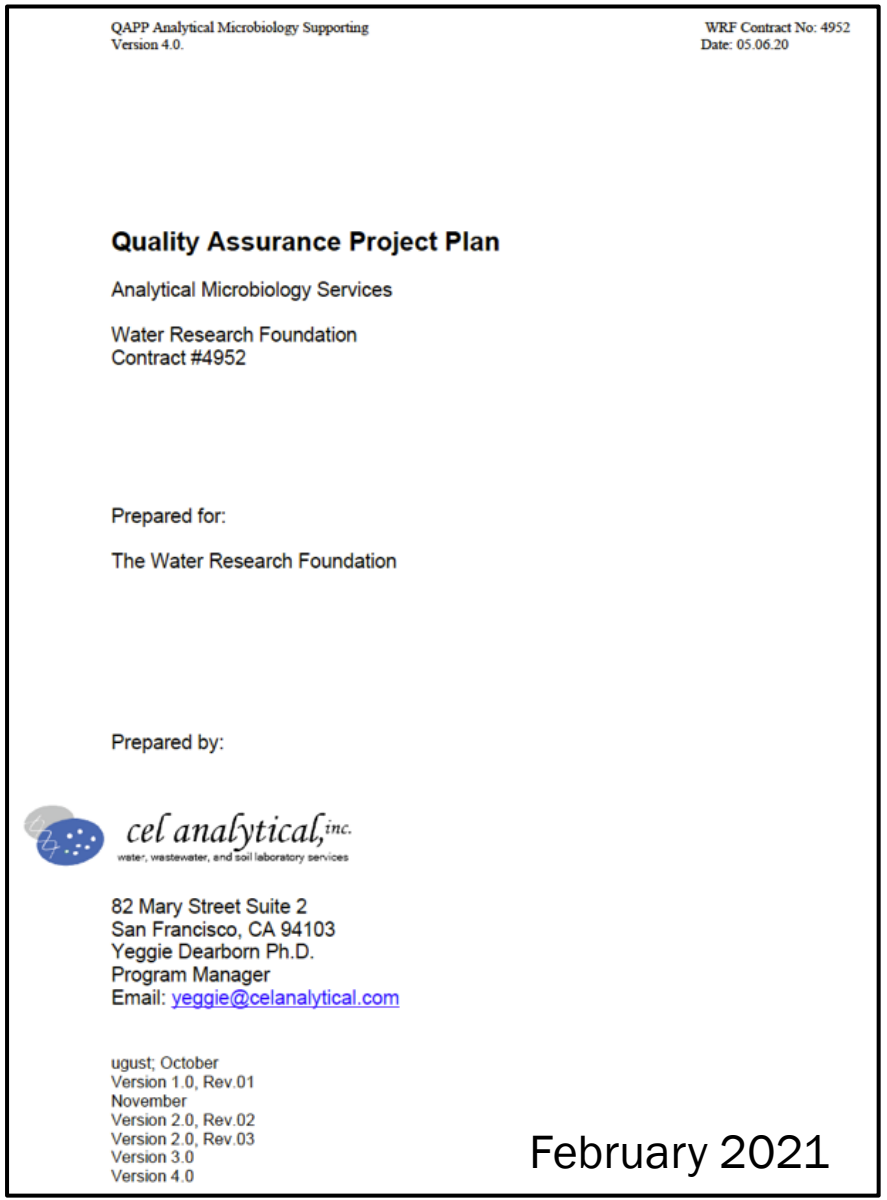
- Limited number of studies
- Low method sensitivity and high frequency of non-detects
- Recovery often not measured
- QA/QC often not strictly followed



- Conclusions
  - Possible to measure pathogens in raw WW
  - Amount and quality of data are insufficient

Method Optimization

- Used to address limitations of past studies
  - Concentration method
  - Volume of sample to process
- Require strict QA/QC
  - Matrix spikes in 75% of all samples
  - Full set of controls
- Recommendation: use DPR-2 QAPP for future studies



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

February 2021

Sampling campaign

Pathogens and Methods

Giardia

Crypto

Entero-virus

Adeno-virus

Noro-virus

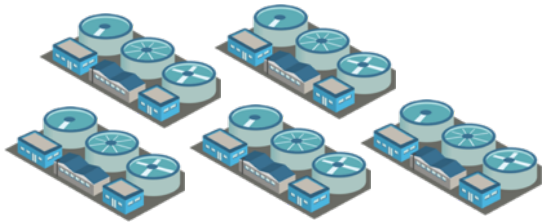
SARS-CoV-2

Microscopy

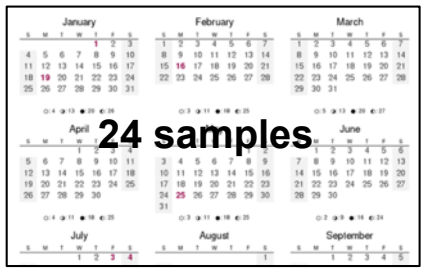
Culture

Molecular

14-month Monitoring Campaign



Five facilities

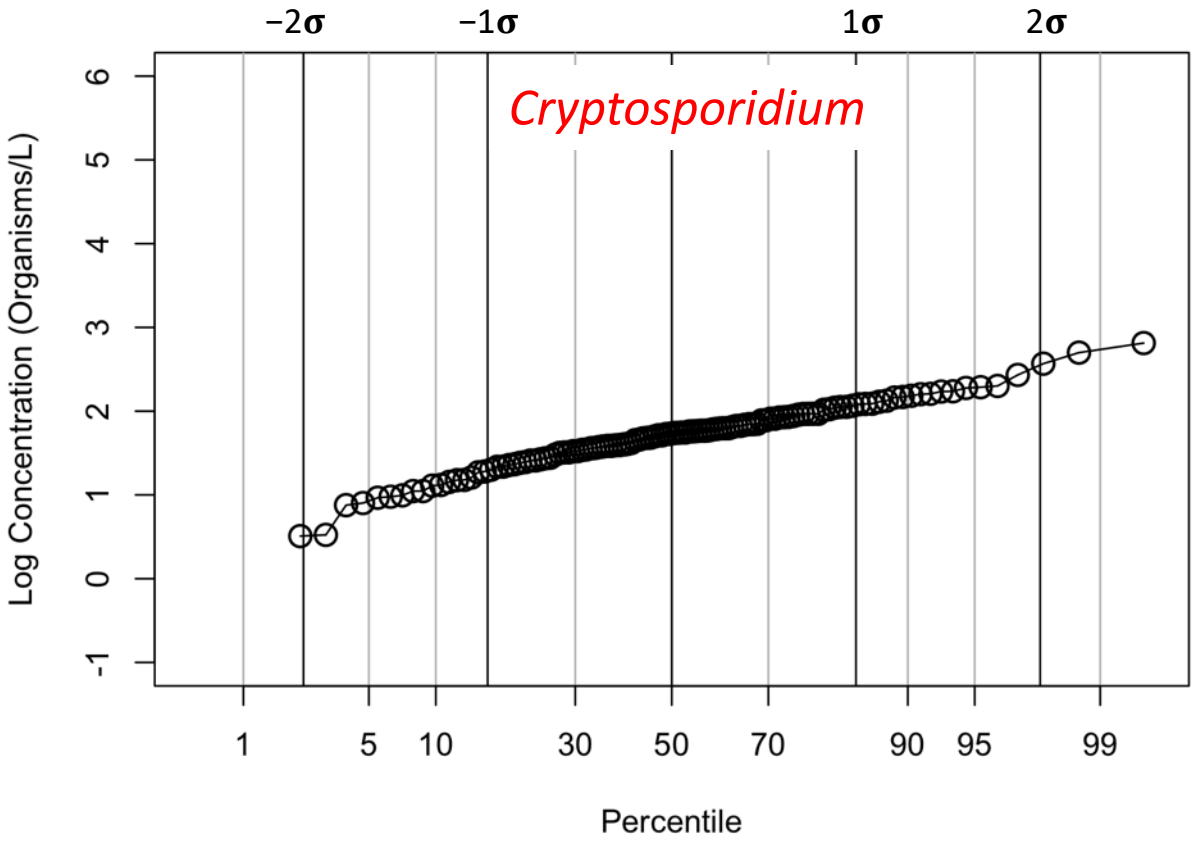


24 samples

Sampling Locations

Range: 30 – 275 MGD

A Closer Look: Pathogen Distributions



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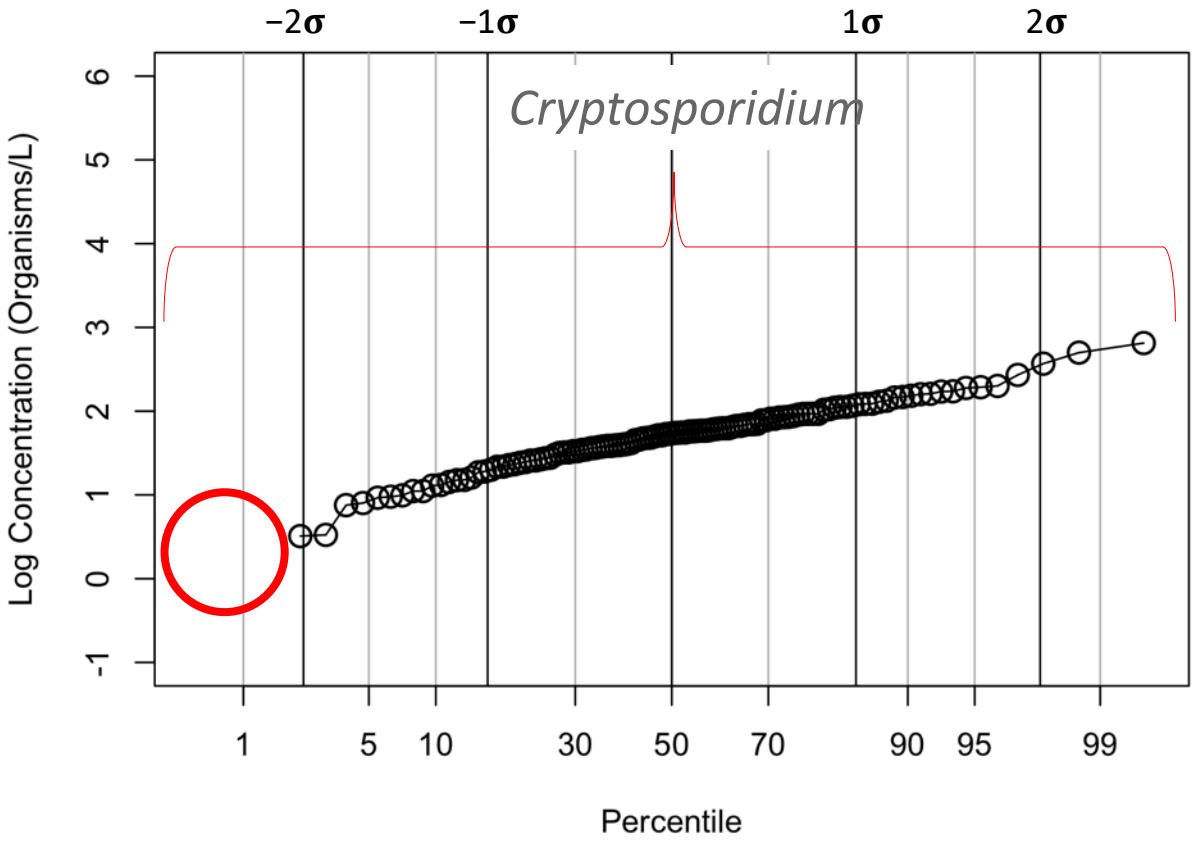

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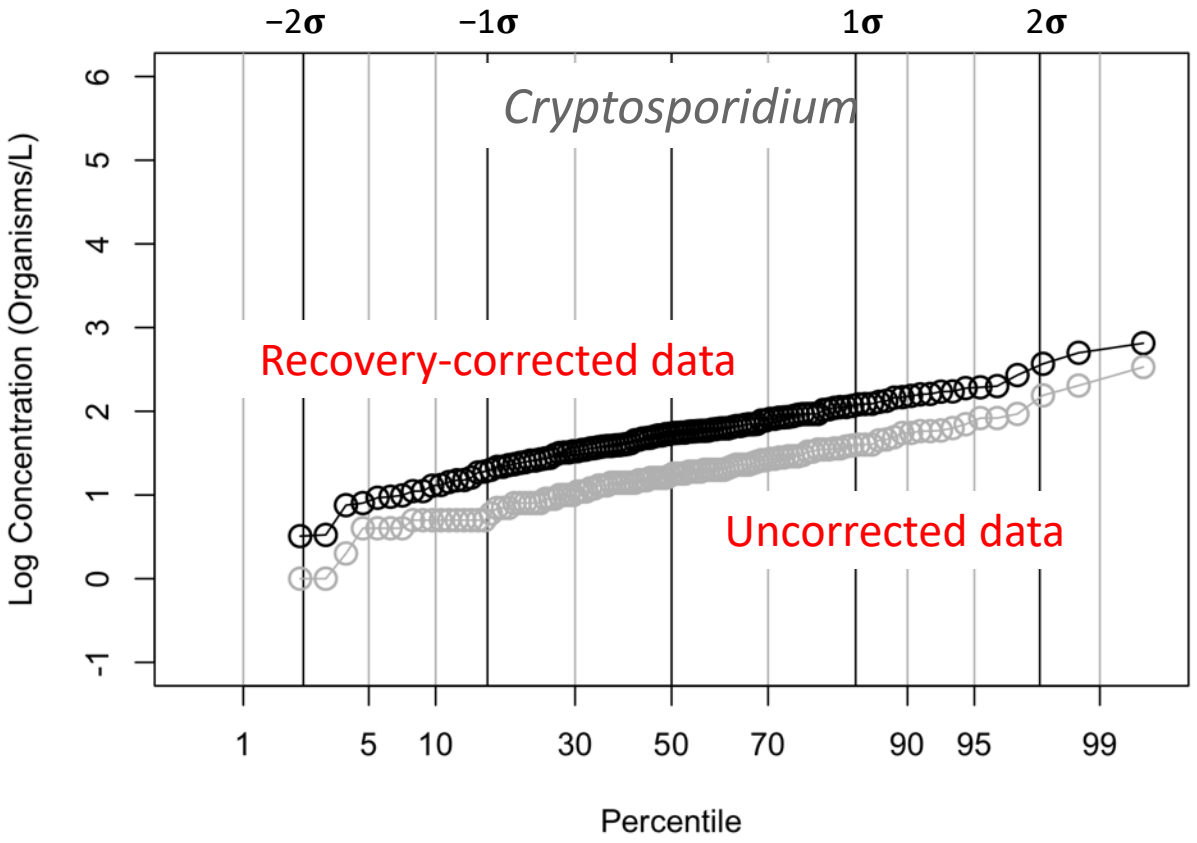

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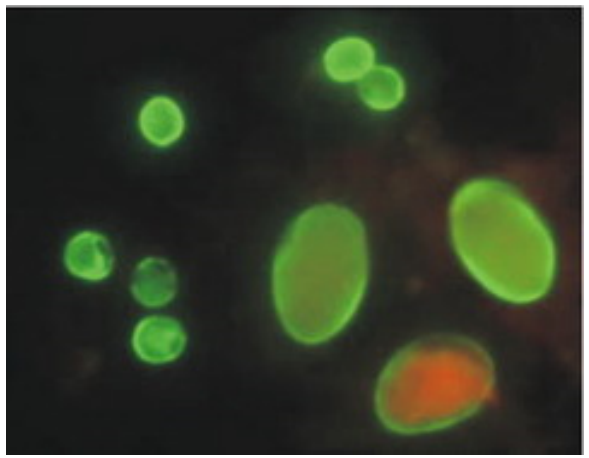
- High <u>recovery efficiency</u>



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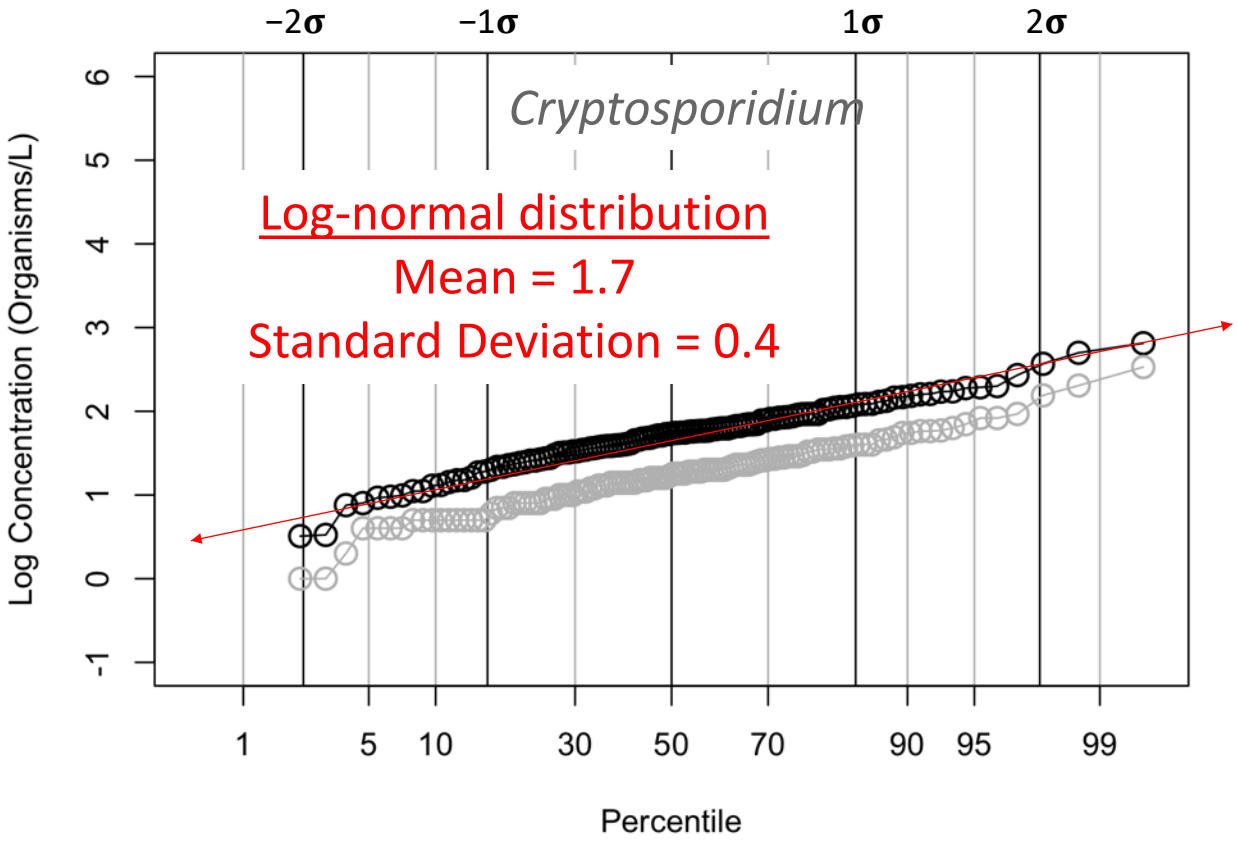

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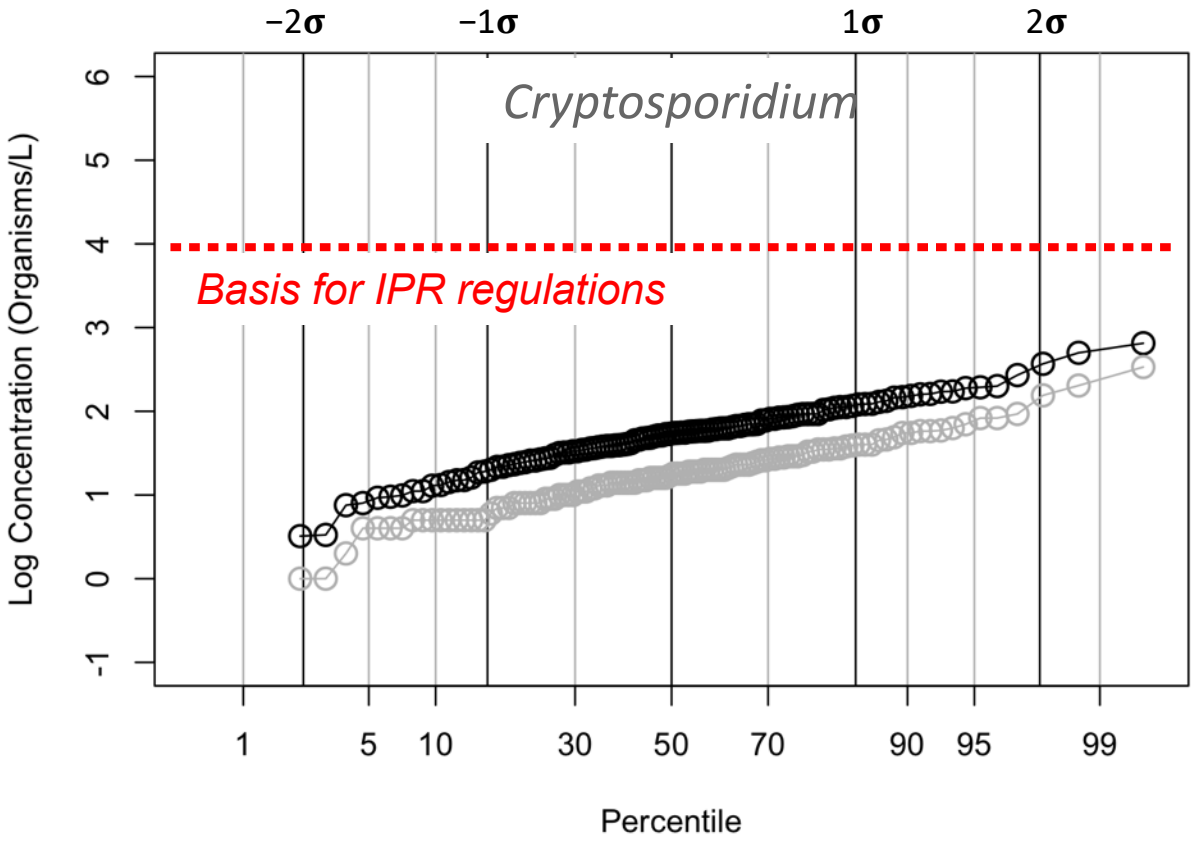

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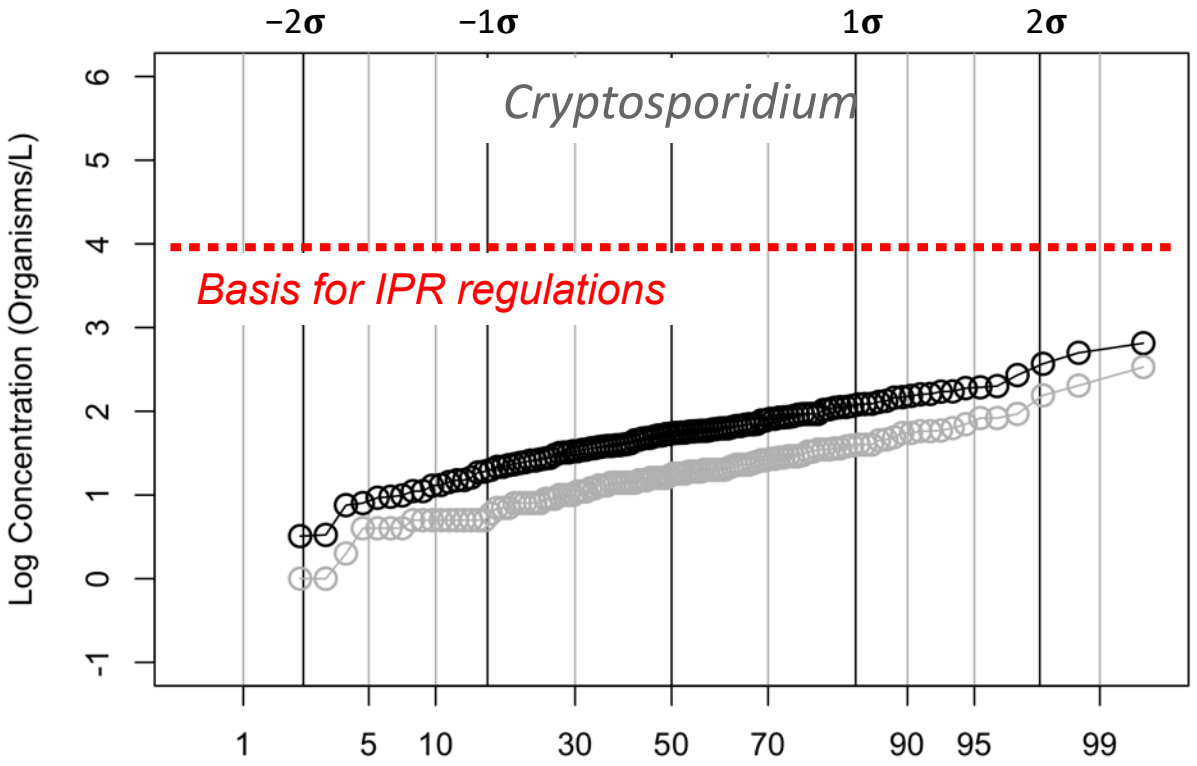

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- Allows for <u>comparison</u> with IPR regs

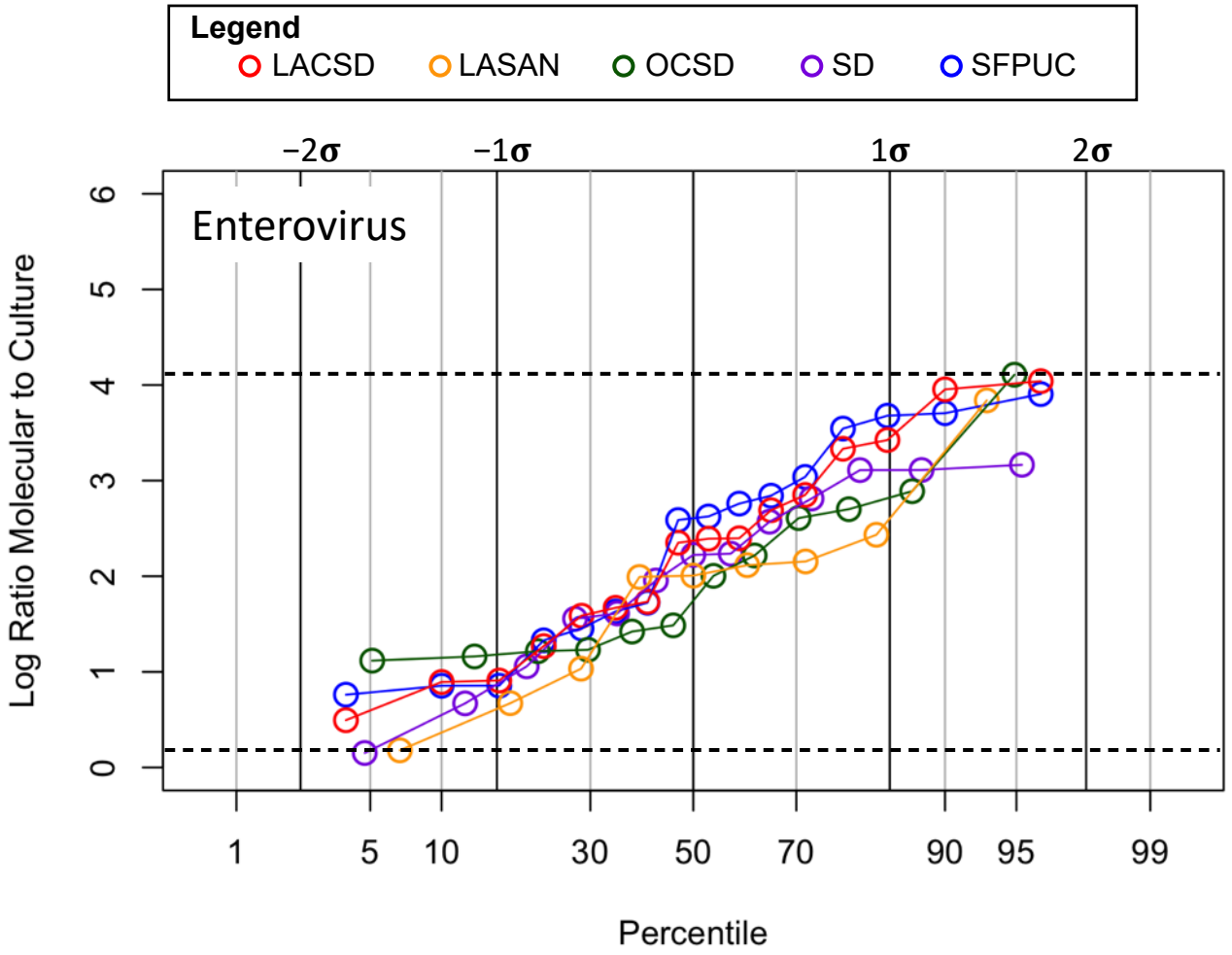
Recommendation:
Use modeled distributions for probabilistic assessments of treatment targets

Other Key Findings

- Pathogen distributions similar across treatment plants
  - 94% of comparisons had no significant differences between facilities
- Minimal level of seasonality observed
  - Enterovirus higher in summer / adenovirus higher in winter
- No clear impact of COVID-19 on concentrations
  - Data collected before and after Stay-at-Home order showed minimal change
- Uncertainties associated with the use of molecular data

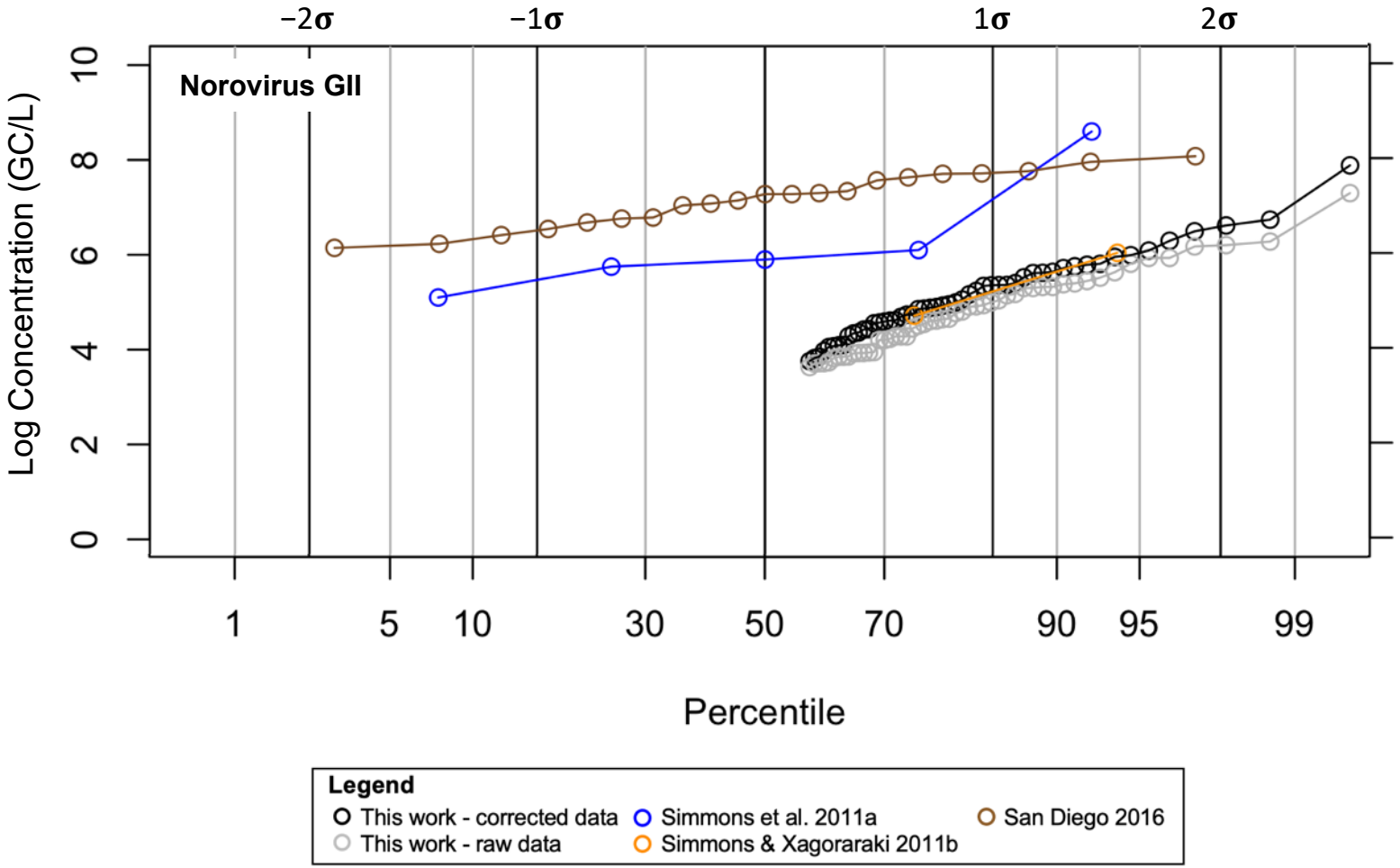
Issues with the use of molecular data

- Genome copies (GC) not always associated with *infective* virus
- Difficult to link GC with infectivity
- DPR-2 ratios span orders of magnitude:
  - 10,000:1 to 1:1 (enterovirus)
  - 100,000:1 to 1:1 (adenovirus)



When is this important?

- Norovirus not culturable
- Dose-response function makes assumptions about “infectivity” of genome copies
- If we assume 1:1, then each GC is an infectious unit (IU)



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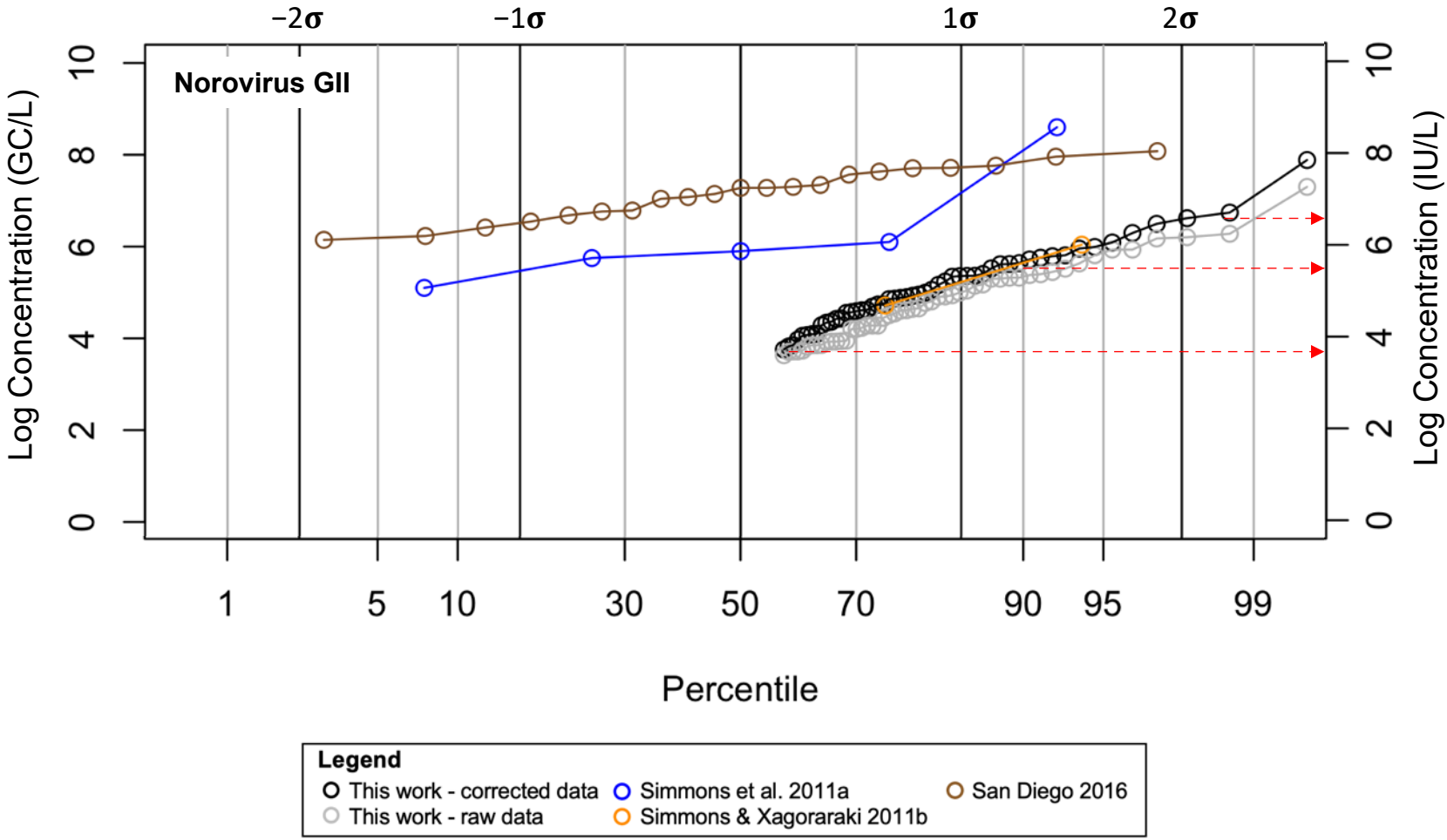
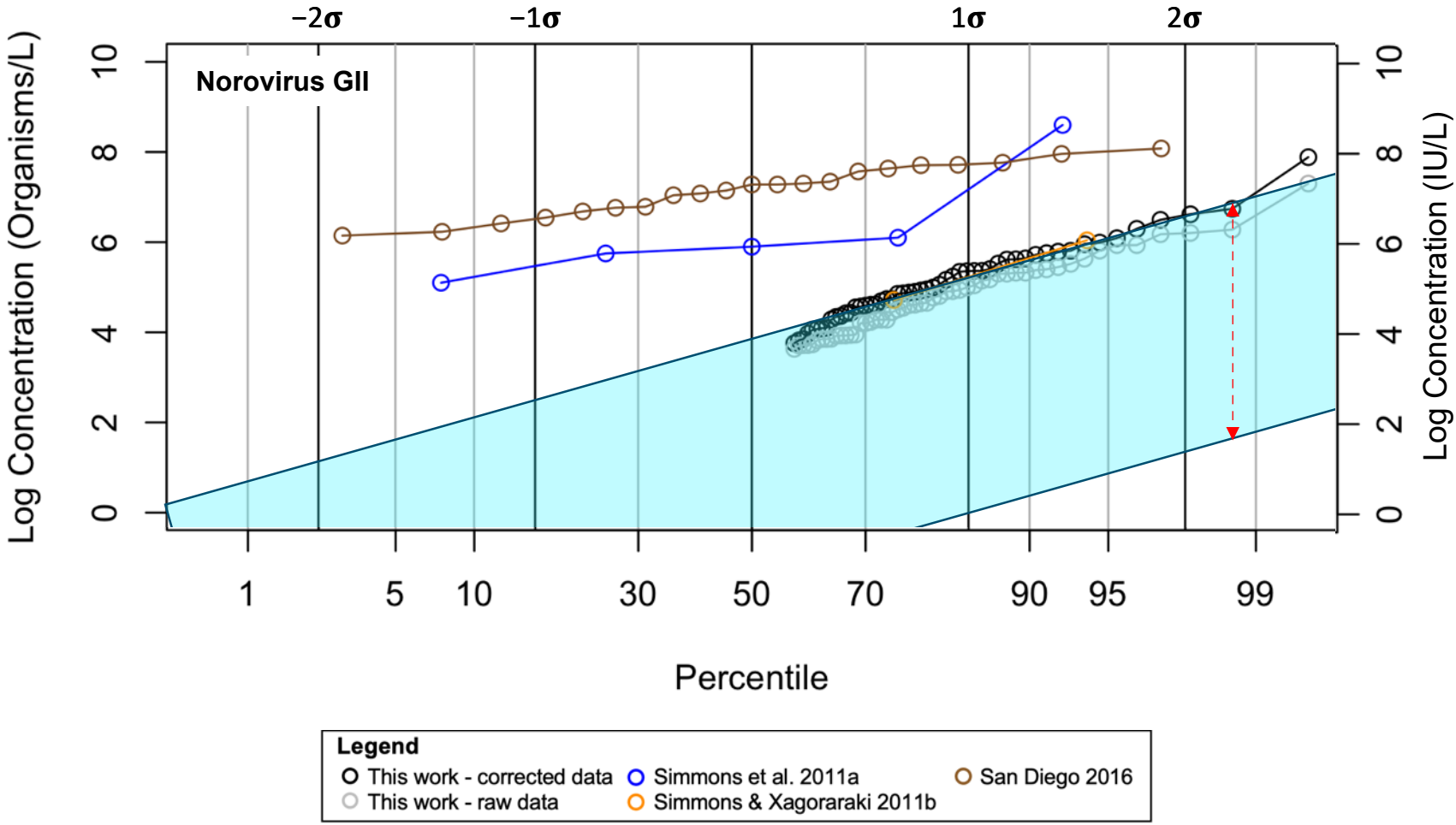


Incorporate uncertainty in risk analyses

- DPR-1 Final Report shows how to incorporate molecular data into analysis
- Results in a “band” of potential values



Recommendations for Regulatory Development

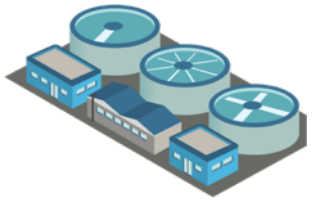
- Use DPR-2 datasets as the raw wastewater inputs for QMRA
- Correct pathogen data for recovery using matrix spikes
- Use culture data to reduce uncertainties with molecular interpretation; follow TWG recommendations for the use of molecular data
- Model the DPR-2 distributions (and relevant literature) for use in probabilistic assessments
- Require DPR-2 QAPP/SOPs for future pathogen monitoring studies

How Much Pathogen Treatment?

Wastewater

What concentration of pathogens are we starting with?

DPR-2: Raw Wastewater Pathogen Monitoring



How much treatment is needed?

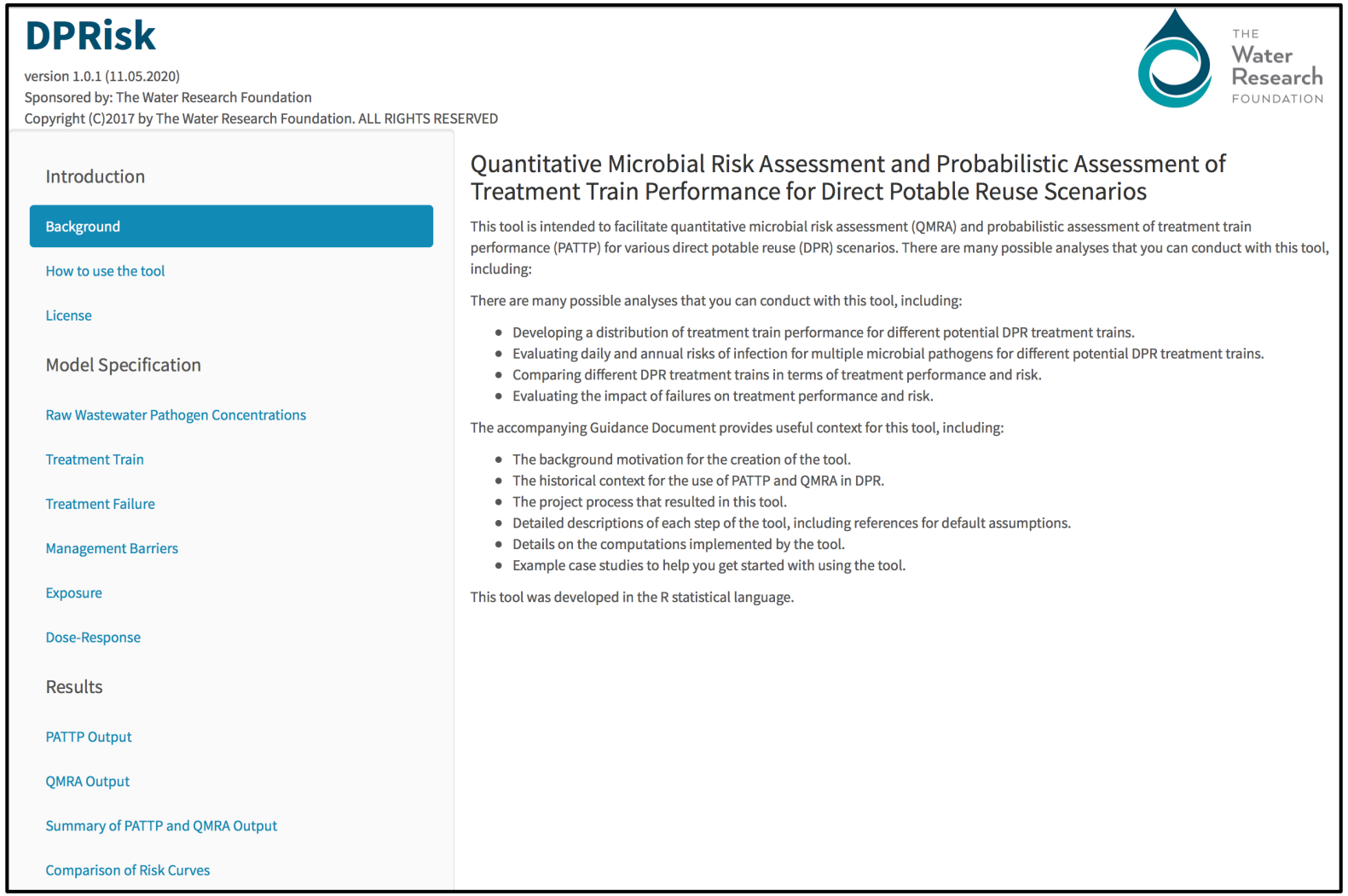
DPR-1: Pathogen Treatment and Risk

Drinking Water

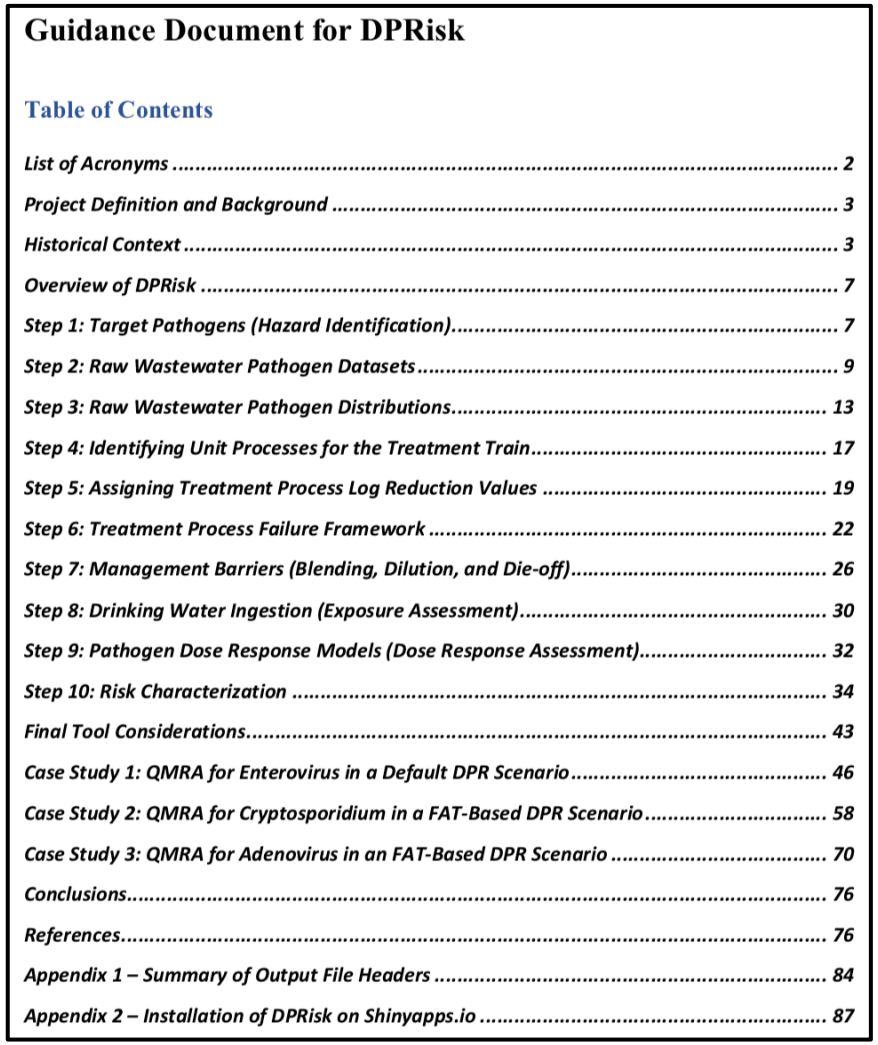
Can we meet our risk goals?

DPRisk Tool and Guidance Document

DPRisk: QMRA Tool



DPRisk: Guidance Document



Guidance Document for DPRisk

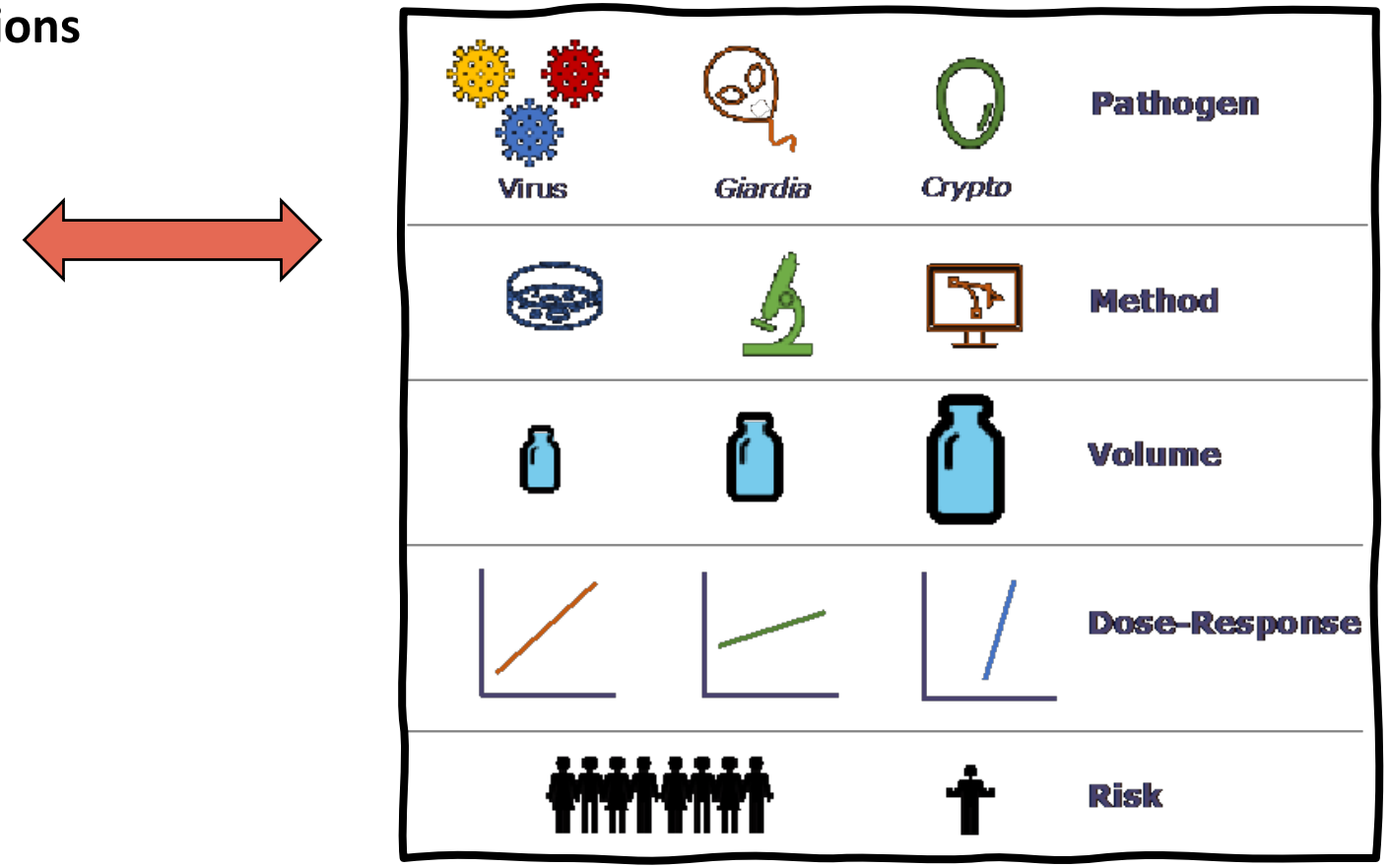
Table of Contents

Also: User Input Files for 3 Case Studies

DPRisk Features

INPUTS:

- **Raw Wastewater Pathogen Concentrations**
- **Treatment Train**
- **Treatment Failure**
- **Exposure**
- **Dose Response**



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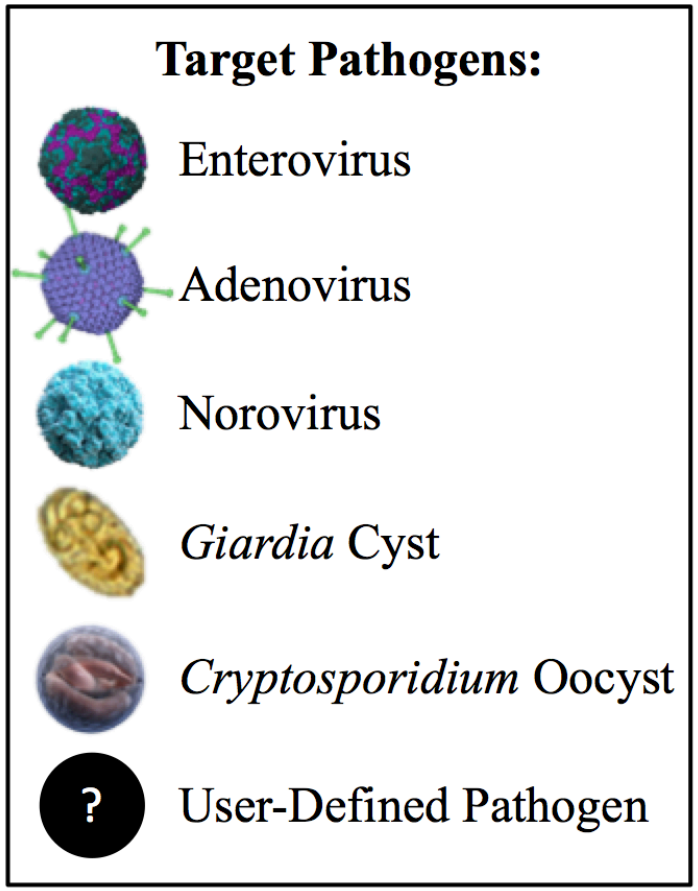

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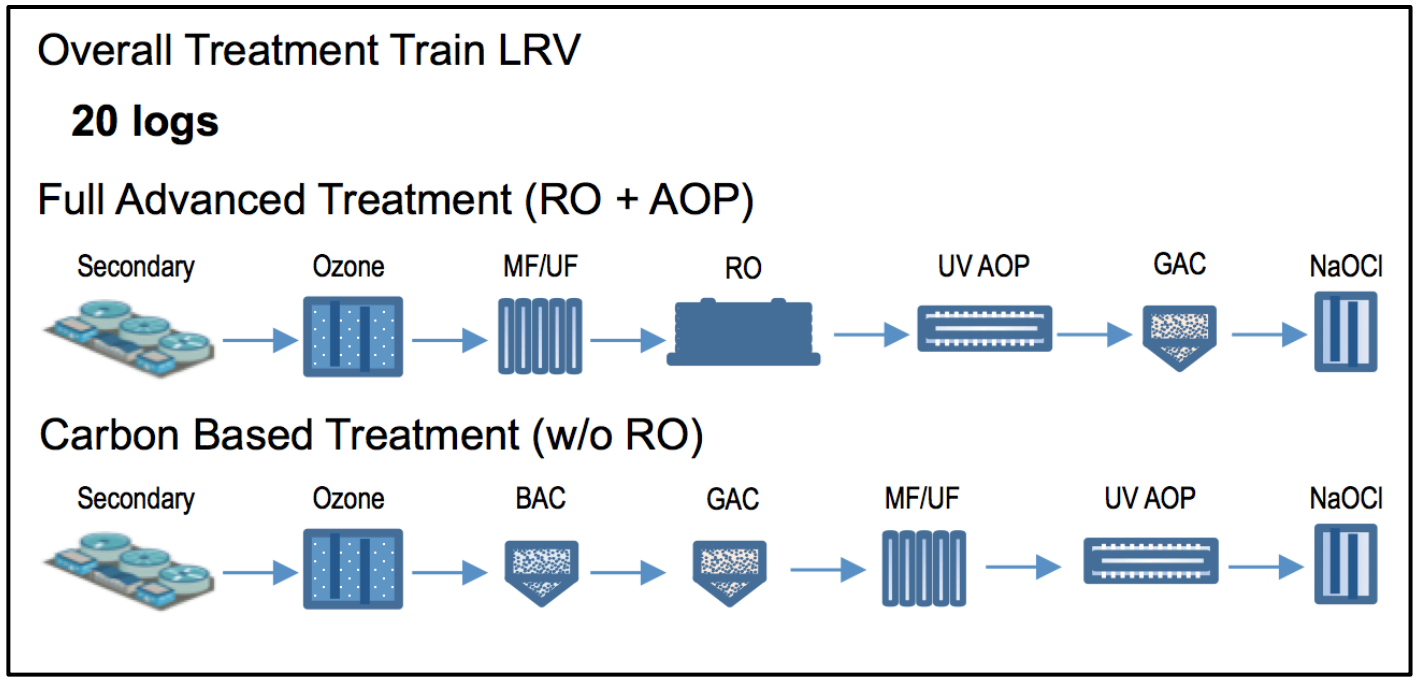
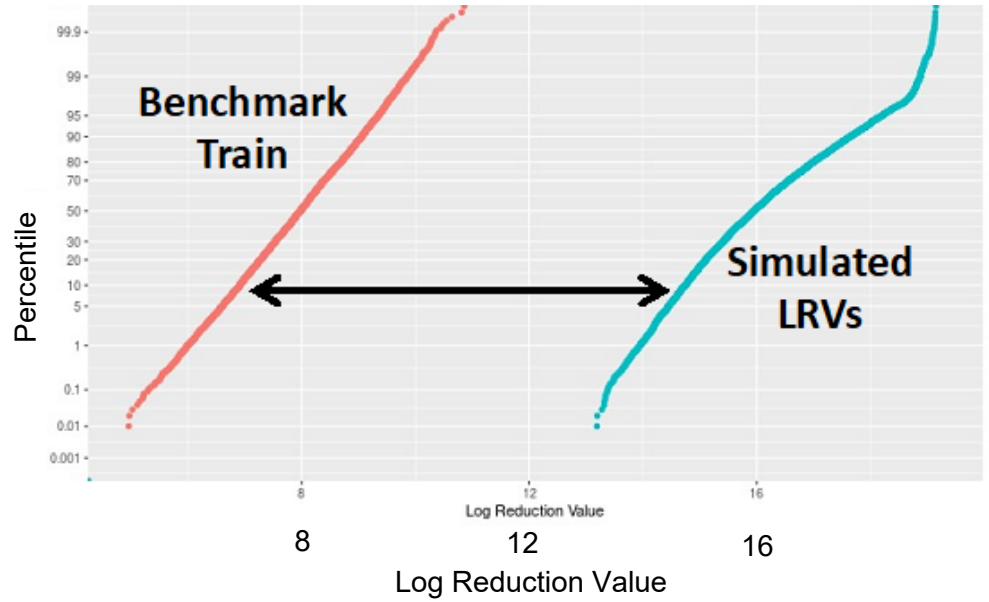
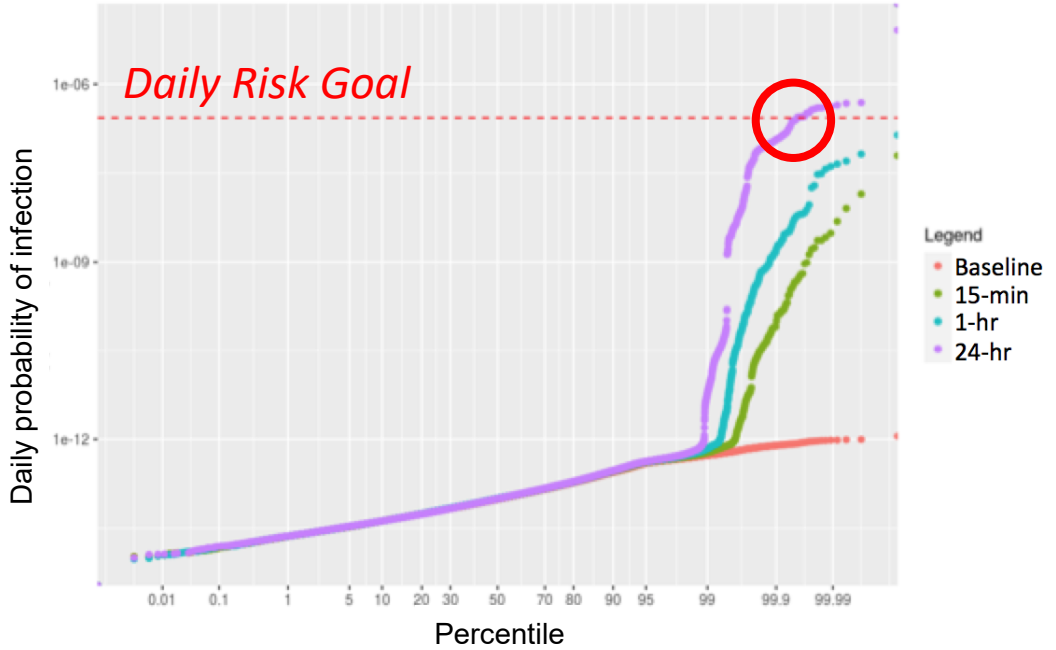


DPRisk Outputs

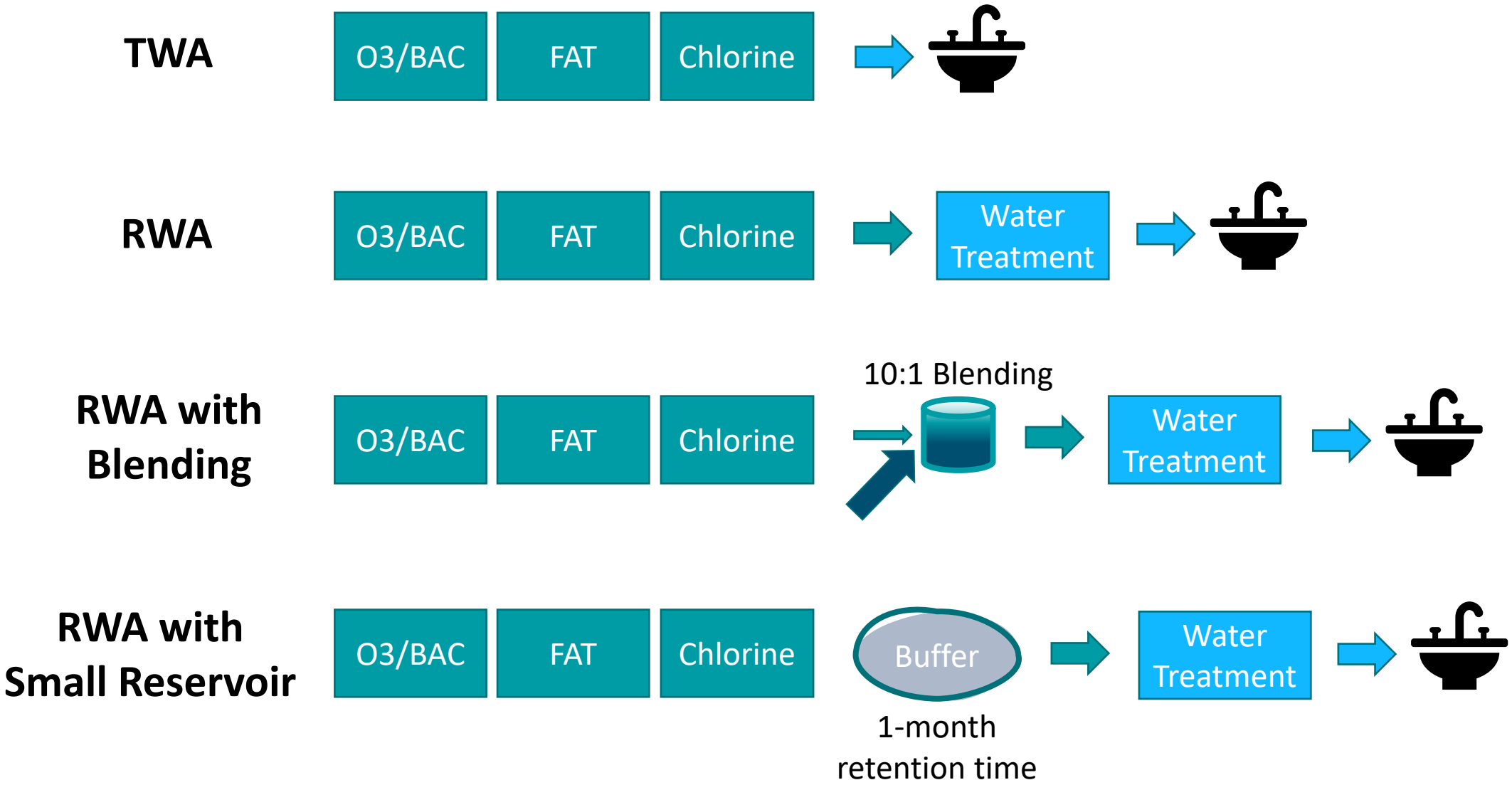
- **Probabilistic Assessment of Treatment Train Performance (PATTP)**



- **Quantitative Microbial Risk Assessment**



Not All DPR Projects Are Alike



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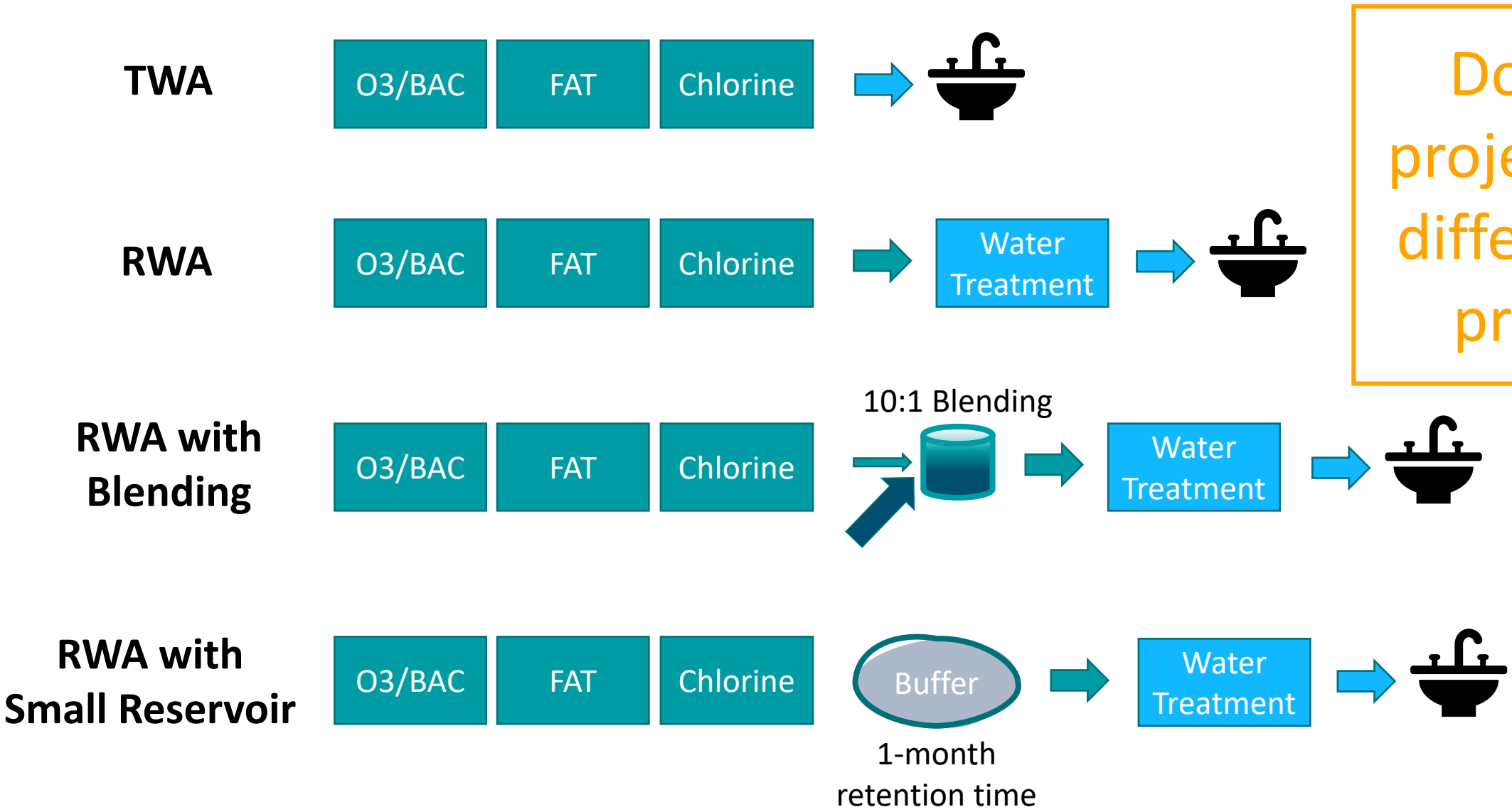


Do these projects have different risk profiles?

DPRisk Includes Management Barriers

DPRisk Inputs

Blending

Specify the log removal associated with blending.

Specify log removal for blending as:

Point estimate

Log Removal:

0

Dilution

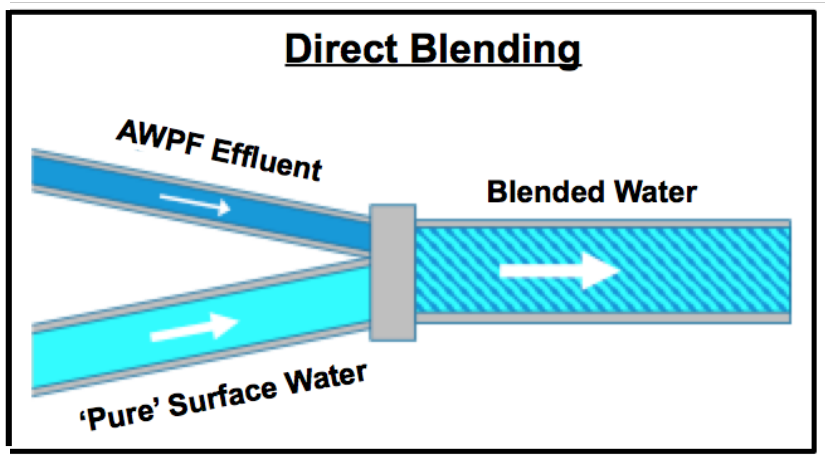
Specify the log removal associated with dilution.

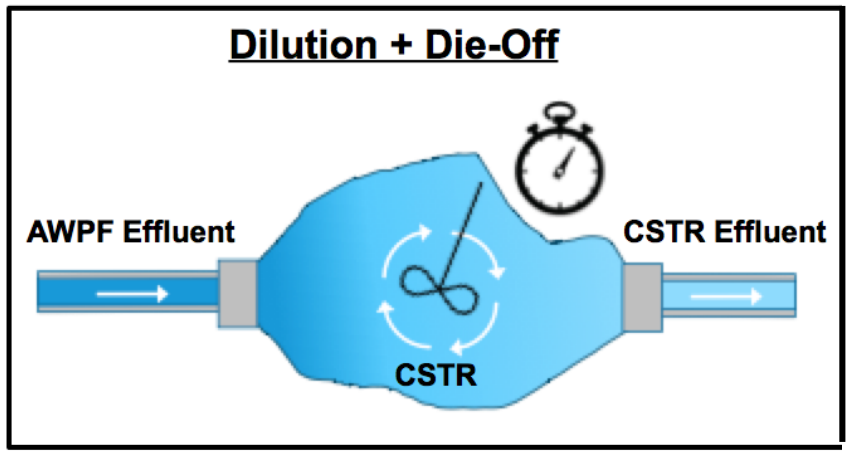
Specify log removal for dilution as:

Point estimate

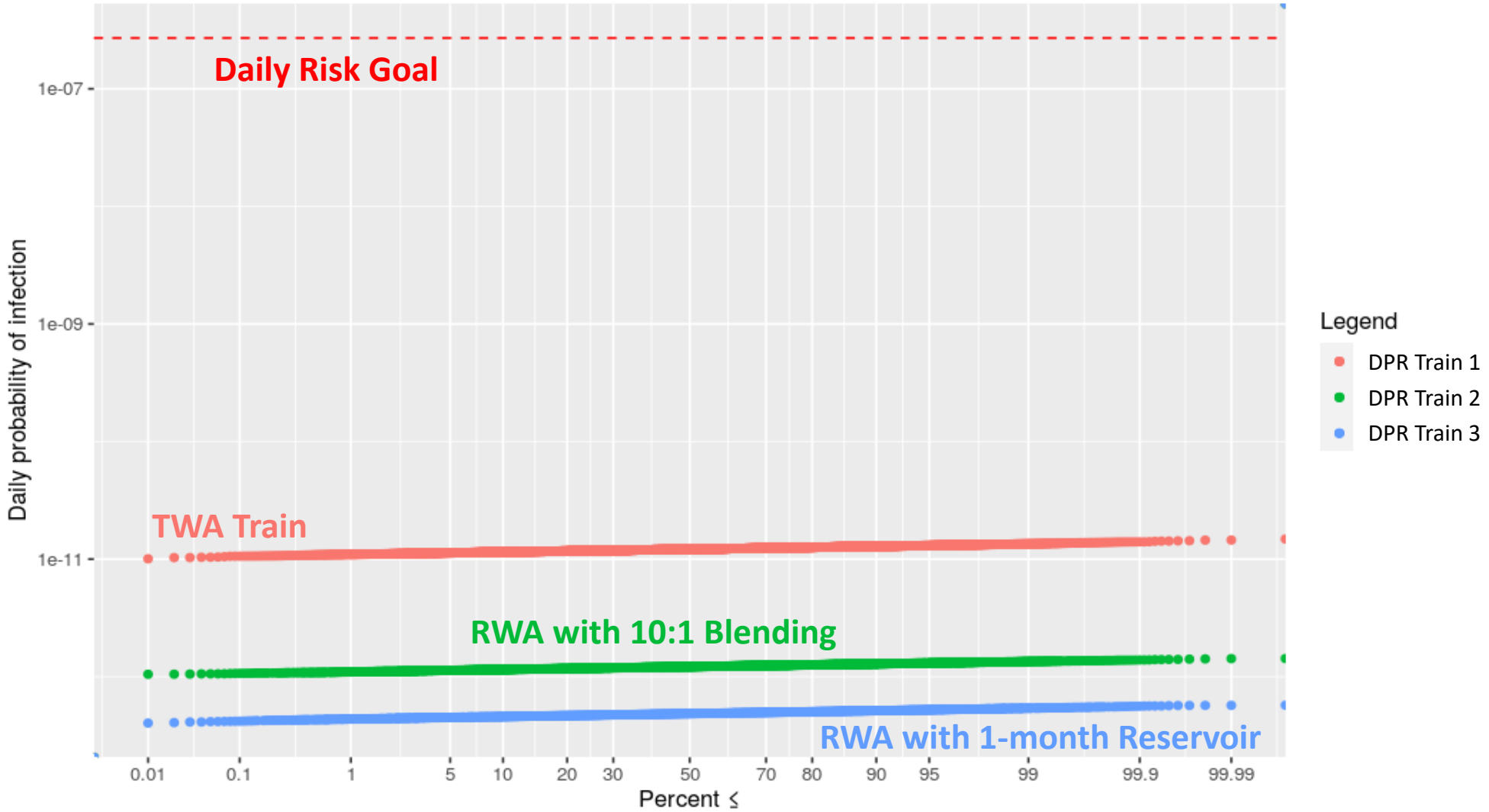
Log Removal:

0



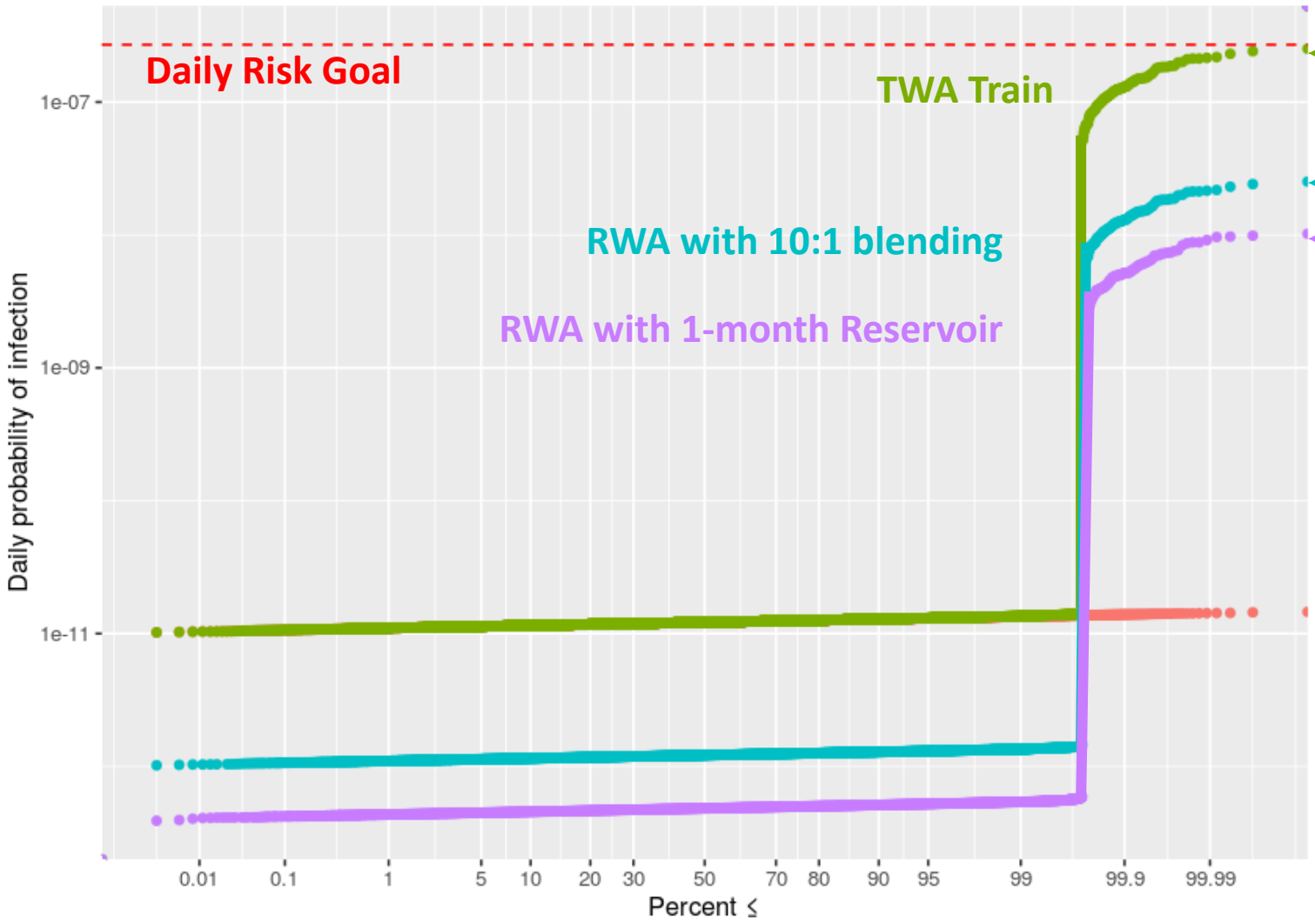


Risk Profiles of RWA and TWA Trains (no failures)



Risk Profiles of RWA and TWA with Failure Analysis

Risk Profiles of RWA and TWA with Failure Analysis



Understanding differences in risk profiles…

…can allow for different DPR requirements.

Recommendations

- Select modeled distributions from DPR-2 as raw wastewater inputs
- Use DPRisk for *probabilistic* assessments of performance and risk
- Develop frameworks to incorporate the benefits of non-treatment (management) barriers in RWA and TWA

Acknowledgements

- Anya Kaufmann, Trussell Technologies (DPR-1)
- Dan Gerrity, Southern Nevada Water Authority (DPR-1)
- Emily Darby, Trussell Technologies (DPR-2)

Questions?

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