



— BUREAU OF —
RECLAMATION

Science and Technology Program 2022–2025 Innovation Strategy

Research and Development Office



Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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About this Strategy

As Reclamation carries out its mission, it encounters a variety of scientific and technical challenges that require innovation. The Bureau of Reclamation Research and Development (R&D) Office administers the Science and Technology (S&T) Program to invest in such innovation, helping to advance Reclamation's technical abilities to manage, develop, and protect water and related resources in an environmentally and economically sound manner. In administering these activities, the R&D Office aspires to the vision of sustainably, efficiently, accountably, and responsively supports innovation that addresses the full range of technical challenges confronting Reclamation water and power managers and their project stakeholders.

The S&T Program Innovation Strategy (Innovation Strategy) describes the S&T Program approach to solve mission-related scientific and technical challenges by investing in innovation activities. Such investments include internally led research projects that may involve external expertise, prize competitions to crowdsource solutions to some of our most difficult challenges, technical transfer engagements with industry to accelerate commercially viable solutions to the marketplace; and, technology transfer efforts with Reclamation users, customers, and stakeholders, facilitating their adoption of high-impact solutions into their operations thereby amplifying the positive impact of these innovation investments. A companion document, Innovation Strategy Implementation Plan, provides an annually updated list challenges that the S&T Program is targeting for funding.

This Innovation Strategy represents an update to the “Science and Technology Program – Science Strategy – FY2018-FY2021” that has guided S&T Program research project investments since Fiscal Year (FY) 2018. Like its predecessor this Innovation Strategy identifies innovation needs through a set of areas and categories and is complemented by annual implementation planning to allow for flexible priority setting that’s responsive to emerging needs. What’s new about this Innovation Strategy is its scope of applicability within the S&T Program: rather than being focused primarily on research investments, this strategy is intended to commonly guide investments within all S&T Program elements (i.e., research, prize competitions, technology transfer, facilitated adoption) and in a more synergistic fashion to spur and accelerate innovation to address Reclamation’s technical challenges.

This Innovation Strategy was produced through an iterative process starting with R&D Office providing the initial draft. Input was then sought from S&T Program Regional Coordinators, Prize Competitions Theme Leads and internal Reclamation stakeholders, including representatives from Dam Safety and Infrastructure, Technical Service Center, Policy and Programs, Power Resources Office, and Reclamation Regions. Following this internal engagement, an external review process was conducted to gather input from a broad cadre of external partners. These external partners included other Department of the Interior Bureaus and other Federal partners such as US Army Corps of Engineers (USACE), Department of Energy (DOE), National Oceanic and Atmospheric Administration (NOAA), Bonneville Power Administration (BPA), Western Area Power Administration (WAPA), and the Environmental Protection Agency. After addressing external review comments, the document was finalized and submitted to Reclamation leadership for final reviews and concurrence.

To support Innovation Strategy implementation, Annual Implementation Plans will be developed to guide priority-setting for the S&T Program Annual Call for Research Proposals as well as planning for future prize competition activities. Annual Implementation Plans further detail and communicate the highest priority innovation needs within each S&T Program category. The Annual Implementation Plan process allows for shifts in emphasis based on emerging needs or accomplishments from previously funded work. The R&D Office routinely engages with subject matter experts from the Regions and other Directorates for input on adjustments to innovation needs and priorities.

Program Elements

In carrying out the S&T Program mission and vision, the R&D Office employs the following administration objectives:

- Develop cost-effective solutions for the technical and scientific challenges affecting accomplishment of Reclamation’s mission, while leveraging funds with other research entities to advance research in a collaborative manner.
- Build and strengthen scientific and engineering capacity for Reclamation in order to advance the most relevant research and demonstration projects for Reclamation.
- Communicate solutions to Reclamation offices, other water and power management officials, and the general public in order to build partnerships with other water and power management agencies and stakeholders.

These administration objectives are carried out through five program elements that spur innovation and transform results of research or prize competitions into solutions for Reclamation water and water-related resources managers, stakeholders, and the larger water resources community of practice:

- research projects
- prize competitions
- technology transfer
- dissemination of research results
- facilitated adoption

These five elements can be grouped into two categories, those that generate solutions (Research Projects and Prize Competitions), and those that advance, transform, or foster the use of solutions (technology transfer, dissemination of research results, facilitated adoption).

Research Projects

S&T Program research projects are internally led and address a wide range of science and technology challenges facing Reclamation water and power managers spanning Reclamation’s mission. Identification and prioritization of research needs under each area are guided by input from Reclamation end-users and informed by perspectives from partner agencies and stakeholders. The program invites research projects through internal research solicitation. Partnering enables Reclamation researchers to leverage external expertise to enhance project teams and likelihood of success for projects.

Research projects are solicited to address strategic research areas and categories (described in this strategy) as well as priorities within those areas and categories (documented in Annual Implementation Plans). Projects typically have strong cost-sharing and collaboration with Reclamation end-users, stakeholders, other agencies, and/or universities. Research funding is awarded to employees bureau-wide, based on proposal relevancy to Reclamation mission and technical merit. Every proposal is reviewed by

independent technical reviewers from within and outside of Reclamation and then reviewed by a program panel that makes funding recommendations for Commissioner’s concurrence.

See Reclamation’s [Directive and Standard RES 02-01](#) for additional information about S&T Program Research, Development, and Demonstration Projects processes.

Prize Competitions

Reclamation utilizes [prize competitions](#) to harness the innovative capacity of the public and private sectors to solve problems related to Reclamation’s mission and stakeholder interests. Prize competitions complement traditional research by providing an innovation tool that can help find breakthroughs where research has stalled or overcome technical obstacles or complexities. Prize competitions have a proven track record in the private sector for accomplishing game-changing results for both large and small problems. Agencies across the Federal government are successfully using prize competitions to spur innovation and advance on long standing challenges.

Reclamation implements prize competitions through collaboration with other Federal agencies with common interests. This approach leverages complementary Federal capabilities, catalyzes interagency working relationships to solve joint problems, and leads to solutions that have a broader impact across the mission of multiple Federal agencies, our stakeholders, and overall public good. Multi-agency collaborations have been formed in three areas central to Reclamation’s mission: Infrastructure, Water, and Environment.

Technology Transfer

Reclamation’s [Technology Transfer](#) activities through the S&T Program pursue a variety of joint venture research partnership agreements with the private sector, including Cooperative Research and Development Agreements (CRADAs), Materials Transfer Agreements (MTAs), and Facility Use Service Agreements (FUSAs), among others, where industry will play a role in maturing and transforming research results into a useable, manufactured product that can be supplied to Reclamation and the broader water management community. In addition, Reclamation uses Federal technology transfer authorities to protect Federal inventions and license them to U.S. industry which creates jobs and helps U.S. industry better compete in global markets.

Dissemination of Research Results

Disseminating results of research projects, beyond the technology transfer activities described previously, targets a wide audience of Reclamation end-users, stakeholders, and others across the Federal and non-Federal water resources community of practice. The R&D Office assures the quality of disseminated innovation data, products and scientific information compliant with [Reclamation’s Peer Review Policy](#), and requires disseminated research products first undergo peer review by at least one independent peer.

The R&D Office utilizes a contemporary knowledge management system to support research dissemination and improve research workflow through the [S&T Program’s website](#). The S&T Program monitors the progress of the funded research projects through quarterly reports and closeout requirements. At the end of a research project, the PI must complete a research report that documents the results of the project. The S&T Program then posts these final reports on the S&T Program website. In addition to posting final reports from all completed research projects, the S&T Program carries out additional outreach as well.

Additionally, for many of our projects, a research bulletin is created and posted to the S&T Program website as well. Research bulletins summarize project results and identify project impacts or potential impacts that may be realized because of the research. Each quarter, the S&T Program publishes a [Knowledge Stream](#) magazine to provide program participants and stakeholders an update related to ongoing or completed research projects. The S&T Program also develops research area summaries for each research area to highlight completed, continuing and new research projects. To highlight successful research project results, the S&T Program also selects a research “Project of the Year.” The S&T Program also maintains an Arc GIS application to show the geographic distribution of where research projects are conducting field investigations.

Dissemination of prize competition solutions is on a case-by-case basis due to the nature of the relationship between Reclamation and solver. Typically, Reclamation receives a license to use the intellectual property (IP), if any, contained in winning solutions while the ownership of the IP remains with the solver. Brief summaries of the winning solutions are shared through public news releases announcing winners and the S&T Program Annual Call for Research Proposals with the intent that Reclamation researchers may want to advance those solutions. Webinars and presentations typically provided by the winners are also a mechanism for disseminating the prize competition winning solutions.

Facilitated Adoption of Innovation Solutions

When a research project or prize competition yield solutions, there are often additional steps needed to transition those solutions into broad use by targeted beneficiaries. Facilitated adoption efforts are valuable in that they boost transition efforts and enhance the S&T Program’s positive impact to Reclamation’s mission. The key challenge of this program element is identifying the best solutions and/or solution adoption opportunities where facilitated adoption will have the greatest effect on these transition efforts. While this implementation step is built into the project plan for some projects, it is often outside the scope of a research project or prize to see the results implemented.

This is the newest program element to be administered in S&T Program, starting informally in FY 2022 with expectations to be formalized in FY 2023. Initial efforts are focused on completed research projects from prior fiscal years and any prize solutions that may be ripe for implementation, S&T Program staff are engaging internal partners who are interested in implementing the results of these activities. Partnerships are critical to the success of any project and this will be particularly true for facilitated adoption.

Identifying Innovation Needs

To identify Reclamation’s innovation needs, the S&T Program uses multiple approaches for receiving input from within and outside of Reclamation. Reclamation leadership is engaged in two ways. First, the Regional Directors are provided an opportunity to identify their top three highest priority research needs each year. These Regional Director Needs are then listed in the call for proposals so that researchers can propose projects that address these needs. Second, Reclamation’s Commissioner’s Office is engaged each year before the call for proposals is issued to receive feedback and concurrence on the priority research needs to be communicated in the call for proposals as part of the Innovation Strategy Implementation Plan (ISIP).

The S&T Program also coordinates with subject matter experts in Reclamation Regions and other Directorates to understand their innovation needs. One way this coordination occurs is through research road mapping, which involves internal and external entities that provide input on where research is needed for a given topic. There is often then a prioritization of these needs and a formal research roadmap document is completed. Research roadmaps have been completed for a number of our research areas and categories. These documents are posted to Reclamation’s peer review agenda for a discretionary peer review, and then final documents are linked to in the ISIP. All published roadmaps can be found on the S&T website ([Science Priorities Research and Development Office](#)).

Regular coordination with internal partners also occurs through direct communication informal coordination with complimentary programs. The S&T Program utilizes research coordinators and prize theme leads as technical experts in the innovation areas and categories identified in this document. Using their own expertise and through their networks of subject matter experts, additional innovation needs are identified and experts that can contribute to innovation activities are recruited to support efforts to develop and implement innovation solutions.

The S&T Program also identifies research needs through coordination with Federal partners. This includes partners at the Federal, State, and local level, described in more detail in the Partners section. One example of a partnership that supports the development of collaborative research needs is with the US Army Corps of Engineers (USACE). Reclamation and USACE’s Engineering Research and Development Center brought its directors, discipline leads, and researchers together to form a collaborative partnership in March 2014. The team developed a charter to steer joint research efforts in the areas of infrastructure sustainability, ecohydraulics, and invasive species. Its goal is to develop and foster inter-governmental research and development teams to produce and infuse solutions for common agency challenges involving water resources infrastructure and environmental stewardship. An annual meeting occurs to discuss this partnership and identify potential research needs that would benefit from collaboration.

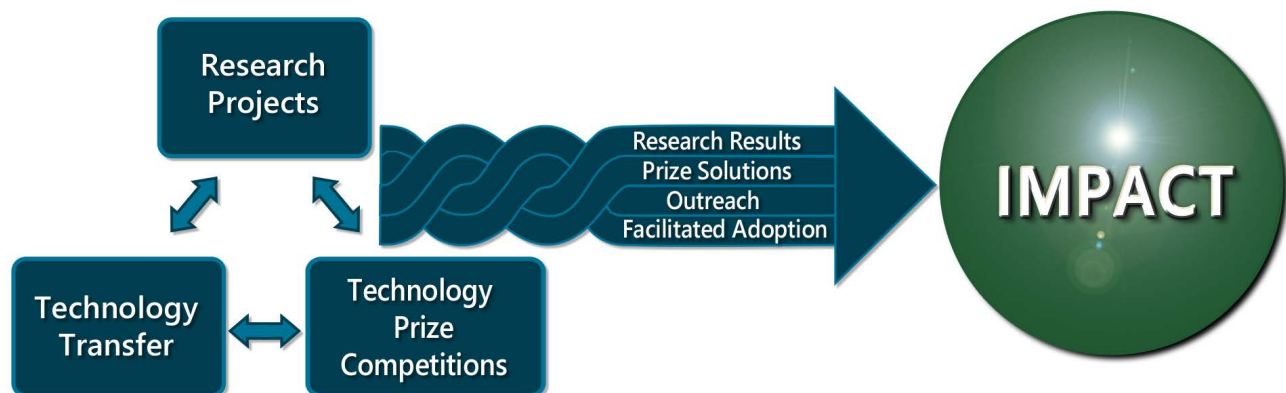
Additional external partner needs identification activities include a charter with Bonneville Power Administration (BPA) and Western Area Power Administration (WAPA). Reclamation meets regularly with BPA and WAPA to identify innovation activities of joint interest. The S&T Program is also engaged in the Memorandum of Understanding (MOU), signed by Reclamation, USACE, and Department of Energy (DOE) in 2020. An action plan for the MOU has been developed and the S&T Program coordinates with the Power Resources Office on innovation activities identified in that action plan.

Integration of Program Elements to Implement Innovation Activities

Once innovation needs are identified, the S&T Program will then determine the appropriate innovation activity to support the development of mature solutions to the need. In some cases, there may be a single program element utilized while in other cases a mix of program elements may be used. Each S&T Program element is complementary and can work in tandem to address an innovation need. For example, if an innovation activity starts out with a research project, knowledge gained from research projects can be used to inform the design of a prize competition, the implementation of research results through facilitated adoption, and/or a technology transfer activity. Alternatively, if an innovation activity starts out as a prize competition, the competition can support the identification of solutions that then require further development through a research project, a technology transfer activity, or may lead to facilitated adoption of results. The determination of which program element is used to further an innovation activity is case-by-case and involves the coordination of program administrators, coordinators, subject matter experts, and the R&D Program Manager.

Throughout the fiscal year, the integration of program elements will be actively supported through a synchronized process between research projects and prizes. During Quarter 1 and 2 the Innovation Strategy Implementation Plan will be developed, which will then inform the call for proposals for research projects released the beginning of Quarter 3. The Implementation Plan will also inform the plan for near and long-term prize competitions based on S&T Program coordination across program element areas.

S & T Program Components



Innovation Need Areas and Categories

The table and narrative descriptions below represent the S&T Program’s areas and categories for 2022 through 2025. The Program structure reflects the alignment between innovation topic areas and Reclamation’s mission. By organizing the Program structure in this way, research needs can be identified in the Innovation Strategy Implementation Plan that closely align with Reclamation’s mission.

The Program structure has not changed significantly, and the only additional research category is “Water Supply Augmentation” under the “Developing Water Supplies” research area. This consistent Program structure reflects to continuing need to innovate across Reclamation’s mission in these topical areas. Within this consistent structure, there have been minor edits to the descriptions of the categories.

The Program structure now aligns Prize Competition Theme Areas with the research areas and categories from the previous Science Strategy document. The Prize Theme Area called Infrastructure is connected to both the Water Infrastructure and Power and Energy innovation area for research projects. The Prize Theme Area Environment is directly connected to the Environmental Issues for Water Delivery and Management innovation area for research projects. The Prize Theme Area Water is connected to both the Water Operations and Planning and Developing Water Supplies innovation areas for research projects. By describing this alignment and connection, this will support better integration of program activities as described later in the document. These established areas broadly support Reclamation’s mission and the innovation needed to support mission related activities in the future.

Prize Theme Area	S&T Area	S&T Category
Infrastructure	Water Infrastructure (WI)	<ul style="list-style-type: none"> ● Dams ● Canals ● Pipelines ● Miscellaneous Water Infrastructure
	Power and Energy (PE)	<ul style="list-style-type: none"> ● Hydro Powerplants ● Pumping Plants ● Non-Hydropower Renewable Energy ● Energy Efficiency
Environment	Environmental Issues for Water Delivery and Management (EN)	<ul style="list-style-type: none"> ● Water Delivery Reliability ● Invasive Species ● Water Quality* ● Sediment Management ● River Habitat Restoration
Water	Water Operations and Planning (WP)	<ul style="list-style-type: none"> ● Water Supply and Streamflow Forecasting ● Water Operations Models and Decision Support Systems ● Open Data* ● Climate Change and Variability*
	Developing Water Supplies (WS)	<ul style="list-style-type: none"> ● Water Treatment ● Water Supply Augmentation ● Groundwater Supplies ● Agricultural and Municipal Water Supplies ● System Losses

*Cross-cutting research areas.

Note: Safety is integrated into the Water Infrastructure and Power and Energy S&T areas.

S&T Program Area and Category Descriptions



Water Infrastructure (WI): Improve safety, reliability, and resiliency of Reclamation water storage and delivery facilities by developing or advancing solutions, tools, and practices that facility managers can use to cost effectively maintain, modernize, or extend the life of Reclamation’s infrastructure. These should be related to operations and maintenance responsibilities of Reclamation facilities.

Categories:

1. **Dams:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, and service life.
2. **Canals:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, and service life.
3. **Pipelines:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, and service life.
4. **Miscellaneous Infrastructure:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, and service life.



Power and Energy (PE): Improve safety, reliability, resiliency, and efficiency by developing or advancing operations and maintenance and regulatory compliance solutions, tools, and practices of Reclamation’s hydropower, pumping, and pump-storage facilities in order to reduce costs and increase energy supplies, and add value, ensuring Reclamation’s hydropower remains a long-term, cost-competitive energy resource with quickly changing energy markets.

Categories:

1. **Hydropower Plants:** Examine, develop, and deploy tools, methods, practices, and strategies to improve safety, operations and maintenance, reliability, efficiency, outage time, and output, including pump-storage plants.
2. **Pumping Plants:** Examine and develop tools, methods, practices, and strategies to improve safety, operations and maintenance, reliability, efficiency, and outage time.

3. **Non-Hydropower Renewable Energy:** Examine and develop tools, practices, and strategies for generating and using non-hydro renewable energy within Reclamation including solar, wind, geothermal, other forms of non-hydro renewable energy, storage, and hydropower and NHRE system support.
4. **Energy Efficiency:** Examine and develop tools, methods, practices, and strategies to improve energy efficiency at Reclamation buildings and non-hydropower facilities.



Environmental Issues for Water Delivery and Management (EN):

Improve the reliability of Reclamation water deliveries by producing effective solutions, tools, and practices that Reclamation water managers can use to carry-out Reclamation’s mission in an environmentally sound manner.

Categories:

1. **Water Delivery Reliability:** Improve the reliability of Reclamation water supplies by finding innovative means to address aquatic and terrestrial ecosystem and species needs while still meeting water delivery contracts.
2. **Invasive Species:** Explore the impacts of invasive species on Reclamation’s infrastructure for water supplies and deliveries, and harm to threatened or endangered species, through the development and improvement of techniques for the prevention, early detection, monitoring, and control of invasive species in Reclamation’s service area.
3. **Water Quality:** Develop and advance tools and practices that Reclamation has the mission responsibility and authority to use in managing water quality issues that are (1) linked to reclamation operations and (2) could impact the reliability of Reclamation water deliveries if not addressed.
4. **Sediment Management:** Develop and improve sediment management solutions and tools that improve the reliability and sustainability of water deliveries from Reclamation reservoirs and associated river systems and improve habitat conditions for threatened and endangered species.
5. **River Habitat Restoration:** Develop and improve aquatic habitat management solutions and tools that improve the ability to comply with regulatory requirements or mitigation measures assigned to Reclamation programs including channel improvements, floodplain connectivity, channel complexity, fish passage and protection, and riparian vegetation enhancement.



Water Operations and Planning (WP): Develop solutions and tools that help Reclamation water managers make effective reservoir and river system operational and planning decisions. Improve the integration, evaluation, understanding, and presentation of critical data and information.

Categories:

1. **Water Supply and Streamflow Forecasting:** Develop and improve solutions and tools to forecast and monitor water supplies, including hydrologic events, and water demands.
2. **Water Operations Models and Decision Support Systems:** Develop and improve reservoir/river system operations and planning models and decision support systems in order to optimally manage water delivery and use for Reclamation. This would include investigations and methods for water supply losses through evaporation.
3. **Open Data:** Develop methods and tools to improve management of Reclamation’s water and related data to make it more comparable across locations, more easily found, and more shareable, both within Reclamation and with other agencies, stakeholders, and the public. This includes expanding applicability and use of the Reclamation Information Sharing Environment (RISE, available at <https://data.usbr.gov/>), a platform for publishing Reclamation’s mission-related data.
4. **Climate Change and Variability:** Develop methods and tools to increase adaptive management and flexibility in the planning, design and operations of Reclamation’s facilities in a variable and changing climate, including management through drought and floods.



Developing Water Supplies (WS): Develop, enhance, and protect water supplies for Reclamation stakeholders with new technologies, solutions, and practices that expand, create, or conserve water supplies.

Categories:

1. **Water Treatment:** Develop technologies, methods, tools, and approaches to advance the treatment of impaired water sources that allow Reclamation to better utilize existing supplies or develop new supplies from non-traditional water resources such as brackish groundwater, seawater, municipal wastewater, produced waters from oil and gas extraction activities, and other impaired sources.
2. **Water Supply Augmentation:** Develop and improve processes, resources, and/or technologies to augment water supplies for Reclamation projects by utilizing water sources such as stormwater; natural treatment systems such as wetlands; or management approaches such as cloud seeding or hydrologic investigations.

3. **Groundwater Supplies:** Develop and improve solutions and tools that advance and optimize groundwater supplies for either storage and/or further understanding of surface water impact on groundwater supplies that can be of use for Reclamation projects.
4. **Agricultural and Municipal Water Supplies:** Develop and improve technologies, methods, tools, and approaches to augment water supplies for agricultural and municipal water demands at a lower cost and mitigating environmental impact for Reclamation stakeholders and projects.
5. **Water Losses:** Develop and improve processes, technologies, and tools that conserve water and/or reduce water losses in Reclamation water storage and delivery systems.

Science and Technology Program Contacts

To request additional information about the S&T Program (research, technology transfer, dissemination of results, or facilitated adoption) or to discuss partnership opportunities, please email research@usbr.gov.

Requests for additional information or interests in potential partnerships in prize competitions can be directed to prize@usbr.gov.