



**Date Posted: Friday, August 14, 2020**

## **REQUEST FOR PROPOSALS (RFP)**

### ***Advancing Low-Energy Biological Nitrogen and Phosphorus Removal (RFP 5083)***

**Due Date:** Proposals must be received by 2:00 pm Mountain Time on  
**Thursday, October 29, 2020**

**WRF Project Contact:** Stephanie Fevig, [sfevig@waterrf.org](mailto:sfevig@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 main objective of this project is to conduct research needed to advance the most promising intensive and efficient low-energy nutrient treatment process(es) and innovative process control approach(es) that utilities can employ and reliably operate at their facilities with a balance of cost-effective investments and appropriate levels of process control complexity. While the scope of this project is open to all low-energy biological nutrient removal intensification processes, we encourage proposers to consider the processes and research topics listed under the research approach section below.

#### **Budget**

Applicants may request up to \$200,000 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**

Addressing nutrients in watersheds is a broad challenge that encompasses both point sources such as water resource recovery facilities (WRRFs) and non-point sources. Achieving stringent nutrient effluent limits requires significant investment in both WRRF process treatment systems and operations. However, utilities are not only funding limited, but also resource limited. Therefore, they are looking for opportunities to maximize the use of their existing infrastructure or invest in cost-effective and sustainable greenfield installations.

The key focus of this WRF priority research area is to identify and advance the most promising intensive and efficient low-energy biological nutrient treatment processes and innovative process control approaches that utilities can employ and reliably operate at their facilities with a balance of cost-effective investments and appropriate levels of process control complexity.

A number of highly sustainable and intensive low-energy processes used for nutrient removal or in enhancing existing biological nutrient removal (BNR) processes have emerged during the last decade. Many of these BNR processes involve aeration control and/or low dissolved oxygen (DO) conditions with the benefit of reducing energy and costs at the utility. One example is the simultaneous nitrification/denitrification (SND) process where the mechanisms for achieving controllable SND are not fully understood and accurately quantifying nitrogen removal through SND remains a challenge. Implementing these processes within existing activated sludge systems is currently more art than science and, in some cases, go against traditional design practice (such as full aerobic conditions, energy required for “adequate mixing” and homogenous mixed liquor suspended solids (MLSS) concentration within reactors).

In a number of studies, innovative processes and aeration control strategies have been introduced (e.g., ammonia-based aeration control, SND, low DO in the aerobic zone of biological phosphorus removal processes), but performance has been inconsistent and challenging in some cases. Also, the methods of implementing low DO conditions, optimum mixing, and how to best implement a low DO gradient within the reactor have not been well understood and can be very process specific. There are currently no clear guidelines to successfully implementing low DO in various BNR processes and configurations to achieve reliable nutrient removal performance in a more sustainable way.

Further research or testing to develop a robust understanding of mechanisms, kinetics, and implementation approaches are needed in addition to updating process models towards understanding which intensive BNR technologies or processes can be enhanced with this low DO strategy, and how to implement these processes and broaden full-scale implementation at WRRFs. The benefit to WRF utility subscribers will be the ability meet their nutrient removal objectives and further improve their effluent quality with lower capital and O&M investment, in a more efficient manner.

### **Research Approach**

The scope of this project is open to all low-energy biological nutrient removal intensification processes and the research approach and activities are open to the researchers to propose in order to encourage creativity and originality. The proposal shall include the following elements:

- An overview of the state-of-the-science, research gaps, and patents related to low-energy biological nitrogen and phosphorus removal processes and strategies based on completed research, testing, and full-scale implementation at various WRRFs. Proposers should clearly outline key prior research work that has been completed to date.
- The rationale for the research scope and approach proposed and how this research will advance the implementation of the low-energy BNR process(es) at full-scale. The rationale should identify the potential benefits to WRRFs and what impacts could be expected on other mainstream or sidestream processes (if sidestream processes are included in the research scope, impacts to mainstream processes should be evaluated).

The following topics are listed here for consideration:

- Low DO processes including SND, focusing on approaches, guidelines, and modeling for optimum stable nitrogen removal in various configurations, taking into consideration specific process configurations and important operational parameters such as C:N ratio, optimum bulk DO, and solids retention time (SRT) and their impact on percent total nitrogen removal while addressing potential challenges such as deterioration in settleability (high SVI). Creative process control approaches and advanced aeration control strategies shall be considered. Characterizing metabolic pathways and microbial ecology in overall nitrogen removal and the impact of different organisms in

the presence of different electron acceptors should be considered. Appropriate mixing and flow conditions and means of best maintaining the DO gradient within the reactor shall also be evaluated. Greenhouse gas emissions associated with nitrous oxide generation should be considered through advanced modeling and/or process monitoring.

- Simultaneous efficient and low-energy nitrogen and phosphorus removal, with a focus on optimum strategies that facilitate efficient biological phosphorus (bio-P) removal and on selection for denitrifying polyphosphate accumulating organisms (DPAOs) and/or robust bio-P in BNR facilities, including those using carbon and resource-efficient nitrogen removal strategies such as SND and short-cut nitrogen removal strategies. The impact of important process parameters shall be considered. Research in this area will focus on process advancement towards full-scale implementation and will build on WRF Project 4819, *Understanding the Impacts of Low-Energy and Low-Carbon Nitrogen Removal Technologies on Bio-P and Nutrient Recovery Processes* and on research by other practitioners. The aim is to develop guidelines for design and operation of high-efficiency and low-energy nitrogen and phosphorus removal processes. WRF project 4819 evaluated kinetics, mechanisms, and operational conditions at bench, pilot, and full-scale that enable selection for DPAOs and/or robust bio-P in low-energy and low-carbon nitrogen removal processes.

### **Expected Deliverables**

Proposers are open to suggest creative and alternative project deliverables in lieu of a single final report. At a minimum, a webcast, a presentation at WEFTEC, and a final deliverable and project summary will be required. The final deliverable shall include, at a minimum:

- Key findings.
- Understanding of upstream impacts and impacts to downstream facility processes.
- Implementation and design guidance on how to apply this process at other WRRFs including limitations, drawbacks, and benefits.
- Future research needs.

### **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 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.

- The Water Research Foundation. [Characterizing Mechanisms of Simultaneous Biological Nutrient Removal During Wastewater Treatment](#) (1008).
- The Water Research Foundation. [Impacts of Mainstream Low DO Conditions at a Full-Scale MBR Water Reuse Plant](#) (1702).
- The Water Research Foundation. [Understanding the Impacts of Low-Energy and Low-Carbon Nitrogen Removal Technologies on Bio-P and Nutrient Recovery Processes](#) (4819).

- The Water Research Foundation. [Bioaugmentation of Activated Sludge with High Activity Nitrifying Granules/Flocs: Population Selection, Survival, Biokinetics](#) (4864).
- The Water Research Foundation. [Combining Nitrite-Shunt/Anammox Processes with Side-Stream EBPR Process for Simultaneous and Sustainable Nitrogen and Phosphorus Removal](#) (4901).

### **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.

### **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 \$200,000. 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 \$200,000. **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 2:00 pm Mountain Time on Thursday, October 29, 2020.** All proposal documents must be compiled into two 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, Stephanie Fevig at (303) 347-6103 or [sfevig@waterrf.org](mailto:sfevig@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](mailto:cbruck@waterrf.org).

## 5083 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.)**

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