

# RECLAMATION

*Managing Water in the West*

Research and Development Office  
Science & Technology Program

## FY 2019 Science Strategy Implementation Plan



U.S. Department of the Interior  
Bureau of Reclamation

April 2018

## FY 2019 Implementation Plan

**Note:** To jump to a section, click on the Contents item, then click on the link in the box.

### Contents

Introduction.....	4
How are Research Needs and Projects Identified? .....	4
FY 2019 Research Needs.....	8
Water Infrastructure (WI).....	8
Dams .....	8
Canals .....	8
Pipelines.....	9
Miscellaneous Infrastructure .....	9
Power and Energy (PE).....	9
Hydro Powerplants .....	10
Pumping Plants .....	10
Energy Efficiency .....	11
Non-Hydropower Renewable Energy.....	11
Environmental Issues for Water Delivery and Management (EN) .....	11
Water Delivery Reliability .....	12
Invasive Species.....	12
Water Quality .....	12
Sediment Management.....	13
River Habitat Restoration.....	13
Water Operations and Planning (WP) .....	14
Water Supply and Streamflow Forecasting .....	14
Water Operations Models and Decision Support Systems .....	14
Open Data .....	14
Climate Change and Variability.....	15
Developing Water Supplies (WS) .....	15
Advanced Water Treatment .....	16
Groundwater Supplies .....	16
Agricultural and Municipal Water Supplies .....	17
System Water Losses.....	17



## Introduction

To support progress in addressing the research areas and categories identified in the *Science and Technology Program – Strategic Science Priorities – FY2018-FY2021*, this document identifies the specific research needs for each category the Science and Technology Program (S&T) is interested in addressing through solicited and brokered projects during the FY2019 call for proposals.

## How are Research Needs and Projects Identified?

### ***Department of Interior Priorities***

S&T works to ensure its priorities align with Reclamation's mission and the Department of Interior's Strategic Plan. In addition the Department has recently released priorities with the applicable ones listed below.

1. Creating a conservation stewardship legacy second only to Teddy Roosevelt
  - a. Utilize science to identify best practices to manage land and water resources and adapt to changes in the environment;
  - b. Examine land use planning processes and land use designations that govern public use and access;
  - c. Revise and streamline the environmental and regulatory review process while maintaining environmental standards;
  - d. Review DOI water storage, transportation, and distribution systems to identify opportunities to resolve conflicts and expand capacity;
  - e. Foster relationships with conservation organizations advocating for balanced stewardship and use of public lands;
  - f. Identify and implement initiatives to expand access to DOI lands for hunting and fishing;
  - g. Shift the balance towards providing greater public access to public lands over restrictions to access.
2. Utilizing our natural resources
  - a. Ensure American Energy is available to meet our security and economic needs;
  - b. Ensure access to mineral resources, especially the critical and rare earth minerals needed for scientific, technological, or military applications;
  - c. Refocus timber programs to embrace the entire 'healthy forests' lifecycle;
  - d. Manage competition for grazing resources.
3. Restoring trust with local communities
  - a. Be a better neighbor with those closest to our resources by improving dialogue and relationships with persons and entities bordering our lands;
  - b. Expand the lines of communication with Governors, state natural resource offices, Fish and Wildlife offices, water authorities, county commissioners, Tribes, and local communities.
4. Striking a regulatory balance
  - a. Reduce the administrative and regulatory burden imposed on U.S. industry and the

- public;
  - b. Ensure that Endangered Species Act decisions are based on strong science and thorough analysis.
5. Modernizing our infrastructure
- a. Support the White House Public/Private Partnership Initiative to modernize U.S. infrastructure;
  - b. Remove impediments to infrastructure development and facilitate private sector efforts to construct infrastructure projects serving American needs;
  - c. Prioritize DOI infrastructure needs to highlight:
    - i. Construction of infrastructure;
    - ii. Cyclical maintenance;
    - iii. Deferred maintenance.

### ***Research Roadmaps***

Research Roadmaps are an intensive effort to elicit and illuminate the needs within a research category. Roadmapping may be done within a research area, research category, or research needs that requires a deeper dive to discover specifics. These efforts are sponsored by S&T and involve bureau-wide input. Roadmaps typically require six months to one year to complete.

### ***Regional Director Needs***

Each year, prior to the Call for Proposals, S&T solicits Regional Directors for a list of their highest priority research needs for a given year. These needs evolve year-to-year and are published in the annual Call for Proposals. S&T works to be responsive and address these needs by developing a combination of solicited and brokered proposals.

### ***Direct Feedback to S&T***

In past years, S&T held a Research Jam, an internal crowdsourcing event to gather innovative research ideas from a bureau-wide audience. While this yielded some good results, S&T is evaluating alternatives to replace the Research Jam with an improved event. In the interim, a [Google Form](#) has been created to allow research needs to be submitted directly to S&T. These submissions are reviewed and evaluated to determine the appropriateness of listing them in this document.

### ***Partnerships***

S&T maintains partnerships with a variety of federal, state, and local government agencies, as well as non-profits, universities, and private entities. During coordination opportunities with these partners, collaborative research opportunities are identified. This allows S&T to share the funding burden of the project and also expand the knowledge base contributing to the project.

### ***Prize Competitions***

Since 2015, several prize competitions launched and closed with over 350 solutions submitted and 50 winning ideas. Some of these solutions are ready for technology demonstration to further reduction-to-practice. For research furthering prize competition solutions, Reclamation has a nonexclusive license to use the solution for our own use, except for those noted in [this document that summarizes the prize solutions received to date](#). This includes the ability to test, use, modify, and communicate the solution for our own benefit. However, these solutions may not be commercialized without additional approval or additional licensing from the solver.

If interested in working on a prize solution next steps research project, please contact the prize manager for that prize, which is listed on the [prizes website](#). The prize manager can help identify any intellectual property issues, recommend strategies for further investigation of the solutions, and connect the lead researcher to the solver, who we encourage you to involve in the next steps research. These research needs are identified within the research area and category for the respective need and are designated with a ++ symbol. For more information visit: <https://www.usbr.gov/research/challenges/past/index.html>

## Fiscal Year 2018-2021 Science Priorities

The table and narrative descriptions below represent S&T's priority research areas and categories for fiscal year (FY) 2018-2021.

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

\*Cross-cutting research areas

## FY 2019 Research Needs

This section outlines short lists of research needs by research area and category.

### Water Infrastructure (WI)

Improve the resiliency of Reclamation water storage, water delivery, and facilities by producing or advancing effective solutions, tools, and practices that Reclamation facility managers can use to cost effectively maintain, modernize, and extend the life of Reclamation's aging infrastructure. These should be related to Reclamation's operations and maintenance responsibilities.

#### *Dams*

**Description:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, service life, and safety.

**Coordination contacts:** Erin Foraker and Bobbi Jo Merten

**Source of research needs:** [Research Priorities to Enhance Dam Infrastructure Sustainability](#)

**Needs Statements:**

1. Remote sensing or inspection method to detect seepage or material transport paths (cross cutting with Canals).++<sup>1</sup>
2. Methods and materials to detect and fill or repair voids under spillway slabs (cross cutting with Canals).
3. Modeling tools to predict the rate of concrete deterioration, including alkali aggregate reaction.
4. Evaluate and verify finite element modeling of existing concrete and embankment dams based on their historical seismic loading for foundations.

#### *Canals*

**Description:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, service life, and safety.

**Coordination contacts:** Erin Foraker and Bobbi Jo Merten

**Source of research needs:** [Research Priorities to Enhance Canals Infrastructure Sustainability](#)

**Needs Statements:**

1. Effective canal seepage detection methods or technologies for use by engineers or field staff to more clearly define seepage paths (cross cutting with Dams).++
2. Enhanced methods for rehabilitation and maintenance of urbanized canals and immediate response systems for changes to these canals.
3. Methods and materials to detect and fill or repair voids under canal lining (cross cutting with Dams)
4. Underwater canal lining repair materials and methods for cracked, buckled, or bulged linings (underwater crack sealants, grouts, etc.) or underwater canal panel placement material or method.

---

<sup>1</sup> [Detecting the Movement of Soils Within Earthen Dams, Canals, Levees, and their Foundations](#)



5. Non-hazardous tools or methods to control or prevent woody vegetation on canals.
6. Improved, less expensive canal lining, cover, and repair materials and methods.
7. Improved inspection methods to reduce siphon pipe failure rates. Less expensive repair methods to repair pipe in lieu of replacement and associated costs (cross cutting with Pipelines).++<sup>2</sup>

## ***Pipelines***

**Description:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, service life, and safety.

**Coordination contacts:** Erin Foraker and Bobbi Jo Merten

**Source of research needs:** [Research Priorities to Enhance Pipeline Infrastructure Sustainability](#)

### **Needs Statements:**

1. Investigate non-metallic pipes for large diameter and high pressure use.
2. Better ROV instrumentation and faster data analysis for evaluating pipe coatings, including film thickness, and pipe body metallic pipe deficiencies, detecting leaks, and faster data analysis.++<sup>3</sup>
3. Robotic coating preparation and application.
4. Identify or evaluate cost-effectiveness and constructability of alternatives to pressure grouting for tunnels.
5. Demonstrate low- or no-power tools or sensors for detecting or monitoring metallic corrosion when embedded in concrete pipes including prestressed concrete cylinder pipes (cross cutting with Canals).++<sup>2</sup>

## ***Miscellaneous Infrastructure***

**Description:** Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, service life, and safety.

**Coordination contacts:** Erin Foraker and Bobbi Jo Merten

**Source of research needs:** There is not a research roadmap currently available for this category.

### **Needs Statements:**

1. Safety - Identify the potential uses for and safety issues related to driverless vehicles and robots.
2. Security - Develop solutions, tools and practices to further Reclamation's understanding of security risks at its facilities using qualitative and quantitative data. The research should result in data and conclusions that can be integrated into Reclamation's security program to provide Reclamation with an enhanced capability to evaluate and manage risk at its critical infrastructure. For additional details regarding security related research needs, please reference [this document](#).

## **Power and Energy (PE)**

---

<sup>2</sup> [Detecting Leaks and Flaws in Water Pipelines - Stage 1](#)

<sup>3</sup> [Long-Term Corrosion Protection of Existing Hydraulic Steel Structures - Stage 1](#)

Develop and advance solutions, tools, and practices that improve the reliability, efficiency, and safety of Reclamation's hydropower facilities in order to reduce costs and increase energy supplies. Develop tools and strategies to increase energy supplies through renewable energy development and energy efficient practices and policies within Reclamation pumping plants and other facilities in support of Reclamation's operations and maintenance responsibilities.

### ***Hydro Powerplants***

**Description:** Examine and develop tools, methods, practices and strategies to improve safety, operations and maintenance, reliability, efficiency, outage time, and output.

**Coordination contact:** Erin Foraker

**Source of research needs:** For additional details regarding hydropower protection system related research needs, please reference [this document](#).

**Needs Statements:**

1. Hydropower Generation
  - a. Improves safety and occupational health.
  - b. Increases reliability, power generation, and performance.
  - c. Improves operations and maintenance practices.
2. Protection systems
  - a. Test method improvements
  - b. Less invasive protection system test methods for all aspects of the protection system including current transformers (CT) / potential transformers (PT), protective relays, lockout relays, and associated wires and equipment
  - c. Broad approaches to improvements, which minimize outage periods, reduce Operation and Maintenance (O&M) costs, improve reliability and protection, etc.
  - d. Online monitoring of protection equipment
  - e. Environmentally friendly lubricants - Determine the applicability and longevity of greaseless technologies and environmentally friendly lubricants to Reclamation's powerplant operations.

### ***Pumping Plants***

**Description:** Examine and develop tools, methods, practices and strategies to improve safety, operations and maintenance, reliability, efficiency, and outage time.

**Coordination contact:** Erin Foraker

**Source of research needs:** [Research Priorities to Enhance Pumping Plant Infrastructure Sustainability](#)

**Needs Statements:**

1. Buried and Encased Pipe
  - a. Research and develop longer service life interior pipe coatings that can be applied at low temperatures and high humidity
  - b. Review and reassess uses of non corrosive materials, such as polyvinyl chloride, for buried and encased pipe
2. Investigate nondestructive inspection tools, such as ultrasonic testing, to improve efficiency and effectiveness of inspections in hard to access areas
3. Pump Economics

- a. Investigate the economics of repairing versus replacing pumps and pump impellers (the Bureau of Reclamation's [Reclamation] Technical Service Center [TSC] has a pumping plant assets inventory data file)
  - b. Investigate the economics of variable frequency drives with regard to operational parameters, equipment and installation costs, and future utility costs (high power factor)
  - c. Identify and modify machine condition monitoring techniques used for powerplants to be applicable for pumping plants
  - d. Investigate composite materials for intake equipment, such as structural fiberglass, including lifecycle cost and benefit-cost analyses
4. Vibration testing of exposed pipe in pump discharge basins (not in roadmap)

### ***Energy Efficiency***

**Description:** Examine and develop tools, methods, practices and strategies to improve energy efficiency at Reclamation buildings and non-hydropower facilities.

**Coordination contact:** Erin Foraker

**Source of research needs:** There is not a research roadmap currently available for this category.

**Needs Statements:**

1. Explore new technologies and approaches to conduct to improve energy efficiency audits by experts and identify facility specific conservation and efficiency measures.
2. Develop, identify, and educate Reclamation personnel on best practices to achieve facility resilience, including energy and water conservation best practices, zero energy and zero water buildings.
3. Develop a methodology to maximize energy efficiency improvements prior to solar PV installations.

### ***Non-Hydropower Renewable Energy***

**Description:** Examine and develop tools, practices, and strategies for generating and using non-hydro renewable energy within Reclamation including solar, wind, geothermal, and other forms of non-hydro renewable energy.

**Coordination contact:** Erin Foraker

**Source of research needs:** There is not a research roadmap currently available for this category.

**Needs Statements:**

1. Identify and develop facility scale solar training strategies to facilitate the use of solar PV at Reclamation facilities where feasible.
2. Develop expert resources to perform renewable energy assessments and assist with RFPs related to solar PV at Reclamation's 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 address state and federal environmental compliance and court orders.

### ***Water Delivery Reliability***

**Description:** 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.

**Coordination contact:** Connie Svoboda

**Source of research needs:** Research roadmap

**Needs Statements:**

1. Determine water operations impacts to flow hydrographs and water dependent ecological resiliencies (e.g. ecosystems, groundwater recharge, biodiversity).
2. Quantify ecosystem services related to environmental flows.
3. Develop best practices to implement adaptive management for operations to support environmental restoration.
4. Operation strategies to reduce stranding of aquatic organisms during low and high flows.

### ***Invasive Species***

**Description:** Develop and improve techniques for detecting and managing aquatic and riparian invasive species that consume Reclamation water supplies or impede Reclamation water deliveries, or harm threatened or endangered species.

**Coordination contact:** Sherri Pucherelli

**Source of research needs:** Research roadmap and [DOI: Safeguarding America's Lands and Waters From Invasive Species](#)

**Needs Statements:**

1. Determine effective site-specific uses of existing and innovative integrated pest management (IPM) for riparian and aquatic vegetation that reduces flow conveyance or impedes operations (e.g., Phragmites, Eurasian watermilfoil).
2. Determine effective site-specific uses of existing and innovative integrated pest management (IPM) for mussels, fish, birds, mammals, etc. that affect threatened or endangered species or impede operations.<sup>++4</sup>
3. Improve detection, spread prevention, and monitoring methods in order to identify invasive species infestations and reduce range expansion.
4. Determine impacts of invasive species and mitigation measures to protect site specific threatened or endangered species, infrastructure, or operations.

### ***Water Quality***

**Description:** 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.

**Coordination contacts:** Mike Horn

**Source of research needs:** Research roadmap.

---

<sup>4</sup> [Eradication of Invasive Mussels in Open Water - Stage 1](#)

**Needs Statements:**

1. Improve understanding of operational effects on salinity, temperature, oxygen, turbidity and nutrient levels in flow releases, and in-reservoir processes
2. Develop methods to predict, manage, and monitor effects of hydrologic variability on water quality (e.g. future hydrologic regimes, sea level fluctuations in estuarine environments)

***Sediment Management***

**Description:** 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.

**Coordination contact:** Sean Kimbrel

**Source of research needs:** Research roadmap.

**Needs Statements:**

1. Improve monitoring methods to track sediment released from reservoirs and associated impacts
2. Improve understanding and practices of how sediment transport and sediment augmentation interacts with channel morphology to create topographic complexity important for downstream habitat
3. Develop indirect methods to estimate reservoir sedimentation (incorporate prize challenge outcomes where possible)<sup>++5</sup>
4. Develop guidelines for managing sediment transport and deposition associated with dam removal or reservoir sluicing

***River Habitat Restoration***

**Description:** 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, and riparian vegetation enhancement.

**Coordination contact:** Jennifer Bountry

**Source of research needs:** Research roadmap.

**Needs Statements:**

1. Develop alternatives that eliminate need for fish screens
2. Improve upstream and downstream fish passage at dams. ++<sup>6</sup>
3. Develop ecosystem health indicators throughout watershed
4. Evaluate post-construction habitat and design feature performance for rehabilitation projects
5. Better understand effects of ecohydraulics on habitat availability, connectivity, and food webs for aquatic species<sup>++7</sup>
6. Improve future channel change predictions in habitat rehabilitation areas and near Reclamation infrastructure

---

<sup>5</sup> [Indirect Estimates of Reservoir Water Storage](#)

<sup>6</sup> [Downstream Fish Passage at Tall Dams](#)

<sup>7</sup> [Quantifying Drift Invertebrates in River and Estuary Systems](#)

## 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.

### *Water Supply and Streamflow Forecasting*

**Description:** Develop and improve solutions and tools to forecast and monitor water supplies, including hydrologic events, and water demands.

**Coordination contact:** Ken Nowak

**Source of research needs:** [Short Term Water Management Decisions](#)

**Needs Statements:**

1. Investigate new technologies and methods to enhance basin hydrologic condition monitoring data (e.g. remote sensing of snow water equivalent [SWE]).
2. Develop techniques to extend or improve skill of temperature and precipitation forecasts to the sub-seasonal time frame, with particular emphasis on wet/dry extreme events.
3. Develop techniques and workflows to automate data acquisition and usage in response to increasing forecast frequency and decreasing latency.
4. Explore possible hydrologic model performance enhancements by leveraging new or additional data for model calibration and forcings (e.g. Gridded Meteorological Ensemble Tool [GMET]).

### *Water Operations Models and Decision Support Systems*

**Description:** 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.

**Coordination contact:** Ken Nowak

**Source of research needs:** There is not a research roadmap currently available for this category.

**Needs Statements:**

1. Develop approaches and tools to support and improve long term planning for changing or uncertain future hydrologic conditions.
2. Demonstrate the application of new or improved data with existing models toward enhanced operational outcomes.
3. Explore and develop decisions support tools that leverage or pair with ensemble forecast products.
4. Explore opportunities for improved planning and operations that can leverage increasing access to high performance computing resources.
5. Explore opportunities to link or better integrate models and decision support systems with related models (e.g. operations, sediment, and water temperature).

### *Open Data*

**Description:** 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 within Reclamation, and with other agencies, stakeholders, and the public. Proposing teams should familiarize themselves with technical issues identified by the Reclamation Open Data Team, and propose projects that complement [recently completed and ongoing work](#) under this category.

**Coordination contact:** Levi Brekke

**Source of research needs:** There is not a research roadmap currently available for this category.

**Needs Statements:**

1. Develop and demonstrate tools that leverage RWIS and RISE data to enhance decision support frameworks and information visualization in support of engagement, communication, and collaboration amongst Reclamation customers, stakeholders, other agencies, and the general public.<sup>++<sup>8</sup></sup>
2. Develop tools and resources that facilitate adoption and expand utilization of RWIS and RISE systems. This may include development and deployment of new data management resources or enhancements to existing ones for compatibility with the RWIS/RISE systems.
3. Identify effective data resource management frameworks and policies in other organizations and evaluate for applicability and effectiveness in supporting the Reclamation Data Council's potential development of associated frameworks and policies.
4. Recognizing advances and trends in data search and usage (e.g. web 3.0, semantic web, etc) that leverage enhanced metadata and learning algorithms, identify and evaluate such technologies for applicability and effectiveness in Reclamation information management; how can Reclamation prepare so as to take advantage in a timely manner?

### ***Climate Change and Variability***

**Description:** 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.

**Coordination contact:** Ken Nowak

**Source of research needs:** [Addressing Climate Change in Long Term Water Resources Planning and Management](#)

**Needs Statements:**

1. Develop tools and resources to support informed use of weather and climate data in water management applications.
2. Develop methods for communicating results and uncertainties to decision makers.
3. Identify risks posed by extreme weather and hydrology to efficient and continuous operation of water and power infrastructure, and potential adaptation strategies.
4. Explore and quantify uncertainty associated with future water availability projections developed from climate model output.

### **Developing Water Supplies (WS)**

---

<sup>8</sup> [Colorado River Basin Data Visualization Challenge](#)



Develop, enhance, and protect water supplies for Reclamation stakeholders with new technologies, solutions, and practices that expand, liberate, or conserve water supplies.

### ***Advanced Water Treatment***

**Description:** Develop technologies, methods, tools and approaches to advance the treatment of impaired water sources that allow Reclamation to better utilize existing supplies, increase existing Reclamation supplies through augmentation, or prolong existing Reclamation supplies by expanding or developing non-traditional supplies from an outside source such as impaired groundwater or surface water.

**Coordination contact:** Yuliana Porras Mendoza

**Source of research needs:** [Desalination: A National Perspective](#) and [Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater](#)

#### **Needs Statements:**

1. Enhance water management decision making by quantifying the non-monetized costs and benefits of potable and non-potable water reuse compared with other water supply sources.
2. Reducing the environmental impact of water treatment by:
  - a. Reducing chemical usage
  - b. Mitigating biofouling
  - c. Improving concentrate management<sup>9</sup>
3. Develop improved techniques and data to consider hazardous events or system failures in risk assessment of water reuse.
4. Develop innovative new water treatment systems (membranes, systems, processes, etc) for treatment of impaired water for various uses (potable, industrial, storage, municipal, agricultural, etc).
5. Develop models for implementation and management of various water sources in need of one or more treatment for one or more end use.
6. Develop innovative new materials, membranes, and/or systems and processes for treatment of impaired water.
7. Development of water-energy nexus research in the following areas:
  - a. Coupling of renewable energy sources with water treatment processes.
  - b. Modeling of energy efficiency for innovative new water treatment processes or combination of existing water treatment processes.
  - c. Treatment and use of produced/fracking water for increase in water supply and energy production.

### ***Groundwater Supplies***

**Description:** Develop and improve solutions and tools that advance and optimize groundwater storage and conjunctive groundwater/surface water storage and use for Reclamation projects.

**Coordination contacts:** Jennifer Johnson and Ken Nowak

**Source of research needs:** [Brackish Groundwater in the United States](#) and [Ongoing Research Needs: Groundwater-Surface Water Interaction](#)

#### **Needs Statements:**

---

<sup>9</sup> [More Water, Less Concentrate - Stage 1](#)



1. Groundwater quality data needs
  - a. Occurrence and Distribution of Groundwater
  - b. Hydrogeologic Characterization
  - c. Geochemistry
  - d. Brackish Groundwater Use
  - e. Brackish Groundwater Sustainability
2. Groundwater-surface water interaction
  - a. Summarize relevant data and overcoming data gaps.
  - b. Models and processes used to evaluate groundwater-surface water interaction in regulated river systems.

### ***Agricultural and Municipal Water Supplies***

**Description:** Develop and improve solutions and tools that automate, measure, and deliver agricultural water resulting in liberated water or a cost savings for Reclamation or its stakeholders.

**Coordination contact:** John Whitley

**Source of research needs:** There is not a research roadmap currently available for this category.

**Needs Statements:**

1. There are currently no specific research needs for this category.

### ***System Water Losses***

**Description:** Develop and improve solutions and tools that conserve water and/or reduce water losses, in Reclamation water storage and delivery systems.

**Coordination contact:** Yuliana Porras Mendoza

**Source of research needs:** There is not a research roadmap currently available for this category.

**Needs Statements:**

1. Improve evaporation measurement technology that is necessary to evaluate the efficacy of evaporation suppression technologies.
2. Improve evaporation measurement data management at Reclamation reservoirs and evaluate the impact of the sustained water loss.
3. Develop new and innovative ways to reduce the loss of water via evaporation at reservoirs and optimize systems to maintain water at Reclamation reservoirs in order to meet water delivery requirements