BUREAU OF RECLAMATION

Knowledge Stream

Research and Development Office

Brackish Groundwater National Desalination Research Facility

U.S. Department of the Interior

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Message from R&D

Welcome to the *Knowledge Stream* magazine!

This issue spotlights Desalination and Water Purification Research (DWPR) Program support of water supply development in the Western U.S. by hosting technology development at the Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, New Mexico.

On technology development at BGNDRF, client hosting activities support developers conducting pilot testing on promising technologies that could enable western U.S. communities to better access brackish (salty) groundwater as a viable water supply source.

Additionally, facility staff engage local to national communities through education, networking, and technology pitch events to bring together private sector, academic, government organizations, and the public.

Also shared are highlights of DWPR financial assistance to non-federal entities who are conducting research and development on technical challenges facing desalination and water purification.

Please enjoy this issue of the *Knowledge Stream* and offer any feedback for continuus improvement of dissemination strategies for transferring solutions to users.

Levi Brekke
R&D Program Manager

About the *Knowledge Stream*

The *Knowledge Stream*, published by the Bureau of Reclamation's Research and Development Office, is a quarterly magazine bringing mission-critical news about the agency's innovations in the following:

- Desalination and Water Research Purification Program
- Science and Technology Program
- Prize Competitions
- Technology Transfer
- Open Water Data...and more.

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Contents

Covers: FRONT - Brackish water wells are part of the 43-acre grounds at BGNDRF. (Reclamation/Ronda Dorsey) BACK: Keith Mallory, a Research Assistant with the University of North Texas, checks equipment at BGNDRF. (Reclamation/Ronda Dorsey)

Community Needs

Technology Development at the Brackish Groundwater National Desalination Research Facility (It's Pronounced "BIG-EN-DORPH")

Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, New Mexico, helps government agencies, universities, and private companies develop and test advanced water treatment technologies. BGNDRF's mission is to serve as a safe, secure proving-ground for developing sustainable, cost-effective, and energy-efficient desalination technologies.

This research facility generally focuses on:

- Renewable energy/desalination hybrids
- Economically viable small-scale desalination systems
- Sustainable concentrate management technologies and processes
- Treatments for produced waters from oil and gas
- Public outreach and education

BGNDRF's state-of-the-art facility including lab space (above), indoor and outdoor testing sites, and office space, supports research for a variety of constituents. (Reclamation/BGNDRF)

The 43-acre grounds offer resources to clients such as:

- Water from four brackish water wells
- Indoor and outdoor testing areas
- Laboratory space
- Spacious conference room
- Office space
- Scientists and environmental engineers with expertise in process development and design

LG Chem, a BGNDRF client, sets up their pilot project on the facility's large-scale test pad. (Reclamation/ BGNDRF)

Three evaporation ponds are also available for nonhazardous concentrate disposal and research (such as enhanced evaporation studies and algal growth in concentrate).

BGNDRF's clients come from a wide range of backgrounds, from individual innovators to large corporations and universities. The research facility also focuses on increasing the opportunities for innovative research. For example, BGNDRF has invested in infrastructure to support agricultural type research, as in the case of the halophyte farming project for concentrate management led by both the University of Arizona and New Mexico State University, and a greenhouse for further support. In FY 2017, a new renewable energy opportunity became available for clients to test water treatment technologies coupled with mobile, solar photovoltaics.

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More Information
https://www.usbr.gov/research/bgndrf

BGNDRF Current and Upcoming Research

Performing Agency	*Research Topic*
New Mexico State University	Halophytes (salt-tolerant plants) and salt transport from brackish water irrigations Algal wastewater treatment coupled with reverse osmosis and forward osmosis for wastewater reuse
University of North Texas	Wind and solar powered desalination for agriculture Innovating concentrate management with shrimp farming and hydrogen fuel cells
University of Texas at El Paso	Liquid cooled photovoltaics for Zero Discharge Desalination (ZDD) technology
AdEdge Technologies	Flow reversal - reverse osmosis
Liquid Hydrodynamics	Produced water treatment using innovative mechanical vapor compression
Aqua-Aerobics Systems	Super-powderized activated carbon for removal of per- and polyfluoroalkyl substances (PFAS) from brackish water

BGNDRF Clients Since 2007

California Polytechnic State University - San Luis Obispo
The California State University - Cal Poly Pomona
Lehigh University
Massachusetts Institute of Technology
New Mexico State University
Texas Tech University
University of Arizona
University of Nevada, Reno
The University of Texas at El Paso

Center for Inland Desalination Systems & Veolia
New Mexico State University & Eco1st
New Mexico State University & General Electric
New Mexico State University & HydroFLOW

Bureau of Reclamation's Desal Prize of 2015
-Atlantis Technologies
-Econopure
-Green Desal
-KII, Inc.
-Massachusetts Institute of Technology
-The University of Texas at El Paso

AdEdge Water Technologies
*Amorphic Tech, Ltd.
**Clear Creek Environmental Solutions*
Danlin Industries & Atlantis Technologies
**Eastern Shore Microbes*
*ecoVAP
Evoqua
GELF
KII, Inc.
LG Chem
**Lhoist*
*Liquid Hydrodynamics
Magna Imperio Systems
Oasys
Omya
Pacific Advanced Civil Engineering
Pacific States Water
*Reticle Inc.
**Toray*
Water Standard
**WIST, Inc*
*Scheduled for 2020

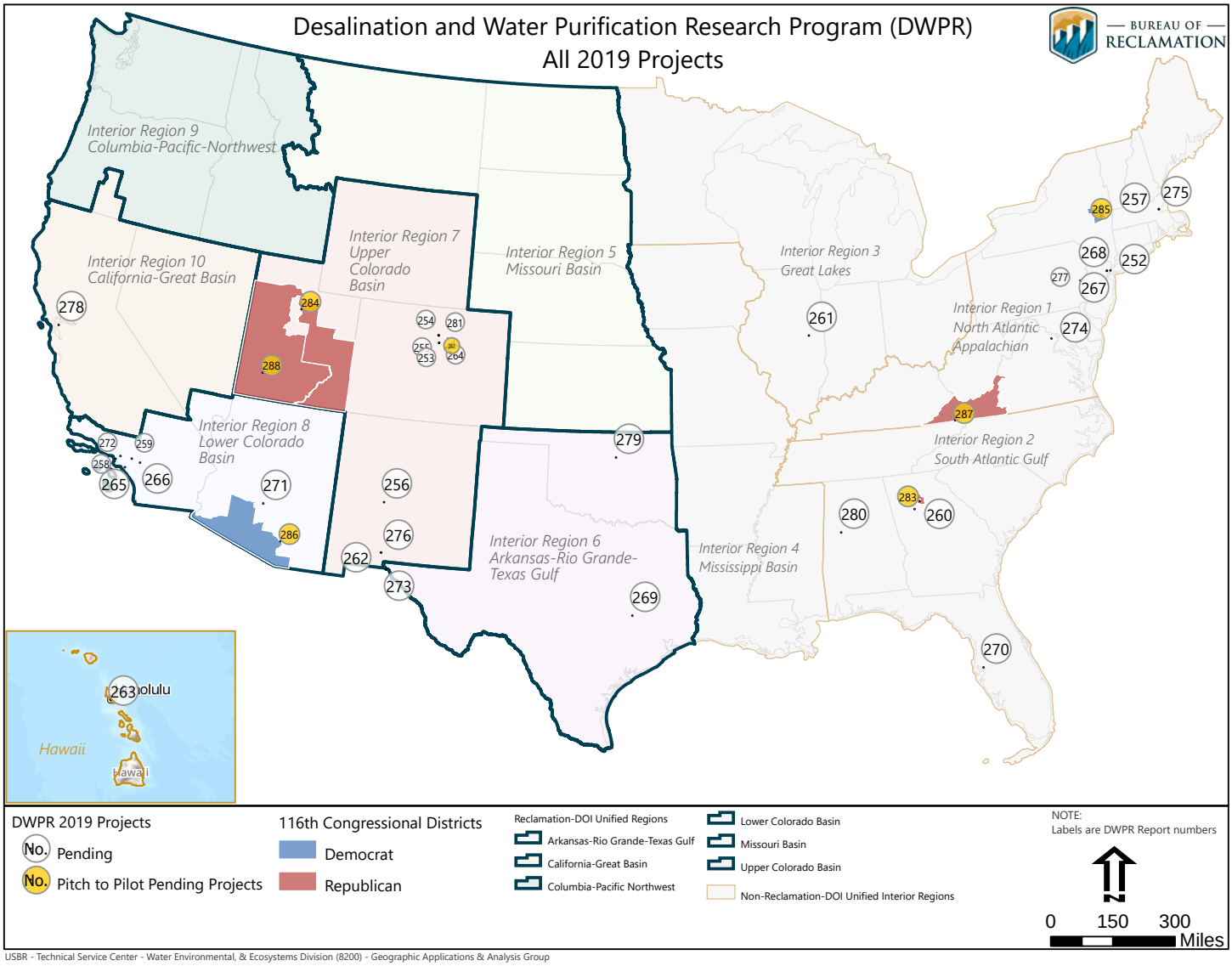
Key Perspectives

Desalination and Water Purification Research Program

The Desalination and Water Purification Research (DWPR) Program provides financial assistance for advanced water treatment research and development. This leads to improved technologies for converting unusable waters into useable water supplies. The program is a primary activity contributing to the Presidential Memorandum on Promoting the Reliable Supply and Delivery of Water in the West (October 19, 2018).

The program contributes to multiple Reclamation priorities, including: increasing water supplies to benefit farms, families, businesses, and fish and wildlife; leveraging science and technology to improve water supply reliability to communities; addressing ongoing drought on the Colorado River; and improving water supplies for tribal and rural communities.

DWPR's competitive financial assistance opportunities and client hosting at the Brackish Groundwater National Desalination Research Facility (BGNDRF) also contribute to the National Water Reuse Action Plan, which was developed in partnership between the federal government, state, local and public sectors.



Research Grants

DWPR Program priorities include development of improved methods of desalination, incorporating energy efficiency into desalination processes, and reducing the costs and environmental impacts of treating impaired waters including, but not limited to, seawater, inland brackish groundwater, municipal wastewater, and produced waters from oil and gas extraction activities. Through the program's two competitive extramural Funding Opportunity Announcements (FOAs), "Research" and "Pitch to Pilot," Reclamation awards research and development cooperative agreements with non-Federal recipients. The program leverages investment from other federal and non-federal entities to facilitate the advancement and deployment of new technologies. Knowledge generated from this investment is made available to communities, organizations, and industry.

Recent participation by the nationwide R&D community in DWPR FOAs underscores how that community's interests align with Reclamation's desalination and water purification innovation priorities, resulting in a highly competitive FOAs and awarding funds to promising R&D proposals. For example, the FY 2019 DWPR Research FOA received 95 eligible applications of which 30 were selected for award; and, the FY 2019 DWPR Pitch to Pilot FOA, featuring a streamlined application process aimed at small businesses, received 29 eligible applications of which seven were funded.

Brackish Groundwater National Desalination Research Facility

The DWPR program funds client hosting as well as the operation and maintenance of the Brackish Groundwater National Desalination Research Facility (BGNDRF), located in Alamogordo, New Mexico. This facility provides opportunity to develop technologies for the desalination of brackish and impaired groundwater found in the inland United States.

The 43-acre facility opened in 2007 and is designed to conduct research on cost-effective advancements of piloting to full-scale testing of desalination and water purification technologies. BGNDRF brings together researchers from Federal government

agencies, universities, the private sector, research organizations, and state and local agencies to work collaboratively and in partnership.

The facility offers state-of-the-art equipment, laboratory space, and experienced environmental engineers and scientists in process development, design, construction and testing. Clients consist of universities, private sector companies, entrepreneurs and government agencies. Since 2017, the facility has operated at full client capacity.

Four on-site brackish groundwater wells provide source water to the clients at the facility. Three evaporation ponds are available for concentrate disposal and research.

In the process of offering client services, BGNDRF has worked toward increasing its energy efficiency via conservation as well as utilization of solar renewable energy. In 2012 BGNDRF won the Better Building Federal Award contest for conserving energy. This accomplishment has been mentioned twice from the floor of the United States Senate. In 2016 BGNDRF contracted for the installation of a 100 kW (AC) grid-tied solar array. It is estimated that approximately 70% of BGNDRF's energy demand is met through solar energy.

In FY 2019, BGNDRF supported research from seven DWPR funded research projects, hosted five clients in their research, organized four major events, and hosted over 1,000 visitors at the facility.

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More Information
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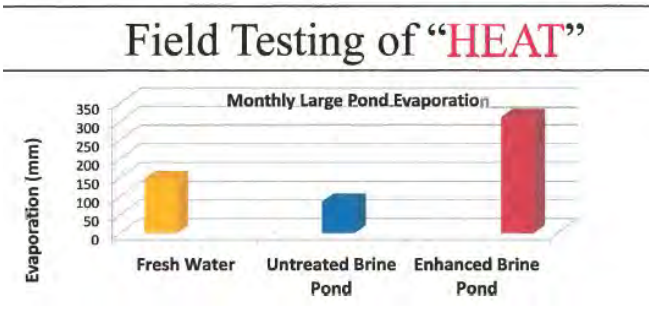
https://www.usbr.gov/research/bgndrf

Current Research

BGNDRF Research Highlights

Eastern Shore Microbes "HEAT"

Eastern Shore Microbes (ESM) markets "HEAT," a biologically, sustainable solar powered system using microbes to enhance evaporation of RO concentrate in order to reduce concentrate volumes for improved economics of concentrate management. ESM claims that when microbes are introduced into the brines, the heat generated by the microbes' metabolism and heat from the sun accelerates brine evaporation in virtually all environments. ESM is now applying this market disrupting approach in the most environmentally responsible and economically sound manner possible.

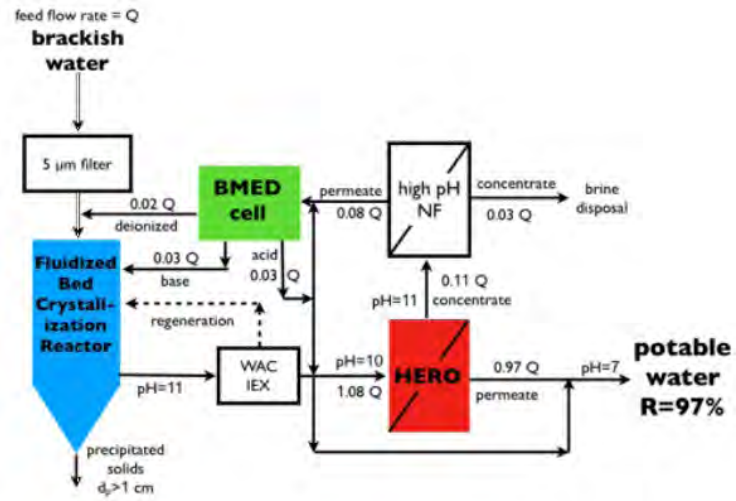


Pond evaporation levels with HEAT. (Eastern Shore Microbes)

ESM will establish an 18-month long evaluation/demonstration of the process at two sites: an end user preparing an industrial park located near a Federal Wildlife Refuge in Chesapeake, VA; and at BGNDRF in Alamogordo, NM. By conducting these experiments in larger pilot scale systems, ESM will be able to have sufficient size and volume to be able to directly apply the data to full production systems. In the case of the proposed industrial park site, the established pilot level tanks will then be converted into specialized maintenance tanks serving as a culture storage and used to maintain the larger functioning disposal system.

University of Arizona "Electrochemically Enhanced High Efficiency Reverse Osmosis (EE-HERO) for Brackish Water Treatment"

The proposed research will pilot test the electrochemically enhanced high efficiency reverse osmosis (EE-HERO) process for converting brackish water into potable water. EE-HERO is comprised of three novel processes:



EE-HERO process for converting brackish water into potable water. (University of Arizona)

1) high efficiency reverse osmosis (HERO) in which the RO process is operated at a high pH value which greatly reduces membrane fouling and scaling; and biofouling of the RO membrane is completely eliminated.

2) the use of a fluidized bed crystallization reactor (FBCR) for removing scale forming ions prior to the HERO process.

3) a bipolar membrane electrodialysis (BMED) stack to produce the acid and base needed to operate the HERO and FBCR.

The proposed research also addresses the major drawback to HERO that has prevented its adoption by the water treatment industry, which is the need for water softening pretreatment. Water softening produces a waste brine stream that reduces water recovery and incurs high disposal costs. The overall process will allow water recoveries from brackish water as high as 97%. As compared to conventional treatment, this is a one order of magnitude reduction in waste brine production.

WIST, Inc. "The First Affordable, Easy-to-Use Silica Pretreatment Solution: Pilot-Scale Validation of SiSorb-Nano"

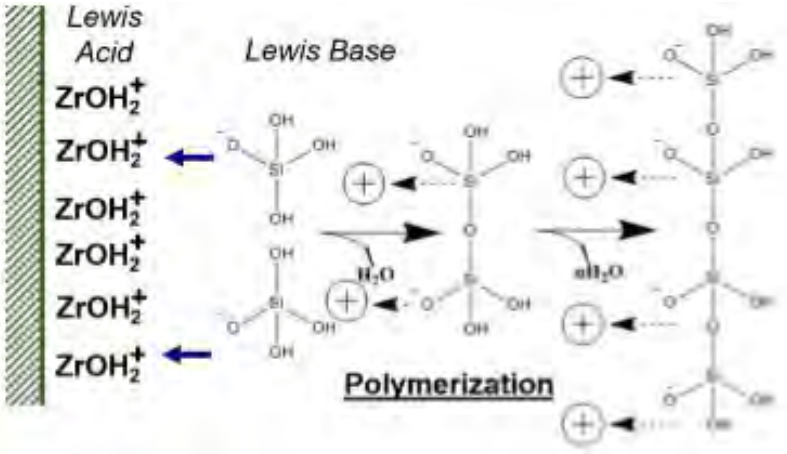
Silica removal to prevent recalcitrant fouling is a challenge facing many industries that require high purity water for high performance systems, e.g., high recovery brackish water desalination, high pressure steam turbines, industrial process equipment.

Silica fouling, calcium carbonate, calcium sulfate, and other types of salt scales create a glass-like surface that cannot be removed by typical acids or bases. Current silica removal treatment strategies include warm/hot lime softeners and mixed bed ion exchange resins. Both are operationally expensive and logistically challenging to operate because of the high volumes of acids/bases required as inputs and sludge generated.

The first high capacity, silica-selective sorbent using nanoparticle technology (SiSorb-Nano) has been developed by WIST, Inc.

Pilot-scale testing of SiSorb-Nano is necessary to optimize regenerant type and long-term silica removal operations. Four columns of SiSorb-Nano will be tested in parallel through multiple cycles of regeneration with four different regenerant solutions over the four different water sources available at BGNDRF.

Rigorous testing will provide insights into how to operate SiSorb-Nano best across varying input water chemistries and conditions. Successful SiSorb-Nano operation will involve many cycles of high performance silica removal across multiple water chemistries through effective regeneration by one or more regenerant solutions.



Silica removal by SiSorb-Nano occurs through selective Lewis Acid-Base interactions followed by slow surface polymerization. (WIST, Inc.)

ecoVAP "Enhanced Evaporation using Biomimicry for Brine Concentrate Disposal"

The ECOVAP Brine Concentrate Disposal Project seeks to build an Evaporation Matrix-Tower ("EM-T") pilot at BGNDRF in Alamogordo, NM.

The purpose will be to test, verify, and optimize the efficacy of ECOVAP's biomimicry-based, enhanced-evaporation technology in dramatically reducing the cost and environmental impacts of RO-Brine Concentrate disposal.

Brine concentrate disposal is increasingly seen as a main constraint for developing in-land brackish desalination given its high disposal costs, energy use, and environmental impacts. The principles behind ECOVAP's biomimicry technology include providing a high surface area and long retention time for the water.

This proposed Brine Concentrate Disposal Project aims to measure the system's evaporation rates (expected to be >59x), energy consumption, and scaling potential. The main economic and environmental benefits of ECOVAP's technology have already been tested in several sectors that use enhanced evaporation to dispose of brine, including oil/gas produced water and mining.

ECOVAP claims to reduce all-in operating costs (including depreciation and waste water transportation) by >70% (depending on local weather, SWD availability, etc.).

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More Information
https://www.usbr.gov/research/dwpr/DWPR_Reports.html

20-Year Timeline

BGNDRF

2000
BGNDRF Conceived

2001-2003
Congressional Appropriation for Planning
Desalination Road Map
BGNDRF Executive Planning Committee

2004-2007
Congressional Funding
Construction is Completed

2007
Grand Opening
1st Client - University of Texas at El Paso

2008-2010
Commissioning and Initial Projects
John Walp, Acting Facility Manager (FM)
Randy Shaw (Current FM) hired 2010

2011
3 Federal FTE Positions Filled
Senator Documentary "DOMENICI"
New Water, New Energy Workshop
1st BGNDRF Newsletter Published
1st International Client
1st Test of Produced Water
Semi-Annual Water Testing Established

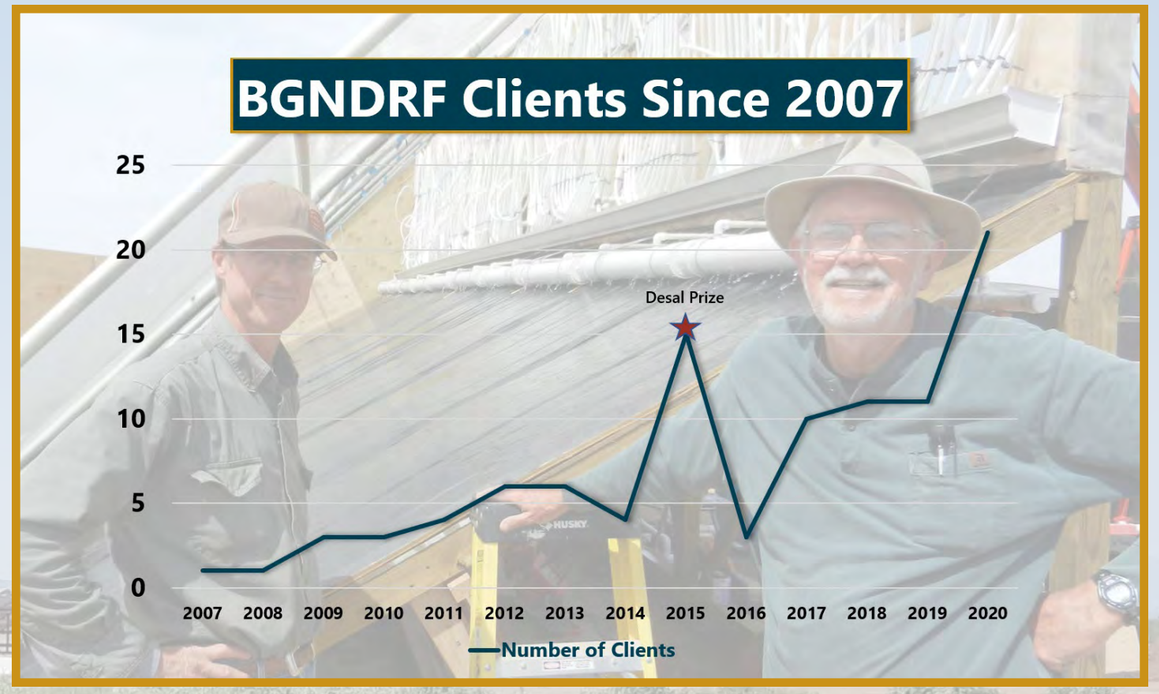
2012
Electronic Tech Position Upgraded
Arc Flash Analysis Study
Reclamation Commissioner Connor Visits

2013
"Better Building Federal Award"
Winner for Energy Savings
Presented by Dr. Unruh of DOE
with U.S. Senator Heinrich

2014
NM Governor Martinez Visits
SCMA Workshop
Construction for Ag Research Area

2015
Reclamation's 1st Prize Competition
"Desal Prize"

2016
1st Pitch to Pilot
1st Discovering Desal for 3rd Graders
Host NM Museum of Space History Camp
Tour with U.S. Senator Heinrich's Chief of Staff



2017
BGNDRF 10th Anniversary Desal-a-bration Event
MOU with Retired and Senior Volunteer Program

2018
1st WIN Workshop
1st Desal 101
Legacy Project on Tiger Drive Completed

2019
New BGNDRF Research Scientist FTE
Congresswoman Smalls Visits
Collaborations with AMTA & WIN Workshops
NM School for Blind and Visually Impaired
added to Discovering Desal

2020
RAI Intern Approved
Projected Record Number of Clients
Construction of Enhanced
Evaporation Lagoons

DWPR Research Highlights

Development of a Novel Photobiological System to Improve Water Recovery in Brackish Groundwater Desalination - Pacific Advanced Civil Engineering

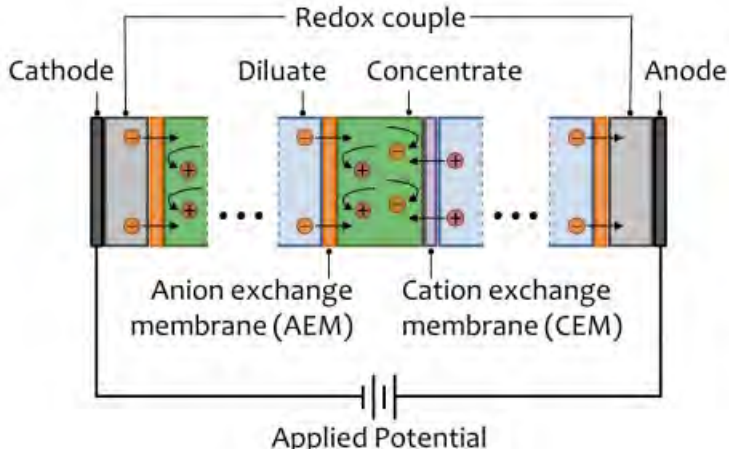
This study investigated the feasibility of a novel photobiological treatment process using a brackish water diatom (*Pseudostaurosira trainorii* PEWL001) to treat silica-rich brackish groundwater and brackish groundwater reverse osmosis (RO) concentrate to enable additional desalination and freshwater recovery using a standard secondary RO process.

The bench- and pilot-scale experiments conducted at Brackish Groundwater National Desalination Research Facility, in Alamogordo, NM, confirmed that silica containing groundwater and RO concentrate could be treated by the photobiological treatment process using this brackish water diatom. A majority (60% to 95%) of reactive silica, as well as calcium carbonate (>60%), could be removed by the photobiological process. A single stage RO limited to 75% recovery can be extended to a two stage RO process with an overall recovery of 92.5% by using the photobiological as an inter-stage treatment to lower silica content of the concentrate from the primary stage, which will then be fed to the second RO stage (70% recovery) for additional treatment.

https://www.usbr.gov/research/dwpr/P2P_Reports.html

Improved Energy Efficiency of Electrodialysis Desalination and Separation: Development of Percolating Network Nanocomposite Ion-Exchange Membranes for High Conductivity - Columbia University

One of the most efficient desalination technologies, reverse osmosis, allows access to seawater, inland brackish water, and reuse wastewater to augment potable water supplies. Reverse osmosis is capable of producing high-quality water, but it is an energy-intensive process. In addition to water, nitrogen, and phosphorus – essential components of agricultural fertilizers – potable water can also be recovered from wastewater as a sustainable approach to address the global food challenges.



Schematic of Electrodialysis with the arrows indicating the direction of (cation (+) and anion (-) permeation. Repeating pairs of CEMs and AEMs selectively allow permeation of counterions while rejecting co-ions. (Columbia University)

Both desalination and wastewater reuse are actively considered options to address the critical water issues facing the American Southwest. The development of more efficient and effective technologies is needed to address energy and water concerns.

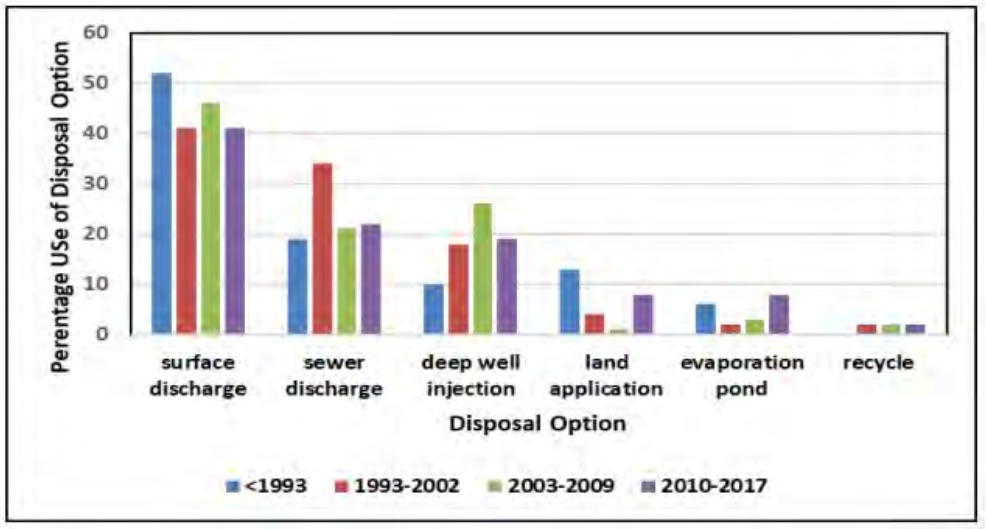
Electrodialysis is a membrane-based process using a stack of multiple membranes to 1) desalinate seawater and brackish water; and 2) separate ions from water based on electrical charge.

A fundamental limitation of electrodialysis is the inherently low conductivity of conventional membranes used in the process. This results in resistance of the electrodialysis circuit, consequently causing lower energy efficiency. Additionally, the low conductivity slows process kinetics by diminishing the ion flux. Nanocomposite membranes fabricated with a percolating network of functionalized one-dimensional carbon nanotubes were used to decrease internal resistance while maintaining membrane selectivity. The embedded carbon nanotubes in the polymer matrix disrupt the compact polymer packing, loosening the structure to create shortcuts for ion electro-diffusion. Thus, the transport pathway is less tortuous and the effective ion diffusivity is correspondingly improved.

https://www.usbr.gov/research/dwpr/reportpdfs/report212.pdf

Updated and Extended Survey of U.S. Municipal Desalination Plants - Mickley and Associates

Dr. Mike Mickley (Mickley and Associates) recently completed a research project to compile data on all of the existing municipal desalination plants in the United States with more than 25,000 gpd (gallons per day) capacity.



U.S. municipal desalination concentrate disposal option use by time period. (Mickley and Associates)

The survey identified 406 desalination plants including potable water plants, wastewater treatment plants, aquifer recharge, and aquifer storage and recovery plants.

Information was gathered on the type of desalination technology employed, feed water quality, product water quality, recovery, and the type of concentrate disposal used.

The survey results can be used to identify trends in the desalination industry over time and across different geographic regions. The survey analysis found that the number of desalination plants and the cumulative installed capacity have both increased linearly since 1990. Florida has the most desalination plants (36% of all US desalination plants are in Florida) and Texas has added more desalination plants in the time period from 2010 to 2017 than any other state, with an average of 2 to 3 new plants per year.

https://www.usbr.gov/research/dwpr/reportpdfs/report207.pdf

Pilot Testing Cost and Performance Optimized Photovoltaic-Powered Electrodialysis Reversal Desalination Systems - Massachusetts Institute of Technology

The goal of this project is to experimentally validate cost- and performance-optimized architectures for community-scale, off-grid, solar-powered electrodialysis reversal (EDR) brackish water desalination systems. The achievements within this project included: (1) experimentally validated analytical models and optimization methods for creating cost- and performance-optimal PV-EDR architectures that lower the costs of potable water production by >40% compared to non-optimized PV-EDR architectures; (2) implemented and evaluated the feasibility of voltage and flow control systems for PV-EDR; and (3) designed and built pilot-scale time-variant PV-EDR prototypes and experimentally tested it at BGNDRF in Alamogordo, New Mexico.

The experimental testing demonstrates the time-variant system's high effectiveness of utilizing variable solar power to produce water efficiently. The improved conversion between variable solar power to freshwater can potentially enable producing the same amount of water during daytime when the sun is available, indicating a further 10-20% cost-reduction associated with battery storage in the traditional static-operated systems.

Published report coming soon.

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More Information
https://www.usbr.gov/research/dwpr/DWPR_Reports.html

Special Events at BGNDRF

DWPR Funding: Pitch to Pilot

The Bureau of Reclamation launched a novel "pitch to pilot" funding opportunity seeking new and innovative technologies or processes for desalination and water purification. Top applicants pitch their ideas to reviewers for the chance to test through a pilot demonstration.

"We are addressing a critical need to reduce the costs, energy requirements and environmental impacts for treating unusable water. Our approach is unique. We are streamlining the funding process by asking the strongest applicants to pitch their concept," said DWPR Program Administrator Yuliana Porras-Mendoza. "This is an opportunity to take a new approach from the lab to a real-world demonstration, providing products that serve the water treatment community and attract commercial interest."

Members of the DWPR Application Review Committee for the 2019 Pitch to Pilot funding opportunity are, from left: Zachary Stoll (BGNDRF), Randy Shaw (BGNDRF), Jeremy Walker (U.S. Army CCDC Ground Vehicle Systems Center), Miguel Arias-Paic and Saied Delagah (both of the Denver Technical Service Center's Water Treatment Group). (Reclamation/Yuliana Porras-Mendoza)

Specifically, Reclamation is seeking:

- a less energy intensive way than current processes and technologies to treat brackish groundwater at the pilot scale.
- to reduce the high cost, energy usage and/or environmental impacts of concentrate management for inland desalination at the pilot scale.
- to improve efficiency of treatment without increasing the total cost and energy usage of current systems for desalination pretreatment.
- to address costs, energy usage and/or environmental impacts of seawater desalination, including intakes and/or outfalls.

Reclamation awards four to six agreements with up to $150,000 available per agreement through its Desalination and Water Purification Research Program. Finalists are invited to present their proposal during the Pitch to Pilot event at BGNDRF.

Though not required, applicants are encouraged to provide a non-federal cost share. Individuals/entrepreneurs, institutions of higher education, commercial or industrial organizations, private entities, state and local governmental entities, federally-funded research and development centers, tribal governments and organizations, and non-profit organizations are eligible to apply.

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More Information
https://www.usbr.gov/research/dwpr/p2p_2019.html

Professional Workshop: Water Innovations and Networking

The second annual Water Innovations and Networking (WIN) Workshop was hosted by BGNDRF on October 28-29, 2019.

The workshop goal was to bring together community members to discuss technology development opportunities. Researchers shared their work with a broader audience in a rich environment for networking with potential clients, investors, partners, regulators, and other interested parties.

Over 130 attendees were present with an audience comprised of representatives from five federal agencies, five state agencies/institutes, eight universities, a national lab, businesses from the water and oil sectors, and many others. Technology topics included: innovations of electrodialysis, pre- and post-treatments, treating high TDS water, agriculture associated research, and reverse osmosis.

Participants had the opportunity to get a first-hand look at BGNDRF and what this Reclamation facility has to offer for technology development, verification testing, demonstration testing, and more. Tom Pankratz, Editor of the *Water Desalination Report*, gave the keynote presentation entitled "A Global Desalination Perspective." Also featured were 3-minute "pitches" from the audience.

Reclamation staff supporting BGNDRF during the Water Innovations and Networking Workshop. From left: Crystal Bing, BGNDRF Facility Operations Assistant; Dr. Zachary Stoll, BGNDRF Research Scientist; Francisco Nisino, BGNDRF Electronics Technician; Alyssa Aligata, Denver Technical Service Center Civil Engineer; Dan Lucero, BGNDRF Engineering Technician; Yuliana Porras-Mendoza, Research and Development Office Desalination and Water Purification Research Program Administrator; Randy Shaw, BGNDRF Facility Manager; Billy Elbrock, Elephant Butte Facility Manager; Stephen Ogle, Denver Technical Service Center Civil Engineer; Ben Kalminson, Elephant Butte Supervisory Facility Operations Specialist; Jennifer Faler, Albuquerque Area Manager; and Dr. David Raff, Science Advisor. (Reclamation/Yuliana Porras-Mendoza)

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More Information
https://www.usbr.gov/research/bgndrf/win.html

Youth Education: Discovering Desal for 3rd Graders

Since 2016, BGNDRF has hosted an annual event dubbed "Discovering Desal" for all the third graders in the Alamogordo public school district. Additionally, private schools and home school groups participate in the event.

In FY 2019, innovative tools were developed to support event participation of 20 students from the New Mexico School for the Blind and Visually Impaired. BGNDRF Staff also took "Discovering Desal' on-the-road to two small towns near the eastern border of New Mexico to support summer school curricula related to desalination and water purification.

To date, the event has reached over 2,600 students educated through a series of learning stations. The students are divided into small groups and spend ten minutes at each learning station related to exercises in:

- the world's fresh and salty water supply
- salty water and where it originates
- removing non-dissolved solids from water
- desalination using reverse osmosis membranes
- solar and wind energy in desalination
- and concentrate management.

Reclamation's Alyssa Aligata and Catherine Hoffman teach Alamogordo third graders how renewable energy powers desalination technologies during BGNDRF's annual Discovering Desal event in March 2019. (Reclamation/Ronda Dorsey)

To document the outstanding impact of this event, Reclamation's Research and Development Office, the Washington Public Affairs Office, and BGNDRF Staff and Volunteers collaborated to create *Making Desal Cool: How Reclamation's Brackish Groundwater National Desalination Research Facility Teaches 3rd Graders the Science of Turning Salty Water into Freshwater*. This video was selected for the 2019 Water Environment Federation's Annual Technical Exhibition Conference (WEFTEC) Interactive Knowledge Exchange (IKE).

The next Discovering Desal event is planned for March 2021.

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More Information
https://www.usbr.gov/research/bgndrf/discover-desal.html

Public Outreach: Desal 101

Desal 101 is a one day course offered to the public that covers the basics of desalination and is taught by BGNDRF staff along with professors from New Mexico State University. The curriculum starts with general information on water scarcity and the need for desalination, and then it explores specific desalination technologies such as reverse osmosis and electrodialysis.

Historically, Desal 101 has been taught at BGNDRF; however, in 2020, it is anticipated the course will be held in Albuquerque, NM and co-taught with local water/desalination experts.

Desal 101 Curriculum

Topic	*Subtopic*
Introduction to Desalination	• The Need for Desal • Source Water (Non-Traditional Water) • Science of Dissolving Salts • Minimum Theoretical Energy • Process (Including Pretreatment and Post Treatment) • Global Application
Reverse Osmosis (RO)	• How It Works • History of Development • Operational Considerations and Monitoring • Various RO Innovation • 3 Major Challenges for RO
Electrodialysis (ED)	• Concept Explanation • Technology Niche • Technology Uses • Various ED Innovations
Sampling of Other Desal Technologies	• Various Thermal Processes (MSF, MED) • Capacitive Deionization (CapDI) • Forward Osmosis (FO) • Membrane Distillation (MD) • Nanofiltration (NF) • Others
Useful Calculations for Desalination	• Recovery • Salt Rejection • Simulation Programs
Concentrate Management	• The Need and Challenges • Technologies and Processes in Development • Example of the Kay Bailey Hutchison Desalination Plant

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More Information
https://www.usbr.gov/research/bgndrf/desal-101.html

Featured Faces: BGNDRF Staff

Reclamation's mission to "manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public" is supported at BGNDRF to pursue research into supply-enhancing technologies for brackish groundwater.

This work happens because of BGNDRF's dedicated, knowledgeable, and professional staff sharing a personal commitment and respect for excellence, innovation, and safety.

Randy Shaw
Facility Manager

Randy, a licensed Civil Engineer and graduate of New Mexico State University, has managed Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) since August 2010.

Prior to BGNDRF, he secured a patent on an oxygen compatibility friction testing apparatus while employed at the NASA White Sands Test Facility.

He also served over two decades with the Bureau of Indian Affairs on irrigation projects receiving water from the Gila River and the Rio Grande.

Zachary Stoll
Research Scientist

Zach is BGNDRF's first Research Scientist holding a Ph.D. in Environmental Engineering from New Mexico State University.

His work focuses on improving various aspects of desalination, such as energy efficiency, concentrate management, and treatment efficacy.

Other interests include furthering produced water treatment and reuse, as well as developing new PFAS (per- and polyfluoroalkyl substances) removal and destruction technologies.

Francisco Nisino
Electronic Technician

Francisco joined BGNDRF in 2018 as an Electronic Technician. He is responsible for the everyday operation and maintenance of electronics, controls, and water distribution systems at the facility.

He also assists clients in the commissioning and troubleshooting of equipment.

Prior to Reclamation, Francisco worked over seven years at the White Sands Missile Range as an Industrial Equipment Mechanic.

Dan Lucero
Engineering Technician

Dan, a retired 24-year Air Force Veteran with 15 years of water treatment and instructor experience, has worked with BGNDRF since 2013.

He serves as technical support for desalination research clients, team member of facility maintenance, and coordinates BGNDRF outreach and education, most notably the Discovering Desal event.

Additionally, he supports the PFAS mitigation research project currently underway at BGNDRF.

Crystal Bing
Facility Operations Assistant

Crystal, a Geological Sciences graduate of New Mexico State University, began her career with Reclamation at BGNDRF in 2018.

Her current responsibilities include facility administration, serving as Collateral Duty Safety Representative, and assisting in BGNDRF event planning, outreach, and research data collection.

Her previous work was with the National Park Service and U.S. Forest Service.

BGNDRF also relies on the support of other Reclamation employees, external federal staff, and volunteers to continually execute innovative opportunities for outreach and special events. Pictured below: BGNDRF Staff and Volunteers at the 5th Annual Discovering Desal for 3rd Graders event in March 2020. (Reclamation/BGNDRF Staff)