THE Water Research FOUNDATION

Date Posted: Monday, August 9, 2021

REQUEST FOR PROPOSALS (RFP)

Understanding the Mechanisms of Chlorine and Chloramine Impact on Opportunistic Pathogens in Distribution Systems (RFP 5118)

Due Date: Proposals must be received by **3:00 pm Mountain Time on Tuesday, September 28, 2021**

WRF Project Contact: Grace Jang, PhD, hjang@waterrf.org

Project Sponsors
This project is funded by The Water Research Foundation (WRF) as part of WRF's Research Priority Program.

Project Objectives
The goal of this project is to elucidate the mechanisms of chlorine and chloramine on opportunistic pathogens (OPs).

Budget
Applicants may request up to $250,000 in WRF funds for this project. WRF funds requested and total project value are evaluation criteria considered in the proposal selection process.

Background and Project Rationale
Disinfectants represent long-standing and effective tools for controlling a wide range of pathogens in drinking water. Studies have shown better control of opportunistic pathogens (OPs) in piped systems with various treatments using chlorine and chloramine. However, OPs pose a new challenge for pathogen control because they survive and even grow within protozoa, where they may be protected from disinfection. Biofilms may supply essential nutrients to facilitate growth, as well as physically protect OPs from contact with disinfectants. While studies have demonstrated that disinfectants can help control OPs, the mechanism of action and the conditions supporting their optimal effectiveness remain to be elucidated.

Different disinfectant types and residuals are likely to impact OPs in different ways that are not evident when a single OP is the target of an investigation. For instance, numerous studies have shown that chloramine is a more promising community-level disinfectant than free chlorine for controlling *Legionella*, a Gram-negative bacterium. However, some evidence suggests that non-tuberculous mycobacteria, which are acid-fast bacteria, increase relative to other biofilm bacteria when chloramine is used as the disinfectant. It is also unknown at this time what effects disinfectant residual levels have, whether bactericidal, bacteriostatic, or other metabolic inhibitions. OPs comprise multiple types of

bacteria, fungi, and protozoa that react differently to disinfection when alone or in a biofilm consortium. Thus, single organism control methods that are successful in the laboratory or undefined model systems do not always translate well to field studies. Information on the mechanisms of action of drinking water disinfectants on OPs in a defined complex model is vitally needed in order to guide utilities in the selection and application of disinfectants.

On October 14-15, 2020, the U.S. Environmental Protection Agency (EPA) held a public stakeholder meeting to inform potential revisions to microbial and disinfection byproducts (M/DBP) rules for further improving public health and implementation of existing M/DBP rules. The opportunity to improve control of OPs was discussed at the meeting as a potential revision to the Surface Water Treatment Rule. Understanding the effectiveness of different disinfectants and their possible mechanisms is important to fill in critical knowledge gaps to better guide strategies for effective control of OPs and to protect public health.

Research Approach

- With a focus on known OPs (e.g., *Legionella pneumophila*, *Mycobacterium avium* complex, *Pseudomonas aeruginosa* and other species within the genera), select at least 3 OPs and provide compelling reasons to support the selection.
- To support the research direction, complete a literature review from peer-reviewed literature and published and unpublished data, focusing on recent advances.
- Conduct controlled laboratory-scale testing that will model water distribution systems to gain insight into the impact of chlorine and chloramine on OPs in reasonably close to real-world conditions. Proposals must clearly detail how this testing will be conducted to achieve the objective of this project. The following list contains suggested factors and issues to consider; however, alternative ideas that are not included in this list are acceptable.
    1. Determine the effectiveness of chlorine and chloramine for OPs. Examine the mode of action (e.g., bactericidal, bacteriostatic, and/or other metabolic effects) of disinfectants on OPs. This study is not intended to evaluate the effectiveness of chlorine and chloramines for a single organism in buffered, demand-free water under a controlled laboratory environment. The study must be performed in a defined complex model.
    2. Consider concentrations of disinfectant residuals that are representative of drinking water distribution systems. Consider other water quality parameters, such as temperature, pH, alkalinity, and biodegradable dissolved organic carbon (BDOC) that influence disinfectant effectiveness.
    3. Consider whether a temporary conversion from chloramines to chlorine (i.e., “chlorine burn”) has either positive or negative effects on OP control.
    4. Examine what levels and types of disinfectant residuals in the system will inactivate OPs as they slough off or are present in bulk water compared to protected in biofilm.
    5. Evaluate the effect of pipe materials on chlorine and chloramine efficacy. Pipe materials should represent both a water distribution system and the subsequent customer plumbing systems.
    6. Consider the impact of pipe sediment and scale on disinfectant effectiveness.
    7. Assess the effects of chlorine and chloramine on OP survival within and/or in the presence of a protozoan host. In addition, consider examining the impact on the microbial community, with species-specific tolerances and responses.
- A field-scale application is desirable, but not required, in order to validate the findings from a laboratory study. However, the research team should provide the recommendation for future field

studies to further demonstrate the applicability of the findings from this research. Field studies offer an opportunity for in-kind support from water utilities and WRF subscribers.
- This project is not intended to develop and optimize methodologies for testing for OPs. The research team should provide justification to support the proposed methodologies.

Expected Deliverables
- A final report should be developed, defining what is now known, what is hypothesized, and what is still unknown about the mechanisms of chlorine and chloramine action to control OPs, and the variables that affect the mechanisms.
- The final report should outline the various components of the research approach and provide a framework on how utilities can apply the findings.
- A WRF-sponsored webcast following project completion.
- Conference presentations or other appropriate outreach (e.g., peer-reviewed open access journals) should be prioritized to share interim results of interest.

Communication Plan
Please review WRF's *Project Deliverable Guidelines* for information on preparing a communication plan. The guidelines are available at https://www.waterrf.org/project-report-guidelines. Conference presentations, webcasts, peer review publication submissions, and other forms of project information dissemination are typically encouraged.

Project Duration
The anticipated period of performance for this project is 24-36 months from the contract start date.

References and Resources
The following list includes examples of WRF-produced research reports, tools, and other resources that may be helpful to proposers. It is not intended to be comprehensive, nor is it a required list for consideration.
- Project 4911: *Sampling and Monitoring Strategies for Opportunistic Pathogens in Drinking Water Distribution Systems*
- Project 4721: *Methods for Detecting and Differentiating Opportunistic Premise Plumbing Pathogens to Determine Efficacy of Control and Treatment Technologies*
- Project 4092: *Free-Living Protozoa and Opportunistic Pathogens in Distributed Water*
- Project 2771: *Impacts of Distribution System Water Quality on Disinfection Efficacy*
- Project 936: *Pathogens in Model Distribution System Biofilms*
- Project 442: *Inactivation of Waterborne Emerging Pathogens by Selected Disinfectants*
- Project 373: *Evaluating Biological Regrowth in Distribution Systems*
- Project 183: *Factors Affecting Microbial Growth in Model Distribution Systems*

Proposal Evaluation Criteria
The following criteria will be used to evaluate proposals:
- Understanding the Problem and Responsiveness to RFP (maximum 20 points)
- Technical and Scientific Merit (maximum 30 points)
- Qualifications, Capabilities, and Management (maximum 20 points)
- Communication Plan, Deliverables, and Applicability (maximum 15 points)
- Budget and Schedule (maximum 15 points)

Proposal Preparation Instructions
Proposals submitted in response to this RFP must be prepared in accordance with the WRF document *Guidelines for Research Priority Program Proposals*. The current version of these guidelines is available at https://www.waterrf.org/proposal-guidelines, along with *Instructions for Budget Preparation*. The guidelines contain instructions for the technical aspects, financial statements, indirect costs, and administrative requirements that the applicant must follow when preparing a proposal.

Proposals that include the production of web- or software-based tools, such as websites, Excel spreadsheets, Access databases, etc., must follow the criteria outlined for web tools presented in the Web Tool Criteria and Feasibility Study for The Water Research Foundation Project Deliverables at https://www.waterrf.org/sites/default/files/file/2021-07/WebToolCriteria.pdf.

Eligibility to Submit Proposals
Proposals will be accepted from domestic or international entities, including educational institutions, research organizations, governmental agencies, and consultants or other for-profit entities.

WRF's Board of Directors has established a Timeliness Policy that addresses researcher adherence to the project schedule. The policy can be reviewed at https://www.waterrf.org/policies. Researchers who are late on any ongoing WRF-sponsored studies without approved no-cost extensions are not eligible to be named participants in any proposals. Direct any questions about eligibility to the WRF project contact listed at the top of this RFP.

Administrative, Cost, and Audit Standards
WRF's research program standards for administrative, cost, and audit compliance are based upon, and comply with, Office of Management and Budget (OMB) Uniform Grants Guidance (UGG), 2 CFR Part 200 Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, and 48 CFR 31.2 Contracts with Commercial Organizations. These standards are referenced in WRF's *Guidelines for Research Priority Program Proposals*, and include specific guidelines outlining the requirements for indirect cost negotiation agreements, financial statements, and the Statement of Direct Labor, Fringe Benefits, and General Overhead. Inclusion of indirect costs must be substantiated by a negotiated agreement or appropriate Statement of Direct Labor, Fringe Benefits, and General Overhead. Well in advance of preparing the proposal, your research and financial staff should review the detailed instructions included in WRF's *Guidelines for Research Priority Program Proposals* and consult the *Instructions for Budget Preparation*, both available at https://www.waterrf.org/proposal-guidelines.

Budget and Funding Information
The maximum funding available from WRF for this project is $250,000. The applicant must contribute additional resources equivalent to at least 33 percent of the project award. For example, if an applicant requests $100,000 from WRF, an additional $33,000 or more must be contributed by the applicant. Acceptable forms of applicant contribution include cost-share, applicant in-kind, or third-party in-kind that comply with 2 CFR Part 200.306 cost sharing or matching. The applicant may elect to contribute more than 33 percent to the project, but the maximum WRF funding available remains fixed at $250,000. **Proposals that do not meet the minimum 33 percent of the project award will not be accepted.** Consult the *Instructions for Budget Preparation* available at https://www.waterrf.org/proposal-guidelines for more information and definitions of terms.

Period of Performance
It is WRF's policy to negotiate a reasonable schedule for each research project. Once this schedule is established, WRF and its sub-recipients have a contractual obligation to adhere to the agreed-upon schedule. Under WRF's No-Cost Extension Policy, a project schedule cannot be extended more than nine months beyond the original contracted schedule, regardless of the number of extensions granted. The policy can be reviewed at https://www.waterrf.org/policies.

Utility and Organization Participation
WRF encourages participation from water utilities and other organizations in WRF research. Participation can occur in a variety of ways, including direct participation, in-kind contributions, or in-kind services. To facilitate their participation, WRF has provided contact information, on the last page of this RFP, of utilities and other organizations that have indicated an interest in this research. Proposers are responsible for negotiating utility and organization participation in their particular proposals. The listed utilities and organizations are under no obligation to participate, and the proposer is not obligated to include them in their particular proposal.

Application Procedure and Deadline
Proposals are accepted exclusively online in PDF format, and they must be fully submitted before 3:00 pm Mountain Time on Tuesday, September 28, 2021.

The online proposal system allows submission of your documents until the date and time stated in this RFP. Submit your proposal at https://forms.waterrf.org/212005866932859

Please ensure you upload the required documents before the deadline. **Proposals submitted after the deadline will not be accepted**.
Questions to clarify the intent of this RFP and WRF's administrative, cost, and financial requirements may be addressed to the WRF project contact, Grace Jang, PhD, at (303) 347-6112 or hjang@waterrf.org. Questions related to proposal submittal through the online system may be addressed to Caroline Bruck at (303) 347-6118 or cbruck@waterrf.org**.**

Utility and Organization Participants

The following utilities have indicated an interest in possible participation in this research. This information is updated within 24 business hours after a utility or an interested organization submits a volunteer form, and this RFP will be re-posted with the new information. **(Depending upon your settings, you may need to click refresh on your browser to load the latest file.)**

Mr. George Kraynick
Water Quality Manager
City of Minneapolis
4300 Marshall St NE
Minneapolis, MN 55421
USA
(612) 661-4923
george.kraynick@minneapolismn.gov

Ms. Becky Lahr
Drinking Water Quality Manger
City of Ann Arbor
919 Sunset Rd.
Ann Arbor, MI 48103
USA
(734) 794-6426
rlahr@a2gov.org

John W. Norton, Jr.
Director of Energy, Research, & Innovation
Great Lakes Water Authority
735 Randolph St.
Detroit, MI 48226
(313) 400-2553
john.norton@glwater.org