BUREAU OF RECLAMATION

Research Updates
R&D Office

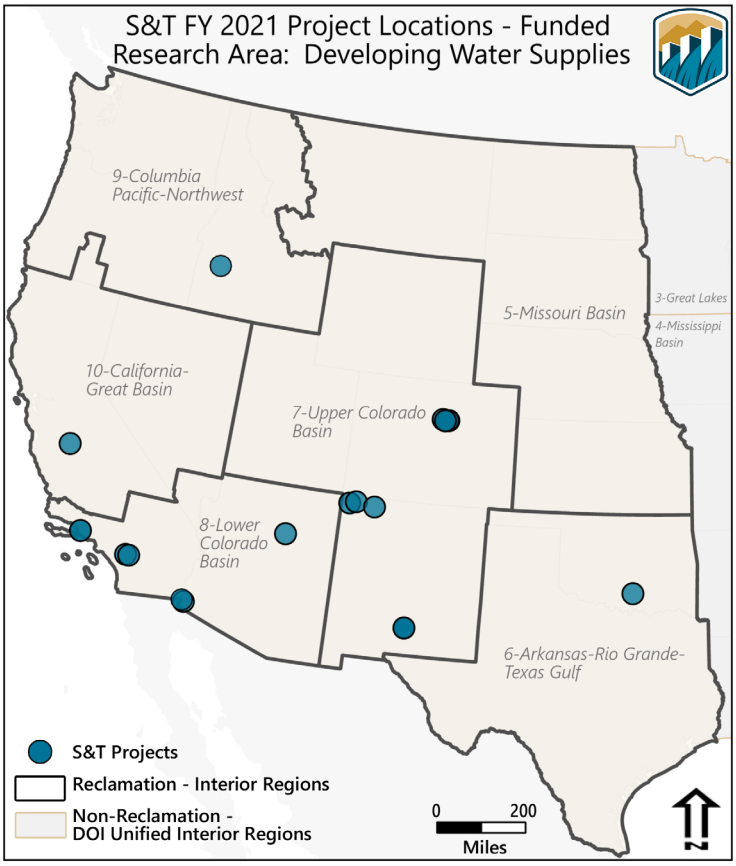
Developing Water Supplies

U.S. Department of the Interior

March 2021

Executive Summary

The Developing Water Supplies (WS) Research Area of the Science and Technology Program (S&T) examines research in the following categories: Water Treatment, Groundwater Supplies, Agricultural and Municipal Water Supplies, and System Water Losses. This document provides a summary on projects in the Water Treatment category only. In FY21, S&T funded 17 WS Projects totaling approximately $1M: three are new totaling $0.5M and 14 are continuing totaling $0.5M. Water treatment is an enormous field of study spanning a wide range of technology types, a diverse group of water users, and a complex landscape of water types. Research in this area is very diverse with work that expands from funding innovative research looking for new materials to treat water all the way to pilot testing of technologies and new treatment processes.



Reclamation's Research and Development Office (R&D) manages the Science and Technology Program (S&T) and is focused on providing innovative solutions for Reclamation water and power facility managers and its western customers and stakeholders, primarily through competitive funding opportunities to Reclamation employees.

The S&T Program has five research areas (listed below) directly related to Reclamation's mission.
For more information, visit: https://www.usbr. gov/research/st/needs_priorities/index. html.

S&T Research Areas and Categories

Water Infrastructure (WI)
Dams, Canals, Pipelines, and Miscellaneous Water Infrastructure

Power and Energy (PE)
Hydro Powerplants, Energy Efficiency, Pumping Plants, and Non-Hydropower Renewable

Developing Water Supplies (WS)
Advanced Water Treatment, Groundwater Supplies, Agricultural and Municipal Water Supplies, and System Water Losses

Environmental Issues in Water Delivery and Management (EN)
Water Delivery Reliability, Invasive Species, Water Quality, Sediment Management, and River Habitat Restoration

Water Operations (WP)
Water Supply and Streamflow Forecasting, Water Operations Models and Decision Support Systems, Open Data, and Climate Change and Variability

Developing Water Supplies Coordinator:
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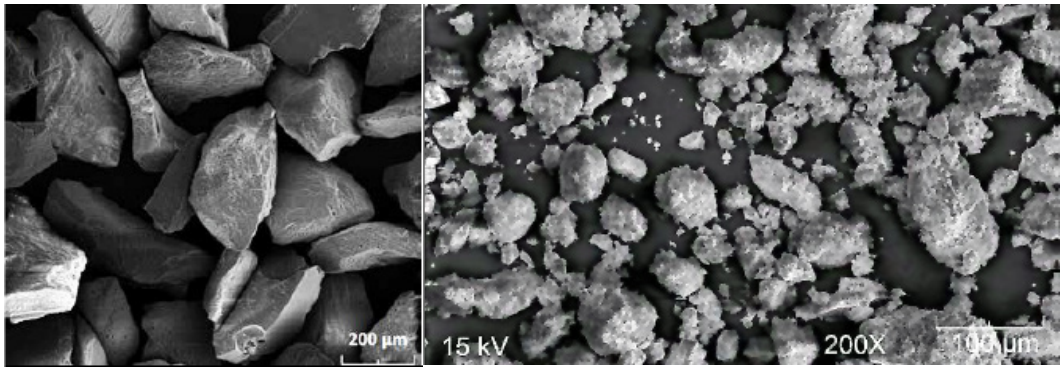
Developing Water Supplies

FY20 Completed Projects

1785: Investigating Biochar as a Water Treatment Filtration Media for Adsorption and Biological Reduction of Dissolved Metals and Fluoride – Anthony Kennedy

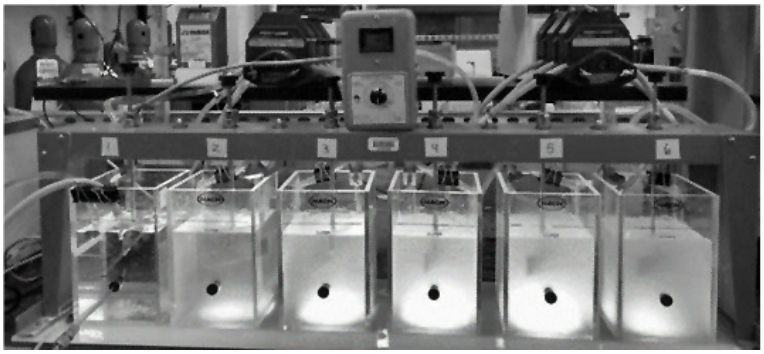
Biochar, which is a low-cost, relatively high surface area material made from the pyrolysis of organic feedstocks (e.g., pine, nut shells, husks, manure, etc.), has recently gained attention as an adsorptive media for water treatment. Specifically, biochar has been tested for the removal of both organic and inorganic contaminants from water, with the goal of providing a potential alternative to conventional media such as activated carbon or ion exchange resins. Overall, this study consisted of three case studies: 1) removal of metals from mine drainage water at the Leadville Mine Drainage Tunnel (LMDT) water treatment plant (WTP); 2) removal of fluoride from groundwater near the City of Lawton, Oklahoma; 3) use of steel slag for the removal of metals from mine drainage water at the LMDT WTP. For case study one, a total of 10 different biochars were tested with removal being very poor and focus shifted to case study three for this type of water. For case study two, bone char was found to be effective at removing fluoride from groundwater and potentially competitive against a best available technology, activated alumina. For case study three, powdered basic oxygen furnace steel slag was found to be effective at removing metals from mine drainage and potentially competitive against widely used chemicals, lime and sodium hydroxide.



Scanning electron microscopy (SEM) of biochar and steel slag.

7120: Crystallization Kinetics and Surface Patterns – Saied Delagah

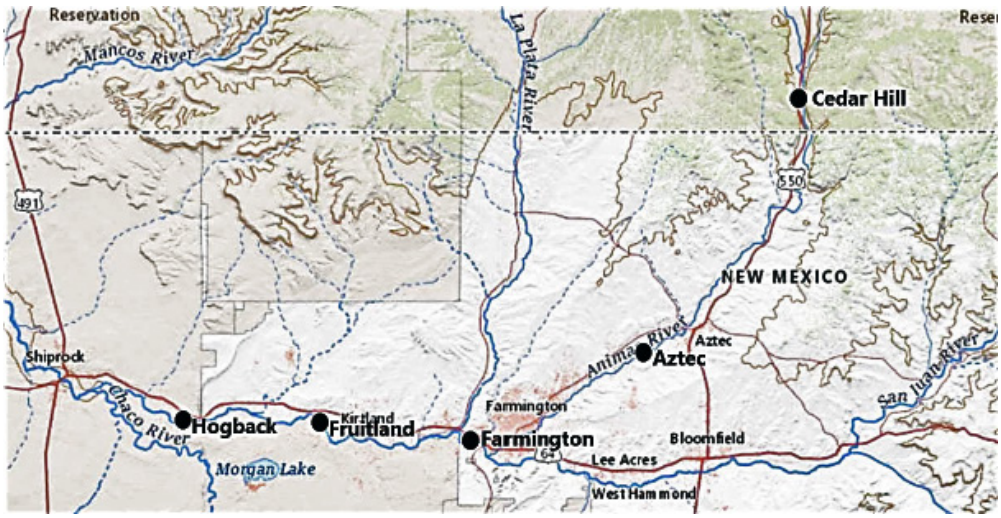
It is well accepted that a major drawback to widespread adoption of reverse osmosis (RO) desalination for inland areas is the lack of economical and environmentally-satisfying solutions for handling the concentrate streams generated from desalination processes. Sparingly-soluble salts from ions such as calcium, barium, strontium, magnesium, and silica, if present, limit the amount of water that may be recovered due to them becoming supersaturated and deposition (scale) on the membrane and other surfaces. This project focused on identifying a methodology and results for measuring crystallization kinetics of sparingly-soluble salt mixtures typical of reject/concentrate streams from membrane-based, inland water supply processes. More usable water can be recovered (and lower disposal costs incurred) from these concentrate streams through efficient crystallization. In this work, a steady state, continuous stirred tank reactors (CSTRs)-in-series approach was created to study crystallization kinetics of a model solution mixture that is supersaturated in calcium carbonate. A rudimentary, semi-empirical model was used to capture the parametric trends of the experimental results. This parameterization may be tested further for design scale-up guidance. This work was published in the peer reviewed journal: *Separation and Purification Technology*, Volume 211, 2019.



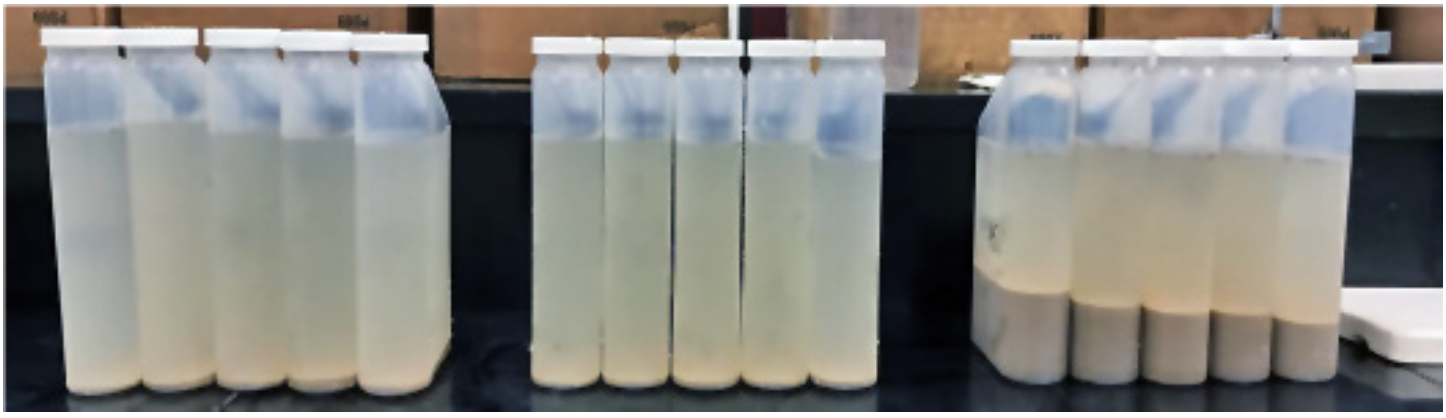
Six CSTRs-in-series running at steady state. Observe the increase in turbidity from left to right.

1790: Water Quality Impacts in the Animas and San Juan River Basins: Literature Search, Sampling Plan and Program – Alyssa Aligata

The Navajo-Gallup Water Supply Project (NGWSP) will convey water from the San Juan River to the Navajo Nation, the Jicarilla Apache Nation, and the City of Gallup, New Mexico. One aspect of the NGWSP is the design and construction of the San Juan Lateral (SJL) water treatment plant (WTP). This project intended to provide information to determine how monsoon events affect the influent water quality to the SJL WTP. Water quality was measured from four storm events: three in 2017 and one in 2018. The parameters that exceeded the Safe Drinking Water Act (SDWA) limitations during the storm events were dissolved aluminum, dissolved iron, total aluminum, total antimony, total arsenic, total barium, total beryllium, total cadmium, total chromium, total iron, total lead, total manganese, total thallium, total uranium, total dissolved solids, and sulfate. The fluctuation in water quality observed in this study have important implications for the design and operation of the NGWSP SJL WTP. Design engineers currently working on the design of this treatment plant can utilize this information to guide design discussions on treatment and intake presedimentation basin.



USGS sampling locations (black dots) relevant to this study.



Sample bottles from the last three samples of Storm Event 3. Note the high amounts of particulate collected in the last sample.

FY21 New Projects

21026: Cost and Performance Evaluation of Electrodialysis Reversal (EDR) Desalination of Brackish Agricultural Drainage Water and Groundwater – Luis Cruzado

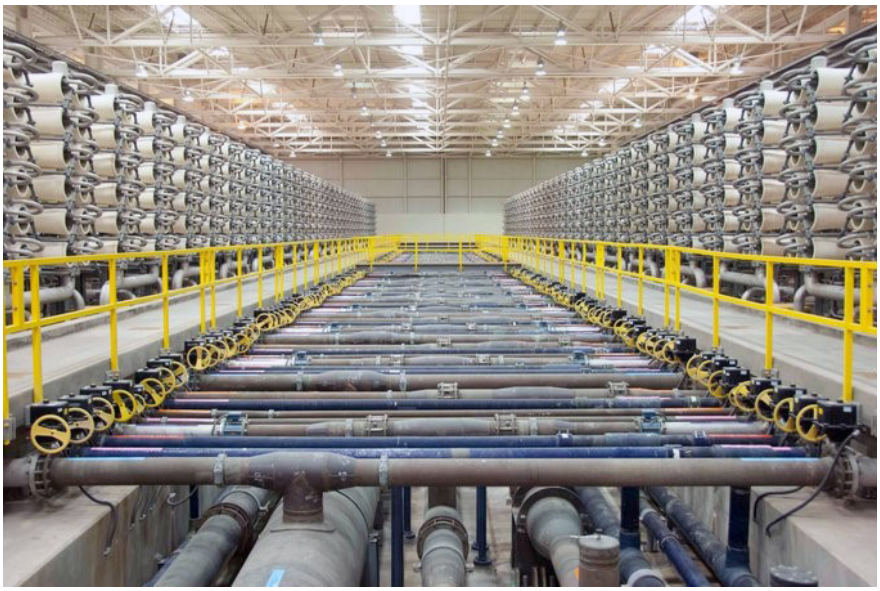
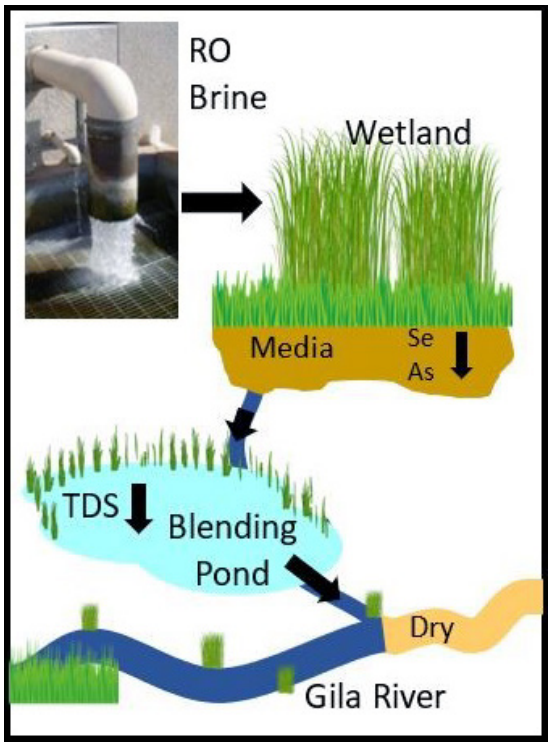


Photo of the Yuma Desalting Plant.
(https://twitter.com/usbr/status/1068625708023332864)

Desalination of brackish water sources is needed to augment conventional water supplies and manage salinity in many arid regions. This project will evaluate advanced electrodialysis reversal (EDR) as an alternative technology to reverse osmosis (RO) for the desalination of brackish agricultural drainage water (ADW) and groundwater. The results of this project will be critical to Reclamation's Yuma Desalting Plant in Yuma, AZ and applicable to other areas considering desalination of brackish water sources. This study is expected to demonstrate that EDR is a lower cost alternative to RO for the desalination of brackish ADW and groundwater, and that no chemical pretreatment is required for EDR desalination of these water sources. The operational data and cost analyses produced by this study are expected to influence water supply and salinity management strategies in the Colorado River Basin, arid regions, closed basins, and former ocean areas with brackish water.

21011: Investigating the Use of Green Infrastructure to Improve Water Quality and Expand Usable Water Supplies – Nathan Kuhnert

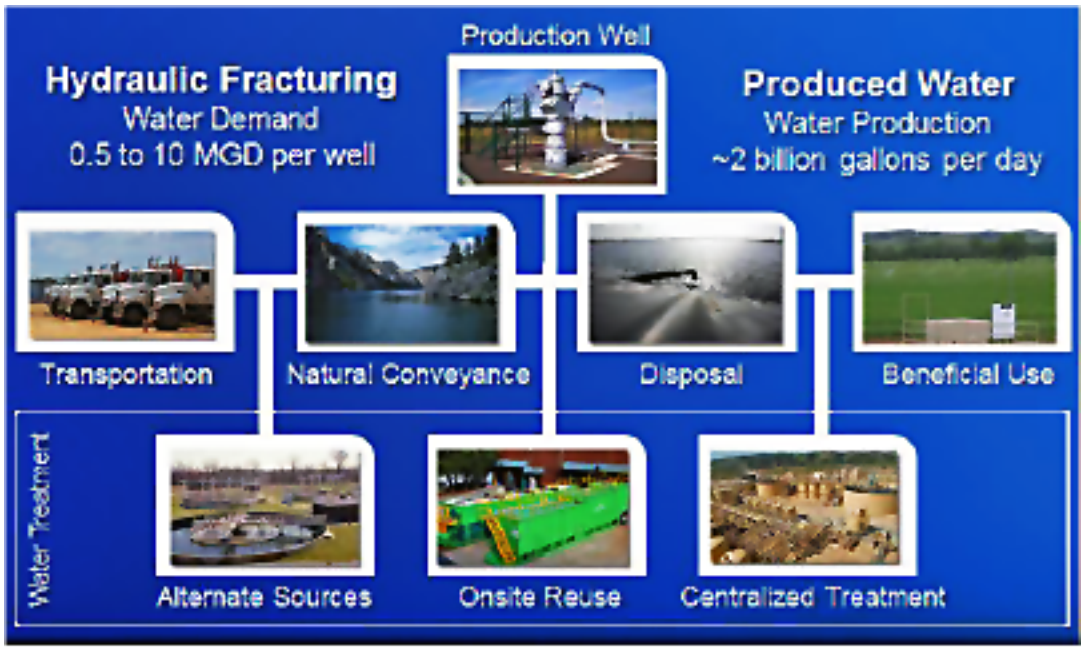
This scoping project will address the need to expand water availability for multipurpose objectives through conjunctive reuse practices. "Green infrastructure" (GI), such as constructed wetlands and soil/aquifer treatment, is an emerging tool to compliment water treatment technologies. GI involves passive, naturally occurring biogeochemical processes such as biodegradation, plant uptake, photolysis, volatilization, sorption, and precipitation, for water quality improvement and environmental protection. The intent of this scoping study is to compile existing design and performance information on GI projects that have been developed by Reclamation (pilot, demonstration, and full-scale), identify areas for potential enhancements based on "lessons learned" from these existing facilities, and identify potential locations where GI can be used to enhance the suitability for use, and thus increase the availability of potential water supplies.



Pilot wetland reverse osmosis concentrate treatment and disposal concept, S&T Project 2922, 2019.

21050: Beneficial Use of Produced Water Outside the Oil and Gas Industry: Development of a Screening, Testing, and Evaluation Framework – Yuliana Porras Mendoza

Produced water, naturally occurring water that exists in subsurface formations co-mingled with oil and gas (O&G), is brought to the surface in extremely large quantities during O&G production. In 2019, roughly 385 billion gallons of produced water were generated in New Mexico and Texas alone. These large volumes pose logistic and economic challenges for the O&G industry that can limit energy production; but produced water also represents an opportunity for water users if managed properly. Excess produced water generation combined with freshwater limitations have led to an interest in the treatment and beneficial use of produced water but have also sparked growing concerns among water users related to water quality and environmental safety. Currently, there is no standardized method for evaluating if produced water can be used outside the O&G fields, and if so, how to go about testing, evaluating, and implementing a solution. The development of a framework that includes screening, testing, evaluating, and down-selecting viable beneficial use options will help Reclamation engage, assist, and/or inform stakeholders about produced water in a manner that is better, faster, and cheaper.



Potential for water treatment to improve water use efficiency during oil and gas production, S&T Project 1601.

FY21 Active Projects

ID	Final Year	Title	Lead	FY21 Funding Amount*
1769	2021	Research to Identify how to Improve Existing Desalination Approaches to Reduce Primary Energy Use	Yuliana Porras-Mendoza	$ -
1780	2021	Determining ts of Long Term Use of RO Concentrate on Atriplex Species, Soil Characteristics, and Microbial Habitats	Denise Hosler	$ -
1855	2021	Scaling Resistant RO/NF Membrane	Saied Delagah	$50,000
1877	2021	Cost Modeling of Membrane Desalination Processes using Reclamation's WaTER Model	Leah Flint	$ -
7100	2021	Evaluation of Approaches to Determine Mixing and Assimilation of Reuse Effluent	Douglas Blatchford	$21,034
7134	2021	Analysis of Microbial Communities in Constructed Wetlands	Yale Passamaneck	$ -
7138	2021	Oxnard Saline Demonstration Wetland	Richard Huggins	$ -
8133	2021	An Ultra-Low-Cost Thermal Energy Storage System using Reverse Osmosis Concentrate	Saied Delagah	$ -
19093	2021	Pilot Testing of Renewable-Energy Powered Desalination Systems in the Navajo Nation for Small and Rural Communities	Jessica Asbill-Case	$167,230
19192	2021	Occurrence of Organic Micropollutants in the San Juan River in Northwest New Mexico and their Removal during Drinking Water Treatment	Anthony Kennedy	$95,000
20008	2022	Navajo-Gallup Water Supply Project – San Juan Lateral Source Water Blending and Corrosion Studies	Bart Deming	$153,576
20058	2022	Concentrate Minimization through Development of an Innovative In-Line Static Mixer	Saied Delagah	$96,512
20083	2021	Evaluating Contaminates of Emerging Concern's Fate in Potable Reuse Membrane Treatment	Saied Delagah	$30,504
20092	2022	Ion Exchange Pretreatment for Desalting Membrane Processes to Maximize Clean Water Production	Miguel Arias-Paic	$90,000
21011	2023	Investigating the Use of Green Infrastructure to Improve Water Quality and Expand Usable Water Supplies	Nathan Kuhnert	$29,656
21026	2022	Cost and Performance Evaluation of Electrodialysis Reversal (EDR) Desalination of Brackish Agricultural Drainage Water and Groundwater	Luis Cruzado	$138,351
21050	2023	Beneficial Use of Produced Water Outside the Oil and Gas Industry: Development of a Screening, Testing, and Evaluation Framework	Yuliana Porras-Mendoza	$ 88,118

* For projects with no funding, these projects are nearly complete and received funding in past years for this work.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