Reuse Projects

Water Research Foundation subscribers can download and/or order completed reports on our website at www.waterrf.org. More information on specific projects can be obtained by contacting Traci Case, Manager, Research Services at 303.347.6120.
**Newly Funded Projects (not yet started)**

**Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring [#4691]**

This Tailored Collaboration project with San Francisco PUC and WE&RF will use innovative building-scale treatment, proven purification processes, real time online monitoring, and advanced analytical tools to demonstrate water quality and public health protection in real time. The advanced purification system for DPR will be sited at the San Francisco Public Utilities Commission Headquarters Building, where an existing Living Machine® System treats the building’s wastewater to non-potable reuse standards. Using this location allows for broad visibility and public access to potable water reuse.

**Challenges and Practical Approaches to Water Reuse Pricing [#4662]**

Worldwide, water reuse is increasingly being considered as a water supply option. More utilities are seeking a diversified and reliable (e.g., climate-independent) portfolio of water sources, driving them to look beyond traditional surface and groundwater sources. Utilities must find the right balance of many factors to provide a resilient, reliable, and affordable water supply. Pressures include increased demand, climate change, lower groundwater levels, water quality challenges, instream flow requirements, financial capacity issues, and reduced reservoir capacity. This project will evaluate water reuse pricing challenges and practical approaches to reuse pricing.

**Conventional Drinking Water Treatment of Alternative Water Sources: Source Water Requirements [#4665]**

Through a literature review, workshop(s), and expert insight, this project will establish ranges for alternative source water quality parameters that would meet or exceed the threshold for “acceptability” in conventional drinking water treatment for potable reuse applications.

**Ongoing Projects:**

**Advanced Oxidation of Pharmaceuticals and Personal Care Products: Preparing for Indirect and Direct Water Reuse [#4213]**

This project determined and characterized the impact of background organic matrices on the efficiency of ozone-based advanced oxidation processes for removal of pharmaceutically active compounds (PhACs). It developed a strategy that employs bioassays for assessing the ability of treatment processes to remove PhACs. It also evaluated the potential of the bioassay residual testing strategy to predict the impact of background organic matter on treatment performance.

**Expected publication in 2016**

**Assessment of Techniques for Evaluating and Demonstrating Safety of Water from DPR Treatment Facilities [#4508]**

With the increasing interest in implementing direct potable reuse (DPR) projects, various states and regions are struggling to determine the optimal monitoring programs to best ensure continued reliability and safety. WRF 4508 (Title: Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities) is an ongoing project to develop the framework to aid in treatment process selection, and more particularly process validation and monitoring.

To date, the project team has completed the literature review to identify the target constituents with greatest potential human health risk in DPR and the associated analytical methods commonly used in wastewater, reclaimed water, potable water, and environmental samples and it is accessible through the WRF website: http://www.waterrf.org/resources/pages/ProjectPapers-detail.aspx?ItemID=70. Microbial indicators and pathogens were discussed and, in particular, some of the advantages and disadvantages of bacteriophages as an indicator are shown in the WRF 4508 project literature review.


**Expected publication 2018**

**Blending Requirements for Water from DPR Treatment Facilities [#4536]**

Water produced from a DPR facility can be inserted directly into the drinking water distribution system, added upstream of a WTP, or added directly within a WTP between various processes. Little is known about the impact of blending in relation to treatability at the WTP and water quality issues both within the WTP and in the finished water. To help understand these impacts, this project undertook a study to provide recommendations and guidance for the appropriate use of blending as part of a DPR project, including evaluations of treatment, impact of different water qualities, and corrosion control issues, impact on engineered storage, blending location, and blending percentages. This study examined the impact of three blending variables: different proportions of recycled water to raw water, different qualities of recycled water (based on the treatment process), and different points of introduction/blending. These scenarios were evaluated at bench, pilot, and full-scale. Research partners: Alameda County Water District, East Bay Municipal Utility District, Contra Costa Water District, Los Angeles Department of Water & Power, San Francisco Public Utilities Commission, and Zone 7 Water Agency.

**Expected publication 2017**
Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of a Direct Potable Reuse Scheme [4541]
This project developed a guidance document that describes standard design guidelines, operational procedures, and response strategies for critical control points to enhance the robustness, reliability, and operability of direct potable reuse projects to ensure public health protection. The focus is on key performance barriers identified as critical control points and the monitoring equipment and instrumentation, including the maintenance and calibration of this equipment. The project includes (1) a hazard assessment to identify health risks, water quality objectives, and critical control points; (2) challenge testing at the bench, pilot, and full scale; and (3) a Monte Carlo analysis. Research partner: WateReuse Research Foundation.

Expected publication in 2016

Enhanced Removal of Nutrients from Urban Runoff with Novel Unit-Process Capture, Treatment, and Recharge Systems [4567]
This research will design and test a pilot-scale stormwater capture, treatment, and recharge (CTR) system. The specific research objective is to quantify and optimize stormwater nutrient and trace organic contaminant removal in unit-process stormwater treatment and recharge systems under conditions representative of regions where the majority of nutrient releases occur in a small number of precipitation events. Research partners: EPA and WERF.

Expected publication 2017

Evaluation of Current and Alternative Strategies for Managing CECs in Water [4494]
This project will aggregate and evaluate management plans for contaminants of emerging concern (CECs) that have been employed or are being considered in North America, Europe, and Australia. Strengths and weaknesses of each will be identified, considering a holistic water approach that takes into account environmental and public health. Alternative approaches that combine the best features of existing approaches will be considered as well. CEC management strategies will then be prioritized to evaluate the costs and benefits of selected approaches in form of a triple bottom line analysis. Research partner: UKWIR.

Expected publication in 2016

Framework for Evaluating Alternative Water Supplies [4615]
Balancing Cost with Reliability, Resilience, and Sustainability. This project will define the elements of an integrated, reliable, resilient, and sustainable water supply, and integrate these elements into a framework to support water supply planning. The main project deliverable will be a compendium of best practices for incorporating reliability, resiliency, and sustainability into water supply planning. Through utility case studies and findings from an expert workshop, the report will provide guidance on water supply planning analysis, decision-making, and stakeholder communication.

Expected publication in 2018

Integrating Land Use and Water Resources: Planning to Support Water Supply Diversification [4623]
This project will explore current and future opportunities to diversify water supplies through better coordination between water utilities and the land use planning and development community. The project team will conduct a literature review on water supply diversification practices that may be available through the integration of water resource and land use planning. Additional information, gathered through an online survey, stakeholder interviews, and focus groups, will be used to develop case studies and inform the other work products. Project deliverables will include a summary report, a Water-Land Use Integration Tool, and a series of user guides.

Expected publication in 2018

This project was co-funded by WE&RF, San Francisco PUC, WRRF, and WRF, managed by WE&RF. The purpose of this project is to develop recommendations on setting appropriate performance criteria, management structure, monitoring, and permitting of on-site non-potable systems, or Decentralized Non-potable Water Systems (DNWS). The final report will provide guidance to state and local health departments, based in part on a risk-based framework that allows these agencies to consider development of a DNWS program that adequately protects public health. A key consideration in the development of this framework was to provide a flexible approach to enable pragmatic design and operation of DNWS that ensures reliable delivery of water that is protective of public health. The DNWS guidance was developed to address non-single residence applications, (i.e., multi-residential, commercial, and mixed-use buildings). However, the risk-based framework presented here is applicable across project scales.

Expected publication in 2018

Soil Aquifer Treatment Characterization with Soil Columns for Groundwater Recharge in the San Fernando Valley [4600]
In June 2014, the California Division of Drinking Water adopted the Groundwater Replenishment Recharge Regulations, allowing for spreading of recycled water treated to Title 22 standards supplemented by adequate dilution water. Facing this regulatory change, LADWP would like to understand the soil aquifer treatment (SAT) process and how it may impact possible reuse in the coming years. Soil columns were operated to mimic a potential full-scale groundwater recharge practice to characterize the effectiveness of SAT by loading the soil columns with local aquifer media, feeding the soil columns with recycled water proposed for the project, and operating the soil
columns in a cyclic mode to simulate regional groundwater recharge practices. Research partner: Los Angeles Department of Water & Power.

*Expected publication in 2016*

**Published Projects:**

**Assessment of Water Reuse as an Approach for Meeting Future Water Supply Needs [#4276]**

This project, co-funded with the National Research Council and other organizations, involved a comprehensive study of the potential for water reclamation and reuse of municipal wastewater to expand and enhance the available water supply alternatives in the United States.

*Published in 2012*

**Augmenting Potable Water Supplies With Reclaimed Water [#371]**


*Published in 1998.*


A Blueprint for Onsite Water Systems was developed that serves as a how-to-guide for communities interested in implementing an onsite water treatment program.

*Published in 2014*

**Comparing Nanofiltration and Reverse Osmosis for Treating Recycled Water [#3012]**

Evaluates the feasibility of nanofiltration (NF) and ultra-low-pressure reverse osmosis (ULPRO) membranes for rejecting total organic carbon, total nitrogen, and unregulated trace organic compounds under a range of experimental conditions at the laboratory-, pilot-, and full-scale to produce water suitable to augment drinking water supplies. Provides utilities with guidance on selecting membranes and predicting solute rejection during NF-ULPRO membrane treatment. Tailored Collaboration partner: West Basin Municipal Water District.

*Published in 2008*

**Enhanced Reverse Osmosis Systems: Intermediate Treatment to Improve Recovery [#4061]**

Designs and develops two inter-stage treatment systems to increase recovery in reverse osmosis preparation of drinking water and thus reduce disposal costs in particular for inland facilities. Compares recovery using advanced oxidation of anti-scaling compounds and subsequent solid precipitation with that of electrodialysis.

*Published in 2011*

**Institutional Issues for One Water Management [#4487]**

Governance, regulations, finance, and culture are often cited as barriers to achieving integrated water management and innovation in water technologies. In an effort to clarify and explain these barriers, WRF, WERF, and Water Research Australia undertook this study to define those barriers. Three in-depth case studies and 25 snapshot case studies provide practical examples of how agencies and communities worked through institutional barriers so they could practice a more integrated and sustainable approach to water resource management. Case studies looked at initiatives and interactions between different levels of government, private entities, NGOs, and citizens across a range of institutional barriers. In addition to the research report (4487a), a Guidebook (4487b) was developed to help utilities take actions to move forward on the path to One Water. Project partners: WERF and Water Quality Research Australia.

*Published in 2015*

**Integrated Water Management: Planning for Future Water Supplies [#4550]**

This project commenced a workshop in 2014 among a diverse group of stakeholders to develop a prioritized list of integrated water management (IWM) research objectives. This final result was a research agenda for the IWM Focus Area and a prioritized list of IWM-related research projects.

*Published in 2015*

**Organic Nitrogen in Drinking Water and Reclaimed Wastewater [#2900]**

Determines occurrence of dissolved organic nitrogen (DON) in raw and finished drinking waters and reclaimed wastewaters. Provides information on DON chemical characteristics and reactivity toward metal hydroxides and oxidants, and on its role in THM and NDMA formation.

*Published in 2006*

**Protocol for Designing and Conducting UV Disinfection Studies [#2674]**

Develops a set of UV disinfection guidelines for drinking water that address dose design, reactor design, reliability and redundancy design, monitoring and alarms, field testing before startup, performance monitoring, and engineering reports. Includes protocols to help in implementing the guidelines. Research partner: NWRI.

*Published in 2001*
Protocol for Evaluating Chemical Pretreatment for High Pressure Membranes [#4249]
This project evaluated the current methods of determining chemical pretreatment needs for high pressure membrane systems (nanofiltration [NF] and reverse osmosis [RO]). The research also developed and validated a practical protocol for evaluating the short- and long-term effectiveness of chemical pretreatment options, particularly antiscalants and scale inhibitors, for different NF and RO membrane materials and feed waters. Research partner: WQRA.
Published in 2014

Removal of EDCs and Pharmaceuticals in Drinking and Reuse Treatment Processes [#2758]
Determines removal efficiencies of conventional and advanced treatment processes for an environmentally and chemically relevant suite of compounds classified as endocrine-disrupting chemicals, pharmaceutically active compounds, and personal care products.
Published in 2007

Research Strategy for Water Reuse Workshop [#3145]
Produced a state-of-the-science report that outlines the present knowledge and indicates possible knowledge gaps and research needs in the arena of water reclamation and reuse.
Research partners: Anjou Research, WRF, CRCWQT, STOWA, WRC, WSAA, and CDC.
Published in 2012

Soil Treatability Pilot Studies to Design and Model Soil Aquifer Treatment Systems [#901]
Describes a comprehensive study on soil aquifer treatment (SAT) to develop correlations between soil characteristics, effluent types, infiltration rates, and SAT efficiencies. Evaluates treatment efficiencies and removal mechanisms for a variety of common soils and effluents in SAT pilot studies. Presents an optimal SAT design methodology and an operational optimization model for application to multi-basin SAT systems.
Research partners: WERF, NWRI, and SROG.
Published in 1998.

Understanding Public Concerns and Developing Tools to Assist Local Officials in Planning Successful Potable Reuse Projects [#2919]
Develops a better understanding of public concerns and potential opposition to indirect potable reuse. Provides an array of approaches (i.e., a toolkit) for utilities to use in working with stakeholders in order to improve planning and implementation of reuse projects. Also provides guidance on using the toolkit and on defining and targeting the resources needed for success. Research partner: WateReuse Foundation.
WateReuse Foundation published a best practices document in 2004 and tools and a Web site in 2006

Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits [#4521]
Water scarcity, population growth, and climate change have driven increased interest in the use of stormwater and graywater as a means to diversify water supply portfolios. This project convened a committee of knowledge experts to conduct a study on the risks, costs, and benefits of on-site water reuse of stormwater and graywater. The study also investigated safety and regulations related to treatment and storage of stormwater capture and graywater reuse for various end uses.
Published in 2016

Water Quality Requirements for Reclaimed Water [#2697]
Identifies the industries that are capable of using large volumes of reclaimed water year-round and summarizes water quality requirements for these industries. Also reports on the viewpoints of suppliers (utilities), users (customers), and regulators (state agencies).
Research partner: WateReuse Foundation.
Published in 2004