

WRRC News and Events

Carl J. Bauer, the new Water Resources Research Center's associate director, will be on the job in August. Dr. Bauer's most recent position prior to joining WRRC was as a Resources for the Future fellow. See page 3 for an article describing Dr. Bauer's background and his approach to the study of water issues.

The annual WRRC conference was conducted June 20-21, with about 400 people attending. Day one consisted of speakers and panels discussing poignant water issues related to growth. Hosted by Arizona State University's Global Institute of Sustainability, day two had participants organized into discussion groups to identify key water issues, management decisions and recommendations. See page 9 for an account of day one; check the following web site for results gleaned from day-two discussions: <http://sustainability.asu.edu/gios/waterworkshop.htm>

Also, check page 8 for information about a recent WRRC publication, funded by the U.S. Bureau of Reclamation — "Projects to Enhance Arizona's Environment: An Examination of Their Functions, Water Requirements and Public Benefits."



Flowers bloom in a geothermal heated greenhouse at Masson Radium Springs Farm in New Mexico. Geothermal heated greenhouse operations are a promising growth area for Arizona agriculture. Agriculture gross receipts could be kept constant while dropping overall agriculture water use if field-grown crops are raised in geothermal greenhouses. Photo: Robb Williamson

Geothermal — Using Water to Generate Energy and Provide Heat

Geothermal water use is nonconsumptive

by Joe Gelt

Geothermal energy is expected to be a topic of growing importance in Arizona. Not only an energy issue, geothermal is also a water issue. In a hydrothermal system, water heated in the earth's interior is brought to the surface to be used as a source of energy. Geothermal heated water is also called geothermal fluid.

Other classifications exist. Because of its heat energy, federal statutory definitions consider geothermal water, when used for heating or electricity generation, a mineral, in the same category as oil and gas.

Geothermal applications represent a relatively new and expanding use of water. A water-use issue usually causes officials to sit up and take notice; geothermal water use, however, has not caused much of a stir. This is because geothermal applications are generally nonconsumptive uses of water. In that sense, geothermal water use is not unlike water set aside for instream flow, with neither use resulting in a reduced supply.

Some say the state's geothermal resources are much underutilized at present and expect greater uses in the future, especially as costs of other energy sources rise. They call for a greater awareness of geothermal resources to help foster a heightened pub-

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lic understanding and acceptance of their uses and benefits. With more geothermal projects operating in Arizona, state regulatory agencies concerned with water will need to determine what, if any, actions they should take.

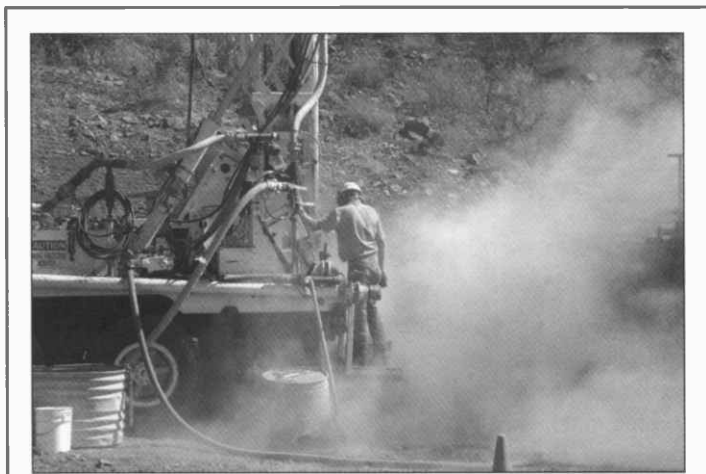
Geothermal is an issue the Arizona water community might take note of — if for no other reason than to further develop an appreciation of the power and potential of water.

Geothermal in Arizona

Of all U.S. regions, the West has the most favorable conditions for geothermal development. It owes its geothermal advantage to the “youth” of its landscape with its abundance of mountains and faults. Mountain building is often associated with higher subsurface heat, and faults serve as pathways to bring hot water closer to the surface.

Most of Arizona’s thermal wells are found in the southern part of the state, south of the Colorado Plateau. Many wells in the area tap into aquifers with warm or even hot waters. Although the water is then used for conventional purposes — irrigation and municipal and industrial uses — a potential exists for geothermal applications.

Arizona lags behind other western states in the development of its geothermal potential largely because of the warm climate in the southern part of the state and the large nuclear and coal generating capacity in the region. Geothermal resources are particularly valued in some regions for generating electricity as a substitute for fossil and nuclear fuels; generating electricity, however, requires higher geothermal temperatures, between 220 and 660 F. The potential of higher temperature resources in Arizona are unexplored.



Arizona Public Service geothermal test drilling project near Clifton found the likelihood of adequate geothermal resource for power generation at a reasonable depth. Photo courtesy of APS. Photographer Carol Shipman.

In general, expensive deep wells would have to be drilled to tap into higher temperature geothermal waters. The U.S Department of Energy is funding a project east of the San Francisco Peaks, an area with some of the youngest volcanism in the state, to determine if hot thermal waters can be accessed to generate electricity.

With DOE funding, Arizona Public Service is involved in a project in the Clifton-Morenci area to determine if thermal water in

that area could be used to generate binary-cycle power for electricity generation. The binary-cycle process enables the use of lower temperature geothermal water (220 to 300 F) to generate electricity.

Geothermal Direct Use

Geothermal waters not warm enough to generate electricity — water of low to moderate temperatures, from 120 to 220 F — are suitable for various residential, commercial and industrial direct uses. These include recreational hot springs, aquaculture, agricultural applications, district heating and resorts. Examples of geothermal use in Arizona include shrimp raised in geothermal water near Gila Bend and fish near Hyder. A Marana farmer waters his citrus with geothermal water in winter. Tonopah, Safford and Mesa have hot springs developed as spas.

Commercial applications in other states include geothermal laundries in Nevada and a geothermal onion dehydration facility in Nevada. Direct geothermal energy can be used in any process that requires large amounts of low grade heat (less than 300 F).

Geothermal applications also can serve as a tool with direct and indirect water benefits. For example, energy consultant Jim Witcher of Witcher and Associates sees a potential for using high-temperature water to desalinate brackish water. Desalination requires heat, and Witcher says, “Geothermal fluids might be able to fill a niche opportunity and provide the heat. We could then make use of the brackish water.” He, however, adds, “I don’t know whether anybody has really looked into this in detail.”

Witcher says very deep wells would have to be drilled to obtain water hot enough for desalination. Costs, however, increase as wells are sunk deeper, and such a project could become prohibitively expensive. Witcher says, “Increases in drilling costs are not linear with depth; they increase exponentially with depth.”

Geothermal technology could provide an indirect water benefit to agriculture if used to heat greenhouses. This is not done much now in Arizona, unlike in neighboring New Mexico, the state with the largest geothermal greenhouse acreage in the nation. The Willcox area could serve as an example of what is possible in Arizona. It is an area with several hundred acres of tomato greenhouses heated with natural gas in the area. It is also here that the DOE is funding a feasibility study for geothermal greenhouse heating.

Energy costs have a lot to do with the profitability of greenhouse operations. Using geothermal energy rather than natural gas to heat greenhouses could result in significant savings. A farmer could then likely successfully compete with Midwest operations with their high energy costs and even gain an advantage over foreign competitors.

Greenhouse operations can have high gross receipts that range from \$300,000 to \$800,000 per acre annually, depending upon the crop. This is a significantly higher payoff than provided by field-grown crops. While water use per acre in the two types of operations is essentially the same, fewer greenhouse acres would be required to generate the same cash flow. A corollary view of geothermal greenhousing heating is that agriculture gross receipts could be kept constant while dropping overall agriculture water use.

Some view geothermal heated greenhouse operations as a very promising growth area for Arizona agriculture; in fact, some say it



Water Vapors

New WRRC Associate Director Urges Comparative View of Water Issues

United States, World Gain When Water Expertise is Shared

Carl J. Bauer, a recently appointed University of Arizona professor of geography and regional development and the Water Resources Research Center's new associate director, believes that an international perspective, one that allows an informational give and take across borders, promotes a better understanding of water problems. It is this comparative view that Bauer will apply at the UA.

His view relates to his experience of having begun his career studying water law, policy, and management in the western United States and then traveling to Latin America and other parts of the world to address the same issues.

Bauer says, "I think it is always useful to do comparative work because you can stretch your thinking about the issues in a particular county as you consider the ways other countries are responding to the same issues. It may or may not give you a solution you can import, but it almost always allows you to stretch the terms of debate."

An international perspective figured in his work in Chile, the world's most prominent example of free-market water policies and institutions. Many people in Chile, staunch in their faith that the free market will resolve problems, are not receptive to suggestions of increasing government water regulations. Bauer was able to point to the United States, essentially a pro-market country, yet where the use of markets to manage water is controversial and sparks pro-and-con debates.

Bauer says, "To be able to point to the fact that water markets are both practiced in the U.S. and much argued about gave me a way to make a case for some greater regulations in Chile than if I had simply stuck to the Chilean context itself." Bauer has written two books about water rights and water markets in Chile.

Bauer finds the comparative, international approach to water affairs especially useful when working in Spain. He says

Spain and the western U.S., both with arid climates, have many water issues in common. In their efforts to reform water policies, Spanish officials have been looking to the western U.S. for helpful examples.

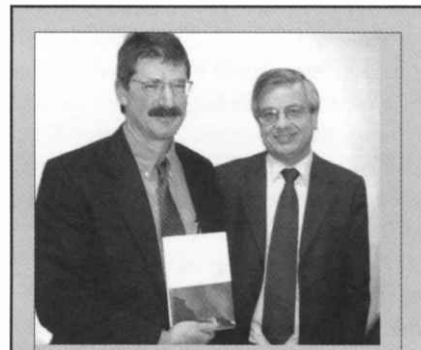
Bauer says, "They have been talking about different kinds of water banks or water market mechanisms. In Spain, these remain mostly untried; they are looking at empirical experiences the U.S. has had to help them decide what to try. ... They are especially interested in what California has done with water markets and water banking."

He says, "Spain is interesting because it is a rich country, relatively speaking; so they have the government regulatory capacity we have in the United States, and that you don't generally have in Latin America."

Also Spain finds common ground with the western U.S. since both are concerned about environmental protection. Bauer says the Spaniards are especially interested in the U.S. Wild and Scenic Rivers Act and different kinds of environmental flow protection laws in place at the federal and state levels.

Spain thus far has been at the receiving end, looking to benefit from U.S. experiences. Bauer believes, however, that it is a two-way street, that the U.S. could learn from Spain's water policy experiences.

"What is striking is that even though



Carl J. Bauer with Humberto Peña, then head of Chilean government water rights agency, 2004.

water issues are very similar in the western U.S. and other parts of the world, especially drier parts of the world, the U.S. is remarkably uninvolved and uninformed about international water policy debates."

Bauer wants to broaden horizons when he is working in Arizona. He hopes he will be able to help confront troublesome western U.S. water issues by encouraging "greater awareness that a number of other countries around the world are arguing about the same things and trying different approaches to the same problems, whether these are problems of over extraction of groundwater, agriculture vs. urban water

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News Briefs

Wise Water Use Earns EPA WaterSense Label

In its effort to raise public awareness about wise water use, the U.S. Environmental Protection Agency has established a water-efficient product labeling program based on its Energy Star program. An Energy Star, which has consumer recognition value, is earned by an electric-using product if its energy use meets certain EPA standards.

The WaterSense program aims to raise awareness about the importance of water efficiency, ensure the performance of water-efficient products and above all provide good consumer information. The WaterSense label will be easily identified on products and services that perform at least 20 percent more efficiently than their less efficient counterparts and will enable consumers to more readily identify them.



Lawn sprinklers will be one of the first water appliances to get a WaterSense label.

Manufacturers can certify these products meet EPA criteria for water efficiency and performance by following testing protocols specific to each product category. In addition, products will be independently tested to ensure EPA specifications are met. These products will be available to families and businesses early next year.

A water-efficient product labeling program has been in the works for some time, with many Arizona water providers, including Tucson and Phoenix water utilities, promoting the program. The Conservation Committee of the American Water Works Association took the lead nationally to coordinate support for the program.

The program will be breaking new ground by providing consumers a national reference tool for water usage efficiency.

Lawn sprinklers will be one of the first products qualifying for WaterSense labeling, with bathroom plumbing products next in line.

For information about the WaterSense water efficiency program check: <http://www.epa.gov/watersense/>

Western Stakeholders Irked by BuRec's Security Costs

Western stakeholders recently testified that they feel they pay an unfair proportion of the costs for the Bureau of Reclamation's security improvement program. In response to the Sept. 11 terrorists' attack,

BuRec bolstered its security efforts to better protect its water and power infrastructure. Security was increased with additional guards, concrete barriers and road closures in sensitive areas.

Western water customers had an opportunity to air complaints about their experiences with the BuRec's program at a House Water and Power Subcommittee oversight hearing. Those testifying included Jay Moyes, representing the Arizona West-side Irrigation and Electrical Districts.

They expressed concern that BuRec passes on many of the security improvement costs to its customers. They said they have no objections to paying a portion of the costs, but since security is a national responsibility the federal government should pay most of the expenses.

Moyes testified that power customers are asked to pay 94 percent of the \$20.9 million cost of additional guards and patrols in fiscal 2005. Furthering their frustrations, they say BuRec officials have not informed them how long they are to continue to pay this share. A number of western water and power agency officials complained to lawmakers that the increased costs are ultimately passed on to residential customers and businesses.

Those testifying generally concurred that BuRec needs to be more forthcoming with information about costs and the justification for specific improvements. Further

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market conflicts or others."

For example, Spain is presently engaged in issues relating to its participation in the European Union. Some of the EU regulations and laws have ambitious environmental goals. Once these laws are passed at the general level, Spain and other member nations have to implement them in some fashion in their national legislation.

Bauer says the United States could benefit from Spain's expertise and experience in this area. He says, "The U.S. is plugged into international trade networks and has to take into account what kind of international environmental regulations may exist as it makes its own domestic decisions. That Spain is already part of a larger international federation suggests it may have something to provide the U.S. in the way of lessons learned."

Bauer expects his move to Arizona will involve him in the study of groundwater, a critical issue in the state. He wants to approach his work with an international perspective, possibly using the Arizona experience to aid other nations. He says, "(Groundwater) is a huge and growing issue in Latin America, Spain and lots of other parts of the world. My understanding of the Arizona case is that it is one of the more advanced in terms of groundwater law and management. I am sure it has its warts as well, but I expect it would be another juicy area for some comparative work."

Bauer was attracted to Arizona and the UA because of the state's commitment to support water policy studies. This emphasis is compatible with the interdisciplinary and comparative approach he applies when studying water issues.

EPA Proposes Water Transfer Rule

The Environmental Protection Agency proposed a rule that would allow the transfer of water for one body of water to another without requiring a National Pollutant Discharge Elimination System permit. NPDES permits are to ensure that certain environmental standards are being met.

EPA says its proposed rule would apply to movements of water between bodies of water when the water is not subjected to intervening industrial, municipal or commercial uses. A permit would be necessary if the water transfer process itself might introduce pollutants.

According to EPA, water transfers include routing water through tunnels, channels, or natural stream courses for public water supplies, irrigation, power generation, flood control and environmental restoration.

The proposed rule is not to the liking of environmentalists who say it exempts an entire class of polluters from the Clean Water Act and allows contaminants to enter drinking water sources, lakes and streams.

The issue is one that has been making the rounds of the courts, all the way to the U.S. Supreme Court. The disputed issue has to do with whether a pumping station in South Florida needs a Clean Water Act permit to pump storm water runoff into the

Everglades. The Miccosukee Indian Tribe argue that such a permit is, in fact, needed, to protect the wetlands from runoff that often contains contaminants, much of it from agriculture areas using phosphorus-rich fertilizers.

The South Florida Water Management District, operators of the pumping station, disagree, arguing that its operation is not the actual source of the pollutants; it is merely transferring water from one side of a levee to another. In other words, the district functions as a neutral conveyor of water, not a polluter subject to EPA and state regulation.

A U.S. Court of Appeals upheld a lower court ruling in favor of the tribe before the case went to the U.S. Supreme Court. The Court didn't rule directly on the issue; it sent the case back to the lower district court for more fact-gathering.

Some view EPA's actions as an attempted "end run" around an expected federal court decision that might agree with the tribal position. Arguments in the case ended in late April, with a ruling expected soon.

The court cases and the EPA proposed rule deal with an issue of much concern in the West. Water transfers are a major western water supply strategy, with water moved to supply urban and other needs a common practice.

concern was raised that under the current allocation structure other agencies that benefit are not paying a fair share, including fish and wildlife and recreation agencies.

Water and power officials urged legislation to cap their share of costs for extra security at \$10 million annually. They also want BuRec to be required to report each year to Congress on its security actions.

Win Some; Lose Some

The following was the lead for an article in the May 1 Chandler News: *Chandler will begin building a wetland area this summer that will include man-made holes where burrowing owls, forced out of their habitat by development, can be relocated.*

Ironically, owls currently living at the site will have to be moved to make way for the project.

The National Water Resources Association participated in the hearings; it is part of a coalition of water and power customers seeking a clear authorization of the program to limit the amount of funds private customers are required to pay for national security upgrades that benefit many public

citizens and entities.

Since Sept. 11 BuRec has spent about \$213 million on site security; officials testified that the agency is working out a policy to make all security costs reimbursable.

Tucson's South Side Residents Get TCE Settlement

It was a long time coming, but residents of Tucson's South Side affected by water contaminated by trichloroethylene or TCE are to receive a final settlement. It took 15 years of litigation and appeals before an insurance company agreed to pay the plaintiffs \$49.5 million. The company once insured the city and the Tucson Airport Authority.

TCE, an industrial chemical used to degrease airplanes, is known to cause cancer in lab animals. It can also disrupt the immune system and cause varied illnesses. Exposure can result from drinking, swimming and showering in water contaminated by the chemical.

In 1952 Hughes Aircraft began using TCE at Air Force Plant 44, a federally-owned missile facility located south of the airport. Its primary method of disposing of

the TCE was to pour the solvent into open pits and sometimes directly on the ground and into drains.

In 1981 the Pima County Health Department, concerned when tests showed soil and water pollution on the South Side from disposal of industrial chemicals, shut down polluted wells. Contamination up to 1,000 times the federal health standard was reported in some estimates. An area approximately one-half mile wide and five miles long was affected by the contamination.

The finding of TCE in South Side wells sparked a number of lawsuits. The city of Tucson agreed to \$35-million settlement in 1989 with 1,600 residents, although three of the city insurers disputed liability in the case. In 1991 Hughes Aircraft and other companies settled an \$84.5-million lawsuit. With the recent \$49.5 million settlement with the last insurance company to hold out, Associated Aviation Underwriters, the total settlement is over \$130 million.

The U.S. Environmental Protection Agency included the Tucson Airport Authority in its Superfund national priority list in 1994, and treatment of the contaminated water got underway with the operation of the Tucson Area Remediation Project.



Guest View

Method to Assess Flow Balances Resource Protection, Development

This Guest View was contributed by Jacqueline King, freshwater ecologist and principal research officer, University of Cape Town, South Africa. (See sidebar for more information about Dr. King)

Thirty years ago I began a study of the ecology of a river near Cape Town for my PhD. I learned that a dam was planned for its headwaters and, concerned about the dam's potential ecological impact, I wrote to the government to ask how much water would continue to flow down the river. A government official wrote back politely enquiring how much I thought should continue to flow downstream. I had no idea how to answer this and so, feeling confused and rather stupid, I never replied.

Fifteen years later I faced this question again when I was awarded funds by the South African Water Research Commission to begin research in a field that was new globally and at that time barely known in my country: the science of advising on the amount of flows required to keep healthy those rivers targeted for water-resource development. Widespread concern that the world's rivers, and other bodies of inland waters including linked groundwater systems, are rapidly deteriorating is the impetus behind the science. Often, the deterioration is solely due to changes in flow brought about by dams or water abstraction. My task was to investigate what was happening in this science internationally, and to make recommendations as to how South Africa should proceed.

Working with colleague Rebecca Tharme, we discovered that the methods used at that time to advise on suitable flows for regulated rivers focused narrowly on maintaining suitable fish habitat — mainly for game fish favoured by sports fishermen. This is not a priority in developing countries, where hundreds of millions of people depend directly on the rivers they live beside. These arteries of 'white gold' running through their landscapes provide construction material for their homes; grazing and shelter for their livestock; and firewood, food, medicines nutritious herbs and drinking water to support their health. In developed countries, where the link between rivers and livelihoods is less direct, healthy rivers continue

to provide a host of goods and services that we take for granted: stable banks, fisheries, clean water for swimming and play, water of good quality that is stored in wetlands and groundwater during rains and released slowly during dry periods, diverse and abundant wildlife, and much more. Even in the most arid areas, where rivers may flow for only a few days per year or decade, groundwater movements along the channels support 'linear oases' — green ribbons in brown landscapes that are vital support systems for people and animals. The rivers are dynamic living systems and when we alter the movement of the water that sustains them they change. The natural goods and services they have provided start to fail, and the costs to nations — still largely unquantified but undoubtedly very large — escalate. Some of these costs could be losses in fisheries; reduced flood attenuation; damaged infrastructure due to increased flooding; deteriorating water quality; silted-up reservoirs; reduced groundwater recharge; declining biodiversity and shrinking wetlands.

We realized that the health and nature of a river is dictated primarily by its flow: the more of its natural flow that is removed, and the further that the remaining floods and low flows are moved from their natural timing, the more the river will deteriorate. Clearly, a more all-embracing approach to managing rivers was needed, one that weighed the health of the river ecosystem and the resources it naturally provides against the benefits that would ensue if its water was used elsewhere. On both sides of this equation there are costs as well as benefits. We envisaged an approach that would identify the trade-offs to be made between resource protection and development so that stakeholders could consider a range of visions of what the future could be like, and decision-makers have more comprehensive and balanced information upon which to make development decisions. More than all this, we realized that water scientists, water managers, developers, political decision-makers, economists, sociologists and all the stakeholders in the river need to see themselves as one team — working together for a solution that they will all recognize as the optimum for their situation.

From my research I recommended to the Water Research Commission that such a new holistic approach be developed, and started work on it with the national Department of Water Affairs. Through the early 1990s I led flow assessments for about 15 rivers that had been identified for development, gradually building up the holistic approach in close collaboration with the country's water scientists, water managers, government officials and decision makers. Our activities produced the first internationally recorded holistic flow assessment method, and ultimately convinced lawyers writing South Africa's new post-apartheid water law that we could quantify the volume of water required to maintain rivers at a level of health negotiated between government and other stakeholders. Water for supporting aquatic ecosystems thus became one of only two rights within the Water Act of 1998 — the other right being for basic human needs. Our water law is now internationally recognized as one

Dr. King Talk Scheduled

Jacqueline King will be presenting a public lecture, "Wounded Rivers, Thirsty Land: Striking the Balance Between Resource Protection and Development (Why Conserving Aquatic Systems Makes Business Sense)" Aug. 9, at 4 p.m. in Room 208 McClelland Hall, Eller College of Management, University of Arizona. Dr. King is an internationally recognized expert on environmental flows: the amount of water rivers and other bodies of fresh water need to survive. She has advocated changing the way rivers and other freshwater bodies, including groundwater, are viewed, protected and managed.

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UA Program Announces Water Research, Education, Outreach Grants

All newly funded programs address Arizona water issues

June 30 marked the end of the first five-years of funding for the University of Arizona Water Sustainability Program (WSP) through the Technology and Research Initiative Fund (TRIF). A wealth of new products and publications have been produced including new tools, patent applications, decision support models as well as investigations and information on conservation measures, emerging contaminants, arsenic and drought planning, to name a few. Also produced were new educational programs and opportunities for legislators, students and the public.

Results of 21 grants projects to be completed this year will be variously reported: in a summary publication, during the second annual water forum in the fall and through updates on the WSP web site: www.uawater.arizona.edu.

Building on the momentum, the next five years of the WSP show great promise for the delivery of many new water technologies, products, services and information to help decision-makers and water managers address Arizona water issues, stimulate economic development and enhance the quality of life.

Beginning in FY 07, UA faculty and staff will be taking on 20 new projects that address water quality, supply and management. Also, multiple water education and outreach projects targeting specific audiences will be conducted. In addition, nine outstanding fellowship students will be supported in their water related studies. A new Recruitment and Research Initiative has been launched that will bring eight world class faculty to several water-related disciplines in the next academic year; seed money to develop proposals for two new cutting-edge centers is being invested, and funds have been committed to three projects to develop state-of-the-art facilities to boost UA's competitive position for national and international research funding.

Each year for the next five years, \$1 million will be awarded to UA faculty and staff, for projects selected through a competitive review process. A panel of reviewers from the university and the public and private sectors will discuss and evaluate proposals and make funding recommendations. The WSP Executive Committee makes the final award selections based on panel recommendations.

This year, grant projects addressing Arizona water quality issues include studies of salinity, arsenic, nitrates, uranium and endocrine disruptors. Water supply studies include analysis of water sources in the Verde Valley, estimation of state-wide water reserves through satellite data and development of a model for outdoor residential water use. Water education and outreach projects include volunteer precipitation monitoring, development of a local



Research will study post-fire floods and debris flow to assess resulting hydrologic and geomorphic process changes. (See page 2, Victor Baker, PI) Above photo is Esperero Canyon, 2004. Photo: Betsy Woodhouse

water budget through community involvement, water education at Phoenix Zoo and bilingual water quality information for the consumer. Other projects address irrigation concerns of salinity and efficiency. Projects are summarized below.

NEW PROJECTS

Maximizing Water Recovery During Reverse Osmosis Treatment of Central Arizona Project Water. \$43,664. Robert Arnold, Wendell Ela, Dept of Chemical and Environmental Engineering, Martin Yoklic, Dept of Soil, Water and Environmental Science. Without treatment for salinity control, full use of the southern Arizona CAP entitlement will add 200,000 tons of salt to the Tucson Active Management Area each year. Reverse osmosis is the most probable method of salinity management. Previously tested RO methods yield a brine volume of ~40,000 AFY. The estimated value of lost water is \$40 M \cdot yr⁻¹. The project will investigate methods to minimize membrane fouling/scaling while maximizing water recovery (minimizing brine volume) during RO treatment of CAP water.

Spanish Translation and Reprints of the Booklet, "Arizona: Know your Water (2004)." \$23,100. Janick Artiola, Dept of Soil & Water Science, Katherine Farrell-Poe, Dept of Agricultural and Biosystems Engineering. This project expands the transfer of water quality related information on home water treatment through Spanish translation and

reprint in English of a TRIF-funded publication. A Spanish translation will provide information on home water treatment alternatives to the Spanish-speaking population of Arizona. A reprinting of the English version will enable a further distribution of this well-received consumer water information booklet.

Assessing Impacts of Arizona Wildfires on Watershed and Riparian Hydrologic and Geomorphic Processes. \$49,620. Victor Baker, Dept of Hydrology and Water Resources. This project will assess post-wildfire hydrologic and geomorphic process changes through the study of post-fire floods and debris flow. Data from various sources will be collected and analyzed to establish factors influencing the occurrence of post-fire floods and debris flows, to evaluate the effectiveness and accuracy of prediction models, and to evaluate post-fire flood discharges with regional paleoflood magnitudes to assess long-term hydrologic variations. Results will provide new methods for predicting, planning and mitigating post-fire geologic hazards, and information for long-term water quality and supply planning.

Electrocoagulation Applied to Water Conservation & Wastewater Treatment. \$75,000. James Baygens, James Farrell, Dept of Chemical and Environmental Engineering. Intel and others in the semiconductor industry are interested in developing a robust, cost effective water treatment technology with broad application to both water conservation and wastewater treatment. The new treatment technology will reduce the number and variety of water treatment unit operations that are currently required, and will enable onsite reuse of much of the water used in semiconductor manufacturing. Electrocoagulation (EC) is one of the few technologies that may be capable of cost effectively meeting these requirements.

Water Discovery (Water Education Exhibits & Discovery Carts). \$45,677. Carla Bitter, Kyle Carpenter, SAHRA, Dept of Hydrology & Water Resources. To encourage public understanding of crucial water issues, SAHRA, in cooperation with The Phoenix Zoo, will develop and construct two stationary and two mobile water education exhibits at The Phoenix Zoo. These will be hands-on demonstration areas to engage zoo visitors with vital water issues in an entertaining and informal setting. Zoo staff and volunteers will participate in workshops to learn to facilitate activities and programs around the exhibits to enhance visitors' knowledge of Arizona water quality, water conservation, and basic hydrology on the Zoo's Arizona Trail.



Outdoor water user

Modeling Outdoor Residential Water Use. \$40,111. Bonnie G. Colby, Dept of Agricultural and Resource Economics. A pilot study in the Tucson metro area will be conducted to model the drivers of outdoor residential water demand. This study will examine the housing structure, socio-economic, climatic, and environmental drivers of outdoor water

demand using multiple sources of data, some provided specifically for this project by government partners. Significantly, not only how housing structure and demographics shape demand will be investigated, but also how nearby non-residential vegetation (undeveloped lots, riparian corridors, golf courses, and parks) and the extent of native vegetation at the lot level, impacts homeowners' outdoor water use. Research results will inform water management, open space conservation and riparian restoration policies, and development and landscaping guidelines in Arizona's urban and rural areas.

Developing a Volunteer Precipitation Monitoring Program for Arizona. \$34,062. Michael Crimmins, Dept of Soil, Water, & Environmental Science. A volunteer, citizen-based precipitation monitoring network will be developed to complement existing official climate monitoring networks across Arizona. The additional denser spatial coverage of observations provided by volunteers will help natural resource managers make more informed decisions regarding the management of water and land resources. This program also provides the opportunity to involve volunteers or 'Citizen Scientists' in data collection and research with respect to climate variability and Arizona water resources.

High Capacity, Environmentally Benign Sorbents for Treating Arsenic Regenerant Streams. \$42,500. Wendell Ela, Eduardo Sáez, Dept of Chemical and Environmental Engineering. Current technologies to remove arsenic from drinking water rely primarily on the use of sorbents utilizing iron-based surfaces. The iron-based sorbents are non-regenerable and, when saturated, will typically be disposed in non-hazardous landfills where the iron is readily reduced to the more soluble Fe(II) state, thus remobilizing the arsenic. This project will investigate non-iron based sorbents for treating arsenic bearing brine streams produced when re-usable sorbents are regenerated. The project aim is to identify and/or develop stable sorbents that can selectively sorb arsenic from a regenerant brine and subsequently retain it (with or without stabilization) under landfill disposal conditions.

On-line Access to Distance-Learning Tools for Watershed Stewardship in Rural Arizona. \$41,469. Robert Emanuel, Arizona Cooperative Extension, Garry Forger, Learning Technologies Center, George Zaines, School of Natural Resources, Michael Crimmins, Dept of Soil, Water, & Environmental Science. The Arizona Master Watershed Steward Program, a partnership of the Arizona Cooperative Extension and the Arizona Department of Environmental Quality, provides watershed management community-driven outreach. The program seeks to increase its reach into rural and isolated areas to enhance skills-based learning. The project will utilize distance-learning tools to allow greater access to the program by underserved communities. The Learning Technologies Center and Arizona Cooperative Extension will collaborate to achieve these goals.

Bioremediation of Hexavalent Uranium Plumes With Inorganic Electron Donors. \$52,762. Jim Field, Dept of Chemical and Environmental Engineering. Hexavalent uranium (U(VI)) is a groundwater contaminant of concern in Arizona. The project goal is to demonstrate that U(VI) can be removed from groundwater by microbial reduction to insoluble

STUDENT FELLOWSHIPS

During the next five-years of TRIF funding, WSP will award fellowships to outstanding undergraduate and graduate students involved in water-related work relevant to Arizona water issues, with \$85,000 allocated annually for this program. Department heads nominate applicants; to date recipients have represented six colleges (Agriculture and Life Sciences, Engineering, Social and Behavioral Sciences, Law, Eller College of Management and Architecture and Landscape Architecture) and 13 different departments, exemplifying the cross-disciplinary nature of UA water programs. Awards are to encourage undergraduates to pursue research and career interests in water and support graduate students with the demonstrated potential to make a water resource impact at UA and beyond.

The WSP Executive Committee selected the following students to receive awards in FY 07 based on academic performance, the quality of research proposals, the relevance of the study area to Arizona water issues and the recommendation of the department head. Funding will begin fall semester, 2006. Students are required to prepare reports and present summaries of their research in spring semester, 2007.

Undergraduate Fellowship Recipients: *Deena Clark*, Veterinary Science & Microbiology, Advisor: Kelly Bright. *Alternative Methods of Drinking Water Disinfection*; *Jerry Shen*, Agricultural and Biosystems Engineering, Advisor: Chris Choi. *Implementa-*

tion of a New Water Quality Model into EPANET in Hopes of Reducing Arizona Public Drinking Water Systems' Vulnerability to Contamination; *Sean Small*, Economics, Advisors: Gary Libecap and Stan Reynolds. *Analysis of Legal Barriers to Trade on the Transfers of Water in the West*; *Devin Whipple*, Chemical and Environmental Engineering, Advisors: Jim Baygents and Jim Farrell. *Electrocoagulation: A Technology for Water Recycle and Wastewater Treatment in Semiconductor Manufacturing*.

Graduate Fellowship Recipients: *Dustin Garrick*, Geography and Regional Development, Advisors: Carl Bauer and Kathy Jacobs. *Simulating Sustainability: Conjunctively Managing Land and Water Resources in the Upper Santa Cruz River Valley*; *Victor Grijalva*, Environmental Engineering, Advisor: Reyes Sierra. *Selective Removal of Heavy Metals from Acid Mine Drainage Using Anaerobic Bioreactors*; *Peter Littlebat*, Environmental Engineering, Advisor: Bob Arnold. *Development of a Bioassay to Measure Thyroid Hormone Activity in Environmental Samples*; *Amy McCoy*, Arid Lands Studies, Advisor: Barron Orr. *Causes, Consequences, and Management Implications of Riparian Tree Die-off in the Upper Santa Cruz River: A Case Study for Shifting Riparian Conditions*; *Aleix Serrat-Capdevila*, Hydrology and Water Resources, Advisor: Juan Valdés. *Climate Change: Coupling Hydrologic Modeling with Policy Making*.

uraninite. The project contemplates the use of elemental sulfur (S0) as an inexpensive electron-donating compound to drive the microbial reaction. S0 is inexpensive and is available in granulated forms that are suitable for a flow through permeable reactive barrier treating contaminated plumes.

Valuation of Binational Effluent in the Upper Santa Cruz Basin: Estimating Willingness to Pay. \$39,552. *George Frisvold*, Dept of Agricultural & Resource Economics, *Terry Sprouse*, Water Resources Research Center. Effluent originating in Mexico, but treated and used in Santa Cruz County, serves southern Arizona by recharging aquifers, sustaining a riparian corridor, attracting tourists, and increasing land values. A FY 2005 WSP project broadly assessed the community value of the riparian corridor; this project focuses on directly estimating willingness to pay for the Mexican effluent and its contribution to the riparian corridor, using a contingent valuation survey. Comparative analysis of prices paid for effluent in other locales also will be used to assess willingness to pay for effluent for other uses.

Control of Emerging Waterborne Parasites: Naegleria fowleri. \$62,741. *Charles Gerba*, Dept of Soil, Water and Environmental Science. The project goal is to reduce the risk of *Naegleria fowleri* exposure in Arizona drinking water. Research suggests that *N. fowleri* contaminates eight percent of municipal drinking water supply wells in Arizona. Our objectives are to develop guidelines for drinking water disinfection and removal of *N. fowleri* by faucet mounted point-of-use (POU) devices. These will be accomplished by determining Ct (chlorine concentration X time) values and UV light dose requirements for

inactivation of *N. fowleri* in drinking water. Consumer available POU units will also be assessed.

Watershed Rainfall, Ground Water Usage, Riparian Stream Flow and Vegetation Monitoring, Middle San Pedro River Basin, Cochise County, AZ. \$2,500. *Phil Guertin*, *Kristine Uhlman*, School of Natural Resources. This project will assist volunteers from the Community Watershed Alliance, a partnership of private citizen stakeholders from five communities and land-use managers in the Middle San Pedro Watershed, by providing instrumentation and training to develop an area water budget. Volunteer efforts will include measuring rainfall, intermittent stream flow in response to periodic rainfall, riparian vegetation and groundwater extraction. Twenty rain gages, ten groundwater flow meters, and six stream flow observation stations will be placed across the watershed, and training will be provided for monitoring riparian vegetation in the Middle San Pedro.

Salinity Induced Disease of Turfgrass. \$9,464. *Mary Olsen*, *Jeff Gilbert*, Dept of Plant Sciences. A new disease of turfgrass, "rapid blight", is problematic in Arizona in coolseason turfgrasses irrigated with high salinity irrigation water. Recent laboratory research shows that elevated sodium chloride is required for disease development while other salts in irrigation water, including potassium and calcium salts, do not cause disease development. Preliminary evidence in the field suggests that disease may be induced in turfgrasses when salinity is increased indicating that the pathogen is present but not active. The project will determine if *L. terrestris* infection can be induced with sodium salts in the field. Field sites will be amended with different

salts to elevated salinities and turfgrasses sampled for colonization by *L. terrestris*. Companion laboratory trials will be conducted in salt amended media and in inoculated seedlings to determine if sodium is a requirement for disease development and/or growth of the pathogen and if anions other than sodium actually suppress disease.

Groundwater Sources, Flowpaths and Residence Times in the Middle Verde River Watershed. \$43,721. James Hogan, Tom Meixner, Dept of Hydrology and Water Resources. The project involves studying a suite of



View overlooking Sedona and the Verde basin.
Photo, James Hogan

naturally occurring isotopic tracers to constrain groundwater sources, flowpaths, and residence times in order to improve the conceptual understanding of basin hydrogeology and better estimate recharge rates within the middle Verde River Watershed.

Specifically the focus is on determining the hydrologic connection between aquifer units in the Coconino Plateau recharge zone and the Verde Valley regional aquifer, and understanding how these water sources and flowpaths contribute to and sustain baseflow within the Verde River. The research will improve understanding of groundwater resources within the Verde Valley and complement ongoing research supported by the USGS, the Arizona Water Institute and SAHRA.

Predicting Groundwater Vulnerability to Nitrate in Arizona. \$69,992. Taubidur Rahman, Dept of Agricultural and Resource Economics, Kristine Uhlman, School of Natural Resources. The project will develop appropriate statistical models to predict vulnerability of groundwater to nitrate concentrations in Arizona and generate "probability maps" that delineate areas according to the probability of detecting nitrate concentrations. The analysis will inform decision-makers as to the magnitude, extent, distribution, and uncertainty of current and anticipated nitrate risks, and help regional and local water managers protect water supplies by targeting land-use planning solutions and implementing monitoring programs where groundwater may be vulnerable.

Mapping Accumulation of Soil Salinity in Landscapes Irrigated With Reclaimed Water. \$31,154. Ursula Schuch, Dept of Plant Sciences, James Walworth, Dept of Soil, Water and Environmental Sciences. The research aims to understand how long-term use of reclaimed water affects soil quality and plant performance. Soil salinity of landscape sites irrigated for five or more years with reclaimed or potable water will be mapped using soil samples and EM38 technology which uses electromagnetic induction sensors to measure soil salinity in situ. This information can be used to develop management strategies that prevent degradation of

soil structure and accumulation of salts in the root zone as sources of irrigation water increase in salinity.

Estimating Arizona's Water Reserves From Space-borne Gravity Observations. \$32,825. Peter Troch, Dept of Hydrology and Water Resources. Total water storage is a fundamental hydrologic state of a river basin and responds to atmospheric forcing on seasonal to inter-annual time scales. Understanding how anomalies in a basin's total water storage relate to hydrologic extremes (e.g. droughts) is an important issue in managing water resources. The Gravity Recovery and Climate Experiment (GRACE) twin satellites observe monthly changes in the Earth's gravity field. Over land, one can adjust the signal for all known processes that affect gravity, producing a signal closely related to changes in total water storage. This research will make significant contributions to our capacity to estimate total water storage dynamics across Arizona.

Quantifying Generational Effects of Endocrine Disruption in Bonytail Chub (Gila elegans) Exposed to Secondary-Treated Wastewater. \$51,174. David Walker, Dept of Soil, Water and Environmental Science. Previous study has proven that a two-thirds dose of wastewater from the Santa Cruz River causes androgenization of female and feminization of male bonytail chub after a three-month period. This is the first study to quantify this effect by comparing treated fish to controls. While this work infers reproductive impairment, quantifying it requires induced spawning and examining fecundity of treatment compared to control fish. Sex ratios and potential endocrine disruption of the F2 generation will also be examined. This will greatly increase statistical power and relevance of the original work.

Implementation of Efficient Surface Irrigation Practices in the Lower Colorado River Region. \$40,000. Dawit Zerihun, Charles A. Sanchez, Yuma Agricultural Center. Surface irrigation is the principal method of irrigation in the lower Colorado River region. Recent research has demonstrated a potential for substantial improvement in surface irrigation performance by implementing improved management practices and guidelines developed by Yuma Agricultural Center research programs. Widespread adaptation of these practices by growers has not yet occurred. This project seeks to hasten the transfer of this technology by overcoming existing obstacles to adaptation and by providing bilingual outreach and training to growers and irrigators.

Water Sustainability Program

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Legislation and Law

Bill Protects Volunteers Who Clean Mine Waste

In an attempt to ensure that one particular good deed goes unpunished, legislation has been introduced to provide legal exemptions for persons volunteering to clean rivers and streams polluted from runoff from old mines. This has been a perennial concern that has prompted various bills for over a decade, thus far without success.

Supporters of the "Good Samaritan Clean Watershed Act" S.2780 hope for success this time around, with legislation that will shield volunteer organizations from potential liability for efforts undertaken to restore watersheds damaged by drainage from mines. The act was introduced by Sen. James Inhofe (R-Okla.) on behalf of the Bush administration. Similar bi-partisan legislation was introduced earlier in the year by Sens. Wayne Allard (R-CO) and Ken Salazar (D-CO).

As it is now, volunteers who work at reducing such pollution could find themselves liable for more than they willingly took on. The Clean Water Act and the Comprehensive Environmental Response, Compensation and Liability Act do not permit partial clean-ups; volunteers whose efforts result in partial cleanup on a mining site could end up liable for all remaining pollution.

Environmental Protection Agency Administrator Stephen L. Johnson says the bill will equip "America's eager army of citizen conservationists with the essential tools to protect our shared environment."

The proposed law's permit process outlines who is eligible for a permit, the sites for which permits may be issued, and what must be included in the permit. The process allows local citizens and communities an opportunity to provide input on Good Samaritan projects. The applicant must submit a clean-up plan indicating a schedule, financial resources, and the waste disposal strategy.


The House of Representatives is working on similar legislation, with Rep. Mark Udall (D-CO) having introduced a companion bill to the Allard and Salazar bill. Rep. John Duncan Jr. (R-TN), Chairman of the House Subcommittee on Water Resources and Environment plans to introduce a companion to Sen. Inhofe's bill. The bills are pending before respective committees.

There are hundreds of thousands of abandoned mines throughout the United States now leaching acid, mercury, arsenic, copper and other heavy metals into streams, with most located in the West. Trout Unlimited figures there are tens of thousands of miles of streams polluted and about 40 percent of stream headwaters in the West.

Responsibility for the pollution is difficult to ascertain, with mine ownership at times going back over a hundred years and involving various private and public organizations. Companies responsible for the pollution may have long been out of business. Identifying responsible parties is thus fraught with complications and uncertainties.

The bill garnered mixed reviews, with one advocacy group hav-

ing encountered the first Bush administration initiative it could support while Rep. Nick Rahall (D-W.Va) was appalled saying that owners of hard rock mines would be getting a "free pass" from liability under the Superfund and the Clean Water Act requirements. Others found the bill lacking for not proposing a funding source and not establishing standards for clean up.

More information on the Good Samaritan Clean Watershed Act is available at <http://www.epa.gov/goodsamaritan/> 

Justices Affirm States' Power to Regulate Rivers

A 9-0 U.S. Supreme Court ruling affirmed the right of states to set environmental requirements for hydropower dams. In effect, the decision was based on an interpretation of "discharge," whether water passing through a hydroelectric dam is discharge. If water moved from one side of dam to the other is discharge, state regulatory agencies could require Clean Water Act permits.

S.D. Warren, a paper company operating five dams in Maine, objected to having to obtain water quality certificates from state authorities as specified by the CWA when it applied to the Federal Energy Regulatory Commission to renew its licenses. It claimed its dams did not result in any discharge into the river, that nothing was added to the stream.


The company argued that federal regulations were sufficient and that state-administered permits are redundant. Daniel Adamson representing the Edison Electric Institute said, "If the state has the authority then the federal power act becomes an anility."

This posed a rather broad threat to states' ability to apply the CWA to require hydroelectric dams to mitigate any detrimental effects on water quality. Environmentalists argued that water passing through a dam undergoes chemical, biological and physical changes that warrant applying CWA regulations. Further, such changes could affect habitat value and fish health.

The Supreme Court sided with the environmental position. "The alteration of water quality ... is a risk inherent in limiting river flow and releasing water through turbines," Justice David Souter wrote. "Changes in the river like these fall within a state's legitimate legislative business and the Clean Water Act provides for a system that respects the states' concerns."

Souter noted that "Warren itself admits that its dams can cause changes in the movement, flow, and circulation of a river."

The decision has implications to more than 1,500 hydroelectric dams in 45 states and whether they may be regulated under the CWA. The opinion is available at <http://www.eswr.com/306/sdwarrenopscotus.pdf>

The opinion upheld a Maine Supreme Judicial Court decision that "water that has left its natural state and has been subjected to man-made control" could be regarded as discharge. The case is S.D. Warren Co. v. Maine Board of Environmental Protection, 04-1527. 



Publications & On-Line Resources

Tribal Water Rights

ESSAYS IN CONTEMPORARY LAW, POLICY, AND ECONOMICS



Edited by John E. Thorson, Sarah Britton, and Bonnie G. Colby

Tribal Water Rights: Essays in Contemporary Law, Policy, and Economics

Edited by John E. Thorson, Sarah Britton and Bonnie G. Colby. University of Arizona Press, \$50 cloth. (Check UA web site for ordering information: <http://www.uapress.arizona.edu/>)

Indian water rights is a multifaceted issue, best approached with an awareness of history and culture and a knowledge of the workings of contemporary law, policy and economics.

In addressing the issue, Tribal Water Rights is a book of many topics and many voices, consisting of articles covering a range of subjects written by authorities, scholars and workers in the field concerned with Indian water rights.

The book is divided into four parts: State-Tribal-Federal Regulations, Quantification, Settlement, and Management. These are the broad categories; practicing attorneys, law, economic and public policy experts and conflict resolution facilitators then address topics within those categories. The authors take varied approaches providing background information, discussing concepts

and relating their experiences.

For example, articles included in the Settlement section are: Negotiating Indian Water Rights, Reassessing Klamath, Filling the Gaps in Western Water Law, and What Makes Water Settlements Successful? They were written by a judge, conflict resolution facilitators, lawyer/associate professor and economics professor respectively.

The coverage is sufficiently broad that the book will interest those wanting to learn about tribal water rights as well as those actively involved in working on settlements and seeking practical advice.

The varied topics and varied approaches provide the reader with abundant information but also emphasize the complexity of the tribal water right issues that challenge efforts to negotiate and implement water rights settlements. Issues that continue to challenge settlements are identified at the same time that progress and successes are noted.

The intent of the book is to encourage a better understanding of the process and thereby aid Native Americans to achieve nonlitigious settlements.

The editors of this volume also collaborated in writing Negotiating Tribal Water Rights. Published in 2005 also by UA Press, the book reviews the processes that lead to successful settlements.

Projects to Enhance Arizona's Environment: An Examination of Their Functions, Water Requirements and Public Benefits

Sharon B. Megdal, Kelly Mott Lacroix and Andrew Schwarz, University of Arizona's Water Resources Research Center. Available on the WRRC's web site: <http://cals.arizona.edu/azwater/> Click "Recent Publications." CD version available upon request.

The decline of wetlands in Arizona has prompted various restoration efforts, to fix damaged sites and create new riparian and wetland areas. In featuring 30 environmental enhancement projects, this publication provides a sample of the many efforts underway in the state. To ensure a diverse sampling, projects were selected with varied sponsors, locations and intentions.

The study focuses on certain characteristics of the enhancement projects that best provide an overview of the projects — their drivers, sponsorship, benefits, water requirements and lessons learned. Drivers are reasons projects were undertaken; most projects have multiple drivers, with 19 drivers cited for the 30 projects. Drivers include providing habitat, economic development, flood protection, environmental education and water quality improvement.

Sponsorship was determined to be an important factor in the design and implementation of the projects. Sponsoring the projects, wholly or in part, are city, county, state and federal agencies, tribes, non-governmental organizations, private landowners and universities.

Varied benefits resulted from the projects — 16 different benefits are identified — with all projects listing more than one. Benefits are qualities over and above the drivers; they are additional accomplishments beyond the primary reasons that initially prompted the project. All 30 projects achieved a habitat value benefit, with the next three most often cited benefits to the advantage to humans: public use, environmental education and flood protection.

Water use is an important part of the study. The authors asked: what is the source of the projects' water? Are unprotected instream flows a source? Are water rights purchased? If so, at what cost? What projects get by without importing water?

Finally there is summary of lessons learned. These are not just research results; lessons learned are information, observations and comments that can qualify as advice. The authors identify the lessons as the six peas (P's) in the pond: preparation, persistence, partnership, progress, pests and post-construction.



Sweetwater Wetlands, Tucson
Photo: Andrew Schwarz



Special Projects

Water Resource Issues Raised, Discussions Abound at WRRC Conference

The title of the Water Resources Research Center's conference, "Providing Water to Arizona's Growing Population: How Will We Meet the Obligation?," posed a very broad question to program participants. Unsurprisingly, posing this big question to a group with diverse and varied backgrounds — rural, urban, environmental, development along with elected officials, utility managers, and local, county, state and federal government officials — evoked a plethora of information and views. Following are a few of the issues discussed at the conference.

The speakers generally held the view that water will not be the factor limiting growth in the state. Grady Gammage, private attorney and senior research fellow at Arizona State University's Morrison Institute, described the situation: "We can continue to (expand) Arizona's population but we do so at a price. We do it at a price of a lifestyle that many people in urban areas currently enjoy." Lifestyle is the critical draw. Water is needed once people settle here, which they are less likely to do if congestion and poor air quality lessen Arizona's appeal and draw.

According to some speakers desalinization holds promise to landlocked Arizona, either for use to treat the state's brackish water

or, through an agreement with California, to treat ocean water. The most ambitious desalinization scheme — he called it "exotic — was offered by CAP's Larry Dozier who outlined a plan to construct a large desalting plant on the Gulf of California and a Palo Verde-sized power plant beside it. He said, "This would form a modular plant that would be able to perhaps produce a million-and-a-half acre feet of water per year."

Gammage challenged Robert Johnson, regional director, Bureau of Reclamation, after

decisions in a vacuum. We can communicate to them the implications of the decisions."

Present state water laws came up for criticism. Director of Water Resources Herb Guenther summarized what he believes to be a deplorable situation. He said, "Water laws are very convoluted; in fact, they are conflicting to a large degree. The problem is that we are unable to make reasonable decisions regarding growth.

"Outside AMAs we ask people to get a determination of adequacy, but if you don't, that is OK; you can build anyway. Those getting a determination of adequacy compete with those with a determination of inadequacy; nobody has priority."

Jacobs suggested that a water adequacy program would attract greater acceptance if it were reframed as a private property protection issue. She said it would gain further support if it were viewed as providing certainties for people making investments. Guenther's and Jacob's were two voices in a chorus of criticism of the water adequacy program.

Guenther also lamented his agency's lack of authority saying, "ADWR is a paper tiger. We growl and snarl and make all sorts of noises, but we have very little enforcement authority."

The Central Arizona Groundwater Replenishment District was vigorously discussed. Several speakers said CAGRDR was working just fine, enabling developers to more readily demonstrate assured water supplies. Warren Tenney, assistant general manager, Metropolitan Water District, very much disagreed with that assessment. He believes the CAGRDR is not serving the long-term water management interest of the state. He said that without CAGRDR subsidies, "Development and growth would be slower; our quality of life would be higher; and our economy would be less growth-based and more diversified and healthy."

Kris Mayes of the Arizona Corporation Commission believes her agency is making strides to protect public interest. She said explosive growth occurring outside Active Management Areas necessitates that actions be taken to protect public interest before granting a water company a Certificate of Convenience and Necessity to serve a region. She said that the ACC can enforce Orders Preliminary, which enables the ACC to outline preconditions to be met by companies before granting a CC&N; thus it would be ensured that specific needs and concerns of a service area are being met including a determination of an assured or adequate water supply.

Environmental needs were considered. Pat Graham, state director of The Nature Conservancy, said an approach to better ensure sustainability from nature's perspective would be "to identify those bounds that are necessary to support our ecosystems and decide water use and consumption (accordingly)."

In conclusion, Jacobs reiterated a message oft repeated at the conference when she urged a collaborative approach to acquiring water supplies rather than everyone looking out the themselves. She said, "We need a collaborative approach because competition is going to hurt everyone." ■

Making of the 100-year Assured Water Supply

In a comment from the audience, Phil Briggs told how 100 years came to be the measure of an adequate water supply. In the early 1970s the Arizona Legislature was discussing the need for a statewide water adequacy statute as a consumer protection measure. In a committee hearing the Arizona Director of Water Resources at the time, Wes Steiner, agreed with lawmakers that a long-time supply needed to be assured. When asked what he considered a long time Briggs said Steiner responded along of lines of, "I don't know. A hundred years?" And it was written into law.

Johnson said during his luncheon speech that his role as water manager is to provide information, with others making land-use decisions. Gammage said water managers need "to get over" that attitude and get more involved in decision making. In the conference's concluding remarks, Kathy Jacobs, executive director of the Arizona Water Institute, picked up on this idea saying that, although elected officials make the decisions, "They don't have to make those



Announcements

Natural Areas Conference

The Natural Areas Association and the National Park Service will co-host the 33rd Annual Natural Areas Conference, "Stewards of the Old and New West," to be held at Northern Arizona University Sept. 20-23. The program will include keynote speakers, symposia, contributed papers and posters covering a broad range of natural area and biodiversity preservation issues. Pre, post and mid-conference field trips will expose participants to the beauty, traditions, and conservation issues of the Colorado Plateau. The conference will address the possible conflicts between the Old West traditions of Native Americans and ranchers and the New West views of new full-and part-time residents. To register or for information about the event check, <http://cpcesu.nau.edu/NAC2006/>

AHS Annual Symposium

The Arizona Hydrological Society's 19th annual symposium, "Water & Water Science in the Southwest — Past, Present, & Future," will be conducted Sept. 13 - 16 in Glendale. The annual AHS symposium is a premier event in the Southwest for hydrology and water resources science, engineering, and public policy. This year's technical sessions will include the following topics as they relate to the history, present state, and future of water and water science in Arizona and southwestern United States: recharge, surface water, subsidence, drought conditions, groundwater remediation, tribal issues, sustainability, Colorado River issues, water rights and adjudications, privatization, regulatory agencies, water supply and delivery/distribution, climate change and growth. For additional information check the AHS web site: <http://www.azhydrosoc.org/>

Floodplain Management Conference

The Floodplain Management Association's annual conference, "Challenges in Sustainable Floodplain Management and Development," will be conducted Sept. 5-9 in Coronado, California. Pre-conference workshops will be conducted Sept. 5, with the regular program beginning the next day. Workshops, oral presentations and posters will address floodplain development and management issues, watershed management planning, environmental restoration

and flood damage reductions, public education and outreach, etc. For more information about FMA and its upcoming conference check: www.floodplain.org



Conference on Managing Stormwater, Harvesting Rain

A conference titled, "Looking Ahead: Managing Stormwater and Harvesting Rainwater for Conservation" will be conducted Oct. 27-28 in Tucson.

Presentations will focus on methods to satisfy federal stormwater management requirements, the incorporation of Best Management Practices, and techniques for the beneficial use of rain and stormwater. Site design, land preparation, roof top collection and groundwater infiltration methods will be presented for large and small scale projects — from subdivision designs to homeowners' yards. An optional field trip will be on Oct. 28. Conference sponsors include the U.S. Bureau of Reclamation, ARCADIS, University of Arizona, the Water Resources Research Center. For more information see www.arcsa-usa.org or contact Cado Daily at cdaily@ag.arizona.edu Submit abstracts to Terry Sprouse at tsprouse@ag.arizona.edu

WaterReuse Symposium

The WaterReuse Association, the Water Environment Federation, and the American Water Works Association are sponsoring the WaterReuse Association's 21st Annual Symposium, Sept. 10-13 in Hollywood, California. The symposium will focus on both water reuse and desalination as alternative sources in today's water-scarce world, with technical sessions devoted to diverse topics such as micropollutants, desalination, indirect potable reuse, operational issues, and global water reuse. Technical tours are also part of the program. For additional information check: www.watereuse.org/2006Symposium/

Guest View...continued from page 6

of the most advanced and innovative in the world.

The trade-offs each country makes when developing rivers — either explicitly through addressing them, or by default through ignoring them — are woven into the very fabric of human society, and they affect us all. How much are we willing to lose in order to gain the benefits that development can bring? How can all stakeholders take part in the discussion on this? How can scientists, sociologists and economists accurately describe the full spectrum of ecological, social and economic

implications of a range of development paths in a way that stakeholders and decision-makers can understand and use? This is where this new science sits today, addressing these challenges, and growing to maturity in countries across the world as a management tool for Integrated Flow Management. Developed and developing countries — more than 50 to date — are embracing a new holistic approach to water management. Their circumstances may differ but the fundamental challenge for all nations is the same: more informed and more equitable decision-making that will enable truly sustainable water development. ■



Public Policy Review

by Sharon Megdal

Time For Annual State-Of-The-WRRC Report



I devote one column a year to providing an update on developments at the Water Resources Research Center. The end of the fiscal year provides a suitable occasion, so here I go.

The WRRC is like most other organizations, with things at times remaining the same and at other times rapidly changing. WRRC acquired new staff, with Susanna

Eden joining us in November as an applied research coordinator. A University of Arizona Hydrology and Water Resources Department graduate who was previously with WRRC, Susanna worked on a chapter on water and growth for the spring 2006 Arizona Town Hall background report. She is heading the WRRC collaborative effort with the Water Education Foundation to develop an Arizona volume for WEF's "Layperson's Guide" series. The "Layperson's Guide to Arizona Water" is scheduled for completion spring 2007.

Among her many other responsibilities, she is working with me on a report on artificial recharge to be issued as part of our Arroyo series. Predating our bi-monthly newsletter, Arroyo reports in-depth on a single issue. Its regular publication disrupted by resource constraints, Arroyo will get a new life with the publication of the recharge issue.

Carl Bauer will become WRRC associate director this fall, with a joint appointment as professor of geography and regional development. His multi-disciplinary background and work on international water will enhance WRRC's policy work. Kerry Schwartz, who has guided Arizona Project WET (Water Education for Teachers) through much expansion, has been appointed associate specialist, a faculty position providing expanded opportunities for professional and programmatic growth. Arizona Department of Environmental Quality funding supported Kristine Uhlman who, working with UA Professor Phil Guertin, developed Project NEMO (Non-point Education for Municipal Officials). Her appointment this fall as area assistant agent with Extension will provide her faculty status, with an affiliation with both WRRC and Pima County Cooperative Extension. Kristine's work focuses on watershed characterization and mapping.

Kathy Jacobs' appointment as executive director of the Arizona Water Institute, a cooperative venture of the three state universities, has reduced her WRRC commitment. WRRC's collaboration with AWI, however, keeps us working together.

The Arizona Board of Regents' approval of the business plan for the Water Sustainability Program, a project funded by the Technology Research Initiative Fund, enables WRRC to continue its work with UA water centers, faculty and staff on water research, education and outreach that address Arizona water issues. WRRC's Jackie Moxley continues to coordinate this program, its key components including competitive grants, student fellowships, and recruitment and research initiatives. We are pleased about the program's

five-year renewal. (See supplement included within this newsletter for description of new WSP-sponsored projects and list of students who were awarded fellowships.)

We continue to take on varied types of programs, including Terry Sprouse's work on water issues in the Ambos Nogales area and water harvesting. Our newsletter, the Arizona Water Resource, continues to garner praise, particularly features written by editor Joe Gelt.

My position as WRRC director took me to Washington, DC to request continuation of U.S. Geological Survey 104B grants program funding. A small program by federal standards, 104B is nevertheless important to water centers across the country. We are optimistic its funding will be restored. Also I journeyed to the capitol to present testimony to the Water and Power Subcommittee of the U.S. House of Representatives Resources Committee, in support of the "United States-Mexico Transboundary Aquifer Assessment Act" (S 214 and HR 469) which would authorize a study of shared aquifers with Mexico.

The wide interest and participation that our annual

conference attracts testifies to its value as a forum to discuss water resource issues crucial to our state's economic vitality. (See page 9 for some highlights of this year's well-attended WRRC conference, "Providing Water to Arizona's Growing Population: How Will We Meet the Obligation?") On a smaller scale, our brown bag seminar series continues to provide opportunities for information sharing and discussion, bringing together university personnel and community members.

We engaged in some program soul searching and came up with a streamlined mission statement that is prominently displayed in the sidebar.

Those visiting our Sol Resnik conference room, whether for a brown bag session, a community or university meeting or a class, will note recent improvements, thanks to the generosity of Salt River Project and Central Arizona Project.

For more information about WRRC projects and programs check www.cals.arizona.edu/azwater/ (By the way, this too is to become better: our web site is to be redesigned for easier navigation and update.) A colorful new WRRC brochure has been developed and is available for distribution.

We are constantly striving to improve, and we thank you for your support and continued involvement in WRRC-related programs and projects. 🏡



WRRC Mission Statement

The University of Arizona's Water Resources Research Center promotes understanding of critical state and regional water management and policy issues through research, community outreach and public education.

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has the greatest potential payoff of all possible geothermal uses in the state. Unbeknownst to them, some farmers may be situated above what could be a very profitable geothermal natural resource.

State Regulations?

If geothermal applications prove to be both technically and economically feasible, developers of such projects will be anxious to get started. Step one will be to obtain the required drilling and land and water use permits. According to energy consultant Amanda Ormond, principal of Ormond Group, the issue is not a lack of relevant rules and regulations. The issue is that state officials have not had much experience processing geothermal applications; as a result, they have been tentative and uncertain about the permitting process.

To shed some light on geothermal issues, including a clarification of the regulatory path, Ormond helped organize an Arizona geothermal direct use conference May 18 in Tempe. Titled "Using the Earth's Energy," the conference assisted those wanting to get geothermal projects off the ground — or rather in the ground. A question discussed at the meeting was: Where does a thermal energy project developer begin the permitting process? The conference demonstrated some uncertainty about the permitting path.

A representative from the Arizona Oil and Gas Commission said a geothermal developer might start by checking with the state water agency. The Arizona Department of Water Resources representative replied that the agency would not likely have jurisdiction over many of the activities. If water is brought up for its heat, then

returned unaltered and untransported back into the ground, which is the case with most geothermal projects, no special water regulations would apply, except for a drilling permit.

Lori Casen from ADWR described a wait-and-see attitude: "As this becomes a bigger issue more and more things will be brought to our attention; you never know what might come out of it that will cause us to say wait a minute we need to track that."

Ormond says, "What I think it pointed out was that there are not super clear lines of where a geothermal project will fall. ...I think the two speakers realized that it is a gray area because it has not been tested very often."

Ormond seeks clarification so that a geothermal project developer will have settled sense of expectations when planning and implementing a project. She says, "We are trying to be proactive (and) go to those agencies that may be affected and say, 'Here is a new use of water that is on the books but not much has been done in practice.' We want to say this may come your way, so that they can get up to speed."

A DOE grant has enabled Northern Arizona University to collaborate with Arizona State University, New Mexico State University, Arizona Public Service Co. and the Ormond Group to inform Arizonans about geothermal possibilities. For information about geothermal resources in Arizona check the web site: www.geothermal.nau.edu Information about technical assistance is available from Amanda Ormond at 480-491-3305 or asormond@msn.com 🏠



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