



COLLEGE OF AGRICULTURE & LIFE SCIENCES
COOPERATIVE EXTENSION

WATER RESOURCES RESEARCH CENTER

ANNUAL
REPORT **2017**

wrrc.arizona.edu



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Both appendices are located at <https://wrrc.arizona.edu/about#annual-reports>

WHO WE ARE

CARRYING ON A TRADITION OF RELEVANT RESEARCH, RELIABLE INFORMATION, AND COMMUNITY ENGAGEMENT AROUND WATER RESOURCE ISSUES

Greater Depth, Broader Perspective For A Clear Water Future

The WRRRC mission is to tackle key policy and management issues, empower informed decision-making, and enrich understanding through engagement, education, and applied research. We use our water resources expertise to produce trusted and reliable water information, conduct “real-world” research, and work with a variety of stakeholders, including decision-makers, professionals, students, and the public. Serving Arizona since 1957, the University of Arizona WRRRC became a federally authorized water resources research institute through the 1964 Water Resources Research Act and was renamed the Water Resources Research Center in that year. A research and Extension unit of the UA College of Agriculture and Life Sciences, the WRRRC has a history of advancing knowledge on water-related issues, engaging stakeholders in knowledge generation, and disseminating that knowledge widely. More than 60 years after its founding, the WRRRC used 2017 to scrutinize its programs and priorities with an eye toward improving efficient use of limited resources and expanding into areas of recognized need and evident promise. Our partners in the water community have been supportive of these efforts and we look forward to many more years of service to Arizona and beyond.



DIRECTOR'S MESSAGE

I am pleased to present you with this overview of Water Resources Research Center activities for 2017. As you can see from the following pages, the WRRRC remains focused on programs and projects that align with our mission to engage the spectrum of water stakeholders, educate students of all ages, and conduct user-driven applied research on water challenges and solutions. I am especially proud of the many partnerships we have built, including with our External Advisory Committee, which provides us with valuable input. As you will see, our accomplishments reflect our collaborative approach.

My own activities in 2017 reflect my commitment to addressing water issues that are important to the people of Arizona and beyond. Many of my programmatic activities relate to Arizona's leadership in groundwater and Colorado River management and our geographic location within the Colorado River Basin and at the U.S.-Mexico border. I continue to work on groundwater governance and management, transboundary aquifer assessment, use of recharge to meet water management objectives, and comparative policy analysis. Through teaching the course "Water Policy in Arizona and Semi-arid Regions" and advising students, I connect University of Arizona graduate students to the most recent water management developments, problems, and potential solutions. I continue to make presentations to audiences of varied backgrounds, and I endeavor to share information through journal articles, columns, and other written materials. In addition, I share information about our Extension and research programs and practices through national and international organizations, including the National Institutes for Water Resources, the Universities Council on Water Resources, the American Water Resources Association, and the International Arid Lands Consortium. I chronicle these and other professional activities, which keep me very busy, on my detailed Curriculum Vitae, which we post at wrrc.arizona.edu/director.



We are always looking to expand and enhance our partnerships. Please contact me any time to share your thoughts about our work and how we can collaborate with you.

About the Director

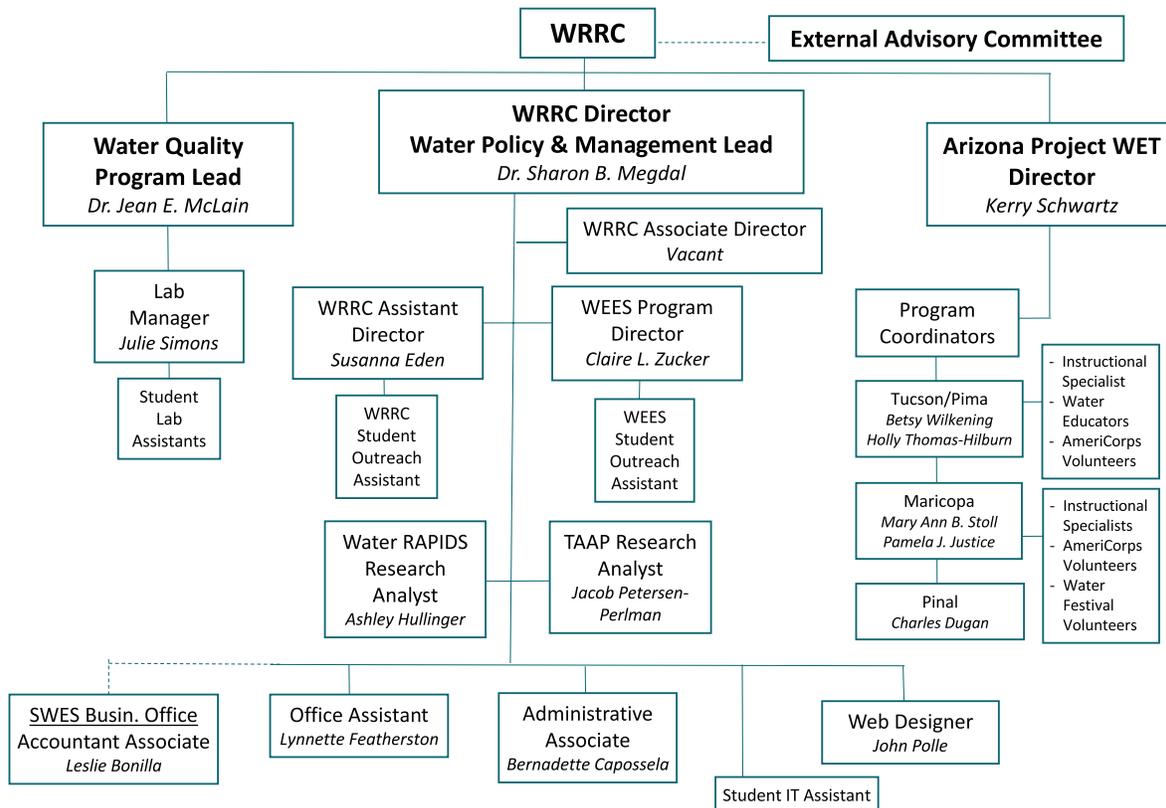
WRRRC Director Sharon B. Megdal is the C.W. & Modene Neely Endowed Professor for Excellence in Agriculture and Life Science and University Distinguished Outreach Professor. She also serves as Director of the University of Arizona TRIF Water, Environmental, and Energy Solutions Initiative. Her primary academic departmental affiliation is the Department of Soil, Water and Environmental Science, and she holds numerous courtesy appointments in departments and colleges across campus.

In addition to her service to many academic and professional associations, in 2017 she continued to serve as an elected member of the Board of the Central Arizona Water Conservation District. In February 2017, the Board elected her to the position of Secretary and Chair of the Central Arizona Groundwater Replenishment District and Underground Storage Committee.

THE WRRC ORGANIZATION

The WRRC is home to a number of programs that contribute to our overall mission to tackle key water policy and management issues, empower informed decision-making, and enrich understanding of water issues through engagement, education, and applied research. Three faculty members are individually responsible for their research, Extension, and education programs. The WRRC's small professional staff carry out research, Extension, and education projects that focus on enhancing the capacity of stakeholders and communities to deal with water resource issues. Collaborations and partnerships are fundamental to the WRRC's approach. The WRRC External Advisory Committee is kept informed and consulted on WRRC plans and activities. As Director, Sharon B. Megdal supervises support and programmatic leadership staff. She is assisted in administrative matters by an administrative associate. In financial matters she is assisted by an accountant associate, whose administrative home is the Department of Soil, Water and Environmental Science. A team responsible for implementation of core outreach and engagement programs meets weekly to coordinate communications and related activities. A staff directory can be found at <http://wrrc.arizona.edu/personnel-directory>.

Water Resources Research Center 2017 Organizational Chart



July 23, 2018

In 2017, WRRC personnel were called upon regularly to give lectures and make presentations to diverse audiences across Arizona. They collaborated with local, state, regional, and federal agencies and organizations, as resources for water resource-related information and as partners on specific projects. WRRC personnel participated on community and regional boards and commissions and served on state and local task forces and study committees. They also responded to inquiries from the public on issues of concern. In 2017, the WRRC, its projects and personnel, were featured 44 times across a variety of news and media outlets.

EXTERNAL ADVISORY COMMITTEE

The WRRC's External Advisory Committee (EAC) is a group of leaders from the Arizona water community who provide valuable advice on WRRC programs and plans. The EAC meets at least once annually. In 2017, they met on December 18th at the Salt River Project's PERA Club in Tempe, Arizona. The members of the EAC as of December 2017 are listed below with their affiliations as of that month.

Tom Buschatzke, *Arizona Department of Water Resources*

Misael Cabrera, *Arizona Department of Environmental Quality*

Guy Carpenter, *aqua TECTURE*

Ted Cooke, *Central Arizona Project*

Mark Cross, *Montgomery & Associates*

Maria Dadgar, *Inter Tribal Council of Arizona*

Tom Davis, *Yuma County Water Users' Association*

Kathleen (Kathy) Ferris, *Attorney, Arizona Municipal Water Users Association*

Alan Forrest, *HDR*

William Garfield, *Arizona Water Company*

Patrick Graham, *The Nature Conservancy*

Andy Groseta, *Groseta Ranches*

Joe Gysel, *EPCOR, Water USA, Inc.*

Jason Hauter, *Akin Gump Strauss Hauter & Feld LLP and Attorney for the Gila River Indian Community*

Bradley (Brad) Hill, *City of Flagstaff*

Bob Johnson, *Retired (National Water Resources Association)*

John Kmiec, *Marana Water*

James (Jim) Leenhouts, *U.S. Geological Survey, Arizona Water Science Center*

Bob Lotts, *Arizona Public Service*

Francis McAllister, *Freeport-McMoRan Copper and Gold*

John McKinney, *Farmers Investment Co. (FICO)*

Leslie Meyers, *U.S. Bureau of Reclamation*

Richard Morrison, *Morrison Institute for Public Policy, Arizona State University*

Joe Olsen, *Metro Water*

Sarah Porter, *Kyl Center for Water Policy, Morrison Institute for Public Policy, Arizona State University*

Dave Roberts, *Salt River Project*

John Shepard, *Sonoran Institute*

David Snider, *Retired (Pinal County Board of Supervisors)*

Kathryn Sorensen, *Phoenix Water Services*

Graham Symmonds, *FATHOM, Global Water*

Warren Tenney, *Arizona Municipal Water Users Association*

Timothy (Tim) Thomure, *Tucson Water*

Chris Udall, *Agribusiness & Water Council of Arizona*

Christopher (Kip) Volpe, *The Estes Company*

Sid Wilson, *Retired (Central Arizona Project)*

Brian Wong, *BKW Farms*

A SNAPSHOT OF OUR PROGRAMS

WRRC-based **Arizona Project WET (Water Education for Teachers)** is a comprehensive water education program that provides curricula, workshops, mentoring, and partnership activities for teachers, students, and community members throughout the state. APW impacts grow through expanding relationships with Arizona's school districts and communities. <https://arizonawet.arizona.edu/>

Conserve2Enhance™ (C2E) connects water conservation to community action. C2E links participant donations, based on their water savings, to funding for local environmental enhancement projects. It can increase the performance of traditional water conservation programs and help utilities meet local conservation goals. C2E is a versatile program that can be implemented in virtually any community. <https://conserve2enhance.org/>

The **Desert Water Harvesting Initiative** was developed to increase the understanding and use of water harvesting, especially in the arid and semi-arid Southwest. It includes a searchable directory of water harvesting experts in Southern Arizona; a searchable list of water harvesting-related articles, manuals, and other publications; links to water harvesting resources; and a Water Harvesting Assessment Toolbox designed to help users develop an appropriate roadmap for implementing water harvesting in their communities. <https://wrrc.arizona.edu/DWHI>

Extension, Outreach, and Engagement are part of all our programs. See next page for signature outreach products.

The **Groundwater Governance and Management Program** investigates how groundwater is governed and extracts lesson on best practices. Projects include analyses of global case studies and surveys of management and governance in the United States that capture current institutions, activities and challenges on a national scale. <https://wrrc.arizona.edu/groundwater>

For the **Middle East Water Program**, the WRRC has been working with colleagues in Jordan, Israel, and the Palestinian Territories to facilitate communication and develop partnerships related to water management and policy in the Middle East, with a focus on the critical water issues of water-stressed regions and transboundary waters. <https://wrrc.arizona.edu/middle-east-water>

The **Transboundary Aquifer Assessment Program (TAAP)** is a federally funded program co-hosted between the USGS Arizona Water Science Center in Tucson, Arizona, and the WRRC. The Upper San Pedro and Santa Cruz river basin aquifers, which have south-to-north drainages bisected by the international border, were designated for priority assessment. <https://wrrc.arizona.edu/TAAP>

Research carried out at the **Water Quality Research Lab** takes place at the interface of water microbiology, soil science, and ecosystem ecology, tackling the challenges of soil and water sustainability within the larger context of public health protection. Current research examines anthropogenic effects on the development of bacterial antibiotic resistance in soil and water, and development of accurate methods to assess microbiological water quality. The laboratory is equipped to utilize molecular and cultural methods in order to understand the unique biological and chemical qualities of recycled municipal wastewater. <https://wrrc.arizona.edu/water-quality-research-lab>

The goal of **Water Research and Planning Innovations for Dryland Systems (Water RAPIDS)** is to help balance water demand for human uses with water needs of natural areas. The team works closely with partners at regional, state, watershed, and local scales to build capacity within communities for water resources and watershed planning. The Water RAPIDS program fosters new approaches that integrate traditional water planning with land use planning. With a diverse mix of partners, this program convened or participated in more than 20 forums, workshops, planning meetings, and lectures across Arizona on subjects ranging from water resource challenges to watershed health forums, and reached over 600 people. <https://wrrc.arizona.edu/waterrapids>

OUR SIGNATURE PRODUCTS

Annual Conference

<https://wrrc.arizona.edu/conferences/2018>

"Irrigated Agriculture in Arizona: A Fresh Perspective," the WRRC's 2017 Annual Conference, was held on March 28th at the UA Student Union Memorial Center in Tucson. Organized in partnership with the Agribusiness & Water Council of Arizona and BKW Farms, the conference presented a broad range of perspectives on Arizona's agricultural water use.



The more than 350 people who attended came from 40 Arizona communities, eight other states and Washington DC, five Arizona tribal communities, and Mexico. They were treated to talks and panel discussions from a full roster of 29 irrigators and other agricultural experts. The conference opened with the screening of the documentary, Groundwater: to enact a law for the common good, which recounts the making of Arizona's 1980 Groundwater Management Act. The filmmakers were on hand for a discussion of the need for water leadership. Keynote speakers included Noel Gollehon, Senior Economist with the USDA Natural Resources Conservation Service, Keisha Tatem, Arizona State Conservationist

for NRCS, and Clint Chandler, Assistant Director, Water Planning and Permitting Division, Arizona Department of Water Resources. The luncheon program featured Jonathan Mabry, Historic Preservation Officer & Archaeologist for the City of Tucson. A poster session provided an opportunity for conferences goers learn about ongoing research and programs. Three students were awarded cash prizes with funding provided by conference sponsors. Planning for the 2018 Annual Conference, "The Business of Water," began in the summer of 2017.

Brown Bag Seminar Series & Special Events

<https://wrrc.arizona.edu/brown-bag-seminars>

During the reporting period, the WRRC presented 23 Brown Bag seminars by speakers who covered a range of water resource-related topics chosen to be interesting to a broad spectrum of audiences. Highlights included Grant Davis, General Manager, Sonoma County Water Agency, speaking on California's Sustainable Groundwater Management Act; Clive Lipchin, Arava Institute, presenting "Water, Wastewater, and Energy Solutions for Off-grid Bedouin, Palestinian, and Jordanian Communities"; and Maria Dadgar, Executive Director of the Inter Tribal Council of Arizona, on tribal programs to address water and natural resource issues in Arizona. In-person attendance averaged 25 people and an average of 19 attended through Go-To-Webinar. In-person audiences were composed of about half from the UA Campus and half from the wider community. Go-To-Webinar recordings and slide presentations of most of the Brown Bag seminars can be viewed by going to the WRRC website.



The 13th Annual WRRC Chocolate Fest offered chocolate and other treats to WRRC friends and colleagues and showcased the WRRC photo contest winners. On March 17, 2017, the WRRC convened a roundtable of 40 interested parties on the subject of how much credit should be awarded for managed recharge (effluent discharged to a permitted recharge project within a stream channel) in Arizona.

The WRRC joined the UA Center for Middle Eastern Studies, Arizona Center for Judaic Studies, and Udall Center for Studies in Public Policy to sponsor the screening of "Voice of the Valley," followed by a panel discussion that included WRRC Director Megdal. In the fall, the School of Natural Resources and Environment hosted the Israeli architect, Liora Meron, co-sponsored

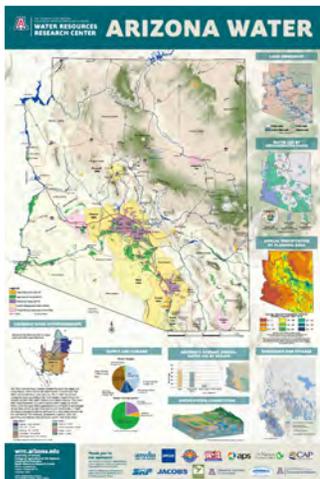
by the WRRC. Continuing its partnerships on Native American water issues, the WRRC co-sponsored a film screening and panel discussion of "Paya: The Water Story of the Paiute." Discussants included individuals from the Bishop, Big Pine, and Lone Pine Paiute tribes of the Owens Valley. Co-sponsors included the UA School



of Geography and Development, Indigenous Peoples Law and Policy (IPLP) program, Native American Law Student Association (NALSA), and UA Environmental Law Society.

Arizona Water Map Poster

<https://wrrc.arizona.edu/arizona-water-map-form>



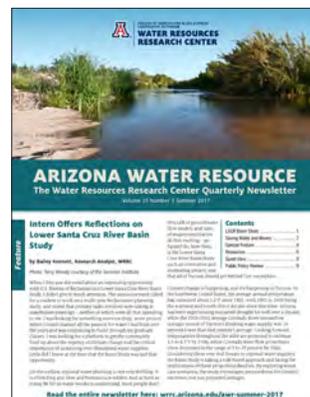
In 2017, the WRRC completed work on the new Arizona Water Map Poster. This fourth edition of the map is the latest in our series of reliable and concise visual representations of Arizona's water resources. The design and review

process engaged stakeholders from across regions and sectors. It reflects the current state of water resources in Arizona, as well as a culture of management and planning unique to the state. Fourteen sponsors are credited on the poster.

Arizona Water Resource (AWR)

<https://wrrc.arizona.edu/publications>

The WRRC's quarterly newsletter moved to an electronic format in 2017. The electronic version retains the AWR design and content and can be downloaded from the WRRC website in as a PDF. To permit resource reallocation, the AWR will be discontinued in 2018 and some of the content moved to the Weekly Wave and website. In this transition year, students contributed significantly to developing articles for the AWR. A Guest View by Paul Brierley, Executive Director, Yuma Center of Excellence for Desert Agriculture, titled "Shouldn't Ag Water Conservation Be Used For... Agriculture?" carried on a discussion started in the 2017 Annual Conference. The winners of the WRRC photo contest were featured in the Winter 2018 issue. In addition to brief news articles and items on new resources, each issue of AWR carried the regular Public Policy Review column by WRRC Director Megdal.



Arroyo



The 2017 Arroyo, WRRC's annual publication that presents a single topic of timely interest to Arizona in clear and concise language for the interested public, was published in May. This 16-page publication discussed the various issues relating to Arizona's water banking, recharge, and recovery. It covered groundwater management and the legal framework for recharge, Arizona's recharge projects, the institutions for groundwater banking and replenishment, and recovering stored groundwater. Drafted by Noah Silber-Coats, the 2016 Summer Writing Intern at the WRRC, the 2017 Arroyo was reviewed both internally and externally by experts and knowledgeable agency personnel.

Work began on the 2018 Arroyo, "Water and Irrigated Agriculture in Arizona," after the selection in April of the 2017 summer intern, Tim Lahmers, a graduate student in the Department of Hydrology and Atmospheric Science. Lahmers steeped himself in the subject, with the help of video recordings from the WRRC's 2017 conference and other research, and produced the first draft of the Arroyo, scheduled for publication in Spring 2018. The Summer Internship and the printing and mailing were funded through donations by the Agribusiness and Water Council of Arizona and BKW Farms.



Susanna Eden, WRRC Assistant Director, continued her management of the federal Water Resources Research Act §104 program and oversaw the 104b proposal and reporting processes. In 2017, she co-authored, edited and managed the review and publication of the 2017

Arroyo on the banking, recharge, and recovery of water in Arizona and guided development of the 2018 Arroyo on Arizona's irrigated agriculture by the WRRC Summer Intern. She organized a course on water resources for the UA Osher Lifelong Learning Institute – Green Valley and presented a class on irrigated agriculture in Arizona. She co-organized a session on water harvesting for a conference in Flagstaff, Arizona, and gave a presentation on the Water Harvesting Assessment Toolbox, developed by the WRRC. In addition, she participated in research and engagement projects in the Upper Gila watershed and Cobre Valley, Arizona, and the Desert Landscape Conservation Cooperative region.

OUR PRIMARY AFFILIATIONS

Arizona Cooperative Extension



THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

As a CALS research and Extension center, the WRRC works within the Arizona Cooperative Extension system to contribute to its vision of creating and applying knowledge to help people build thriving, sustainable lives, communities, and economies. This relationship

makes us part of a statewide network of knowledgeable faculty and staff, which itself is part of a nationwide educational network of scientists and educators who help people solve problems and put knowledge to use. APW coordinates directly with County Extension Office Directors at Pinal County and Maricopa County where six APW staff members are based, and partnership with Coconino County was initiated. APW also partners with Extension Agents in other counties who assist with the Arizona Water Festivals. In 2017, the WRRC held meetings with county Extension directors to explore options for increased collaborations, which informed our internal planning and priority setting discussions. Cooperative Extension agents and specialists were involved with WRRC activities in Cochise, Gila, Graham, and Greenlee Counties.

National Institutes for Water Resources (NIWR)



National Institutes for Water Resources (NIWR) is a national organization of water research institutes formed in 1964. The WRRC is the water resources research institute for Arizona, federally authorized under the Water Resources Research Act (WRRRA).

Institutes receive base funding to support a small competitive grants program, open to investigators from all three of Arizona's public universities, and information transfer projects. In September 2016, the WRRC solicited research grant proposals from student

researchers and their faculty advisors. Two graduate student research projects were funded for the 2017-2018 grant year: "Impact of Projected Climate-change on Mountain-block Recharge Processes" and "Might Recycled Wastewater Solve the Rising Problem of Toxin-producing Algae?" In the fall of 2017, we again called for student research proposals, expanding the eligibility to include undergraduate students. Nine proposals were submitted for 2018 funding.

Water, Environmental, and Energy Solutions

The WRRC has an integral role within Water, Environmental, and Energy Solutions (WEES), which supports research that brings innovative and practical solutions to Arizona's pressing environmental, energy, and water challenges. It is funded through the Technology and Research Initiative Fund (TRIF), a university-directed fund generated via a voter-approved sales tax. UA-TRIF has the goal of strengthening research, industry engagement, workforce development, and interdisciplinary collaborations at UA.

In financial year 2017, TRIF-WEES invested in research and equipment with application to topics such as dryland agrivoltaics, optimizing membrane technologies for water treatment, and field equipment to measure chlorophyll fluorescence with applications to global water and carbon cycles. WEES also funded new

faculty hires with water, environmental, and energy expertise, and provided a means for UA scientific knowledge and technology to interface with industrial partners and the public. WEES hosted three campus-wide faculty engagement events and supported several seminars and events helping to connect UA to the broader community. WEES provided investments to several transdisciplinary research institutes, including the WRRC, and continued to support APW's K-12 water education activities in Maricopa County.



Claire Zucker is the Program Director for the Water, Environmental, and Energy Solutions (WEES) Initiative at the University of Arizona. As Program Director, Ms. Zucker ensures that proposed WEES investments are vetted through a transparent cross-disciplinary proposal review process and are aligned with WEES priorities, and that return on investment is tracked and reported. In 2017, she coordinated the WEES Executive Committee meetings, facilitated grant awards totaling approximately \$1.2 million, built understanding about WEES objectives and accomplishments through presentations and materials, and worked within the UA Water Resources Research Center on a variety of WEES-linked projects. She also oversaw the Water Network web portal, <https://www.water.arizona.edu>. As part of this effort, she provided faculty and researchers with key information about research, grant, and student opportunities through the Water Network Faculty Listserv.

OUR CORE SERVICES

Support services

The WRRC facility is open to the public and continues to provide a reception area featuring informational materials on water-related topics and the Sol Resnick Conference Room, a space for water-related meetings.

Achieving our mission depends on the support of effective and efficient administrative personnel. A small, dedicated staff excels at seeing that faculty, professionals, and students can focus on mission-oriented projects.

Our work is supported in important ways by a cadre of outstanding students. A list of our students can also be found in Appendix B – Supplemental Information.

Website & Other Communication Media

<https://wrrc.arizona.edu/>

Our main website continues to feature news, events, and programs, as well as publications and other resources. The site also provides access to the WRRC YouTube channel and Brown Bag webinar recordings. Between January and December 2017, the WRRC website received 130,000 page views from 50,000 users. Thirty-five videos were added to WRRC YouTube channel, including videos from the 2017 WRRC Conference and Upper Gila River State of the Watershed. We also added to our gallery of original photographs of water in Arizona through the WRRC Photo Contest that this year attracted 44 submissions from throughout the state of Arizona as well as Colorado and California.

In 2017 branding efforts linked our achievements in the minds of partners and constituents with our name, Cooperative Extension, CALS and UA. Examples include the 2017 Conference bookmark, email announcements through Constant Contact, and the 2016 Highlights 4-page brochure, which featured our programs and activities. WRRC communications expanded in 2017; WRRC news, events, and accolades appeared in UA outlets and a variety of other news media. Increased use of social media outlets, including Facebook, Twitter, and YouTube resulted in modest increases in shares, views, retweets, follows, and likes.

The Weekly Wave is an e-news digest sent to subscribers each week during the academic year and every two weeks during the summer. Each edition includes WRRC and water community events, news, media appearances, and announcements. During the reporting period, the distribution lists grew by approximately 180 recipients to approximately 2,380. Growth in Weekly Wave readership brought increased website traffic, event attendance, and dissemination of WRRC news through other outlets. The average open rate for the Weekly Wave was 36 percent.



Lynette Featherston, Office Assistant, is the face of the WRRC to the public, fielding inquiries, and greeting visitors. A valuable team member, she assists the Administrative Associate and Accountant Associate and handles exceptional tasks as they arise. She also maintains the WRRC contacts databases, oversees the preparation of WRRC facilities for events, and maintains the lobby displays.



Bernadette Capossela, Administrative Associate, carries out a wide range of administrative duties and operational functions that keep the WRRC humming. She maintains the Director's calendar and provides her administrative support. In addition, Capossela is an active member of the communications committee, coordinating the Brown Bag activities and assembling the Weekly Wave. She is also responsible for conference logistics.



Leslie Bonilla, the WRRC's Accountant Associate, is in charge of the accounting at the WRRC. She processes accounts payable and accounts receivable transactions, reconciles accounts, processes Arizona Map sales transactions, and performs various other accounting duties.



John Polle creates, develops, and manages content for the WRRC website and keeps up with the ongoing maintenance of the site. He designs printed and digital outreach materials for the WRRC and various associated programs. He also manages and provides support for the audio and visual needs of the WRRC and when necessary, provides IT support. In 2017, he worked with WRRC staff to redesign the Arizona Water Map Poster and marketing materials associated with its distribution. He created marketing pieces for WRRC programs and engagement activities, including the WRRC 2017 Conference, the Annual Report, and associated infographic insert/brochure. He worked with the TAAP to develop a bi-lingual handout to be used by TAAP members in both the United States and Mexico. He continued to work with the Conserve2Enhance program and UA Water Network, maintaining and updating their websites.



EXTERNALLY FUNDED RESEARCH & ENGAGEMENT

Water & Food Safety

In 2017, water quality research examined the microbiology of surface water and irrigated soils. The work is funded by grants from the Arizona Department of Agriculture, the National Science Foundation (NSF), and the U.S. Agency for International Development (USAID). Graduate students carried out projects on self-sterilizing harvesting materials and irrigation pipelines, identifying factors that enhance toxin production by blue-green algae, and groundbreaking work in characterizing bacteria in irrigation water and performing food safety outreach projects on tribal lands. In the international realm, 2017 saw the completion of the water quality work on a USAID project, “Developing a Sustainable Seafood Safety Infrastructure in Myanmar.” This highly successful project not only established a seafood safety testing lab at the University of Yangon in Myanmar, but it also resulted in the training of more than 200 instructors from 40 universities in Myanmar in laboratory methods used to assess seafood safety.



Associate Director **Jean McLain** continued to lead laboratory research projects and to present her research results at local and national meetings. In April 2017, she was invited to join a team of university and U.S. Food and Drug Administration researchers to refine current irrigation water quality guidelines

to make them less onerous for fresh produce growers. Dr. McLain’s expertise in the development of antibiotic resistance in environmental bacteria led to invitations to present keynote addresses at the Water Environment Federation Technical Conference in Chicago and the 2017 Pacific Northwest WaterReuse Conference in Boise, Idaho. In addition, she worked actively on conference organizing committees, including the 4th International Conference on Environmental Dimensions in Antibiotic Resistance (Lansing, Michigan); the 2018 Pacific Northwest WaterReuse Conference (Portland, Oregon), and the 2018 XENOWAC II Conference (Limassol, Cyprus). In the fall of 2017, Dr. McLain took on a new teaching role, teaching “Scientific Writing for Environmental, Agricultural, and Life Sciences” to more than 60 University of Arizona undergraduate and graduate students.

National Groundwater Governance Survey

Although groundwater is relied upon as a major source of water for communities, industries, and irrigators, governance of the resource has been historically neglected. A team from the WRRRC designed and administered a nationwide survey, focused on groundwater quality, to develop a better understanding of groundwater governance in the United States. State water professionals identified a wide variety of groundwater concerns, from water quality and quantity to staffing and budget issues. A report summarizing the survey findings, *State-Level Groundwater Governance and Management in the U.S.: Summary of Survey Results of Groundwater Quality Strategies and Practices*, was completed. Results confirmed that groundwater governance and management practices vary considerably across the United States, and most states have seen significant changes to groundwater quality policy in the last 10 years. Funding from the Ground Water Research and Education Foundation (GWREF) supported the study. A journal article summarizing the research findings is in preparation.

Water Resources in Arid Regions

International work on comparative analysis of water policy and management has evolved and varied over time. It includes interactions with water academics and professionals globally. Connections with multiple international networks and projects on transboundary aquifer assessment, groundwater governance, and water governance and management more generally expanded. Water management practices of Arizona and the Colorado River Basin, including transboundary issues and water banking practices, became better understood through presentations and participation in international discussions. In particular, work highlighted the connections between Arizona and the Colorado River Basin with water management in Israel and Jordan. A major effort during 2017 was co-chairing the international water conference “Cutting-Edge Solutions to Wicked Water Problems”. Held in September in Tel Aviv, Israel, the conference was co-convened by the American Water Resources Association and the Water Research Center at Tel Aviv University.

Transboundary Aquifer Assessment



The TAAP collaborators continued their assessment efforts on the priority San Pedro and Santa Cruz binational aquifers as specified in 2006 by Public Law 109-448. During 2017, the team worked with TAAP partners in compiling a draft of the Binational Study of the Transboundary Santa Cruz Aquifer, which is undergoing review, and a bilingual summary brochure for the Binational Study of the Transboundary San Pedro Aquifer. Under the leadership of UA Professor Christopher Castro, team members contributed to high-resolution regional climate projections for the Santa Cruz River Binational Basin and completed a survey of existing hydrologic models for the Santa Cruz River Aquifer in Mexico. The team explored the feasibility of using a modeling framework created for the Arizona side of the Santa Cruz River Aquifer to analyze possible impacts of climate uncertainties. The team also started assessing the implications of variabilities of climate and effluent discharges to the Santa Cruz River on groundwater recharge downstream of the Nogales International Wastewater Treatment Plant.

WRRRC TAAP team members also published articles and gave seven presentations to disseminate TAAP research findings and publicize the program. Presentation venues included regional, national, and international meetings and conferences, including the World Water Congress in Cancún, Mexico, and the Comisión Sonora-Arizona & Arizona-Mexico Commission Annual Meeting in Puerto Peñasco, Sonora. The team engaged through a workshop held in Sierra Vista, Arizona. WRRRC Director Sharon Megdal's Public Policy Review column in the Summer 2017 issue of AWR discussed the TAAP Cooperative Framework document and its applicability for other transboundary studies. Petersen-Perlman and Megdal authored an invited chapter on transboundary aquifer assessment, and WRRRC team members wrote an invited article for a special issue of the *Journal of Hydrology: Regional Studies* on transboundary aquifer research. Binational cooperation included TAAP partners at USGS, the International Boundary and Water Commission, the University of Sonora, CONAGUA, New Mexico State University, and Texas A&M University.



Jacob Petersen-Perlman is a Research Analyst for the WRRRC. He has primarily focused on contributing towards the TAAP and research on groundwater governance and management. Along with graduate student Elia M. Tapia, he has been planning a stakeholder engagement forum for the TAAP in Sierra Vista, Arizona, and additional workshops to be held later in the year. Petersen-Perlman gave six public presentations: three about efforts of the TAAP, and three about his work on groundwater governance and management in the United States. Additionally, he co-authored a book chapter on transboundary groundwater governance and assessment, a report on groundwater governance and management in the United States, and an article on the TAAP.

Stakeholder Driven Solutions to Local Water Challenges

A multi-staged project within the Water RAPIDS Program, funded by the U.S. Bureau of Reclamation, was completed in September 2017, after three years of collaboration among the WRRRC, Arizona Cooperative Extension, and the Gila Watershed Partnership (GWP). The project focused on principles and techniques for engaging stakeholders in decisions that affect their water resources and creating science translation resources for decision-makers and water users. Resources included a handbook for landowners on the Upper Gila River answering common questions about applicable rules and regulations. The culminating event was a State of the Watershed Upper Gila River forum, held in fall 2017, featuring Senator Jeff Flake as the keynote speaker. The forum was a joint effort of the GWP, Graham County Cooperative Extension, Eastern Arizona College, and community members. More than 130 participants, including citizens, scientists, non-profits, industry, and government, came together to share information and find common ground for future work. Research and information developed through this project will be customized for the GWP and their partners over the next year and incorporated into the GWP Watershed Assessment Plan.

Another Water RAPIDS project funded U.S. Bureau of Reclamation involved extensive stakeholder engagement activities in 2017 to review data gaps and explore primary stakeholder and decision-maker concerns related to water resources in the Cobre Valley in central Arizona. These activities, which included presentations and meetings with Gila County, Town of Miami, City of Globe, and other community entities, resulted in critical feedback regarding the current status of water resources in the region. Based on compiled data about local water resources and issues, as well

as the feedback of the communities, a primary output of this project was recommendations to Reclamation pertaining to opportunities for greater regional collaboration.

Water for Natural Areas

In 2017, the WRRC, in partnership with Northern Arizona University, published the Desert Flows Methodology Guidebook for Determining and Establishing Water Flows for Riparian Ecosystems in the Deserts of the U.S. and Mexico. The project area encompasses the watersheds of the Desert Landscape Conservation Cooperative. Based on more than 400 articles in the WRRC's Desert Flows Database, additional case studies, and interviews with local, state, and federal government agency representatives, this guide for land and water managers answers key questions on how to establish and maintain flows in desert streams. A product of past Water RAPIDS Program projects, the Desert Flows Database continues to be downloaded regularly.



Ashley Hullinger is a Research Analyst for the Water RAPIDS program. Much of her work revolves around developing effective stakeholder engagement processes for sustainable water management throughout Arizona. She works directly with government agencies, non-profits, and rural communities to evaluate the factors that have contributed to current water resource conditions in order to explore collaborative solutions. Hullinger's work in 2017 focused on science translation and stakeholder engagement for a range of projects including Sky Island Waters and Watershed Planning in the Upper Gila. She has coordinated and led other projects at the WRRC, including the Cobre Valley Needs Assessment.

The WRRC partnered with the Tucson non-profit Sky Island Alliance on a three-year initiative funded by the Nina Mason Pulliam Charitable Trust to develop regional dialogues and local on-the-ground actions to protect and enhance water resources in southeastern Arizona. In 2017, this project progressed in developing a toolbox to protect flows and ecosystem function at springs in the Sky Island region. Meeting multiple times per year, a statewide steering committee connected regional efforts to statewide issues, while the technical committee focused on how tools developed by this project will function on the ground.

Video-based Public Education and Engagement

Winner of a 2017 American In-house Design Award from Graphic Design USA, *Beyond the Mirage* is a documentary and online engagement experience developed through collaboration with CALS Video and Web Development and Arizona Public Media. In 2017, the documentary, which was broadcast on public television stations across the United States, received a Rocky Mountain Emmy for Best Topical Documentary. The WRRC developed a business concept for program sustainability that involves a partnership with Filmstacker, a UA launched company based on technology developed in CALS for *Beyond the Mirage*. The video content has been integrated as an educational tool into several WRRC programs and the documentary was screened for various audiences.

K-12 WATER EDUCATION BY ARIZONA PROJECT WET (APW)

In 2017, the Arizona Project WET (APW) team of 10 dedicated educators engaged over 25,000 students directly with engaging water education and over 1200 adults in learning to facilitate lessons through exploration and inquiry. Beyond delivering established and effective education programs, 2017 was a year for visioning and planning for APW. Kerry Schwartz, APW Director became a member of the International Project WET Foundation Board of Directors. This opportunity and honor connected Arizona Project WET to new knowledge and partners. For instance, presenting the paper, "A Model for Activating Learning at a Riparian Area Field Day through Corporate Mentorship," at the 2017 Wildlife Habitat Council Conference, activated new connections with major corporations, including Freeport McMoRan, ExxonMobil, Toyota and Monsanto.

Teacher Training

APW helped 563 teachers develop their instructional mastery of water-related content through STEM integration using systems thinking, interdisciplinary standards inclusion, project-based learning, and relevant real-world applications in 2017. Knowledge/skill gains averaged 73 percent based on pre- and post-self-rating surveys and 97

percent of teachers strongly agreed or agreed with the statement: “The resource materials provided will be helpful for teaching about water & environment.”

In addition to multi-day academies totaling 446 hours, the APW team develops curriculum units that teachers integrate into their curriculum to support learning goals. Project-based learning opportunities in 2017 focused on building rainwater harvesting systems, operating underwater ROVs, building efficient piping systems, modeling the Central Arizona Project water lifting system, and conserving water with water-efficient fixtures.

Rainwater Harvesting Education

As one of five winning NOAA proposals out of 200, the new Recharge the Rain Initiative, conceived by APW in partnership with Watershed Management Group, is working with a cohort of 16 teachers over the next four years to advance community resilience to extreme weather by engineering rainwater recharge to mitigate flooding and to reduce heat through augmented shade and evapotranspiration. Learning focused on rainwater harvesting systems offers a project-based learning opportunity that can increase literacy in climate science, STEM, engineering design, and social justice and lead to action at school, home and/or within the community.



Kerry Schwartz is Director of the APW water education program and Associate Specialist with Arizona Cooperative Extension at UA with an academic home in the Soil Water and Environmental Science Department. She is responsible for programs that teach science, STEM literacy, and systems thinking skills to educators, K-12 students, and community members. She works statewide, supervising 10 personnel located in three extension offices. She and the APW team work to develop and evaluate STEM-focused education programs and teacher professional development that incorporate real world science and engineering practices and foster thinking and problem solving. This year, in partnership with the ThinkWater team from University of Wisconsin, Stevens Point and Cornell University, she published systems thinking research on a train-the-trainer model to provide middle school students with a structure and framework for thinking. She continues to develop rainwater harvesting as a scalable, real-world STEM and project-based learning opportunity for students from fourth grade to university level. Kerry serves on the International Project WET Foundation Board of Directors and as such, presents on student-centered instructional practices nationwide.

Direct Student Engagement

APW facilitators and trained water educators directly engaged over 25,681 students in learning about a range of water science, engineering, and management topics. At Sweetwater Wetland Festivals, student knowledge improved by 170 percent on understanding the concept of a watershed and 123 percent on the water cycle. In building foundational knowledge about the value of a riparian area, we saw a 216 percent increase in students' awareness that wetlands provide food for plants and animals and a 556 percent increase in their recognition of shelter provided by wetlands. Finally, after changing the water conservation lesson to focus on technology rather than behavior, we calculated learning gains of 135 percent.



By working with students on school and home water audits, APW drove a projected water savings of over two million gallons of water. A total of 709 students participated in the Water Scene Investigations Program from 35 classes with the installation of 332 water efficient aerators, for a total projected water savings of 1,721,050 gallons. School Water Audits were conducted by 1,087 students who replaced 156 aerators for a projected water savings of 430,164 gallons. Student Self-Reports showed that 87 percent of the students were surprised or amazed at the amount of water that an aerator could save, and compared to other things learned in school, 70 percent of the students felt that the water audit was either interesting or really exciting.

Water Festivals

Implemented in 23 communities, the Arizona Water Festival Program engaged 14,163 4th grade students and 537 teachers in learning about Arizona's water resources in 2017. That same year, 720 community volunteers were trained to facilitate water festival lessons delivering a total of 5,694 hours. These Festivals were made possible by sponsorships from 40 organizations and partnerships with many more.



Betsy Wilkening is the Education Coordinator for the APW Tucson Program. In 2017, the Recharge the Rain: Community Resilience Through STEM Education NOAA Environmental Literacy Grant completed year one. Sixteen Tucson teachers participated in 14 days of professional development provided by APW and Watershed Management Group. They developed climate literacy curricula for their classrooms and learned how to design and install rainwater harvesting systems. Schoolyard rainwater harvesting system installations are scheduled for 2018. Additionally, Wilkening partnered with Marine Advanced Technology Education (MATE) to provide Underwater Robotics & Engineering Design Academy, to 20 teachers in July. These teachers brought equipment and materials back to their students and prepared them for a competition in Spring 2018.



Holly Thomas-Hilburn is Coordinator of Applied Programs for APW. She holds a Master's degree in Teaching and Teacher Education with an emphasis in environmental learning. Utilizing her education and evaluation background, she supports evaluation and assessment efforts throughout the program. She has led the effort to develop the Aqua STEM program, a series of project-based STEM units that integrate systems thinking skills, giving students a language and structure for thinking. Employing new methods, meta-mapping, and models that make thinking tangible, she is seeing significant results in students' ability to think more creatively and critically. In 2017 she began working more closely with the Tucson team to integrate systems thinking across

the program.



Chuck Dugan has nearly four years as the APW Pinal County Water Program Coordinator. With his leadership, Pinal County Water Festivals have seen an increase of nearly 10 percent in student and teacher participation. He engaged a total of 2,525 students, 96 teachers, 90 parents, 20 museum visitors; trained 60 community volunteers; and mobilized 120 community volunteers to facilitate lessons in 2017. The 120 adult volunteers provided 840 hours of service. His programs also drove calculated water savings of 236,000 gallons thru October 1, 2017, increasing the water conservation ethic in the community. His work with Pinal County partners and sponsors led to continued funding from the Arizona Department of Corrections, Nissan and Global Water. His work with Abbott Nutrition, the program's founding sponsor, continues to promote a community water conservation ethic in Pinal County.



Mary Ann Stoll is an Education and Technology Coordinator with Arizona Cooperative Extension at the UA, celebrating eleven years of working with APW's water education program. She holds a Master's degree in Educational Technology and is an avid systems thinker. Stoll develops and delivers curriculum for APW's new Aqua STEM Program and facilitates professional development in STEM literacy. She is a team leader in the integration of best instructional practices for teachers and educators. She also designs, develops, and maintains APW's website, which provides an online connection to the community and ready resources for participants in APW programs. This year her work focused on the Water Savings Investigation data collection and graphing module to enable students to analyze their own home water savings and compare it with the savings of other classmates and students across Arizona. The Arizona Water Festival resource teachers' page is also more easily accessible online thanks to her work.



Pam Justice, Senior Education Coordinator, has represented APW at the Maricopa County Cooperative Extension office since 2003. She coordinates educational and outreach programs that improve the understanding of both youth and adults regarding water issues. She also develops and delivers curriculum and professional development in STEM literacy. She led three water festivals in 2017, delivering professional development workshops for teachers, coordinating logistics and evaluation with teachers, recruiting and training volunteers, organizing festivals for over 1,800 students at a time, and developing partnerships for program sustainability. In 2017, Justice engaged 709 sixth grade students in 35 classes in the Water Scene Investigations home water audit within the Gilbert, Higley, and Chandler School districts. A total of 332 aerators were changed, producing a total projected annual water savings of 1,721,000 gallons.



Julie Hasty is a Senior Instructional Specialist with Arizona Water Festivals, a fourth-grade water education program that focuses on four key areas: watersheds, groundwater, water cycle, and water conservation. Her work with Arizona Water Festivals includes delivering teacher professional development workshops that align with Arizona Science Standards to teachers of participating classes. Her role in coordinating statewide festivals includes volunteer recruiting and training, organizing festival logistics for events serving up to 1,800 fourth graders, and developing community partnerships to support the program.



Sandra Hurlbut is the Community Coordinator leading the Aqua STEM program in Maricopa County. She holds Master's Degrees in Energy & Environmental Studies and Public Affairs. As the Aqua STEM Community Coordinator, she supports participating teachers by facilitating classroom activities on groundwater, water in the environment, rainwater harvesting, riparian habitat explorations, and water conservation; working with 117 classes, (3,900 students) in her first six months with Arizona Project WET. Hurlbut helps develop curriculum and assessments for the Aqua STEM Program. She also assists in the development and facilitation of System Thinking-based professional development workshops and academies, and supports grant writing and other writing projects for APW.



Miriam Aleman-Crouch is the Senior Instructional Specialist for Arizona Project WET's Tucson Program. She works with K-12 teachers and students to provide a unique learning experience about Tucson's groundwater system, watershed, and water conservation. She coordinates in-classroom presentations and field trips. She also provides support to the program director and coordinators. She assisted with hiring and training 12 water educators to deliver the program's lessons. In 2017, the Tucson program made in-classroom groundwater presentations for over 3,000 students and reached 2,900 students with their Sweetwater Wetlands Water Festival. Aleman-Crouch also coordinated outreach events with program sponsors and schools to support STEM literacy. She supported STEM Academy participants to implement the school water audit program (SWAP) and water scene investigations (WSI) in which students learn about water saving technology.

NOTEWORTHY CHANGES

Personnel Changes

In May 2017, WRRRC Associate Director Jean McLain, was promoted to Full Research Scientist in the Department of Soil, Water and Environmental Science (SWES). A reorganization of her duties accompanied the promotion and McLain teaches a Fall semester technical writing course to 60 undergraduate and graduate students from several UA Colleges and Departments, and officially assumed a role within College of Agriculture and Life Sciences Cooperative Extension. In December 2017, Dr. McLain was hired into the position of Assistant Dean for Faculty Advancement in the College of Agriculture and Life Sciences. She had to leave her role as Associate Director of the WRRRC, but she continued her active involvement in WRRRC research and outreach programs.

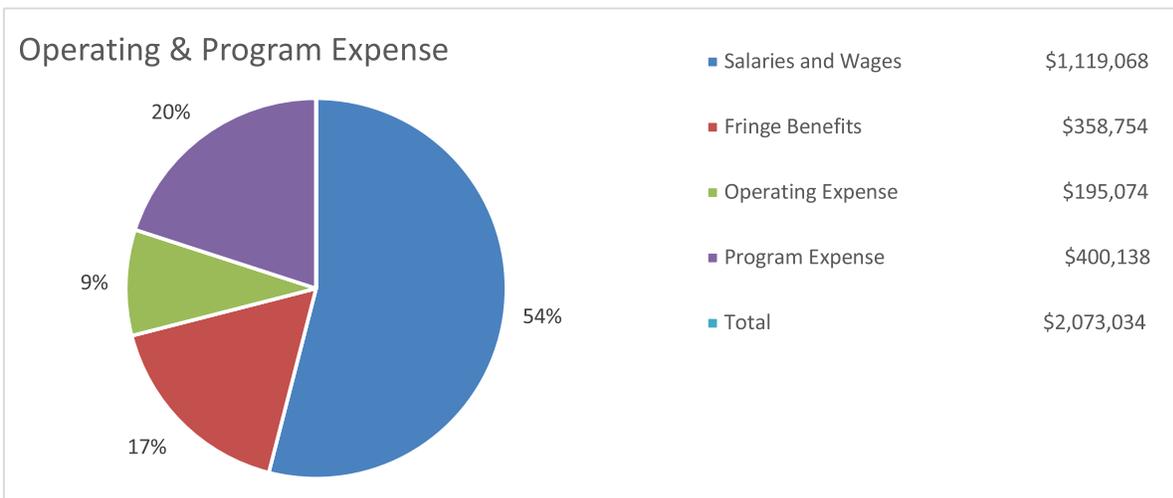
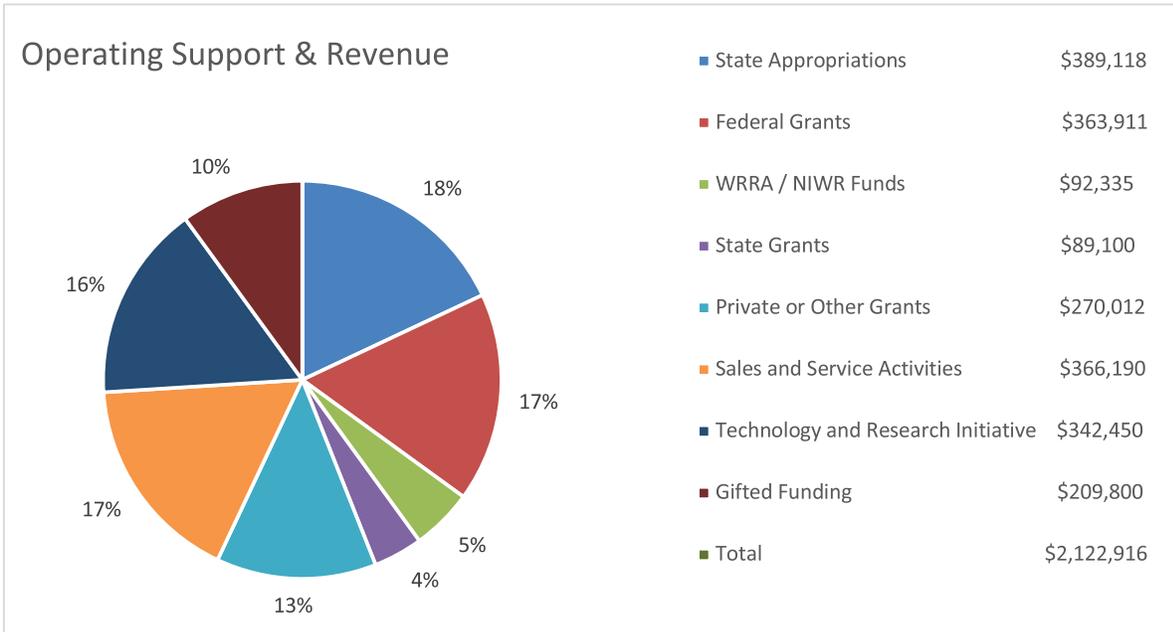
Our Business Manager, LaVonne Walton, retired in December after many years of dedicated service to the UA and the WRRRC. Her duties were assumed by a new business center led by the SWES Senior Business Manager Christie Mills and including accountant associate Leslie Bonilla who is located within the WRRRC.

Program Changes

In 2018, the WRRRC will discontinue production of the AWR quarterly newsletter and redirect some components to the Weekly Wave and WRRRC website. The WRRRC hopes to maintain, update, and expand *Beyond the Mirage*, as an innovative way to engage and educate on water issues. However, additional funding will be required. The WRRRC has plans to broaden statewide engagement by building on connections with Arizona Cooperative Extension and others through joint initiatives involving rural communities, farmers, ranchers and other Arizona stakeholders. WRRRC staff have been gathering information on collaborative opportunities to fill information gaps and better support regions throughout the State.

At the end of 2017, the WRRRC began to prepare for a periodic review by assembling a self-study report focused on the past five years. Going forward, the WRRRC will develop initiatives that respond to recommendations produced by the review, which involved an independent review committee, as well as the Dean of CALS, Director of Cooperative Extension, and UA Vice-President for Research.

FINANCIAL REPORT CY 2017



Notes:

Operating Support and Revenue

State Appropriations: State General Fund and tuition collections appropriated to the College of Agriculture and Life Sciences by the State of Arizona.

Federal Grants: Monies received for awarded competitive national federal grants and federally-funded cooperative agreements awarded to the WRRC.

WRRRA / NIWR Funds: U.S. Geological Survey 104(b) 5-year Cooperative Agreement funded annually in March. The WRRC receives this federal funding as Arizona's State Water Resources Research Institute.

State Grants: Revenue provided by the State of Arizona through competitive grants awarded to the WRRC by departments of the State of Arizona.

Private or Other Grants: Revenues received by the WRRC through the University and the UA Foundation from local governmental agencies and non-governmental organizations.

Sales and Service Activities: Revenue from one-time transactions accrued over time by the WRRC from publication sales, annual conferences, and miscellaneous services.

Technology and Research Initiative Fund (TRIF): Revenue from TRIF, a state sales tax- derived fund supporting a range of educational programs. TRIF funding is allocated to UA Water, Environmental, and Energy Solutions (WEES), which provides direct support to the WRRC.

Gifted Funding: One-time gifts from individuals and companies and revenue generated by endowment interest bearing accounts.

Operating and Program Expense

Salaries and Wages: Includes salaries, wages and supplemental compensation paid to WRRC faculty, appointed personnel, classified staff, graduate assistants, and student hourly employees.

Fringe Benefits: Includes costs of employee fringe benefits (ERE) for insurance, medical and retirement benefits.

Operating Expense: Includes UA revenue and expense service fees; Facilities & Administration (Indirect Costs); UITS Network Funding Fees (Access to University communication systems for staff); Background checks; Membership dues; Subscriptions; Building & equipment maintenance and upgrades; Employee training; Brown Bag Seminar Series; *Arroyo* Annual publication; Conference.

Program Expense: Includes University and Lecturer's fees, Participant support and Temporary labor; Subcontractual research agreements for 104(b) grants at Northern Arizona University (NAU); Printing and publications; Communications; Office, Research, Educational, and General supply; Employee travel; Conference registration fees; Facility and vehicle rental; Meetings and Workshops.



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The Weekly Wave e-News Digest

The Weekly Wave e-News Digest is distributed each Friday and contains WRRC news, events and much more.

Arizona Water Resource Newsletter

The Arizona Water Resource is the WRRC's quarterly newsletter that provides timely and informative coverage of water issues, research, news, and resources.

Arroyo

The Arroyo is published each spring and summarizes knowledge on a single water topic.

Arizona Water Map Poster

The updated Arizona Water Map Poster is available exclusively from the WRRC for \$16.78 (Includes tax and shipping).

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