Project Information Summary

Unlocking the Nationwide Potential of Water Reuse: Task A (5197A)

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Goal and Objectives

The goal of Task A is to quantify and better characterize the microbial and chemical risks of water reuse through three research objectives:

1. Apply lessons learned from wastewater-based epidemiology (WBE) conducted during the COVID-19 pandemic to potable reuse applications
2. Communicate this new knowledge through potable and agricultural reuse case studies developed within an existing quantitative microbial risk assessment (QMRA) tool
3. Assess whether existing approaches for mitigating chemical risks overlook specific compounds or compound classes that are unique to water reuse applications.

Background and Motivation

The COVID-19 pandemic has renewed interest in WBE and will yield an abundance of pathogen concentration data—not only for SARS-CoV-2, but also for targets of direct relevance to potable reuse (e.g., enterovirus, adenovirus, and norovirus). Interpretation of these robust datasets may lead to better characterization of wastewater concentration dynamics and improvements in outbreak detection and response. Because raw sewage pathogen concentrations reflect community health conditions, it may be possible to leverage traditional public health surveillance efforts (e.g., syndromic surveillance) and novel datasets (e.g., consumer purchases) to develop near-real-time estimates of pathogen loads. This presents an opportunity for high-resolution risk assessment and even treatment optimization.

With respect to risk assessment, members of this research team recently developed a publicly available, web-based tool encompassing QMRA and probabilistic assessment of treatment train performance. The accompanying guidance document provides context, input data, assumptions, and example case studies for users to perform a generalized or even site-specific QMRA. The tool, now known as DPRisk, was originally envisioned for use by regulators and other stakeholders to inform the development of risk-based criteria for the design and operation of direct potable reuse (DPR) systems in California. However, the tool's inherent flexibility allows for it to be expanded far beyond DPR. Expanding stakeholder access to relevant tools and empowering them to perform their own assessments of water reuse feasibility and safety may help overcome persistent barriers to reuse implementation.

In addition to higher pathogen loads, domestic and industrial wastewater have the potential to contain more diverse chemicals—perhaps at higher concentrations—compared to drinking water sources not directly impacted by wastewater discharge. Thus, one of the current barriers to broad implementation of water reuse

(particularly as the industry transitions toward DPR) involves constituents of emerging concern (CECs). Because occurrence (frequency and magnitude) is a significant factor in identifying chemicals for priority research and regulation under the Safe Drinking Water Act, current regulatory frameworks may have a 'blind spot' for chemicals unique to wastewater. Therefore, broader adoption of water reuse may necessitate an evaluation of current practices and safeguards, particularly for the identification, characterization, and mitigation (if warranted) of CECs.

Research Approach

Task A1 – Wastewater-Based Epidemiology (WBE).

1. ***Leverage existing and future sample biobanks accumulated by research team members and through collaboration with a contract laboratory currently engaged in wastewater surveillance at the national level.*** The research team will analyze these nucleic acid extracts for viral targets of interest in water reuse applications. These samples encompass facility-, subsewershed-, and sewershed-scale surveillance activities in multiple locations and across multiple years.
2. ***Assess dataset for spatial and temporal trends and identify influential sewershed characteristics.*** Wastewater and public health surveillance data will be analyzed to assess whether enteric virus concentrations are linked to infection incidence in the local community and whether they are impacted by sample (e.g., grab vs. composite) and sewershed characteristics (e.g., flow rate, population).
3. ***Develop an outbreak readiness response plan for One Water.*** Lessons learned from the COVID-19 pandemic will be outlined and presented in the context of water reuse to help utilities and stakeholders navigate future outbreaks and even pandemics.

Task A2 – Quantitative Microbial Risk Assessment (QMRA).

1. ***Integrate data into DPRisk to quantify the implications of spatial, temporal, and sewershed variables.*** The existing web-based DPRisk tool will be used to visualize and communicate the knowledge gained through the Task A1 effort.
2. ***Expand DPRisk to encompass agricultural reuse.*** DPRisk and its associated guidance document will be modified to incorporate elements that are specifically relevant to agriculture.
3. ***Develop tailored case studies for potable and agricultural reuse.*** The research team will collaborate with utility and stakeholder partners to develop and implement site-specific QMRAs as a means of facilitating regulatory development and/or project implementation.

Task A3 – Constituents of Emerging Concern (CECs) in Water Reuse Applications.

1. ***Building the chemical universe.*** The research team will screen a broad universe of chemicals relevant to water reuse to generate occurrence data for raw, conventionally treated, and advanced treated wastewater. Monitoring will be conducted at pilot- and full-scale sites for chemicals lacking occurrence data.
2. ***Identifying health risk reductions.*** A spreadsheet-based relative health index (RHI) tool will be used to i) identify chemicals in various types of reuse waters that pose the highest remaining health risks, ii) compare the RHI values between potable reuse with non-wastewater-impacted drinking waters, iii) compare RHI values between various source waters for reuse, and iv) determine the effectiveness of various potential treatment technologies.

Deliverables

- Expanded datasets, improved characterization, and visualization of raw wastewater pathogen and CEC concentrations.
- Tailored case studies for potable (***DPRisk***) and agricultural (***AGrisk***) reuse applications.
- Outbreak readiness response plan for the One Water sector.

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