BUREAU OF RECLAMATION

FY 2024 Science and Technology Research Projects

Additional Funded Projects – Spring 2024

Evaluation of Foul-Release Coatings Against Mussel Fouling for Long-Term Use, Year 1 Funding: $63,000

Quagga and Zebra mussels are an invasive species of freshwater mussels that continue to impact hydropower and water-management agencies. Field evaluation of commercially available foul-release coatings (FRC) has shown specialized coatings to be effective in the prevention of zebra and quagga mussel fouling, in the short term. However, these commercially available products are designed to be applied to ship hulls and offshore marine platforms which are recoated regularly, often not exceeding six years. Due to Reclamation's operation requirements, a 15 year or greater service life is required. Since this time requirement exceeds the designed service life of commercially available FRCs, long-term testing is required to determine how the coatings will retain their foul-release properties, to determine the coating's durability, and to determine when failure occurs. This proposal will collect data on long term coating durability to allow for proper coating selection on structures. This information will also allow for predicted service performance, which will be used to conduct an economic study on the cost savings from reduced outages, cleaning, and lost revenue, and the rate of return of recoating structures. Information and data collected from previous research and this project will be used and shared with partner organizations to develop more durable foul-release coatings.

Methodology Assessment for Large-Scale Particle Image Velocimetry, Year 1 Funding: $45,000

Large-Scale Particle Image Velocimetry (LSPIV) is a technique utilized by Reclamation and other entities to obtain surface velocity measurements both in field and laboratory settings. LSPIV differs from other techniques used to collect velocities in that it uses images to track particle movement, often a seeding material such as foam beads in the lab or a biodegradable option in the field, over time. As this method of acquiring velocities is non-intrusive, it can be used in areas of interest that would be harder to access or are too shallow for other velocity measurement techniques. Currently, Reclamation's Hydraulics Laboratory uses LSPIV on physical model and field studies that would benefit from streamline information and surface velocity data such as habitat restoration and fish passage projects. However, there are issues with the LSPIV techniques currently being employed. Clumping of the seeding material and settings in the data collection process can skew velocity readings around key areas. This can result in a decrease in performance of fish passage and river restoration projects. Recently, new advances have been made in software processing packages including USGS's recently released TRiVIA. This project would aim at testing LSPIV techniques from seeding material to data processing to ensure best practices are being utilized.

Fluorotelomer Alcohol Presence Within the California-Great Basin Region: Determine Potential Data Gaps and Identify Risks to Reclamation Waterways, Year 1 Funding: $30,000

Recent per- and polyfluoroalkyl substances (PFAS) research suggests that precursor compounds contribute most of the mass from PFAS used in manufactured products (Pickard et al., 2022). One group of precursor compounds, Fluorotelomer Alcohols (FTOHs), is of particular concern because they are easily dispersed throughout the atmosphere and readily degrade to form PFAS. These characteristics suggest that levels of PFAS contamination could be predicted from assessing the potential risk of FTOH presence. This study is a targeted review of existing published FTOH research, with a focus on California-Great Basin (CGB) Region watershed areas. Risk factors that may indicate FTOH presence and/or environmental impacts from PFAS will be compiled and used to develop a risk-assessment tool for ranking potential risk for PFAS contamination. Reclamation currently does not have a standardized method for assessing waterbody risk of PFAS contamination. Given the elevated level of regulatory activities, a risk-assessment tool may offer an early-warning and ranking process that could inform further monitoring and prevention efforts as well as guide decision-makers.

Modeling Wildfire Effects on Surface-Water Quality at a Watershed Scale, Year 1 Funding: $100,000

Wildfire can greatly alter natural processes that govern the quantity and quality of downstream water resources in forested watersheds. Unburned watersheds provide a suite of ecosystem services that produce high-quality surface water, such as shading, increased infiltration, decreased erosion, and nutrient uptake. Burning can have profound impacts on the hydrologic cycle including potentially large changes in evapotranspiration, surface water runoff, and groundwater recharge and resulting baseflow. Current gaps in our knowledge of wildfire effects on surface-water quantity and quality include transport of sediment, nutrients, and metals. Further, predictive models are not currently available to water managers to evaluate the effects of wildfire on surface-water quantity and quality. This research will conduct a literature review, sample and analyze pre- and post-fire soil, water, and wildfire ash, build a watershed model to describe and simulate effects of wildfire on surface-water quantity and quality, and test and apply the model in Lake Berryessa (Pope Creek and Putah Creek) watershed. The modeling approach will test the differential effects of low, medium, and high burn severity on water quality. This information will allow land managers to consider the impacts on water resources when deciding about fuel reduction and fire management strategies.

Understanding the Impacts of Winter Flow on Habitat Use and Availability for Native and Non-native Trout in the South Fork Snake River in Eastern Idaho (Water Operations and Planning), Year 1 Funding: $35,000

Palisades Dam, located in eastern Idaho, is owned and operated by Reclamation. It primarily controls flow in the Snake River, which is the largest contributor to water supplies in eastern and southern Idaho. The South Fork Snake River (SFSR) from Palisades Dam downstream to the confluence of the Henrys Fork with the Snake River is home to a highly prized trout fishery with a large economic value to the surrounding areas. Winter flow from Palisades Dam is strongly correlated with native and non-native trout survival. Successful recruitment of all species of trout largely depends on flow, and consequently, available habitat during their first winter. The objective of this research will be to develop critical insight into two areas: 1) the relationship between flow below Palisades Dam and habitat quality and quantity, 2) the impact

of habitat availability on juvenile survival and mortality during the winter. Specifically, the research will provide critical information to management groups, primarily Reclamation and Idaho Fish and Game, to effectively manage both water supplies for future years irrigation use as well as fisheries health.

Determining Optimal Mni Wiconi Treated Water Quality to Minimize Impacts on Distribution System Materials, Year 1 Funding: $80,000

The Mni Wiconi Rural Water System provides potable water to a service area about one sixth the total area of South Dakota. The distribution systems are supplied with treated surface water from the Mni Wiconi Water Treatment Plant (MWWTP). Segment 1 of the South Core Pipeline, an 8 mile section of cement mortar lined steel pipe, has experienced thirteen pipe failures since June 2015, averaging $250,000 per repair. Based on a sampling and modeling study, it was recommended that the pH of the treated water be controlled to 8.0 in the MWWTP treated water. After this change in pH, pipeline leak frequency has significantly decreased from 9 per year to 4 in the last 15 months. Additional bench scale tests have been conducted also corroborate that increasing the pH protects steel by precipitating a layer of calcium carbonate onto the surface. However, difficulties exist in controlling pH at the bench scale, therefore testing at the full-scale facility is proposed in this study. Additionally, this study looks to analyze the potential of foregoing replacement of the existing core pipeline or selectively replacing pipe sections by testing core pipeline materials and determining long-term surface characteristics and material response to the water quality.

Changes to GHG emissions as a result of Dam Removal in the Klamath, Year 1 Funding: $222,500

Freshwaters constitute an important, highly variable, and poorly characterized component of the global carbon cycle. Reservoirs are an important, management-sensitive subset of freshwater ecosystems with a disproportionately large impact on carbon cycling. Dam construction and associated river impoundment is often assumed to increase both sediment carbon storage and carbon-based GHG emissions. In contrast, dam removals are expected to reduce carbon storage and the potency of reservoir GHG emissions. However, studies comparing pre-dam and post-dam carbon cycling are exceedingly rare, and studies comparing dammed reservoir fluxes with post-dam-removal carbon fluxes are non-existent. This work seeks to use the rare, large-scale ecosystem manipulation of the Klamath River (the largest river restoration project in history) to improve understanding of how dam removal affects reservoir/river carbon cycling, while providing generalizable, fundamental and management-relevant insight into environmental controls on aquatic carbon cycling.

Snow Depth Estimation using InSAR (Interferometric Synthetic-Aperture Radar) Technique, Year 1 Funding: $180,888

Accurate estimation of snow depth and snow water equivalence (SWE) is critical for water supply forecasts and water management at Reclamation. This proposal aims to develop collaboration among Reclamation and National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) Interferometric Synthetic-Aperture Radar (InSAR) experts to evaluate the suitability and limitations of using the InSAR satellite remote sensing technique as a comprehensive monitoring tool for evaluating seasonal snow depth and SWE and informing snow-melt water resources for the Reclamation water information system. The proposed research will develop an alternative snow depth estimation approach using InSAR data and time-series analysis that will offer an alternative to current methods used by the Reclamation water resources area offices and other agencies. The periodic collection of InSAR data and the

time-series analysis results will provide valuable information to Reclamation in the evaluation of snowmelt water resources in the future.

Laboratory Investigation of Commonly Used Geomembrane Liner Materials, Year 1 Funding: $88,000

Reclamation's Materials and Corrosion Laboratory (MCL) has multiple subgroups handling cathodic protection, coatings, hazardous materials, and geosynthetics projects and research. The coatings subgroup has spent many years curating coatings tabulations though research involving durability and advanced weathering testing protocols. Coatings tabulations are designed to recommend multiple coating options from an array of manufacturers that have been tested and approved for specific applications. There are coatings tabulations for atmospheric coatings, buried coatings, and impacted immersion coatings to name a few. Currently the geosynthetics subgroup does not utilize any type of tabulation system and has not conducted laboratory durability and weathering testing for materials from the array of different geomembrane manufacturers that are currently in business. Just like any industry, there are high-quality geomembranes, and low-quality geomembranes. The goal of this research is to evaluate different geomembrane materials, from several different manufacturers, to develop a tabulation system for the different types of liner applications and projects that Reclamation engineers write specifications for. This research will allow Reclamation engineers to curate geosynthetics tabulations based on quantitative laboratory testing data. These tabulations will allow the engineers to specify the best materials for each individual geomembrane lining project, providing immense value to Reclamation, and addressing this clear need.

Investigating methods to detect turbidity currents; Tuttle Creek, Year 1 Funding: $135,120

Turbidity currents can be an effective approach to evacuating sediment from reservoirs under the right set of conditions. Identifying the location and rate at which turbidity currents progress towards a dam/ reservoir outlet can be challenging, and effective methods of detection are still in the evaluation stage. This proposal is an ancillary effort to an Army Corps of Engineers injection dredging project at Tuttle Creek (KS). The Corps has requested that Reclamation be involved by deploying a variety of technologies within the reservoir to determine what techniques are effective at detecting the turbidity current. The objective is to assess the performance and reliability at detecting a turbidity current for a variety of devices currently used by Reclamation for different purposes; for example, an acoustic doppler current profiler (ADCP) which is primarily a flow measurement device. A simple presence/absence level of detection is the intention. Quantifying sediment concentration or load within the turbidity current is beyond the scope of this proposal. The list of devices to be tested includes, but is not limited to: ADCP, Castaway, LISST-ABS, ADV attached to a sounding weight, spring-loaded point sampler, DH-48, and sub-bottom profiler.

Initial Funded Projects – Fall 2023

Investigating the Need for Corrosion Protection of Steel Reinforcements in Concrete at Reclamation, Year 1 Funding: $43,100

Reinforcing steel bars (rebar) are commonly used to improve the tensile strength of concrete, but the structural integrity of this material can be compromised by environmental factors that lead to pitting corrosion of steel. Methods for protecting rebar from corrosion include the use of galvanic anodes (a form of cathodic protection) and corrosion inhibitors. These techniques are frequently used in private industry but are not common within Reclamation. This scoping study will evaluate Reclamation's need for corrosion protection of rebar and potential for cost savings by identifying facilities with repeated concrete deterioration issues and determining whether corrosion protection could provide savings in concrete maintenance.

Investigation of Remote Sensing Tools for Harmful Algal Blooms, Invasive Mussels, and Invasive Aquatic Vegetation, Year 1 Funding: $36,128

Harmful algal blooms (HABs), invasive zebra and quagga mussels, and invasive aquatic vegetation pose water quality and economic challenges to Reclamation's operations. A promising method to identify and monitor these hazards is the use of spectral indices derived from remotely sensed satellite imagery. This project will assess open-source tools to remotely sense HABs, with the goal of developing Standard Operating Procedures for use within Reclamation. It will investigate techniques to detect invasive mussels and vegetation by reaching out to staff at other federal agencies and conducting a literature review to assess the state of the science. Results will support a proposal to develop new tools for monitoring HABs, invasive mussels and aquatic vegetation that can be easily adopted across Reclamation.

Monitoring Field Trials and Optimizing Cavitation-Resistant Coating Systems, Year 1 Funding: $122,272

This project aims to provide practical solutions to severe cavitation and erosion in infrastructure in collaboration with key stakeholders in the hydroelectric industry. A previous S&T project tested cavitation-resistant coatings and identified two candidates for field trials. The first part of this project will monitor the field trials of these coatings at the Grand Coulee G21 turbine runner and Flatiron power plant Unit 2 butterfly valve. The second portion will implement another field trial for Reclamation infrastructure experiencing severe cavitation and erosive conditions. The third component entails collaborating with Denver Water on a cavitation-resistant coating field trial at their facilities. The final part involves partnering with the Army Corps of Engineers to develop a Military Specification coating system. Expected outcomes include improved coating performance, reduced maintenance costs, and increased equipment reliability and availability.

Instrumented Standard Penetration Testing (ISPT) to Increase Accuracy and Reliability in Penetration and Delivered Energy Data for Geotechnical Analysis and Liquefaction Evaluation, Continued: $80,000

The Standard Penetration Test (SPT) is an in-situ geotechnical test for foundation design, but it has many opportunities for error. For deep (200+foot) borings common to Reclamation facilities, these errors can produce significant discrepancies (up to 50%) in calculated material strength and liquefaction resistance. Previous work has applied technology developed for a related

geotechnical test to the SPT, with the goal of developing an off-the-shelf Instrumented Standard Penetration Test (ISPT). This research looks to improve the SPT to provide a continuous profile of penetration resistance to determine soil density and evaluate liquefaction potential.

Impacts of Large-Scale Stormwater Recharge on Aquifer Salinity in Arid Lands, Year 1 Funding: $35,000

This proposal asks the research question, what are the impacts of large-scale stormwater recharge on aquifer salinity in arid lands? A team from the University of Arizona, Arizona State University, and Northern Arizona University (Tri-Uni) are leading a study to identify locations in Arizona where unappropriated stormwater may be harvested for aquifer recharge. Reclamation's Phoenix Area Office and the city of Buckeye, Arizona are partners on a study comparing the effectiveness of conventional stormwater infrastructure and Green Stormwater Infrastructure. Buckeye and a member of the Tri-Uni team propose to assist with planning a stormwater/groundwater blending model to assess aquifer salinity.

Pilot-Scale Carbon Dioxide Treatment for Dreissinids, Year 1 Funding: $164,000

This research continues a collaboration with the USGS Upper Midwest Environmental Sciences Center and initiates a new partnership with ECO2, an independent company specializing in gas dissolution systems, to use carbon dioxide to control invasive mussels in the Davis Powerplant. Carbon dioxide is an alternative to registered molluscicides due to low costs, wide availability, ease of application, lack of harmful chemical residues and disinfection byproducts, and low risk to human health. The TSC has shown that a Speece Cone, a conical shaped gas transfer reactor, can efficiently carbonate water of a similar quality to that found in Lake Mohave. This project will test a pilot-scale Speece Cone system to carbonate mussel-infested water within the raw water-cooling lines of a Davis Powerplant power generation unit. The expected outcome is the successful prevention of quagga mussel settlement in the Powerplant's raw water-cooling lines.

Evaluation of an Upstream Bank Stabilization and Sediment Removal Project on Fish Passage for Threatened and Endangered Species at Marble Bluff Dam on the Lower Truckee River Above Pyramid Lake, Year 1 Funding: $88,740

The Marble Bluff reservoir on the Truckee River has completely filled with sediment, impeding upstream passage of fish including the threatened Lahontan cutthroat trout and endangered Cui-ui sucker. These species are very important to the Pyramid Lake Paiute Tribe, a project partner. Reclamation is planning a sediment removal and bank stabilization project upstream of Marble Bluff Dam, which will include a new channel flow path. This study will monitor fish movement through the dam and the reach upstream before and after implementation of this project. Results will illustrate the impact of sediment management on endangered and threatened species.

Evaluating Rust Creep Testing Methods: Improving Metal Loss Predictions for Improved Coating Lifetimes, Year 1 Funding: $79,000

Reclamation's water infrastructure uses protective coatings as the primary means to prevent corrosion and metal loss. Rust creep occurs in areas where the coating is damaged from corrosion progressing between the coating and the substrate metal. The standard test used to evaluate rust creep has several weaknesses that affect its reproducibility. Researchers will

partner with U.S. Army Corps of Engineers coating specialists to implement automated digital light methods in rust creep testing. This project will improve the accuracy and precision of rust creep testing data for use in construction specifications.

Developing an In-stream Sr Isoscape for California's Central Valley to Determine Migration Patterns of Anadromous Fish, Year 1 Funding: $93,582

California's Central Valley waterways – the Sacramento-San Joaquin River system – are home to several fish species listed under the Endangered Species Act, including steelhead trout, green sturgeon, and four distinct runs of Chinook salmon. Managing these species is a challenge, as the large geographic extent and the complex water infrastructure make it difficult to track population dynamics and rearing habitats. Linking the strontium (Sr) isotope composition of fish otoliths (calcium carbonate 'ear stones') to Sr isotope variation across a river system is a powerful tool for identifying habitats and migration paths, but it is limited by the spatial extent and accuracy of existing data. In collaboration with researchers at the University of California Davis, the University of California Santa Cruz, and the National Oceanic and Atmospheric Administration, this project will leverage existing Sr isotope data and collect additional Sr isotope samples to improve spatial coverage and capture seasonal variability.

Development of Environmental RNA (eRNA) as a Tool for Dreissenid Mussel Detection and Assessment of Invasive Mussel Populations, Year 1 Funding: $60,000

The presence of invasive mussels leads to many negative impacts on Reclamation facilities and the environment. Over the last five years, eRNA has emerged as an area of research that allows researchers to determine an organism's life stage, response to certain stresses in the environment, and general health that better inform management decisions. This project will build on the findings of a previous eRNA project that investigated the collection, extraction, and analysis of bulk water samples for the presence of quagga mussel (QM) signals. Three questions that will be addressed over the course of this project are: (1) Have new methods of eRNA sample collection and handling emerged over the last few years? (2) What is the limit of detection of eRNA transcripts in bulk water samples? (3) Are there additional transcripts from the QM genome that can provide information on the health and status of a QM population? The results will provide a foundation for adding eRNA to the toolbox of assays used to assess QM populations.

Identification of Kokanee and Burbot Spawning Habitats in Lake Roosevelt Using Environmental DNA and RNA, Year 1 Funding: $125,368

The kokanee (Oncorhynchus nerka), a sockeye salmon that lives its entire life in freshwater, and the native burbot (Lota lota) fish species are culturally and spiritually important to Native Americans in the Columbia River Basin. However, their population levels are impacted by operations at Grand Coulee Dam. Population management for both species is limited by a lack of information regarding spawning locations and recruitment success. A more effective method of identifying spawning grounds is key to their conservation and management. This project aims to use environmental DNA (eDNA) and environmental RNA (eRNA) to identify spawning locations in Lake Roosevelt, the Columbia River, and its tributaries. Environmental RNA (eRNA) will be used to gain a more detailed insight into the timing and location of spawning.

Determining the Lowest Effective Liquid Copper Concentration to Prevent Invasive Mussel Fouling at Hydropower Plants, Year 1 Funding: $225,905

Invasive mussel fouling in raw water systems at hydropower plants, water supply systems, and other water facilities can result in significant increases in maintenance needs and unplanned outages. Commonly used treatments such as chlorine and ultraviolet light can be expensive and are not feasible at all locations, due to site-specific limitations. A few USACE and Reclamation hydropower and pumping plants have installed EarthTec QZ copper treatment and found it to be effective at manufacturer recommended and tested doses. This study will help identify the lowest effective concentration and treatment regime that will significantly reduce treatment costs and the amount of copper released into the downstream river. Modeling of the copper in the downstream river will likely provide additional evidence that the treatment is safe, even when sensitive species are present. If this study is successful, it will provide a more cost-effective invasive mussel control method that is safer for the environment and minimizes exposure of powerhouse personnel to potentially harmful chemicals.

Install, Commission, and Finalize Evaluation of Cost-Effective, Flexible Excitation and Governor Control System Platform Speed Governor & Voltage Regulator Prototypes, Year 1 Funding: $120,000

The hydropower industry is unique in how controller functions are implemented, and many manufacturers rely on Reclamation engineers to supply them with control algorithms and techniques to use in their software. Currently, Reclamation is in the process of upgrading many excitation/governor systems and there is a lack of consistency in among controller manufacturers, even within the same region. A "Reclamation-made" controller using off-the-shelf industrial hardware could be easily retrofitted and installed in place of obsolete controllers, while leaving the power train hardware in place. This would provide a lower-cost and simpler alternative to currently available products. It would also dramatically decrease the amount of time required to install and commission a new excitation/governor system, which in turn would reduce overall costs. An additional benefit would be lower training costs since employees wouldn't need to maintain multiple types of controllers.

Develop Filtering Technology to Improve Data Acquisition and Subsequent Regulatory Modeling of a Simulated Power Grid, Year 1 Funding: $61,000

Generator models test the response of hydro-electric generators' excitation and governor systems to disturbances on the grid. Since off-the-shelf options do not provide a sufficient level of variety and detail, Reclamation's control-system engineers have developed reliable, effective in-house models. These models can be further improved by using filtering and varying sampling rates to validate generator characteristics when connected to the power grid. Utilizing proper filtering and sampling rates allows for accurate representation of inherent signal properties and enables improved model validation. In addition to satisfying regulatory compliance standards, validated models can be used to fine-tune excitation and governor systems.

Creating Effective Monitoring and Response Guidance for Addressing Surface and Benthic Algal Blooms within Reclamation's California-Great Basin Region, Year 1 Funding: $30,000

Harmful Algae Blooms (HABs) have become an increasing concern for water managers as they threaten municipal drinking water, wildlife habitat and impair human recreational opportunities. Expanding upon an S&T report, "Reclamation Harmful Algal Bloom Impacts and Research Needs", this scoping project will conduct an extensive literature review to produce (a) a summary of research concerning the physical, chemical, and temporal factors that promote and impede acute and chronic HAB occurrences and (b) a report summarizing HAB monitoring methods and instrumentation, including information about instrument costs and availability. In coordination with the California State Water Board, a Reclamation-specific guidance document/standard operating procedure for HAB monitoring and response will be developed for Reclamation's California-Great Basin region.

Development of a Digital Twin: Coupling Building and Geologic Models for a Reclamation Dam, Year 1 Funding: $97,000

This study will leverage commercial software to develop a coupled Building Information Model (BIM – the model of a structure and/or structural components)/ Ground Information Model (GIM – the model of the subsurface geology) digital twin of a Reclamation structure. The data of interest will include a GIM developed in Leapfrog software using geologic data, a BIM developed in REVIT and/or Civil3D software, and data obtained from a UAS platform (photogrammetric point clouds) to construct a detailed 3D coupled BIM/GIM which includes geometric surfaces, the foundation, and subsurface interpolations. This BIM/GIM will also include other types of structural health information such as concrete crack locations, piezometer data, drain discharge, etc. A selected software package will be used to create a visualization of the structure and foundation at a single snapshot in time (the digital twin). Once developed, software solutions for change and anomaly detection will be investigated such that the structure can be viewed within a time-domain.

Explore Options to Implement Better Overcurrent Protection Practices of the Generator Field Winding for More Accurate Coordination and Cost-Effective for Units to Implement, Year 1 Funding: $99,867

A generator field winding overcurrent has the potential to cause catastrophic generator failure costing millions of dollars to repair. There are methods to protect generators against this form of failure, but all of these have significant drawbacks. In many cases, the cost of installing the protection system is prohibitive. In other situations, engineers must travel to the field to install and tune the protection system, increasing costs. This project looks to implement inverse time overcurrent protection that does not require significant labor and equipment. This could be achieved by identifying a way for a protection device to measure the DC current of the generator. The equipment would be lab-tested for accuracy and repeatability, then commissioned and coordinated with limiters in powerplant installations.

Reducing Canal Seepage with Innovative Materials, Year 1 Funding: $108,000

The Water America's Crops prize competition sought to incentivize new approaches to minimizing seepage in unlined canals. In Phase I, participants submitted a white paper solution containing descriptions of the proposed solution along with supporting photographs and drawings. In Phase II, solvers developed a lab-scale prototype for accelerated weathering and durability laboratory evaluation. This proposal seeks to further the winning and runner-up

solutions from the WAC prize competition. Reclamation engineers will partner with the WAC solver teams to perform additional testing to better understand durability, strength, and workability, and then perform a field scale installation.

Innovative Use of the Hydraulic Profiling Tool (HPT), High-Resolution K (HRK), and Nuclear Magnetic Resonance (NMR) Logging for Optimizing Dewatering System Designs, Year 1 Funding: $121,020

A Reclamation research team will collaborate with the Kansas Geological Survey and Geoprobe, Inc. to evaluate the use of the Hydraulic Profiling Tool (HPT) system, high-resolution hydraulic conductivity (HRK), and nuclear magnetic resonance (NMR) for improved subsurface investigations to assist with dewatering system designs in excavations. The innovative use of HPT, HRK, and NMR logging may: (1) mitigate uncertainty of the geologic profile at ongoing dam safety projects, (2) recommend suitable well designs based on site-specific geologic formations and identify permeable and impermeable zones, (3) estimate hydrogeological parameters of aquifer systems prior to further aquifer tests, (4) implement optimized dewatering system designs, (5) provide more realistic geological profiles and hydrogeological parameters for groundwater models, (6) mitigate potential risks of dewatering systems in excavation areas of dam sites, and (7) simulate numerical groundwater modeling to assess the impacts of irrigation pumping on streamflow.

Assessment of Invasive Mussel and Hydroid Biofouling in the Glen Canyon Forebay to Inform a Fish and Thermal Barrier Design, Year 1 Funding: $110,452

Reclamation's Upper Colorado Basin (UCB) Regional Office is working with the Technical Service Center (TSC) to design a forebay thermal and fish exclusion barrier in Glen Canyon Dam. Biofouling is a serious design concern in Lake Powell because of established quagga mussel and colonial hydroid populations, which are among the worst freshwater biofouling species. Biofouling commonly results in the failure of submerged equipment, due to the formation of thick mats that add weight and impede operation. This study will provide information about biofouling conditions at Lake Powell to optimize the design of the barrier. The effort needed to remove biofouling from each material will be investigated to better understand future maintenance requirements. The study design will be informed by experts and partners from the UCB and TSC, as well as the National Park Service, Western Area Power Administration, Pacific Northwest National Laboratory, and River Connectivity Systems.

Constructing a Generalized Framework for Implementing Risk-Informed Reservoir Operations, Year 1 Funding: $96,720

Use of forecast information in the context of flood and dam safety risk -- e.g., to allow conservation storage above a rule curve or seasonal storage target without increased risk -- is commonly referred to as Forecast-Informed Reservoir Operations (FIRO). Recent discussion among Reclamation staff has revealed that forecast information is being evaluated and incorporated differently across time-scales and objectives. In addition, the institutional requirements for implementation of FIRO remain unclear, including criteria and procedures required for approval to deviate from the rule curves or target storage levels established to manage flood and dam safety risks. This project will construct a generalized framework for developing and implementing FIRO at Reclamation facilities. It will define key technical

components, including representation of forecast skill, system response, and relevant risks, as well as institutional components such as criteria and procedures for implementation. Key outcomes include facilitating a consistent approach to developing and implementing FIRO at Reclamation facilities, identifying technical and institutional gaps, engaging with Reclamation stakeholders, and scoping next steps.

Identification of Strengths and Weaknesses in Climate Model Bias Correction Strategies, Year 1 Funding: $100,000

This project will quantify the impact of bias correction strategies as they are frequently used in the climate applications community. This work is important because there are a wide variety of bias correction strategies, and they can result in very different climate change projections. Currently, bias correction strategies are selected based on intuition and philosophical arguments, with very little grounding in evidence. In this project, we will make use of a collection of high-resolution regional climate simulations (WRF, 4km grid) to evaluate different bias correction techniques for future change, and a large ensemble of global model simulations to test the stability of different bias correction techniques to chaotic model variability. NCAR will serve as the primary partner in this project and this work will be collaborative between the Technical Services Center, NCAR, and NOAA to quantify the impact on dam safety evaluations.

Reservoir Sedimentation Management: Evaluation of Nature-based Solutions for Distributed Sediment Detention and Storage in Water Supply Watersheds, Year 1 Funding: $78,937

This study aims to evaluate the degree to which watershed-scale sediment management practices can address reservoir sedimentation issues, with emphasis on the performance of in-channel controls. We will use a combination of field studies and numerical watershed models developed by Reclamation to characterize structures that imitate natural systems, including beaver mimicry structures and rock detention structures. Specifically, we will study the beneficial impact of watershed-scale restoration provided by wetlands and beaver ponds within the channel network on sediment delivery. Our focus will be on the Paonia Reservoir (Colorado) watershed, given its well-known sedimentation issues and the availability of sediment flux data. The outcome will be the capability to inform watershed-wide sediment reduction strategies that are environmentally friendly, cost-effective, and efficient for Reclamation's reservoir sediment management.

Creation and Consumption of Machine Condition Monitoring Data Using Mobile Devices, Year 1 Funding: $90,000

Reclamation's Machine Condition Monitor (MCM) data acquisition application has proven that it can reduce operation and maintenance costs, while ensuring plant sustainability, reliability, and operation. This proposal seeks to improve the value of MCM systems by researching options for connecting mobile devices to MCM systems, for both creation and consumption of process information in MCM. Creation of data would include process conditions commonly logged with pen and paper by plant personnel and rarely made available in digital formats, to be used for maintenance decisions. Consumption of data would extend the ability to view MCM data beyond the hardwired viewing stations. The goal would be to allow supervisors and management to view condition-based maintenance indicators of all the plant's generators centrally in real time.

Experimental and Numerical Modeling of Block Plucking with Applications to Spillway Erosion, Year 1 Funding: $118,714

Current spillway erosion models work relatively well for cohesive rock or soil-covered unlined spillways, but their capabilities break down in scenarios with highly fractured rock where the primary erosional mechanism is by plucking. We propose to progress the understanding of plucking mechanisms through a combination of numerical and laboratory experiments in collaboration with the University of Idaho and BGC Engineering. We will utilize Flow3D, a computational fluid dynamics (CFD) package, to explore the time-averaged relationships between fluid forces that cause entrainment and block geometries. The results of these numerical models will be used to inform the physical modeling that will be conducted at the University of Idaho. We will use the data to develop a new theoretical relationship between these controlling variables that can be applied to models of spillway and bedrock river erosion to generate better predictions of erosion by plucking.