Fall 2016-04

RECLAMATION
Managing Water in the West

Knowledge Stream

Research and Development Office Magazine

Advanced Water Treatment

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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Message from the Chief

Greetings and welcome to the Fall 2016 edition of the *Knowledge Stream* magazine! This issue addresses Research and Development Office (R&D) work in the field of Advanced Water Treatment (AWT). AWT supports the goals and objectives stated in "Water Resource Challenges and Opportunities for Water Technology Innovation," published in December 2015, which supports the White House Initiative on clean water technologies.

Activities highlighted include R&D's Desalination and Water Purification Research (DWPR) and Science and Technology (S&T) Programs, which together fund a wide range of research, development, and demonstration activities in such areas as pre-treatment, water treatment, and concentrate management technologies, as well as innovation to reduce the costs, energy requirements, and environmental impacts of these various technologies. Many of these activities occur at Reclamation's laboratories and facilities, which are also highlighted in this issue.

In addition to traditional research and development, you will read about how R&D is jointly applying technology prize competitions to enlist a diverse, nationwide solver community to help address some of the most difficult challenges in water treatment, including prize competitions on finding cheaper ways to minimize concentrate waste from desalination and more effective ways to detect arsenic in source waters. Lastly, we are pleased to introduce you to several bright new faces in Reclamation's water treatment research community, joining both Reclamation's Technical Service Center and Lower Colorado Region Yuma Area Office.

On a final note, we are excited to share this issue of the *Knowledge Stream* as it reveals the continued iteration of a new look and feel of our flagship information resource, migrating from a newsletter- to magazine-style. As always, R&D welcomes your feedback and ideas for continual improvement on our dissemination strategies for transferring solutions to users!

Levi Brekke
Chief of R&D

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Contents

Yuliana Porras-Mendoza in Reclamation's Research and Development Office and Saied Delagah in Reclamation's Technical Service Center served as topic editors for this issue.

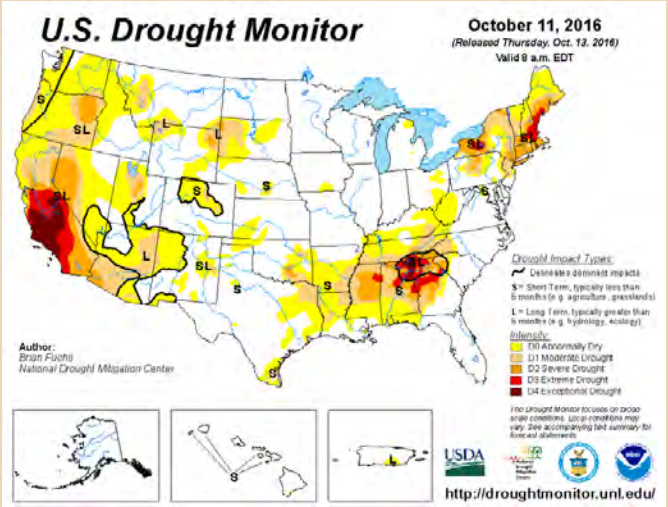
IN THE NEXT ISSUE

"Year in Review and Upcoming Initiatives"

Programs Overview

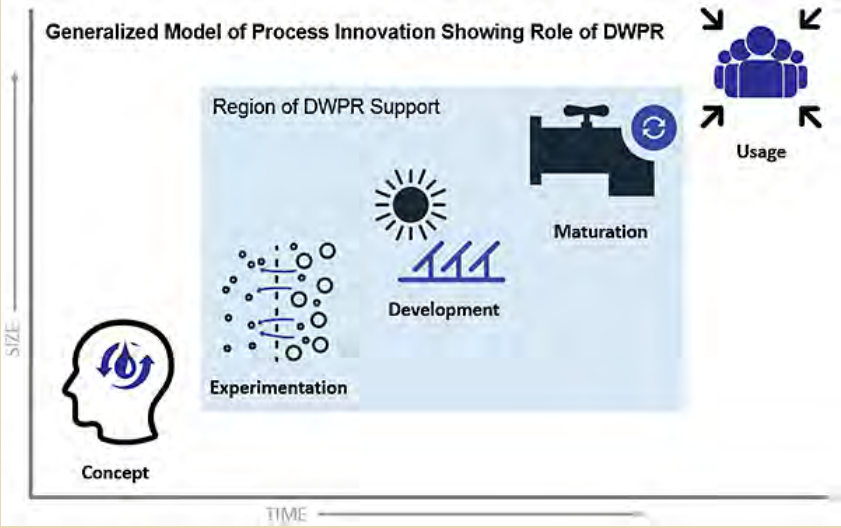
Desalination and Water Purification Research Program

The Desalination and Water Purification Research (DWPR) Program is a nationwide competitive, merit-based program that funds research at three major levels: laboratory-scale, pilot-scale, and demonstration-scale projects. While the need for water for irrigated agriculture is greatest in the arid West, the need for high quality water for drinking and for industry is nationwide. The DWPR Program works with Reclamation researchers and partners to develop more innovative, cost-effective, and technologically efficient ways to treat impaired waters to augment useable water supplies.



The United States Drought Monitor map is updated weekly, along with the Current National Drought Summary, and can be found at: http://droughtmonitor.unl.edu/.

Through the DWPR Program, Reclamation is forming partnerships with private industry, universities, water utilities, and others to address a broad range of desalting and water purification needs. The DWPR Program funds research where the benefits are widespread but where private sector entities are not able to make the full investment and assume all the risks. The DWPR Program also funds research that has a national significance—where the issues are of large-scale concern and the benefits accrue to a large sector of the public.



DWPR focuses on the experimentation, development, and maturation steps of this general model.

The water treatment technologies five-step model looks at the size and time it takes to develop innovations from a concept to industry usage. DWPR Program funding plays a critical role in iterating an idea from the laboratory through to a real-world demonstration that can both attract industry commercialization and serve the water treatment community in its usefulness by focusing its efforts in the middle three critical steps (see figure).

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Science and Technology Program

The Science and Technology (S&T) Program is a Reclamation-wide competitive, merit-based applied research and development program. The S&T Program focuses on innovative solutions to water and power challenges in the Western United States for Reclamation water and facility managers and the stakeholders they serve. Reclamation employees are the principal investigators eligible to submit to the S&T Program research proposals and receive research funding yearly.

Advanced Water Treatment is one of the S&T Program's priority areas. This priority area focuses on funding research to augment useable water supplies from impaired water sources to mitigate drought and to diversify water portfolios across the Western United States.

Testing New Ideas: Pitch to Pilot

Reclamation made an effort in fiscal year 2016 to pursue a unique competition approach designed to accelerate proposal review and selection and focus on the goals and objectives stated in the White House Initiative on clean water technologies, "Water Resource Challenges and Opportunities for Water Technology Innovation," which was published in December 2015. This new cooperative agreement initiative encourages individuals, universities, companies, private and public entities, Tribal Governments, and others to develop innovative new technology or processes at the pilot-scale level to:

- Treat brackish groundwater with less energy than current processes and technologies
- Reduce the high cost, energy usage, and environmental impacts of concentrate management for inland desalination
- Pretreat water used in reverse osmosis processes without increasing the total cost and energy usage of current systems

This Pitch to Pilot competition is comprised of two phases:

- Phase I – Each applicant submitted a 15-page white paper from which 6 finalists were selected to move on to Phase II.
- Phase II – Each finalist will deliver their "pitch" at an in-person meeting with the final judging panel at Reclamation's state-of-the-art Brackish Groundwater National Desalination Research Facility in Alamogordo, New Mexico (see article on page 8).

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www.usbr.gov/research/st/index.html

www.usbr.gov/research/st/pitchtopilot.html

Laboratories and Facilities

Denver Water Treatment Engineering and Research Laboratory

The Water Treatment Group in Reclamation's Technical Service Center uses and maintains the Denver Water Treatment Engineering and Research Laboratory (Denver WaTER Lab), which has a bench-scale chemistry laboratory and a laboratory-scale testing facility. The Denver WaTER Lab equipment is continually updated, based on Reclamation and its stakeholders' research needs.

Top left: The Denver WaTER Lab has the capability to build experimental and pilot-scale testing systems and test a wide variety of water treatment processes.

Bottom right: The Denver WaTER Lab can characterize water samples for a range of water quality parameters including alkalinity, pH, free chlorine, absorbance, and many HACH® methods.

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The Water Quality Improvement Center

The Water Quality Improvement Center (WQIC) is one of six "National Centers for Water Treatment Technologies." The WQIC comprises a 12,000-square-foot research facility with two mobile laboratories, located at the southern end of the Colorado River in Yuma, Arizona. This research facility offers laboratory space, equipment, and experienced engineers and technicians knowledgeable in water treatment processes and operations. The WQIC's purpose is to make pilot water research and field testing more cost effective and practical for entities interested in water quality improvement. The WQIC can also test customer-supplied technologies, including equipment, instrumentation, and control. Collaborators interested in using this facility can also conduct their research or testing on a variety of source waters, including brackish agricultural runoff and groundwater, and Colorado River water.

Top: The WQIC.

Right: One of WQIC's two mobile research laboratories.

Bottom: WQIC's analytical laboratory.

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Brackish Groundwater National Desalination Research Facility

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:

- Desalination technologies in the pilot phase of technology development
- Sustainable concentrate management technologies and processes
- Renewable energy/desalination hybrids
- Economically viable small-scale desalination systems
- Treatments for produced waters from oil and gas
- Public outreach and education

This 43-acre research facility offers 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 chemical/environmental engineers with expertise in process development and design

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 individuals to large corporations and universities. Some of the clients that have visited and/or done work at BGNDRF in fiscal year 2016 are:

Reclamation's BGNDRF, Alamogordo, New Mexico.

- Evoqua Water Technologies
- Stage 2 Innovations
- University of Arizona
- Oasys Water
- Massachusetts Institute of Technology's Global Engineering and Research Laboratory
- University of North Texas
- Global Environmental Legacy Foundation
- Trailblazer Technologies
- GC Solutions, Inc.
- LG NanoH_2O, Inc.
- New Mexico State University
- KII, Inc.

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 inaugural halophyte farming project for concentrate management led by both the University of Arizona and New Mexico State University. In fiscal year 2017, a new renewable energy opportunity will become available for clients to test water treatment technologies coupled with solar photovoltaics, as well as continuing to reduce and optimize the energy consumption in the facility by using dedicated solar energy to power the main building.

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Teaching Kids the Science Behind Making Fresh Water From Salty Water

Teaching third-graders about desalination, brackish water supplies, the world's water situation, and other topics being studied at BGNDRF seemed impossible. But BGNDRF's Director, Randy Shaw, and his staff hosted every third-grader in the Alamogordo Public School system—nearly 500 kids—with help from local volunteers and Reclamation staff from Denver, Colorado and Albuquerque, New Mexico.

BGNDRF staff members Steve Holland, Bobby Granados, and Dan Lucero did an exceptional job in simplifying the material and teaching it to the children. Stations included exercises in salty water and where it comes from, the world's fresh and salty water supply, removing solids from water, desalination using membranes, desalination using electric charges, solar and wind energy in desalination, and tour of the property.

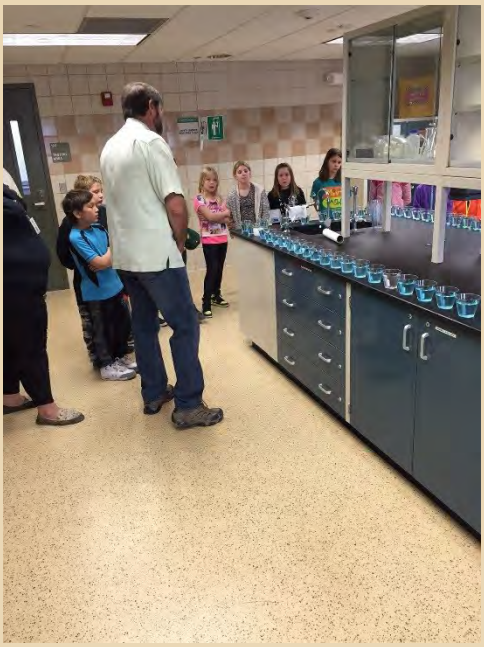
Dan Lucero, BGNDRF's Facility Operations Assistant, having fun with kids while teaching them about removing non-dissolved solids from water.

Teachers and students expressed excitement throughout the day in the various teaching techniques used to explain such complicated matters. For example, staff member Dan Lucero used a basket with different sized grates and blue balls representing water and large pink and purple balls representing dirt. The kids tossed the balls into the basket and were able to see the water moving down as the large dirt balls were filtered. But eventually the basket plugged with all the solids and the water could not move through.

Discussions are already under way for more tours next year as this could be an annual event.

More Information

See additional images on back cover.



Volunteer Will Little is explaining the meaning behind the "100 cups of water." The 97 cups of blue water represent 97 percent (%) of the planet's water that is too salty to drink or grow a crop. The two cups of ice represent 2% of the planet's water that is fresh, but unavailable in the polar ice caps. The one cup of clear water represents 1% of the planet's water that is fresh and available to use.

Steve Holland, BGNDRF's Electronics Technician, explaining how water becomes salty as it moves through the ground.

Roberto Granados, BGNDRF's Engineering Technician, showing kids the concept of electrodialysis using hand-held magnets.

Research Efforts and Partners

Concentrate Management

In Brief:

Desalination processes produce both product water and a concentrated stream that contains the salts removed from the product water. While many seawater plants can discharge this concentrate back into the sea, inland concentrate disposal methods include deep well injection, surface water injection, wetland treatment, evaporation ponds, and others.

Managing and disposing of this concentrate stream inland can be costly and could pose environmental concerns. Thus, Reclamation and many others are researching more effective management techniques.

Brackish water desalination plants are being installed across the country in an effort to diversify water supply portfolios and improve overall supply reliability, particularly due to drought, climate change, and population growth. Concentrate management for inland brackish desalination remains a major hurdle to widespread use of desalination for inland applications.

Survey of municipal desalination plants. Source: USGS (http://water.usgs.gov/ogw/gwrp/brackishgw/use.html).

The National Academy of Sciences report, *Desalination, A National Perspective*, emphasizes the need to increase the Nation's "new" water supplies through the treatment of alternative water sources. Producing drinking water from brackish groundwater and seawater resources using reverse osmosis (RO) desalination technology increases annually to supplement the national water supply. The U.S. Geological Survey's (USGS) brackish groundwater assessment reports that more than 95 percent of the desalination facilities in the United States (U.S.) are inland, and most facilities are designed to treat groundwater with dissolved-solids concentrations in the brackish range.

RO processes currently desalinate brackish groundwater and seawater in the U.S. Feed water is pressurized and separated into two streams by RO membranes. One stream is pure water and the other is a highly concentrated salt solution known as "concentrate." Other desalination processes typically produce a concentrate stream as well. The cost to manage or dispose of concentrate streams is rather large and limits the use of desalination in inland applications.

Operating and maintaining the capital investment involved in desalination facilities is an important criterion in continuously generating new water supplies. Lowering desalination costs remains a high priority research topic for Reclamation's Advanced Water Treatment efforts.

Reclamation is funding research studies to gain a better understanding of how to best manage concentrate streams and has funded four different approaches to find solutions:

1. Concentrate management toolbox – assessment of existing technologies
2. Concentrate contaminants of emerging concern (CECs)
3. Eastern Municipal Water District's (EMWD) pilot-scale demonstration of General Electric's (GE) AquaSel technology at its Menifee Desalter, California
4. Prize competitions to capture more water and reduce concentrate

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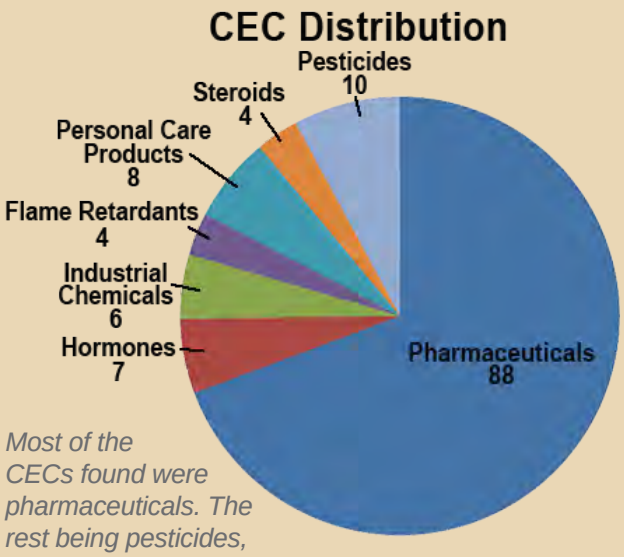
The first approach is a research study that focuses on creating an assessment and selection toolbox for concentrate management technology solutions to address the following questions:

- What methods are available to treat, manage, and reduce the volume of concentrate generated by inland desalination of brackish water?
- How can different concentrate management methods be compared?
- Which criteria should be used to compare different methods, and how might these criteria differ by location and/or water quality?

The second approach is a research study that focuses on emerging contaminants contained in concentrate streams of water reuse desalination facilities. With potable water becoming an increasingly scarce commodity around the world, more regions are looking toward reuse projects to facilitate their water needs. Potable reuse and treatment via RO is gaining popularity due to continuation of drought and limits to water conservation efforts, along with lower cost of treatment in comparison to ocean or brackish water desalination. Therefore, there is a need to study the effect of CECs in RO concentrate streams of reuse treatment plants and add reuse as a viable option in the water supply portfolio across the West.



Most of the CECs found were pharmaceuticals. The rest being pesticides, steroids, personal care products, flame-retardants, industrial chemicals, and hormones.

It is important to develop a more comprehensive understanding of CECs found in the concentrate streams when using RO to produce water for direct and indirect potable reuse. RO concentrate streams generated from potable reuse feed streams are highly concentrated in CECs. Research on CECs for wastewater effluents and reuse in product water is ongoing. However, studies related to concentrate streams from RO that treat reuse waters are lacking. The goal of Reclamation-funded research is to find the best way to manage and dispose of concentrate streams containing high levels of emerging contaminants with the least impact to the environment.

Pipeline scaling from concentrate streams. Photograph by and courtesy of the Santa Ana Watershed Project Authority, 2010.

As a third approach, EMWD, GE, and Carollo Engineers, Inc., partnered to test a new GE technology named AquaSel. The AquaSel process aims at increasing water recovery and reducing concentrate from an RO process. Over a 9-month period, the AquaSel process was tested at EMWD's Menifee and Perris Desalters in California. The main objective was to evaluate this new process as a concentrate reduction treatment option and to increase the water recovery from the desalters from 75 to 95 percent, while producing an acceptable quality product stream. Both of these goals were achieved and demonstrated during the testing period.

Reclamation's fourth approach is to seek solutions from the broader solver community and the general public through an upcoming prize competition in minimizing concentrate volume. See the "Technology Prize Competitions" segment in this issue for more information regarding this and other prize competitions.

Through Reclamation research and development on Advanced Water Treatment, internal and external solvers are moving forward and are encouraged to find solutions for concentrate management. Lack of concentrate management solutions is a large barrier to widespread use of desalination for inland, non-coastal applications and water supply augmentation.

Water Reuse

Update on the Latest WateReuse Research Foundation Agreement

Reclamation and the WateReuse Research Foundation (now the Water Environment & Reuse Foundation [WE&RF]) entered into a cooperative agreement in 2010 to continue the collaboration and assistance in funding-applied research projects. The WateReuse Research Foundation (Foundation) funded 13 projects covering a broad spectrum of issues in water reuse and desalination, including chemical contaminants, microbiological agents, treatment technologies, salinity management, public perception, economics, and marketing. Reclamation funded a total of $2,070,000 with a Foundation match of $3,961,854, including $303,162 in cash from the Foundation itself. Among the numerous funding partners contributing to these projects are the California State Water Resources Control Board, California Department of Water Resources, Pentair Foundation, and water and wastewater agencies throughout the United States.

As part of this cooperative agreement, the Foundation published 10 final reports and 2 accompanying publications, and completed 8 workshops. Three final reports are currently amid production (WRRF-10-06, Phase II; WRRF-11-01; and WRRF-11-02). The 13 funded projects are:

- WRRF-10-03 – Regulatory workshop on critical issues of desalination permitting
- WRRF-10-04 – Impingement mortality and entrainment reduction guidance for existing seawater intakes
- WRRF-10-05 – Role of retention time in the environmental buffer of indirect potable reuse projects
- WRRF-10-06 – Challenge projects on low energy treatment schemes for water reuse, two phases
- WRRF-10-07 – Development of bio-analytical techniques to assess human health impacts of recycled water
- WRRF-10-10 – Demonstration of filtration and disinfection compliance through soil-aquifer treatment
- WRRF-10-11 – Ozone pretreatment of non-nitrified secondary effluent before microfiltration
- WRRF-10-15 – Establishing nitrification reliability guidelines for water reuse
- WRRF-10-16 – Enzymes: the new wastewater treatment chemical for water reuse
- WRRF-10-17 – Urban recycled water programs
- WRRF-11-01 – Monitoring for reliability and process control of potable reuse applications
- WRRF-11-02 – Equivalency of advanced treatment trains for potable reuse

In Brief: Partners

Reclamation has had a long partnership with the WateReuse Research Foundation since the early 2000s. The WateReuse Research Foundation and the Water Environment Research Foundation merged earlier this year to become the Water Environment & Reuse Foundation (WE&RF).

The merger strengthens the industry movement toward the "One Water" concept—water from all sources should be managed cooperatively to meet economic, social, and environmental needs—and Reclamation is excited to continue to work with the new WE&RF in its research efforts.

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Goodyear Pilot Wetlands Project

Reclamation's Science and Technology (S&T) Program and Lower Colorado Region's Phoenix Area Office are working with the City of Goodyear, Arizona, to develop a cost-effective and environmentally sensitive Advanced Water Treatment alternative for managing inland reverse osmosis (RO) concentrate generated at the City of Goodyear's Bullard Water Campus.

A past Reclamation S&T Program research project constructed the pilot wetlands and demonstrated that the wetlands successfully reduced arsenic, selenium, chromium, and nitrate concentrations to meet surface water discharge standards. Based on the results of the pilot wetlands, Reclamation and the City of Goodyear entered into another partnership, the Demonstration Wetlands Study, to identify a location and determine the associated engineering requirements to construct a demonstration-size wetland treatment facility.

Left to right: Mark Holmes, Water Resources Manager, City of Goodyear, Arizona; Guy Carpenter, WateReuse Association President; and Deborah Tosline, Program Manager, Phoenix Area Office in Reclamation's Lower Colorado Region.

The wetland treatment uses vertical upflow wetlands to remove biologic and metal constituents from water using organic media. In addition, a new Reclamation S&T Program Pilot Wetlands Study is assessing transit times and organic media and vegetation loading rates. Following wetland treatment, the treated concentrate is blended with other water types to reduce total dissolved solids (TDS) concentrations for ultimate discharge to the Gila River. The wetland treatment concept would increase reuse options of three water types: treated effluent, treated Superfund water, and RO concentrate.

The Pilot Wetlands Study builds on the experience, equipment, and partnerships from historic work and the current Demonstration Wetlands Study to evaluate the use of wetlands to treat RO concentrate and answer:

- How can vertical flow wetlands be implemented in a full-scale application to provide a viable inland RO concentrate management alternative?
- What are the design criteria associated with wetlands for concentrate management (i.e., factors contributing to operations and maintenance costs, capital costs, etc.)?
- How can wetlands be incorporated into city education and recreation plans to provide added benefits beyond concentrate management?

As part of the Demonstration Wetlands Study, Reclamation conducted a Geographic Information Systems (GIS) analysis to identify optimum locations for the demonstration facility and selected Estrella Mountain Regional Park in Arizona. This site selection resulted in a new partnership with the Maricopa County Parks and Recreation Department, which owns and manages the park.

The *Water & Wastes Digest* has tapped this demonstration study as the 2016 "Top Project" for the United States (U.S.). The *Water & Waste Digest* is the largest utility journal within the U.S., and the Top Projects Program recognizes new facilities and projects, as well as innovative upgrades and notable water and wastewater solutions. The *Water & Waste Digest* will showcase the "Top Project" in its December issue.

Additionally, the Demonstration Wetlands Study project was recognized and received the 2016 "Innovative Project of the Year" award at this year's 31st Annual WateReuse Symposium.

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Innovative Research and New Opportunities

Removing Chromium 6 With Ion Exchange Resins

In Brief:

Reclamation has been working on innovative research and new opportunities, executing new research on removing constituents that pose health concerns such as hexavalent chromium. The goal is to improve the treatment process and make it more economical for small communities to deal with this problem.

California State Polytechnic University, Pomona

In addition, through Reclamation's work with California State Polytechnic University–Pomona, researchers at the university are working on commercializing a portable, automated, off-grid system to treat brackish water to drinking standards at an economical cost.

While some forms of chromium are not toxic, hexavalent chromium (Cr^{6+}) is naturally present in many groundwater aquifers used as drinking water and poses a risk to human health. The State of California has set the maximum contaminant level (MCL) for Cr^{6+} at 10 micrograms per liter (µg/L) for drinking water. Many drinking water utilities in California now require expanded treatment operations to meet the California MCL. If a nationwide regulation is implemented for Cr^{6+}, it is anticipated that thousands of entry points in public water systems would require additional treatment to meet a similar MCL.

Strong base anion exchange is one treatment technology that is effective for removing Cr^{6+}. Hexavalent chromium is found in natural waters as chromate (CrO_4^{2-}), which has a negative charge. Ion exchange resins are small beads with a charged surface that pulls charged ions out of the water. Once the resin capacity is full, it can be regenerated using a concentrated salt solution.

Reclamation is collaborating with a rural water district in California to test strong base anion exchange processes at two well sites at a pilot scale. Reclamation's Denver Water Treatment Engineering and Research Laboratory (see article on page 6) is testing a regeneration process that removes Cr^{6+} and other constituents, such as sulfate, from ion exchange resins so they can be used again. Research engineers are working to optimize the regeneration process to improve treatment efficiency. Nanofiltration processes are used to recover regeneration salt (a liquid solution also used in the regeneration process and an important chemical cost) and reduce the volume of waste. These efforts will help make water treatment in small communities more economical.

Top: Pilot-scale ion exchange columns. Bottom: Regeneration brine.

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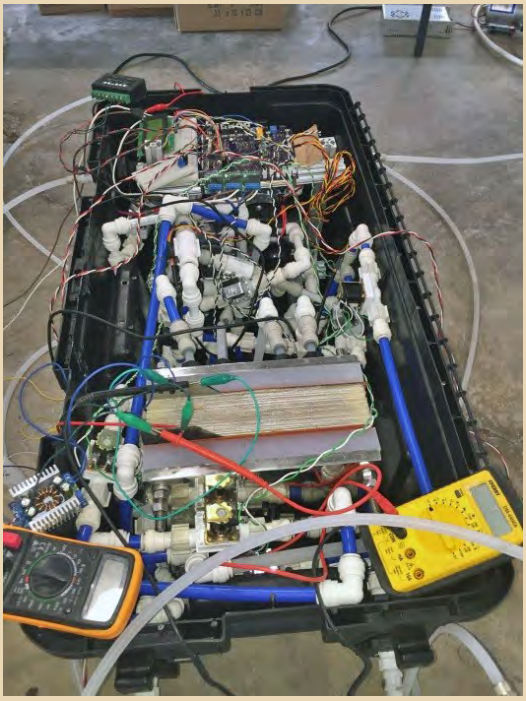
A Household Photovoltaic Electrodialysis Desalination System

A unit that is portable, automated, off-grid, costs as little as $4,000, and able to treat brackish water so that it is drinkable? This is a dream well on its way to an industry reality. Reclamation partnered with California State Polytechnic University–Pomona to develop this unit, which is now being commercialized. Emergency response teams, homes, and villages in rural areas where fresh water is scarce but brackish water is abundant, and others are certainly looking forward to this product.

The system uses solar power (i.e., photovoltaic panels). Brackish water is treated with electrodialysis, and flow and water quality are metered to ensure that water is fully desalinated. A hydraulic system turns pumps on and off, and the system is automated so these interacting components can run efficiently in a variety of different situations and adapt to events of a day. Advantages of this system include:

- The unit takes up very little space
- Solar tracking makes it energy efficient—only 100 watts needed
- Battery charging means no electricity required
- Can treat enough for a typical household's water consumption

Researchers tested this system at Reclamation's Brackish Groundwater National Desalination Research Facility in Alamogordo, New Mexico (see article on page 8) from June through September 2015. They achieved a 75 to 85 percent recovery rate with a feed water of 2,000 to 4,000 micro siemens per centimeters (µS/cm) to a product water of 500 to 1,000 µS/cm. (Note that 0 to 800 µS/cm is considered good drinking water, while 800 to 2,500 µS/cm can be consumed by humans. Source: http://mrccc.org.au/wp-content/uploads/2013/10/Water-Quality-Salinity-Standards.pdf.)



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The solar-powered electrodialysis desalination system.

Working Towards Optimizing the Water-Energy Nexus

Providing reliable energy supplies in remote, island, rural, and Tribal areas require complex timing to balance available supplies and demands. Reclamation is working with the National Renewable Energy Laboratory (NREL) to find the best times to use energy to treat water. Researchers developed a water treatment and conveyance module within NREL's modeling platform, REopt. Now, the model is ready to be used to identify new operational and design strategies for water treatment plants, water storage, and renewable energy power systems to optimize power available and water supply. The model identifies solutions that minimize the overall cost of energy to the community, while still ensuring that the water demand is met at every time period.

In fiscal year (FY) 2015, Reclamation contributed $100,000 supporting model development and initial testing. In FY16 and FY17, the proposed budget is tentatively $100,000 for testing in a remote community. Reclamation's Research and Development Office plans to use its Advanced Water Treatment experts, working in conjunction with NREL's REopt team, to further develop and test this model.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Reclamation and NREL also worked jointly to identify a remote community in which to optimize water and energy needs, as well as provide an appropriately challenging analysis to test the enhanced REopt software. The two pilot projects to test the new software are Delta Diablo (California) and 5T529 (Arizona).

R&D Contacts

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American Membrane Technology Association/Reclamation Fellowships for Membrane Technology

Reducing the cost, energy usage, and environmental impacts in Advanced Water Treatment and desalination depends on innovating new systems or optimizing existing technology. The need for additional work in innovation is necessary to meet the demand for water supplies in the United States (U.S.), greater so in the arid Western States of the country.

Reclamation and the American Membrane Technology Association (AMTA) are partnering and collaborating to provide funding for graduate student fellowships. The AMTA/Reclamation Fellowships will consist of competed awards given to graduate students pursuing full-time master's or Ph.D. degrees at a U.S. university or college conducting research in innovations for water treatment in membrane-related research.

This funding will aid in the advancements needed to pursue innovation in membrane technologies and pursue the goals and objectives stated in the White House Initiative on clean water technologies, "Water Resource Challenges and Opportunities for Water Technology Innovation," which was published in December 2015.

Contact

American Membrane
Technology Association
772-463-0820
info@amtaorg.com

More Information

www.amtaorg.com/amta_reclamation-fellowships-for-membrane-technology

Call for Nominees Application Deadline is Wednesday, November 9, 2016.

R&D Contact

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Improving Understanding of Water Quality Patterns and How Various Events Add to Rivers' Complexities

Water quality in rivers depends on complex and interrelated factors, such as flow, sediment composition, local ecosystems, and more. Random snapshots of water quality do not provide enough clues to uncover patterns, cause, and effect relationships. To do that, frequent, consistent, and timely measurements are needed. For example, on August 5, 2015, the Gold King Mine waste spill in Colorado shone a spotlight on water quality in the Animas River, approximately 22 miles upstream of the San Juan River.

Water monitoring taken in the Animas River near Durango, Colorado, on August 14, 2015. Photograph by Eric Vance, U.S. Environmental Protection Agency.
Source: U.S. Environmental Protection Agency (www.epa.gov/goldkingmine).

Reclamation took water samples immediately after the event on August 7 through 17, 2015. The U.S. Environmental Protection Agency continued with almost daily sampling through mid-October 2015. Significant increases in concentrations of dissolved and total metals on 3 days (August 27, September 6, and September 24, 2015) were surprising, as they did not correspond to the spill. Rather, these spikes corresponded to rain events, which rapidly increased in the Animas River flow. But what could be the culprit? What was causing these increases in metals during these flow events?

Researchers compared these observed concentration increases to the U.S. Geological Survey's historical dataset before the Gold King Mine spill and found similar events. Several samples exhibited increases in metal concentrations that corresponded with flow events in the Animas River. Yet there were no significant increases observed during the spring 2014 snow runoff. Researchers examined sediment analyses along the San Juan and Animas Rivers, which suggest that sediment loadings and exports have an important impact on water quality. As the Animas River is subject to large flow variations, particularly in the fall, and the sediment of the river is rich in metals, these sudden and significant increases in metal concentration will likely continue into the future. While increased sampling after the Gold King Mine spill led to discovering these spikes, more research is needed to understand the dynamics of water quality and sediment transport in this area.

Contact

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Research Bulletins

The following list of Research Bulletins showcase completed research within Reclamation's Science and Technology Program. This list of Bulletins relates to this issue's theme of addressing Advanced Water Treatment. Please contact the principal investigators for more information about these final research projects.

Project ID 9252

Treat Impaired Water or Import Fresh Water?

Evaluating the benefits of treating locally impaired water supply sources versus importing fresh water

"Treating a locally available, impaired water resource offers advantages over importing fresh water for some applications."

Katie Guerra, Chemical Engineer
Reclamation's Technical Service Center

www.usbr.gov/research/docs/updates/2016-03-water.pdf

Project ID 4850 and 6806

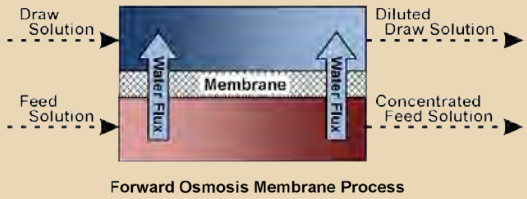
Solar Photovoltaic Desalination Using Distillation

Off-grid solar photovoltaic desalination on the Navajo Nation Reservation

"This research project will allow the 150 families in this area of the Navajo Nation much closer access to better quality water. These families now travel to Leupp, or even Flagstaff, Arizona, to obtain their livestock and drinking water. This will reduce their travel time and associated costs. Moreover, this concept can be replicated anywhere in the world where people need better quality water and do not have access to the traditional water and electrical infrastructure."

Mitchell Haws, Water Resources Planner
Reclamation's Lower Colorado Region

www.usbr.gov/research/docs/updates/2016-04-photovoltaic.pdf



Forward Osmosis Membrane Process

Project ID 7911

Can Reclamation Benefit From Forward Osmosis?

Evaluating potential applications for forward osmosis

"There has been extensive research conducted on forward osmosis touting the minimization of fouling and low energy requirements of the process—yet there is seldom such a thing as a free lunch. Where forward osmosis is most applicable must be scrutinized and tested, and this literature survey will help guide research areas that Reclamation believes are best suited for this technology."

Miguel Arias-Paic, Environmental Engineer
Reclamation's Technical Service Center

www.usbr.gov/research/docs/updates/2016-25-forward-osmosis.pdf

Technology Prize Competitions

Water Prize Competition Center Contact

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Reclamation's Water Prize Competition Center Update

Reclamation's Water Prize Competition Center is launching two new prize competitions to find innovative solutions for Advanced Water Treatment, in addition to two prize competitions related to water supply forecasting and sediment management:

Water Availability Theme Area

More Water - Less Concentrate: Stage 1

Grand Challenge – Launching Fall 2016

As the demand for fresh water increases, the need to develop new water supplies from non-traditional water sources, such as saline (brackish) groundwater and surface water using desalination technologies continues to grow.

Nationwide, desalination can help meet the increasing demand for fresh water, diversify water supply portfolios, and improve water reliability, particularly in areas affected by climate change, population growth, and drought.

This is a Grand Challenge envisioned to consist of three main stages. Stage 1 is a concept competition requiring a white paper submittal with a total prize purse of $150,000. Stage 2 is envisioned as a subsequent reduction-to-practice (RTP) competition to demonstrate proof-of-concept data at bench-scale with a total prize purse of at least $450,000. Stage 3 is envisioned as an RTP demonstration at full-scale in a field-test setting with a total prize purse of at least $500,000.

Reclamation also plans to invite industry, non-profit organizations, and venture capital representatives to participate as partners and/or official judges and seek potential business deals with prize competition participants.

Prize Competition Team Lead: Saied Delagah | sdelagah@usbr.gov

Water Availability Theme Area

Detecting Arsenic at the Source

New Technology Challenge - Launching Fall 2016

Reclamation and the U.S. Environmental Protection Agency are joining forces to launch this arsenic sensor prize competition for the development of new technology to detect arsenic in water.

The Safe Drinking Water Act requires that public water systems monitor regulated contaminants in drinking water to ensure public safety. Arsenic, a naturally occurring element, is one of the many drinking water contaminants actively monitored by drinking water systems because it can result in adverse health conditions, including an increased risk for a range of cancers.

A more efficient arsenic monitoring technology could help to improve the monitoring system, reduce costs, and better protect human health and the environment.

Prize Competition Team Lead: Katie Guerra | kguerra@usbr.gov

Water Availability Theme Area

Sub-Seasonal Forecast Rodeo - Beat NOAA

Reduction-to-Practice Challenge - Launching Winter 2016

Water managers need more accurate information on weather and climate conditions with lead-times ranging from 15 to 45 days and beyond.

Lacking information limits water managers' ability to predict streamflow and water supply for sub-seasonal forecast lead-times. This gap in sub-seasonal weather and climate information, in turn, limits the ability to prepare for shifts in hydrologic regimes, such as the onset of drought or occurrence of wet weather extremes.

In response, Reclamation is launching a water supply forecasting prize competition where solvers will submit forecasts of temperature and precipitation for 1 year, competing in real-time against other teams as well as official forecasts from the National Oceanic and Atmospheric Administration (NOAA). Recognizing NOAA's leadership and role in forecasting, Reclamation has partnered with NOAA on this prize competition. To be eligible for prizes, solvers with skillful performance during the prize competition will be required to submit documentation of their forecast technique.

Prize Competition Team Lead: Kenneth Nowak | knowak@usbr.gov

Ecosystem Restoration Theme Area

Better, Faster, Cheaper: Measuring Reservoir Capacity

Ideation Challenge - Launching Fall 2016

Accumulating sediments pose a significant problem for Reclamation in determining how to measure reservoir storage capacities.

Sediment deposition in reservoirs—or the accumulation of particles like pebbles, sand, mud, and salts carried by wind, water, or ice—limits the active life of reservoirs by reducing storage capacities and impacting structures, such as water outlets and intakes.

Developing an efficient and accurate indirect estimate model of reservoir storage would result in a significant better, faster, and cheaper solution and support Reclamation in meeting water and power deliveries now and into the future.

Prize Competition Team Lead: Sean Kimbrel | skimbrel@usbr.gov

Ecosystem Restoration Theme Area Contact

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More Information

www.usbr.gov/research/challenges

www.challenge.gov

Featured Faces

Highlighting People That Contribute to Reclamation Research and Development

New Employees in the Water Treatment Group in Reclamation's Technical Service Center

The Water Treatment Group provides engineering and research services for the treatment of contaminated water supplies, wastewater, hazardous and industrial waste streams, and agricultural drainage. The group combines the multidiscipline expertise of chemical, environmental, and mechanical engineers to develop comprehensive water treatment solutions.

Miguel Arias-Paic, Ph.D., P.E., Environmental Engineer, has spent more than 10 years designing water treatment plants. His areas of expertise include ion exchange, control of disinfection byproducts, and minimization of waste streams.

Anthony Kennedy, Ph.D., Environmental Engineer, has worked for 3 years on pilot- and bench-scale testing for conventional and advanced treatment technologies, including membranes, granular activated carbon, and biofiltration.

Richard Huggins, Ph.D., Environmental Engineer, has 5 years of water and wastewater treatment experience, including laboratory and field testing with membrane bioreactors and developing analytical models for biological, chemical, and physical treatment processes.

Julie Korak, Ph.D., Environmental Engineer, has 5 years of experience in water treatment research. Her areas of expertise include characterization and removal of natural organic matter and the use of fluorescence spectroscopy for monitoring of organic constituents.

Erika Focht, Administrative Assistant for two TSC groups, has 3 years of experience in office administration, gaining multiple skills that include data entry, property management, purchasing, and budgeting. Erika also uses her people and presentation skills to provide tours of TSC's laboratory facilities.

New employees in the Water Treatment Group. From left to right: Erika Focht, Richard Huggins, Miguel Arias-Paic, Anthony Kennedy, and Julie Korak.

New Desalting Team Employee in the Yuma Area Office in Reclamation's Lower Colorado Region

New Desalting Team employee, Luis Cruzado; Yuma Desalting Plant in background.

The Desalting and Program Management Office works to fulfill Reclamation's core mission of promoting water reuse, water research, and the development of water resources in the interest of the American public. In partnership with Reclamation's stakeholders, it conducts state of the art reverse osmosis (RO) research in the Water Quality Improvement Center (see article on page 7) and manages one of the largest desalination plants in the world, the Yuma Desalting Plant.

Luis Cruzado, E.I.T., Chemical Engineer, has 1 year of experience working in desalination. His current projects include RO membrane evaluation, supporting academic and commercial research projects, and designing plant improvements such as tanks and piping, ball mills, and RO skids.

Retiring Advanced Water Treatment Experts

Reclamation's retirees have given a fine legacy and great foundation for innovative water treatment and desalination work. Esteemed retirees include: Kevin Price, Andrew Murphy, Michelle Chapman, John Walp, and Charles Moody.

Thanks to their hard work, Reclamation continues to be a leader in research in these areas with the creation of many of its current research programs, research facilities, and long-lasting relationships within and outside the Federal Government. Thanks for your leadership, intellect, and countless hours of dedication and work.

About the *Knowledge Stream*

The *Knowledge Stream,* published by the Bureau of Reclamation's Research and Development Office, is a seasonal magazine bringing mission-critical news about the agency's research and science, as well as the many challenges associated with managing water and generating power in the West, including: projects, tools, methods, practices, results, innovation, prize competitions, publications, and more.

Regional Science and Technology Coordinators Contact Information

Whether you are a regional researcher, Reclamation partner or customer, or just have an idea for a project that can help your region, the Regional Science and Technology Coordinators can help you with your research ideas, proposals, and projects.

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**Rod Wittler is also the Mid-Pacific Region Science Liaison.*

On the Covers—

Front Cover: Advanced Water Treatment stream.

Back Cover: Kids Day at Reclamation's BGNDRF, Alamogordo, New Mexico (see article on page 9)—

Bottom Right: Katie Guerra, from Reclamation's Technical Service Center, showing kids a classic still and teaching them on the use of solar and wind energy for desalting water. Behind them is a small windmill unit for demonstrating the use of wind for desalting water.

Bottom Left: Volunteer Jeffrey Bacon taking kids on a cart tour, a highlight of the day, of the 43-acre BGNDRF complex.

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