EPA

Office of Research and Development

SAFE AND SUSTAINABLE WATER RESOURCES RESEARCH PROGRAM

SSWR BoSC Meeting – May 27, 2021
Research Area 9: Wastewater/Water Reuse
Ann Grimm, RA Coordinator

Background

- Microbial and chemical contaminants continue to be an issue for wastewater and water reuse treatment processes.
- Emerging issues, such as SARS-CoV2 and antimicrobial resistant bacteria, need further research to minimize risk to human health and the environment.
- New innovations in treatment processes and approaches for risk management can improve the quality of discharged and recycled water.

Water reuse research will focus on fit-for-purpose applications for several sources and end uses. Wastewater research will include efforts to identify and quantify chemical and microbial contaminants in support of OWM and OST efforts in wastewater and biosolids.

Water Treatment and Infrastructure

Research Area 7

Drinking Water/Distribution Systems

Provide essential results and tools to our customers for managing existing and future drinking water needs. Specifically, it focuses on areas of recent concern that require novel solutions.

Research Area 8

Per- and Polyfluoroalkyl Substances (PFAS)

Robust analytical methods for analyzing PFAS in water, solids, and tissue samples, and a centralized website for treatment and pretreatment recommendations for wastewater and reuse.

Research Area 9

Wastewater/Water Reuse

Guidance on new and existing treatment technologies and analytical methods for emerging contaminants and contaminant risks.

Research Area 10

Integrated Stormwater Management

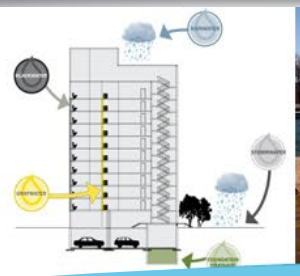
Integrated aspects of green/gray infrastructure and stormwater flow control to help states, municipalities, and utilities reduce the number of combined sewer overflows.

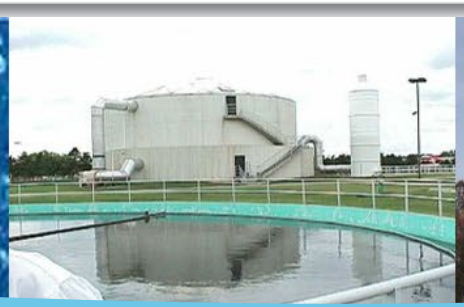
Research Area 11

Technical Support

Provide a means for rapid response to specific, unplanned program office, state, tribe, and community research needs concerning high-priority issues.

Wastewater/Water Reuse




This research area will provide essential results and tools to the program offices, primarily the Office of Water, states, tribes, and communities to manage existing and future wastewater and Water Reuse issues.

- **Agency Drivers:** CWA, National Pollution Discharge Elimination System requirements, state regulations, future regulatory determinations under SDWA and CWA.
- **Focus:** Areas of recent concern that require novel solutions.
  - SARS-CoV-2 and antimicrobial resistant bacteria
  - CECs
  - Fit-for-purpose water reuse

Research Outputs Overview

Output 9.1: Analytical methods, exposure and effects assessment processes, and tools for wastewater and fit-for-purpose water reuse

Output 9.2: Treatment technologies for wastewater and fit-for-purpose water reuse

Research Output 9.1

Analytical Methods, Exposure and Effects Assessment Processes, and Tools for Wastewater and Fit-for-Purpose Water Reuse

Lead: Jay Garland

SSWR 9.1.1: Effects-based Methods for Assessing Chemical Contaminants in Wastewater and Reclaimed Water

Problem: EPA Regional and Program Office (PO) partners need updated test methods for evaluating quality of water with potentially complex contaminant mixtures.

Action: Develop updated whole effluent toxicity (WET) tests for consideration for multi-laboratory validation by PO partners. Evaluate the use of innovative bioassays for screening water quality.

Results:

- Draft WET tests for Daphnia magna, mussels (FY21). Future WET test development may focus on mayflies and trout.
- Single-laboratory validation for assay detecting thyroid disrupting activity in water samples.
- Endocrine disrupting activity screening in water samples with single-lab validated bioassays.
- Non-targeted analyses of WW for identifying chemicals of emerging concern (CEC).
- Fate of CECs in de facto water reuse (FY20).

Impact: Provide options for Regional/Program Office and state partners for evaluating the quality of wastewater effluents and recycled waters.


NTNU, Faculty of Natural Sciences

Product POC: Elizabeth Medlock-Kakaley (CPHEA)

Internal Partners: Laura Phillips (OW-OWM); Adrian Hanley, Colleen Flaherty (OW-OST)

External Collaborators: CA State Water Resources Control Board, SoCal Coastal Water Research Project, USGS

SSWR 9.1.2: Quantifying Microbial Contaminants in Wastewater and Reclaimed Water

Problem: Pathogenic viruses are difficult to isolate and enumerate in WW and water reuse systems and, therefore, risk assessments for viable viruses are challenging. Emerging issues, such as antimicrobial resistant bacteria and/or genes (ARB/ARG) require rapid detection methods for risk assessment and management.

Action: Conduct research on innovative approaches for monitoring and enumerating virus and ARB/ARG in WW and recycled water.

Results (Anticipated):

- Assessment of ARB/ARG loadings on WWTPs using molecular and cultivation-based assays and improving bacterial concentration methods.
- Develop a quantitative polymerase chain reaction panel for the broad-range analyses of ARB/ARG in WW.
- Evaluate sewer collection systems and treatment plants for dominant sources of ARB to WW.
- Monitor trends of SARS-CoV-2 in wastewater and evaluate methodologies
- Evaluation of the prevalence of ARB/ARG in biosolids and identify further research needs for managing ARB in biosolids.

Impact: Provide stakeholders with information and tools for managing viruses and ARB/ARG in WW treatment and collection systems and water reuse facilities.

Product POC: Eunice Varughese (CESER)

Internal Partners: Smiti Nepal (OW-OWM), Sharon Nappier (OW-OPME), Elizabeth Reseck (OW-OST)

External Collaborators: Patrick McDermott (FDA), USDA-ARS, CDC, Ohio Department of Health, Cincinnati MSD

SSWR 9.1.3: Identification of Surrogates to Monitor Process Performance in Wastewater and Reclaimed Water

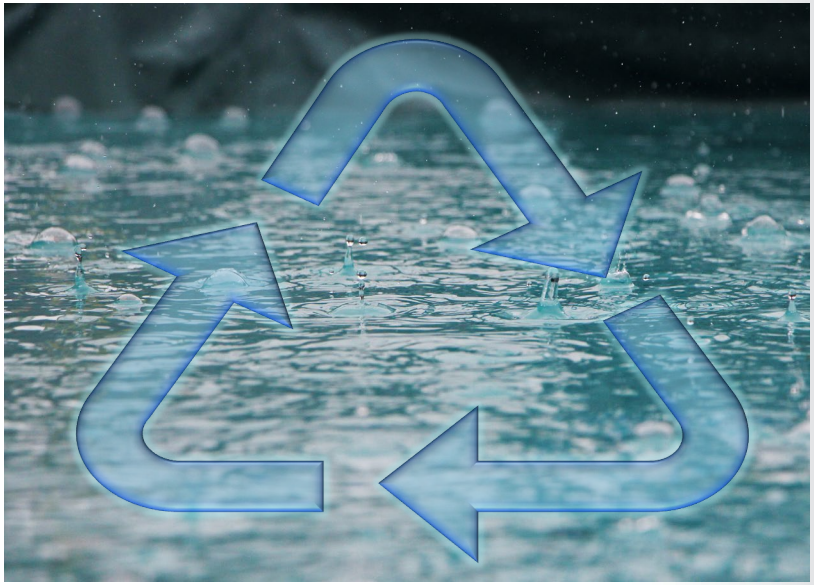
Problem: Viable pathogenic viruses and bacteria and CECs may cause deleterious effects in discharged or recycled waters at low concentrations. For many pathogenic organisms, detection is difficult and benchmarking management strategies challenging.

Action: Conduct research on surrogate organisms that can be easily quantified and correlate with low-concentration pathogens. Explore the application of surrogates to measuring treatment processes.

Results (Anticipated):

- Quantify potential viral surrogates in source water of on-site non-potable reuse systems.
- Recommendations for bacterial and viral surrogates for monitoring on-site non-potable reuse systems.
- Develop non-targeted analyses workflows for WW and reuse.

Impact: Utilities will have resources to better monitor and manage treatment performance for removing pathogens and CECs.



Product POC: Nichole Brinkman (CESER)

Internal Partners: Sharon Nappier (OW-OPME)

External Collaborators: National Blue Ribbon Commission for Onsite Non-Potable Water Systems, SFPUC, University of Colorado-Boulder, Colorado State University, WRF

Research Output 9.2

Treatment Technologies for Wastewater and Fit-for-Purpose Water Reuse

Lead: Jay Garland

SSWR 9.2.1: Development of Risk-Based Guidance for Fit-for-Purpose Treatment and Reuse of Wastewater

Problem: Communities considering fit-for-purpose water reuse lack robust risk-based quantitative assessments for implementation and often rely on conventional water quality indicators (e.g. coliforms).

Action: Develop risk assessment models to define treatment targets for relevant end uses.

Results (Anticipated):

- Comparing risk-based water reuse approaches to those based on conventional water quality indicators.
- Blue Ribbon Commission report documenting updated pathogen log reduction targets for onsite non-potable water systems.
- Reports providing risk-based guidance for industrial water reuse, e.g. protein processing and oil and gas production.
- Report on water quality of air conditioning condensate and guidance for its onsite non-potable use.
- Incorporation of antimicrobial resistance into risk assessment models.

Impact: Provide communities with frameworks to implement fit-for-purpose water reuse.

Product POC: Michael Jahne (CESER)

Internal Partners: Sharon Nappier (OW-OPME), Smiti Nepal (OW-OWM), Tricia Pfeiffer (R8)

External Collaborators: National Blue Ribbon Commission for Onsite Non-Potable Water Systems, Tyson Foods, USDA

SSWR 9.2.2: Optimization of Wastewater and Water Reuse Treatment Processes

Problem: Cost-effective, innovative technologies are needed for advancing WW and water reuse operations.

Action: Conduct research on alternative disinfection and treatment strategies for chemical and microbial contaminants.

Results (Anticipated):

- State-approved field studies of PAA/chlorination and PAA/UV.
- Bench-scale proof-of-concept of tetraacetylethylenediamine (TAED)-based peracetic acid (PAA) generation/delivery system.
- Performance evaluation of advanced disinfection processes, including Pilot/field testing of TAED-PAA system based on successful proof-of-concept, pilot scale evaluation of on demand PFA generation and disinfection system.
- Demonstration of a pilot scale MicroEVAP tested with laboratory prepared brines representative of RO concentrate streams, and actual brine solutions.

Impact: Provide stakeholders (wastewater treatment , desalination plants) with additional innovative tools and resources for WW and water reuse treatment.

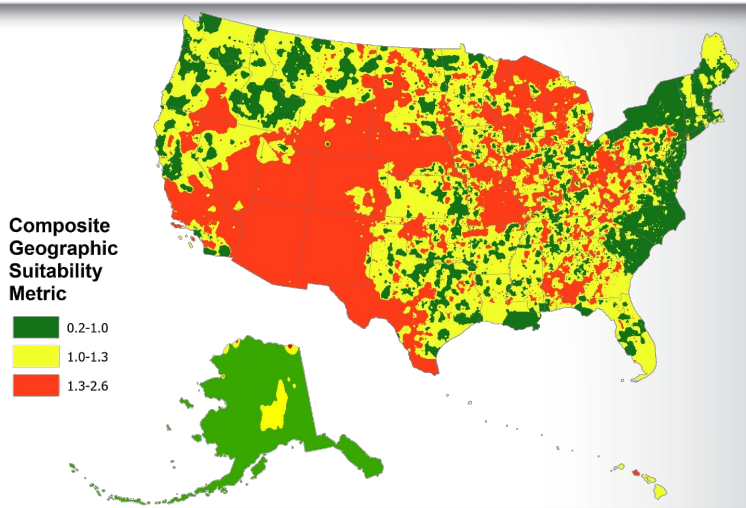
Product POC: Jay Garland (CESER)
Internal Partners: Mohammed Billlah (OW-OWM), Sharon Nappier (OW-OPME)

External Collaborators: Cincinnati Metropolitan Sewer District,, Lubrizol Advanced Materials, Inc., Kimera, Inc., Ohio EPA, Micronic Technologies, Inc.

SSWR 9.2.3: Systems Analysis of Alternative Treatment Approaches

Problem: Communities considering alternative water management strategies, such as fit-for-purpose reuse, lack comparisons of costs/benefits between more conventional systems and alternatives, and design guidance.

Action: Conduct research on sustainability and costs-benefits on alternative water management approaches.



Results (Anticipated):

- Integrated sustainability assessment of mixed wastewater and graywater decentralized treatment for non-potable reuse (NPR).
- Develop an online calculator to aid decision-making for NPR from alternative sources at building scales.
- Integrated assessment for ozone/biological activated carbon and reverse osmosis-advanced oxidation for direct potable reuse.
- Analysis on energy expenditure distribution and the mechanism for paradigm changes in urban water systems to inform the optimization of system designs.

Impact: Provide communities with resources to aid decisions on alternative water management strategies and support National Water Reuse Action Plan (WRAP).

Product POC: Cissy Ma (CESER)
Internal Partners: Sharon Nappier (OW-OPME), Smiti Nepal (OW-OWM), Mario Sengco (OW-OST)

External Collaborators: The National Blue Ribbon Commission; **SFPUC, CA; Gwinnett County, GA; MSD/GCWW, OH; US Green Building Council; Water Reuse Association**

Research Area 9 and the Water Reuse Action Plan

ORD Leader/Co-leader

- 2.3.5 - Assess Specifications of Wastewater in Food Animal Protein Processing Facilities
  - EPA POC: Jay Garland (ORD)
- 2.4.5 - Support Air-Cooling Condensate Water Reuse in Large Buildings
  - EPA POC: Jay Garland (ORD) and Greg Eades (ORD)
- 2.7.5 - Coordinate and Promote Water Reuse Technology in Federal SBIR Programs
  - EPA POC: April Richards (ORD)
- *New Proposed Action* 2.3.6 - Viral Pathogen and Surrogate Approaches for Assessing Treatment Performance
  - EPA POC: Sarah Ludwig-Monty (ORD)

Partner Led Action with ORD involvement

- 2.3.4 - Develop Research and Tools to Support ONWS (NBRC)
  - EPA POC: Jay Garland (ORD)
- 2.4.2: Implement New Mexico Produced Water Research Consortium to Identify and Fill Science and Technology Gaps for Off-Field Use of Treated Produced Water (NM Environment Department)
  - Michael Jahne ORD POC
- *New Proposed Action* 2.5.2 - Identify Monitoring Practices for Reuse Applications (WRF)
  - Elizabeth Medlock-Kakaley, Nichole Brinkman ORD POCs

Questions?

Charge Question 2

ORD water reuse researchers have worked closely with other organizations (e.g. Water Research Foundation) to avoid duplicative research, especially in large municipal direct potable reuse systems. This coordination led to SSWR implementing research focused on non-municipal sources of wastewater (e.g. industrial, agricultural) and decentralized non-potable end uses that can contribute to increased resiliency of water resources, especially in areas facing increased frequency, intensity, and duration of higher temperatures and drier climate patterns.

Please comment on the implementation of ORD's water reuse research, and what suggestion(s)/ recommendation(s) does the Subcommittee have regarding SSWR's water reuse research for helping to innovatively augment water supplies and improve resiliency by identifying promising alternative water sources?