



REQUEST FOR PROPOSALS (RFP)

Optimizing Densified Systems for Nutrient Removal, Energy Savings, and Reliable Performance (RFP 5371)

Date Posted

Monday, September 22, 2025

Due Date

Proposals must be received by 3:00 pm Mountain Time on Thursday, November 20, 2025.

WRF Project Contact

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Project Sponsors

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

Project Objectives

- Expand the applicability of densification strategies to plants of varied size and process configurations without anaerobic selectors, with a goal of stable performance across diverse plant designs, by:
 - Refining design parameters to optimize biological selection, such as food-to-microorganism (F/M) ratios, carbon to nitrogen ratios (C/N), selector sizing, hydraulic retention times (HRT), solids retention times (SRT), selective wasting schedules, and aeration and mixing.
 - Investigating the impact of floc size, granule-to-floc ratio, and dissolved oxygen (DO) control on simultaneous nitrification-denitrification (SND) in densified systems.
- Bridge research findings with practical implementation by developing a “recipe book” for densification, ensuring findings translate into actionable strategies for wastewater utilities.

Budget

Applicants may request up to \$300,000 in WRF funds for this project.

Background and Project Rationale

Wastewater treatment facilities face continuing pressure to increase capacity in an environment with limited financial resources and physical space for expansion. Process intensification provides one avenue for addressing these challenges.

Densification strategies have emerged as a promising approach for increasing treatment capacity, enhancing nutrient removal, and improving sludge settleability in wastewater. Formation of denser microbial aggregates enhances solids-liquid separation, allowing utilities to achieve higher performance (solids and nutrient removal) within existing infrastructure.

Previous research on densification (Regmi et al. 2024 and related studies) demonstrated that granule mass fractions as low as 10% can lead to significant settleability improvements. In addition to gaining insight into important biological selection factors like F/M ranges, particle size, and granule-floc composition, the project demonstrated that physical selection also holds promise for improving sludge settleability. Physical selectors for granules (e.g., hydrocyclones) were found to be effective in step-feed and multi-stage biological nutrient removal (BNR) configurations, with the next challenge being expansion to other configurations. This work also showed that SRT decoupling, i.e., differential removal of flocs and granules based on their settling properties, can enhance process stability, but further quantification is necessary. The inclusion of a high F/M anaerobic selector basin was integral to achieving densification in previous research. There is a need to develop design criteria for densification in process configurations without anaerobic selectors and quantify the impact of SRT decoupling on nutrient removal, energy costs, and performance reliability.

Regmi et al. 2024 made significant progress in promoting the practical application of densification, including by providing detailed standard operating procedures (SOPs) and design criteria for continuous-flow facilities. This project is intended to build upon its findings and assist a more diverse range of utilities in implementing densification strategies.

Research Approach

A successful proposal will focus on the extension of Densified Activated Sludge (DAS) technology to common process configurations without anaerobic selectors, such as Modified Ludzack Ettinger (MLE) or four-stage Bardenpho. The study should use a combination of literature review, controlled experiments, and data collected from existing installations to address, at minimum, the following questions:

- What biological selection strategies (such as F/M ratios, timings, feast and famine schedules) promote densification in process configurations without anaerobic selectors, including configurations with other biological (aerobic vs. anoxic) or physical selectors?
- Do optimum particle size ranges and granule-to-floc ratios vary for different treatment, nutrient removal, or energy efficiency objectives?
- How can SRT decoupling through physical selection be leveraged to optimize densification processes and increase nutrient removal capacity?
- How does partial physical selection (e.g., hydrocyclone use on specific waste streams) compare with full physical selection in terms of treatment performance?
- How does increased densification affect nitrification and denitrification rates compared to conventional processes of the same configuration?

Proposals may also consider additional research topics. Some suggestions are:

- How densification and changes in sludge characteristics influence downstream processes such as sludge thickening, digestion, and disinfection, to inform integrated system design and operational practices.
- Seasonal impacts and whether there are certain conditions where densification will not be achievable.
- Whether densification affects the microbial community composition as compared to a conventional system of the same configuration.

Proposers are encouraged to refer to the final report from Regmi et al. 2024 for a comprehensive list of open questions and knowledge gaps following that study, which could be explored in this project.

Densification efficiency should be evaluated through performance metrics like sludge volume index (SVI), mixed liquor suspended solids (MLSS), and sludge rheology. Other parameters, such as chemical oxygen demand (COD), floc size distribution, DO, energy consumption related to aeration, effluent quality, and microbial community composition, may also enhance the study.

Expected Deliverables

- A research report detailing the data and findings with respect to the project objectives.
- A peer-reviewed publication presenting the major findings.
- Webcasts and/or conference presentations.
- Guidance for implementing densification at a wider variety of plant sizes and configurations, particularly those with non-anaerobic selectors. This should include considerations for design, operation, and troubleshooting, such as physical dimensions for a reactor. The format of this is intentionally left flexible. Proposers should describe one or more deliverables that will convey this guidance. Some suggestions include:
 - A “recipe book” for densification
 - Fact sheets
 - Workshops
 - A conceptual framework for selection of strategies (a decision tree, spreadsheet, etc.)

Communication Plan

Please review WRF’s [Project Deliverable Guidelines](#) for information on preparing a communication plan. Conference presentations, webcasts, peer-reviewed publication submissions, and other forms of project information dissemination are typically encouraged.

Project Duration

The anticipated period of performance for this project is 36 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.

Regmi, P., R. Maltos, M. Armenta, K. Bauhs, B. Sturm, and J. P. Boltz. 2024. *Advancements in Continuous Flow Densified Sludge System Design and Operation*. Project 5130. Denver, CO: The Water Research Foundation. <https://www.waterrf.org/research/projects/advancement-continuous-flow-densified-sludge-system-design-and-operation>.

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 15 points)
- Communication Plan, Deliverables, and Applicability (maximum 20 points)
- Budget and Schedule (maximum 15 points)

PROPOSAL PREPARATION INSTRUCTIONS

Proposals submitted in response to this RFP must be prepared in accordance with WRF's *Guidelines for Research Priority Program Proposals*. 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, spreadsheets, databases, etc., must follow the criteria outlined for web tools presented in the [Technology Deliverables Guidance](#).

Eligibility to Submit Proposals

Proposals will be accepted from both U.S.-based and non-U.S.-based entities, including educational institutions, research organizations, governmental agencies, consultants, or other for-profit entities.

WRF's Board of Directors has established a [Timeliness Policy](#) that addresses researchers' adherence to the project schedule. 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. 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*.

Budget and Funding Information

The maximum funding available from WRF for this project is \$300,000. The applicant must contribute additional resources equivalent to at least 33% 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% to the project, but the maximum WRF funding available remains fixed at \$300,000. Proposals that do not meet the minimum 33% of the project award will not be accepted. Consult the *Instructions for Budget Preparation* 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.

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 of utilities and other organizations that have indicated an interest in this research. Proposers are responsible for negotiating utility and organization participation in their proposals. The listed utilities and organizations are under no obligation to participate, and the proposer is not obligated to include them in their proposal.

Application Procedure and Deadline

Proposals are accepted exclusively online, and they must be fully submitted before 3:00 pm Mountain Time on Thursday, November 20, 2025.

To submit a proposal for this RFP, please visit <https://waterrf.org/proposals> and follow the instructions on the page.

Questions to clarify the intent of this RFP and WRF's administrative, cost, and financial requirements may be addressed to the WRF project contact, Maitreyi Nagarkar at 571.384.2117 or mnagarkar@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.