Digital Participant Packet

University of Arizona Student Union Grand Ballroom, Tucson, AZ
Tuesday, July 11, 9:30am – 5:00pm
Wednesday, July 12, 8:00am – 5:00pm

1. Conference Agenda
2. Speaker/Moderator Bios
3. Sponsors
4. SAWUA Flyer
5. WRRC 2022 Highlights
6. Arroyo 2023: Arizona's Agricultural Outlook
7. Arizona Water Factsheet Series
8. Venue Map
9. Conference Participant Evaluation

THE UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION
WATER RESOURCES RESEARCH CENTER

WRRC 2023 Annual Conference

What Can We Do?

SOLUTIONS TO ARIZONA'S WATER CHALLENGES

July 11 – 12, 2023
University of Arizona Student Union
Grand Ballroom, Tucson, AZ

TUESDAY, JULY 11, 2023

9:30-10:30	REGISTRATION AND REFRESHMENTS
10:30-10:40	**Welcome** • **Sharon B. Megdal,** Director, Water Resources Research Center, The University of Arizona • **Robert C. Robbins**, President, The University of Arizona
10:40-11:10	**Keynote: Protecting Water Quality in Arizona** • **Karen Peters**, Director, Arizona Department of Environmental Quality
11:10-12:10	**Session 1: Addressing Water Quality** • **Erin Jordan**, Arizona Department of Environmental Quality, *How Is Surface Water Quality Protected in Arizona?* • **Jason Jones,** Arizona Department of Environmental Quality, *Assessing the Health of Arizona's Waters* • **Grant Weinkam,** Arizona Department of Environmental Quality, *Prioritizing Restoration of Arizona's Impaired Waters* • **Joseph Hoover,** University of Arizona, *Using Mobile Applications to Visualize Water Quality Data for Underserved Communities* **Moderator: Natalie DeRoock,** Tucson Water
12:10-1:10	LUNCH
12:50-1:10	**Luncheon Keynote: Central Arizona Project Response to Shortages** • **Patrick Dent**, Assistant General Manager, Water Policy, Central Arizona Project

Free non-interactive livestreaming

1:10-2:10	**Session 2: Filling Information Gaps** • **Rachel O'Connor**, Environmental Defense Fund, *OpenET: Filling a Critical Data Gap for Sustainable Water Management* • **Noah Silber-Coats**, USDA Southwest Climate Hub, *The Water Adaptation Techniques Atlas: A Catalog of Solutions for the Southwest* • **Jessie Pearl**, The Nature Conservancy, *Success of Water Conservation Actions in Arizona* • **Faith Sternlieb**, Lincoln Institute of Land Policy, *Overview of the Internet of Water (IoW) Coalition and Update on Core Technology* **Moderator: Jim Leenhouts**, Arizona Water Science Center, US Geological Survey
2:10-3:10	**Session 3: Improving Farming Practices** • **Sterling Johnson,** Ajo Center for Sustainable Agriculture, *Tohono O'odham Traditional Dryland Farming and Crops - Lessons to be Learned for Arizona Water Challenges* • **Ethan Orr,** University of Arizona, *University of Arizona Cooperative Extension's Water Irrigation Efficiency Program* • **Ricardo Aguirre,** WEST Consultants, Inc., *A Solution for Long-Term Water Security in the Southwest* • **Debankur Sanyal,** University of Arizona, *Soil Health Management Under Water Limited Environments* **Moderator: Jeff Silvertooth**, University of Arizona
3:10-3:25	SPONSOR VIDEOS — NETWORKING BREAK
3:25-3:55	**Keynote: Managing Groundwater in Arizona** • **Natalie Mast,** Active Management Areas Director, Arizona Department of Water Resources
3:55-4:55	**Session 4: Working with Nature** • **Sarge Green,** California Water Institute at California State University Fresno, *Optimizing Watershed Conditions for Sustainability* • **Kim Schonek,** The Nature Conservancy Arizona, *Opportunities for Stormwater Recharge in Arizona: Augmentation and Streamflow Benefits* • **Xochitl Coronado-Vargas,** Tucson Water, *Tucson's Green Stormwater Infrastructure Program* • **Neha Gupta,** University of Arizona, *Opportunities to Enhance Recharge in Arizona: A Tri-University Study* **Moderator: Megan Martin**, Salt River Project
4:55-5:00	CLOSING REMARKS - END OF DAY 1
5:30-7:00	RECEPTION - Gentle Ben's Brewing Company, 865 E University Blvd

WEDNESDAY, JULY 12, 2023

8:00-9:00	REGISTRATION AND REFRESHMENTS
9:00-9:05	**Welcome** • **Sharon B. Megdal,** Director, Water Resources Research Center, University of Arizona
9:05-10:00	**Keynote Panel: The Importance of Tribal Consultation for Solutions** • **Amelia Flores**, Chairwoman, Colorado River Indian Tribes • **Stephen Roe Lewis,** Governor, Gila River Indian Community • **Terry Rambler**, Chairman, San Carlos Apache Tribe **Moderator: Sharon B. Megdal**, University of Arizona
10:00-11:15	**Session 5: Adapting Policy** • **Elia Tapia**, University of Sonora, *Transboundary Aquifers* • **Rashi Bhushan**, University of Arizona, *Identifying Policy Barriers Towards a Net Zero Urban Water Future in Southwestern US* • **Tres English**, Sustainable Tucson, *Sustaining Tucson - Living Within Our Limits* • **Raluca Mihalcescu**, Arizona Water Company, *Water Conservation: A Viable Part of the Solution for Private Water Utilities* • **Richael Young**, ERA Economics, LLC, *Central Arizona Water Clearinghouse* • **Stephanie Anagnoson**, Madera County, California, *Allocations for Water Management on Farms* **Moderator: Juliet McKenna**, Montgomery & Associates
11:15-11:30	NETWORKING BREAK
11:30-12:30	**Session 6: Growing the Workforce** • **Gary Woodard,** Water Resources Consulting, *Ramping up Regional Conservation Capacity* • **Joshua Ruddick,** University of Arizona, *Career and Technical Education Building Water Related Pathways to a Green Workforce* • **Selwyn Sekaquaptewa**, Hopi Utilities Corporation, *Hopi Experience with Tribal Workforce Capacity* • **Frank Barbaro**, Central Arizona Project, *CAP Apprenticeship Program* **Moderator: Maria Dadgar**, Inter Tribal Council of Arizona
12:30-1:30	LUNCH
1:10-1:30	**Luncheon Keynote: Salt River Project's Role in Arizona's Water Future** • **Leslie Meyers**, Associate General Manager, Salt River Project

1:30-2:30

Session 7: Utilizing Technology

- **David Proctor,** BKW Farms, *A Commercial Application of Controlled Environment Agriculture in the Southwest*
- **Ben Cloud,** Biodel AG Inc., *Microbial Soil Reclamation*
- **Greg Barron-Gafford,** University of Arizona, *Agrivoltaics*
- **Nazario Prieto,** City of Phoenix, *City of Phoenix Advanced Purified Water Plan*
- **Jing Luo,** Apex Applied Technology, Inc., *A STAR Solution to Safe Drinking Water Challenges on Navajo and Hopi Reservations*
- **George Bomar,** Texas Weather Modification Association, *Harvesting the Skies of the American Southwest*
- **Robert Pulliam,** Tubular Rail Inc., *Ocean Imports of Fresh Water for Augmentation of the Colorado River*
- **Mark Witten,** Witten Technologies Inc, *Low-Energy Desalination Technology*

Moderator: Dave Wegner, Woolpert

2:30-2:45 SPONSOR VIDEOS, NETWORKING, AND DESSERT

2:45-3:45

Poster Session

- **Sarah Cerra,** New Mexico State University, *Student: Using Atriplex for RO Concentrate Reuse: Managing Soil Salinity and Microbes*
- **Laura Condon,** University of Arizona, *HydroGEN: A Web Based Hydrologic Scenario Generation Platform for a Changing World*
- **Robert Jimenez-Wieneke,** University of Arizona, *Student: AZstreamCAT*
- **Courtney Lee,** University of Arizona, *Student: Designer Biochars for Removal of PFAS from Contaminated Water*
- **Robert Masson,** University of Arizona, *Monitoring Sprinkler Water Use on the Farm*
- **Molly McCandless,** New Mexico Tech, *Student: Assessing the Potential Impact of Irrigated Agriculture Along the Rio Sonoyta Valley on the Vegetation and Hydrology in the Organ Pipe Cactus National Monument*
- **Roberto Molina,** North American Development Bank, *Bay Acres Wastewater Collections System and Wastewater Treatment Plant Expansion in Douglas, AZ*
- **Melanie Moore,** Gowan High School, **Robert Masson**, University of Arizona, *Student: Building the Water Bank: Moisture Retention Qualities of Soil Amendments in Desert Agricultural Soils*
- **Shaku Nair,** University of Arizona, *How is Water Management Related to Pest Management?*
- **Kun Qi,** University of Arizona, *Student: Flash Flood Simulation Using HEC-HMS Model for an Arid Watershed in Arizona*
- **Zoey Reed-Spitzer,** University of Arizona, *Student: How do Groundwater Levels Vary with Economic and Climate Factors?*
- **Tom Smolarek,** Cypress Ltd, *Advanced Cooling Tower Water Treatment Integrated System to Reduce Water, Waste, Energy and Chemicals*
- **Amanda Trakas,** University of Arizona, *Arizona Water Factsheets*
- **Ashley Wright,** University of Arizona, *Collective Impact: Documenting Small Scale Efforts That Lead to Systems Wide Changes*

3:45-4:20	**Session 8: Portfolio-Based Approaches to Address Near-Term and Long-Term Water Demands** • **Lauren Hixon,** City of Gilbert • **John Kmiec,** Tucson Water • **Bill Swanson,** Stantec • **Brian Biesemeyer,** Scottsdale Water • **John Take,** Stantec **Moderator: Lisa Beutler,** Stantec
4:20-4:35	**Session 9: Arizona State University's Arizona Water Innovation Initiative** • **Susan Craig,** Arizona State University, *ASU's Arizona Water Innovation Initiative: An Investment in Water & Climate Resilience*
4:35-4:55	**Keynote: Financing for Water, Wastewater, Stormwater, and Water Conservation Infrastructure Projects** • **Chuck Podolak,** Director, Water Infrastructure Finance Authority of Arizona
4:55-5:00	CLOSING REMARKS - END OF CONFERENCE

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

Free non-interactive livestreaming

Updated: July 7, 2023 9:15 AM

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

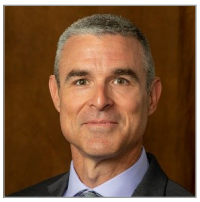
Ricardo Aguirre, *Director of Land Management and Water Security, WEST Consultants, Inc.*

Ricardo Aguirre is a director with WEST Consultants, Inc. and is developing the land management and water security service line. Aguirre has 25 years of experience in civil engineering with primary skills in hydraulics, hydrology, stormwater infrastructure design, land management, groundwater recharge, and project management. He works toward evolving the conventional engineering perspective by integrating natural processes into large-scale engineering. His primary professional focus is implementing functional design strategies to achieve multiple synergistic objectives, such as harvesting water and increasing soil organic matter to control excess flooding, reduce soil loss, improve water, soil, and air quality, recharge aquifers, prevent wildfires, provide passive irrigation for vegetation, control invasive species, lessen heat island effect, and sequester carbon in soil. Aguirre also has written papers that explore regenerative strategies as an alternative to traditional drainage engineering practices.

Stephanie Anagnoson, *Director of Water and Natural Resources, Madera County, California*

Stephanie Anagnoson is a geologist and serves as Water and Natural Resources Director for Madera County, California. She has worked for public and private water districts, including water wholesalers and water retailers. In her current role, Anagnoson works with California's Sustainable Groundwater Management Act (SGMA), which fundamentally changed farming's relationship to groundwater in California. She is the manager of 220,000 acres within Madera County that have historically not been represented by irrigation or water districts or had a surface supply. Anagnoson has introduced an allocation with penalties as well as robust recharge and land repurposing opportunities.

Frank Barbaro, *Centralized Maintenance Manager/ Apprenticeship Committee Chairman, Central Arizona Project*



Frank Barbaro completed his HVAC apprenticeship in 1999 through the International Union of Operating Engineers Local 30 in New York City. He began working for Central Arizona Project (CAP) in 2004 as an HVAC Technician, was promoted to HVAC-Fire Protection Systems Supervisor in 2010 and then promoted to Centralized Maintenance Manager in late 2019. Barbaro serves as CAP's Apprenticeship Committee Chairman, where he collaborates with others to provide the necessary training and development required to become a successful HVAC technician journeyman. Barbaro achieved his Certified Reliability Leader certification in May 2019 and is currently working on his Certified Maintenance Reliability Professional certification.

Greg Barron-Gafford, *Professor, School of Geography, Development & Environment, School Gardens Workshop, Biosphere 2, University of Arizona*

Greg Barron-Gafford is an Earth system scientist who has been building the field of 'agrivoltaics' – the concept of co-locating agriculture and photovoltaics (renewable energy from solar panels). Barron-Gafford began this work in Southern Arizona studying the benefits across the food-energy-water nexus and over the years has

developed a national and international program connecting with researchers in Colorado, Africa, and the Middle East. Working to develop science-based solutions that help people adapt to the increasing pressures that come from a changing climate is a personal and professional goal of his.

Lisa Beutler, *Executive Facilitator, Senior Principal, Stantec*

Lisa Beutler is among the top strategic planning, public affairs, and public outreach professionals in the water industry. A leader with over 38 years of experience, she is nationally recognized for her work with public policy and stakeholders. Formerly the Associate Director of the Center for Collaborative Policy at Sacramento State, and an American Water Resources Association past president, earlier in her career she was a state park ranger eventually assuming roles in special offices of two governors and as an agency undersecretary overseeing 50,000 employees and a $3.5 billion dollar budget. She has a proven track record leading numerous complex, high-profile projects.

Rashi Bhushan, *Postdoctoral Research Associate, University of Arizona*

Rashi Bhushan is a postdoctoral research associate at the University of Arizona, College of Architecture Planning and Landscape Architecture (CAPLA). She is currently working on Net Zero Urban Water for the southwest U.S., which aims to achieve a sustainable water future for the region. Bhushan's research is motivated by the impacts of climate change on freshwater availability and water resources systems operation. Her interests include hydrologic modeling, adaptive management under uncertainty, systems analysis, and multi-objective optimization. With her skills, Bhushan intends to address problems related to freshwater scarcity, water access inequity, and infrastructure operations under climate uncertainty.

Brian K. Biesemeyer, *Executive Director, Scottsdale Water*

Brian Biesemeyer is the Executive Director of Scottsdale Water and has held this position since 2012. From June 2015 to January 2017, Biesemeyer had the additional duty of being the acting City Manager for Scottsdale. He is a retired U.S. Army Lieutenant Colonel with over 30 years of organizational leadership experience. He is a registered professional environmental engineer and holds Arizona Department of Environmental Quality Grade 4 Operator Certifications in four disciplines. Brian is a State of Arizona Water Protection Fund Commissioner, a past president of WateReuse Arizona, and a past board member of the WateReuse Association.

George Bomar, *Texas State Meteorologist (Ret.), Author*

George Bomar has devoted his 46-year career in government to the development and use of cloud seeding technologies to help address Texas' growing demand for water. He worked with the Texas Legislature in establishing a statewide rain-enhancement program, at a cost of nearly $30 million, that covered a quarter of Texas' land area by 2003. That initiative remains today as the largest in the U.S. and among the most productive in the world. Bomar has served as President of the national Weather Modification Association and Chairman of the North American Weather Modification Council.

Ben Cloud, *CEO, Biodel AG Inc.*

Ben Cloud is a Co-Founder of Biodel AG Inc and became CEO in 2019. Biodel AG works to reduce water use through Microbial Soil Reclamation. Increasing the flow of carbon in soil to raise organic carbon levels during crop production can dramatically increase the water holding capacity and water use efficiency.

Xochitl Coronado-Vargas, *Public Outreach Coordinator, City of Tucson*

Xochitl Coronado-Vargas serves as Public Outreach Coordinator with the City of Tucson's Storm to Shade program. She engages with the public during design, construction, and maintenance of green stormwater infrastructure (GSI) throughout the prioritized areas of the City. Coronado-Vargas holds a master's degree in public health and has worked for various non-profit and public-service organizations to bring about positive health and educational outcomes to underserved and marginalized communities. In her spare time, she enjoys spending time with her family, cooking, hiking, and dancing.

Susan Craig, *Program Director, ASU Global Institute of Sustainability and Innovation*

Susan Craig, Program Director for ASU's Global Institute of Sustainability and Innovation, is leading the Impact Water – Arizona program, part of the Arizona Water Innovation Initiative to foster community understanding and engagement in Arizona's water challenges and solutions. Previously, Craig worked for ASU's Kyl Center for Water Policy at the Morrison Institute for Public Policy, driving projects on water resilience, such as the award-winning Arizona Water Blueprint, an interactive tool providing information to empower inclusive and informed decision-making. Having worked for Arizona's three primary state water agencies, the Arizona Department of

Environmental Quality, Arizona Department of Water Resources, and Water Infrastructure Finance Authority, Craig has extensive knowledge of the state's water issues, policies, and players. She is passionate about contributing to the solution space and making an impact in securing Arizona's water future.

Maria Dadgar, *Executive Director, Inter Tribal Council of Arizona*

Maria Dadgar is an enrolled member of the Piscataway Tribe of Accokeek, Maryland. She is Executive Director of the Inter Tribal Council of Arizona (ITCA), a Tribal consortium of 21 of the 22 Tribes in Arizona and one of the oldest and largest inter-Tribal organizations in the U.S. In her more than 20-year career in higher education, non-profit executive management, and Tribal economic development, she has been involved in advocating on behalf of Tribal nations. She has advocated for public policies and legislation regarding economic development, American Indian health policy, environmental justice, and American Indian education. Starting in non-profit management as Co-Founder/National Program Coordinator of Washington Internships for Native Students (WINS) at American University in Washington, DC, which was selected as one of "America's Best Practices," by President Clinton's Race Relations Commission for Outstanding Educational/Work Experience Opportunity for American Indian College Students. Dadgar holds an AA in Journalism/Mass Communications from Prince George's Community College in Largo, Maryland, a BA in Liberal Studies from American University, and an MBA from Grand Canyon University in Phoenix.

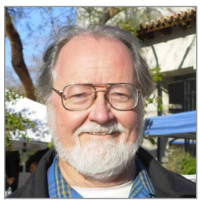
Patrick Dent, *Assistant General Manager, Water Policy, Central Arizona Project*

Patrick Dent is CAP's Assistant General Manager over Water Policy and has been with CAP for 23 years. He is responsible for long-range planning, policy analysis, development, and program implementation for the CAP service area, the Colorado River, and the Central Arizona Ground Water Replenishment District (CAGRD).

Natalie DeRoock, *Senior Public Information Officer, Director's Office, Tucson Water*

Natalie DeRoock is Senior Public Information Officer for Tucson Water. She is a former public affairs strategist for the U.S. Department of State. DeRoock served overseas, where she amplified global programming for research partnerships, economic development, and higher education and directed the national Fulbright Program. She was also the co-recipient of a National Science Foundation award for best practices in cross-disciplinary STEM education at the University of Arizona. She is a natural multicultural communicator and is best known by colleagues as a "water diplomat."

Tres English, *President, Sustainable Tucson*



Tres English is a longtime Tucsonan and residential property manager with a degree in Engineering Physics. He has been heavily involved in a wide variety of local sustainability issues, including as a member of three comprehensive planning efforts by the city and Pima County, Co-chair of PAG regional transportation planning committee, and Co-founder and President of Sustainable Tucson. He designed and built experimental aquaponics and wicking bed garden systems, built six active water harvesting systems, created a documentary on Tucson's water future, produced a study of Pima County's 200,000 aging, uninsulated pre-1980s homes, and organized high school and adult home repair training programs. He is currently working with Pima College, City of Tucson, and Pima County to develop the capacity to train the workforce to repair the aging housing stock.

Amelia Flores, *Chairwoman, Colorado River Indian Tribes*

Chairwoman Amelia Flores is Mohave and an enrolled member of the Colorado River Indian Tribes (CRIT). In 2020, she was elected as the CRIT's first Chairwoman. Previously, she served as CRIT Tribal Councilwoman from 2013 to 2020 and as Tribal Council Secretary for two two-year terms (2013 – 2015 and 2017 – 2020). Since 2011, she also has served as a Board Member of the Parker Unified School District #27. A former Tribal Librarian/Archivist, she has volunteered her time serving on local, Tribal, and state committees, boards, and commissions. She was appointed to the 2021 Governor's Water Augmentation Board and served by appointment on Arizona First Things First, Early Childhood Development and Health Board from 2018 – 2020. She has received many awards for her Library/Archives and Language work and recently was recognized as 2021 Leader of the Year – Environment/Public Policy by the Arizona Capitol Times. She holds a BS in Education from Northern Arizona University and a master's in Linguistics from the University of Arizona.

Sarge Green, *Water Management Specialist, California Water Institute at Fresno State University*

Sarge Green is a water management specialist at Fresno State University. He has been with FSU for 14 years. He is currently a part-time research scientist for the water programs at Fresno State. Green previously served as Director of the Center for Irrigation Technology and Associate Director of the Water Resources and Policy Initiatives program for all 23 CSU Campuses. His current professional

affiliations include serving on the Board of Directors of the Fresno Metropolitan Flood Control District, the Tule Basin Land and Water Conservation Trust, and the Association of California Water Agencies.

Neha Gupta, *Assistant Research Professor, Arizona Institutes for Resilience, University of Arizona*

Neha Gupta is an assistant research professor in the Arizona Institutes for Resilience at the University of Arizona working on urban hydrological and water resource management issues. She participates in and conducts research on using stormwater as a resource, green infrastructure in arid urban environments, and interdisciplinary approaches to evaluating and addressing water supply and demand imbalances. Prior to joining the University of Arizona, Gupta worked as an environmental consultant on contaminated soil and groundwater issues.

Lauren Hixson, P.E., *Water Resources Manager, Town of Gilbert*

Lauren Hixson is Water Resources Manager for the Town of Gilbert. Since coming to Gilbert, she has helped lead the Town's sustainable operations vision to reduce groundwater pumping and played a key role on the update to the Town's local water shortage response plan. She has 11 years of experience in the water industry with a background in water resource planning and water/wastewater design and engineering. Hixson earned a BS in Civil Engineering from the University of Arizona and is a registered professional engineer. She is passionate about supporting the community by managing water resources wisely and efficiently from policy to operations.

Joseph Hoover, *Assistant Professor, Department of Environmental Science, Indigenous Resiliency Center, University of Arizona*

Joseph Hoover is an assistant professor in the Department of Environmental Science and core-faculty affiliate of the Indigenous Resilience Center at the University of Arizona. His line of research emphasizes integration of community-engaged research approaches with geospatial technology to address environmental health challenges with Indigenous and underserved communities. He co-directs the Center for Native Environmental Health Equity Research based at the University of New Mexico and co-leads the Native EH Equity Center Community Engagement and Dissemination Core. He earned a BS in Environmental Science from Northwestern University, a master's in Geography from the University of Arizona, and a PhD in Geography from the University of Denver. He joined the UArizona faculty in Fall 2022.

Sterling Johnson, *Co-Director, Ajo Center for Sustainable Agriculture*

Sterling Johnson is Co-Director of the Ajo Center for Sustainable Agriculture, a 501 c3 Native American-governed community-based non-profit organization, and a member of the Tohono O'odham Nation. With a background in ranching and rodeo, he started his career in agriculture as a farmer apprentice in 2011 at Tohono O'odham Community Action (TOCA). He went on to serve as Farm Manager, Mentor, and Educator at the Ajo Center for almost a decade and has been a co-director for a year. His work focuses on revitalization of traditional O'odham agricultural practices and seeds, removing barriers to access to healthy nutritious foods, and providing economic opportunities, including youth internships, beginning farmer training, and mini grants. Johnson is a culture bearer and mentor for O'odham agriculture and himdag (way of life), working for an organization that firmly believes that Ak-chin Oidag (Mouth of the Wash Farming) or dryland farming practices of the Tohono O'odham people are a key to creating a climate smart agriculture future for all.

Jason Jones, *Senior Scientist, Arizona Department of Environmental Quality*

Jason Jones is the Clean Water Act monitoring and assessment coordinator for the Arizona Department of Environmental Quality. Jason started as a permit writer in 2001. Since then, he has led Arizona's programs for groundwater, wetlands, fish tissue, and lakes and streams. His recent projects include a probabilistic assessment of fish tissue contaminants in Arizona lakes and an application that interactively displays exceedances of water quality portal data.

Erin Jordan, *Value Stream Manager, Arizona Department of Environmental Quality*

Erin Jordan is a value stream manager in the Water Quality Division at the Arizona Department of Environmental Quality. She has a PhD in Arid Lands Resource Sciences from the University of Arizona and undergraduate degrees in Geosciences, Botany, and Communications from Miami University and Mississippi State University. Joining the agency in 2017 as the media administrator, Erin moved into her current role of managing the team monitoring, assessing, and enhancing surface water quality in Arizona in 2020.

John Kmiec, *Director, Tucson Water*

John P. Kmiec is the Director for Tucson Water. His career spans several decades with an emphasis on water resource management, utility leadership, and water quality challenges. Throughout his career, and during his tenure as Director of Marana Water (2012-2019), he amplified efforts to shape Arizona's long-term vision and policy about sustainable water supplies, water quality, and the principle that all water has value. As a strategic and tactical leader, Kmiec served as an appointed member of Governor Ducey's Water Augmentation, Innovation, and Conservation Committee and currently sits on Governor Hobb's Water Policy Council. Kmiec is also a member of the Board of Directors for the National WateReuse Association and the AZ Water Association Board.

Jim Leenhouts, *Center Director, United States Geological Survey Arizona Water Science Center*

Jim Leenhouts is Center Director of the USGS Arizona Water Science Center (AZWSC). The AZWSC has a mission to produce stakeholder-driven water data and investigations that support informed decisions by water resource managers. Leenhouts joined the AZWSC as a Hydrologist in 2000 and has overseen a variety of science projects, including San Pedro River Basin investigations, USGS work in the Upper Verde River Basin, aspects of the Transboundary Aquifer Assessment Program, and most recently, USGS participation in the Minute 323 Colorado River Delta restoration. He has an undergraduate degree in Geology from Oberlin College and MS and PhD degrees in Hydrology from University of Arizona.

Stephen Roe Lewis, *Governor, Gila River Indian Community*

Stephen Roe Lewis has been Governor of the Gila River Indian Community since being elected in 2014. He was raised in Sacaton, "Gu-u-Ki", on the Gila River Indian Community. His parents are Rodney B. and Willardene Lewis. His paternal grandparents were Rev. Roe Blaine and Sally Lewis, and his maternal grandparents were Willard and Catherine Pratt. As Governor, he oversees the implementation of the Community's Water Settlement of 2004 (the largest water settlement of its kind in U.S. history). He also serves on the Board of Directors for the Native American Rights Fund, the Executive Board for the National Indian Gaming Association, and the Board of Trustees for the Heard Museum of Phoenix. Governor Lewis advocates for renewable and green technologies guided by O'otham agricultural history and cultural teachings. He was the first Native film curator for the Sundance Film Festival in Park City, Utah, and was an Associate Producer for the groundbreaking and critically acclaimed TBS six-part feature documentary, "The Native Americans." Governor Lewis graduated with a BS from Arizona State University and pursued graduate studies at John F. Kennedy School of Government at Harvard University.

Jing Luo, *Vice President, Apex Applied Technology*

Jing Luo has over 20 years' extensive experience working in the water industry. She is a professional engineer in Arizona. After graduating with a PhD in Environmental Engineering from the University of Arizona in 2003, she worked as a civil engineer and civil engineering manager for Pima County RWRD, Sr. Civil Engineer for the City of Mesa, and City Engineer for the City of Sierra Vista. She is now Director of Marana Water. In 2010, Luo founded Apex Applied Technology, Inc., a professional consulting firm providing active outreach and technical assistance to socially disadvantaged groups and communities.

Megan Martin, *Senior Analyst, Water Rights & Contracts, Salt River Project*

Megan Martin has been working on natural resources and water policy in various capacities for over a decade. Most recently, she joined Salt River Project's Water Rights & Contracts group as a senior analyst, where she is responsible for analyzing water resources issues throughout Arizona. Prior to this role, she was a member of SRP's State Government Relations team, focusing on water, energy and natural resources issues at the Arizona Legislature. Martin got her start in policy as an intern at the Arizona Legislature and has served in various roles at the Capitol working on natural resources and water issues. She has an undergraduate degree from Arizona State University and a JD from Gonzaga School of Law.

Natalie Mast, *Active Management Areas Director, Arizona Department of Water Resources*

Natalie Mast is the Active Management Areas (AMA) Director at the Arizona Department of Water Resources (ADWR). Natalie and her team are responsible for ongoing AMA activities (such as annual reporting, data compilation and analysis, conservation program management, etc.) and are working to establish the necessary structures for the new Douglas AMA and Hualapai Valley INA. Natalie also provides support for the team developing the water supply and demand assessments required by recent legislation. Natalie has been with ADWR since 2016, previously serving in Statewide Planning, as the Data and Planning Manager for the AMAs, and leading the team that developed, drafted, and adopted the 5th Management Plans.

Juliet McKenna, PG, *Principal Hydrogeologist, Montgomery & Associates*

Juliet McKenna is a hydrogeologist and water planning consultant with Montgomery & Associates, a water resources consulting firm headquartered in Tucson. McKenna helps clients in the municipal, Tribal, and nonprofit sectors navigate challenging waters through regulatory and policy guidance, water portfolio planning, and hydrogeologic investigations. She is a member of the UArizona Water Resources Research Center Advisory Board, the City of Tucson Citizen's Water Advisory Committee, and Co-Chair of the Water Resources Committee of AZ Water.

Sharon B. Megdal, *Director, Water Resources Research Center, University of Arizona*

Sharon B. Megdal is Director of the University of Arizona Water Resources Research Center, an Extension Center and research unit in the College of Agriculture and Life Sciences. She is also Professor of Environmental Science, C.W. & Modene Neely Endowed Professor, and Distinguished Outreach Professor. The geographic focus of her water policy and management work ranges from local to international. Current research projects focus on groundwater governance, managed aquifer recharge, and transboundary aquifer assessment. Engagement efforts include Indigenous Water Dialogues and Diversifying Voices in Water Resources. Megdal endeavors to bridge the academic, practitioner, and civil society communities. Recently, she completed 12 years as an elected member of the Central Arizona Project Board of Directors, and she is active in many professional organizations. Past state-level public service activities include the Arizona Corporation Commission, the State Transportation Board, the Arizona Medical Board, and several other boards and commissions. Sharon Megdal holds a PhD in Economics from Princeton University.

Leslie Meyers, *AGM & Chief Water Resources and Service Executive, Salt River Project*

Leslie Meyers is Associate General Manager & Chief Water Resources Executive at Salt River Project. She joined SRP in 2022, with more than 30 years of water resources management experience in Arizona and the southwest. Throughout her career, Meyers has worked on strategic initiative planning and implementation with federal, state, and local governments, Tribes, irrigation districts, non-governmental organizations, and others. She received a BS in Civil Engineering from Texas A&M University and is a registered Professional Engineer.

Raluca Mihalcescu, *Water Conservation Coordinator, Arizona Water Company*

Raluca Mihalcescu grew up in Alaska and moved to Arizona with her family in 2009. She received her undergraduate degree in Environmental Resource Management and a master's in Innovation and Venture Development, both from Arizona State University. She worked for the City of Tempe's Water Conservation Program for just under three years before joining Arizona Water Company as the company's first dedicated water conservation specialist. In the two years she has been with the company, she has spearheaded the launch of five Integrated Demand Management Programs, providing additional conservation resources for just over 60% of Arizona Water customers. Mihalcescu loves the fast-paced environment and challenges of her current job Arizona Water Company's Water Conservation Coordinator.

Rachel O'Connor, *Manager, Climate Resilient Water Systems, Environmental Defense Fund*

Rachel O'Connor, Manager with Environmental Defense Fund's Water Program, has spent over a decade working across the western U.S. advancing the sustainable use of water resources through implementing policies and management practices that support communities and ecosystems. She works collaboratively across sectors to enable increased and equitable access to data and information to advance more inclusive development and implementation of durable water solutions. Prior to joining EDF, O'Connor consulted for organizations across the West on water transaction program design and water management decision support tools. She holds a master's in environmental science and management from the Bren School at UC Santa Barbara.

Ethan Orr, *Director, Water Irrigation Efficiency, Cooperative Extension, University of Arizona*

Ethan Orr is a fourth-generation Arizonan. He is an associate professor in Community Development and Associate Director for Agriculture, Natural Resources and Economic Development at the University of Arizona. He oversees the $45 million on-farm water irrigation efficiency program. He has served in the Arizona State Legislature and in senior economic development positions at the municipal level. He started the Empowerment Zone in Pima County, which has generated over $500 million in tax credits and supported downtown revitalization. In his leadership role at UArizona, he is active in programming addressing forest health, watershed management, and crop production.

Jessie K. Pearl, *Freshwater Scientist, The Nature Conservancy*

Jessie K. Pearl provides scientific support to inform freshwater conservation planning, strategies, and priorities at the Arizona chapter of The Nature Conservancy. Additionally, she develops and pursues research that anticipates future changes in climate, hydrology, and ecosystem resilience and demonstrates impacts of conservation practices at regional scale. Ultimately this research is used to catalyze policies, funding, and partnerships. Pearl received her PhD in Geosciences with a minor in Global Change from the University of Arizona. Her background is in paleoclimate, geochronology, and dendrochronology. Her dissertation and postdoc work used tree-ring records to reconstruct climate and extreme events in the northeastern and northwestern United States.

Karen Peters, *Director, Arizona Department of Environmental Quality*

Karen Peters is an Arizona lawyer and veteran public manager; most recently having served as a deputy city manager for the City of Phoenix. She has over 30 years of experience in environmental and water law and policy and helped write Arizona laws and regulations on critical issues like protecting rivers and streams, cleanup of groundwater and soil contamination, and air quality. She earned her undergraduate degree from Arizona State University, studied law at Georgetown University, then returned to Arizona to begin her career.

Chuck Podolak, *Director, Water Infrastructure Financing Authority of Arizona*

Chuck Podolak is Director of the Water Infrastructure Finance Authority of Arizona, where he leads an agency tasked with helping Arizona residents secure clean and reliable water supplies into the future. Prior to joining WIFA, Podolak led a team at Salt River Project focused on addressing water conflicts throughout the state. He also served as Natural Resources Policy Advisor to two elected officials - Governor Doug Ducey and Senator Jeff Flake. In those roles he was responsible for policy and legislation relating to Arizona's water, land, environmental quality, wildlife, agriculture, and energy issues. Podolak has a Bachelor's degree from the U.S. Air Force Academy and a PhD in river sciences from Johns Hopkins University.

Nazario Prieto, *Assistant Water Services Director, City of Phoenix*

Nazario is an assistant director at Phoenix Water, overseeing and managing the city's wastewater utility, including the Treatment, Collection, and Engineering Divisions. He has over 17 years of experience at the City of Phoenix, 15 of which have been in the Water Services Department. Prior to coming to Phoenix, Nazario worked for three years at the Metropolitan Water District of Southern California in Los Angeles. He has a Civil Engineering degree from the University of Texas El Paso and is a registered professional engineer in Arizona.

David Proctor, *Vice President, BKW Farms*

David Proctor is the Vice President of BKW Farms, a third-generation family farm in Marana, Arizona. Growing up on the Wong's farm, he took an early interest in sustainable agriculture. He is passionate about controlled environment agriculture and the role it will play for future generations. Utilizing controlled environment growing techniques, Proctor developed and heads BKW's USDA organic mushroom operation, which provides fresh, local varieties of oyster mushrooms year-round.

Robert Pulliam, *President, Tubular Rail Inc.*

Robert Pulliam is a semi-retired inventor and entrepreneur who holds several patents. He studied Urban Planning and Economics at Michigan State University; his professional career involved handling hazardous materials, logistics, and maritime construction. Pulliam has an interest in water-related issues caused by population growth and our changing climate. He believes there are cost effective and achievable engineering solutions for many of our environmental concerns and that these solutions can be market based and turn a profit. He is also interested in public policy and the roadblocks to innovation.

Terry Rambler, *Chairman, San Carlos Apache Tribe*

Terry Rambler is a member of the San Carlos Apache Tribe and is fluent in the Apache language. In 2010, he was elected Chairman of the San Carlos Apache Tribe, with subsequent re-elections in 2014, 2018, and 2022. He is currently serving his fourth consecutive term. Chairman Rambler has also served as Chairman and Vice Chairman of the Arizona Indian Gaming Association (AIGA), President and Vice President of the Inter-Tribal Council of Arizona (ITCA), President and Vice President of the Inter-Tribal Association of Arizona (ITAA), Vice President and Secretary/Treasurer of the

Apache Alliance, and was appointed by Department of Interior Secretary Deb Haaland to serve on her Secretary's Tribal Advisory Committee.

Robert C. Robbins, *President, University of Arizona*

Robert C. Robbins assumed his position as the 22nd president of the University of Arizona on June 1, 2017. Previously, he served as president and CEO of the Texas Medical Center (TMC) in Houston from 2012 to 2017. In this role, he significantly enhanced TMC's commitment to collaboration, introducing five cross-institutional research initiatives centered on innovation, genomics, regenerative medicine, health policy and clinical research. While at the University of Arizona, Robbins has led the creation and implementation of a strategic plan focused on the opportunities and challenges presented by the Fourth Industrial Revolution, the convergence of biological, and digital and physical technologies and sectors. Designed to amplify Arizona's competitiveness on the world stage, the plan emphasizes the university's strengths as a public, land-grant research university with global reach and a rich history of international collaboration.

Joshua Ruddick, *Community Outreach, AZ Project WET*

Josh Ruddick is an experienced educator and business executive. After he spent 15 years in the health care industry running business operations and consulting for large consortiums of insurance companies, he returned to school. He graduated with a master's degree in Secondary Science Education in 2012 from the University of Arizona and subsequently became a certified teacher for Biology, Earth and Space Science, and Career and Technical Education. During his teaching career, Ruddick established a program in sustainable agriculture and natural resource management and was recognized locally and internationally for his work with students and the community.

Debankur Sanyal, *Soil Health Specialist, Environmental Science, University of Arizona*

Debankur Sanyal is an assistant professor and soil health specialist at the Department of Environmental Science, University of Arizona. As a researcher, he specializes in soil biogeochemistry at multiple scales as impacted by various plant-soil-microbe-climate interactions, using approaches that range from laboratory incubations to greenhouse trials to extensive field trials. His current research focuses on soil health best management practices under environmental stresses like drought, salinity, and heat. Sanyal runs a statewide soil health research and extension program as he seeks climate-smart agronomic solutions for commercial growers and agricultural industries in Arizona. He spends a significant amount of time testing and evaluating existing and novel soil health conservation tools and techniques.

Kim Schonek, *Arizona Water Program Director, The Nature Conservancy*

Kimberly Schonek is the Arizona Water Program director for The Nature Conservancy with more than 14 years of experience focusing on water management in the Verde River and San Pedro River basins. Previously, Schonek worked with the Oregon Water Trust, U.S. Forest Service, and City of Portland. She holds a master's degree in environmental management with an emphasis in hydrology.

Selwyn Sekaquaptewa, *Water Utility General Manager, Hopi Utilities Corporation*

Selwyn Sekaquaptewa is the Water Utility General Manager for the Hopi Utilities Corporation. He manages the Hopi Arsenic Mitigation Project that built the new Hopi Regional Water System. He currently manages three staff people and is charged with growing the water and wastewater aspect of this utility. Sekaquaptewa began his career in 1999 as a water operator for Kykotsmovi Village. In 2014, he was recognized as "Tribal Water Operator of the Year" by the Inter-Tribal Council of Arizona. In 2019 he became Construction Control Inspector for the Indian Health Service, Office of Environmental Health and Engineering.

Noah Silber-Coats, *Postdoctoral Fellow, USDA Southwest Climate Hub*

Noah Silber-Coats is a postdoctoral fellow with the USDA Southwest Climate Hub, where his work focuses on identifying effective solutions to water scarcity for the region. He leads development of the Water Adaptation Techniques Atlas (WATA), an online tool that documents these solutions. Prior to joining the Hub, he completed a PhD in the School of Geography, Development, and Environment at the University of Arizona, where his dissertation focused on the political economy of legalized cannabis agriculture in Oregon. He has also conducted research on agave agriculture and spirits in Sonora and on conflicts over governance of hydropower development in central Mexico.

Jeff Silvertooth, *Professor & Extension Specialist, Agronomy & Soil Science, Department of Environmental Science, University of Arizona*

Jeff Silvertooth conducts a program directed towards the development of irrigated crop production management strategies that optimize the soil-plant system agronomically, economically, and environmentally. Principal areas of operation for this desert agriculture program include studies of soil-plant relationships, particularly regarding nutrient and water requirements for cotton, chiles, cantaloupes, and other regional crops, and salinity and sodicity management in agricultural soils. Silvertooth has been recognized as a Fellow by both the American Society of Agronomy and Soil Science Society of America.

Faith Sternlieb, *Associate Director of Engagement, Internet of Water, Center for Geospatial Solutions, Lincoln Institute of Land Policy*

Faith Sternlieb is the associate director of engagement for the Internet of Water (IoW) initiative at the Center for Geospatial Solutions, Lincoln Institute of Land Policy, where she facilitates the IoW Coalition and fosters public-private partnerships from local to international scales to support water data modernization. She holds degrees in anthropology, agricultural, and earth sciences, and she has15 years of experience working with stakeholders at the nexus of water science, policy, and technology in the Colorado River Basin. Sternlieb aims to help diverse communities achieve environmental justice, water sustainability, and climate resilience through appropriate technology, smart design, collaboration, sound science, and political resolve.

William Swanson, P.E., *Global Practice Leader, Water Resources, Stantec*

Bill Swanson leads the water resources planning practice for Stantec and has nearly four decades of experience leading complex water resource projects that address water supply, flood control, and environmental protection. He is adept at integrating technical, economic, financial, and institutional information to support decision-making and permitting. He excels at communicating information in clear and understandable terms to agencies, stakeholders, and the public. Bill is a member of the American Water Resources Association, a registered professional engineer in California and Texas, and holds a BSCE from State University of New York.

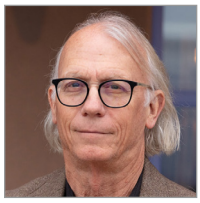
John Take, P.E., *Executive Vice President, Chief Growth & Innovation Officer, Stantec*

As Executive Vice President and Chief Growth & Innovation Officer, John oversees the activities of Stantec's five business operating units with a focus on strategic growth initiatives and campaigns, business-building innovation, client relationships and development, and key account management. John previously led Stantec's water business and has been involved in hundreds of water planning and design projects locally in Tucson and around the world in both the municipal and industrial sectors over the past 30 years. Take is a member of the AZ Water Association, the Water Environment Federation, and the U.S. Water Alliance, where he currently serves on the Board of Directors and champions the One Water movement. John has an active commitment to community and is proud to serve as a member of the Arizona Coyotes Foundation Board. He is an active corporate sponsor and supporter of Water For People, as well as enabling and equipping organizations focused on delivering education, training, and micro-loan funded support for the refugee and immigrant community in Southern Arizona.

Elia Tapia-Villaseñor, *Faculty Professor, University of Sonora*

Elia Tapia is a faculty professor at the University of Sonora in Hermosillo, Mexico. She holds a PhD in Arid Lands Resource Sciences with a minor in Hydrology from the University of Arizona. Tapia has 13 years of experience in applied hydrology, hydrogeology, climate change studies, and disaster risk assessment. She has been contributing to the United States-Mexico efforts on the Transboundary Aquifer Assessment Program (TAAP) for over 12 years, among many other projects for private and public institutions in the United States, Latin America, and the Caribbean. Her areas of interest involve water governance, climate change, stakeholder engagement, and water resources management, particularly in transboundary settings.

David Wegner, *Senior Strategic Consultant, Woolpert*



David Wegner is a Senior Strategic Consultant with Woolpert, an architecture, engineering, geospatial, and strategic consulting firm. Wegner is a biological scientist and engineer based in Tucson, a member of the Water Science and Technology Board of the National Academies of Sciences, Engineering, and Medicine and EPA Environmental Finance Board, and serves as a mentor advisor for the International Association of Hydro-Environment Engineering and Research organization. He has served as senior principal investigator or the equivalent on dozens of water and environmental studies conducted on behalf of the U.S. Army Corps of Engineers Civil Works program, BLM, DOI,

BOR, FWS, NOAA, and EPA agencies. For 14 years he served as Program Manager for the Glen Canyon Environmental Studies in the Grand Canyon that led to first EIS on the operations of Glen Canyon Dam and established the scientific and governance strategy that exists today as the Grand Canyon Adaptive Management program. Wegner has provided scientific and engineering support as a member of the senior staff for the U.S. House of Representatives and continues to serve as technical and policy counsel to several members of Congress and their staff.

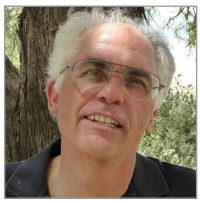
Grant Weinkam, *Associate Environmental Science Specialist, Arizona Department of Environmental Quality*

Grant Weinkam has over fifteen years of experience with lab and field based applications of environmental chemistry, biology, and engineering principles to improve water quality and public health. Currently, he is the subject matter expert for the Sampling and Source Identification Unit in the Surface Water Improvement Section of the Arizona Department of Environmental Quality. Projects focus on Total Maximum Daily Load (TMDL) development and involve analyses of the fate and transport of contaminants in surface water, groundwater, wastewater, and soil systems to improve the quality of rivers, streams, and lakes in Arizona.

Mark Witten, *Research Scientist, University of Arizona*

Mark Witten is an Emeritus Professor of Pediatrics at the University of Arizona serving in the Department of Pediatrics for 25 years. He has been a Research Scientist in the UArizona College of Agriculture & Life Sciences for the past four years. His "low-energy" desalination technology was developed while conducting research for the U.S. Air Force Office of Scientific Research.

Gary Woodard, *Principal, Water Resources Consulting*



Gary Woodard has more than 40 years of experience both as a consultant and as a researcher at the University of Arizona. He specializes in integrating economic analysis with water resources issues, providing a critical bridge often missing from policy decisions. He applies his "toolkit" — econometric modeling, benefit-cost analysis, policy analysis, survey techniques, and legal analysis — to projects that involve modeling municipal water demand, forecasting trends, evaluating water portfolios, valuing water rights, and assessing water conservation programs. Woodard's clients include municipalities, water companies, water wholesalers, Tribes, developers, water regulators, conservation groups and other not-for-profits.

Richael Young, *Senior Economist, ERA Economics, LLC*

Richael Young is a senior economist at ERA Economics. She applies complementary skill sets in economics and engineering to develop innovative technology solutions for water management. She led the development and implementation of the first smart markets, or electronic clearinghouses, for surface water and groundwater, has consulted on the design of water trading programs across the western United States, and took to market a mobile app that helps growers manage complex groundwater allocations without new hardware. Young is passionate about helping water users reduce their water risk while meeting their regulatory obligations and sustainability goals.

Free non-interactive livestreaming

THE UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION
WATER RESOURCES RESEARCH CENTER

WRRC 2023 Annual Conference

WHAT CAN WE DO?

SOLUTIONS TO ARIZONA'S WATER CHALLENGES

Photo: Stephen Cumberworth - "Rainfell", Tucson, AZ
WRRC 2022 Photo Contest

Wi-Fi Access

Network: UAGuest

1. Open a browser.
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4. Enter your username and password on the Welcome UAGuest webpage.

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THANK YOU TO RII AND TRIF/WEES

Research, Innovation & Impact

Partial funding for the WRRC 2023 Annual Conference was provided by the Technology Research Initiative Fund/Water, Environmental and Energy Solutions Initiative administered by the University of Arizona Office for Research, Innovation and Impact.

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SAWUA

Southern Arizona Water Users Association

SAWUA Members

The Southern Arizona Water Users Association (SAWUA) is comprised of 15 members including the largest water providers in the Tucson region, wastewater reclamation entities, and agricultural water users. The members meet monthly to discuss federal, state, and regional water policies and their impact to Southern Arizona.

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FICO

Flowing Wells Irrigation District

Green Valley Water District

GWR
Global Water Resources

Kai Farms

Marana water

Metro Water District

Oro Valley Arizona
Founded 1974

Pima County
Wastewater Reclamation

Sahuarita
Water Company

Town of Sahuarita

Tucson Water
A proud part of the City of Tucson

City of Tucson

Southern Arizona Water Users Association

About SAWUA

The Southern Arizona Water Users Association (SAWUA) is comprised of 15 members including the largest water providers in the Tucson region, wastewater reclamation entities, and agricultural water users. SAWUA member agencies have water management authority to provide municipal water and wastewater service to over 900,000 residents in the Santa Cruz River Basin. Collectively, SAWUA delivers almost 200,000 acre-feet per year of potable water and treats over 64,000 acre-feet of wastewater annually.

Members meet monthly to discuss federal, state, and regional water policies and their impact to Southern Arizona. The Association coordinates in the development of effective water resource policy and planning in an effort to preserve and enhance the region's water resources' quality and quantity.

A key role for SAWUA is to provide one voice from Southern Arizona at the State Capitol and Legislature on water legislation and issues. By having a unified position, SAWUA has effectively protected and advanced water issues in the region. In addition, by being united, SAWUA has been able to collaborate with the Phoenix area Arizona Municipal Water Users Association (AMWUA) and the Northern Arizona Municipal Water Users Association (NAMWUA) on state- wide water policies.

SAWUA and its members work closely with the Arizona Department of Water Resources, Central Arizona Project, and Arizona Department of Environmental Quality and other governmental entities that affect water in Southern Arizona.

SAWUA believes it should exercise leadership and initiative to determine and encourage the most effective management of the region's sustainable supplies of quality water.

SAWUA is a voluntary nonprofit association organized in 1999.

COLLEGE OF AGRICULTURE & LIFE SCIENCES
COOPERATIVE EXTENSION

WATER RESOURCES RESEARCH CENTER

GREATER DEPTH, BROADER PERSPECTIVE FOR A CLEAR WATER FUTURE

We tackle key water policy and management issues, empower informed decision-making, and enrich understanding through engagement, education, and applied research.

2022 HIGHLIGHTS

Photo: Robert Baker – Greasewood Park; Tucson, AZ; 2019 (cropped) **WRRC Photo Contest**

505 PARTNERS/COLLABORATORS engaged on diverse projects and programs

8,793 RECIPIENTS of the annual *Arroyo* publication

3385 SUBSCRIBERS to the Weekly Wave e-News Digest

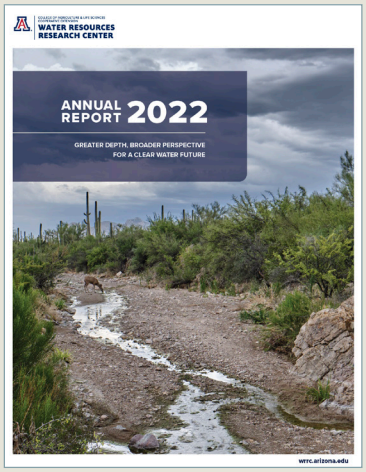
779 ATTENDEES at the 2022 Annual Conference

62 PRESENTATIONS by WRRC personnel to diverse audiences

28 PUBLICATIONS by WRRC personnel

160 SUBMISSIONS to the annual WRRC photo contest

93 PUBLIC INQUIRIES submitted and answered via WRRC-Extension's online information request form



ANNUAL REPORT

More information and metrics can be found **here**.

CONNECTING TO THE PUBLIC

As Arizona and the region face unprecedented water challenges, the WRRC continued to serve as a trusted source for reliable information. The WRRC received many requests for comments from both national and international media outlets covering a range of water management issues including the developing water crisis in the Colorado River basin. Through research, outreach, and engagement, the WRRC has continued to contribute to water resource planning, assessment, and capacity building, as well as to expand water awareness and understanding of water resource issues.

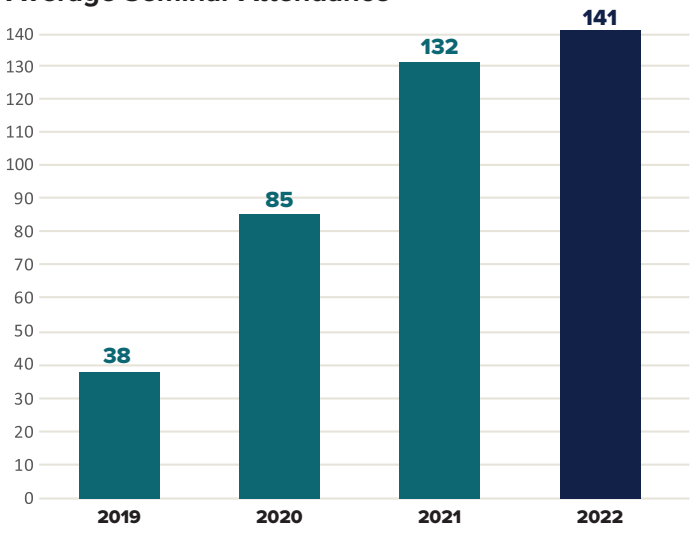
Annual Conference

The 2022 Annual Conference, *Arizona's Agricultural Outlook: Water, Climate, and Sustainability*, brought together more than 40 speakers over a span of three days. Held in person for the first time since February 2019, Day 1 of the conference attracted nearly 200 attendees. Days 2 and 3 were held virtually with close to 600 attending. The full recorded program is available online.

WRRC Seminar Series

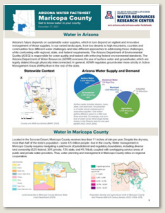
The WRRC's Seminar Series continues to attract diverse audiences in growing numbers for presentations and dialogues on a wide range of water topics.

Average Seminar Attendance



RESOURCES

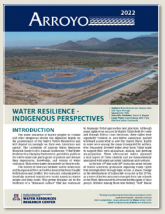
Online and Print



Arizona Water Factsheets

These county-level factsheets are designed to answer common questions about water resources, tailored to every county in Arizona so as to foster understanding of the local nature of Arizona water resource challenges and solutions.

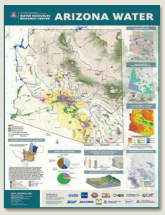
Factsheets



Arroyo

The *2022 Arroyo — Water Resilience - Indigenous Perspectives* — covers the history of the 1980 Groundwater Management Act, as well as subsequent legislation that created today's regulatory and management structure for addressing groundwater management issues and crafting solutions.

Arroyo



Arizona Water Map Poster

Order your water map using this **Order Form**.

Water Research and Planning Innovations for Dryland Systems

Through a flexible approach to water resources planning, the Water RAPIDS program seeks to strengthen local and regional economies while supporting the natural resources that contribute to quality of life.

Water RAPIDS

Transboundary Aquifer Assessment Program (TAAP)

TAAP is a federally funded program co-hosted by the USGS Arizona Water Science Center in Tucson, Arizona, and the Water Resources Research Center (WRRC) at the University of Arizona.

TAAP
TAAP Spanish

WRRC Website

The WRRC website highlights programs, activities, news, and events. Seminars and annual conference presentations are posted for easy access, along with publications and online resources.
wrrc.arizona.edu

- **WRRC Conference**
- **Groundwater Governance**
- **Middle East Water**
- **Publications**

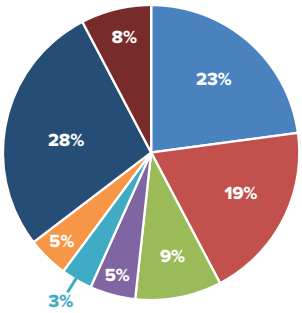
REFLECTIONS

WRRC Director Sharon B. Megdal published nine *Reflections* essays via the Weekly/Summer Wave.

wrrc.arizona.edu/reflections

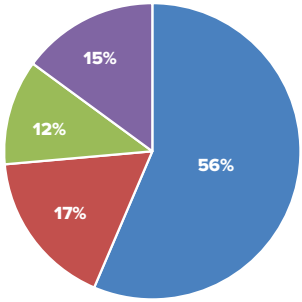
2022 FINANCIAL SUMMARY

Operating Support & Revenue



State Appropriations	$324,855
Federal Grants	$275,891
WRRA/NIWR Funds	$133,770
State Grants	$70,691
Private or Other Grants	$48,465
Sales and Service Activities	$63,829
Technology Research Initiative Fund	$393,642
Gifted Funding	$109,055
Total	$1,420,198

Operating & Program Expense



Salaries and Wages	$691,885
Fringe Benefits	$203,236
Operating Expense	$128,413
Program Expense	$142,056
Total	$1,163,336

KEEP UP WITH WATER NEWS AND EVENTS

Subscribe to the **Weekly Wave** – the e-News Digest that offers the latest in water news, notices of upcoming events, and announcements from the WRRC and others. Subscribers also receive the *Arroyo* – an annual publication that examines a timely topic of importance to Arizona.

Subscribe

Member of the National Institutes for Water Resources

The WRRC is Arizona's federally authorized Water Resources Research Institute (WRRI), and as such, is one of 54 members of the National Institutes for Water Resources.

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WATER RESOURCES RESEARCH CENTER

The University of Arizona
Water Resources Research Center
A unit of Arizona Cooperative Extension
350 N. Campbell Ave.
Tucson, AZ 85719
(520) 621-9591

wrrc.arizona.edu

ARROYO 2023

ARIZONA'S AGRICULTURAL OUTLOOK: WATER, CLIMATE, AND SUSTAINABILITY

Authors: Luke Presson and Susanna Eden
Layout: John Polle
Executive Publisher: Sharon B. Megdal
Cover Photo: David Quanrud - Chasing a Rainbow, Sulphur Springs Valley, AZ, 2010

INTRODUCTION

Arizona's development has been dominated by the five Cs—copper, cattle, cotton, citrus, and climate—three of which are products of agriculture. However, the cultural and economic contributions of the agricultural industry have declined with the increase of urbanization and economic diversification. Climate conditions and ongoing drought pose additional challenges to farmers. A megadrought has persisted in the western states for more than 20 years, resulting in a dangerous drop in available water storage. As drought forces difficult decisions on water use, food security — assured access to sufficient safe and nutritious food — is emerging as a key concern. Given these conditions and ever-increasing needs for food and fiber, what is Arizona's agricultural outlook? This *Arroyo* aims to address this question by focusing on how the state can adapt to a new climate reality and sustain the agricultural productivity and culture that has defined the character of the state for so long.

With water shortages in the Colorado River, policymakers and stakeholders are looking for every opportunity to increase water efficiency and decrease water use. Urban areas have been implementing successful conservation measures, but continued population growth still raises concerns about

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The *Arroyo* is published by the Water Resources Research Center
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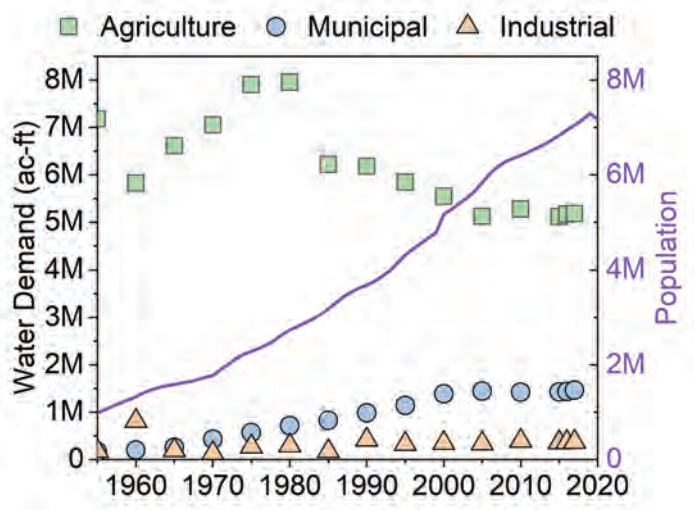
rising water use. Although irrigated agriculture in Arizona improved its efficiency, it still accounts for roughly 72 percent of the state's water use. For this reason, it continues to receive attention as a potential source of water for other uses. With such a



Yearly water demand by sector and population in Arizona.

large portion of the state's water budget, agriculture likely will have to absorb a large share of any cuts in Arizona's water supplies, beyond the large cutbacks that central Arizona agriculture already has suffered from mandated reductions associated with the agreements that apportion Colorado River shortages. However, given agriculture's significant economic, social, cultural, and historical value, water management decisions affecting farming and ranching must be weighed carefully.

In summer of 2022, the WRRC's annual conference, *Arizona's Agricultural Outlook: Water, Climate, and Sustainability*, highlighted the diversity of the state's agriculture. Several topical themes emerged, including interactions between water and land use, adaptation to a new water regime, and sustainable agriculture.

To better capture the insights into Arizona's agricultural landscape and outlook that were shared during the conference, this *Arroyo* has a new structure. It first presents a summary of the discussions around the three above-mentioned themes and then directs readers to relevant factsheets to learn more about specific topics.

ARIZONA'S AGRICULTURAL DIVERSITY

Arizona's agriculture industry is diverse. According to the most recent US Department of Agriculture census (2017), 19,086 farms operated in the state, and most of them—nearly 74 percent—were smaller than 100 acres. Of these small farms, 84 percent were owned by individuals or families with sole ownership. Of producers in Arizona, 59 percent were indigenous farmers and 47 percent were women.

The climate in much of Arizona allows for year-round production, making the state critical to the nation's food supply during winter months. For example, the lower Colorado River Valley in the Yuma area, stretching into the Imperial Valley of California, grows 90 percent of the nation's leafy greens from November through March.

Some of the most valuable among the wide range of agricultural commodities produced by Arizona farms are lettuce, cattle, and dairy. Lettuce is a key crop grown in Arizona, responsible for over 16 percent of the revenue from agricultural commodities. Arizona farmers hold an inventory of around 171,000 beef cattle, and the state's dairy cows produce almost five billion pounds of milk yearly. Many varieties of wheat are cultivated in the state, including large quantities of durum wheat, and local bakeries use heritage crops like White Sonora wheat to great acclaim.

There is a strong effort by Native American growers and others to continue growing traditional crops, like corn, beans, and squash, that have been grown in the region for centuries. Indigenous farmers cultivated crops over generations that had

Rows of mature lettuce plants in a field ready for harvest - Arizona.

adapted to the climate, making them critical to sustainable agriculture in the face of severe water shortages.

Additionally, farmers are introducing to the area crops with high economic value and relatively low water use. The state is home to a burgeoning wine industry, as grapes grow well in the arid

A field of guayule in Arizona.
Image: https://sbar.arizona.edu/

climate. The production of guayule, a crop with desert shrub characteristics, long growing cycles, and no need for re-seeding, is in the early stages of development as a long-term crop that can reduce our dependence on imported natural rubber. Some of these newer enterprises face challenges in market development—historical perceptions about the provenance of good wine, for example, can dampen consumer enthusiasm—but the high quality of the product is opening doors.

THEMES

Interactions between Water and Land Use

The high water demand of irrigated agriculture often begs the question, why farm in the desert? The agriculture industry is important for Arizona's economy, despite its relatively small percentage of the state's GDP (about 1.7 percent), and it provides stability for rural communities. Farming and ranching also contribute to the state's culture and tradition, adding value that is hard to quantify. In addition, local food security is related to local sourcing. For example, much of Arizona's demand for milk and cheese is supplied locally. Many people, significantly native communities, aim to rely less on processed foods by increasing the share of food staples produced by local farms.

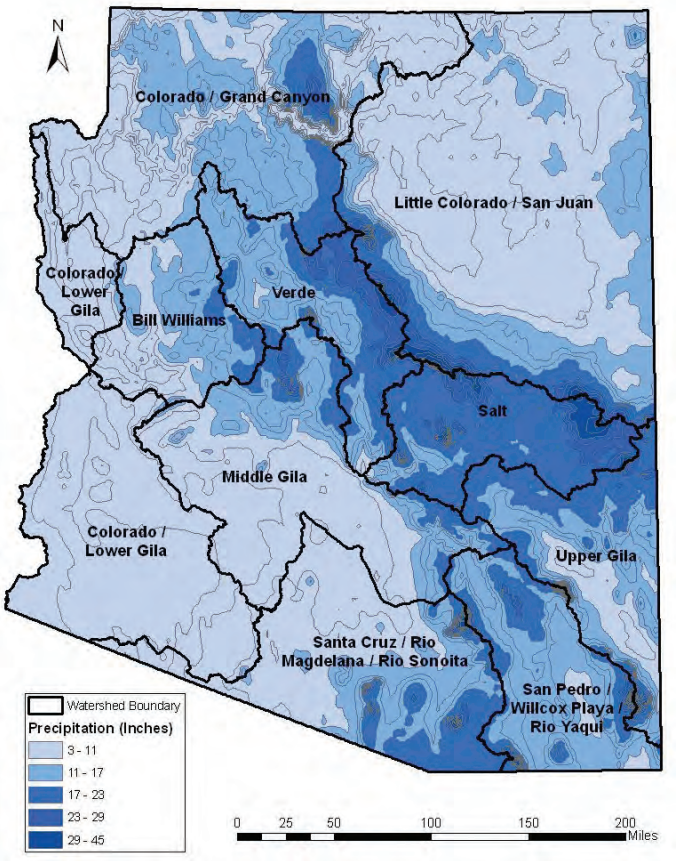
Maintaining land in agriculture also maintains flexibility and adaptability in ways that urban development cannot do. Farmland can be fallowed, a practice in which land typically used for crop production is set aside for one or more cycles. Fallowing allows farmers to restrict water use while keeping the land available for future crops, although it can lead to land degradation through the loss of topsoil and soil fertility. Some crops like alfalfa are often maligned for high water use, but cultivating them makes intermittent fallowing possible, which is useful given water supply uncertainties.

Further, some agricultural land use patterns can contribute positively to desert environments. They can support wildlife and play an integral role as avian flyways. Additionally, healthy agricultural soils can encourage microbial diversity, soil retention, and even carbon sequestration, and farms near urban areas can alleviate some heat island effects.

The agriculture industry has decreased water use in recent decades but still uses more water than other land uses. *How exactly do farms and crops use water?* ***See Factsheet 1 to learn more***. The projected population growth rate in Arizona is double the national average. Pressures of a growing population have resulted in the conversion of some of Arizona's farmland to houses and businesses. Arizona is a desirable place to live and people will continue to move here. Converting farmland with established infrastructure and water uses to residences and businesses may be better water management than developing raw desert, which frequently results in urban sprawl and new water uses. If planned properly, however, smart urban development can benefit cooperating farms. Urban infill and dense communities provide local markets for agricultural products. Cooperative fallowing and water leasing arrangements can generate funds for new equipment that can be used to increase agricultural water efficiency and conservation. Finally, with proper design, regulation, and infrastructure, farms on or even beyond the urban fringe can benefit from agritourism.

Adaptation to a New Water Regime

One of the major themes of the WRRC conference was adaptation; that is, how agriculture in Arizona may change to thrive in the new climate reality. *What is the state of drought and water supply in the region?* ***See Factsheet 2 for details***. Most of Arizona receives little precipitation, and with diminishing river flows and declining groundwater levels, farmers are developing creative approaches. Examples of farms experimenting with new ideas include Oatman Farms, which is embracing regenerative agriculture strategies and exploring new markets to restore farmland and conserve water. BKW Farms is another local producer that has adopted new approaches, including controlled environment facilities in which to grow mushrooms in reusable pails. In fact, cutting-edge technologies like controlled environment agriculture and



Average annual precipitation in each watershed in Arizona. Image: Gregg Garfin

agrivoltaics are gaining attention as they become more economically and technologically viable. *What are these new technologies and their benefits?* ***See Factsheet 3 to learn more***.

Farmers may also adapt by changing which irrigation technologies they employ. *How do farmers in Arizona get water from the source to the plant?* ***See Factsheet 4 for more information***. These technologies can increase the percentage of diverted water used directly for the growth of crops. *But does increased irrigation efficiency always lead to water conservation?* ***See Factsheet 5 to learn more***. Financial barriers, however, may hinder adoption of newer, more water-efficient technologies, especially for the many farms on leased land. Farmers who do not own their fields are unlikely to invest in new infrastructure.

Other significant adaptations to water conservation have been discussed. Electing to plant crops like grapes or guayule that have relatively low water use and high economic value is an option, though undeveloped supply chains and market access often limit adoption. Fallowing fields for one or more crop cycles can conserve large volumes of water, although this practice has an economic penalty. Farmers may be more willing to participate in fallowing programs if incentivized by conservation subsidies or other mechanisms.

Vineyard in Sonoita, AZ.

With these adaptations, protecting public health is critical. Water is often used to clean food and facilities, a practice that must continue despite water cuts. Additionally, as farmers search for and adapt to alternative water sources, maintaining water quality becomes increasingly important. *Reclaimed water is one alternative water source for agriculture.* ***See Factsheet 6 for more information***. There is some concern over the presence of trace organic contaminants in water sources and how they might accumulate in soils or plants. These substances are largely unregulated, as research focusing on them is in the early stages, and methods of dealing with them are relatively undeveloped. Although irrigators are not required to test or treat water for these substances, some do. Better understood, bacteria and other pathogens are a main concern for irrigators, but these can be deactivated and removed by good filtration and disinfection procedures.

Sustainable Agriculture

Ensuring that farming in Arizona remains viable over the long term is critical. Agricultural sustainability includes practices that meet current needs while ensuring the sector continues to thrive for generations to come. Regenerative agriculture, mentioned earlier in this issue, is a broad term concerned with ensuring that lands and waters remain healthy for future generations. One aspect of this approach to sustainability focuses on soil health and methods farmers can use to minimize soil erosion and other accelerants to land decline. Adhering to regenerative agriculture principles is essential to slowing and preventing desertification and the permanent loss of land productivity. *What*

are some ways farmers are improving soil health? ***See Factsheet 7 for a further description.***

Regenerative agriculture could also be considered a philosophy that encourages practitioners to draw on their imaginations and optimism to form a more holistic food and fiber supply. This philosophy could include encouraging practices that ultimately decrease crop yield but ensure sustainability.

These approaches to sustainability are not necessarily new, and many have been practiced in some way by Indigenous farmers for generations. With an emphasis on land stewardship, practices that native communities use are gaining attention. *What are some examples of these practices?* ***See Factsheet 8 for more information***.

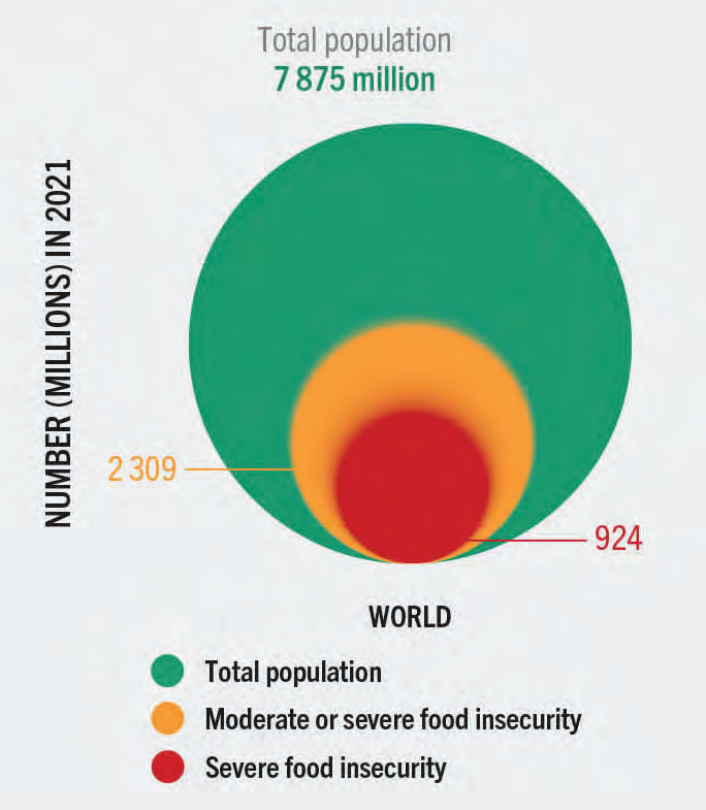
Native voices have much to contribute on philosophical approaches to agricultural sustainability. Being mindful and respectful of crops and ecosystems can affect how farmers interact with the land and inspire more sustainable methods. Discussions throughout the WRRC conference highlighted the idea that growing only within your needs can allow the land to survive and thrive during difficult times. It is increasingly rational to take these approaches seriously; after all, it is no accident that Indigenous communities protect 80 percent of the Earth's biodiversity on only 5 percent of the land.

In Arizona, efforts to improve the local supply chain, limiting waste and increasing product traceability, are supporting an increased focus on local food supply and resilience. The US Cotton Trust Protocol, for example, is an organization and movement that aims to improve the transparency and traceability of cotton from farm to consumer. By prioritizing experimentation, measurement, and data reporting throughout the supply chain, the organization encourages continuous improvements in sustainability, particularly when focused on responsible consumption and production. These approaches are consistent with sustainable development goals espoused by the United Nations. It is estimated that one-third of food produced globally is never consumed due to supply chain inefficiencies. By focusing on these improvements, Arizona agriculture can continue to provide high-quality food and fiber while conserving significant quantities of water.

Sustainability also can refer to the future vitality of agricultural professions. Less water available for agriculture creates concern that farmers will leave the industry and fewer new producers will join. The resulting loss in experience, knowledge, and expertise could have detrimental effects on food security. If increased fallowing and other conservation actions are required, attention will need to be focused on keeping farming economically viable.

Individual growers or the agricultural community can only do so much on their own. Other sectors of society have a role in solving sustainability problems with respect to water and agriculture. This could be a role for government action at the local, state, and federal levels. With increased investments in infrastructure and appropriate regulations and incentives, agriculture can continue to flourish in Arizona. Revenue generated through growth could be directed to sustaining the local food and fiber supply. In fact, significant state investments have been authorized that aim to help farmers conserve water while remaining profitable. Many policy questions and issues remain that well-informed, responsive, and cooperative government partnerships can address. Arizona could implement policies defined through consensus on issues from water quality and reuse to groundwater pumping.

One of the most important discussions on water shortages remains Colorado River water allocations within Arizona and among neighboring states. Interstate negotiations about cutbacks gain



Fraction of people experiencing varying levels of food insecurity globally. Image (cropped): https://www.fao.org/

Center pivot sprinkler irrigation with drip lines is a water saving innovation. Image: https://img.agriexpo.online

urgency as key reservoirs reach critical levels. A drought contingency plan was passed in 2019 and began the crucial process of devising mechanisms to ensure sustainability in the face of drought and climate change. The process of negotiation among the multiple various interests at regional, state, and federal levels is ongoing. Providing incentives may be the most viable and effective method to encourage the deployment of costly but necessary conservation technologies and strategies. Funds for these incentives can come from federal programs like the Inflation Reduction Act (IRA), which contributes significantly to the development of drought resilience. The IRA provides funds for water conservation and projects that mitigate the effects of drought. Some funds are earmarked for disadvantaged communities. In addition, Arizona is investigating water augmentation and committing an unprecedented funding pool for promising strategies.

CONCLUSION

While the trends in water supplies in Arizona are worrying for all water users, including irrigators, the clear-eyed and collaborative approaches offered at the 2022 WRRC conference show promise. With coordination and smart development, land use can be designed in a way that benefits agriculture and urban areas. Farmers are adapting to the new climate reality by testing and installing more efficient irrigation methods, and tests of innovative technologies like agrivoltaics are promising. With less predictability in water availability, some farmers are switching crops to gain flexibility or selecting crops with low water demand. To keep the agriculture industry resilient, many farmers are modeling more sustainable practices. Strengthening and improving the soil through regenerative agriculture and prioritizing sustainability over yields is increasingly important. With influential farmers involved in these discussions and some signs of optimism, Arizona's agricultural outlook remains positive.

Photo: Clayton Lyon

WRRC 2022 Annual Conference Day-1 Agenda

The WRRC 2022 Annual Conference, *Arizona's Agricultural Outlook: Water, Climate, and Sustainability*, was the inspiration and basis for this *Arroyo*. The hybrid conference consisted of one day of live-streamed in-person sessions on July 12, and two days of webinar sessions on July 13-14. The July 12 agenda is reproduced below. To see the complete agenda and link to the recorded presentation, visit the WRRC website at wrrc.arizona.edu or go to ***https://wrrc.arizona.edu/news-events/past-conferences/2022***.

July 12, 2022

Opening Keynotes: Arizona's Agriculture, an Overview

Mark Killian, Director, Arizona Department of Agriculture
Jeffrey Silvertooth, Environmental Science, University of Arizona

Highlight Talks – Part 1: Arizona's Diverse Agriculture

- Tom Davis, Yuma County Water Users Association - Irrigated Agriculture in the Yuma Area
- David Proctor, BKW Farms - Heritage Crops
- Michael Kotutwa Johnson, Indigenous Resilience Center, University of Arizona - Tribal Heritage Agriculture
- Sarah King, King's Anvil Ranch - Ranching

Moderator: Faith Sternlieb, Lincoln Institute of Land Policy

Highlight Talks – Part 2: Arizona's Diverse Agriculture

- Ashley Ellixson, United Dairymen of Arizona - Dairy Farming
- Phyllis Valenzuela, San Xavier Cooperative Farm - Tribal Community Farming
- Brandon Merchant, Community Foodbank of Southern Arizona - Community Gardens
- Dax Hansen, Oatman Farms - Regenerative Organic Farming
- Mark Beres, The Flying Leap Vineyard - Viticulture

Moderator: Faith Sternlieb, Lincoln Institute of Land Policy

Afternoon Keynote #1: Agricultural Renaissance

A.G. Kawamura, Solutions from the Land

Panel – Advancing Sustainable Agriculture in Arizona

- Greg Barron-Gafford, School of Geography, Development & Environment, University of Arizona - Agrivoltaics
- Murat Kacira, CEA Center, University of Arizona - Controlled Environment Agriculture (CEA)
- David Dierig, Agro Operations, Bridgestone - Guayule
- Andrea Carter, Native Seeds/SEARCH - Sustainability Through Diversity

Moderator: Paul Brierley, Yuma Center of Excellence for Desert Agriculture, University of Arizona

Afternoon Keynote #2: Sustainable Responses to Water Scarcity – Examples from Israel

Uri Shani, Former Director, Israel Water Authority

Storytelling – Voices of Arizona's Agriculture

- Ron Rayner, A Tumbling T Ranches
- Maegan Lopez, Mission Garden
- Delia Carlyle, Ak-Chin Indian Community

Moderator: Daniel Sestiaga Jr., AIRES/Haury Indigenous Resilience Center, University of Arizona

Land Acknowledgement

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

About the Authors

Luke Presson is a graduate student in the Department of Chemical and Environmental Engineering. His research focuses on membrane technologies for potable water reuse. He expects to graduate in summer 2024 and after graduation plans to work in the public sector helping to bridge the communication gap from scientific research to policy. Since 1988, Susanna Eden has held various positions at the university's Water Resources Research Center, including 10 years as assistant director. She holds a Ph.D. from the UArizona Department of Hydrology and Water Resources (now Hydrology and Atmospheric Sciences).

Acknowledgements

Production of this *Arroyo* was funded in part by Bridgestone and the Southern Arizona Water Users Association.

The authors thank the following reviewers for their comments and suggestions on this *Arroyo*. Any errors or misstatements are the authors' and cannot be attributed to these conscientious reviewers: Paul Brierley, Linda Buchanan, David Dierig, Dax Hansen, Michael Kotutwa Johnson, Murat Kacira, Bill Plummer, David Proctor, Ron Rayner, Ross Rayner, Jadee Rohner, Jeffrey Silvertooth, Chris Udall, and David Wegner.

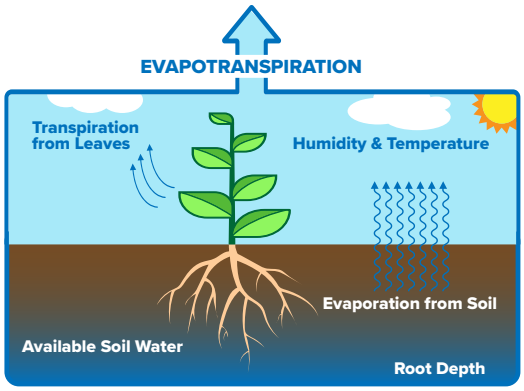
Suggested citation: Presson, Luke and Susanna Eden. "Arizona's Agricultural Outlook." *Arroyo*. Tucson, AZ: University of Arizona Water Resources Research Center, 2023. https://wrrc.arizona.edu/arroyo-2023

1 Water Use by Crops

Irrigated agriculture makes up 72% of Arizona's water use.

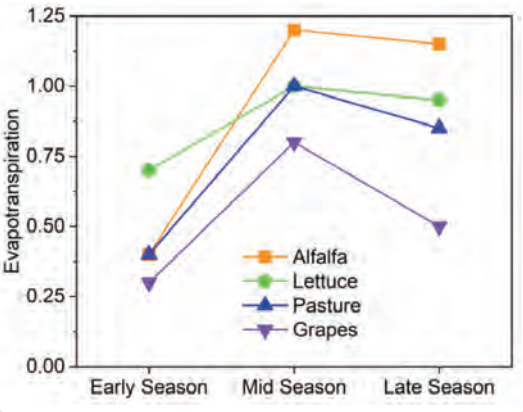
Water applied to crops is consumed mainly by evapotranspiration or "ET" – evaporation plus transpiration.

- Evaporation – when liquid water on the surface or in the soil transforms to water vapor
- Transpiration – when liquid water taken up by plants is 'exhaled' as water vapor (Plants 'breathe in' CO_2 and 'breathe out' O_2 and water vapor.)
- ET can be calculated from satellite data.



ET is an essential variable for calculating crop water needs. It depends on many factors, including local climate and crop type.

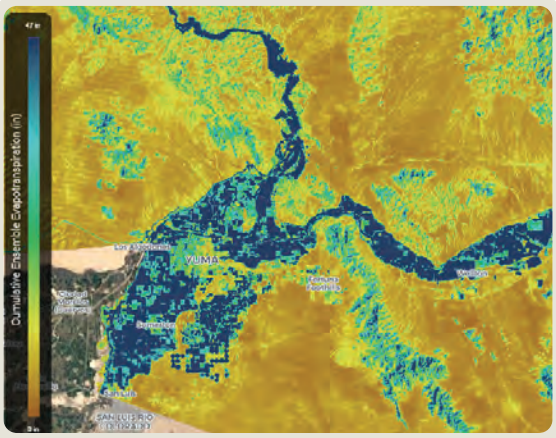
- $ET = ET_0 \times K_c$
  - ET_0 – Reference ET for a specific location dependent on local climate factors like temperature, humidity, and wind.
  - K_c – The ET coefficient unique to each crop at different growth stages.



ET coefficients for common crops.

Water is also used to leach away the salt left behind when water evaporates, because salinity reduces a plant's ability to extract water and nutrients from soil.

- Removing salt from irrigated fields is a significant portion of farmers' water use.
- Leaching water carries salt down below the root zone and may reach the aquifer.



Satellite map of 2021 cumulative evaporation in the Yuma area. Source: OpenET.

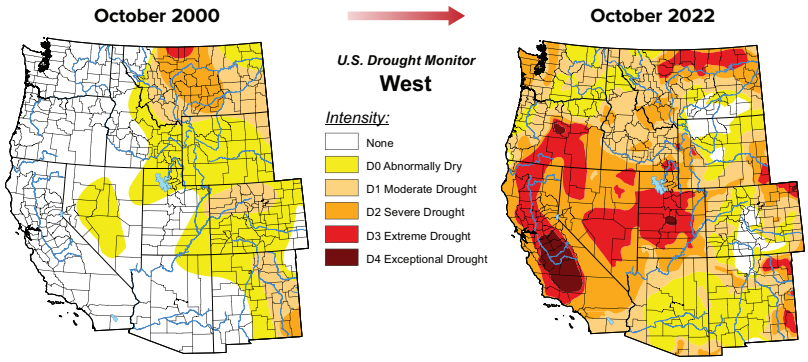
Up to 99% of the water taken up by a plant is used for transpiration.

2 Water Scarcity Trends

Most of Arizona is desert, where average annual precipitation ranges from zero to 16 inches, but where flowing rivers and large aquifers are sources of abundant water. A history of reservoir, canal, and groundwater pump development has meant that over the past century, water was readily available for almost any use in most of the state. Improvements in water efficiency and increases in conservation have allowed continued growth; however, drought and groundwater overdraft signal a new era of limits.

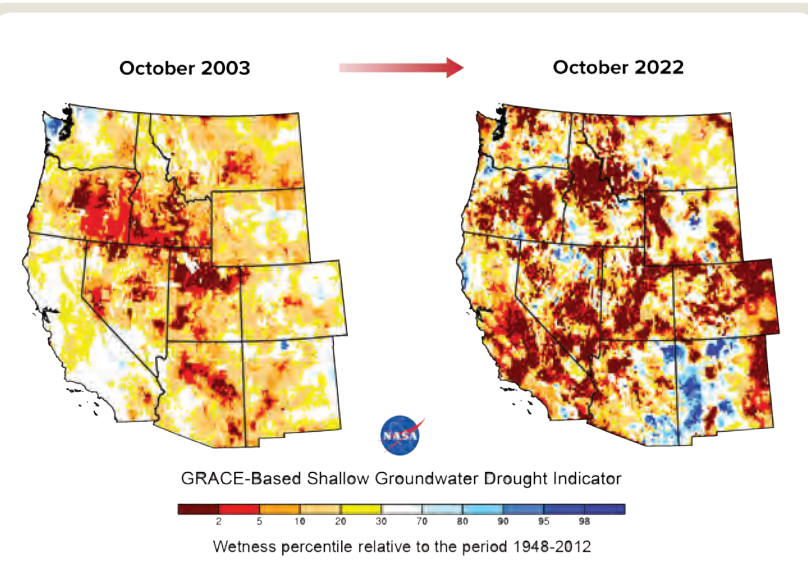
Surface Water

- For the past two decades, the American West has been enduring a hot "mega-drought" that may indicate a new normal.
- The drought in Arizona has been less intense than in other western states, and local surface water remains relatively reliable.
- **BUT** much of the Colorado River Basin has been experiencing exceptionally hot dry conditions, resulting in low runoff.
- The river's diminished flow volume threatens Arizona's Central Arizona Project (CAP) surface water supply.



Groundwater

- With proactive policies, Arizona has maintained and even improved aquifer storage in some areas;
- **BUT** CAP water has been central to the state's groundwater strategy. It replaced groundwater use by agriculture in much of Central Arizona and was the main source of water for aquifer recharge.



- With less Colorado River water delivered through CAP, some farmers will return to groundwater use. To maintain adequate water supplies it is increasingly important to find alternatives and additional water efficiencies.

Controlled Environment Agriculture (CEA)

In CEA, environmental factors such as temperature and humidity are controlled. The most common example of CEA is a greenhouse. Inside a basic greenhouse, temperature and humidity will increase, CO_2 concentration will vary, and some sunlight will be blocked.

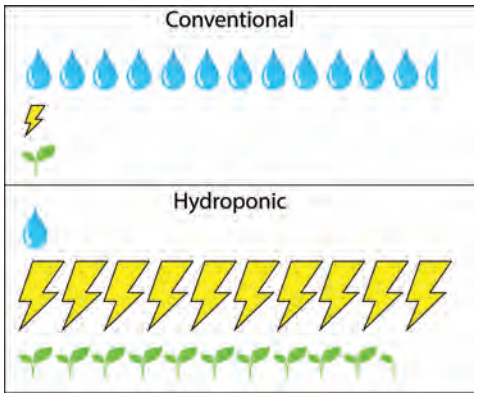
Initial effect of basic greenhouse enclosure.

Temperature	Humidity	CO_2 Concentration	Light Intensity
↑	↑	↑ or ↓	↓

Adding technology and automation allows these and other factors to be precisely controlled, and the use of water recycling technology makes CEA extremely water efficient.

Hydroponic greenhouses are a popular form of CEA. In Yuma, for example, hydroponic greenhouses

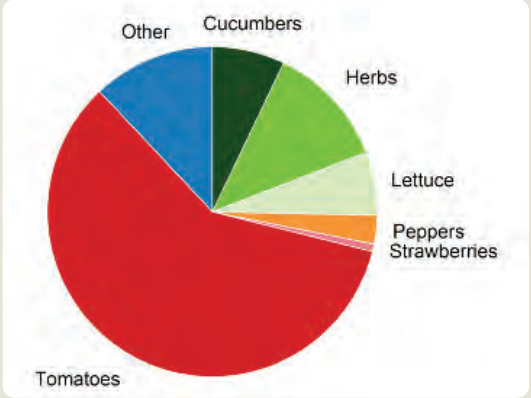
- use about 13 times less water than conventional agriculture for the same lettuce yield.
- can yield 11 times more than conventional agriculture from the same land area.
- **BUT** require 82 times more energy to produce the same yield.



Relative resource use and yield for hydroponics v conventional lettuce production

Adoption of CEA depends on specific benefit-cost calculations.

- CEA's high capital and operational costs limit its use to high-value crops.
- **BUT** its relatively small water and land area demands make CEA well suited for areas with water or land scarcity while minimizing waste and transportation costs.

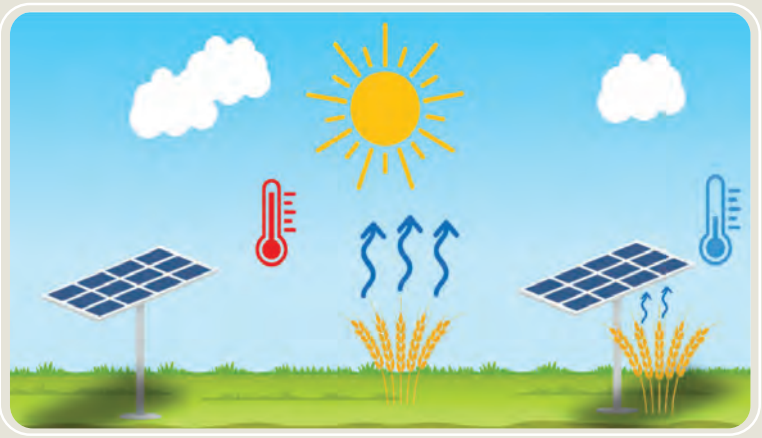


Crops produced in CEA greenhouses in the United States

Agrivoltaics

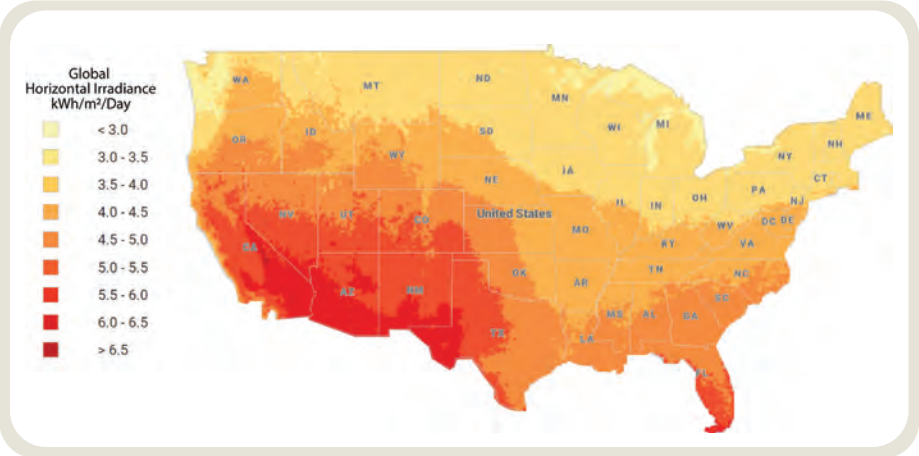
Agrivoltaics can combine solar energy production with agricultural production. Placing solar energy panels on agricultural land promises to produce energy while reducing water use and maintaining or slightly improving crop yields over time.

- Shade from photovoltaic panels moderates the temperature near the crop, decreasing evaporative water loss.
- Evapotranspiration from the crop cools the photovoltaic panels, increasing their efficiency.



Arizona's climate is particularly well suited for adopting agrivoltaics

- The state receives a lot of solar radiation with little cloud cover
- Arizona has very high global horizontal irradiance (GHI)
- GHI is the total solar radiation experienced on a horizontal surface and is one of the most important factors in predicting solar panel output.



Limits on water supplies and high water and energy costs may force some farmers to fallow land and potentially abandon farming.

- Agrivoltaic energy production augments income and makes farms resilient to costs and price volatility.
- Temporary fallowing and investments in water efficiency are more politically and economically viable with a more resilient agriculture industry.

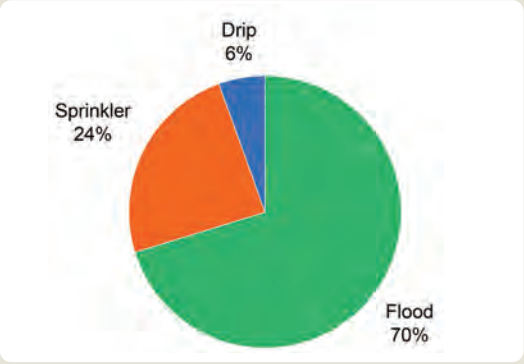
4 Irrigation Methods

The most common irrigation methods are flood, sprinkler, and drip irrigation. Each method has pros and cons, and the best choice depends on variables such as crop type, soil type, and cost.

Flood irrigation:

Water flows across a field, usually through furrows, and seeps into the soil.

- The simplest, least costly method;
- Considered the least efficient method;
- **BUT** best for some specific uses;
- **AND** efficiency can increase to 80% or more with land leveling, automation, and reuse of runoff.

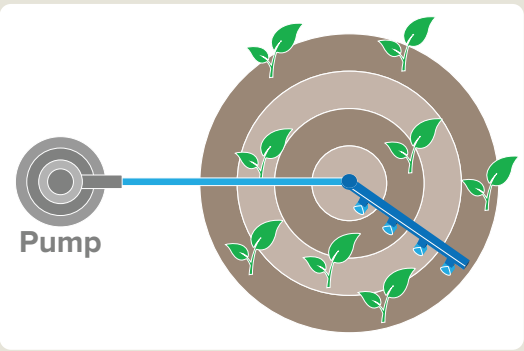


Percentage irrigation method in Arizona

Sprinkler irrigation:

Controlled spray of pressurized water is aimed at crops, often simulating rainfall.

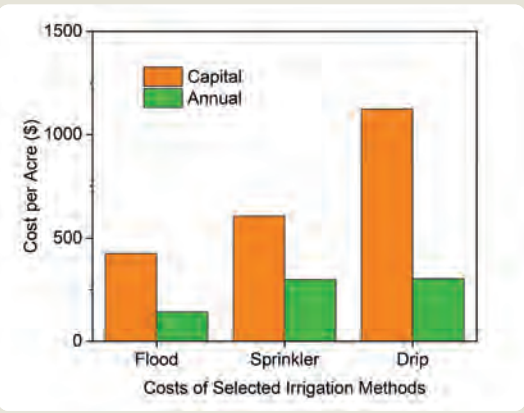
- Sprinkler technology is varied and includes center pivot (shown at right), linear move, traveling gun, etc;
- Relatively efficient, with little runoff or deep percolation;
- **BUT** airborne droplets may be blown away by wind and evaporate quickly;
- **HOWEVER**, some newer systems reduce losses by carrying sprinkler heads close to the soil surface.



Drip irrigation:

Distribution lines apply small volumes of water with extreme precision.

- Considered the most efficient irrigation method. Evidence suggests it can produce higher yields with less water than other methods;
- Each installation can be designed and customized;
- **BUT** Changing a field or crop is more burdensome;
- **AND** soil salinity may be a problem. Salt builds up in soil if irrigation water is high in minerals, and drip irrigation alone does not flush salts to below the root zone.



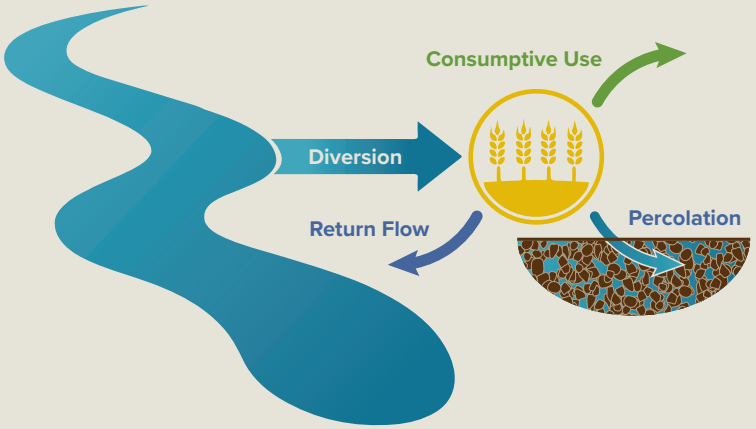
One acre-foot of Colorado River water can leave behind around one ton of salt!

5 Conservation vs. Efficiency

Agricultural water **conservation** means diverting less water from streams or aquifers. Alternatively, water **efficiency** is defined as the amount of water consumed in comparison to the total amount diverted.

- Diversion – When a farmer diverts water to a field.
- Consumptive Use – Fraction of diverted water used to grow the crop.
- Return flow and percolation – Water not consumed can return to the stream or aquifer.

When efficiency is improved, a higher percentage of water is consumed and less returns.

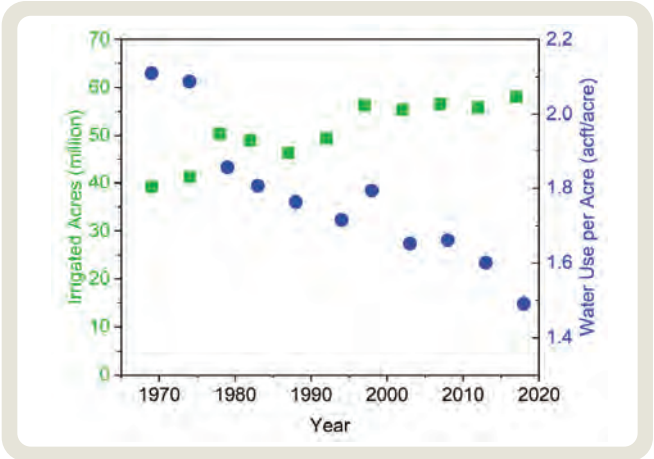


Takeaway: Improved efficiency reduces the amount of water used to maintain crop yield; but the saved water may be used to grow more. Return flows and percolation may actually decrease. Only if less water is diverted overall is water conserved.

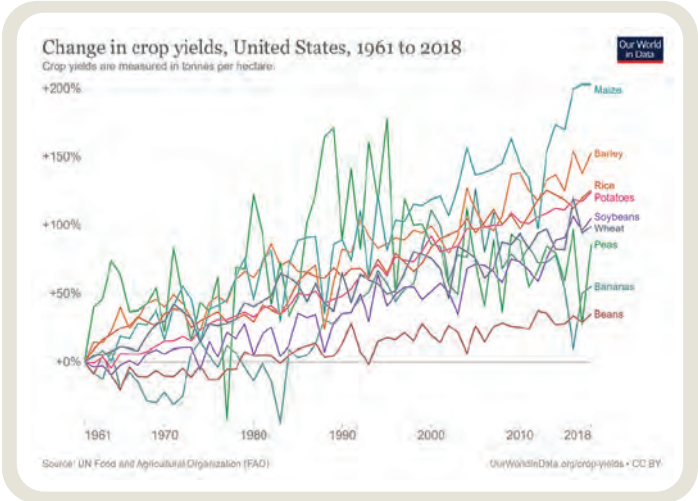
Agricultural Water Efficiency in the United States

Water efficiency of irrigated agriculture in the United States has been improving for decades, yet water use has not decreased.

- Water used per acre has gone down by almost 30%,
- **BUT** acres irrigated have increased by 48%



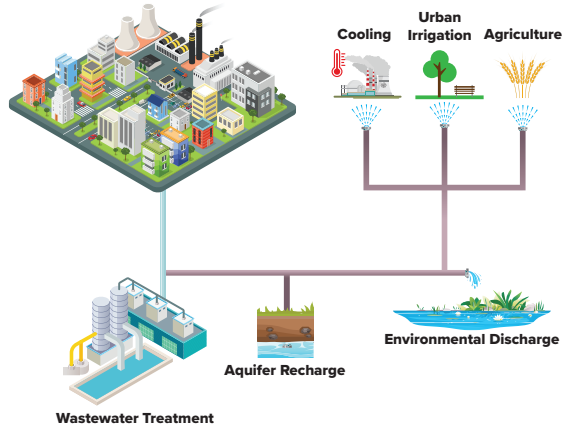
Efficiency doesn't always lead to water conservation, but with improved farming practices the United States can produce more food with about the same amount of water.



6 Reclaimed Water in Agriculture

Water reuse, or water recycling, reclaims wastewater and treats it to quality standards suitable for beneficial uses including irrigation.

Although Arizona is a leader in the United States in reusing wastewater for irrigation, it still uses only 119,000 ac-ft/year or 2.3% of the water used by Arizona's irrigated agriculture. Nationwide, less than 1% of total water use for agricultural irrigation is reclaimed water.

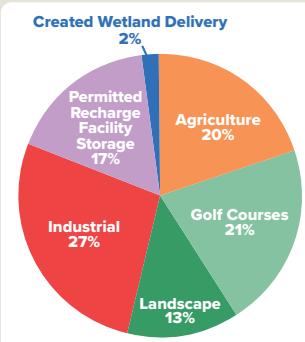


Reasons for low utilization of reclaimed water by agriculture include:

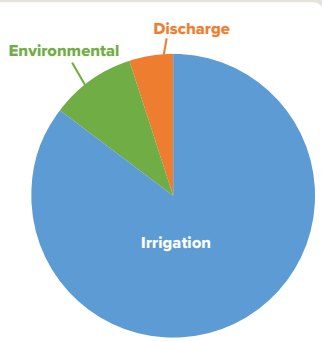
- Use for other purposes
- Difficulty transporting to agricultural areas
- Insufficient treatment

The proximity of wastewater treatment plants to urban areas favors urban reuse. Infrastructure investment in transport of reclaimed water would be needed to boost agricultural reuse.

Israel provides an excellent example of using reclaimed wastewater beneficially. Almost 90% of Israel's treated wastewater is reused for irrigation; the remainder is discharged to the sea or used for environmental purposes. Israel's small size (about 13x smaller than Arizona) and well-developed water transport infrastructure are key to this reuse.



Treated wastewater reuse in Arizona, 2010.



Fraction of reclaimed water used for different purposes in Israel.

While treated wastewater is not suitable for all crops, most of Arizona's treated effluent is high enough quality to use for most agricultural purposes. The state's water reuse regulations specify the minimum quality of reclaimed water for specific uses.

Water Class	Criteria	Type of Reuse
A	• 24-hour average turbidity is < 2NTU (measure of clarity); • No detectable fecal coliform bacteria in four of the last seven daily water samples taken, and • The maximum concentration of fecal coliform bacteria in a single water sample < 23 per 100 mL	Irrigation of food crops, residential and open access landscape irrigation, spray irrigation of an orchard or vineyard.
B	• The concentration of fecal coliform bacteria in four of the last seven daily water samples taken < 200 per 100 mL; • The maximum concentration of fecal coliform bacteria in a single water sample is < 800 per 100 mL	Surface irrigation of an orchard or vineyard, golf course irrigation, restricted access landscape irrigation, pasture and water for dairy animals.
C	• The concentration of fecal coliform bacteria in four of the last seven daily water samples taken < 1000 per 100 mL; • The maximum concentration of fecal coliform bacteria in a single water sample is < 4000 per 100 mL	Pasture and watering for non-diary animals, irrigation of sod farms, fiber, seed, forage, and similar crops.

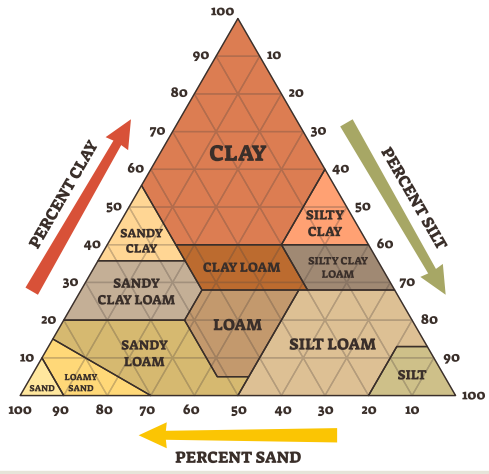
Soil Texture

Soil texture is a crucial component of a soil's water holding capacity (WHC).

- Sandy soils have a low WHC and must be irrigated frequently.
- Clay and silt have high WHC and can be irrigated less frequently.

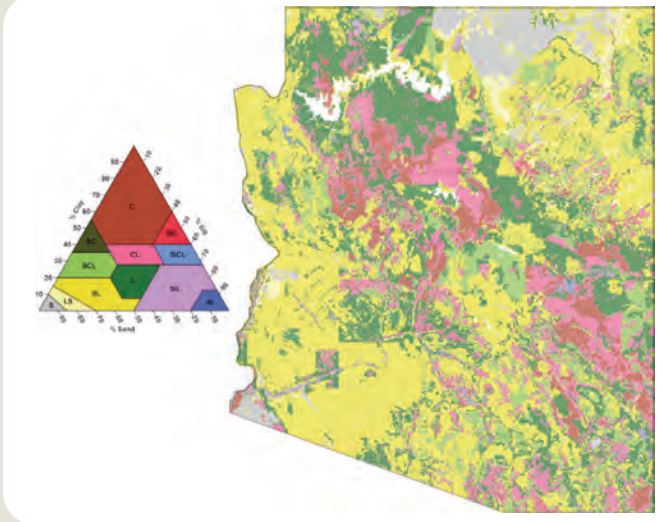
BUT the amount of water a plant can extract from the soil also depends on texture.

- Clay soils may be farmed, but clay holds water so tightly it impedes extraction by plants.
- Silty soils are great for farming as they hold a lot of water available to crops.

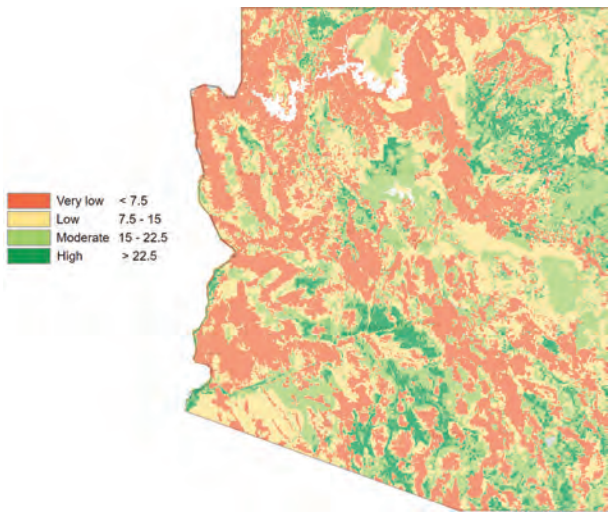


Soil Types

AND higher WHC is not always better. Sandy soils have low WHC but great drainage with little risk of waterlogging.



Soil Texture



Water Holding Capacity (cm)

Soil Organic Matter

- Can hold large volumes of water—much of which is available to crops.
- High SOM can also improve infiltration rates by providing structure to the soil and protecting against crusting and compaction.

Soil Improvement Practices

While soil texture is largely out of farmers' control, soil health can be improved.

Crop Rotation – Alternating crops seasonally or annually

- Balances and cycles nutrients while minimizing risk from pests and disease.
- Diverse root systems improve soil structure and provide soil microbes with different food sources.

Cover Crops – Planted primarily to support soil health rather than crop production

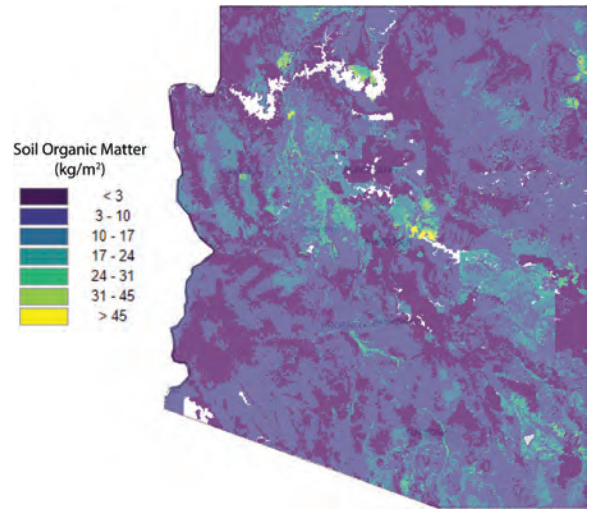
- Used on only ~6% of Arizona's farmland because the year-round growing season encourages planting and irrigating more profitable crops.
- **BUT** cover crops add nitrogen and improve soil health.
- **AND** can control weeds, reducing the need for herbicide.

Conservation tillage – Reducing or eliminating tillage on agricultural fields

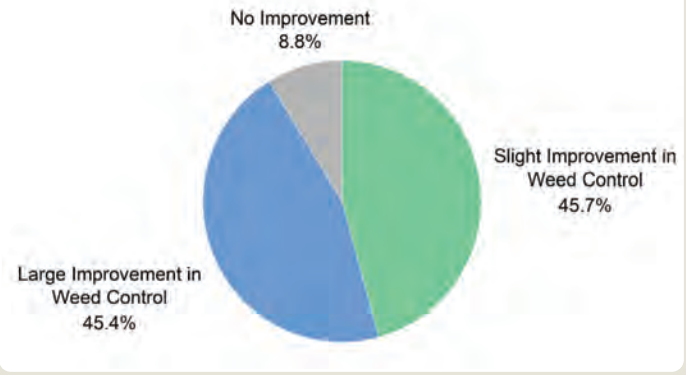
Most of Arizona's farmland is operated under intensive tillage, but between 2012 and 2017, no-till practices increased while intensive tillage decreased by nearly 14%.

Decreased Tillage can:

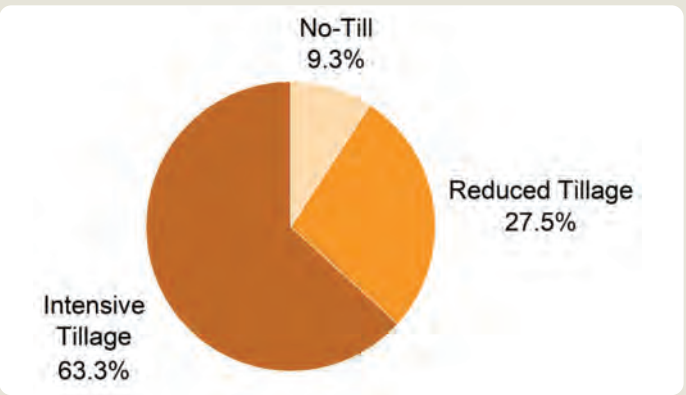
- Save time, money, and fuel;
- Increase SOM, water retention, and drainage;
- Prevent erosion, soil compaction, and CO_2 release;
- Improve yields over the long term.



Soil Organic Matter



US Farmer survey responses on cover crop weed control.



Fraction of acres under intensive, reduced, or no-till practices in Arizona. (2017)

8 Native Agriculture

Several of Arizona's Native Tribes operate successful modern farms, using varieties of standard agricultural practices. However, many agricultural conservation practices have roots in native traditions and knowledge. A select few native agricultural traditions are discussed below.

Companion or Guild Planting - planting different crops together rather than in the separate fields of conventional agriculture

- Each plant benefits from the contributions of nutrients, structure, and/or shade from the others.
- The Three Sisters—beans, squash, and maize—are the primary example of companion planting.
- A diet based on the Three Sisters is nutritionally complete and healthy.
- The Three Sisters have cultural significance that connects the farmer to the land.

The Three Sisters by Anna Juchnowicz

Corn grown on Hopi land with dryland farming techniques.

Dryland Farming - farming without irrigation

- Crops grow with as little as 10 inches of yearly rainfall and often are cultivated by hand.
- Corn—perhaps the most important crop for many Native American tribes—is planted deep in carefully selected locations.
- Farming in these conditions relies on generational knowledge and familiarity with the land.

Desert-adapted Crops - the selection and cultivation of seeds adapted to local conditions

- Farmers select the seeds of successful plants from the recent harvest to use the following season.
- Successive seasons of this practice produce crops adapted to the needs of the land.
- This adaptation is critical for farm sustainability and land stewardship.

Tohono O'odham White Tepary beans (image from Nativeseeds.org)

ARIZONA WATER FACTSHEET SERIES

Get to Know Water in Your County - June 2023

BACKGROUND: The Arizona Water Factsheet series began in 2021 to highlight the local nature of water resources challenges and solutions throughout the state. These factsheets offer accessible and relevant water information at the county scale covering topics such as: land management, water sources, water uses, water challenges, sustainable water management, and the future of county water. They highlight the unique cultural and economic characteristics of each of Arizona's counties that affect water and address common questions about local water resources.

FACTSHEET DEVELOPMENT TIMELINE

MONTH 1
- A first meeting is held to discuss the Factsheet and identify important local stakeholders.
- The local Technical Advisory Committee (TAC) is formed.

MONTH 2
- The first draft is created using an existing template and sent to TAC for review.
- The TAC provides comments and suggestions on the content.

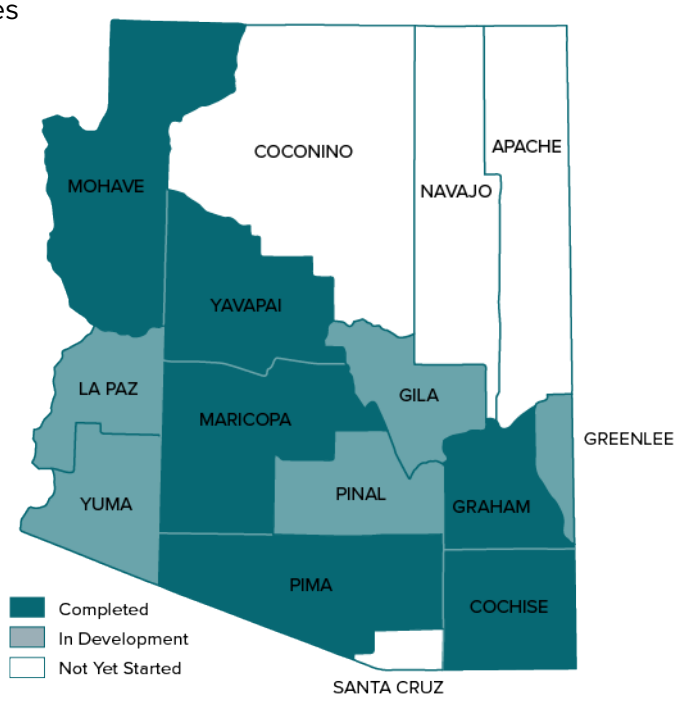
MONTH 3
- Comments are addressed by the WRRC and a second draft of the Factsheet is created.
- A meeting is held with TAC members to review second draft.

MONTH 4
- The second draft is finalized based on feedback from the meeting and sent for external review.

MONTH 5
- Comments received from the external review are addressed to create the final draft of the Factsheet.
- The final draft is sent to the TAC for final review and approval.

MONTH 6
- Any final TAC comments are addressed and an internal WRRC review process begins.
- The Factsheet is released.

STATUS OF ARIZONA WATER FACTSHEETS



PROCESS: The factsheets reconcile different sources of information, as well as organize relevant topics and available resources for a general audience. The factsheet template provides flexibility to incorporate information about the unique water situations and values of each county, such as Pima County's emphasis on the value of flowing rivers and healthy riparian habitats.

For each factsheet, the WRRC partners with Cooperative Extension offices in the respective counties to create a Technical Advisory Committee (TAC), consisting of local experts. While the WRRC does the "heavy lifting" of drafting content and visualizing data from standard sources, we depend on the TAC to highlight the significance of readily available data for their county and suggest additional information. We then seek expanded input of other stakeholder groups through a broader review process.

This iterative process of pooling water topics and available information, and then evaluating and improving the product with local experts, results in relevant and trustworthy resources.

Interested in contributing to a Factsheet currently in development or soon to be started? Please contact:

Amanda Trakas, Statewide Water Information Manager
atrakas@arizona.edu

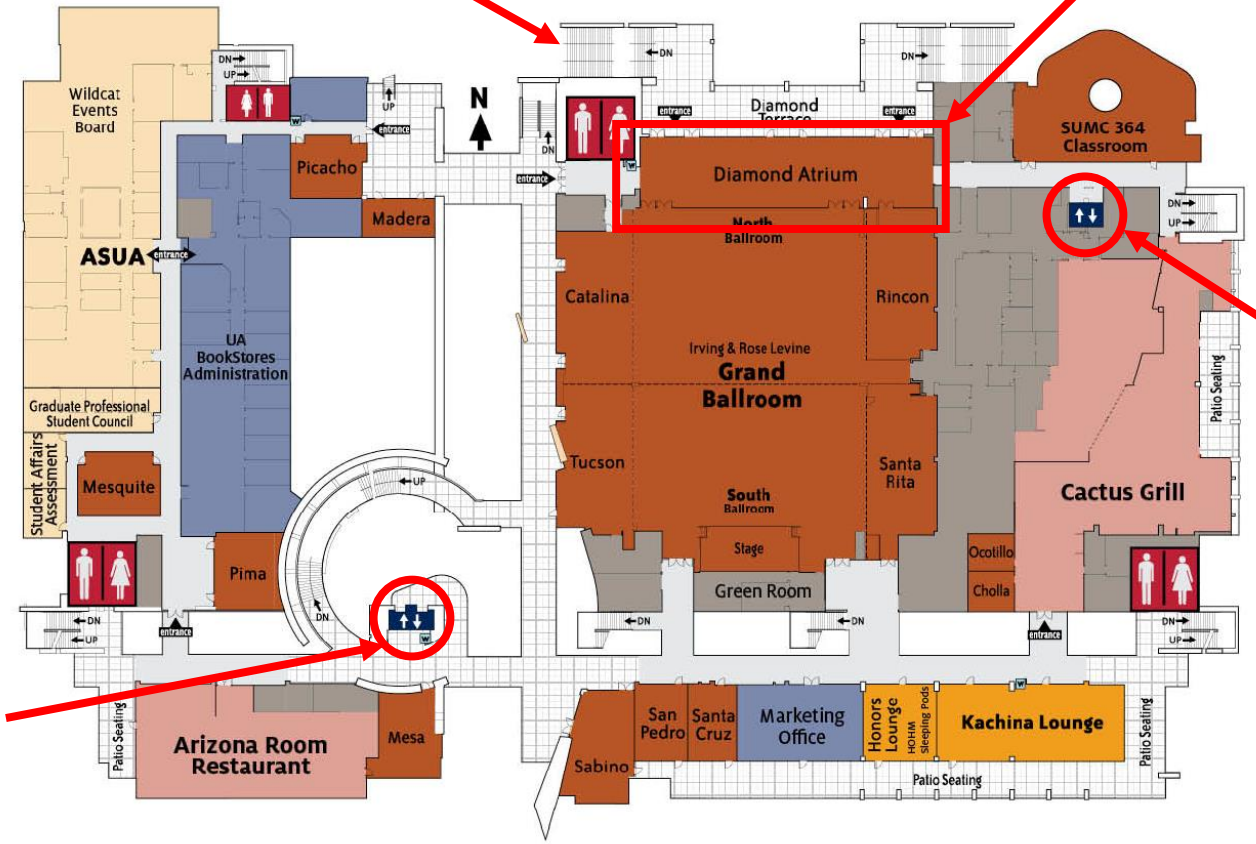
Arizona Water Factsheets

COLLEGE OF AGRICULTURE & LIFE SCIENCES
COOPERATIVE EXTENSION
WATER RESOURCES RESEARCH CENTER
wrrc.arizona.edu/arizona-water-factsheets

↑ To Second Street Parking Garage

Stairway from Main Level

Conference Registration



Elevator to Main Level

Elevator to Main Level

FLOOR PLAN KEY

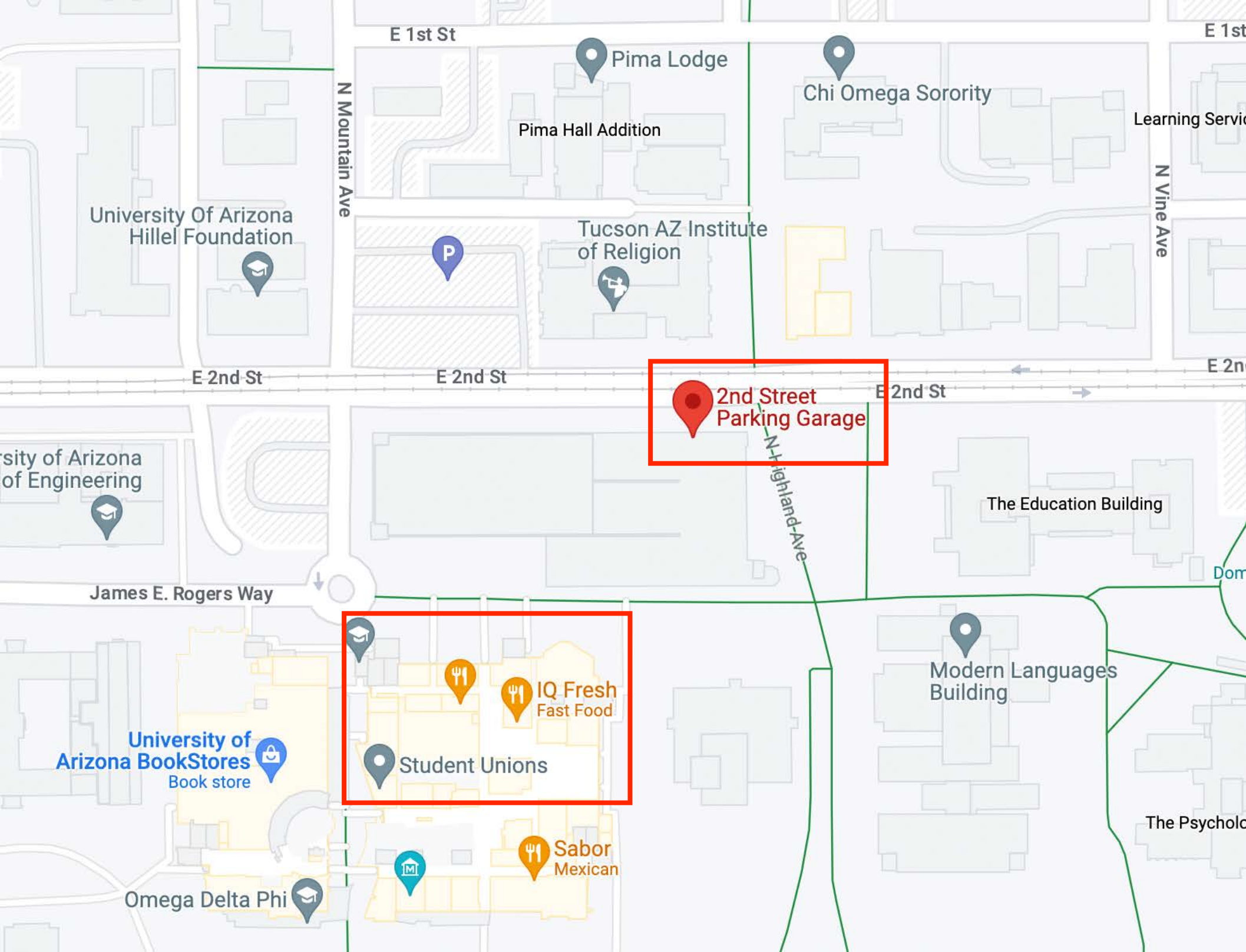
ATM	Involvement	Rest Rooms	Services	Walkways
Elevator	Lounges	Restricted	Vending	Patios & Open Seating
Food	Meeting Rooms	Retail	Water	

The Student Union memorial Center (SUMC) is a place of restricted public access. The SUMC is intended for the use of student, faculty, staff, guests of the University, and participants in authorized on-campus activities. Loitering or interfering with this intended use is prohibited, and violators will be required to leave.

Authority: ABOR Policy 7-201 • UA Campus Use Policy • A.R.S. § 13-2905, -2911

UA is tobacco free.
TobaccoFree.arizona.edu

THIRD LEVEL


E 1st St
Pima Lodge
Chi Omega Sorority
Pima Hall Addition
N Mountain Ave
N Vine Ave
University Of Arizona
Hillel Foundation
Tucson AZ Institute
of Religion
E 2nd St
E 2nd St
E 2nd St
2nd Street
Parking Garage
N Highland Ave
The Education Building
James E. Rogers Way
IQ Fresh
Fast Food
Student Unions
University of
Arizona BookStores
Book store
Modern Languages
Building
Sabor
Mexican
Omega Delta Phi

WRRC 2023 Annual Conference
What Can We Do? Solutions to Arizona's Water Challenges
July 11 – 12, 2023

Participant Evaluation Form

Thank you for attending the WRRC 2023 Annual Conference! We value your feedback.

Please take this short survey to help guide future conference programming.

https://uarizona.co1.qualtrics.com/jfe/form/SV_dgVtdyanSHKw6b4

QR Code to the Online Survey