

UA Water Researchers Protect and Preserve State Water Resources

Technology and Research Initiative Fund supports research work

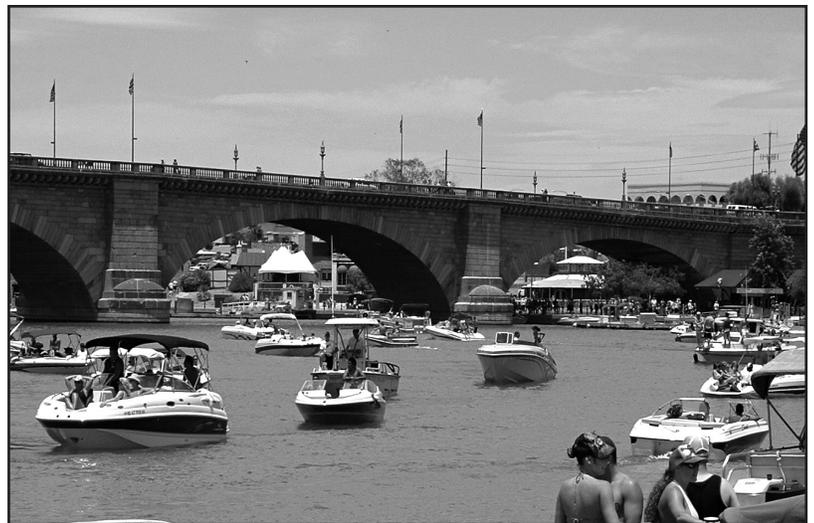
The University of Arizona, Water Sustainability Program (WSP) admirably demonstrates that various interests can work together to ensure Arizona's water future. With the state population expected to double by 2030 and with drought, urban heat island effects and impacts of climate change persisting, water researchers, educators, water and land managers, decision makers and the public at large have much hard work to do to protect and preserve our water resources. State sales tax dollars provided to the UA through the Technology and Research Initiative Fund (TRIF) support the work needed to achieve this goal.

Five campus water centers that have been recipients of major federal and private sector funding are the principal centers of faculty and staff research and education as well as distributors of TRIF dollars for WSP. These centers are: the Engineering Research Center for Environmentally Benign Semiconductor Manufacturing (ERC); the Center for Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA); the Water Quality Center (WQC); the Water Resources Research Center (WRRC); and the newest addition this year, the Superfund Basic Research Program (SBRP). Directors of the five water centers serve as the WSP Executive Committee. The basic components of WSP are: (a) a broad, internally competitive grants program; (b) strategic recruitment and research initiatives; (c) student fellowships; (d) education and outreach programs; and (e) center-directed initiatives and center activities support.

WSP announces awards for the 6th round of the competitive grants program. Review panels made up of university, government and private sector experts evaluated

proposals from UA faculty and staff that addressed water research, education and outreach focused on Arizona's needs. The WSP Executive Committee made the final selections based on panel recommendations. Sixteen new projects were selected for funding in FY09, with four multi-year projects granted funding continuation.

Following is information about the recent award decisions for the grants and student fellowship programs. Visit the WSP website at uawater.arizona.edu for more information.



Will global climate change result in an increased occurrence of contamination events and waterborne pathogens? To help answer this question researchers Kelly Bright and Chuck Gerba will be testing recreational surface waters in the state. Lake Havasu, shown above, is among the recreational waters to be monitored. (See project description at right bottom.)
Photo courtesy of Havasu Magazine

WATER QUALITY PROJECTS

Engineering for Underground Storage and Recovery of CAP Water in Northwest Pima County. Robert Arnold and Wendell Ela, Chemical & Environmental Engineering; 1 year; Award: \$45,491.

The project investigates engineering challenges attendant to aquifer storage and recovery of treated CAP water by northwest Pima County utilities. Problems motivating the study include (i) water loss during reverse osmosis for salinity reduction, (ii) well scaling/fouling associated with treatment of CAP water, and (iii) formation of disinfection by-products when CAP water is chlorinated to control fouling. A suite of technical solutions will be investigated including chemical and membrane softening, ion exchange, pH adjustment, chlorine dose adjustments and others. *Partners:* Metropolitan Domestic Water Improvement District, Town of Marana, Town of Oro Valley, City of Tucson and Flowing Wells Irrigation District.

Impact of Temperature and Precipitation Events on Recreational Water Quality in the State of Arizona. Kelly Bright and Chuck Gerba, Soil, Water & Environmental Science, 2 years; Award: \$47,917.

Human-induced global climate changes caused by greenhouse gases are predicted to cause worldwide increases in temperature and precipitation. These may cause an increase in waterborne disease outbreaks through contamination events and a rise in the occurrence of thermotolerant waterborne pathogens. Multi-seasonal surveillance study of the bacteria *Vibrio cholerae* and *Aeromonas spp.* and the parasite *Naegleria fowleri* from recreational surface waters will be conducted to determine their occurrence and distribution and to attempt to correlate these with global climate change factors such as temperature and precipitation events. *Partners:* Cedar Systems, LLC and Arizona Department of Environmental Quality.

Use of Secondary Treated Wastewater and Ground Water in Algae Photobioreactors for Biofuel Production. Joel Cuello, Agricultural & Biosystems Engineering and Kim Ogden, Chemical & Environmental Engineering; 1 year; Award: \$47,498.

This study has two specific aims: 1) to use the algae *Botryococcus Braunii* to remove nitrogen and phosphorus from secondary-treated wastewater coming from a treatment plant; and 2) to use the algae *Chlorophyceae Dunaliella Tertiolecta* grown in groundwater or brackish groundwater to determine if alternative water sources can be used in photobioreactors to produce biofuels. Specifically, how non-purified water and wastewater affect algae wastewater bioremediation, algae growth, and algae biofuel production will be investigated. *Partners:* Zelen Environmental and Los Alamos National Laboratory.



Stocks of green algae used for biofuel production.
Photo: Joel Cello

Anammox for Nutrient Nitrogen Removal from Sludge Liquors. James Field and Reyes Sierra, Chemical & Environmental Engineering; 2 years; Award: \$53,450.

Sludge liquors from the dewatering of digested sludge contain high concentrations of ammonia which account for 15-25 percent of the N load at municipal wastewater treatment plants. This load poses a serious challenge to existing nutrient removal technologies. The project aims to demonstrate the feasibility of the recently discovered anaerobic ammonium oxidation (anammox) process, in which bacteria oxidize ammonium to benign dinitrogen gas (N₂) under anaerobic conditions, as an economical and sustainable alternative to nitrogen nutrient removal from sludge liquors. *Partners:* Los Angeles County Sanitation District and Pima County Regional Wastewater Reclamation Department.

Detection and Intervention of Vulnerable Tap Water Via Customer Surveillance and Enhanced Water Quality Monitoring. Ian Pepper, Soil, Water & Environmental Science and Mary Derby, Epidemiology; 1 year; Award: \$43,166.

EPA estimates that 16.4 million enteric illnesses attributable to drinking water occur annually, with a recent increase of illnesses linked to contaminated groundwater sources. In response to EPA Homeland Security, and CDC's recommendations to enhance water surveillance and monitoring programs, water utilities are evaluating water quality indicators under their control, such as customer reports of illness that can be used to enhance surveillance. A water utility monitoring surveillance protocol will be developed driven by customer reports of illness and water quality monitoring for early detection and intervention of compromised tap water. In addition, indigenous baseline microbial water quality in municipal tap water

will be determined. *Partners:* Tucson Water and US EPA National Homeland Security Research Center.

Seasonal Reclaimed Water Quality: An Assessment of Nutrient, Chemical and Biological Variability. Channah Rock and James Walworth, Soil, Water & Environmental Science; 1 year; Award: \$35,430.

Increasing demands on limited water resources have made wastewater reclamation for municipal irrigation an attractive option for extending water supplies in the semiarid Southwest. However, limited knowledge is available on the seasonality of chemical and microbial constituents found in reclaimed water. This study will define water quality markers by quantifying indicator organisms and variations of chemical constituents in reclaimed water delivered to four end-users in southern Arizona. This study will explore spatial and temporal variations in microbial contamination and provide a better understanding of chemical impacts and potential consequences relating to the environment and society. *Partners:* US Arid-Land Agricultural Research Center and Global Water Corporation.

Preliminary Evaluation of Antibiotic and Illicit Drug Contaminants in the Colorado River and Their Potential for Food Chain Transfer. Charles Sanchez, Yuma Ag Center; 1 year; Award: \$14,400.

Several antibiotics and illicit drugs have been detected in portions of the Colorado River and in one significant waste stream tributary (Las Vegas Wash). One or more of these chemicals has been detected in the sediments and plant material collected from the Las Vegas Wash. Trace levels of these contaminants have the potential to adversely affect human health and biota. Preliminary information on distribution of these compounds in the Colorado River will be obtained and the potential for food chain transfer into edible food plants from irrigation water will be evaluated. *Partners:* USDA CSREES Regional Water Quality Extension Program and USEPA National Exposure Research Laboratory.

WATER SUPPLY/RESOURCES PROJECTS

Yuma Desalting Operations, Water Quality and Vegetation Distribution in the Cienega de Santa Clara. Karl Flessa, Geosciences; 1 year; Award: \$30,895.

Water quality and vegetation in the Cienega de Santa Clara wetlands will be monitored in order to predict how water quality, in particular salinity, affects the density and distribution of marsh vegetation. The bird diversity of the wetlands, located in Sonora, Mexico, makes the area a top conservation priority in the Colorado River delta. The Cienega's principal source of water is brackish groundwater from Arizona's Wellton-Mohawk Irrigation District.

RESEARCH PARTNERS MAKE A DIFFERENCE

The Water Sustainability Program benefits by collaborating with external agencies that offer expertise and financial assistance in support of research projects. Involvement of off-campus partners ensure that research addresses problems of the "real world." Project descriptions list external partners that have provided dollar matches and/or in-kind contributions. The WSP thanks its partners for their invaluable assistance.

CONTINUING PROJECTS

James Baygents and James Farrell, Chemical & Environmental Engineering; Award: \$72,000. Partner: Intel Corporation. Electrocoagulation was proven to be a cost-effective treatment for removing a wide range of contaminants from wastewaters generated during semiconductor manufacturing. The addition of complementary technology to remove hardness ions will be the focus this year.

Charles Gerba, Soil, Water & Environmental Science; Award: \$39,330. Partners: Pima County Wastewater Reclamation Department, Orange County Sanitation District, Synagro, Northwest Biosolids Management, Los Angeles Sanitation Districts. Quantitative methods were developed for the growth and assay of prions in environmental samples. Research is now under way to assess the recovery and survival of these prions in reclaimed water and biosolids added to soil mixtures.

Kathleen Lohse, School of Natural Resources, Paul Brooks, Jennifer McIntosh, and Thomas Meixner, Hydrology & Water Resources; Award: \$47,797. Partners: City of Tucson, Sandia National Laboratories, USGS, USDA ARS. Contaminant and isotope analysis on storm runoff will be completed and further investigation into runoff processes and trans-

port of contaminants to ground water will be evaluated. Results will be incorporated into decision support tools and education models in conjunction with partners and stakeholders.



Sampling storm water along a Tucson wash. Photo: Kathleen Lohse

Susan Pater, Cochise County Cooperative Extension, Gary Woodard, SAHRA, Hydrology & Water Resources, et al; Award: \$15,644. Partners: Cochise County and Badger Meters. The methodology being developed in this study aims to provide low-cost, high-frequency meter reading, making it feasible to determine basin-wide impacts of large numbers of domestic wells. Once the well owners are identified and meters are installed, statistical analysis of the water metering data will begin.

Critical bird habitat could be affected if the Yuma Desalting Plant (YDP) is re-started. Baseline water quality data will be generated to evaluate potential impacts. *Partners: Central Arizona Project and Centro de Investigación en Alimentación y Desarrollo.*

Spatial and Temporal Variability of Clogging on Stream-Aquifer Interaction in the Upper Santa Cruz Valley. Tom Meixner, Hydrology & Water Resources, and Paul Sheppard, Laboratory of Tree-Ring Research; 1 year; Award: \$30,266.

In water-limited environments effluent is a valuable water source for riparian restoration and aquifer recharge. In-stream infiltration of effluent in the Upper Santa Cruz River has helped to maintain safe-yield conditions in the Santa Cruz Active Management Area. It has been observed, however, that recharge has been influenced by stream bed clogging. In this study, the impact of effluent on riparian vegetation and the spatial and temporal variability of clogging on riparian water use and recharge rates will be determined. Tree ring analysis will be used to help develop a robust understanding of an effluent dominated river system. *Partners: USNPS, Sonoran Institute and Friends of the Santa Cruz River.*

Climate Change Adaptation Strategy Research Project. Jonathan Overpeck, Institute for the Study of Planet Earth; 1 year; Award: \$47,976.

This project will provide the basic climate change information

needed to support Governor Napolitano's proposed climate change adaptation strategy initiative. A collaborative effort is underway to develop an enhanced climate change web resource for the state. This effort will engage scientists and stakeholders across the state, particularly those relating to water resources and those involved with the Governor's climate change adaptation working group, to ensure that the climate change web resource is optimal for supporting climate change adaptation strategy discussions. *Partner: Arizona Department of Environmental Quality.*

Optimum and Minimum Irrigation Requirements of Landscape Trees. Ursula Schuch, Plant Sciences, Ed Martin, Maricopa Ag Center and Rick Gibson, Pinal County, Cooperative Extension; 1 year; Award: \$20,959.

This long-term research and demonstration project addresses landscape water use and conservation. The performance of nine species of commonly used landscape trees will be assessed when supplied with irrigation at 30, 50

or 75 percent of reference evapotranspiration. With trees established in January 2007 and irrigation treatments starting in February 2008, data will be collected for the next five years to document differences in growth and overall appearance. The site will be a valuable resource for educating and training landscape professionals, policy makers, and homeowners. *Partners: Arizona Landscape Contractor's Association, Pinal County Master Gardeners and the City of Maricopa.*

Ground Water Age Dating for Water Budget Development in the Show Low Watershed, Navajo County, AZ. Kristine Uhlman, Water Resources Research Center, Chris Eastoe, Geosciences and Steve Campbell, Navajo County, Cooperative Extension. 1 year; Award: \$4,800.

The vulnerability of water resources to climate change in the Show Low Creek Watershed will be assessed by isotopic age-dating. Ground water samples will be collected and analyzed for naturally occurring isotopes that will identify water source, resident time in the aquifer, and length of time since the water fell as precipitation to recharge the aquifer. Results will assist resource managers and policy makers in developing a water budget to balance competing resource demands. *Partners: Arizona NEMO (Nonpoint Education for Municipal Officials), Arizona Department of Water Resources and Show Low Creek Watershed Enhancement Partnership.*

STUDENT FELLOWSHIPS

Eight outstanding students, four undergraduates and four graduates, were selected to receive awards to support their studies in water resources. This year's group will tackle a variety of hot topics related to water resources including biodiesel production, green roofs, climate change, reclaimed water and new technologies for water treatment.

Undergraduate Fellowship Recipients (\$2,750)

Lucy Cheng, Implementation and Testing of Water Quality Monitors, Agricultural & Biosystems Engineering
Jarrod Shawn Deverse, An Evaluation of the Effects of Land Application of Biosolids on Pathogens in Irrigation Return Flows, Agricultural & Biosystems Engineering
Ritika Mohan, Electrocoagulation for Arsenic Removal, Chemical & Environmental Engineering
Sarah Dam, Adaptive Governance and the Politics of Reclaimed Water, Political Science

Graduate Fellowship Recipients (\$18,500)

Hoori Ajami, Quantifying Recharge in Semi-Arid Basins: Translating Impact of Climate Variability and Change on Groundwater Resources, Hydrology & Water Resources
Jenna Bloxom, Aridity and Algae: Biodiesel Production in Arizona, Latin American Studies
Brent Jacobsen, Sustainable Roofscapes: Methods for Linking Green Roofs and Urban Riparian Corridors for the Benefit of Human and Wildlife Habitats, Landscape Architecture
Jelena Vukomanovic, Conservation Easement Monitoring: Development of a Monitoring Protocol for Riparian Area Management, Arid Lands Resource Sciences

of multiple rainwater collection systems for public demonstrations. Classes will be offered to the public, and participants who complete all classes will be awarded a certificate. Participants will construct both passive and active collection systems. Materials created for class will be applicable across the state. *Partners:* City of Sierra Vista, Cochise County Master Gardeners, Davey Water Products Pty Ltd, Rain Harvesting Pty Ltd and Oasis Water Harvesting.

Science Education That Makes a Difference — Through Inspired Teacher Leaders. Kerry Schwartz, Water Resources Research Center; 1 year; Award: \$34,479.

By engaging teacher leaders in bringing water education into local schools, including feeder schools, a network of water champions in the Greater Phoenix Area will be established. Water education market-



Arizona Project WET trains new water champions.
 Photo: Kerry Schwartz

ing and delivery is ineffective if approached from a top down perspective. This project creates an on-the-ground, grassroots network of individuals responsible for bringing water education resources and opportunities to their area schools and communities, enhancing delivery of new water initiatives into the Greater Phoenix Area. *Partners:* ASU Polytechnic Science Education Program, and Arizona Foundation for Resource Education.

Arizona Rivers' High School Riparian Research Experience Collaboration with NEMO's Surface Flow Wet/Dry Monitoring Campaign. Martha Whitaker and Jim Washburne, Hydrology & Water Resources; 1 year; Award: \$1,810.

AZ Rivers is collaborating with NEMO (Nonpoint Education for Municipal Officials) to have AZ Rivers high school students and volunteers participate in NEMO's Annual Surface Flow Wet/Dry Monitoring Campaign. This project will provide training and will purchase 12 GPS units and field supplies for 12 teams of two to three volunteers. The GPS units will be available for loan year-round to AZ Rivers teachers, students, volunteers and NEMO volunteers. *Partners:* Science Foundation Arizona, Arizona NEMO and Pima Association of Governments.

WATER EDUCATION & OUTREACH PROJECTS

Simple Techniques for Backyard Water Harvesting: An Online Instruction Module. Theresa Crimmins and Katherine Waser, Office of Arid Lands Studies. 1 year; Award: \$44,781.

Water is a scarce commodity throughout Arizona. Rainwater when properly harvested can supply a large percentage of the water used for landscaping purposes. The proposed on-line learning module will communicate techniques for backyard water harvesting using video, animations, and supplemental downloadable documents. These materials are intended for use by homeowners, neighborhood associations, and by established programs such as Mater Watershed Stewards, Master Gardeners, UA Extension's WaterSmart workshops. *Partners:* City of Tucson, Town of Marana and the Sonoran Permaculture Guild.

Rainwater Harvesting Certificate Program and Demonstration Project. Cado Daily, Cochise County, Candice Rupprecht, Master Watershed Stewards and Cynthia Warzecha, Coconino County, Cooperative Extension. 1 year; Award: \$5,746.

This certificate program will increase the level of knowledge and application by participants on the collection and non-potable use of rainwater, and will result in the construction

Arizona Water Resource Supplement

Water Sustainability Program

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