Water Research Foundation’s Advancing Potable Reuse Initiative & Current Projects

Julie Minton
Director of Strategic Initiatives
Water Research Foundation
jminton@waterrf.org

Arizona Water Reuse 2018 Symposium
Flagstaff, AZ
July 23, 2018
The (New and Improved!) Water Research Foundation

Merged July 2016

Officially integrated January 2018
WE&RF and WRF Integration

- A more interconnected research and innovation agenda
- Access to an expanded collection of water research
- Leverages funding
- Communicates more effectively with government partners
- Strengthens relationships with water partners
- Creates a model for collaboration across the water community

The evolution of water research

- 1,200 subscribers
- 2,300 research studies
- $700M integrated research portfolio

Denver, Colorado

Alexandria, Virginia
What does The WRF do?

- Accelerate innovation and adoption of technology
- Transfer knowledge
- Set an industry research agenda
- Provide exceptional water research
- Applied research in water and the environment

Fields:
- Drinking Water
- Stormwater
- Wastewater
- Water Reuse
- Desalination
WRF Reuse Program Covers the Full Spectrum of Reuse
A Brief History of DPR Research

California Legislation – SB 918 (2010)
• “Feasibility of developing criteria for DPR”
• State Water Board established “DPR Expert Panel”

WateReuse Research Foundation + WRCA: DPR Research Initiative (2012-2016)
• $6 million raised – Leveraged to $24 million -- 34 projects funded

Outcomes
• DPR Expert Panel report
• SWB Report to legislature – Dec 2016 (Yes, developing criteria for DPR is feasible!)

California Legislation – SB 574 (2017)
• Established deadline for DPR legislation of 2023

SWB Recycled Water Grants – awarded in June 2017
• $4.5M for potable and non-potable research Awarded to Water Research Foundation
### Recycled Water Grants from SWB (CA)

<table>
<thead>
<tr>
<th>Grant 1: $1M</th>
<th>Grant 2: $3.5M</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 5 projects recommended by the SWB DPR Expert Panel for developing DPR regulations in California</td>
<td>- For research recommended by the WRF’s Water Reuse Issue Area Team (IAT) and SWB.</td>
</tr>
<tr>
<td>- Agreement executed February 28, 2018</td>
<td>- $2M of this will be designated for potable reuse</td>
</tr>
<tr>
<td></td>
<td>- $1.5M will be for non-potable reuse</td>
</tr>
<tr>
<td></td>
<td>- Agreement executed March 30, 2018</td>
</tr>
</tbody>
</table>
The Need: Leverage the SWB funding

- $4.5M SWB Grant + $3-4M Matching = **$7.5-8.5M Total**
- Goals:
  - Advance DPR in California
  - Support potable reuse regulations and implementation of projects across the country

Fundraising Initiative to cover:

- Additional Research
- Expenses not covered by the SWB Grant:
  - Indirect costs; Tuition; Travel outside of CA
- Grant 1 Coordinating Committee
- WRF Grant administration, Program and project management
SWB Grant 1: 5 DPR Research Projects

1. Quantitative Microbial Risk Assessment
2. Measure Pathogens in Wastewater
3. Collecting Pathogens in Wastewater During Outbreaks
4. Treatment Process for Averaging Potential Chemical Peaks
5. Low Molecular Weight Unknown Compounds
SWB Grant 1: Oversight & Communication

Coordinating Committee
Oversees the project
• Science officer
• Two external science experts
Participation of DDW Technical Advisor

TWG
• Scientific experts overseeing the research
• Develop Request for Proposals (if needed)
• Select Research Teams
• Conduct the work when no RFP

Research Team
• Scientific engineers, experts, etc. conducting the work

WRF Project Director
Science Officer

DDW Technical Liaison

CA SWB DDW Technical Advisor

SWB Grant 1: Oversight & Communication
SWB Grant 1 DPR Research Program

Pathogens

Outbreak Monitoring
Pathogen Monitoring
Confirm Pathogen LRVs
Quantitative Microbial Risk Assessment

Chemicals

Source Control
Control of Chemical Peaks
Non-Targeted Analysis and Low Molecular Weight Compounds
DPR – 2: Pathogen data collection

Objective: Collect new pathogen data to understand occurrence of pathogens in wastewater and inform QMRA

Approach: Three Phases

Recommend pathogen monitoring and reporting requirements:

- Select of enteric viruses, bacteria, protozoa, and microbial indicators
- Define duration and frequency of sampling
- Select wastewater treatment plants
- Consider whether/how cell culture and/or molecular methods should be used
- Define data collection and reporting criteria

Select contractors (RFP/Q process)

Conduct analysis of pathogen monitoring of wastewater (raw and secondary)
**DPR – 1: Quantitative Microbial Risk Assessment & Treatment Performance Analysis**

**Objective:** Develop and implement a quantitative microbial risk assessment (QMRA) to confirm the necessary base-line log removal values (LRVs) and incorporate probabilistic analysis of treatment train performance (PATTP).

**Approach:** Three Phases

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1 – Lit Review and Develop QMRA-Reliability SOW | - Develop a uniform method to review and evaluate base-line LRVs using probabilistic QMRA.  
- Develop a set of most relevant and important scenarios  
- Develop a scope of work including specifications and requirements for QMRA and PATTP |
| 2 – Conduct SOW | - Run the QMRA on selected pathogens (*Crypto, Giardia, Virus*)  
- Test the PATTP using available treatment performance data.  
- Develop documentation, web-based interface, user guides and training material on use of QMRA and PATTP tools (all transparent assumptions with documentation) |
| 3 – Recommendations for Electronic Date Reporting | - Recommendations to address treatment performance data needs (i.e., collection, analysis and reporting for projects) |
DPR – 3: Investigate the feasibility of collecting pathogen concentration data associated with community outbreaks of disease

Objective: Investigate the feasibility of collecting pathogen concentration data associated with community outbreaks of disease
DPR – 4: Evaluate options to reduce chemical spikes

**Objective** - Identify suitable treatment options for final treatment processes that can provide some “averaging” with respect to potential chemical peaks (in particular, for chemicals that have the potential to persist through advanced water treatment).

**Approach**: Three Phases

<table>
<thead>
<tr>
<th>Literature Review</th>
<th>Case Studies (3)</th>
<th>Experimentation to Address Knowledge Gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Identify chemicals and further define issue</td>
<td>• Consider source control, operational, monitoring, and treatment options; and potential response protocols (evaluation is not limited to last or final process)</td>
<td>• Document existing chemical challenge tests, and evaluate TOC analyzers to measure specific chemicals</td>
</tr>
</tbody>
</table>

Results of Online TOC Monitoring Before and After RO at GWRS ([Dadakis and Dunivin, 2013](#))
DPR – 5: Low Molecular Weight - Unknown Compounds

**Objective:** Evaluate potential analytical methods for assessing unknown contaminants, such as non-targeted analysis (NTA), to identify contaminants not presently detected by current monitoring approaches, particularly low molecular weight compounds that may occur in wastewater and may not be removed by advanced treatment (e.g., halogenated solvents, formaldehyde, and 1,4-dioxane).

**Approach:** Effort builds on SWB 2018 CEC report. The project will develop a white paper on recommendations for the use and interpretation of analytical results to identify unknown contaminants.
SWB Grant 2: Potable and Non-Potable Research

**Potable Research needs**
- Phase 1: 2017 projects - Soon to be awarded:
  - Evaluation of CEC Removal by Ozone/BAF Treatment (17-04);  
  - Understanding Wastewater Treatment Performance on Advanced Water Treatment Processes and Finished Water Quality (17-05)
- Phase 2: 2018 projects
  - $2M+ research determined at Feb IAT meeting → RFPs Fall 2018
- Phase 3: 2019 projects
  - ~$1M+ research determined at Q1 IAT meeting

**Non-potable Research Needs**
- Industrial reuse/produced water
  - Call for pre-proposals issued in January 2018 → full proposals are now being evaluated → funding projects in fall 2018
- Agricultural Reuse
  - Ag research needs meeting Jan 2018 – prioritization of research by IAT ag committee and SWB → RFPs in fall 2018
## 2018 Potable projects (1) – RFPs coming in fall/winter

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration of High Frequency Performance Data for Microbial and Contaminant Control in Potable Reuse Systems</td>
<td>Operations</td>
<td>$400,000</td>
</tr>
<tr>
<td><strong>Research Manager – Grace Jang</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Evaluate the integration of performance data and statistical process control (e.g., control charts) into potable reuse operations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Evaluate the use of control charts for process control.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Develop recommendations to design potable reuse monitoring and control systems to process and utilize the large quantity of data collected on a real-time basis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Develop recommendations for the commissioning of sensors networks and monitoring systems.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compiling Evidence of Pathogen Reduction through Managed Aquifer Recharge and Recovery</td>
<td>Monitoring and Validation</td>
<td>$100,000</td>
</tr>
<tr>
<td><strong>Research Manager – Stefani McGregor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Document and quantify performance of pathogen reduction through groundwater based on the following parameters:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Residence Time, Temperature, Source Water quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Aquifer characteristics, both physical and geochemical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Method of introduction (surface spreading vs. direct injection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicator Viruses for Advanced Physical Treatment Process Performance Confirmation</td>
<td>Monitoring and Validation</td>
<td>$300,000</td>
</tr>
<tr>
<td><strong>Research Manager – Grace Jang</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Review and summarize research conducted evaluating the removal of viruses by advanced physical treatment processes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Recommend virus types and cost-effective quantification methods for use in periodic evaluation of performance of advanced physical treatment processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Collect full-scale virus data (e.g. RNA, DNA, pathogens, etc.) for treatment processes and aquifer recharge projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Correlate, where possible, full-scale sampling virus data with potential online surrogates.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2018 Potable projects (2) – RFPs coming in fall/winter

**4958  New Techniques, Tools, and Validation Protocols for Achieving Log Removal Credit across NF and RO Membranes**  
*Research Manager – Justin Mattingly*
- Build off the results from project WRRF-12-07.
- Perform extensive challenge testing under a variety of conditions (ex: oxidized membrane, chemically clean membrane, new membrane).
- Evaluate chemicals and particles at the same time; consider possible relationship between the two.
- Consider the use of QPCR techniques.

**Monitoring and Validation**  
$350,000

**4961  The Use of Next Generation Sequencing (NGS) and Metagenomics Approaches to Evaluate Anti-Microbial Resistance, Plant Challenge, Biological Removal Processes**  
*Research Manager – Stefani McGregor*
- Include case studies that show the applicability of these technologies as well as pit-falls that may be encountered. Examples include, 1) how do microbial communities impact treatment systems (e.g., biological filtration), and 2) how these methods can be used to inform risk, including antibiotic resistance.
- Special attention should be given to the following: data interpretation, databases used to query, importance of peer review and appropriate expertise in initiation and management of the project.

**Monitoring and Antibiotic Resistance**  
$300,000
## 2018 Potable projects (3) – RFPs coming in fall/winter

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Title</th>
<th>Goals</th>
<th>Funding</th>
</tr>
</thead>
</table>
| 4960           | Review of Industrial Contaminants Associated with Water Quality or Adverse Performance Impacts for Potable Reuse Treatment | - Identify contaminants or families of compounds related to industry or manufacturing (e.g. pharmaceuticals, CECs, etc.), and the types of industries that may discharge these compounds.  
- Group listed contaminants in terms of risk to water quality (public health and aesthetic) and impact to advanced treatment effectiveness (e.g. loss of throughput, impact to treatment, etc.).  
- Develop mitigation strategies including, but not limited to, treatment, inspection frequency and methodology, and monitoring requirements.                                                                                                                                  | $200,000 |
| 4953           | Considerations and Blending Strategies for Drinking Water System Integration with Alternative Water Supplies | - Identifying and evaluating impacts of alternative water supplies, such as potable reuse, on the water quality to the end users’ existing drinking water systems that have known issues with tuberculation (e.g., corrosion, biological regrowth, legionella, aesthetics, biofilm, etc.).  
- Understand impacts of blending ratios of alternative water supplies, including potable reuse, at a full-scale system into existing treated water on a variety of issues (e.g., nitrification, total chlorine residual, ammonia, nitrite, nitrate, etc.).  
- Develop management strategies and options to mitigate adverse impacts.                                                                                                           | $400,000 |
| 4959           | Evaluation of Tier 3 Validation Protocol for Membrane Bioreactors to Achieve Higher Pathogen Credit for Potable Reuse | - Determine if a proposed Tier 3 validation protocol for MBRs is feasible.  
- Adapt validation protocol for potential testing in the United States.  
- Develop recommendations on how to implement protocol.                                                                                                                                                                                                                                      | $25,000  |
Research to Develop and Standardize Bioanalytical Screening Tools for use in Source and Recycled Water Applications

Objectives

- Identify, develop, optimize and standardize a suite of bioanalytical tools for screening bioactive responses for evaluating the relative water quality of potable reuse sources and treated waters.
- Develop the capacity for laboratories to conduct these analyses.
- Discuss how to interpret bioassay results.

Deliverables

- Standard operating procedures for selected bioassays from sample collection to data analysis and interpretation.
- Training workshop summary and webinar with start-up guide for labs wanting to conduct these assays.

Duration: 2 years  
Budget: $1.5M
## 2018 Non-potable projects – RFPs coming in fall/winter

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Project Title</th>
<th>Research Manager</th>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>4962</td>
<td>Identifying the Amount of Wastewater that is Available and Feasible to Recycle in California</td>
<td>Stephanie Fevig</td>
<td>$75,000</td>
</tr>
<tr>
<td>4963</td>
<td>Developing a New Foundational Understanding of SAR – Soil Structure Interactions to Provide Management Options for Reclaimed Water Use in Agriculture</td>
<td>Kristan VandenHeuvel</td>
<td>$200,000</td>
</tr>
<tr>
<td>4964</td>
<td>Assessing the State of Knowledge and Impacts of Recycle Water Irrigation on Agricultural Crops</td>
<td>Kristan VandenHeuvel</td>
<td>$120,000</td>
</tr>
<tr>
<td>4966</td>
<td>Potential of Oilfield Produced Water for Irrigation in California - unsolicited program (Pacific Institute)</td>
<td>Ashwin Dhanasekar</td>
<td>$150,000</td>
</tr>
</tbody>
</table>

- Identify the amount of treated municipal wastewater that is available for recycled water production now in California and projected into the future.
- Determine how much of the treated municipal wastewater much could feasibly be produced and used, and the associated cost (feasibility should consider the required minimum instream flows, water quality, and feasibility considerations including cost).

- Investigation for a better understanding of SAR/EC interactions with specific soils (e.g. textural classes, SOM content).
- Investigation of specific plant – soil interactions as affected by irrigation with saline waters.

- Create a database regarding the characterization and variability of recycled water quality used for agricultural irrigation and treatment technologies.
- Assess recycled water properties (such as TDS, SAR, sodium and chloride concentrations) and potential impacts on soil physical, chemical, and microbial properties crossing a range of different types of soil and agricultural management.

- Evaluate Title-22 Recycled Water Regulations as a Science and Policy Template for produced water.
- Develop a geospatial model and online, interactive map identifying areas with the greatest potential for expanded reuse of produced water for irrigation, using inputs from the two indices, information on OPW availability, and water demand for irrigation, and other relevant factors.
Thank you for your attention.

Water shouldn’t be judged by its history, but by its quality

~Lucas van Vuuren (1927-2014)

Julie Minton
jminton@waterrf.org