BUREAU OF RECLAMATION

Fiscal Year 2025 Science and Technology Research Projects

Identifying and Assessing Dreissenid Mussel Parasites for Biological Control in North America

Lead researcher: Jacque Keele

Year 1 Budget: $459,140

Invasive quagga and zebra mussels are two of the most devastating aquatic invasive species in North America because of their ability to attach to hard underwater surfaces, reproduce in large numbers, and filter water, which can change both the water chemistry and food web. Once these invasive mussels establish in a waterbody, the only available control methods are chemical treatments which are costly, can have off-target effects, and cannot feasibly be scaled to treat large open water systems. Reclamation has partnered with Molloy & Associates to search for parasites in mussel species closely related to quagga and zebra mussels throughout Eurasia. The goal of this project is to search for and assess potential biocontrol agents that can be used to control quagga and zebra mussel populations. The advantage of a biocontrol agent is that it will be self-replicating, specific to quagga and zebra mussels, cost effective, and not cause harm to the environment.

The Laboratory Investigation of Utilizing Recycled Rubber Fills in the Infrastructure-Phase I

Lead researcher: Belay Nerea

Year 1 Budget: $100,000

The U.S. generates about 300 million scrap tires annually, with approximately 60 million scrap tires ending up in landfills each year. This volume of scrap tires presents serious environmental problems. The proposed research aims to utilize scrap tires as a fill material in infrastructure applications. Tire-derived aggregates, processed from the waste rubber tires, possess unique engineering properties of being durable, lightweight, allowing drainage, and having cohesive abilities. These properties reduce pressures on infrastructure, alleviate erosion and the loss of aggregates on unpaved service roads, increase the bearing capacity of foundations, and improve the stability of slopes and embankments. A comprehensive literature review and a series of experiments will be conducted to better understand and quantify the engineering properties of tire-derived aggregates. Recommendations and technology developed for tire-derived aggregates will be transferred via technical presentations, reports, and publications.

A Comparison of Reverse Osmosis and Carbon-Based Treatment Trains for Implementing Direct Potable Reuse of Wastewater for Existing Facilities
Lead researcher: Miguel Arias-Paic
Year 1 Budget: $105,000
With periods of prolonged drought, the American West is impacted by water scarcity and ever-increasing demand. Drought impacted communities are looking to utilize advanced water treatment to further treat municipal wastewater, a readily available local source, to augment potable water supplies. Direct Potable Reuse is the purification and treatment of reclaimed water to a level suitable for drinking, highlighting its potential as a safe and reliable drinking water source. The state of Arizona is implementing regulations for Direct Potable Reuse and trying to understand the technological capabilities required to meet their water quality goals. This project will conduct bench-scale process testing of two advanced water treatment methods to assist in the selection of the treatment train that will best satisfy Arizona's proposed Direct Potable Reuse regulations taking effect in 2025.

Evaluation of Permanent and Laboratory Reference Electrode Performance
Lead researcher: Grace Weber
Year 1 Budget: $94,500
Past Reclamation experience has shown that reference electrodes do not always meet manufacturer lifetime claims. Reference electrodes are used to monitor the performance of cathodic protection systems, either via permanent installation for continuous monitoring or during discrete inspections. This project will investigate this finding and include new reference electrodes technology, to determine if it is superior to typical reference electrodes. Researchers will also evaluate the reference electrodes used for lab testing, due to concerns regarding detrimental effects that may occur during continuous use in long duration tests. Testing will include a variety of types of reference electrodes in conditions common to Reclamation facilities. The expected outcome is that staff will be able to update design specs for field and lab equipment, which will improve work quality and benefit clients. Outcomes will benefit the research partners (USACE ERDC-CERL, Fresno Dam, and FCCO) and all Reclamation facilities that use, or are interested in, reference electrodes.

Augmenting Dissolved Oxygen at Glen Canyon Dam, AZ to Benefit a Downstream Blue-Ribbon Trout Fishery
Lead researcher: Alexander Walker
Year 1 Budget: $58,000
Releases of water from Glen Canyon Dam in Arizona control downstream water quality. Recently, low dissolved oxygen concentrations from Glen Canyon Dam releases are a matter of concern due to their impact on the tailwater ecosystem. Many aquatic taxa are sensitive to low dissolved oxygen and effects on rainbow trout populations in Glen Canyon Dam are expected to be particularly pronounced. Low dissolved affects survivability of trout populations and can cause death. Increasing dissolved oxygen would improve trout population survivability, supporting an important recreational trout fishery, as well as meeting environmental goals. We identified aeration or oxygenation as potential methods to elevate tailwater dissolved oxygen.

These dissolved oxygen techniques are established, have been applied previously at multiple dam sites, and significantly improve tailwater ecosystems. Still, questions exist at about cost-effectiveness and optimal design. We will develop financially and logistically feasible options for augmenting downstream dissolved oxygen.

Establishing Risk-Informed Coating Maintenance for Steel Penstocks
Lead researcher: Bobbi Jo Merten
Year 1 Budget: $155,648

This proposal establishes a risk-informed coating maintenance approach for Reclamation steel penstocks that includes ultrasonic thickness (UT) testing, coating visual assessment, and coating impedance spectroscopy (impedance) testing. Reclamation repair costs to address corrosion pitting and corrosion-caused metal loss due to poorly maintained coatings are growing. The risk-informed approach will prioritize coating maintenance across different facilities. This will minimize penstock corrosion risk and consequences while maximizing coating investments. The findings will also inform ongoing condition-based maintenance initiatives using permanent sensors.

Evaluating Rock Material Properties from In-Situ Flexible Membrane Dilatometer Tests Using an Inverse Modeling Approach
Lead researcher: John Foran
Year 1 Budget: $87,000

Effective engineering design of our infrastructure depends on the proper characterization of the material it is founded on. Laboratory testing of earth materials is the industry standard for determining material properties of the subsurface; however, it falls short in that we are limited by the size of samples we can test. In-situ tests allow us to test larger volumes of material compared to similar laboratory tests, but in the case of the flexible membrane dilatometer test, there is considerable uncertainty in the direct applicability to engineering design. This proposal aims to reduce uncertainty in foundation characterization by developing a numerical model that will allow us to evaluate the engineering properties of in-situ materials from flexible membrane dilatometer tests.

Combining Physically Based Spatially Distributed Snow Modeling with High Spatial Resolution Remote Sensing to Improve Snowmelt Runoff Forecasts in the Truckee-Carson Basin
Lead researcher: Austin Balser
Year 1 Budget: $100,000

This project seeks to develop a model to track snowpack evolution spatially across the Truckee and Carson River watersheds. The upper reaches of the Truckee and Carson basins are characterized by large elevation changes, from 5,000 feet above sea level to over 10,000 feet above sea level. The prominence of the highest elevations in the basin lead to significant impacts from wind redistribution of snow and changes in the snowpack that are not accurately represented in data from lower elevation observation sites, such as those typically used from the Snow Telemetry network. Better understanding the extent of snow in the basin will improve

forecasting and inform operational decisions for the management of water resources, while protecting life and property in the basins.

A Biological Agent to Safely Eradicate Invasive Mussels in Reservoirs
Lead researcher: Sherri Pucherelli
Year 1 Budget: $290,500

When invasive dreissenid (zebra and quagga) mussels become established, they can significantly impact habitat for native species and the maintenance and operation of hydropower plants. Unfortunately, there are no viable control methods available to reduce or eliminate mussel populations in large reservoirs. This project has the potential to safely eliminate or suppress zebra and quagga mussels in U.S. waters through the engineering of a natural pathogen known as a disseminated neoplasia. Previous work on the project has established methods of dreissenid aquaculture, spawning, and production of early embryos. The embryonic material has allowed for development of methods for the introduction of foreign RNA, DNA, and other materials into dreissenid cells. This project will focus on creating cells which will be tested to determine quagga verses zebra specificity, relative toxicity, and capacity for dissemination in infested water bodies.

Integration of Renewable Energy Sources – Implementation of a Hydro Generation Start/Stop and Cycling Costs Methodology
Lead researcher: James Dehaan
Year 1 Budget: $99,500

In today's power market, many hydro facilities are struggling financially. Often these facilities are providing more and more load balancing services, as the amount of wind and solar energy on the power system increases, while revenue streams based solely on hydro energy production are not sufficient to cover the added costs associated with providing these additional services. Without a method to identify, evaluate, and determine the cost of providing load balancing ancillary services that include start/stop cost and cycling costs, it is impossible to determine the financial impact to hydro facilities and justify budgetary compensation. There is an urgent need to identify these costs so that hydro facilities can either minimize these costs or be sufficiently compensated for supplying these needed power system services.

Accelerating Breakthroughs in Cavitation Resistant Materials Performance
Lead researcher: Allen Skaja
Year 1 Budget: $101,940

The development of improved cavitation resistant materials is significantly reducing the cost of cavitation repairs. A 2024 Science and Technology Return-on-Investment analysis found a potential return of 127,000% if a 5% outage reduction could be achieved. Reclamation laboratories are limited in the scale of this research by the current facilities and have observed a lack of correlation between lab results with the existing apparatus and preliminary field performance. This proposal addresses these limitations by upgrading Reclamation's cavitation testing facility and standardizing testing procedures across Reclamation, its research partners, and other water infrastructure entities. These improvements will provide immediate benefits to

cavitation resistant materials research by realizing testing efficiencies, increasing throughput, and providing better correlation to field performance. In the future, cavitation resistant materials may also provide significant cost savings to Reclamation facilities.

Demonstration of Remoted Inspection for Inaccessible Metallic Pipe
Lead researcher: David Tordonato
Year 1 Budget: $195,752

Traditionally, Reclamation's interior inspections of buried or encased metallic pipe, such as penstocks and outlet works, have been completed by humans, typically using rope access techniques where necessary. Robotic crawlers and submersibles may offer the ability to physically collect information without putting humans at risk. This project seeks to identify and demonstrate solutions for inspection of inaccessible features, such as penstocks with small diameters (less than 42-inches), as well as restricted or challenging access points.

Using Monitoring While Drilling Technology to Improve Subsurface Characterization
Lead researcher: Evan Lindenbach
Year 1 Budget: $115,000

This research project will continue a previous effort focused on improving subsurface characterization with Measuring while Drilling technology. Measuring while Drilling incorporates a number of state-of-the-art sensors onto a drill rig to capture significantly more information about the subsurface and facilitate a data-driven approach. The use of Measuring while Drilling is rapidly evolving for geotechnical exploration programs; Reclamation is at the state of the art and is partnered with the FHWA, USACE, and several universities to forward the technology. As geotechnical explorations are occurring across Reclamation during all parts of the year, with costs well in the millions of dollars, any improvements to the data collection, analysis, and end use represent a significant value proposition.

Optimized Detection of Invasive Mussels to Protect Reclamation Assets
Lead researcher: Diane Mench
Year 1 Budget: $373,612

Early detection of invasive quagga and zebra mussels will allow managers at Reclamation reservoirs and facilities to contain incipient populations and implement controls to prevent or reduce devastating ecological and economic impacts. This project will support sample collection and analysis for the Reclamation invasive mussel early detection program. It will focus on optimizing sample collection and analysis methods, data management, communication, and biosecurity. The project will also investigate methods to develop a cost-benefit analysis framework, to estimate the value associated with the invasive mussel early detection program.

Field Evaluation of a Mussel Mitigating Structural Repair System for Small Diameter Piping
Lead researcher: Vesta Zhelyaskova
Year 1 Budget: $131,144

Small diameter piping is an essential but vulnerable part of Reclamation's water infrastructure. In areas impacted by invasive mussel populations, pipes with diameters of less than 24 inches are at risk of clogging from mussel growth on the pipe interior. Clogged piping can result in costly disruptions at dams and hydropower plants, i.e. unexpected water outages and overheating of power-generating units. Furthermore, many of these pipes are found to be structurally compromised by corrosion. This work proposes a small diameter pipe refurbishing technology that combines structural repair and mussel mitigation. The system is based on a commercial fiber reinforced polymer pipe repair system, but is augmented with a foul-release coating. When installed in a small diameter pipe, the system will provide structural reinforcement to mitigate corrosion damage, in addition to protecting the pipe from mussel overgrowth. The project will evaluate the field performance of this novel system.

Hydropower Runner In-Situ Polymer Extensions for Improved Operations
Lead researcher: Kelly Kepler
Year 1 Budget: $126,152

Drought and fluctuating reservoir conditions are changing the way powerplants in Reclamation's fleet operate. Powerplants are being asked to be more flexible in their operations than before by operating in off-design or high and part load regions, which can result in cavitation damage or excessive vibration. This project evaluates a novel low cost, in-situ polymer extension option to alter runner performance with respect to cavitation and overall operating range. The project will select a powerplant to test leading and trailing edge polymer extensions and their effect on unit performance, with the goals of reducing cavitation damage, increasing operating ranges, and promoting climate resilience in hydropower operation.

Hydropower Runner Alternative Manufacturing Methods
Lead researcher: Kelly Kepler
Year 1 Budget: $107,568

Improving the value of hydropower has been a Reclamation and federal government goal in recent years, as operation, maintenance, and replacement costs have steadily increased with aging infrastructure and stagnating manufacturing processes. In this project, Reclamation will partner with General Electric Vernova, the Department of Energy, and Hoover Powerplant to investigate and demonstrate a runner manufactured through a novel automated process developed by General Electric Vernova, using additive manufacturing and robotic welding. The final runner will be installed on-site at Hoover Powerplant. The project will make recommendations on the best uses and inspections for the new manufacturing method.

Using Machine Learning to Automate Crack Mapping and Structural Health Monitoring
Lead researcher: Evan Lindenbach
Year 1 Budget: $99,000

Machine Learning, and the broader umbrella of Artificial Intelligence, are tools where a user can utilize iterative algorithms to find hidden patterns in a data set. These patterns may not be readily apparent to the outside observer. The use of Machine Learning is rapidly growing across

all industries, with many applications for dams, water conveyance systems, and power generation.

This proposal seeks to fund the development of Machine Learning tools for two immediate areas of need: 1) automating the detection and mapping of cracks in concrete, and 2) improving structural health monitoring and anomaly detection. The research will be performed by a cross-disciplinary team of engineers and scientists and will have impacts across Reclamation. These tools are in demand at our facilities, as evidenced by the broad project team and the direct connection to need statements in the ISIP.

Investigating Adhesion and Internal Stress of Coatings
Lead researcher: Allen Skaja
Year 1 Budget: $144,920

This project will investigate the internal stress and loss of adhesion developed in coatings during fluctuating immersion exposure conditions for gates, bulkheads, and stop logs. These types of infrastructure are subjected to changing conditions including ultraviolet (UV) light, water immersion, and wetting/drying cycles. The strains from changes in temperature and hydration levels, combined with the difference in thermal properties of the coatings and steel substrates, impart significant stresses to the coatings and can result in coating failure. Vinyl coatings were historically used on many structures in fluctuating service conditions and have performed well over many decades. A better understanding of coating failure by coating adhesion and internal stress is needed to find longer service life coatings.

Concentrate Minimization Pilot Using Novel In-Line Precipitator to Reduce Cost of Inland Water Treatment
Lead researcher: Saied Delagah
Year 1 Budget: $145,096

Desalination technologies today use membranes and can recover 50 to 85% of the feedwater as pure water, with the remaining discharged as the concentrate stream, containing the minerals, contaminants, and salts. This remaining concentrate stream is an expensive barrier to wide-scale adoption of inland desalination. Impaired waters containing salts can crystalize and form "scale" on the membranes during desalination, thus impeding high water recovery and increasing the cost of treatment. Our pilots will demonstrate a novel in-line precipitator that controls the point of crystallization, which will reduce the cost of concentrate management, facilitate inland desalination and create additional usable water supplies.

Developing a Low-Maintenance Precipitation Sensor
Lead researcher: Joseph Wright
Year 1 Budget: $188,896

Reclamation water managers rely on precipitation measurements for both planning and operations. Such measurements are used to characterize watershed hydrology and monitor basin conditions. These measurements are also critical inputs for hydrologic models, streamflow forecast models, and other decision support tools. A low-maintenance, non-contact

sensor would eliminate many of the challenges and constraints of current precipitation gauges. These include the use of antifreeze fluid to melt solid precipitation in all-season storage gauges (e.g., the "rocket gauge" design used at NRCS SNOTEL) sites, as well as the high-power requirement needed by heated tipping bucket gauges. This project continues the effort made by Reclamation's "Counting Every Drop" prize competition by developing a low-maintenance, non-contact precipitation sensor that can be deployed in remote Reclamation watersheds.

Investigation of Relationships among Water Resource Management Adaptation Strategies

Lead researcher: Saied Delagah

Year 1 Budget: $58,860

Some water resource management adaptation strategies (namely conservation, water reuse/recycle, and desalination) are increasingly used to address water scarcity and water quality issues. These strategies can affect the volume and composition of watershed waters (labeled as 'effects' in the proposal). The research will investigate the effects of implementing WRM adaptation strategies on watershed waters and examine how these effects may influence the feasibility of using and/or processing the affected waters.

Multiple Approaches to Managing Salinity Accumulation in California's Central Valley

Lead researcher: Grace Scarim

Year 1 Budget: $90,000

Salt is accumulating in California's Central Valley due to the concentration of agricultural (ag) drainage. The Central Valley, a national hub for food production, is experiencing more impacts to land each year due to the importation and accumulation of salt. Salt has fallowed 250,000 acres and limited farming productivity for an additional 1.5 million acres due to crop sensitivities. There is currently no solution for salinity importation. This work looks to limit salinity impacts while providing safe water for wildlife and decreased communal financial burden. This research is applicable to saline ag drainage / water that is not being managed. This project aims to test several treatment options, including a "minimal selenium removal" option, to determine the water quality necessary to feed a passive constructed wetland to manage ag drainage. Water quality will be compared to other successful wetlands fed by agricultural drainage, such as the Ciénega de Santa Clara in Mexico.

Uncrewed Autonomous Systems Solutions Scoping

Lead researcher: Robert Allen

Year 1 Budget: $46,100

There has been significant progress made over the last twenty years in the autonomous systems space, with a variety of systems, from divers to uncrewed aerial systems, to humanoid or canine-like robots being developed. Can Reclamation adopt the use of uncrewed, autonomous systems to improve personnel safety, efficiency, and expand its capabilities? This scoping study will assess the various systems and weigh factors such as capabilities (e.g. types of sensors, weight of load that can be lifted, method of movement, etc.) and other parameters

(e.g. cost, active battery life, charging capabilities), to see if there is potential for use of these systems in Reclamation facilities.

Novel Potable Reuse Treatment Process to Lower Cost and Energy Requirements, and Increase Contaminant Removal
Lead researcher: Saied Delagah
Year 1 Budget: $140,400

Climate change impacts on the water cycle reduce the availability of drinking water sources. Direct and indirect potable reuse (potable reuse) are becoming an increasingly popular means for communities to extend their water resources. Two major issues for expanding reuse projects exist: first, water reuse has relatively high energy demand; and second, there are concerns about health risks due to increasing organics and a number of contaminants of emerging concern ubiquitous in water sources today.

This study will further test and develop a resilient, more energy-efficient method to produce sustainable water and remove organics and contaminants of emerging concern from the environment. If successful, the novel treatment approach could be applied at wastewater treatment plants considering direct or indirect potable reuse.

Developing a Standard Method for Ball Mill Disaggregation of Slakable Rock and Desiccated Fine-Grained Soil
Lead researcher: Richard Bearce
Year 1 Budget: $97,000

Reclamation's facilities have complex geology. Often, soil and rock contain materials that are difficult to sample and test due to their fine-grained composition and bonded/cemented nature. Breaking down slakable fine-grained rock and soil by hand for laboratory testing is time consuming, labor intensive, and inconsistent depending on operator. Preparing samples via ball mill provides more accurate and consistent laboratory results and is also less labor intensive than hand processing. This project builds on previous research evaluating the variables associated with ball milling geomaterials to develop a standardized approach.

Informing Best Practices During Permeability Testing
Lead researcher: Carolyne Bocovich
Year 1 Budget: $100,000

Permeability, the rate that water flows through a soil medium, is essential data for seepage analysis and modeling, as well as for evaluating dam performance and the risk of potential failure modes, such as internal erosion. It is also a critical design criterion for seepage cutoff walls. Permeability testing is conducted as part of nearly every Reclamation Project; accurate test results are critical to the project and Reclamation’s mission. This research will refine the state of the current practice by informing best practices outlined in the ASTM D5084 Standard used to determine permeability through laboratory testing. Further, this research will investigate methods to validate laboratory testing equipment used across the industry, when conducting the flexible wall permeability test. By informing the ASTM Standard, this research

will address best practices within Reclamation laboratories and across the geotechnical industry.

Developing Guidance for Hydrokinetic Technologies in Open Waterways - Culmination of Field and Laboratory Testing

Lead researcher: Joshua Mortensen

Year 1 Budget: $87,000

Hydrokinetics (HK) use the energy from flowing water in open channels to generate power. Although HK is marketed as a low-cost system that utilizes existing infrastructure and has widespread implementation potential (making Reclamation an attractive target), important considerations for impacts to canal operational and safety must be addressed. Canal systems were designed to convey water at low speeds for effective operation and minimal energy dissipation. HK field demonstrations from past research have produced increased water levels, which can increase risk for overtopping, canal leakage, and disruptions to general canal operations. This project continues work under an existing CRADA into FY25-26 to combine findings from field and laboratory testing and develop guidance for safe and effective application of HK technologies. This guidance will be a valuable resource for engineers, water and power managers, canal operators, and HK developers in both government and private sectors.

Using Cloud-Seeding Simulations to Understand Precipitation and Streamflow Impacts in the East River Basin of Colorado

Lead researcher: Lindsey Bearup

Year 1 Budget: $179,846

This project aims to understand how cloud seeding affects the annual precipitation and streamflow within the East River Basin, Colorado. Pre-existing simulations of cloud seeding will drive new simulations of hydrology under varying initial land-surface conditions (i.e. soil moisture), to quantify how cloud seeding could affect different components of the water budget. Comparison with field campaign data will help to constrain models to produce more accurate simulations of cloud seeding and its impacts in an area of complex terrain. Such analysis will benefit water managers in this region by using new capabilities to assess the potential for weather modification to enhance snowpack, streamflow, and soil moisture in a drought-prone region of the Upper Colorado River Basin.

Current and Future Potential for Heavy Springtime Liquid Precipitation in the Bitterroot Mountains

Lead researcher: Amanda Stone

Year 1 Budget: $31,440

The potential for floods caused by large rain events on snow during spring in mountainous watersheds is generally not well understood, due to few observations in the streamflow records. This phenomenon is even more elusive in orographically protected regions, where large rain events are less probable and therefore less likely to be observed directly. Future climate may also result in shifts from snow to rain during spring. In collaboration with climate

scientists at NCAR, we will examine the current and future potential for springtime liquid precipitation events in orographically headwater basins. Research will take place at a pilot study site at Como Dam, in the Bitterroot Mountains of Montana. Findings will improve the understanding of the potential for liquid precipitation during a time period when reservoirs are filling rapidly and storage is crucial, but dam safety risks are still present.

Modeling Reservoir Sediment Distribution Through Time
Lead researcher: Melissa Foster
Year 1 Budget: $82,600

Dams trap river sediment in reservoir deltas. Understanding our current and future ability to deliver water and produce hydropower hinges upon understanding both the volume and location of sediment deposited in reservoir deltas. Recent Reclamation applied science projects constrained the total future sediment volume at Reclamation reservoirs. This project seeks to address a key data gap associated with past work: where is sediment deposited in the reservoir delta? Modeling the reservoir area and capacity at a range of elevations will enable better predictions of when key infrastructure, such as low-elevation intakes and dead pool storage, will be impacted by sedimentation. This project will partner with US Army Corps of Engineers (USACE) to apply HEC-HMS, a model developed by USACE, to model reservoir sedimentation profiles. Once the model is calibrated with past data, we will move forward to generating elevation profiles for predictions of modern-day reservoir area and capacity.