Water Research Commission South Africa COVID-19 Environmental Surveillance in Sewersheds

THE Water Research FOUNDATION

Dr Peter Grevatt
Chief Executive Officer
The Water Research Foundation

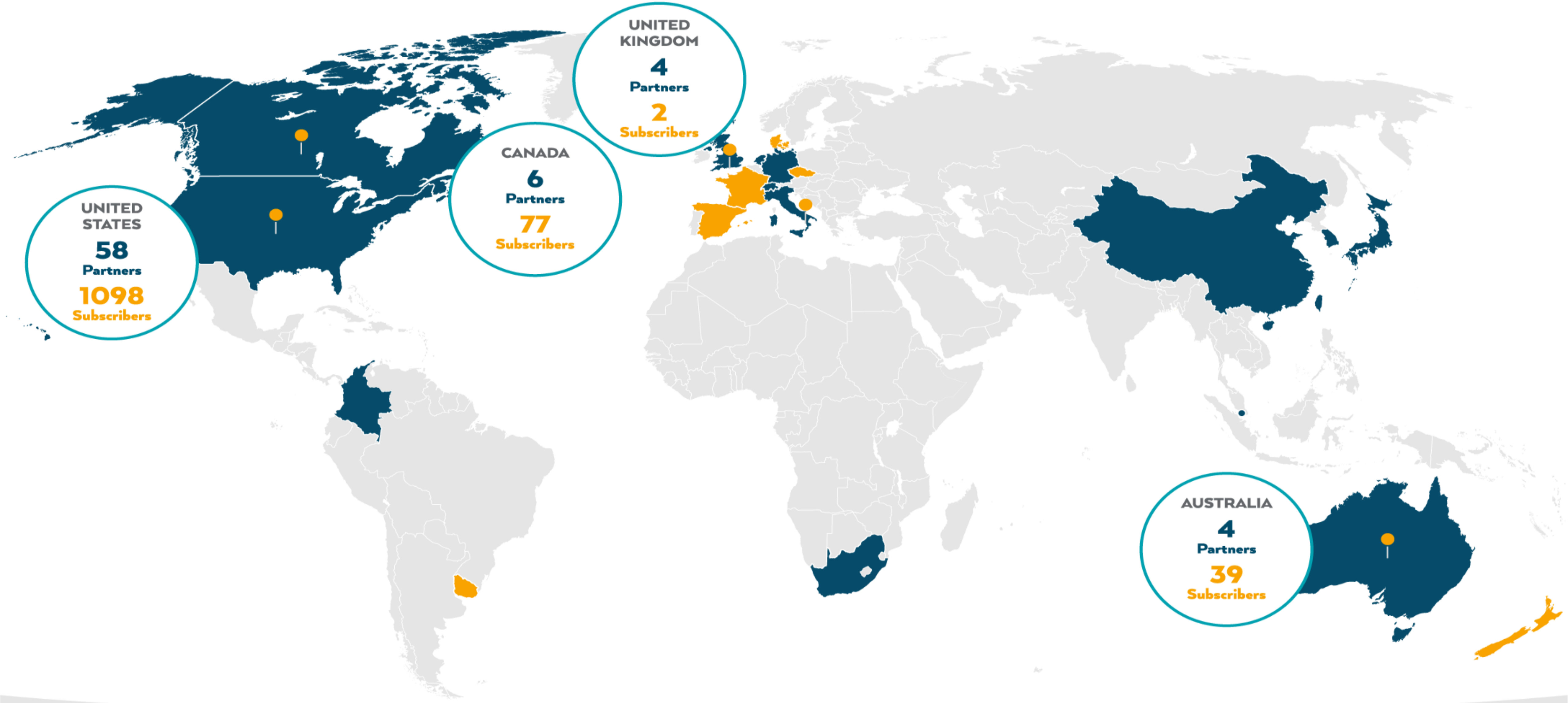
ABOUT

MISSION

Advancing the science of water to improve the quality of life.

VISION

To create the definitive research organization to advance the science of all things water to better meet the evolving needs of subscribers and the water sector.



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THE Water Research FOUNDATION®

International Water Research Summit

Environmental Surveillance of COVID-19 Indicators in Sewersheds

April 27-30, 2020

3:00 PM – 5:00 PM EDT USA

Working Group on Data Interpretation

Co-Chairs

Chuck Haas, Drexel University

Doug Yoder, Miami-Dade Water and Sewer

Gertjan Medema, KWR

Vanessa Speight, University of Sheffield

Participants

Mia Mattioli, Centers for Disease Control and Prevention (CDC)

Jay Garland, Environmental Protection Agency (EPA)

Jeff Soller, Soller Environmental, LLC

John Norton, Great Lakes Water Authority

Jeff Prevatt, Pima County Regional Wastewater Reclamation Dept.

Dimitri Katehis, New York City Dept. of Environment Protection

Steve Rhode, Massachusetts Water Resources Authority

Ken Williamson, Clean Water Services

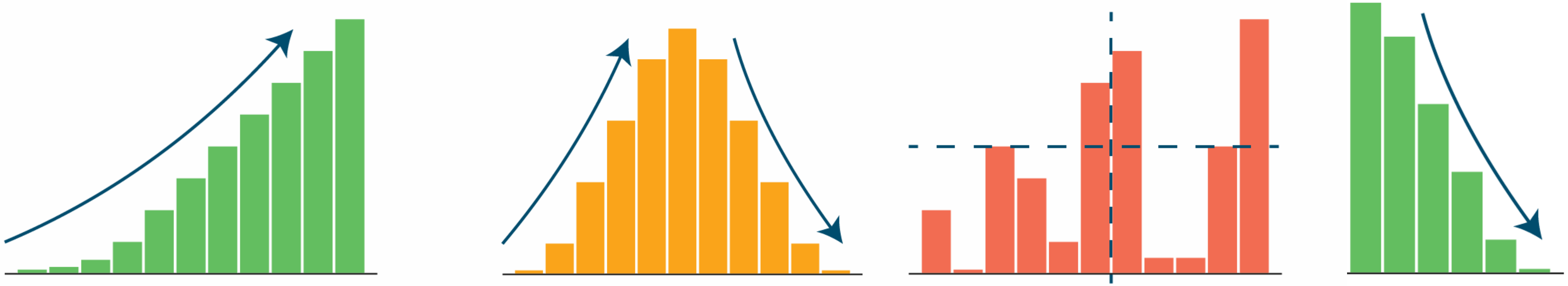
Paul Kadota, Metro Vancouver

Reynald Bonnard, SUEZ Environmental Research Center

What Can You Use Sewershed Surveillance Data For Now?

General Use Cases	Can Inform	Current Feasibility
Trends/Changes in Occurrence	Early detection of Occurrence. Tracking the impact of medical and social interventions: A) curve increasing; B) curves decreasing	A) ++ B) +
Assessment of Community Infection	Tracking disease prevalence in the community. Identification of areas of concern	+/-
Risk Assessment	Risk to utility workers and those exposed to raw sewage	+/-
Viral Evolution	Source tracking of the virus	-

General Use Case: Trends/Changes in Occurrence



Pre- and early event

- Detection most important
- Grabs may be sufficient
- Sentinel sites

Mid-Event

- Quantitation important
- Flow-based samples likely needed
- Less uncertainty in community calculations better supports studies of correlation with medical and social interventions

Late event

- Detection again becomes important
- Sentinel sites serve, again, as a metric of occurrence
- Monitor well past last incident of detection

Working Group on Communication

Co-Chairs

Jim McQuarrie, Denver Metro Wastewater Reclamation Dist.

Cathy Bailey, Greater Cincinnati Water Works

Dan Deere, Water Futures

Participants

Jeff Oxenford, Rural Community Assistance Partnership

Vince Hill, Centers for Disease Control and Prevention (CDC)

Claire Waggoner, CA State Water Resources Control Board

Karen Mogus, CA State Water Resources Control Board

Chris Impellitteri, Environmental Protection Agency (EPA)

Diane Taniguchi-Dennis, Clean Water Services

Gabriella Rundblad, King's College London

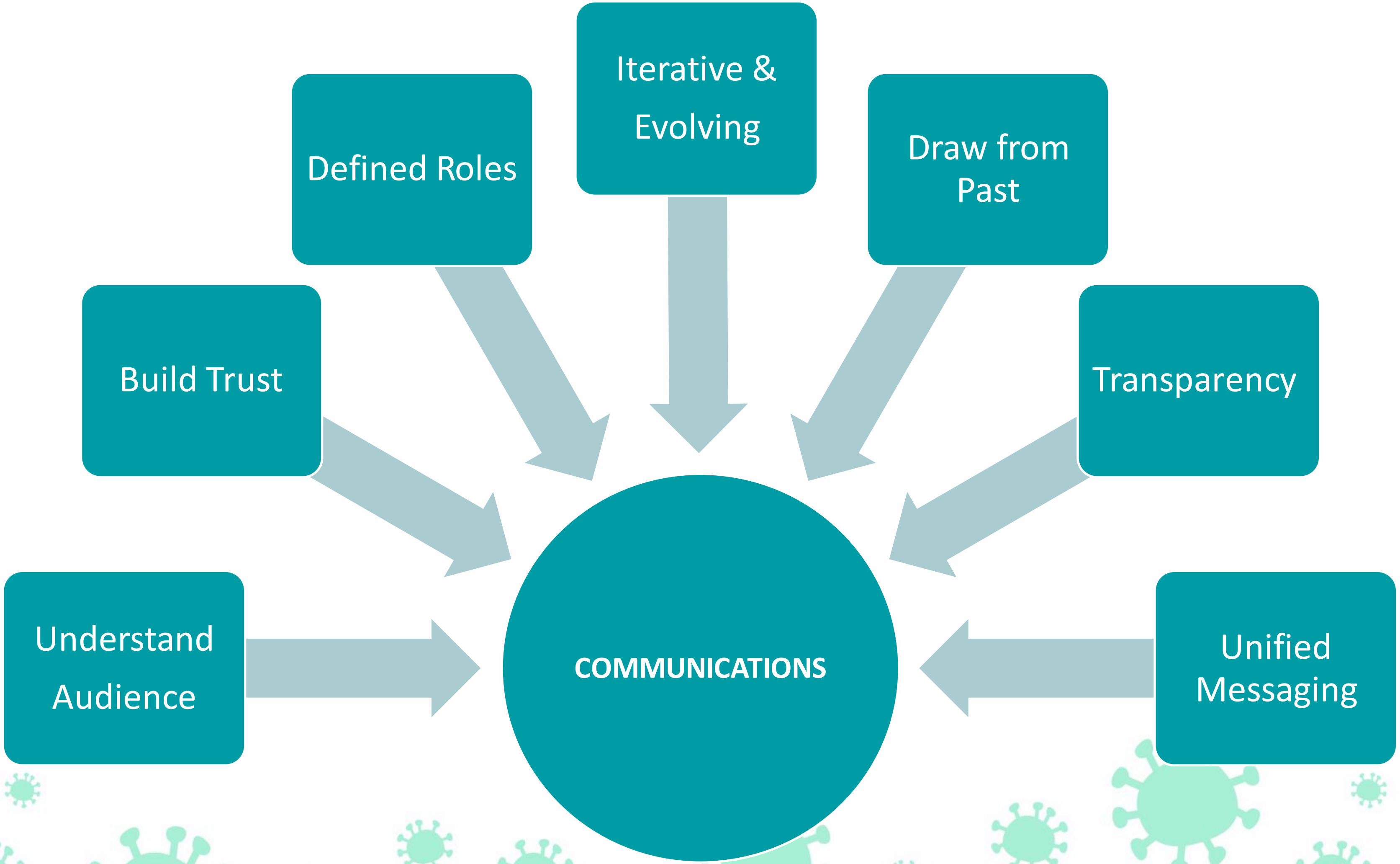
Josef Klinger, Technologiezentrum Wasser (TZW)

Bruno Tisserand, Veolia

Stephanie Rinck-Pfeiffer, Global Water Research Coalition

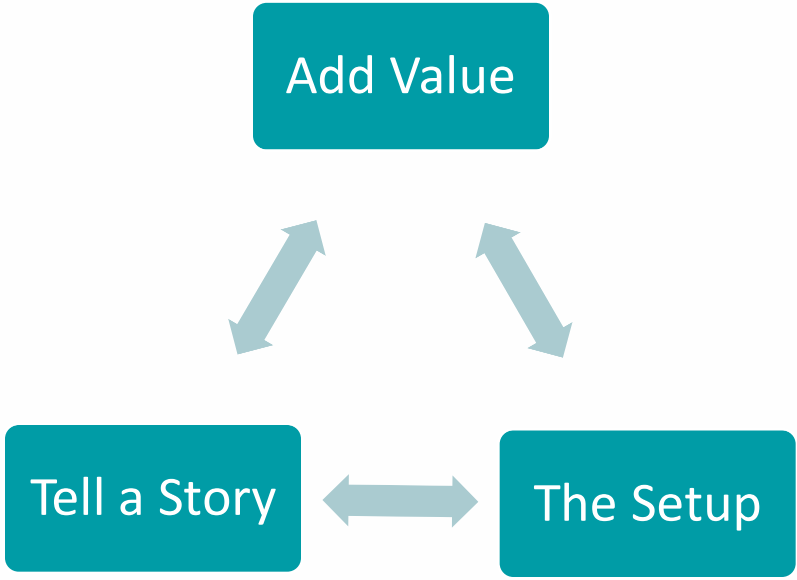
Yvonne Forrest, Houston Water

Communications Guiding Principles



Messaging

- **Add Value - We are contributing to the community**
  - *"We have the ES data, we know a lot, we are evaluating the best way to interpret and act on the data."*
- **The Setup - The relationship matters**
  - Establish the relationships you want with public, media, etc.)
- **Tell A Story - The Beginning, The Middle, and The End**
  - What are you doing now?
  - What are you going to do?
  - What is the outcome?



Working Group on Sample Collection

Co-Chairs

Chuck Gerba, University of Arizona

Jim Pletl, Hampton Roads Sanitation District

Dan Gerrity, Southern Nevada Water Authority

Participants

Mark Sobsey, University of North Carolina at Chapel Hill

Amy Pickering, Tufts University

Mark Jones, UK Water Industry Research (UKWIR)

Katrina Charles, Oxford University

Kelly Hill, Water Research Australia

Christoph Ort, Eawag – Swiss Federal Institute of Aquatic Science and Technology

Matt Burd, New York City Dept. of Environmental Protection

Kaylyn Patterson, Metropolitan Water Reclamation Dist. of Greater Chicago

Amy Kirby, Centers for Disease Control and Prevention (CDC)

ES Sample Plan Design: General Considerations

- Partnering with information customers
- Study goals
- Grab vs. Composites, study-specific
- Timing within an event
- Sensitivity vs. Quantitation in monitoring
- Complexity of wastewater infrastructure
- Frequency & Duration
- Representativeness
- Comparability

Sample Collection Guiding Principles

Baseline assumption of centralized WWTP

Require some consistency in practices and documentation and metadata for data comparability

Recommendations are adaptable and modifiable to best meet needs

Intention is NOT to inhibit utility operations during a pandemic

Balance study goals with practical considerations: resources, operator ability, freezer storage space, budget

Some best practices for sample collection apply to all use cases, whereas others are use-case specific

Consider worker safety in sampling and sample prep guidance

This is a proof of concept exercise – intended to support research, meta-analysis, practice/implementation and retrospective learning

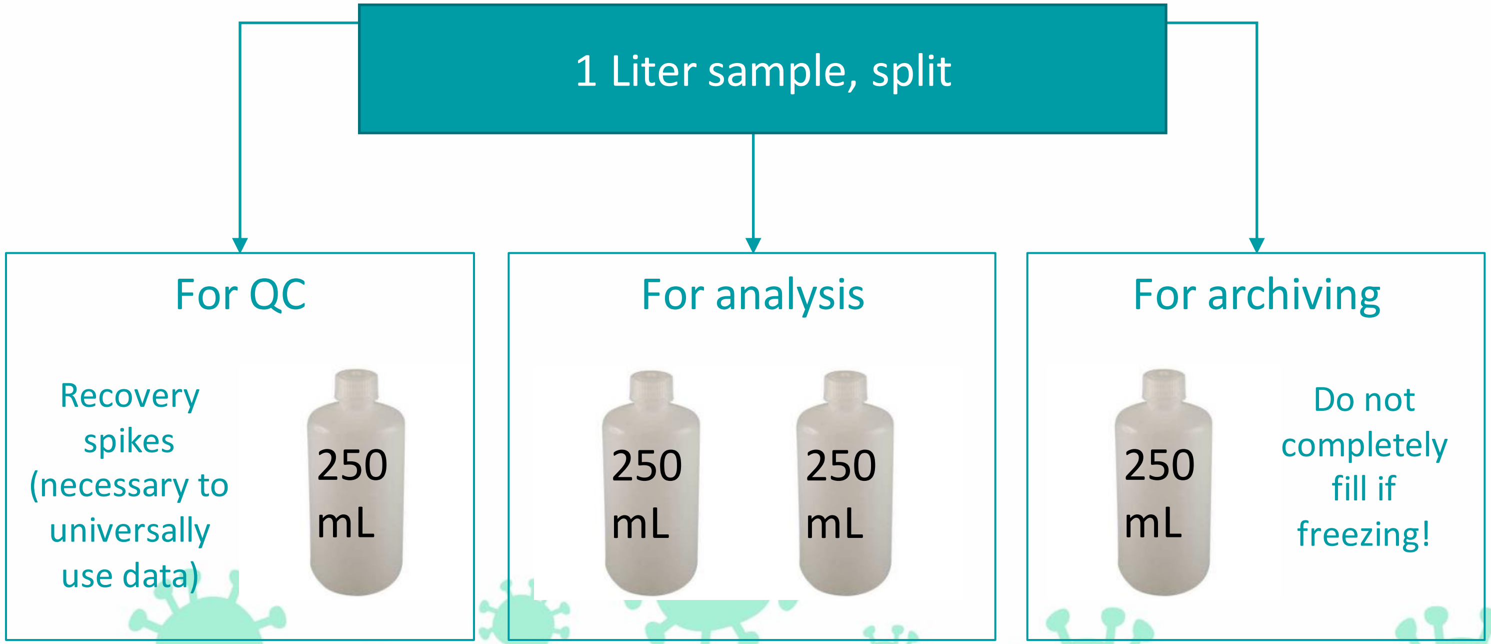
Critical Metadata

- Sample type: Grab vs. Composite
  - Composite type (flow vs. time)
  - Composite duration
  - # of aliquots
- Time of sample
- Sample ID + container labeling
- Who collected the sample
- Location
- Weather: Rain events?
- Flow rate
- Separate or CSO
- Population served
- Public health data
- Sample characteristics – TSS, pH, temperature, chlorine residual
- Storage temperature
  - qPCR: -20C min, -80C best
  - Avoid freezer defrost cycles
- Pasteurized? (not for infectivity study)
- Concentrated? (inhibition)

Sample Collection & Storage: Best Practices

- Use new polycarbonate containers, leak-proof

- Field/trip blanks
- Equipment blanks
- Recovery spikes



Working Group on Sample Analysis

Co-Chairs

Krista Wigginton, University of Michigan

Frederic Been, KWR

Joan Rose, Michigan State University

Participants

Raul Gonzalez, Hampton Roads Sanitation District

Kellogg Schwab, Johns Hopkins University

Scott Meschke, University of Washington

Rosina Girones, University of Barcelona

Kaye Power, Sydney Water

Sudhi Payyappat, Sydney Water

Zia Bukhari, American Water

Farida Bishay, Metro Vancouver

Tiong Gim Aw, Tulane University

Analysis Guiding Principles

- There is a need to provide credible information to decision makers
- Detection of target nucleic acids (RNA for SARS CoV-2) is a powerful tool
  - Fraught with challenges and potential misinterpretation
- Ultimately, molecular methods need to provide **reproducible, reliable and preferably quantitative information**
  - Evaluation and validation of methods are critical
  - Controls need to be included in each step during initial validation, so that the impact on subsequent steps are understood
    - For routine evaluation, overall recovery and detection controls can be used to streamline costs and efficiency

Analysis Guiding Principles

- **A Quality Assurance/Quality Control (QA/QC) checklist is essential**
- **Respect the matrix** – wastewater can be a complex mixture of municipal and industrial effluents (and is quite different from clinical samples)
  - The limit of detection/quantification needs to be established for your assay and the sample matrix
  - Biosafety considerations upstream of nucleic acid extraction
- Data must be collected for each sampling or analytical step to ensure that the appropriate context can be given to subsequent interpretation of results
- It is important to report on **all of the factors** in the study that could impact the result (i.e. detection results need to be related to water quality and other metadata)

QA/QC Checklist

Minimally acceptable QA/QC standards for every assay include:

- ✓ Positive control
- ✓ Negative control
- ✓ Inhibition control

Validate recovery during method development:

- ✓ Initial Precision Recovery controls
- ✓ Matrix spike (periodic assessment)
- ✓ Estimate of the limit of detection and limit of quantification
- ✓ Reporting of the equivalent volume of sample analyzed

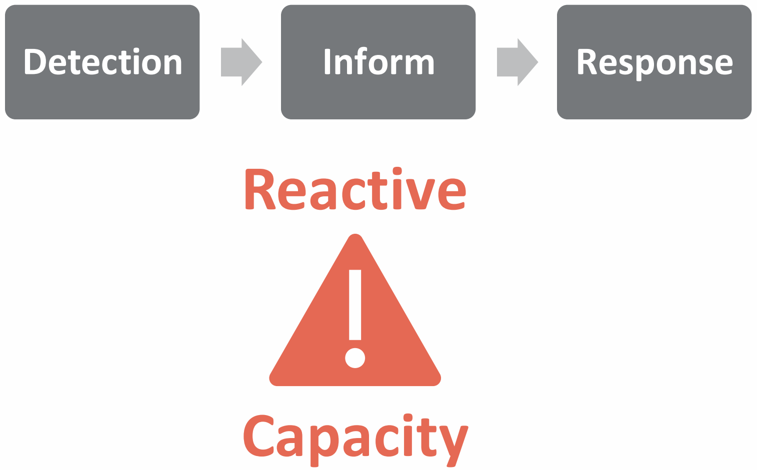
A primary source of error in qPCR occurs when the standard curve is generated. Each standard curve should be checked for validity

- ✓ Use appropriate standards for an RNA virus, specifically, the use of reverse transcriptase prior to PCR

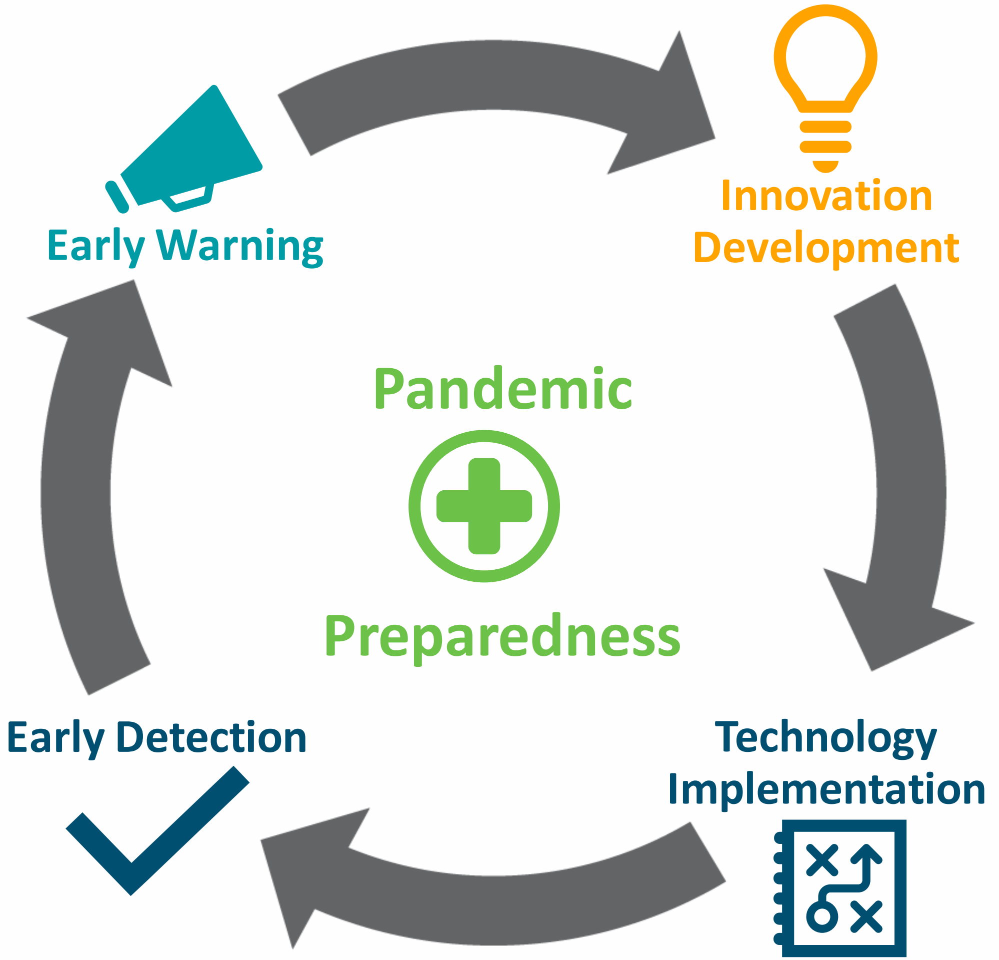
Near-term Research Priorities

- Interlaboratory and Methods Assessment
  - Which methods produce the most reliable results for analyzing the COVID-19 genetic signal
  - The extent to which laboratories are able to reproduce sample results
- Stability of Genetic Signal in Wastewater Matrix
  - Dilution of the genetic signal in sewage
  - Loss of the genetic signal while in transit in the collection system
  - Loss of the genetic signal due to interference from other wastewater constituents
  - Effect of the wastewater treatment process on the genetic signal
- Impact of Storage and Pre-Treatment Methods on Signal Strength
  - Heating wastewater samples to inactivate potentially live virus
  - Addition of chemicals to inactivate potentially viable pathogens in the wastewater samples
  - Storage of samples at 4°C, -20°C, -40°C, -80°C
- The Water Research Foundation is actively seeking funding partners for this research

Present vs. Future Virus Detection



Current State



Future State

Key
- Public Health Agencies
- Utility
- Private Sector

Q&A and Next Steps

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Peter Grevatt, PhD

Chief Executive Officer

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