DIRECT POTABLE REUSE

CALIFORNIA STATE WATER BOARD PARTNERSHIP

The California State Water Resources Control Board (SWB) independent panel determined that it is feasible to develop uniform criteria for direct potable reuse (DPR) that adequately protect public health. The panel also identified six areas of additional investigation that would enhance SWB efforts to develop DPR criteria and regulations. Through a $1.4M grant, The Water Research Foundation is managing five of these research projects.

The priority research areas pertain to the control of contaminants, both microbial pathogens and toxic chemicals. Pathogen topics include developing additional information on pathogen concentrations in raw wastewater (under typical and outbreak conditions) and the use of quantitative microbial risk assessment (QMRA) to understand microbial risk and how treatment can be used to control those risks. Chemical topics include enhanced source control, evaluation of strategies to define and control chemical contaminant peaks, and evaluation of feasibility and use of non-targeted analysis to identify unknown contaminants or those more likely to pass through advanced treatment (low molecular weight compounds).

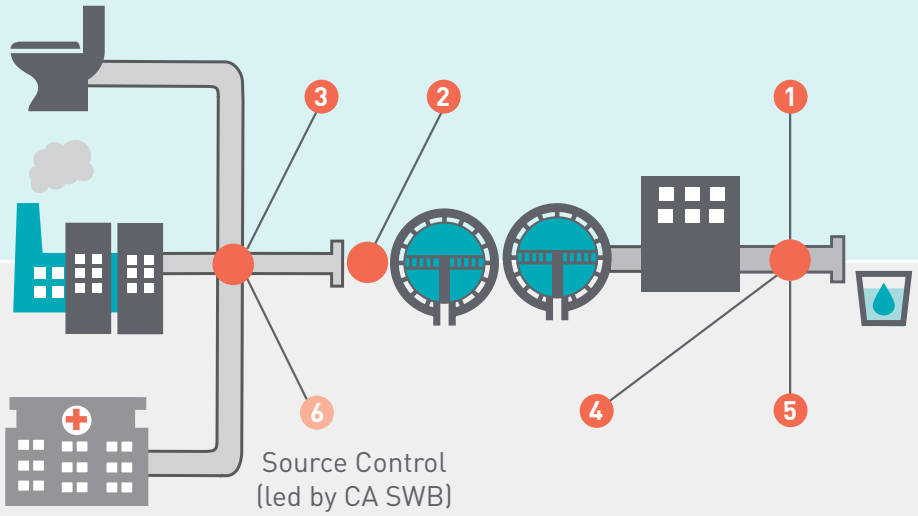
PROJECTS TO INFORM THE DEVELOPMENT OF DPR REGULATIONS

PATHOGENS

1. Tools to Evaluate Quantitative Microbial Risk and Plant Performance/Reliability
2. Measuring Pathogens in Wastewater
3. Collecting Pathogens in Wastewater During Outbreaks

CHEMICALS

4. Defining Potential Chemical Peaks and Management Options
5. Low Molecular Weight Unknown Compounds



THE Water Research FOUNDATION

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

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1 Tools to Evaluate Quantitative Microbial Risk and Plant Performance and Reliability

Scope:

As California moves to DPR, there will be increasing and unprecedented reliance on engineered solutions for public health protection. The ability of these systems to provide equivalent degrees of protection warrants further evaluation. Probabilistic assessments of both treatment train performance and QMRA offer unique opportunities to understand the reliability of DPR systems. This project will develop a freely available, user-friendly tool that can be used to quantify and characterize pathogen risk in DPR applications based on an evaluation of treatment performance. The main benefit of this tool is that it can be used to identify log reduction values (LRVs)—i.e., performance requirements—necessary for achieving different levels of public health protection from waterborne pathogens. In particular, it provides a metric to evaluate necessary LRVs of viruses, *Cryptosporidium*, and *Giardia* needed to maintain a risk of infection equal to one or more acceptable thresholds: Both 10^{-4} per person per year and $2.7x10^{-7}$ per person per day. This approach provides a tractable metric for evaluating overall treatment plant reliability including treatment process redundancy and robustness (multiple barriers).

Principal Investigator:

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2 Measuring Pathogens in Wastewater

Scope:

The risk-based framework used to develop existing potable reuse regulations (i.e., groundwater recharge and surface water augmentation) develops treatment requirements by understanding the level of pathogen log reduction required to reduce concentrations of pathogens in untreated wastewater down to acceptable levels in final potable water. Consequently, one of the key data inputs for this process is accurate information on the concentration of relevant pathogens in source water, i.e., untreated wastewater. To better inform decisions associated with developing LRV requirements and conducting probabilistic-based QMRA and plant performance modeling, this research will assess the concentration of relevant pathogens in raw wastewater over a year-long campaign. The two principal research objectives are to:

1. Collect empirical data on the concentration and variability of pathogens in untreated wastewater for the purpose of verifying LRVs necessary to adequately protect public health in DPR projects (includes method development, standardization, and validation).
2. Develop recommendations for collection and analysis of samples and data interpretation on pathogens in untreated wastewater for use in this campaign and future regulatory monitoring requirements.

The monitoring campaign is assessing untreated wastewater at five large California wastewater agencies (located in San Diego, Orange County, Los Angeles, and San Francisco) to provide more complete information on concentrations and variability of various waterborne pathogens and indicators.

The campaign is following a standard operating procedure, using current methods to evaluate a suite of pathogens and indicators, including: enterovirus and adenovirus (using culture and molecular methods), norovirus (molecular), bacteriophage (culture and molecular), *Giardia* and *Cryptosporidium* (microscopy). The monitoring plan is designed to collect 24 samples at each of five facilities and will be completed in spring 2021.

COVID Update: In addition to key waterborne pathogens, researchers have added SARS-CoV-2 to the list of organisms of concern and are investigating the feasibility of analyzing SARS-CoV-2 in samples archived since November 2019, as well as optimizing the methods to analyze SARS-CoV-2 in the samples moving forward through January 2021. The plan is to provide a discussion of the methods and preliminary results of the SARS-CoV-2 effort in a pre-publication in the second quarter of 2020.

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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.

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4 Defining Potential Chemical Peaks and Management Options

Scope:

The goal of this project is to define a chemical peak and identify and evaluate options to manage peaks, particularly for chemicals with the potential to persist through advanced water treatment. Options to be evaluated include enhanced source control, improvements to plant operations and monitoring, and additional treatment. Management options can include modifying treatment processes that cause the removal or transformation of a contaminant or may involve a blending or dilution scheme to reduce chemical peaks to background levels.

The project includes three phases:

Phase 1: This phase is a detailed literature review of the rejection of chemical constituents or surrogates by several individual processes or a combination of advanced treatment processes. It includes an assessment of the types of chemicals that may be addressed with industrial source control enhancement, identification of, and definition of the term "peak" statistically considering influent concentration, treatment process performance, analytical variability and duration, and identification of frequency of sampling/monitoring needed to effectively enable the identification of peaks.

Phase 2: This phase involves preparing a case study report that surveyed three utilities (City of San Diego, California; Orange County Water District, Fountain Valley, California; and the Singapore Public Utilities Board) to gather information on their experiences of detected chemical peaks, as well as response protocols, during such events. The case study report evaluates the impact of illicit discharges for different sewersheds and chemical volumes and identified available options for reducing or eliminating chemical peaks.

Phase 3: This phase includes experimentation to address knowledge gaps, including identifying chemicals and chemical groups of concern. Experiments will be conducted in this phase to evaluate the ability of total organic carbon (TOC) analyzers to measure specific chemicals that should be targeted for reduction/removal in different water matrices. Subtasks in Phase 3 include pre-testing of laboratory sampling and analysis procedures, a round robin study, evaluation of online and laboratory TOC meters, and data analysis and reporting in a final report.

Phases 1 and 2 are well underway. Phase 3 was initiated, but was put on hold due to the COVID-19 pandemic. The project will be completed by March 2021.

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5 Low Molecular Weight Unknown Compounds

Scope:

This project focuses on evaluating potential analytical methods, including but not limited to, NTA, to identify contaminants not presently detected by current monitoring approaches, particularly LMW compounds that may occur in wastewater and recycled water and that may not be removed by advanced water treatment processes. The effort will build on recent results and recommendations from the State Water Board 2018 Constituents of Emerging Concern report (Drewes et al. 2018). This project will develop a white paper on recommendations for the use and interpretation of analytical results to identify unknown contaminants.

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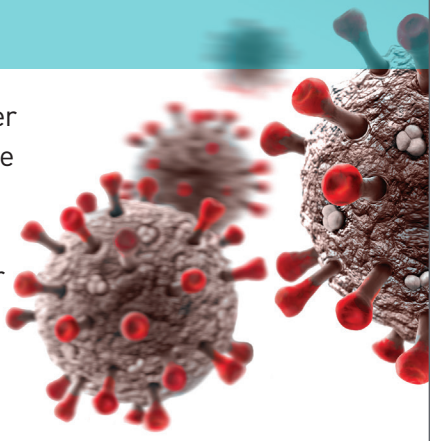
RESPONDING TO COVID-19



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.

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