



Request for Proposals (RFP):

RFP #: NAWI-2-2021

<u>Key Dates for this Request for Proposals</u>	
Request for Proposals Released	May 24, 2021
Concept Papers Due	June 15, 2021*
Encourage/Discourage Decision Notification	Week of July 19, 2021
Full Proposals Due	September 2, 2021*
Pre-Selection Clarifications, if needed	Week of October 25, 2021
Expected Date for Selection Notification	Mid-November, 2021
Anticipated Project Start Date	February 2022

*Due at 5:00 pm PT

- Interested applicants must submit a Concept Paper by the deadline to be eligible to submit a Full Proposal.
- To apply to this RFP, applicants must register with and submit application materials through the online application portal NAWI Exchange at <https://nawi.infoready4.com/>
- Applicants must designate primary technical and business points-of-contact in NAWI Exchange with whom NAWI will communicate to conduct negotiations. If the application is selected for award negotiations, it is not a commitment to issue an award. It is imperative that the applicant be responsive during award negotiations and meet negotiation deadlines. Failure to do so may result in the cancelation of further award negotiations and rescission of the selection.
- Classification Code: North American Industry Classification System (NAICS) Code: 541715, Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology), and the corresponding size standard is 1,000 or fewer employees.
- The University of California, Lawrence Berkeley National Laboratory ("University" or "LBL" or "LBL"), managed and operated by The Regents of the University of California ("Contractor"), was selected by the Department of Energy (DOE) under the Funding Opportunity Announcement ("FOA") DE-FOA-0001905 for the Energy-Water Desalination Hub to lead in the establishment and operation of the National Alliance Water Innovation Hub ("NAWI" or "Hub").



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1 Executive Summary

Solicitation Title	National Alliance for Water Innovation Request for Proposals (RFP): Funding #: NAWI-2-12021
Means of Submission	Electronic – NAWI Exchange
Total Amount to be Awarded under this RFP	Up to \$6,500,000 federal funds with a minimum of 25% cost share divided among the total awards.
Anticipated Awards	Between 6 and 11 awards
Period of Performance	Up to 36 months (split into 12-month budget periods)
Limited Submission Eligibility	A person/performer participating may only participate on one Concept Paper per Area of Interest (AOI) regardless of their role in the Concept Paper. There are no other institutional submission limits.
Performance of Work in the United States	Unless a waiver is provided, the Lead Organization must show that 100% of the direct labor cost for the project (including Participating Organizations labor) will be incurred in the United States and its territories.
Cost Share Requirement	A minimum of 25% cost share is required.
Application Forms	Required forms for Applications are available on https://NAWI.infoready4.com/
Questions:	Submit questions to NAWI-RFP@lbl.gov . Questions and answers will be posted on https://NAWI.infoready4.com/ .

1.1 Background

The National Alliance for Water Innovation (NAWI or Hub) was established to support the US Department of Energy’s efforts to advance transformational technology and innovation to meet the nation’s need for safe, secure, and affordable water. Lawrence Berkeley National Laboratory (“LBNL”), managed and operated by The Regents of the University of California, was selected to operate NAWI. Details of the NAWI research vision and mission can be found at www.nawihub.org.

Proposers are encouraged to view recorded presentations about the program and research priorities.

- NAWI Research Program – released 20-06-17: <https://vimeo.com/430106267>
- NAWI Introduction to Process Innovation and Intensification (PI&I) – released 20-07-10: <https://vimeo.com/437258004>
- Introduction to Materials and Manufacturing – release 20-08-22: <https://vimeo.com/449893826>
- NAWI Alliance Orientation and Discussion – released 20-06-30: <https://vimeo.com/434115461>
- General intro to NAWI – released 20-02-21: <https://vimeo.com/393080271>

The strategic goal of NAWI is to conduct early-stage applied research Technology Readiness Level 2 – 4 (TRL 2 – 4), leading to a portfolio of technologies that enable pipe parity for 90% of nontraditional water sources – water sources that are currently not treated and reused. Nontraditional water achieves pipe parity when the marginal intensity (i.e., cost/energy intensity/failure rate/etc.) of supplying water from the nontraditional source is lower than that of the next available traditional source. Technologies that facilitate fit-for-purpose treatment and local reuse of nontraditional waters will be essential to meeting these pipe parity goals. Cost-effective and energy-efficient brine management is a critical element of this decentralized reuse paradigm.

1.2 NAWI Hub Pipe Parity Metrics

Pipe parity is defined as technology solutions for treating and reusing non-traditional water sources that are competitive with conventional water sources for specific end-use applications. In the Concept Paper Technical Narrative (Appendix A), applicants are asked to clearly explain how their approach improves upon one or more pipe parity metrics, without significantly compromising other pipe parity metrics. An example of a technological solution that does **not** move closer to pipe parity would be the development of an ion exchange resin with double the capacity, but that costs twice as much to purchase and implement at scale as the current state-of-the-art. Specific pipe parity metrics of interest include:

- **Cost:** Cost metrics can include levelized costs of water treatment as well as individual cost components, such as capital or operating and maintenance (O&M) costs
- **Energy Performance:** Energy performance metrics can include the total energy requirements of the water treatment process, the type of energy required (e.g., thermal vs. electricity), embedded energy in chemicals and materials, and the degree to which alternative energy resources are utilized.
- **Water Treatment Performance:** Water treatment performance metrics can include the percent removal of various contaminants of concern and the percent recovery of water from the treatment train.
- **Human Health and Environment Externalities:** externality metrics can include air emissions, greenhouse gas emissions, waste streams, societal and health impacts, land-use impacts.
- **Reliability and Availability:** System reliability and availability metrics can include factors related to the likelihood of a water treatment system not being able to treat water to a specified standard at a given moment, how quickly the system can restart operations after being shut down for a given reason, confidence in source water availability, the degree to which the process is vulnerable to supply chain disruptions, and the ability to withstand environmental, climate, or hydrological disruptions.
- **Process Adaptability:** Adaptability metrics can include the ability to incorporate variable input water quality; the ability to incorporate variable input water quantity flows; the ability to produce variable output water quality; and to operate flexibly in response to variable energy inputs.
- **Compatibility:** Compatibility metrics can include ease of operation and level of oversight needed, how well the technology integrates with existing infrastructure, how consistent the technology is with existing regulations and water rights regimes, and the level of social acceptance.
- **Sustainability:** Sustainability metrics can include the degree to which freshwater inputs are

required for industrial applications, the percentage of water utilized that is reused or recycled within a facility, and watershed-scale impacts.

1.3 Project Call Purpose

The NAWI Hub is seeking proposals that directly address the knowledge gaps and research needs that have been identified in Sections 1.5 (Autonomous Water) and 1.6 (Precision Separation) and clearly deliver impact aligned to the NAWI pipe parity metrics outlined in Section 1.2. Proposals will be focused on addressing challenges within the Autonomous Water or the Precision Separation Area of Interest, not both. Appendix A outlines what NAWI is looking for in a Concept Paper, and the Concept Paper review criteria is provided in Section 6.1.

A person/performer participating may only participate on one Concept Paper per AOI regardless of their role in the Concept Paper. However, an applicant may submit more than one concept paper for this RFP (by submitting one Concept Paper per AOI). While you can submit multiple applications, each application must be unique/different. We discourage nuanced applications that are the same proposal with slight changes in the scope and submitting the same proposal but with a different lead and/or team member. If multiple white papers from the same applicant are encouraged, then the same applicant can submit multiple full proposals. Applicants must have a white paper encouraged to be eligible to submit a full proposal.

NAWI is not requiring teams to have a specific partnering structure but envisions that successful projects will include collaborations among/between industry, academia, national laboratories, trade associations, and other stakeholders that can advance NAWI-relevant technologies. The Hub strongly encourages teaming as an effective strategy for the successful advancement of NAWI-relevant technologies. Teams with access to adjacent supply chain technologies, vital technical expertise, or unique facilities can accelerate technology development, build long-lasting partnerships, and strengthen the NAWI ecosystem.

1.4 Technical Justification for the RFP Subjecta

The strategic goal of NAWI is to conduct early-stage applied research leading to a portfolio of technologies that enable pipe parity for 90% of nontraditional water sources. A nontraditional water supply achieves pipe parity when the key metrics (i.e., cost/energy intensity/failure rate/etc.) of supplying water from the nontraditional source is equivalent to that of the next available traditional source. Technologies that facilitate fit-for-purpose treatment and local reuse of nontraditional waters will be essential to meeting these pipe parity goals.

Roadmapping was conducted for each of the PRIMA waters, which identified technical knowledge gaps, research priorities, and specific research Areas of Interest (AOI) across all the Challenge Areas. NAWI intends to release an RFP that focuses on funding two of the six Challenge Areas: Autonomous Water and Precision Separations. The objective of NAWI's Autonomous Water Challenge Area is to develop sensor networks and adaptive process control for efficient, resilient, and secure water desalination treatment systems. The objective of the Precision Separation Challenge Area is to develop flexible platform technologies that remove (and/or recover) target compounds from one or more priority classes of contaminants (oxyanions, nutrients, metals, and organics) and from at least one of five "PRIMA" water end-use sectors: power, resource extraction, industrial, municipal, and agricultural.

1.5 Autonomous Water Challenge Area and Area of Interest

1.5.1 Overview of Autonomous Water Challenge

The objective of NAWI's Autonomous Water Challenge Area is to develop sensor networks and adaptive process control for efficient, resilient, and secure water desalination treatment systems.

In most situations, water desalination treatment systems require human intervention (i.e., decisions made by operators) to adapt to variations in water quality, effects of component degradation, to initiate and complete cleaning and other maintenance cycles, and to correct operational failures. Coupling advanced sensing and control networks with models that account for interdependencies between unit processes will facilitate the deployment of a network of autonomous, distributed water desalination treatment systems. The innovations required to create such systems could also improve the performance of centralized desalination treatment systems by enhancing process efficiency and reliability while simultaneously reducing the number of trained personnel needed on-site to maintain and operate desalination treatment systems. Together, these innovations could significantly lower the cost of both centralized and distributed desalination systems.

Although there has been considerable progress in the development of simple sensor and actuator systems for individual water desalination treatment processes, numerous early-stage applied research challenges remain before integrated autonomous systems can reach their full potential. For example, existing SCADA systems that control desalination treatment systems are often unable to access data collected in pre-treatment modules or data from grab samples collected by treatment plant operators. To realize the promise of the digital twin approach, a standardized and generalizable platform that can be used to manage data and assure that control systems are secure against manipulation by unauthorized users is needed. This platform will enable researchers to access large amounts of data from operating water desalination treatment trains in a manner that allows them to create robust process models capable of taking advantage of the power of information technology. By making large amounts of temporally resolved data from operating desalination treatment plants available, researchers will be able to test new approaches for detecting process upsets and operating interdependent water treatment processes in a more efficient and robust manner. Finally, substantial improvements in addressing data sparsity or drift through improvements in fault detection and self-calibration or improvements in sensor systems will further improve the performance and reduce the cost of autonomous water desalination treatment systems. By taking advantage of the latest developments in sensor design and data processing and analysis, it will be possible to lower the cost of collecting data, which will provide a basis for continuously adjusting processes to make them more robust and cost-effective.

To pursue these objectives, NAWI's Master Roadmap articulates a research vision across four Areas of Interest (AOI)¹ for Autonomous Water. The present RFP will fund work in AOI A-3, Predictive Algorithms for Process Control and Fault Detection, but projects will be expected to synergize with the effort and output across all four AOIs. Proposals that include scope that focuses on other AOIs (beyond synergistic activities) **will not be considered for funding**.

¹ The Master Roadmap was synthesized from the NAWI PRIMA Roadmap Publications, which can be found at <http://www.nawihub.org/roadmaps>. Note, the Master Roadmap has not yet been released, but a draft version is available.

AOI A-1: Uniform metadata schema for water treatment trains: By adopting standardized metadata schema it will be possible to rapidly deploy advanced analytics and controls platforms that access all of the information being collected at water desalination treatment facilities. Identification of such metadata will require the development of a data library and an informatics platform.

AOI A-2: Water treatment data library: The creation of an accessible data stream consisting of sensor and process operation data from approximately 20 full-scale desalination treatment trains will provide a testing platform against which researchers can evaluate the potential for robust water treatment analytics to improve the overall efficacy of desalination processes.

AOI A-3: Predictive algorithms for process control and fault detection: With the assistance of the aforementioned data stream, researchers can generate and evaluate algorithms that optimize process control settings, cleaning and maintenance intervals, prevent process upsets, optimize sensor placement and predict process performance under a range of conditions. This AOI encompasses two themes: A) Process analytics and modeling and B) Process control and fault detection.

AOI A-4: Extend capabilities of deployable sensors: Fundamental advances including the development of more robust sensors, lower-cost sensing platforms, vibrational and other non-immersed sensors, and better communication capabilities can reduce the costs of collecting data under the conditions encountered in water desalination treatment systems.

1.5.2 State-of-the-art and Technical Justification for Research in Predictive Algorithms for Process Control and Fault Detection:

The state-of-the-art in water desalination treatment plant automation is rudimentary compared to many other industrial sectors where robotics and automation are more firmly entrenched. The overarching issues in this sector are:

- (i) Substantive reliance on legacy operational technology (OT) and little to no proliferation of modern information technology (IT) in these plants. Many of these assets are currently operated under the principle of air-gaps and strict firewalls between the OT and corporate IT layers, which implies that the OT layer cannot be easily accessed remotely through the internet or other means. Cybersecurity protocols govern most public utilities as these are critical infrastructures.
- (ii) Water quality and process variable (and cleaning and maintenance requirements) are often addressed by operators in a subjective manner (for instance: color, odor, foam, floc character), inline water quality analysis can be unreliable and sometimes disregarded, laboratory data are infrequent, and many quantitative analytical laboratory results lag or fail to capture process dynamics.
- (iii) Interoperability and transparency between consecutive treatment steps and trains are often missing, resulting in a poor global view of the plant's health and operational fitness.

Today's water desalination facilities fall on a spectrum of OT and IT integration. On one end of the spectrum are facilities with either fixed or limited control features and programming embedded at the remote terminal level associated with different unit operations or processes (such as in programmable logic controllers utilizing ladder logic or similar programming techniques). These

types of plants primarily utilize humans in the loop to control the process. Both types of plants need to be considered and addressed.

On the other end of the spectrum are modern reverse osmosis (RO) facilities that deploy controllers featuring a supervisory control and data acquisition (SCADA) layer that can leverage integrated sensors, programmable drive controllers (VFD/VCD), advanced human-machine interfaces, data historians, and model-based control concepts. While the core RO unit operations are often comprehensively automated, they may not be integrated with the intake and pre-treatment steps. As a result, challenges caused by influent water quality excursions can cascade downstream to the RO units with little to no advance warning to the operators and result in significant constraints and challenges for the operators.

Regardless of where desalination treatment systems fall on this spectrum, the motivation is to develop automation technologies that allow these plants to achieve a level of process intelligence that transcends individual unit operations. In short, while today's water treatment control systems typically operate in open-loop configurations that rely on plant operator heuristics to regulate process variables and determine cleaning and maintenance intervals, next-generation closed-loop systems will rely on sensors for continuous monitoring, models that relate process variables to sensed outputs across the full desalination treatment train, and a variety of classical and modern controls techniques. The goal of the Predictive Algorithms for Process Control and Fault Detection Area of Interest is to foster, focus, and deploy applied research targeting next-generation automation frameworks for water desalination plants; both to improve operational performance and efficiency and to optimizing maintenance activities such as clean-in-place (CIPs), backwashes, and preventative maintenance. This includes advances in both data analytics and process control schema.

These early-stage applied research projects should contribute to realizing "smart" desalination plants that autonomously operate with minimal human intervention, anticipate and detect faults in plant components, predict and identify excursions in influent water quality, and assist operators to dynamically optimize the efficiency, reliability, and productivity of these plants. This will be achieved through the combination of continuous monitoring, autonomous intervention, as well as timely and insightful decision support for the plant operators. Furthermore, as the existing or legacy plants cannot be immediately discarded and replaced by such smart plants, it is envisioned that most of these solutions will be initially deployed as a retrofit or additive solutions to existing plants and assets.

1.5.3 Priority Area of Interest for this RFP:

This RFP will support project scope in both AOI A-3 themes: A) Process analytics and modeling and B) Process control and fault detection. Proposals may address one or both themes, but all proposals should demonstrate the potential for substantive impact on pipe parity metrics for water desalination treatment facilities.

1.5.3.1 Process Analytics and Modeling:

The development of efficient mathematical models will be critical to enabling model predictive control (MPC) and alternative advanced controls methods. These advanced process analytics and modeling approaches can either be physics-based or black-box (leveraging machine learning and artificial intelligence) that abstract and simplify the dynamic behavior of the plant. Models are often based on sensor temporal data are not precise realizations of the physical plant, but rather

approximations subject to sensor calibration, drift, aging, and operational errors. Given these limitations in both model and sensor inputs, the fidelity of the model predictive control depends on the continuous, synergistic cross-validation of models and sensor data streams. Ultimately, accurate, robust, and replicable models will be deployed for real-time parameter estimation and integration with control schema for a broad range of water desalination treatment processes and plants.

Proposals with scope in this theme are expected to address one or more of the following research questions as part of this AOI:

- What are the most appropriate data analytics methods, tools, and systems that (a) are applicable for one specific water treatment processes; (b) are generalizable across a broad range of water treatment processes; (c) are generalizable across a broad range of complete desalination treatment trains and scales to enable on-site and/or remote process monitoring, including assessment of process efficiency, incipient upset identification, identification of changes necessitating process control adaptation?
- Process irregularity/inconsistency and sensor errors are common in many water desalination treatment applications. Can analytics approaches be automatically and dynamically adjusted to consider significant and unforeseeable variations in (a) system inputs (e.g., water availability/demand, water source quality, weather) and (b) system behavior while maintaining accurate and reliable predictions without frequent tuning by analytics or application domain experts?
- How does the lack of real-time measurements for key variables (e.g., a lack of real-time quantitative water composition data or lack of reliable water availability and water quality predictions) affect the choice, tuning, and implementation of analytics methods that attempt to characterize treatment performance, either qualitatively or quantitatively?
- How can data from disparate sources (e.g., grab samples, composite samples, and online sensors; data silos) effectively be integrated or fused in a frictionless fashion to improve the effectiveness of automated process monitoring analytics, considering that every water desalination treatment facility is unique in aspects of design, build, location, operation, and regulatory oversight?
- What is the expected improvement in treatment performance if variations that are currently considered unpredictable or measurable in practice can be predicted using data analytical methods (e.g., water availability/demand, water source quality, weather, system behavior), how accurate or reliable should these predictions be, and what kind of data analytical tool can deliver the demanded accuracy or reliability?
- What kind of process-, plant- or domain-specific knowledge is critical to obtain accurate and/or reliable predictive performance in the context of the above questions? What kind of process-, plant- or domain-specific information can be learned from online data sources, thus eliminating the largely manual and tedious task of knowledge representation?

There are several approaches to process modeling and estimation, and responses should consider a variety of approaches as appropriate for the plant being modeled and, ultimately, controlled.

A) Physics-based models where parameters are estimated in real-time or near real-time based on acquired data, and historical trends/information. Example of physics-based approaches include:

1. Basic statistical modeling in support of control via standard control chart techniques.
 2. Classical approaches that use time-invariant statistically optimal techniques such as maximum likelihood estimators (*e.g.*, Wiener Filters or Kalman Filters).
- B) Other techniques such as machine learning / artificial intelligence (ML/AI), or so-called black-box approaches, that map inputs to outputs for either parameter estimation or model development. Model development based on data taken from sensors as well as other historical data could encompass:
1. AI/ML as well as classical models based on statistics and optimal/maximum likelihood estimation.
 2. Cloud, fog, and edge modeling techniques. Edge operations are related to modeling at the edge, and cloud operations are related to modeling in the cloud. Fog operations require initial cloud operations to develop the model and then edge operations to utilize real-time data for model refinement.
 3. Continuous model validation ensuring model validity. Nominally, this relates to more sudden or catastrophic changes in the system (including sensor failure) where the model no longer accurately represents the physical system.
 4. Transfer learning concepts to extend models from specific or targeted systems, to a broader range or class of systems.

1.5.3.2 Process Control and Fault Detection:

Autonomously controlled water desalination treatment systems are particularly well suited for responding to variable water quality, especially during the period when desalination treatment trains are first deployed or when source water quality fluctuates in an unanticipated manner. Although many water desalination treatment systems are outfitted with arrays of sensors, their application is primarily focused on detecting system failures. NAWI seeks research that shifts the paradigm for data use in water treatment systems from one of preventative monitoring and regimented cleaning and maintenance to adaptive control and optimized cleaning and maintenance.

Research in this theme could focus on any or all three distinct applications of process control at water desalination treatment facilities:

- 1) Real-time, data-driven tools that optimize process control settings for improved desalination treatment train performance (*e.g.*, reducing the cost or energy needs of desalination treatment processes by continuously adjusting settings) and adaptability to variable influent composition or required treated water quality;
- 2) Methods for early detection, attribution, and correction of system faults (*e.g.*, sensor drift; cyber-attacks, upset recovery); and,
- 3) Methods to assess model predictive ability, robustness, interpretability, and interoperability across desalination treatment trains to reduce the need for extended calibration and training periods. Researchers are encouraged to develop and test algorithms for a variety of water desalination treatment trains and operating modes (*e.g.*, intermittent operation) of relevance to NAWI's vision of autonomous, distributed treatment systems.

Within these application area(s), proposals are expected to address one or more of the following research questions:

- What controls and autonomous process optimization approaches are most reliable, effective, and facile to implement at representative desalination facilities?
- What are the most cost-effective strategies for mitigating the effects of sensor errors, drift, fouling, etc., on controls schema performance?
- Are preferred controls approaches a function of system size, installed desalination treatment trains, operational mode (e.g., steady-state; non-steady-state), etc.?
- What are the optimal or improved sensing configurations for representative water treatment processes that enable controls approaches that optimize performance?
- Are the hardware shortcomings in water desalination treatment systems or data availability limitations that prevent implementation of various control schema?
- What level of autonomy can be achieved at what cost? Do cost and energy savings from sensing and controls schema exceed these costs?

Improved closed-loop control approaches are likely to include one or more of the following, and proposers should rationalize and clearly benchmark their proposed approach relative to other methods and the present state-of-the-art:

1. Classical approaches (e.g., PID).
2. Classical statistical control (e.g., control charts)
3. Model-based control.
4. Optimal control.
5. Adaptive control.
6. ML/AI-based control.
7. Hybrid control architectures based on a combination of the forementioned approaches.

Hierarchical controls should also be considered based on desired overall system performance and response.

1.5.4 Impact Evaluation Criteria for AOI-A3:

The same NAWI impact evaluation criteria will apply to both themes (Process Analytics and Modeling and Process Control and Fault Detection) described above. The specific Concept Paper evaluation review criteria is provided in Section 6.1, and the Concept Paper Technical Narrative Requirements is provided in Appendix A. Full Paper review criteria and Narrative Requirements are provided in Sections 6.2 and Appendix B, respectively. Proposed research should offer a clear pathway toward achieving one or more of the following technical targets if implemented in an operational facility.

1. Demonstrate effective implementation of control algorithms to reduce OpEx by >20%,
2. Reduce of energy use by >10%,
3. Reduce regular maintenance and cleaning cycle costs by 50%, and increase uptime by 50% over long durations and several operational “challenge” conditions (e.g., changing influent water conditions, degradation of component performance, or sensor quality issues such as drift, fouling, etc.)

1.5.5 Additional Guidance for AOI-A3:

The goal of NAWI is to enable rapid translation of the proposed research ideas to real-world desalination plants. Therefore, it is preferable that the project proponents ensure (or at least consider) that any research idea conforms to current industrial automation and cybersecurity standards applied in critical utilities - for instance, adhere to NIST [Guide to Industrial Control Systems \(ICS\) Security \(nist.gov\)](https://nist.gov/publications/detail/guide-to-industrial-control-systems-ics-security/2015/11) and/or ISO/IEC 27000 cybersecurity frameworks for industrial control systems.

The performance of the different data analytics and control approaches should be quantitatively and qualitatively compared on the basis of their ability to address classical accuracy, disturbance, noise and modeling error rejection/robustness issues; ease of deployment; and cost of deployment. The resulting pipe parity benefits are easiest to quantify for actual facilities and deployments and proposers are encouraged to partner with operating facilities and systems (NAWI has lists of participating facilities). Examples include the prevention of plant shutdown by predictive control, optimized control and improved energy efficiency, and decreases in the time that plants are out of compliance or shut down for maintenance.

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1.6 Precision Separations Challenge Area and Area of Interest

1.6.1 Overview of the Precision Separations Challenge Area

The term *precision separations* refers to processes that, by design, efficiently and selectively remove targeted species from an aqueous stream. For present purposes, these processes also include transformations that upgrade or destroy the contaminant by changing its form or chemical composition.

Many water desalination treatment systems rely on inefficient bulk separation processes (e.g., pressure-driven membranes) to remove solutes that occur at trace levels. Although they are effective, they increase the cost, energy intensity, or size of desalination treatment plants and can create a waste management problem by also removing other solutes. A more targeted approach to trace contaminant removal has the potential to reduce the cost and energy intensity of desalination treatment processes while simultaneously reducing system complexity and waste management costs.

Precision separation also enhances the likelihood of profitable recovery and valorization of brines, thereby offsetting the overall costs of desalination systems. Chemical transformation (e.g., converting to a more easily recoverable or fully benign form, upgrading to a more valuable form, etc.) is more efficient when precisely directed toward contaminants of concern. For example, chemical oxidation (i.e., advanced oxidation processes) is effective in mineralizing organic contaminants (e.g., 1,4-dioxane) that inhibit water reuse, but the non-selective nature of the hydroxyl radical—the main oxidant employed in these processes—greatly reduces the efficiency of this approach when it is used to treat water with high concentrations of organic matter, bicarbonate or other radical sinks. In contrast, solvated electrons produced from water radiolysis or by photolysis of precursors like sulfite can selectively reduce recalcitrant contaminants like PFAS in the presence of other solutes. Unfortunately, current approaches require the removal of dissolved oxygen prior to treatment. Although they offer great potential, selective reduction of trace contaminants is not widely used in water treatment because of the energy intensity and cost of current removal processes.

To address these technical challenges and fill in knowledge gaps, NAWI plans to fund early-stage applied research that addresses AOI P-1: Trace Contaminant Separation or Transformation. This AOI focuses on the removal (and/or recovery) of target compounds from one or more priority classes of contaminants (*oxyanions, nutrients, metals, and organics*) and from at least one of five PRIMA, water end-use sectors: *power, resource extraction, industrial, municipal, and agricultural*.² Note that priority classes of contaminants are often problematic in multiple end-use sectors, as indicated in Table 1. By developing novel approaches for the removal (and possible recovery) of these constituent classes, pipe parity can be advanced by reducing the complexity of desalination treatment trains and increasing the potential for valorization of wastes.

Within these general contaminants classes, different industries, source waters, and end-use applications require removal of specific contaminants of concern. Recognizing this fact, NAWI seeks precision separations platforms with the greatest flexibility for selective removal within a contaminant class and within a range of complex source water compositions.

² Priority classes of contaminants were identified as part of the NAWI Roadmapping process. See the NAWI PRIMA Roadmap Publications at www.nawihub.org.

Table 1: Priority classes of contaminants occurrence in the five PRIMA water sectors. Examples of target compounds are provided in parentheses.

Sector	Oxyanions (Se, B)	Nutrients (PO_4^{3-} , NO_3^- , NH_4^+)	Metals (Pb, Cu, Cd, NORM, Ca^{+2} , Mg^{+2} , etc.)	Organics (PFAS, hydrocarbons, natural organic matter, etc.)
Power	X	X	X	X
Resource Extraction	X		X	
Industrial	X	X	X	X
Municipal	X	X	X	X
Agriculture	X	X	X	X

1.6.2 State-of-the-Art and Technical Justification for Research in Precision Separations

NAWI Roadmapping, baselining, and analysis has identified four priority classes of contaminants for which precision separations would enhance the economic viability and energy efficiency of non-traditional water reuse across multiple sectors.

1. **Oxyanions.** The primary oxyanions of interest are selenium (selenate and selenite), borate, and silicate. Other important oxyanions include chromate, arsenate, and sulfate. Phosphate and nitrate are separately classified as nutrients (see below). Borate at environmental pH exists as charge-neutral boric acid, which transports through RO membranes and thereby impacts municipal water supply and agricultural reuse. Selenium oxyanions (as well as silicate and nitrate) build up in power plant recycle waters, requiring treatment before discharge. Both boron and selenium may contaminate irrigation waters and agricultural drainage with implications for environmental health. Silicate also poses challenges for zero liquid discharge applications. Competing bulk ions such as sulfate, carbonate, and phosphate may be expected to pose difficult chemical challenges for precision separations of such trace contaminants. Some potential methods applicable to oxyanions include reduction (e.g., Se(VI) to Se(IV) or Se), ion exchange, electrodialysis, precipitation/crystallization, bio sorbents (which can also transform), and biological reduction.

Priority will be given to proposals addressing: 1) borate, such as the development of an economically viable, single-stage boron-removal process that obviates the need for multi-stage membrane or post-treatment processes and, 2) selenium, such as the development of an economically viable process train that meets selenium discharge requirements through selective reduction in the presence of competing ions (e.g., sulfate, nitrate, chloride) without generating toxic organo-selenium species.

2. **Nutrients.** Nutrient contaminants are constituents that promote harmful eutrophication in surface waters, the most important being phosphate, nitrate, and ammonium ions. Phosphate has the broadest impact, being felt in the agricultural and power sectors. Nitrate, as a common

groundwater constituent, also poses a human health concern for drinking water. For phosphate, struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) precipitation has gained use but the success of the predominant approaches are affected by temperature, pH, reagent types and their dosages, and the presence of competitive ions.³ Struvite precipitation has been commercially implemented; however, struvite precipitation is limited by the P concentration in wastewater (typically 6-10 mg/L in municipal wastewater, and up to 60 mg/L in digested sludge supernatant), and by purity. During struvite precipitation, toxic heavy metals and organic contaminants in wastewater may also co-precipitate or adsorb to struvite, compromising the quality of fertilizer for safe agricultural uses.

Priority will be given to selective phosphorus recovery technologies, especially technologies that recover phosphorus in a form that is amenable to reuse and/or valorization (such as struvite).

3. **Metals.** Primary metals of interest include lead, copper, and cadmium. Other metals of interest include iron, manganese, mercury, and NORM. Such metals can exceed discharge limits in power-plant cooling water and require treatment. They also can limit available reuse, end-use, and disposal options for industrial waste streams. Large volumes of metal-contaminated waters from mining are highly toxic. Treatment technologies can involve, for example, ion exchange, adsorbents, membranes, precipitation/crystallization, and electrochemical methods.
4. **Organics.** The class of organic contaminants includes various materials with diverse implications for desalination system performance and associated treatment strategies. Priority organics for drinking water treatment applications include PFAS and toxic, neutral, low-molecular-weight compounds (e.g., NDMA, 1,4-dioxane). Many of these contaminants pass through RO membranes, requiring energy-intensive post-treatment. Other organics of interest complicate the adoption of membrane-based treatment trains, including soluble organics, lignan-derived compounds, proteins, oils, and greases. Separation may not be sufficient, but rather tandem concentration/destruction may be the most successful approach in many cases. A variety of past efforts have deployed bio-based treatment, biosorbents, modified carbonaceous sorbent materials, engineered adsorbents, membranes, and nanofiltration. Other destruction-based approaches that have been previously deployed include electrocatalysis, advanced oxidation, photolysis, plasma, and bio methods.

Priority will be given to proposals that focus on the selective removal of per- and poly-fluoroalkyl substances (PFAS) and/or trace organics that pose special concerns for the integrity of membrane-based desalination systems (e.g., 1,4-dioxane, acetone, TCE, BTEX).

1.6.3 Priority Area of Interest for Precision Separation

Precision separation of trace constituents during water treatment may provide substantial cost and energy savings for desalination systems by avoiding energy-intensive bulk separations, reducing the size and complexity of the treatment train, reducing the cost of managing residual wastes, or valorizing recovered materials. NAWI seeks novel precision separations platforms for removing

³ For a more complete assessment of struvite precipitation approaches, see: <https://doi.org/10.3390/su12187538>

or recovering trace contaminants that inhibit further treatment or reuse. Successful proposals shall demonstrably improve on one or more pipe-parity metrics relative to status quo technologies without seriously compromising other pipe-parity metrics. Approaches exhibiting small footprints, fast kinetics, and process stability in the face of variable water quality are particularly attractive because they may be well suited for distributed treatment trains. Additional background regarding specific constituents of interest and current technological barriers for precision separations technologies can be found in Appendix D.

More specifically, NAWI is seeking to fund research developing precision separation platforms that:

1. Target contaminants within at least one of four priority classes of contaminants: *oxyanions*, *nutrients*, *metals*, and *organics* (detailed description above). Note that proposals that address priority classes of contaminants/end-use water sectors outside of this list will only be considered if they present a sufficiently strong case for game-changing impact;
2. Apply to contaminant problems in at least one of five PRIMA water end-use sectors (*power*, *resource extraction*, *industrial*, *municipal*, and *agricultural*);
3. Are adaptable and are not one-off sorbents/solutes for a niche application;
4. Demonstrate substantive improvements over state-of-the-art approaches across multiple pipe parity metrics relative to status quo technologies without seriously compromising other pipe-parity metrics; and

Are focused on material development or process improvements that advance a separations platform from technology readiness level 2 (technology concept and/or application formulated) to technology readiness level 4 (component and/or system validation in a laboratory environment). Computational modeling is encouraged to support material and process design and function, but projects featuring modeling alone must make clear how the resulting understanding would solve a critical problem toward obtaining a game-changing precision separation platform. Presumably, such a solution would be followed by experimental validation in a functional laboratory system that enables estimates of process economics.

In addition, a portion of the project budget (up to \$25K) must be dedicated to performing a detailed techno-economic analysis (TEA) of the proposed concept that quantitatively establishes technical targets for the proposed project. The TEA must include both up- and downstream impacts, which are expected to reflect the pipe parity benefits relative to state-of-the-art separation approaches. Furthermore, separation unit operations must not incur greater net costs in other parts of the treatment system. TEAs should be comparative, showing how the proposed technology could be superior to current industry practice and other technologies currently under development.

1.6.4 Impact Evaluation Criteria for AOI P-1

A strong proposal would propose process and materials separation platforms that demonstrate the potential for substantive improvements over state-of-the-art approaches and across multiple pipe parity metrics. Strong proposals would not only consider pipe parity metrics with respect to their material or process in comparison to state-of-the-art processes but would also consider systemic impacts on these metrics with respect to the impact on other unit operations within the treatment train.

The specific Concept Paper evaluation review criteria is provided in Section 6.1, and the Concept Paper Technical Narrative Requirements is provided in Appendix A. Full Paper review criteria and Narrative Requirements are provided in Sections 6.2 and Appendix B, respectively.

2 Eligibility

A single person or individual is eligible to apply; however, the preference is to team on a project.

A person/performer participating may only participate on one Concept Paper per AOI regardless of their role in the Concept Paper. However, an applicant may submit more than one concept paper for this RFP (by submitting one Concept Paper per AOI). While you can submit multiple applications, each application must be unique/different. We discourage nuanced applications that are the same proposal with slight changes in the scope and submitting the same proposal but with a different lead and/or team member. If multiple white papers from the same applicant are encouraged, then the same applicant can submit multiple full proposals. Applicants must have a white paper encouraged to be eligible to submit a full proposal.

DOE/NNSA federally funded research and development centers (FFRDC)/National Labs can apply to the NAWI funding opportunity as a *lead* applicant and as a partner. If an FFRDC is part of a Full Proposal selected for negotiations, the FFRDC will not respond to the Subcontract Business Management Volume linked in Section 7.7.

Alliance membership is not required to lead or to be part of a team that submits a Concept Paper or Full Proposal. If a Full Proposal is selected for award negotiations, all organizations that are part of the project would then be required to join the [NAWI Alliance](#). Alliance membership is free.

If a foreign entity is part of a project that is selected for negotiations, foreign entities must complete the foreign entity participation waiver request and be approved by DOE to join the NAWI Alliance and the NAWI Research Consortium. Please refer to Sections 8.1 - 8.3 of this RFP. The paperwork and approval will occur after a Full Proposal is selected for award negotiations.

3 NAWI Exchange Registration Requirements

There are several one-time actions that must be completed before submitting an application in response to this solicitation, which are as follows:

Register and create an account on NAWI Exchange at [<https://nawi.infoready4.com/>]. Each organization or business unit, whether acting as a team or a single entity, should only use one account as the point of contact for each application submission. Each project should have one lead organization that is responsible for starting and submitting a Concept Paper and, if encouraged, a Full Proposal through NAWI Exchange. The lead organization can have their partners serve as Proxies in NAWI Exchange to assist with completing the required information. Each NAWI Exchange account/user can submit multiple Concept Papers. Each project team/organization should determine who will take the lead in starting and submitting an application. If one organization has several individuals that will submit multiple concept papers, that organization can decide if one person/account is responsible for starting and submitting all Concept Papers or if multiple people/accounts will submit their own Concept Paper.

- Applicants should not wait until the last minute to begin the submission process. During the final hours before the submission deadline, applicants may experience server/connection congestion that prevents them from completing the necessary steps in the NAWI Exchange to submit their applications.
- Submission of an application and supplemental information under this solicitation through electronic systems used by this solicitation, including NAWI Exchange, constitutes the authorized representative's approval and electronic signature.

- Once the Concept Paper or Full Proposal is submitted in NAWI Exchange, applicants may revise or update that submission until the expiration of the deadline. To make changes to a submitted Concept Paper or Full Proposal, an applicant must request the application be returned by sending a request to NAWI-RFP@lbl.gov. If changes are made to the Concept Paper or Full Proposal, the applicant must resubmit using NAWI Exchange before the applicable deadline.
- In order to save draft/preliminary information prior to submission, make sure you click "Save as Draft" at the bottom. Then the next time you log in, you can access the draft application from the Applications tab.
- Each project team/organization should determine who will take the lead in starting and submitting an application. If Person C creates an account, make sure the "Applicant First Name" and "Applicant Last Name" and "Email Address" for the Technical Point of Contact are correct. You may need to delete the autofill with Person C's information and correct it to reflect Person A's information. Only one account can be technically associated with the submission, though as many Proxies as you need can contribute. Whoever initially clicks the "Apply" button to start the submission should make sure any other contributors are added as a Proxy for their account by going to their profile in the upper right corner (next to "Hello") and adding the appropriate Proxies' email addresses.

3.1 NAWI Exchange Proxies

There can only be one main applicant, but that applicant should use the Proxy functionality to add co-applicants if you want those users to be able to view the application. This link contains articles for Proxy help: <https://infoready.freshdesk.com/support/solutions/folders/14000121852>

The person you are applying on behalf of will receive an email confirmation of the submission.

You can add Proxies from your user profile.

Once added to your user profile, the Proxies can then access the draft by logging in, going to the opportunity, and selecting the main applicant from their "Apply as Proxy" menu. They can then view and make changes (if needed). They can then save as a draft or submit.

If the user you are a Proxy for previously started a draft application, or if you saved a draft application previously on their behalf, follow the steps below to return to the draft.

If you started the application, the steps are the same. The only difference is that the application title will appear next to the applicant's name in the dropdown (see #3 below).

Steps to Access a Draft Application as a Proxy

1. Go to the competition/opportunity. You will most likely access this from the homepage of the site or via a direct link.
2. Click the Apply as Proxy button from the local menu on the right side of the screen.
3. From the dropdown in the Proxy section, select the name of the applicant for whom you are submitting an application.
4. If only one application is allowed for the competition, the draft application will then appear in the fields, and you can continue making edits.
5. If more than one application is allowed for the competition, select the appropriate draft application title or New Application to begin a brand-new application (shown below).

6. Fill out the application form as you normally would.
7. Save or submit the application as needed.
8. You will see confirmation of the submission on the screen and the applicant.

If you are a Proxy but are not inputting initial data for this PI, go to ***Select Application:** and select from the dropdown options, the application one wants to view.

Questions related to the use of NAWI Exchange website should be submitted to NAWI-RFP@lbl.gov.

Applicants are encouraged to review the posted questions and answers daily. Please be as specific as possible when asking questions to ensure that questions will be adequately addressed. Failure to be specific may result in additional time to address the question or require further correspondence for further clarification regarding the submitted question(s).

All questions and answers related to this solicitation will be posted at <https://nawi.infoready4.com/>. The NAWI will respond to questions within three business days, unless a similar question and answer have already been posted on www.NAWI.infoready4.com.

4 Cost Sharing

The cost share must be at least 25% of the total project costs. Cost share must be calculated based on the total allowable costs for the applicable entity and must come from non-Federal sources unless otherwise allowed by law. (See 2 CFR Part 200 for the applicable cost sharing requirements.)

All proposals must meet the required 25% cost share. Proposals that exceed the required cost share will review more favorably.

The Lead Organization is solely responsible for managing cost share contributions by the project team and enforcing cost share obligation assumed by Participating Organizations.

The project as a whole is responsible for meeting the cost-share requirement. Any partner that provides cost share to the project would count towards the overall project cost share.

4.1 How Cost Sharing is Calculated

As stated above, cost sharing is calculated as a percentage of the Total Project Cost. Following is an example of how to calculate cost sharing amounts for a project with \$1,000,000 in federal funds with a minimum 25% non-federal cost sharing requirement:

Formula: Federal share (\$) divided by Federal share (%) = Total Project Cost

Example: \$1,000,000 divided by 75% = \$1,333,333

Formula: Total Project Cost (\$) minus Federal share (\$) = Non-federal share (\$)

Example: \$1,333,333 minus \$1,000,000 = \$333,333

Formula: Non-federal share (\$) divided by Total Project Cost (\$) = Non-federal share (%)

Example: \$333,333 divided by \$1,333,333 = 25%

4.2 Cost Share Allocation

Each Project Team is free to determine how much each organization will contribute towards the cost share requirement. The amount contributed by an individual Organization may vary, as long as the cost share requirement for the project as a whole is met.

4.3 Cost Share Types and Allowability

Every cost share contribution must be allowable under the applicable Federal cost principles.

Project teams may provide cost share in the form of cash or in-kind contributions. Any partial donation of goods or services is considered a discount and is not allowable.

Cash contributions include, but are not limited to personnel costs, fringe costs, supplies and equipment costs, indirect costs, and other direct costs.

In-kind contributions are those where a value of the contribution can be readily determined, verified and justified but where no actual cash is transacted in securing the goods or services comprising the contribution. Allowable in-kind contributions include but are not limited to the donation of volunteer time, the donation of space, or use of equipment.

Project teams may use funding or property received from state or local governments to meet the cost share requirement, so long as the funding was not provided to the state or local government by the federal government.

The Recipient may not use the following sources to meet its cost share obligations, including, but not limited to:

- Revenues or royalties from the prospective operation of an activity beyond the project period;
- Proceeds from the prospective sale of an asset of an activity;
- Federal funding or property (e.g., federal grants, equipment owned by the federal government); or
- Expenditures that were reimbursed under a separate federal program.

Project teams may not use the same cash or in-kind contributions to meet cost share requirements for more than one project or program.

Cost share contributions must be specified in the project budget, verifiable from the organization's records, and necessary and reasonable for proper and efficient accomplishment of the project. As all sources of cost share are considered part of the total project cost, the cost share dollars will be scrutinized under the same federal regulations as federal dollars to the project. Every cost share contribution must be reviewed and approved in advance and incorporated into the project budget before the expenditures are incurred.

Because FFRDCs are funded by the Federal Government, costs incurred by FFRDCs generally may not be used to meet the cost share requirement. FFRDCs may contribute cost share only if the contributions are paid directly from the contractor's Management Fee or another non-Federal source. The cost share must be at least 25% of the total project costs including FFRDC costs.

The cost share partner does not have to be firmly established at the time of the concept paper but must be firmly in place at the time of the full proposal. We strongly encourage applicants to be in discussions with potential cost share partners prior to concept paper submittal. Note, the criteria

for rating concept papers are shown in the InfoReady/NAWI Exchange.

The Period of Performance for a proposed project is up to 36 months (split into 12-month budget periods). Cost share should be costed during the period of performance of the proposed research.

4.4 Cost Share Verification Commitment Letters

Cost share must be verified with a cost share commitment letter upon submission of the Full Proposal. Upon selection for award negotiations, applicants may be required to provide additional information and documentation regarding their cost share contributions.

5 Application and Submission Information

5.1 Application Process

The application process will include two phases: A Concept Paper phase and a Full Proposal phase.

Only applicants who have submitted an eligible Concept Paper and are encouraged to submit a Full Proposal will be eligible to submit a Full Proposal. Discouraged Concept Papers are not eligible to submit a full proposal.

All submissions must conform to the form and content requirements, including maximum page lengths, and must be submitted via NAWI Exchange. Acceptance of late submissions will be at NAWI's discretion. NAWI reserves the right to reject any submission, to waive any minor irregularities, or to cancel this RFP at any time prior to award without cost to NAWI. NAWI will not reimburse any firm for preparation costs or any other costs related to the participation in this RFP.

5.2 Pre-Selection Clarification

NAWI may determine that pre-selection clarifications are necessary from one or more applicants. These pre-selection clarifications will solely be for the purposes of clarifying the application and will be limited to information already provided in the application documentation. Information provided by an applicant that is not necessary to address the pre-selection clarification question will not be reviewed or considered. A pre-selection clarification will be carried out through written responses. Estimated timing of pre-selection clarifications, if needed, is identified on page 1 of the RFP.

The information provided by an applicant to NAWI through pre-selection clarifications is incorporated in its application and contributes to the merit review evaluation and NAWI's selection decisions. If NAWI contacts an applicant for pre-selection clarification purposes, it does not signify that the applicant has been selected for negotiation of award or that the applicant is among the top ranked applications. Applicants will have at least five (5) business days to respond.

NAWI will not reimburse applicants for expenses relating to the pre-selection clarifications, nor will these costs be eligible for reimbursement as pre-award costs.

If NAWI determines that revised proposals are necessary, NAWI may solicit them from only those applicants deemed (based upon evaluation of the current submission) to have a reasonable chance to be selected for award. NAWI reserves the right to make no awards, a single award, multiple awards, award a part or portion of a proposal, or reject any and all proposals in whole or in part as a result of this solicitation, if it is in the best interest of NAWI.

5.3 Restriction on Disclosure and Use of Proposal Data

LBNL/NAWI will safeguard any commercial or financial data or information contained in proposals from disclosure, when marked in accordance with paragraph (e) of Federal Acquisition Regulation clause 52.215-1, from dissemination outside LBNL/NAWI or the Government. Such data or information includes (i) trade secrets or (ii) commercial or financial information which is privileged or considered business confidential, either of which is developed at private expense.

LBNL/NAWI will endeavor to properly maintain such data and information to the same degree as its own data and information and not disclose such data or information to individuals other than those involved in the evaluation of the submission or involved with the award negotiations. These individuals will be bound by an obligation of confidentiality to use such data or information solely for the purpose of evaluation of the proposal or negotiating the award. Submission material received will be retained and disposed of in accordance with requirements in LBNL's prime contract with DOE.

5.4 Use of Product or Process with Patent Position

If an applicant intends to use a product or process in which there is a patent position, the proposal should so indicate and list patent applications and/or patents granted (including dates, numbers, and descriptions), and whether the Government has rights related to the patents.

5.5 Submission Format Requirements

The Concept Paper and Full Application must conform to the following requirements:

Each must be submitted in PDF format unless stated otherwise;

Each must be written in English;

All pages must be formatted to fit on 8.5 x 11-inch paper with margins not less than one inch on every side;

Use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures or tables, which may be 10-point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies. Line spacing should not be less than single-spaced.

References must be included as footnotes or endnotes in a font size of 10 or larger. References are NOT counted toward the maximum page requirement.

For Concept Paper and Full Proposal documents, the lead technical point-of contact's last and first name AND the lead organization's name should appear in the upper right corner of the header of every page ("Last Name, First Name; Org"; Example: Smith, Jane; University of State).

Page numbers must be included in the footer of every page.

Each submission must not exceed the specified maximum page limit, including charts, graphs, maps, and photographs, when printed using the formatting requirements set forth above and single-spaced. If applicants exceed the maximum page lengths, NAWI will review only the authorized number of pages and disregard any additional pages.

Applicants are responsible for meeting each submission deadline. Applicants are strongly encouraged to submit their Concept Papers and Full Proposal at least 24 hours in advance of the submission deadline.

All Concept Papers and Full Proposals that pass the eligibility review will undergo comprehensive technical merit review according to the criteria identified in the solicitation.

Note the maximum file size that can be uploaded is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the solicitation, it must be broken into parts and denoted to that effect.

For example:

ApplicationID_LeadOrganization_XXX_Part_1

ApplicationID_LeadOrganization_XXX_Part_2

5.6 Concept Paper, Full Proposal, and Financial Templates

The application forms, templates, and instructions are available at www.NAWI.infoready4.com. Two Appendices to this RFP are also included in NAWI Exchange, Appendix A contains the Technical Narrative outline for a Concept Paper while Appendix B contains the Technical Narrative outline for submission of a Full Proposal.

6 Application Review Information

The evaluation process consists of multiple phases; each includes an initial eligibility review and a thorough technical review. Rigorous technical reviews of eligible submissions are conducted by reviewers that are subject matter experts. Ultimately, the Source Selection Committee considers the recommendations of the reviewers based on their evaluation of the proposal submitted against the evaluation criteria in sections 6.1 and 6.2, along with other considerations such as Other Selection Factors (Section 6.2.2), in determining which applications to select. The following adjectival ratings will be used to rate the evaluation factors:

Superior	10	<ul style="list-style-type: none"> Comprehensively addresses all aspects of criterion Contains significant strengths Has no notable weaknesses Leaves no doubt of applicant's capability to perform the criterion
	9	<ul style="list-style-type: none"> Comprehensively addresses all aspects of criterion Has significant strengths Contains only a few easily corrected weaknesses Strengths far outweigh the weaknesses Leaves no doubt of applicant's capability to perform the criterion
Good	8	<ul style="list-style-type: none"> Addresses all aspects of the criterion Contains only a few easily correctable weaknesses Strengths outweigh the weaknesses Demonstrates applicant's capability to perform the criterion
	7	<ul style="list-style-type: none"> Addresses all aspects of the criterion Contains several correctable weaknesses Strengths outweigh the weaknesses Demonstrates applicant's capability to perform the criterion

Satisfactory	6	<ul style="list-style-type: none"> • Most aspects of the criterion addressed • Strengths slightly outweigh the weaknesses • Applicant will likely be able to perform the criterion
	5	
Marginal	4	<ul style="list-style-type: none"> • Some aspects of the criterion not addressed • Has one or more strengths and weaknesses • Weaknesses outweigh the strengths • Some doubt as to the ability to perform the criterion
	3	
Unsatisfactory	2	<ul style="list-style-type: none"> • Most aspects of the criterion not addressed • Contains significant weaknesses that would require a major revision • Applicant's ability to perform the criterion not demonstrated
	1	

6.1 Concept Papers

Concept papers will be evaluated against the technical criteria described in this RFP. This technical evaluation process will produce a list of encouraged Concept Papers. NAWI will consider the overall evaluation results and other selection factors as listed in section 6.2.2 to select a final set of encouraged Concept Papers to provide a Full Proposal. All criteria and sub-criteria are of equal weight.

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Concept Paper Review Criteria

1. Relevance and Impact:
1.1 To what extent does the proposal align with the Challenge Area and Area(s) of Interest defined in the NAWI RFP? (Section 1.5 for Autonomous Water and Section 1.6 for Precision Separation).
1.2 The current state-of-the-art for the given CA and AOI is clearly described, as well as how the proposed work improves upon state-of-the-art deficiencies.
1.3 The Applicant clearly and explicitly describes how the proposed work improves on one or more pipe parity metrics without significantly compromising other pipe parity metrics.
1.4 The Applicant clearly describes how the proposed work will address major gaps in scientific knowledge and/or significantly advance a water treatment technology approach.
1.5 The current maturity level of the proposed research is in the technology readiness level TRL range of 2 – 4. See Appendix C.

2. Scientific/Technical Merit:
2.1 Does the proposed work explore original concepts or approach critical technical challenges in an original and transformative manner?
2.2 The concept is explained clearly and is technically sound.
2.3 The technical approach is clearly outlined in the concept paper and is likely to achieve the goals of the research.
2.4 For the Autonomous Water AOI only: Proposed research offers a clear pathway toward achieving one or more of the technical targets listed in Section 1.5.4, if implemented in an operational facility.
2.5 For Precision Separation AOI only: The TEA approach is clearly defined and provides a SMART method for assessing project impacts through the duration of the project.

3. Resources:
3.1 The team qualified to conduct the proposed R&D.
3.2 The requested resources adequate for successfully completing the proposed activities.
3.3 There a plausible pathway for commercial partnership and 25% cost share acquisition.
3.4 Does the proposal leverage unique strengths of each team member and include collaborative research (e.g., collaboration between multiple organizations where there is a combination of unique expertise that produces an improved research result)?

6.1.1 Compliance Review of Concept Papers

NAWI will perform a compliance review to determine that (1) the information required by this RFP has been submitted; and (2) all mandatory requirements are satisfied. Only Concept Papers meeting these review criteria will be considered during the Concept Paper scientific/technical review process.

6.1.2 Scientific/Technical Review Criteria of Concept Papers

NAWI will perform a scientific/technical review of Concept Papers based on the review criteria. All applications will be reviewed and evaluated in an encourage/discourage manner on an

individual basis.

6.2 Full Proposal

Multiple peer reviewers will independently evaluate the applications in accordance with the technical review evaluation criteria described in this solicitation. Also, NAWI will complete a program relevancy/priority review process in accordance with the criteria described above. The Source Selection Committee will consider the overall evaluation results and other selection factors as listed in section 6.2.2 to ultimately select proposals for award negotiations.

All Full Proposals submitted will be reviewed by NAWI for 1) compliance and 2) for direct relevancy/priority to NAWI's mission and work scope. Additionally, each application will be evaluated and reviewed for technical merit as described in this solicitation by a panel of reviewers. Review of full applications shall be based on how well the applications meet or exceed the technical evaluation criteria provided below. All criteria and sub-criteria are of equal weight.

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Full Proposal Review Criteria

1. Relevance and Impact:
1.1 To what extent does the proposal align with the Challenge Area and Area(s) of Interest defined in the NAWI RFP? (Section 1.5 for Autonomous Water and Section 1.6 for Precision Separation).
1.2 The current state-of-the-art for the given CA and AOI is clearly described, as well as how the proposed work improves upon state-of-the-art deficiencies.
1.3 The Applicant clearly and explicitly describes how the proposed work improves on one or more pipe parity metrics without significantly compromising other pipe parity metrics.
1.4 The Applicant clearly describes how the proposed work will address major gaps in scientific knowledge and/or significantly advance a water treatment technology approach.
1.5 The current maturity level of the proposed research is in the technology readiness level TRL range of 2 – 4. See Appendix C.
2. Scientific/Technical Merit:
2.1 The proposed work explores original concepts or approach critical technical challenges in an original and transformative manner.
2.2 The technical approach is clearly defined in the concept paper, is credible, and is it likely to achieve the goals of the research.
2.3 Project Deliverables, Timeline, and Milestones are clearly described and described in sufficient detail.
2.4 The Applicant clearly describes how the proposed work will enable applied R&D (TRL 5- 9).
2.5 Risk elements are clearly defined, and a mitigation strategy is provided.
2.6 For the Autonomous Water AOI only: Proposed research offers a clear pathway toward achieving one or more of the technical targets listed in Section 1.5.4, if implemented in an operational facility.
2.7 For Precision Separation AOI only: The TEA approach is clearly defined and provides a SMART method for assessing project impacts through the duration of the project.
3. Resources:
3.1 The team is qualified to conduct the proposed R&D.
3.2 The requested resources are adequate for successfully completing the proposed activities.
3.3 The project meets or exceeds the required NAWI cost share requirements?
3.4 The proposal leverages unique strengths of each team member and include collaborative research (e.g., collaboration between multiple organizations where there is a combination of unique expertise that produces an improved research result).

6.2.1 Compliance Review of Full Applications

Prior to a comprehensive merit evaluation, NAWI will perform a compliance review to determine that (1) the named applicant and PI have not changed from the concept paper or, if they have, NAWI has been notified and provided approval; (2) the information required by the announcement has been submitted; and (3) all mandatory requirements are satisfied. Only applications meeting these review criteria will be considered during the merit review and award selection decision.

6.2.2 Other Selection Factors

The Source Selection Committee may consider the following program policy factors in the selection process:

4. Other Selection Factors:
4.1 Degree to which proposed project optimizes/balances/maximizes use of available NAWI funding to achieve NAWI program goals and objectives, including how those R&D projects support water research.
4.2 Research portfolio diversity, geographic distribution and/or how the projects support other complementary efforts that, when taken together, will best achieve program research goals and objectives.
4.3 Application selection may optimize appropriate mix of projects to best achieve NAWI and/or water research goals objectives.
4.4 Cost/Budget considerations, including availability of funding. While being an important factor, Cost/Budget is not in and of itself the determining factor in the selection. Cost/Budget is not weighted; rather, each budget will be evaluated for realism, reasonableness, and completeness.

Any of the above factors may be independently considered by the Source Selection Committee in determining the optimum mix of applications that will be selected for support. These factors, while not indicators of the application's merit, may be essential to the process of selecting the application(s) that, individually or collectively, will best achieve the program objectives. Such factors are often beyond the control of the applicant. **Applicants should recognize that some very good applications might not receive an award because of program priorities and available funding.** Therefore, the above factors may be used by the Source Selection Committee to assist in determining which applications shall receive funding support.

7 Award Administration Information

7.1 Concept Paper Notifications

NAWI will notify applicants of its determination to encourage or discourage the submission of a Full Proposal via a notification letter by email or through the NAWI Exchange to the technical and business points of contact designated by the applicant in NAWI Exchange.

A notification encouraging the submission of a Full Proposal does not authorize the applicant to commence performance of the project.

Full Proposals will not be accepted from entities that were notified that their Concept Paper was discouraged.

You may change, add, or substitute partners for the Full Proposal stage, if your Concept Paper is encouraged.

7.2 Full Proposal Notifications

NAWI will notify applicants of its determination via a notification letter by email or through the NAWI Exchange to the technical and administrative points of contact designated by the applicant in NAWI Exchange. The notification letter will inform the applicant whether or not its Full Proposal was selected for award negotiations. Alternatively, NAWI may notify one or more applicants that a final selection determination on particular Full Proposals will be made at a later date, subject to the availability of funds or other factors.

7.3 Successful Applicants

Receipt of a notification letter selecting a Full Proposal for award negotiations does not authorize the applicant to commence performance of the project. If an application is selected for award negotiations, it is not a commitment by LBNL/NAWI to issue an award. Applicants do not receive an award until award negotiations are complete and the LBNL/NAWI executes the funding agreement.

We anticipate that the award negotiation process will take approximately 90 days. Applicants must designate a primary and a backup point-of-contact with whom LBNL/NAWI will communicate to conduct award negotiations. The applicant must be responsive during award negotiations (i.e., provide requested documentation) and meet the negotiation deadlines. If the applicant fails to do so or if award negotiations are otherwise unsuccessful, LBNL/NAWI will cancel the award negotiations and rescind the selection. LBNL/NAWI reserves the right to terminate award negotiations at any time for any reason.

7.4 Alternate Applicants

NAWI may designate certain Full Proposals as alternates. Applicants that fall into this category will be notified by email that a final selection determination on particular Full Proposal will be made at a later date, subject to the availability of funds or other factors.

7.5 Unsuccessful Applicants

NAWI shall promptly notify by email each applicant whose application has not been selected for award or designated as an alternate.

7.6 Type of Award Instrument

LBNL/NAWI will negotiate a subcontract or CRADA (Cooperative Research and Development Agreement) with each organization that is part of a project team. Subcontracts will be issued to organizations that are receiving federal funds from LBNL/NAWI. CRADAs will be issued to organizations that are performing work scope and only providing cost share (not receiving federal funds from LBNL/NAWI). The subcontract/CRADA will include mandatory flow-down terms. The Sample Subcontract and CRADA can be found at NAWI.infoready4.com. The R&D project Lead Organization will not issue agreements to the Participating Organizations. All organizations will execute a subcontract or CRADA from LBNL/NAWI. Organizations receiving federal/NAWI funds will execute a subcontract. Cost share only partners (not receiving federal/NAWI funds) will execute a CRADA.

This negotiation is governed by procurement policies and procedures established under the LBNL's Prime Contract No. DE-AC02-05CH11231 with the U.S. Government, represented by the Department of Energy (DOE), for management and operation of LBNL.

DOE will fund a DOE/NNSA FFRDC contractor through an EERE AOP (Annual Operating Plan) and non-DOE/NNSA FFRDC through an interagency agreement with the sponsoring agency. DOE/NNSA FFRDCs will be awarded to the FFRDCs directly from DOE-AMO via a work authorization. A Field Work Proposal is not required at the Full Proposal phase. If your organization requires a Field Work Proposal before submitting a Full Proposal, then please follow your organization's requirements. A cognizant Contracting Officer (CO) authorization letter is not required in this RFP. Please follow your organization's policies and procedures. If your organization requires a CO authorization before submitting, then please follow your organization's requirements.

Each organization must execute the Research Consortium Agreement by the time of award. A link to the Research Consortium Agreement can be found below.

Each member must also become an Alliance Member and execute the Alliance Membership Agreement. Alliance Membership is free. A link to the Alliance Membership process and forms can be found below.

7.7 Summary of Required Documents

Document requirements at the Concept Paper phase. Applicants shall complete and submit the following enclosures. See Appendix A.

- | |
|---|
| <ol style="list-style-type: none">1. One Slide Overview (see template in NAWI Exchange; Right Column under Concept Paper Files)2. Summary Budget (see template in NAWI Exchange; Right Column under Concept Paper Files)3. Technical Concept Paper Narrative (2-page limit, see template in NAWI Exchange; Right Column under Concept Paper Files)4. Project Overview (enter in the text box in NAWI Exchange; 250-word limit) |
|---|

Document Requirements at the Full Proposal phase. Applicants shall complete and submit the following enclosures. See Appendix B.

- | |
|---|
| <ol style="list-style-type: none">1. One Slide Overview (see template)2. Detailed Budget (see template)3. Technical Full Proposal Narrative (see template; 10-page limit)4. Cost Share Commitment Letters (see examples)5. Biographical Sketches (2 pages max per key participant; compiled into one document)6. Project Overview (enter in the text box in NAWI Exchange; 250-word limit) |
|---|

Document requirements **AFTER a Full Proposal is selected for negotiations.** NAWI and LBNL will work with organizations selected for negotiation to determine exactly which documents are required.

Overall Team	Subcontract Organizations (Orgs. that will receive NAWI/Federal Funds) Please see the Subcontract Business Management Volume for complete details.	Cost Share Only Organizations (Orgs. that are only providing cost share. Orgs. will NOT receive NAWI/Federal Funds)	FFRDCs
1. Milestone Table and Statement of Project Objectives	1. Representations & Certifications Form (Rep-Cert Form) 2. Pre-award Survey of Prospective Subcontractor's Accounting System or last two (2) year of Single Audit Reports 3. Cost Proposal 4. Employee-Vendor Relationships Certification 5. Small Business Subcontracting Plan (Required only from the successful non-small business offeror) 6. Cost Accounting Standards (CAS) Notices and Certification of Exemptions 7. Certificate of Current Cost or Pricing Data (COPD) 8. Alliance Membership Agreement 9. Consortium Agreement 10. Subcontract and its Incorporated Documents 11. Approved Intra-University Transfer Agreement which includes NAWI program requirements (Only for University of California) 12. Insurance Certificate , as needed	1. Sample CRADA and its Incorporated Documents, if needed 2. Alliance Membership Agreement 3. Consortium Agreement	1. Alliance Membership Agreement 2. Consortium Agreement 3. EERE AOP (Annual Operating Plan) or Interagency Agreement

8 Other Information

8.1 Foreign Entity Participation (Federally funded and/or providing cost share)

It is the goal of the NAWI program to foster U.S. domestic innovation and economic growth in the water technology industry, and NAWI research funding is intended to be directed toward U.S. institutions. DOE invests in research and development as part of a broad portfolio approach to addressing our Nation's energy and environmental challenges. Specific to the Energy-Water Desalination Hub, DOE seeks to address water security issues in the U.S.

Please see Appendix I in the [Consortium Agreement for more details](#). All participants in the Hub must be incorporated (or otherwise formed) under the laws of a State or territory of the United States with majority domestic ownership or control and have a physical place of business in the United States. Entities who do not meet these requirements are considered foreign entities.

A foreign entity may become eligible to participate in a project if the entity obtains a foreign entity participation waiver approved by DOE. To obtain a waiver, the foreign entity must demonstrate to the satisfaction of NAWI and DOE that: 1) its participation is in the best interest of NAWI, U.S. industry, and U.S. economic development; 2) adequate IP and data protection protocols exist between the U.S. subsidiary and its foreign parent organization; 3) the work is conducted within the U.S. and the entity acknowledges the U.S. Manufacturing Plan; and 4) the entity will comply with any other conditions that may be deemed necessary by NAWI and DOE to protect U.S. government interests. The U.S. Manufacturing Plan is Appendix H in the [Consortium Agreement](#).

Certain characteristics make some Foreign Entities more likely to meet the waiver criteria to the satisfaction of DOE and the NAWI Hub than others. For example, foreign companies that have current U.S. manufacturing capacity and major facilities within the U.S. that operate and employ people in the U.S. and can readily implement manufacturing improvements or provide significant R&D capabilities have greater potential benefit to the Institute and its mission than an entity with no U.S. presence. Foreign Entities with small or no current U.S. presence could be considered for participation but may be less likely to meet the Foreign Entity participation criteria. Commitments to locate in the U.S. or expand U.S. operations could be a positive consideration depending on the strength of the commitment, and any demonstrated unique value or resources.

One of the primary purposes of the Hub is to increase U.S. manufacturing competitiveness by strengthening the security and economic resilience of U.S. manufacturing. This purpose may be frustrated by unauthorized transfer of scientific and technical information to foreign government entities. Participation in a foreign government talent recruitment program could conflict with purposes of NAWI. Therefore, no individual on a project team for NAWI may participate in foreign government talent recruitment programs of countries designated by DOE as a foreign country of risk. The purpose of this requirement is to ensure the continued flow of scientific and technical information consistent with DOE's broad scientific mission, while also ensuring protection of U.S. competitive, economic and national security interests and DOE program objectives; and limiting unauthorized transfers of scientific and technical information.

8.2 Foreign Work Waiver (Federally funded and/or providing cost share)

Please see Appendix I in the [Consortium Agreement](#) for more details on the Foreign Work Waiver. All NAWI Work must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, Consortium Members should purchase supplies and equipment within the United

States in accordance with their Project agreement terms. There may be limited circumstances where it is in the interest of NAWI or a Project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit an explicit waiver request. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

Unless a waiver is provided, Lead Organization must show that 100% of the direct labor cost for the project (including Participating Organizations labor) will be incurred in the United States and its territories. If any project work will be done in a foreign country, NAWI will work with the project team to complete a Foreign Work Waiver (FWW) that will be submitted to DOE for review and approval.

8.3 U.S. Manufacturing Plan

Please see Appendix H in the [Consortium Agreement](#) for the complete U.S. Manufacturing Plan. A goal of the NAWI Hub is to provide benefit to the U.S. manufacturing sector, including the ability to deploy and refine methods, materials and processes that are developed by the Research Consortium members through NAWI Funding awards (receiving federal funds and/or providing cost share). NAWI Research Consortium members will agree to the following commitment as a condition of their receipt of federal funding and/or providing cost share:

Any products embodying any Subject Invention or produced through the use of any Subject Invention will be manufactured substantially in the United States. “Subject Invention” means any Invention of a Consortium Member that is conceived or first actually reduced to practice in the performance of NAWI Work or under NAWI Funding. This requirement will be binding on any sub-awardee and any assignee or any entity otherwise acquiring rights to any Subject Invention including subsequent assignees.

NAWI Consortium Members may propose an alternate U.S. Manufacturing Plan with more specific commitments that would be beneficial to the U.S. economy and competitiveness. For example, an applicant may commit specific products to be manufactured in the U.S., commit to a specific investment in a new or existing U.S. manufacturing facility, keep certain activities based in the U.S. or support a certain number of jobs in the U.S. related to the technology.

DOE will review such plans and will determine at its sole discretion if the more specific commitments would provide a sufficient benefit to the U.S. economy and industrial competitiveness. If accepted, the alternate U.S. Manufacturing Plan together with the specific commitments will become part of the terms and conditions of that NAWI Project agreement.

8.4 Statement of Project Stewardship

NAWI will exercise normal stewardship in overseeing the project activities performed under NAWI awards. Stewardship activities include, but are not limited to, conducting site visits; reviewing performance and financial reports; providing assistance and/or temporary intervention in unusual circumstances to correct deficiencies that develop during the project; assuring compliance with terms and conditions; and reviewing technical performance to ensure that the project objectives are being accomplished during and after the project.

8.5 Post Award Technical Performance Monitoring & Reporting

NAWI will monitor the technical and cost performance of each project. NAWI Project Control Specialists will oversee the Hub-awarded projects and work with the PIs to ensure projects are

executed on time, on budget, and consistent with the project statement of project objectives (SOP). Project teams will submit the reports listed below to their identified Topic Area Lead and the NAWI Project Control Specialists to fulfill their reporting requirements.

Monthly Report – The Lead Organization will prepare a monthly report which will include high-level information.

Quarterly Technical Status Report & Financial Reports – The Lead Organization will prepare a Quarterly Report based upon the Quarterly Reporting Template. This information will be incorporated to the Quarterly report that NAWI submits to DOE.

Quarterly Technical Reviews (QTR) – The Lead Organization may be required to prepare a Quarterly Presentation which must include a Technical Status and a Financial Status to include detailed technology development status, schedule status and/or schedule modifications, project issues, budget expenditure, and cost share, etc.

Annual Reports – The Lead Organization may be required to prepare an annual report that will be presented at the Annual NAWI Hub Meeting.

Final Technical Report – At the completion of the NAWI Project, the Lead Organization will submit a Final Technical Report, which will provide a comprehensive, cumulative, and substantive summary of the progress and significant accomplishments achieved during the total period of the NAWI Project effort.

8.6 Generated Data

Data generated under the award that will be made public must be uploaded to the Water Data and Analysis Management System (Water-DAMS) repository. The Prime Recipient must upload data to NAWI no later than 60 days after the end of the quarter in which a complete data set is generated. The data must be sufficiently complete, in a format acceptable to DOE, and include all files required for an independent analyst to reproduce and verify the work. The data will be submitted to NAWI at [www.nawihub.org/waterdams]. While most data formats may be uploaded to the NAWI Water-DAMS repository, DOE prefers reusable, structured data that supports conclusions communicated in project quarterly and other reports. If the data are protected or subject to a moratorium, they will not be made publicly available until the moratorium has expired, and they will be held in a secure section of the NAWI WATER-DAMS repository. Protected Data will be treated according to the Intellectual Property Provisions.

8.7 Go/No-Go Review

Each project selected under this solicitation will be subject to a periodic project evaluation referred to as a Go/No-Go Review, which will be determined during award negotiations. Go/No-Go decisions will be made at each stage (at least one Go/No Go decision point for every 12 months). At the Go/No-Go decision points, project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the NAWI program goals and objectives will be evaluated. Funding beyond the Go/No-Go decision point (continuation funding) is contingent upon; (1) the availability of future-year budget authority; (2) Recipient's technical progress compared to the Milestone Summary Table of the award; (3) Prime Recipient's submittal of required reports; (4) Prime Recipient's compliance with the terms and conditions of the award; (5) The Go/No-Go decision; and (6) written approval of the next budget period.

As a result of the Go/No-Go Review, the following actions may be authorized: (1) continue to fund the project; (2) recommend redirection of work within the general scope under the project; (3) place a hold on funding for the project, pending further supporting data or funding; or (4) discontinue funding the project because of insufficient progress, change in strategic direction, or lack of funding.

The Go/No-Go decision is distinct from a non-compliance determination. In the event a Recipient fails to comply with the requirements of an award, NAWI may take appropriate action, including but not limited to, redirecting, suspending, or terminating the award.

8.8 Amendments

Amendments to this solicitation will be posted on the NAWI Exchange. However, if you register for email notifications for this solicitation in NAWI Exchange you will only receive an email when an amendment for the solicitation is posted. We recommend that you register as soon after the release of the solicitation as possible to ensure you receive timely notice of any amendments or other solicitations.

8.9 Evaluation and Administration of Non-LBNL/NAWI Personnel

In conducting the merit review evaluation, NAWI may seek the advice of qualified non-LBNL/NAWI personnel as reviewers. The Applicant, by submitting its application, consents to the use of non-LBNL/NAWI reviewers/administrators. All reviewers will sign conflict of interest and non-disclosure agreements prior to reviewing an application.

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Appendix A: Concept Paper Requirements

CONCEPT PAPER TECHNICAL NARRATIVE REQUIREMENTS

The Concept Paper must be submitted through the NAWI Exchange (NAWI.infoready4.com). The information below is provided for planning and information purposes.

The Concept Paper Technical Narrative submission is limited to **2 pages**. See Section 5.5 for formatting requirements.

The subheadings should be included as headings. The subheadings should not be removed. You may use abbreviated subheadings. See Concept Paper Technical Narrative Template in InfoReady for more details.

Letters of support should not be included as part of the concept paper submission.

TITLE

Start Title with the abbreviation of the relevant Challenge Area (AW=Autonomous Water; PS=Precision Separation) followed by ": ". Example "**AW**: Title of Concept Paper"; "**PS**: Concept Paper Title"

Use Title Capitalization. Do not use all Caps.

1 PROBLEM STATEMENT AND GOALS

- 1.1 How does the proposed work address the Technical Challenge Area (CA) and Area of Interest (AOI) research needs described in the Request for Proposals (Section 1.5 for Autonomous Water and Section 1.6 for Precision Separation)?
- 1.2 What is the current state-of-the-art for the given CA and AOI?
- 1.3 How will the proposed research objectives advance the current state-of-the-art and overcome challenges?

2 TECHNICAL APPROACH

- 2.1 What is the technical approach to solve the challenge?
- 2.2 How does the proposed work explore original concepts or approach critical technical challenges in an original and transformative manner?
- 2.3 Project Deliverables, i.e., what will be delivered upon successful completion of the project?

3 PROJECT IMPACTS

- 3.1 How does the proposed work have the potential to address a major gap in scientific knowledge or significantly advance a water treatment technology approach?
- 3.2 How will the proposed work transform use of non-traditional water sources and impact pipe parity metrics defined in Section 1.2 of the RFP?
- 3.3 For the Autonomous Water AOI only: How does the proposed research offer a clear pathway toward achieving one or more of the technical targets listed in Section 1.5.4, if implemented in an operational facility?
- 3.4 For Precision Separation AOI only: What is the TEA approach and how will the project impacts be assessed through the duration of the project?

OTHER CONCEPT PAPER REQUIREMENTS

1 PROJECT OVERVIEW

There is a 250-word limit for the Project Overview. Paste the Project Overview text into the designated text box in NAWI Exchange. The Project Overview should only be uploaded in the designated text box in NAWI exchange. Do not include the Project Overview in the 2-page Concept Paper PDF.

Provide an overview of the proposed project. Include general background, challenges and knowledge gaps being addressing, key outcomes, general benefits, etc. The project overview should not include any proprietary/business sensitive information.

2 ONE SLIDE OVERVIEW

This is not part of the 2-page Concept Paper page limit. Upload as Microsoft PowerPoint into NAWI Exchange. The template is available in NAWI Exchange. You may move the logos to the upper right quadrant along with the staffing, in order to create more room in the lower left quadrant for showing the technical approach.

Include the following information:

- Project Name
- Project Technical Point of Contact
- Problem statement
- Project goals
- Technical approach
- Potential impact
- Performers and roles
- Total Project Cost, % Cost Share, and Duration

3 BUDGET SUMMARY

This is not part of the 2-page Concept Paper page limit. Upload as Microsoft Excel into NAWI Exchange. The template is available in NAWI Exchange.

The Full Proposal budget may differ from the Concept Paper. The budget should align with the scope of work proposed. There is not a limit on the percentage by which it can vary.

There is not a limit to the percentage of cost-share that can be met with in-kind contributions.

There are not per proposal funding limitations; however, we do expect most proposals will be in the \$2 million to \$500,000 range. There is not a minimum amount of funding that needs to be requested. Budgets should reflect the propose work scope.

Please use the indirect rates that are approved for your organizations. NAWI will pay indirect rates that are approved for your organizations. If no indirect rates are established for you or your organizations, please do not include an indirect rate. In this case, all budget items should be directly charged.

Appendix B: Full Proposal Requirements

FULL PROPOSAL TECHNICAL NARRATIVE REQUIREMENTS

The Full Proposal must be submitted through NAWI Exchange (NAWI.infoready4.com).

The Full Proposal Technical Narrative is limited to **10 pages**. See Section 5.5 for formatting requirements.

The subheadings should be included as headings. The subheadings should not be removed. See Full Proposal Technical Narrative Template in InfoReady for more details

TITLE

Start Title with the abbreviation of the relevant Challenge Area (AW=Autonomous Water; PS=Precision Separation) followed by ": ". Example "AW: Title of Full Proposal"; "PS: Full Proposal"

Use Title Capitalization. Do not use all Caps.

1 PROBLEM STATEMENT AND GOALS

- 1.1 How does the proposed work address the Technical Challenge Area (CA) Area of Interest (AOI) research needs described in the Request for Proposals?

2 BACKGROUND AND RATIONALE

- 2.1 What is the current state-of-the-art for the given CA and AOI?
- 2.2 How will the proposed research objectives advance the current state-of-the-art and overcome existing challenges?

3 TECHNICAL APPROACH

- 3.1 How does the proposed work explore original concepts or approach critical technical challenges in an original and transformative manner?
- 3.2 What specific research tasks and methodologies will the proposed work deploy to address the technical challenge?
- 3.3 Project Deliverables, i.e., what will be delivered upon successful completion of the project
- 3.4 What is your vision for how this research will enable applied R&D (TRL 5 – 9)?
- 3.5 What are the riskiest elements of your technical approach or plan?

4 PROJECT TIMELINE AND MILESTONES

Please provide a high-level schedule of the proposed work and include key milestones.

5 PROJECT IMPACTS

- 5.1 How does the proposed work have the potential to address a major gap in scientific knowledge or significantly advance a water treatment technology approach?
- 5.2 How will the proposed work transform utilization of non-traditional water sources and impact pipe parity metrics defined in Section 1.2 of the RFP?

- 5.3 For the Autonomous Water AOI only: How does the proposed research offer a clear pathway toward achieving one or more of the technical targets listed in Section 1.5.4, if implemented in an operational facility?
- 5.4 For Precision Separation AOI only: What is the TEA approach and how will the project impacts be assessed through the duration of the project?

6 PERFORMERS AND ROLES

Please describe the technical qualifications of the proposed team members and their respective roles in the proposed research

7 EQUIPMENT AND FACILITIES

Please describe the Project Team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project.

OTHER FULL PROPOSAL REQUIREMENTS

1 PROJECT OVERVIEW

There is a 250-word limit for the Project Overview. Paste the Project Overview text into the designated text box in NAWI Exchange. The Project Overview should only be uploaded in the designated text box in NAWI exchange. Do not include the Project Overview in the 10-page Full Proposal Technical Narrative PDF.

Provide an overview of the proposed project. Include general background, challenges and knowledge gaps being addressing, key outcomes, general benefits, etc. The project overview should not include any proprietary/business sensitive information.

2 BIOGRAPHICAL SKETCHES

Attach biographical sketches (no more than 2 pages each) for key participating team members as an appendix. The biographical sketches do not count towards the 10-Full Proposal page limit. Combine all biographical sketches into one document and upload into NAWI Exchange as one PDF file. There are not any additional format requirements beyond font and page limit for the biosketches.

3 ONE SLIDE OVERVIEW

This is not part of the -page Full Proposal page limit. Upload as Microsoft PowerPoint into NAWI Exchange. The template is available in NAWI Exchange.

Include the following information:

- 3.1 Problem statement
- 3.2 Project goal
- 3.3 Technical approach
- 3.4 Potential impact
- 3.5 Performers and roles
- 3.6 Project cost, cost share, and duration

4 COST SHARE VERIFICATION COMMITMENT LETTERS

Please address your Letter(s) of Commitment to either Dr. Peter Fiske; 1 Cyclotron Road; Berkeley, CA 94720 or the Principal Investigator.

5 DETAILED BUDGET

This is not part of the 10-page Full Proposal page limit. Upload as Microsoft Excel into NAWI Exchange. The template is available in NAWI Exchange.

The Full Proposal budget may differ from the Concept Paper. The budget should align with the scope of work proposed. There is not a limit on the percentage by which it can vary.

There is not a limit to the percentage of cost-share that can be met with in-kind contributions.

There are not per proposal funding limitations; however, we do expect most proposals will be in the \$2 million to \$500,000 range. There is not a minimum amount of funding that needs to be requested. Budgets should reflect the propose work scope.

Please use the indirect rates that are approved for your organizations. NAWI will pay indirect rates that are approved for your organizations. If no indirect rates are established for you or your organizations, please do not include an indirect rate. In this case, all budget items should be directly charged.

Additional organizations may be added to the budget template by inserting columns to include all project partners.

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Appendix C: Technology Readiness Level Definitions

TRL 1:	Basic principles observed and reported
TRL 2:	Technology concept and/or application formulated
TRL 3:	Analytical and experimental critical function and/or characteristic proof of concept
TRL 4:	Component and/or breadboard validation in a laboratory environment
TRL 5:	Component and/or breadboard validation in a relevant environment
TRL 6:	System/subsystem model or prototype demonstration in a relevant environment
TRL 7:	System prototype demonstration in an operational environment
TRL 8:	Actual system completed and qualified through test and demonstrated
TRL 9:	Actual system proven through successful mission operations

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Appendix D: Additional Background on Technical Challenges and Research Opportunities for Precision Separations Technologies

Transformational research in precision separation technologies could target order of magnitude performance improvements of existing separation platforms or introduce new separation concepts that replace one or more existing unit processes that are currently being deployed to address constituents of concern. In both cases, proposed research concepts should be benchmarked relative to state-of-the-art technology performance metrics for specific contexts and evaluated for pipe parity benefits for non-traditional water sources. Whenever possible, applications should clearly describe:

1. Justification for the selection of the constituent(s) of interest in the context of the impacts it has on state-of-the-art treatment trains for one or more sectors;
2. Justification of the selection of the proposed technology platform relative to other platforms performing comparable separations;
3. Key technology performance metrics of the proposed technology platform and technical challenges associated with improving those metrics;
4. Novelty of the proposed approach to overcoming current technology limitations;
5. Assessment of the impact of the proposed research on improving technology metrics for one or more source waters or reuse applications.

To aid applicants with this process, NAWI has qualitatively and quantitatively estimated the relative impact of new precision separations technologies for specific constituents of concern within four classes of problematic constituents: Organics, Metals, Oxyanions, and Nutrients (Figure 1). This list was developed by identifying contaminants of concern that were frequently highlighted in the NAWI Water User Roadmaps for the power, resource extraction, industrial, municipal, and agricultural sectors (access NAWI Roadmaps here: <https://www.nawihub.org/roadmaps>). The potential application of constituent treatment was based on the number of sectors affected by each constituent weighted by the estimated volume of water affected and urgency of treatment need. To estimate the potential improvement to pipe parity, representative treatment trains across sectors were evaluated for removing these constituents of concern based on their costs, energy intensity, reliability, and other pipe parity metrics. For each treatment train, the team assessed either A) the benefits of precision separations alternatives to current bulk separations processes on these baseline treatment trains or B) the benefits of improving one or more precision technology attributes in baseline treatment trains that were already using precision separation approaches. The quantitative results were augmented with expert elicitation outcomes to ensure the assessment reflects future trends and needs beyond the NAWI case studies. The results of this analysis are intended to be illustrative and to serve as a starting point for applicants as they seek to justify the focus of their precision separations schema. This list is not exclusionary; applications that target constituents outside of this prioritized list will be considered when accompanied by detailed justification of the critical importance of the critical constituent within a treatment train and/or sector.

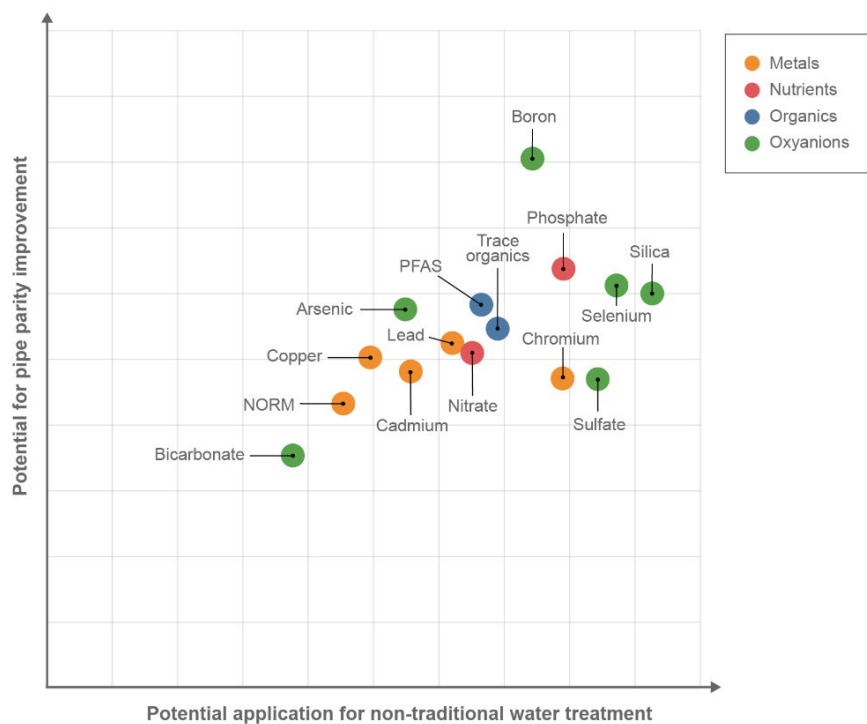


Figure 1. Relative ranking of constituents of interest for NAWI research based on NAWI Roadmapping and Baseline analysis. NAWI will consider other constituents based on proposal justifications.

Roadmapping studies identified the following fifteen constituents limiting non-traditional water use or substantially impacting recovery in non-traditional water desalination treatment trains: Arsenic, Bicarbonate, Boron, Cadmium, Chromium, Copper, Lead, Nitrate, Naturally Occurring Radioactive Materials (NORM), Phosphate, Per- and Polyfluoroalkyl substances (PFAS), Selenium, Silica, Sulfate, and Trace Organics that pose special concerns for the integrity of membrane-based desalination systems (e.g., 1,4-dioxane, acetone, TCE, BTEX). This list is not entirely comprehensive of constituents that could be of interest that limit recovery in non-traditional water desalination treatment trains. NAWI welcomes consideration of other constituents of interest with sufficient justification.

NAWI Baseline treatment trains from 24 sites treating a diverse set of water sources employed a wide array of approaches to address these constituents of concern, including both precision and bulk technologies (Figure 2). Across the suite of case studies, reverse osmosis (RO) was the most commonly used technology for removing constituents of concern. While RO represents an intensified approach for bulk removal of multiple constituents simultaneously, the baseline studies also highlighted the frequency of using RO to address a specific target constituent. In these latter cases, replacing RO with a precision separations technology could reduce costs and energy requirements.

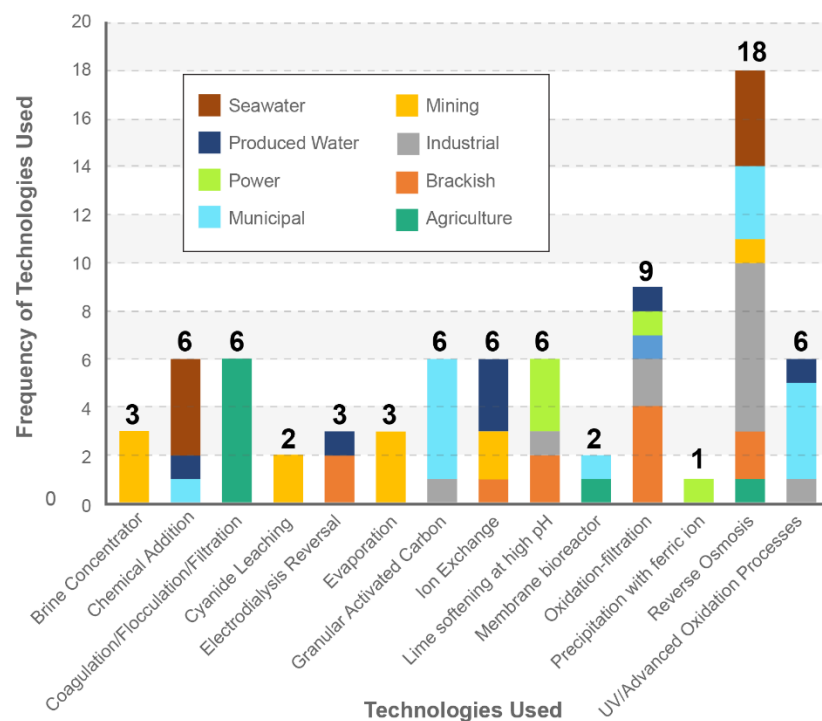


Figure 2. Frequency of technology usage for addressing NAWI constituents of interest in the NAWI Baseline Case Studies

Table 1 reviews both bulk and precision separations technologies for removing priority constituents of concern, including commonly deployed and emerging technologies. In each case, we summarize the technology’s respective strengths, weaknesses, and the key research needs for advancing the state-of-the-art. The commonly deployed technologies have been studied across multiple sectors and installations, and research challenges are more clearly defined. The emerging technologies have limited deployment at-scale and have broader research needs. Applications should define key challenges and barriers for their selected technology and clearly describe how the proposed technology approach overcomes current limitations.

Table 1. Selected Technologies Relevant to Precision Separations^{1,2}

<i>Common Bulk Removal Technologies that May Be Displaced by Innovative Precision Separations</i>		
Technologies	Description of Strengths and Weaknesses	Precision Separations Research Needs
Coagulation-precipitation³	Well understood; fairly flexible to influent quality changes; low energy use but high chemical and sludge management needs. Current energy use: up to 0.02 kWh/m ³ and 4 kWh/m ³ for drinking water and produced water, respectively; Current operating cost for produced water: \$0.1-0.8/m ³ , and varies with water quality, removal.	None
Reverse osmosis/nanofiltration (RO/NF)	Provides bulk separation based on physical and/or chemical properties; modular; high energy consumption, especially at high salinities; prone to fouling and scaling. Current	See selective membranes below.

Activated carbon	energy use: 0.55-4 kWh/m ³ ; increases with higher TDS and/or, recovery.	
	High surface area materials that sorb dissolved constituents; granular or powdered form; cost-efficient; scalable; flexible; low energy use but may require regeneration and/or disposal of residuals; performance can be affected by other constituents in water.	See functionalized sorbents below.
Conventional biological treatment⁴	Cost-effective for most organics at larger scales; low chemical use; potentially high land requirements; sensitive to influent characteristics and operational parameters; sludge management required. Current cost: \$0.33/m ³ to remove nitrate at a 1MGD drinking water facility.	None
Selected technologies with applications in precision separations		
Technologies	Description of Strengths and Weaknesses	Precision Separations Research Needs
Ion exchange (IX)^{4,5,6,7}	Established technology effective for ions; modular; low energy needs; high regeneration/disposal costs, especially when hazardous. LCOW for arsenic and nitrate removal is ~\$0.26/m ³ (2.5 MGD system).	Increase capacity and selectivity in the presence of competing ions, especially at high ionic strength; improve uptake and regeneration kinetics; reduce cost for regeneration and/or residual management, especially for distributed applications.
Selective membranes^{8,9}	Robust and tunable membranes incorporating selective chemical and/or sorbing properties to intensify desalination (e.g., electrodialysis) processes; depending on configuration, may improve kinetics, capacity, and/or durability.	Reduce costs. Increase valence selectivity, capacity, structural and chemical tunability. Improve rejection of uncharged polar organics; regeneration and treatment of regenerant streams. Specific functionalization for target constituents. Optimization of treatment platform and configuration with real world waters needed.
Functionalized sorbents^{10,11,12}	Materials with large area of accessible reactive specialized surfaces of particular chemistry. physical properties (e.g., magnetic), and/or microbial amendments targeted to separation needs and geometry designed for low pressure drop. High adsorption capacity. Ability to customize the surface reactivity to a variety of constituents and operational conditions. Many forms are relatively low cost; low energy use but requires regeneration and/or disposal of residuals.	Better characterized performance for materials and/or form (e.g., powdered or granulated); improve physical stability in complex real-world water. Scalable manufacturability for innovative materials. Recoverable regeneration brines that minimize disposal needs, regardless of whether this occurs on- or off-site. Performance in complex chemistries varies. Develop manufacturable materials and better release mechanisms for elution and regeneration of the sorbent.
Advanced oxidation processes (AOP), including electrochemical processes¹³	Degrades organics; flexible, modular, adjustable reactor configurations; electrochemical approach is compatible with renewable energy and, depending on the electrode design, removal efficiency may exceed conventional AOP. Current energy use: 0.05-1 kWh/m ³ for ozone and UV/AOP processes for drinking water, depending on TDS.	Develop selective oxidation in complex mixtures; avoid toxic byproduct formation; optimizing reactor configuration to reduce costs; quantify energy use for destruction (e.g., for PFAS). For electrochemical approaches, electrode material development and testing, longevity and efficiency in real-world water quality.
Selective crystallization^{9,14}	Selective crystallization into hydrogen-bonded or metal-organic crystalline solids of low solubility; effective for anions like sulfate, chromate, selenate, phosphate, nitrate; Removal is only effective down to ppm levels.	More efficient removal for constituents; improve physical and chemical stability in complex waters; develop manufacturable forms of crystalline solids for treatment applications (e.g., membranes).

**Catalytic
hydrodehalogenation**

Catalytically breaks carbon-halogen bond to dehalogenate organics. Can be highly selective in complex matrix. Recent advances in single atom catalyst improves costs and improves selectivity.

Low TRL materials development and computational simulation to address manufacturing challenges, cost, longevity, catalyst poisoning; performance in real world waters.

Note: Table was developed from cited sources and expert elicitation conducted as part of NAWI's roadmapping and baselining activities.

Applications should clearly describe the potential impact of the proposed research on improving technology performance metrics for one or more source waters or reuse applications. Specific performance metrics and current state-of-the-art values can vary depending on technology type and the specific constituent context. Whenever possible, applications should clearly state relevant performance metrics for current state-of-the-art technologies and the potential improvements that the proposed research could achieve. Key performance metrics based on the technology type are further detailed in Table 2.

Table 2. Key Performance Metrics of Technology Approaches

Performance Metrics for Sorbents	Performance Metrics for Filtration/Membranes	Performance Metrics for Destruction/Reduction/Oxidation/Precipitation
Capacity (meq/mL)	Permeability ($\text{m}^3\text{m}^{-2}\text{s}^{-1}\text{Pa}^{-1}$)	Removal (%)
Kinetics (Empty Bed Contact Time, Regeneration Rate)	Selectivity ($1/B[\text{L}^{-1}\text{m}^2\text{h}]$)	Capital Cost (\$/ m^3/day)
Regenerability (number of cycles, regeneration efficiency)	Membrane cost (\$/ m^2)	O&M Cost (\$/ m^3)
Stability of sorbent (chemical, physical, thermal)	Membrane lifetime (years)	Specific Energy Consumption (kWh/m^3)
Removal (%)	Recovery (%)	Residual, byproduct, and waste production (consider volume, mass, composition, disposal needs)
Capital Cost (\$/ m^3/day)	Capital Cost (\$/ m^3/day)	
O&M Cost (\$/ m^3)	O&M Cost (\$/ m^3)	
Specific Energy Consumption (kWh/m^3)	Specific Energy Consumption (kWh/m^3)	
Residual, byproduct, and waste production (consider volume, mass, composition, disposal needs)	Residual, byproduct, and waste production (consider volume, mass, composition, disposal needs)	

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