THE Water Research FOUNDATION

Date Posted: Wednesday, September 11, 2019

REQUEST FOR PROPOSALS (RFP)

Precursors and Control of Halogenated Acetonitriles (RFP 5053)

Due Date: Proposals must be received by 2:00 pm Mountain Time on Tuesday, November 5, 2019
WRF Project Contact: Djanette Khiari, dkhiari@waterrf.org

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

Project Objective
The objectives of this project are to:

- determine the sources and precursors of halogenated acetonitriles (HANs) and their formation and stability in drinking water systems
- assess the effectiveness of organic and inorganic HAN precursors

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
Halogenated acetonitriles (HANs), also referred to as haloacetonitriles, are a group of nitrogenous disinfection byproducts (N-DBPs). They are formed during chlorine, chloramine, or chlorine dioxide oxidation of anthropogenic and naturally occurring substances, including algae, fulvic acid, and proteinaceous material. N-DBPs, including HANs, are more toxic than regulated carbonaceous DBPs, trihalomethanes (THMs), and haloacetic acids (HAAs), with HANs contributing significantly to the overall toxicity of treated water. In addition, comparative toxicity studies (Plewa et al. 2008) show that iodinated and brominated HANs are more cytotoxic and genotoxic than their chlorinated analogues.

Several studies (Mitch et al. 2009, Simpson and Hayes 1989) have reported the occurrence of HANs in treated waters. The most frequently detected HAN species (HAN4) are trichloroacetonitrile (TCAN), dichloroacetonitrile (DCAN), bromochloroacetonitrile (BCAN), and dibromoacetonitrile (DBAN).

While the World Health Organization is considering guidelines for DBAN and DCAN, there are no regulations for HANs in the United States. However, considering the reports of increased frequency of detection and new evidence of HAN toxicity, future regulations may be considered for the protection of public health.

Previous studies (Chuang et al. 2013, Lee et al. 2007) have shown that bulk organic matter parameters, such as dissolved organic carbon (DOC), dissolved organic nitrogen (DON), and bromide levels, play important roles in HAN formation. For example, high levels of bromide lead to the formation of the more toxic brominated HAN species. Another important factor is the type of disinfectant used; the reactivity of various precursors is different with chlorine versus chloramine.

Though HANs have been detected in drinking water for over a decade, surprisingly little is known about their precursors in water supplies. Much of the available literature on HAN precursors focuses on a relatively small number of low molecular weight model compounds (e.g., amino acids, aspartic acid), and it is thought that aromatics that produce THMs/HAAs also produce HANs. Nitrogen source tracking with application of ^{15}N-labeled monochloramine demonstrated that approximately 60-90% of DCAN from different dissolved organic matter isolates was from inorganic nitrogen incorporation from chloramine. Higher DCAN formation was exhibited from hydrophobic fractions than from transphilic and hydrophilic fractions in chloramination. Colloidal and transphilic fractions enriched with proteins and amino sugars tend to have higher DCAN yields in chlorination. There tends to be a weak correlation between DON and HANs.

HANs have been shown to exhibit greater stability in chloraminated systems than in chlorinated systems. Decay of HANs in chlorinated distribution systems can result in higher potential health risks due to degradation byproducts, such as haloacetamides.

HANs are polar compounds, are usually water-soluble with low octanol/water partition coefficients, and are not expected to be removed by adsorption. Recent studies (Stanford et al. 2019) demonstrated that HAN formation is unaffected or even increased by granular activated carbon treatment, and DBAN emerges as a dominate risk in finished drinking water. While HANs can decay and eventually form THMs and HAAs upon free chlorination or at alkaline conditions, they continue to form during chloramination.

The scientific community has realized through the study of other N-DBPs that watershed, wastewater, and in-plant chemicals can be precursors for N-DBPs and HANs. The frequent occurrence, stability, and significant toxicity of HANs and their degradation products can result in critical risks to human health.

There is a need to identify the most common precursors for HANs, assess control measures to remove them, and understand their formation and stability in potable water systems.

Research Approach

Control of DBPs requires information on their sources, precursors, formation, and fate. The goal of this research is to better understand the sources of HAN precursors and the conditions that favor their formation. Such knowledge is necessary for the development of effective mitigation strategies (e.g., at wastewater treatment plants, in watersheds, in drinking water treatment plants), and may potentially help identify appropriate control measures for public health protection.

This project will investigate the sources and precursors of HANs on natural and wastewater impacted drinking water supplies by:

- Conducting bench-, pilot-, and/or full-scale studies in representative waters with a range of impacts (e.g., wastewater, algae, biological treatment), and determine relative sources of HAN precursors
- Identifying compounds and/or functional groups that could potentially form HANs
- Investigating the mechanisms of formation and the role of disinfectants on the selected precursors, and confirming these mechanisms in real waters with various water matrices

Expected Deliverables

- A final report detailing HAN precursors in water and wastewater, including the contribution and relative importance of natural and anthropogenic sources of HAN precursors
- Guidelines to help utilities minimize, and potentially prevent, the formation of HANs

Communications Plan

Please review WRF's *Project Deliverable Guidelines* for information on preparing a communications plan. The guidelines are available at http://www.waterrf.org/funding/Pages/proposal-guidelines.aspx. 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 30 months from the contract start date.

References and Resources

The following list includes examples of 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.

- Chuang, Y. -H., A. Y. C. Lin, X. -H. Wang, and H. -H. Tung. 2013. "The Contribution of Dissolved Organic Nitrogen and Chloramines to Nitrogenous Disinfection Byproduct Formation from Natural Organic Matter." *Water Res*, 47 (3): 1308-1316.
- Lee, W., P. Westerhoff, and J. P. Croué, 2007. "Dissolved Organic Nitrogen as a Precursor for Chloroform, Dichloroacetonitrile, N-Nitrosodimethylamine, and Trichloronitromethane." *Environ Sci Technol*, 41 (15): 5485-5490.
- Mitch, W., S. Krasner, P. Westerhoff, and A. Dotson. 2009. *Occurrence and Formation of Nitrogenous Disinfection By-products*. Denver, CO: AWWA Research Foundation.
- Plewa, M. J., E. D. Wagner, M. G. Muellner, K. -M. Hsu, and S. D. Richardson. 2008. "Comparative Mammalian Cell Toxicity of N-DBPs and C-DBPs." *Disinfection By-Products in Drinking Water*, 995: 36-50.Simpson, K. L., and K. P. Hayes. 1998. "Drinking Water Disinfection By-products: An Australian Perspective." *Water Res*, 32 (5): 1522-1528.
- Stanford, B. D., D. Knappe, C. Maness, C. Zhang, R. S. Summers, R. Mulhern, S. D. Richardson, A. Cuthbertson, S.Y. Kimura, H. Liberatore, E. R. V. Dickenson, E. Verdugo, C. Glover, A. Ghosh, C. Seidel, M. Selbes, A. Reinert, M. Pierce, and E. Rosenfeldt. 2019. *GAC Control of Regulated and Emerging DBPs of Health Concern.* Denver, CO: The Water Research Foundation.

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 http://www.waterrf.org/funding/Pages/proposal-guidelines.aspx, 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.

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 http://www.waterrf.org/funding/Pages/policies.aspx. 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 http://www.waterrf.org/funding/Pages/proposal-guidelines.aspx.

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 http://www.waterrf.org/funding/Pages/proposal-guidelines.aspx 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 http://www.waterrf.org/funding/Pages/policies.aspx.

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 2:00 pm Mountain Time on Tuesday, November 5, 2019. All proposal documents must be compiled into two (2) PDF files consisting of your technical review documents and your financial review documents. All forms and components of the proposal are available in the *Proposal Component Packet* zip file on the proposal website at https://proposals.waterrf.org/Pages/RFPs.aspx. An FAQ and a tutorial are also available. A login is required to access the proposal website and download the packet. Proposers are encouraged to create logins and verify the validity and compatibility of the system well in advance in order to avoid last-minute errors or delays.

The online proposal system allows submission of your documents until the date and time stated in this RFP. To avoid the risk of the system closing before you press the submit button, do not wait until the last minute to complete your submission.

Questions to clarify the intent of this RFP and WRF's administrative, cost, and financial requirements may be addressed to the WRF project contact, Djanette Khiari at (303) 734-3478 or dkhiari@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 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.)**

N/A